EVALUATION OF DISASTER RESILIENCE ON WASTE MANAGEMENT IN DEVELOPING COUNTRIES

マリョノ

https://doi.org/10.15017/1500708

出版情報：九州大学, 2014, 博士（工学）, 課程博士
バージョン：

EVALUATION OF DISASTER RESILIENCE ON WASTE MANAGEMENT IN DEVELOPING COUNTRIES

MARYONO

EVALUATION OF DISASTER RESILIENCE ON WASTE MANAGEMENT IN DEVELOPING COUNTRIES

A Thesis Submitted

In Partial Fulfillment of the Requirements

For the Degree of

Doctor of Engineering

By

MARYONO

九州大学

to the

DEPARTMENT OF URBAN AND ENVIRONMENTAL ENGINEERING

GRADUATE SCHOOL OF ENGINEERING

KYUSHU UNIVERSITY

Fukuoka, Japan

FEBRUARY, 2015

DEPARTMENT OF URBAN AND ENVIRONMENTAL ENGINEERING

GRADUATE SCHOOL OF ENGINEERING

KYUSHU UNIVERSITY

Fukuoka, Japan

CERTIFICATE

The undersigned hereby certify that they have read and recommended to the Graduate School of Engineering for the acceptance of this thesis entitled, ''***Evaluation of Disaster Resilience on Waste Management in Developing Countries***'' by **Maryono** in partial fulfillment of the requirements for the degree of **Doctor of Engineering**.

Dated: February, 2015

Thesis Supervisor:

....

Prof. Takayuki Shimaoka, Dr. Eng.

Examining Committee:

....

Prof. Kenichi Tsukahara, Dr. Eng.

....

Prof. Hiroki Tanikawa, Dr. Eng.

....

Associate Prof. Hirofumi Nakayama, Dr. Eng.

TABLE OF CONTENTS

Abstract xiv

CHAPTER 1

Introduction 1

1.1 Introduction for evaluation disaster waste management resilience in developing countries 1

1.2 Review existing research 3

1.3 Objective, scope and dissertation organization 6

1.3.1 Objective and scope of study 6

1.3.2 Organization of dissertation 9

CHAPTER 2

Evaluation of Disaster Waste Management in Indonesia and Thailand 10

2.1 Introduction 10

2.2 Evaluation of disaster waste management in Indonesia 12

2.2.1 Methodology for evaluation of disaster waste management in Indonesia 12

2.2.2 Planning for treatment and implementation 15

2.2.3 Planning for management 20

2.2.4 Result of evaluation 24

2.2.5 Model proposed for estimating disaster waste generation in Indonesia 29

2.3 Evaluation of disaster waste management in Thailand after flood 2011 34

2.3.1 Thailand flood 2011 time line and damages 34

2.3.2 Normal disposal of waste in Bangkok 35

2.3.3 Bangkok waste disposal during flooding 38

2.3.4 Problems in flood waste treatment 43

2.4 Discussion 45
2.4.1 Discussion of evaluation of disaster waste management in Indonesia 1990-2012 45
2.4.2 Discussion of evaluation of disaster waste management in Thailand after flood 2011 48
2.5 Conclusion and proposal for fostering disaster waste management 50
2.5.1 Conclusion and proposal for fostering disaster waste management in Indonesia 50
2.5.2 Conclusion and proposal for fostering disaster waste management in Thailand (flood disaster waste) 54

CHAPTER 3

Designing Indicator for Evaluation of Disaster Resilience on Waste Management in Developing Countries 57

3.1 Introduction 57
3.2 Methodology 59
3.2.1 Development model for measuring disaster resilience on waste management 59
3.2.2 Integrated indicator assessment: criteria and description 60
3.2.3 Data collection 66
3.2.4 Method for assessment and measurement 68
3.3 Measuring disaster resilience on waste management in Indonesia 69
3.3.1 Capacity of municipal solid waste management in Indonesia regions and selected cities 69
3.3.2 Preparedness of disaster waste management in Indonesian regions and selected cities 78
3.3.3 Socio demography and biophysical vulnerability in Indonesian regions and selected cities 80
3.3.4 Indicators assessment in Indonesia regions and selected cities 85
3.3.5 Result of measurement of disaster resilience index on waste management 93
3.4 Discussion 97
3.5 Conclusion and proposal for improving disaster waste management preparedness 98

CHAPTER 4

Identification of Factors Affecting Stakeholders` Intentions
to Promote Preparedness in Disaster Waste Management:
A Structural Equation Modeling Approach ... 100

4.1 Introduction ... 100
4.2 Development model of factors affects disaster waste management preparedness ... 101
4.2.1 Identification factor ... 101
4.2.2 Structural equation model ... 104
4.2.3 Stakeholders' intentions and initial model of factors ... 106
4.2.4 First order factor model ... 109
4.2.5 Higher order factor model ... 111
4.3 Testing factor model: measurement causal correlation between factors ... 113
4.3.1 Field survey and sample characteristics ... 113
4.3.2 Evaluation of causal correlation between factors ... 114
4.4 Discussion ... 119
4.4.1 Identification factor affecting disaster waste management by using SEM ... 119
4.4.2 Implication to planning for waste management ... 120
4.5 Conclusion and proposal for fostering disaster waste management preparedness ... 121

CHAPTER 5

Summary and Conclusions ... 124

Reference ... 132

List of figures ... viii

List of tables ... xi

Appendices

A. Questionnaire survey for assessing disaster waste management preparedness in selected cities of Indonesia ... 147

B. Questionnaire for identification factor affect stakeholder intention to promote disaster waste management preperadness 149

Acknowledgements 151

Biography 153

LIST OF FIGURES

CHAPTER 1

Figure 1.1 Traditional clean-up and recycling of disaster waste after fire in Jakarta`s slum area fires 1

Figure 1.2 Framework and activities of post disaster debris reverse logistic system 4

Figure 1.3 Research framework: collecting data and model development 7

Figure 1.4 Organization of dissertation 9

CHAPTER 2

Figure 2.1 Target of evaluation disaster waste management events in Indonesia 1990-2012 12

Figure 2.2 Method for evaluation of disaster waste management in Indonesia 1990-2012 14

Figure 2.3 Method for measurement and assessment of each disaster waste management targeted in Indonesia 1990-2012 15

Figure 2.4 Disaster waste management for post Indian earthquake –tsunami 2004 18

Figure 2.5 Land clearance from tsunami waste, support of municipal solid waste collection, and building demolition of Indian tsunami waste in Banda Aceh 18

Figure 2.6 Cash for work, tsunami wood recycle, capacity building for facility maintenance, updating Gampong landfill capacity 19

Figure 2.7 Disaster waste management for Jakarta flood 2007 19

Figure 2.8 Basic legal framework of disaster waste management in Indonesia 20

Figure 2.9 Institutional involvement for disaster waste management in Indonesia 22
Figure 2.10 Performance achievement of selected previous disaster waste management in Indonesia 1990-2012 28
Figure 2.11 Procedure of estimation of disaster waste generation in Indonesia 32
Figure 2.12 Map of maximum flood extent (the world bank, 2012) 34
Figure 2.13 Location of waste transfer stations and landfill sites for municipal waste treatment in Bangkok 37
Figure 2.14 Disaster waste composition analysis after Thailand flood 2011 41
Figure 2.15 Disaster waste in industrial area after Thailand flood 2011 42
Figure 2.16 Submerged seven industrial parks in the north of Bangkok 43
Figure 2.17 Disaster waste after flood discharged to the street, and field incineration 45

CHAPTER 3

Figure 3.1 Clean up municipal waste from river 57
Figure 3.2 Procedure to determined disaster resilience in on waste management 59
Figure 3.3 Method for data collection: measuring disaster resilience on waste management in Indonesian regions and 9 selected cities 67
Figure 3.4 Method for data utilization: measurement and assessment index 68
Figure 3.5 Indonesian population distribution, and waste generation statistic 69
Figure 3.6 Indonesian waste composition estimation in year 2008 69
Figure 3.7 Population, area and waste generation in some Indonesia cities 70
Figure 3.8 Vehicle type of solid waste transport in Indonesia 72
Figure 3.9 Proportion and recycling rate of solid waste management in Indonesia 73
Figure 3.10 Lifespan of final disposal system in Indonesia 74
Figure 3.11 Degree of poverty in Indonesia (in percentage population year 2010) 80
Figure 3.12 Socio demography vulnerability condition in Indonesian regions 1990-2012 81

Figure 3.13 Map of disaster events in Indonesia 1979-2009 82
Figure 3.14 Socio demography vulnerability condition in each selected cities of Indonesia 1990-2012 84
Figure 3.15 Disaster resilience index on waste management in Indonesian regions 93
Figure 3.16 Disaster resilience index on waste management in selected cities of Indonesia 95

CHAPTER 4

Figure 4.1 A structural equation model demarcated into measurement model and structural component 105
Figure 4.2 A diagram for the theory of plan behavior (TPB) hybrid with mathematic symbol 107
Figure 4.3 Full hierarchy structural equation model of DWM-P 108
Figure 4.4 Structural equation model of DWM-P 115

LIST OF TABLES

CHAPTER 1

Table 1.1 Disaster waste generation from several previous disasters 1990-2012 2

CHAPTER 2

Table 2.1 Institution target for data collection of disaster management Indonesia 1990-2012 13

Table 2.2 Estimation of Banda Aceh`s earthquake tsunami waste generation 2004 16

Table 2.3 UNEP Estimation of construction and demolition waste for Indonesia 16

Table 2.4 Performance achievement of planning for treatment and implementation of disaster waste management in Indonesia 1990-2006 24

Table 2.5 Performance achievement of planning for treatment and implementation on selected disaster waste management events in Indonesia 2007-2012 25

Table 2.6 Performance achievement of planning for disaster waste management in Indonesia 1990-2006 26

Table 2.7 Performance achievement of planning for disaster waste management in Indonesia 2007-2012 27

Table 2.8 Estimation disaster waste of in Indonesian major disaster 1990-2012 33

Table 2.9 Normal municipal waste properties in Bangkok (physical composition) 37

Table 2.10 Normal municipal waste properties in Bangkok (density, heat value) 38

Table 2.11 Waste analysis finding at locations thought to be flood waste collection sites 40

Table 2.12 Waste composition compared under normal and flooding conditions 41

CHAPTER 3

Table 3.1 Summary assessment of indicator and criteria of capacity 62

Table 3.2 Summary assessment of indicator and criteria of preparedness 64

Table 3.3 Summary assessment of indicator and criteria of vulnerability 66

Table 3.4 Assessment of capacity`s indicators in each selected cities of Indonesia 76

Table 3.5 Integrated indicators value of capacity in Indonesian regions 76

Table 3.6 Integrated indicator value of capacity in each selected cities of Indonesia 77

Table 3.7 Assessment of preparedness`s indicators in each selected cities of Indonesia 78

Table 3.8 Integrated indicator value of preparedness of disaster waste management in Indonesian regions 79

Table 3.9 Integrated indicator value of preparedness of disaster waste management in each selected cities of Indonesia 79

Table 3.10 Socio demography vulnerability assessment in selected cities of Indonesia 81

Table 3.11 Biophysical vulnerability in Indonesia regions for year 1990-2012 83

Table 3.12 Biophysical vulnerability in selected cities of Indonesia 84

Table 3.13 Result of data assessment of capacity condition in each Indonesian regions 85

Table 3.14 Result of data assessment of capacity condition in each selected cities of Indonesia 86

Table 3.15 Result of data assessment of preparedness condition in each Indonesian region 87

Table 3.16 Result of data assessment of preparedness condition in each selected cities of Indonesia 88

Table 3.17 Result of data assessment of preparedness condition in each selected cities of Indonesia (continued table 3.16) 89

Table 3.18 Result of data assessment of socio demography vulnerability in each Indonesian region 90

Table 3.19 Result of data assessment of biophysical vulnerability in each Indonesian region 91

Table 3.20 Result of data assessment of socio demography and biophysical vulnerability in each selected cities of Indonesia 92
Table 3.21 Measurement integrate index on disaster waste management (Indonesian regions) 94
Table 3.22 Measurement integrate index on disaster waste management (selected cities in Indonesia) 96

CHAPTER 4

Table 4.1 Effect expectation from Indian tsunami 2004 waste management program 104
Table 4.2 Statistical criteria and results of evaluating model 115
Table 4.3 Correlation coefficients of the model for each stakeholder group 117
Table 4.4 Causal correlation coefficient of higher factor for each group stakeholder 118

Abstract

Disaster events such as earthquakes, tsunamis, floods, volcano eruptions generate tremendous amount of waste and debris causing considerable waste removal and disposal challenges for local public officials. Proper disaster waste management would reduce the economic losses, and help quick emergency response and recovery. To achieve resilience on disaster waste management, it requires acceleration of facility and personnel, organization and communication including legal frameworks. However, many obstacles are found because the waste generation and its characteristics are difficult to predict. Moreover, for developing countries, because of the poor municipal waste management system and lack of management plan, it is very difficult for stakeholders to implement proper waste treatment in disaster events. Researches that describe achievement of proper disaster waste management are not mature. The aim of this research is to evaluate resilience on disaster waste management in developing countries and to propose a strategy for enhancing the preparedness for stakeholders. This study investigated three main objectives; first is pattern of disaster waste management, second is degree of resilience on waste management and third is factor that affect stakeholders' intention to promote preparedness in disaster waste management.

In chapter 1, the background of evaluation for disaster waste management in developing countries, objective of research, theoretical framework for model development, model scoping were presented.

In chapter 2, the generation and disposal of disaster waste were examined using data obtained through field surveys and interviews with involved organizations. Indonesia and Thailand were chosen as case studies. Formula to estimate disaster waste generation by the type of building is proposed, then demolition waste generation caused by major disasters in Indonesia 1990-2012 were estimated such as Flores Earthquake-tsunami in 1992 , Yogyakarta Earthquake in 2006 and West Sumatra Earthquake in 2009. Then the problems with disaster waste treatment were revealed. These included a shortage of waste collection capacity under emergency conditions, a lack of appropriately designed temporary waste storage at waste transfer stations, a lack of recycling systems, and the possibility that mixed disposal of municipal and industrial waste introduced contamination. To improve flood waste treatment, proposals were provided for the pre-disaster, disaster and post-disaster stages.

In chapter 3, disaster resilience index on waste management (DWRMi) was proposed. It is an integrated index using capacity of facilities, preparedness and vulnerability considering the social and economic conditions, disaster experiences in each region and cities in Indonesia. Results indicated that most of the cities and regions were classified at the level middle or low resilience category. Among regions, the highest index was Java region (index estimated 1.58). The lowest was Sumatra region (index estimated 0.83). Among cities, Banda Aceh was the highest (index estimated 2.78) and Medan was the lowest (index estimated 0.48).

In chapter 4, a model of structural factors that affect stakeholder intention`s to promote disaster waste management and preparedness were presented using structural equation modeling approach. With exploring in tsunami waste management in Banda Aceh at which run for year 2005-2012, the research identified critical factor for promote preparedness and then examine the structure of the factor model. The research defined that factor of awareness of the difficulty running a 3R (reduce, reuse, and recycle) was the most important factor to promote preparedness (correlation coefficient of 0.89). Other factors that have a significant effect of preparedness are awareness of cooperation with other organizations (correlation coefficient 0.83) and concern about previous experience (correlation coefficient 0.78). The result confirmed that preparing plan for intermediate treatment such as ability to run 3R and than manage the capacity of landfill site is the key point to achieve resilience in disaster waste management.

In chapter 5, summary and conclusion of the study concerning the evaluation of disaster resilience on waste management in developing countries were presented.

CHAPTER 1

Introduction

1.1 Introduction for evaluation of disaster waste management resilience in developing countries

Disaster waste management is a process to handling waste generated by disaster (UN-OCHA, 2011). Disaster is likely to increase in recent decades, and more than 60% occur in Asia (EM-DAT, 2014). The Great East Japan earthquake-tsunami 2011 is the biggest of calamity with economic losses estimation $ 217 billion (EM-DAT, 2014). Around 21,610 humans are died by natural disaster In 2013, with the annual average around 106,654 people death for year 2003-2012 and than 96.5 million people were suffered from the disasters (Guha-Sapir D, et all, 2014). Proper of disaster waste management would accelerate safety life, emergency response and disaster recovery. Proper of disaster waste management also could reduce the economic losses. An accuracy of quick disaster waste such as clean up to open the access blocks would reduce the victims.

Resilience in disaster waste management could be achieved with five stages of activities in disaster handling such as mitigation, preparedness, emergency response, early recovery, recovery (UNEP-OCHA, 2011, Carson et al,2012). However, many obstacles always found because of the waste generation, composition and characteristic of waste mostly un predicted. In developing countries, poor condition of waste management such waste treatment facility, economics, organizational, legal frameworks, funding and social considerations (Brown, 2011b) reduced the acceleration of required equipment. Moreover, the existence of informal sector such as waste picker and scavenger in recycling process influence to the coordination (Wilson, et al 2007, Sasaki and Araki, 2012)

Figure 1.1 Traditional clean-up and recycling of disaster waste after fire in Jakarta`s slum area fires

Table 1.1 Disaster waste generation from several previous disasters (1990-2012)

Disaster and conflict	Year	Waste quantities	References
Hurricane Andrew, US	1992	43 million cubic yard	Luther (2008)
Conflict in Mostar, Bosnia	1995	Estimation 200,000 tonnes	Petersen (2004)
Great Hanshin-Awaji Earthquake, Kobe, Japan	1995	18,5 million tonnes	Kuramoto (1995)
Marmara Earthquake, Turkey	1999	13 million tonnes	Baycan (2004)
Cedar and Paradise Fires, US	2003	estimated 127,000 tonnes	Country of San Diego (2005)
Indian Ocean Tsunami	2004	10 million cubic metres (Indonesia)	Brown (2011)
Hurricane Katrina, US	2005	114 million cubic yard	Luther (2008)
Sichuan earthquake , China	2008	380 million tonnes	Xiao, et al (2012)
Victorian Bushfires, Australia	2009	Estimation 393,000 tonnes	Brown (2010)
The Great East Japan Earthquake-tsunami	2011	Estimation 23 million tonnes	UNEP (2012)
The Thailand Flood	2011	Estimated 3,25 Million	(Piyapanpong, 2013)

Disaster generates waste automatically and it is unusual. Increasing of disaster waste recycle usually found new problems with unpredictable solutions such as facility and resources requirement because of many tonnes of disaster waste (Nasli, 2011). For example in Great Japan earthquake disaster waste management, needs a new strategy for sharing financial and other required resource to install new incinerator and final disposal facility (Asari et al 2013). For developing countries, mostly they use landfill method in their final disposal system. However mostly the lifespan of the landfill have been passed. Thus handling disaster waste conducted with dispose it in vacant land or burn it in street. Figure 1.1 shown the traditional of recycling disaster waste in East Jakarta slum are fire 2012. While table 1.1 describes several disaster waste generation cause by disaster in 1990-2012.

Research in disaster waste management in developing countries is not mature, and information toward issues in disaster waste management in developing countries is not yet clearly constructed (Milke, 2011). Evaluation toward disaster waste management in developing countries is very needed not only for identify the pattern of the issues in management, but also for measuring stakeholder understanding of disaster waste management. It is one of the critical points to ensure stakeholder in preparing program to minimize the impact caused by disaster. Preparation (pre planning for post disaster waste management) for disaster waste management is one of the critical points to reduce risk according to the Hyogo action target (Tajima et, al, 2014; ISDR, 2005). Moreover, evaluation toward disaster waste management in developing countries is needed to measure disaster resilience on waste management, since disaster waste management is one of the basic lifelines (Manyena, 2006, Brawn et al, 2010).

This study merges two theoretical frameworks, disaster resilience and disaster waste management. This study defines disaster resilience on waste management as a process to achieve ideal performance of disaster waste management (Manyena, 2006, Brawn, 2011b). There are several stages and actions on the disaster waste management such as mitigation, preparedness, emergency respond and recovery (Carlson et, al, 2012) and there are several aspect that influence of the degree of resilience, such as engineering, economic and social consideration including community, organizational, psychology and legal framework (Brawn, 2011b, Irajifar, et, al, 2013).

1.2 Review of existing research

Started by Holling (1973), concerning measurement the stability of ecology, and Holling (1996) concerning comparison of the engineering resilience and ecological resilience, the terminology of resilience become familiar used, especially to assess the capability and capacity of system to resolve disturbances. In disaster management, resilience terminology becomes more widely explored after the declaration of Hyogo action in 2005 (Irajifar, et al, 2013). Resilience associated with disaster could be distinguished as two term (Manyena, 2006; Gilbert, 2010; Calrson, et al, 2012; Irajifar, et al, 2013); the first one is outcome oriented that assessing the robustness from the disturbance. The second one is the process oriented that assessing capability of system to absorb speed, learning from previous event and then used to increase the performance. It is associates with sustainability of environment to support development due to disaster or conflict. In the context of infrastructure system or infrastructure lifeline, resilience could simplified as the way to measure the robustness of system associated with delay (Bruneau et al, 2003, Chang and Shinozuka, 2004)

Disaster resilience on waste management depend on the acceleration of system to respond-clean up, reuse, recycle, then discharge rest material of disaster waste environmentally. Hu and Sheu (2013) introduce a reverse logistic system that shown stages of activity to collect, reproduced and supply material resulted to recovery, and disposed rest material waste environmentally. Figure 1.2 depicts the reverse logistic system for comprehensive of post-disaster waste management. Asari et al (2013) explore several possibility treatment and operation of disaster waste management including cooperation with outside area affected, when the huge disaster waste generated. The ability to run system to solve the unpredictable issues in technical, social and psychology is the key point to achieve disaster resilience on waste management. Furthermore, resilience could be achieved by proposed planning such as in mitigation, preparedness, early response and recovery (FEMA, 2007; UN-OACHA, 2011,).

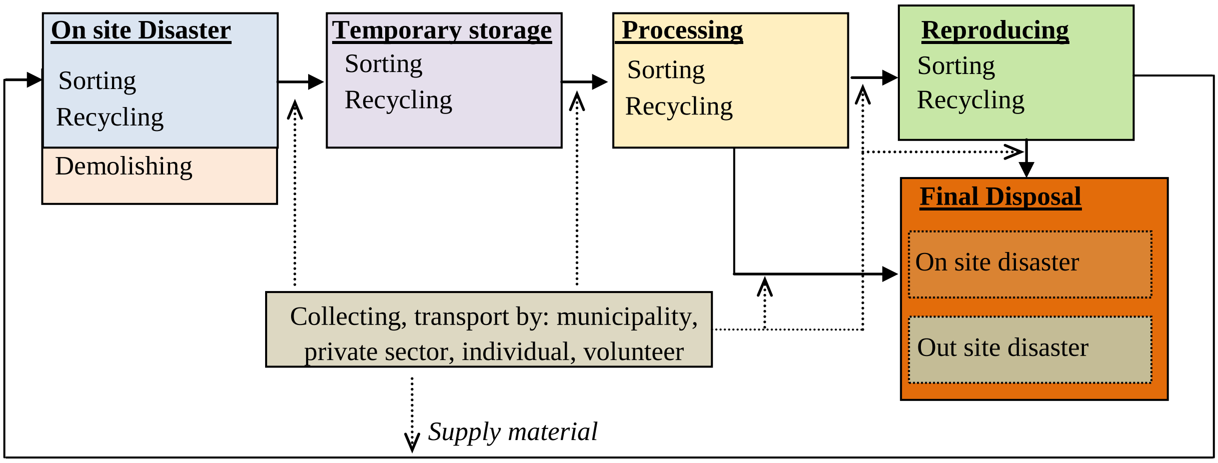


Figure 1.2. Framework and activities of post –disaster debris reverse logistic system , modified from Asari,et al, (2013); Hua and Sheu (2013)

As a cycle, Pattern of planning for disaster waste management and stakeholder understanding for disaster waste management in developing countries could be determined according to the input-output-outcome of previous events (McLaughlin 1999; Tajima et al, 2014). Because of many aspect involved, indicator selection on the evaluation is one of the key point to building resilience (Cutter, et al 2010). Indicators in evaluation should cover the strategic problem in disaster waste management. Indicators of evaluation that selected, in turn, would influence the priority of program for fostering resilience (McLaughlin 1999; Cutter, et al 2010). Composite indicator at which merge technical, economic, social, is one alternative for evaluate disaster waste management in developing countries because all of aspect of waste management in developing countries mostly are poor (Cutter, et al 2010, Zurbrugg, 2002).

Disaster waste estimation is basic component in disaster waste management. Stakeholders in developing countries are not introducing yet approach to assessing disaster waste generation. This study combines several approach of disaster waste estimation from develop countries such as Hazus (1995), Shimaoka (1995); FEMA (2010); Chen, et al, (2007); CEMA (2010) and Hirayama et al (2010); Xiao et al (2012) and modify it to measure earthquake and tsunami waste from previous disaster. This study also evaluates communication and information system associated with statistical data of disaster waste generation and composition for example, what stakeholder in developing countries have been prepare to utilize GIS for disaster waste management (bhargava et al, 2007; Gao et al, 2011; Abasi et al, 2012,). Furthermore, this study evaluates the performance disaster waste handling

Planning for post disaster waste management is other indicator to ensure resilience on disaster waste management (Tajima et al, 2014, UNOCHA, 2011). Planning for disaster waste management is consists of mitigation, preparedness, early emergency response, emergency response, and recovery (UNOCHA, 2011; Brown, 2011b). Equipment, tool, and duration of each stages are varied depending on level disaster, volume and composition of disaster waste (UNOCHA, 2011; Brown, 2011b). Stakeholder capacity to determine equipment, duration of each stages and identification of possibility negative impact such as odor, public health, are indicators of resilience in disaster waste management (UNOCHA, 2011, Hu and Sheu, 2013). Refers to figure 1.2, there are three major components of planning for disaster waste handling. First planning is for collection and transport, second planning is for intermediate treatment and third planning is for proper final disposal. While associated with aspect, planning for disaster waste management covers legal framework, institutional framework and budgeting.

Collection and transport is one of the main activities in disaster waste management. Availability, readiness of equipment and vehicle are the key point to achieve resilience. Usually, stakeholder in developing countries difficult to propose planning for estimate ideal equipment for collection and transport of disaster waste, eventhough only for emergency response such as in Haiti earthquake 2010 (Yates and Paguette, 2011; lee et al, 2010). Beside readiness of equipment, others aspect that influence the performance is organizational and institutional coordination (Chang, 2013). In developing countries, transfer from normal condition into the disaster event from each responsible organization mostly not clearly stated both for organization and legal framework (Duit et al, 2010; Chang, 2013). Moreover, usually no clear guideline, administrative procedure to conduct additional equipment such as contract with private company. In this case, normal procurement will delay for service. (Schapper, et al, 2006; Kovacs and Spens, 2007).

Intermediate treatment (including temporary site selection for reduce, recycle, and reproduce disaster waste) is other significant indicator to evaluate degree of resilience in disaster waste management. It is the main goal of planning for disaster waste management (Fater and Rake, 2012; Asari et al, 2013; Hu and Sheu, 2013). However, awareness and willingness to increase recycling of disaster waste handling in developing countries is very complex. First, it is associated with public awareness (Paton, et al, 2001; Srinivas et al, 2008). Second it is associated with governance of disaster management (Chang, 201; Duit et al, 2010), and third it is associated with responsible organization capacity (Karunasena, 2009, Lauritzen, 1998). Recycling activity provides economic opportunity for the vulnerable people (Cutter, 2003; Wilson, 2009).

System and method for final disposal was the other significant indicator to evaluate degree of resilience in disaster waste management. However, it is very difficult to set indicator for performance of final disposal since most of final disposal method in developing countries is open dumping (ngoc and Schnitzer, 2009). Although the condition of landfill is good and clear, performance of final disposal could be determined by measure lifespan of landfill (Teixiera and Neves, 2009). Because of difficulties to set disposal, final disposal of disaster waste is very sensitive for developing countries. For example, for Indian tsunami waste, there a lot of waste that disposed in farm land (Srinivas, 2008; Zakiya, 2012). Refer to the construction of Blang Bintang final disposal at which at least three year time need (UNEP, 2008), and Great East Japan at which need to coordination with outside local government (Asari et al, 2013), design final disposal of disaster waste is very complicated. It is associated with others aspect in planning such as legal framework, organization and financial capacity.

1.3 Objective, scope and dissertation organization

1.3.1 Objective and scope of study

Evaluation of disaster waste management could be designed related to the activity (disaster waste handling) such as evaluation of collection, sorting, transport, temporary storage selection, intermediate treatment and plans for the final disposal of waste disaster. Evaluation of disaster waste management also could be designed related to the stages of management such as evaluation of mitigation, preparedness, early emergency response, emergency response, and recovery. Three main objectives of the study are describes as the following below:

- Identification pattern of disaster waste management in developing countries
- Assess and measure resilience on disaster waste management in developing countries
- Identification factor that affect stakeholders' intention to promote preparedness in disaster waste management.

Pattern of disaster waste management is identified by exploring disaster waste management in Indonesia Major disaster for year 1990-2012. Disaster waste management for post Thailand flood disaster in 2011 also explored to assess recent patterns of disaster waste caused by flood. This study evaluates disaster waste management related to the activity that has been done such as collection and transport, intermediate treatment and final disposal method in developing countries. This study also evaluates pattern of planning that consist of legal framework, institutional, and budgeting have been design to handling disaster waste. In the assessment and measurement of resilience, this study concentrates in the preparedness stages. Preparedness stages are measured by investigation of several aspects such as technical, economic and social. Preparedness in technical is investigated from the increasing of coverage area, increasing of recycling rate, and final disposal lifespan. In the aspect of economic and financial, preparedness is investigated from the waste fee or retribution and increasing operational cost. Preparedness in social consideration is investigated from the evolution of organization and coordination for disaster management Identification of stakeholder intention to promote preparedness is conducted by exploring tsunami waste management in Banda Aceh 2005. Factor that investigated affect disaster waste management preparedness such as concern about previous experience; stakeholder awareness of the difficulty running 3R and proper final disposal; awareness of cooperation with other organization, difficulty running 3R and proper final disposal, concern about disaster waste knowledge

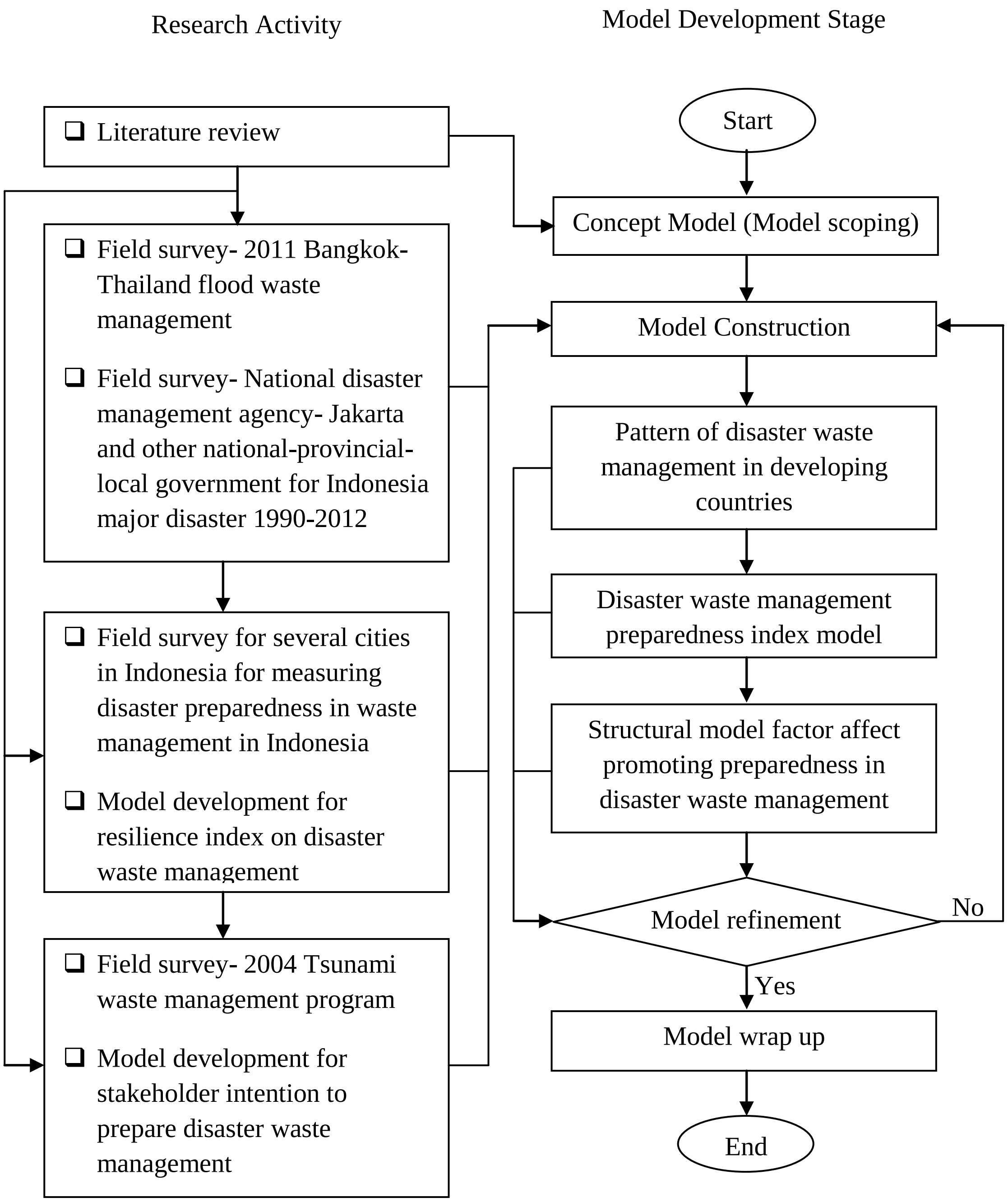


Figure 1.3 Research framework: collecting data and model development

Field survey was conducted in Bangkok metropolitan area and surrounding city to collecting data associated with disaster waste management after Thailand flood 2011. Interview with stakeholder in Bangkok metropolitan area and other stakeholder associated with disaster waste management, especially with one of private company at which responsible to the one transfer station (on nut) and one disposal site also was conducted. Investigation to landfill site, and roughly investigation for disaster waste composition after flood is conducted in three selected points surrounding Bangkok. To compare with normal condition, especially to measure the degree of preparedness, data of waste management in normal condition also selected for municipal waste management and industrial waste management.

Field survey in Indonesia was conducted to collect several data associated with identification of pattern of disaster waste management, evaluate performance of disaster waste management preparedness and identification of stakeholder intention to promoter preparedness. Serial interview was conducted at the National Disaster Agency in Jakarta to identified Indian tsunami waste management program. The interview also was held with other national agencies and institution such as Ministry of Public Work, Ministry of Environmental and Ministry of National Planning (Bappenas), Ministry of Interior and Ministry of National Welfare. In this stage of collecting data, macro policy associated with disaster and disaster waste management, pattern of Indonesian disaster waste management and pattern of Thailand waste management were set as final goal of collection data to answer the first objective of study

Collecting data is continued by interview with stakeholder in selected cities of Indonesia. In this stage, the goal of data collection is to answer and measure degree of disaster resilience on waste management. Disaster resilience on waste management is measured at region level that consist of Sumatra, Java, Bali Nusatenggara, Kalimantan, Sulawesi, Maluku and Papua. Disaster resilience on waste management also is measured in several selected cities such as Banda Aceh, Medan, Padang, North Jakarta, Yogyakarta, Surakarta, Banjarmasin, Maumere/Sika District. Data collection and interview are conducted with relevant institution such as responsible organization in municipal waste management, disaster waste management and disaster management.

Final field survey is data collection to construct model associated with factor that affect stakeholder intention to promote preparedness in disaster waste management. Banda Aceh cities is selected as case study, because Banda Aceh has a comprehensive and experience for disaster waste management. Collection data is conducted by interview relevant agencies such as department of cleansing, Banda Aceh secretariat, department of environment management, department of public work, Banda Aceh agency for disaster management, and Indonesia army force sub-district Banda Aceh. Initial factor model is proposed based on the interviewed result from key persons in the institution. Next step, questionnaire is administered to the relevant stakeholder to measure variable response of factor that affect intention to promote preparedness in disaster waste management

1.3.2 Organization of dissertation

Organization of dissertation is described in Figure 1.3 below.

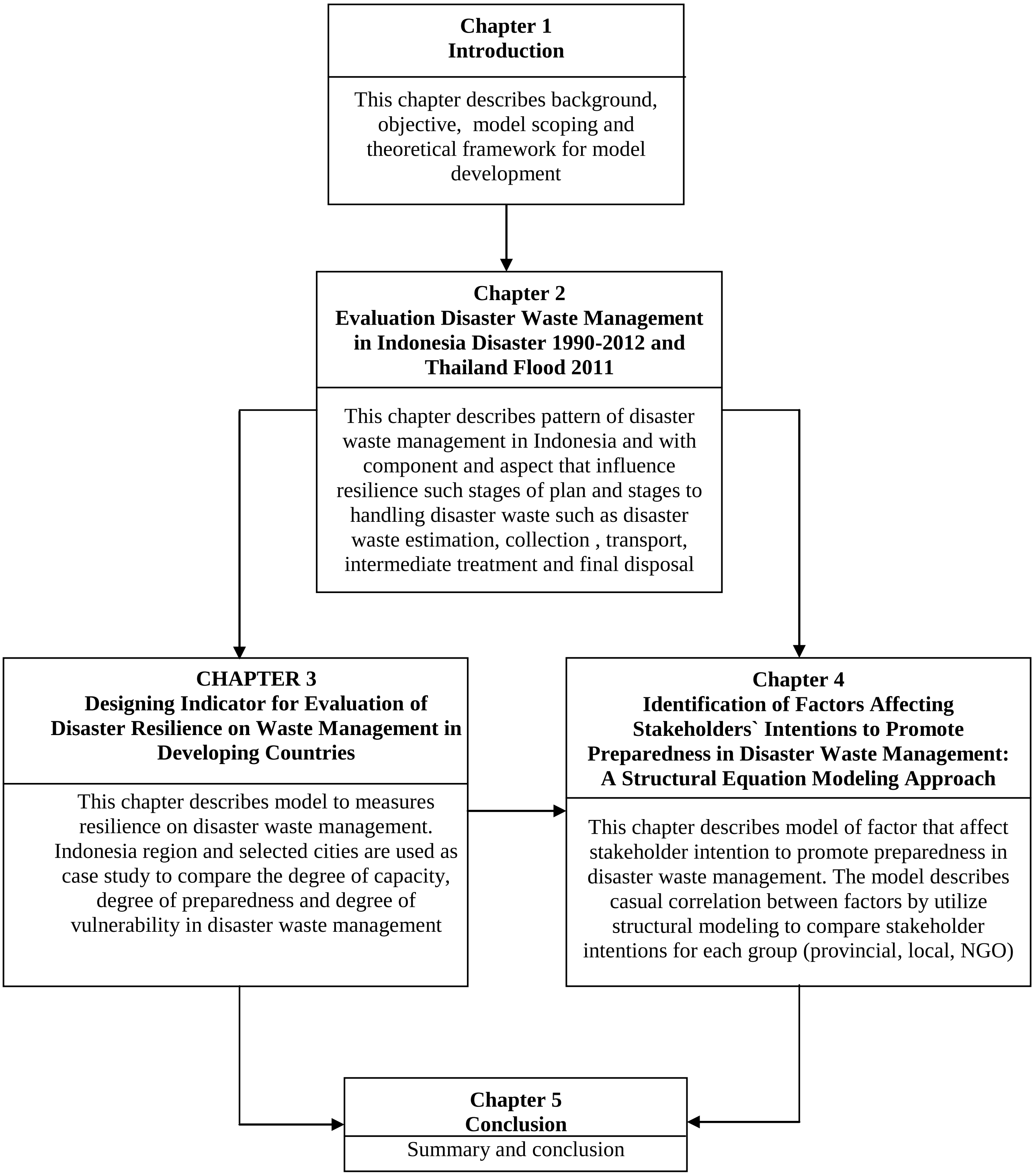


Figure 1.4. Organization of dissertation

CHAPTER 2

Evaluation of Disaster Waste Management in Indonesia and Thailand

2.1 Introduction

Disaster events such as earthquakes, tsunamis, floods, volcano eruptions generate tremendous amount of waste and debris causing considerable waste removal and disposal challenges for local public officials. However information about performance achievement of disaster waste plan and implementation were very limited. There were also very limited about evaluation of the development on disaster waste management system learning from past experience of disaster including evaluation of the accuracy of estimation in disaster waste generation. The objective of this study was to evaluate of the development on disaster waste management system learning from past experience of the disasters including evaluation of the accuracy of estimation in disaster waste generation. The research measured performance achievement of plan for disaster waste treatment and implementation and plan for disaster waste management.

Disaster waste management is process to managed waste generated by actual disaster or later during (UN-OCHA, 2011). Comprehensive process of disaster waste management consist several stages such as emergency respond, early recovery, recovery, while the main operation are collection-transfer and transport, intermediate treatment, including selection of temporary storage and final disposal (US EPA, 2008, UNOCHA, 2011). Disaster waste management pattern is varied depending on the characteristic of waste and disaster (Asari et al, 2013, UNOCHA, 2011). The first important aspect on disaster waste management was a procedure and formulation of the estimation of disaster waste generation (Asari, et all 2013, Hiryama, et al., 2010, Shimaoka, 1995). There are some parameter that use to assessing disaster waste generation such as type of disaster, location, spatial structure associated with the arrangement of community activity, access, arrangement of building, office and public facility, commercial land use (USACE, 2005, CEMA, 2010, Hirayama et all, 2010).

There are many option for disaster waste management process from simple method into complex method, however, a minimum strategy of treatment should ensure that there is no impact on disaster waste (Asari et al, 2013). Disaster waste management planning such as guidelines utilized a step by step associated exploring technical capability including equipment of day to day disaster management (Brawn, 2011b). Generally the guidelines also demonstrated procedure of management such as arrange the organization responsible, communication procedure and flow, arrangement of contract with private company including MOU, providing and recording data and statistical of disaster waste (Brown, 2011b). In developing countries, such as Indonesia and Thailand, day to day waste management service was poor and mostly less than minimum requirement due to poor of technical and management problems (Shekdar, 2009).

Legal framework of waste management is designed to arrange guidelines and planning of proper waste service including disaster waste management. Legal framework governs such as procedure to provide of waste service including public procurement for any equipment and tools that were required. Legal framework was the manifest of guidelines for several option of action in delivery of service waste. For example, the procedure of proper handling of hazardous waste contained the implication such as punishment for responsible employee and organization due to the un-clear result. However, in developing countries usually not yet clear provide a standard to what degree and in what circumstances an action and procedure is acceptable (Brown, 2012). This part of study evaluates the impact of previous disaster waste management associated with the performance of achievement in legal framework of their waste management.

Institutional framework covers the organizational arrangement and their responsibility of disaster waste management. There were two organizational arrangement determined performance of waste management Brown (2011b); first is organizational in overall disaster management and then second is organizational in physical works of disaster waste management program. Organizational in overall disaster management influence to the disaster waste management in general term such as time allocation, budgeting. Effectiveness in disaster waste management would influence the achievement organizational resilience in whole process of disaster management (Chang, 2013). Physical works organization associated with the action in every stage of disaster waste management for collecting, transport, transfer, running intermediate treatment and conduct final disposal (Brown, 2011b; Asari et al., 2013). This study explores the performance of institutional framework in Indonesia and Thailand.

Budgeting or funding arrangement for disaster waste management was strategic issues both in develop and developing countries since it was vary depend between contexts, location and type of disaster. For example more than 27 % of total cost in emergency response of Hurricane Katrina funding was allocated for debris management (FEMA, 2007 Cite in Fetter and Rakes, 2012). Disaster waste management funding was depended on the system of disaster management and its regulation. Moreover, Fetter and Rakes (2012) recorded that City of Chesapeake, VA, in 2004 allocated more than $8 million for collection, transport, reduction, separation, and recycling process of Hurricane Isabel debris generation.

Planning for disaster waste management started with assessment of the accuracy of the estimation of Disaster waste following by treatment process such as planning for collection, running intermediate treatment, control final disposal and performance associated with achievement of planning for management such as legal framework, organizational arrangement and budgeting would be investigated.

2.2 Evaluation of disaster waste management in Indonesia

2.2.1 Methodology for evaluation of disaster waste management in Indonesia

(1) Target of disaster waste management events in Indonesia 1990-2012

Disaster such as earthquake, tsunami, floods, volcano eruptions could generate tremendous amount of debris and waste causing considerable waste removal and disposal challenges for local public officials. For example, earthquake in Sichuan China in year 2008 generated 380 Million tonnes (Xiao et al., 2012). For developing countries, there was limited information of performance achievement of disaster waste management. Figure 2.1 depicts target of evaluation disaster waste management events in Indonesia 1990-2012 as follow:

1. Earthquake-tsunami Flores 1992
2. Flood Bengawan Solo 1998
3. Indian Tsunami 2004
4. Earthquake Nias 2005
5. Yogyakarta Earthquake 2006
6. Bengkulu Earthquake 2007
7. Flood Jakarta 2007
8. West Sumatra Earthquake 2009
9. Mentawai Tsunami 2010

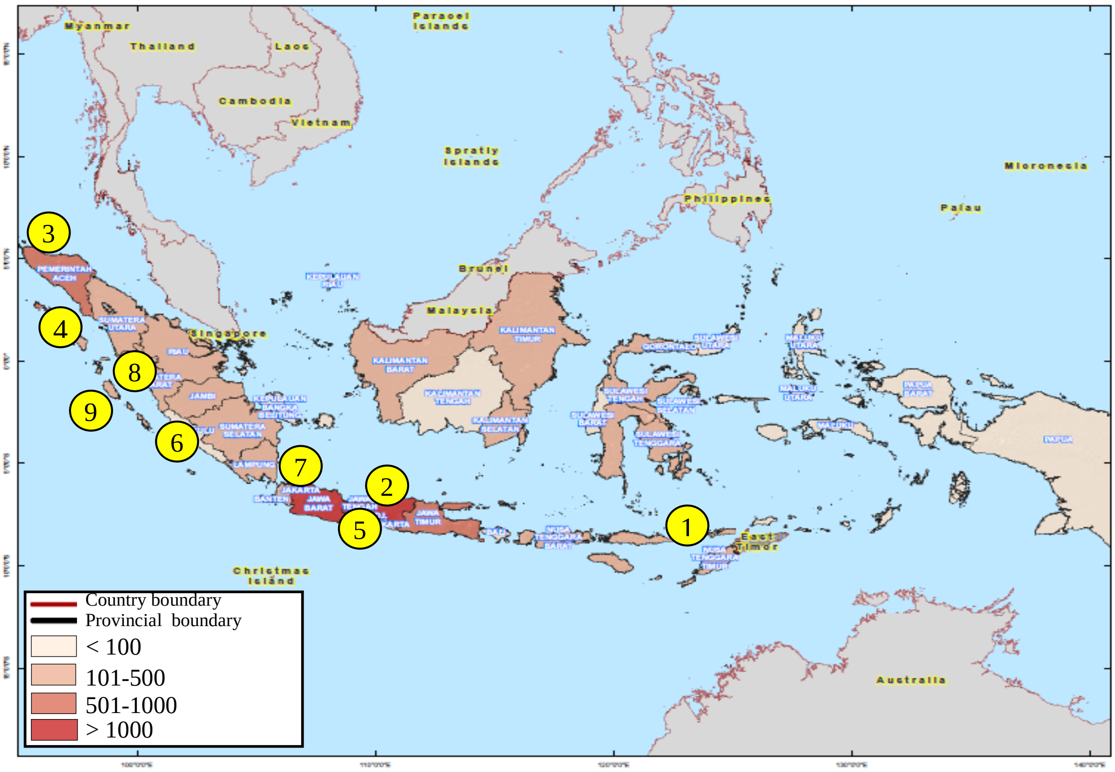


Figure 2.1 Target of evaluation disaster waste management events in Indonesia 1990-2012
Source of map: BNPB (2012)

Table 2.1 Institution target for data collection of disaster management Indonesia 1990-2012

No	Organization	Category	Level of Operation
1	Ministry coordinator of Social Welfare	National Government	National
2	Ministry of home affairs	National Government	National
3	Ministry of National Development Planning	National Government	National
4	Ministry of Public Work	National Government	National
5	Ministry of Environment	National Government	National
6	Indonesian taskforce for water and sanitation	National Government	National
7	National Disaster Management Agency	National Government	National
8	Planning and Development Agency	Provincial	Provincial
9	Department of Public Work	Provincial	Provincial
	Environmental Management Agency	Provincial	Provincial
11	Department of Disaster Management	Provincial	Provincial
12	Planning and Development Agency	Local	Local
13	Department of Public Work	Local	Local
14	Environmental Management Agency	Local	Local
15	Department of Disaster Management	Local	Local
16	Tsunami and Disaster Mitigation Research Center	Disaster research center	National
17	University of defense, Jakarta	University	National
18	Tsunami Waste Recovery Management Project (UNDP)	International Funding	International
19	National Red Cross	National NGO	National
20	Mercy Corps	International NGO	International
21	INSWA (Indonesia Solid Waste Association)	National Association	National

(2) Data collection

The research collected data by conducting questionnaire survey, direct interview and assessing statistical data and report from previous disaster management events. Data collection started from august 2012 until October 2012. Data collection covered of damage and losses, comprehensive of disaster management and disaster waste management including emergency response, program for rehabilitation and reconstruction. Data for evaluation of disaster waste management collected from national, provincial and local government. Data also collected from International funding, international and National NGO in Indonesia.

(3) Data Analysis

The research is evaluation of the development on disaster waste management system learning from past experience of the disasters by using logic model approach (McLaughlin and Jordan, 1999). The general hypothesis of the evaluation research refers to the logic model that ideal result of development and performance achievement of planning for disaster waste treatment and planning for management of disaster waste is getting better year by year in two decades 1900-2012. Stakeholder using and utilized previous experience to increase the performance of disaster waste management.

As depicted in figure 2.2, the research proposed two aspect of disaster waste management evaluation in developing countries with case in Indonesia as follow; the first one was evaluation of planning and implementation of treatment and second one was evaluation of planning for management.

The research proposed four quadrants to measure the performance achievement of each disaster events in developing countries. The performance achievement was assess by using likert scale (Allen, and Seaman, 2007). The research proposed simple likert scale by sign as follow:

- Signed of (-) to describe there was no data and information of the subject and component that evaluated.
- Signed of (+) to describe there was a limited information of the subject and component that evaluated. Statistical data collected was not formal from institution.
- Signed of (++) to describe there was information of the subject and component that evaluated. Statistical data collected from formal institution and formal report such as from government institution or international agency at which participate in disaster waste management in Indonesia.

Hypothesis:

- ❑ Performance achievement of disaster waste management (DWM) is getting better.
- ❑ Stakeholder utilized previous experience to increase performance achievement

Aspect that evaluated:

1. Planning and implementation for treatment
   - ❑ Estimation of disaster waste generation and characteristics
   - ❑ Disaster waste treatment
2. Planning for management
   - ❑ Legal framework
   - ❑ Institutional framework
   - ❑ Budgeting system

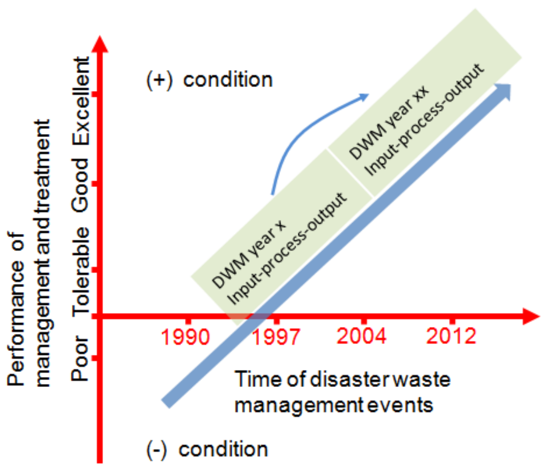


Figure 2.2 Method for evaluation of disaster waste management in Indonesia 1990-2012

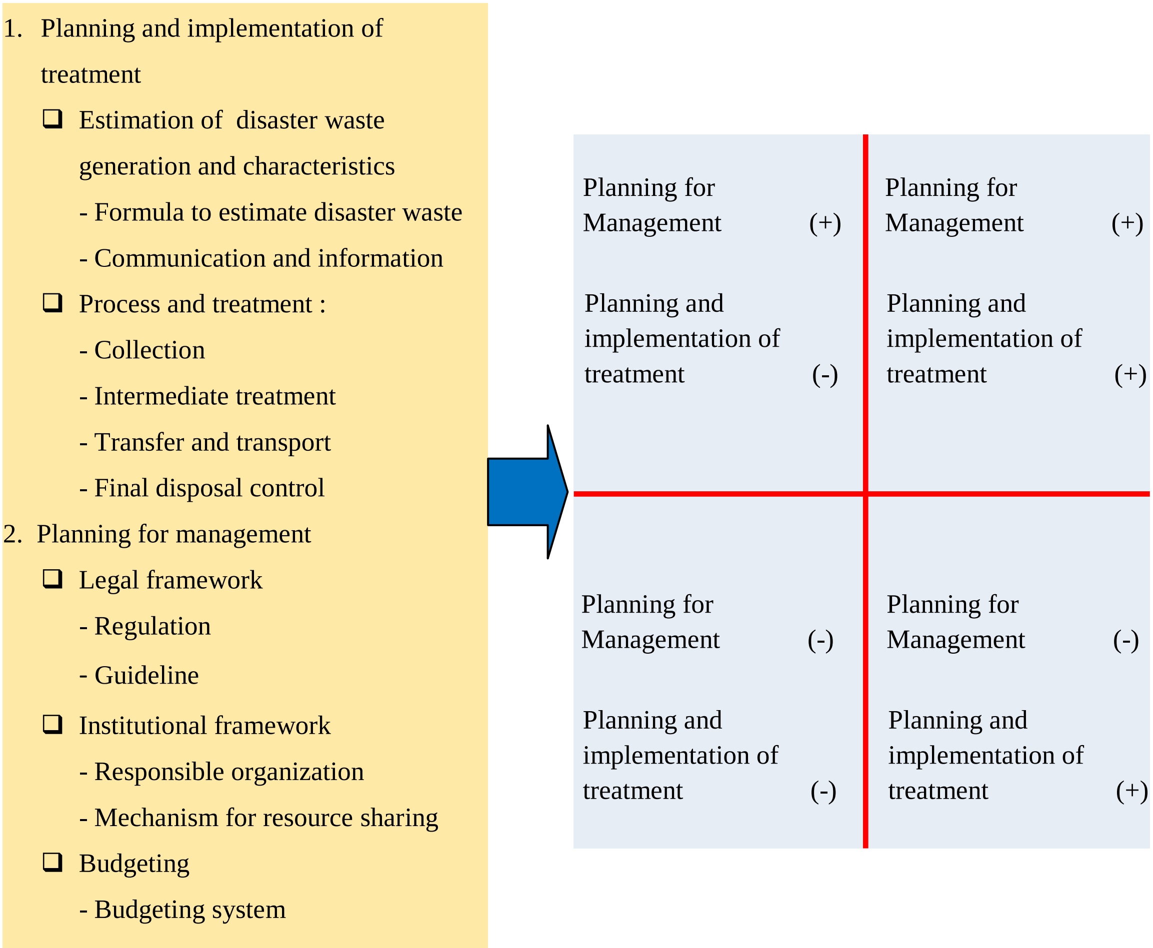


Figure 2.3 Method for measurement and assessment of each disaster waste management targeted in Indonesia 1990-2012

2.2.2 Planning for treatment and implementation

(1) Estimation of disaster waste generation and characteristics

Indonesia is one of the disaster–prone countries in the world. Indonesia national disaster management agency (BNPB) recorded that flood is the most frequently attack in Indonesia, while the losses were predominantly due to earthquake tsunami (BNPB, 2013). For year 2013, BNPB as national agency for disaster management recorded around 18,837 natural disasters, with 337,905 people died. The Indian tsunami 2004 is the worst natural disaster in Indonesia`s history with 100,229 dead, 12,132 missing and 703,518 displaced in Aceh and Nias North Sumatra (Ministry of Planning, 2005). Other major disaster in Indonesia are Tsunami Flores 1992 with killed 2100 people (USGS, 1992), and the latest big disaster is Merapi volcano eruption 2010 attached peole in Yogyakarta and Central Java. This study explored method to estimate disaster waste generation and characteristic that generated by major disaster in Indonesia for year 1990-2012.

Indian Tsunami 2004 generated disaster around 10.000.000 m^3 in Aceh (Brown et al, 2011b). Tsunami waste management program in Banda Aceh city, treated around 1.7 million m^3 disaster waste (UNEP, 2008). The characteristic of disaster waste consist of construction and demolition (c&d waste), vegetation, soil/mud/solid. Construction & demolition waste in Banda Aceh estimated 608.104 ton. The composition of construction and demolition waste in Banda Aceh consist of 13.2% single storied wooden house; 43.4 % single storied brick and concrete house; 10.4% single storied commercial establishment and 33.0% multi storied commercial establishment (Notodarmojo, 2007). Table 2.1 depicted the estimation and characteristic for the investigation of tsunami waste in Banda Aceh City.

Table 2.2 Estimation of Banda Aceh`s earthquake tsunami waste generation 2004

No	Composition	Weigh(Ton)	Volume(M3)
1	C & D Waste		
	a. Single Storied Wooden house	29,503	95,722
	b. Single storied brick and concrete house	290,492	315,005
	c. Single storied commercial establishment	60,963	75,484
	d. Multi storied commercial establishment	227,146	239,629
	e. foundation of all C & D	91,216	128,090
2	Vegetation	N.a	186,645
3	Soil/Mud/Solids	N.a	702,139
Total			1,742,714

Source: UNEP, 2008

Table 2.3 UNEP Estimation of construction and demolition waste for Indonesia

No	House and Item	Estimation C&D Waste	
		Normal	Disaster
1	Average Wood House*	70 -155 kg/m^2	80 kg/m^2
2	Average Single modern brick house	731-746 kg/m^2	736 kg/m^2
3	Average single storied commercial	731-746 kg/m^2	746 kg/m^2
4	Average multiple storied commercial	812-827 kg/m^2	817 kg/m^2

Source: UNEP, 2008; * Y.Haryono, cited in Notodarmojo, 2007

(2) Disaster waste treatment

Banda Aceh Tsunami waste management program 2004 was a comprehensive demonstration of disaster waste management in Indonesia. Disaster waste management in Banda Aceh has recycled more than 1 Million meter cubic disaster waste and reused for establish 100 km road and make 12,000 furniture from tsunami wood (Zakiya, 2012). Many international donors participated to conduct disaster waste management in Banda Aceh that caused by Indian tsunami 2004. Totally 8 process for Banda Aceh Tsunami waste management demonstrated, namely :

- Land clearance from tsunami waste;
- Support of municipal solid waste collection;
- Building demolition;
- Cash for work program;
- Waste reduction-recycling. In this stage, a practical training to handling construction and demolition such as reduce volume is run and then reuse to cover or rebuild the road. Other material such as metal, wood is recycled. Other program are;
- Dumpsite rehabilitation;
- Capacity Building for government and community due to enhance governance performance and finally
- Developed regional landfill site

For other disaster waste management such as earthquake, flood disaster waste, there was a limited information of the plan for treatment disaster waste and the implementation. For example, stakeholder not clear described the process of collecting, not clear described the number of vehicle used to transferring disaster waste to the intermediate facility. Stakeholder also not clear explained the process of reduce, recycle and reproducing of disaster waste. There was no information of the intermediate treatment. Disaster waste transported to the landfill site, part of them discharge in farmland or vacant land. An informal recycle conducted by survivors, in line with rehabilitation and reconstruction.

Jakarta Flooding 2007 is the major disaster flood in Indonesia, floods waste management in Jakarta. Flood waste clean-up on Jakarta floods 2007 shown that floods waste clean-up done by local state 59,227 meter cubic, with 130 truck and 70 wildfire car. Ministry of public work support 10 hard equipment, 50 truck. National State agency , Indonesia Chamber of commerce and industry help 327 hard tools from many type and clean flood waste 27,490 meter cubic, local government contract 200 private truck for clean 45,000 meter cubic. 3 centre point in Bantargebang landfill site install special for treat flood waste. One of the centre point, around 2,1 hectare with capacity 500 – 1000 ton waste per day (Widya, 201).

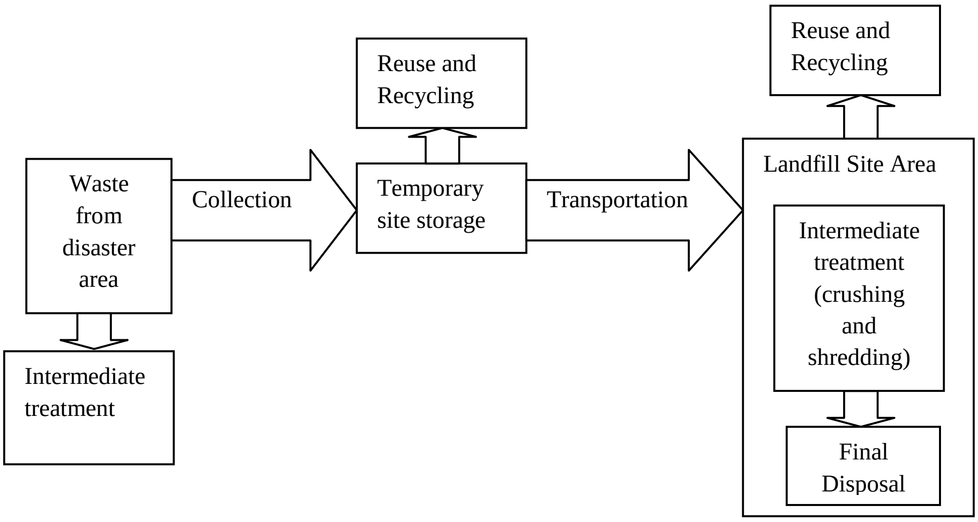


Figure 2.4. Disaster waste management in post Indian earthquake –tsunami 2004

Photo by : Ahmad Syamil
Department of Sanitation and Park , Banda Aceh 2005

Photo by : Ahmad Syamil
Department of Sanitation and Park , Banda Aceh 2005

Photo by : Ahmad Syamil
Department of Sanitation and Park , Banda Aceh 2005

Photo by : Ahmad Syamil
Department of Sanitation and Park , Banda Aceh 2005

Figure 2.5 Land clearance from tsunami waste, support of municipal solid waste collection, and building demolition of Indian tsunami waste in Banda Aceh

Photo by: Ahmad Syamil
Department of Sanitation and Park , Banda Aceh 2005

Photo by: Ahmad Syamil
Department of Sanitation and Park , Banda Aceh 2005

Photo by : Ahmad Syamil
Department of Sanitation and Park , Banda Aceh 2005

Photo by : Ahmad Syamil
Department of Sanitation and Park , Banda Aceh 2005

Figure 2.6 Cash for work, tsunami wood recycle, capacity building for facility maintenance, updating Gampong landfill capacity

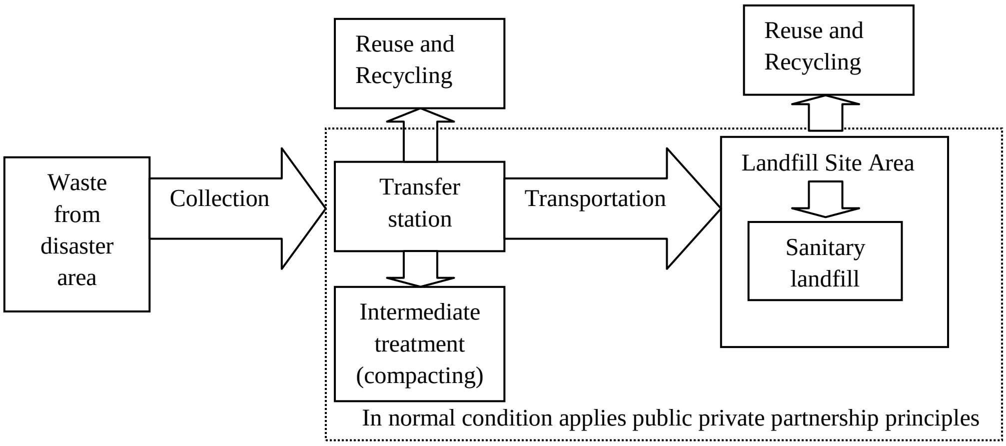


Figure 2.7. Disaster waste management for Jakarta flood 2007

2.2.3 Planning for management

(1) Legal framework

There are four system of the basic regulation of environmentally sound of disaster waste management in Indonesia. Figure 3 described the legal framework of disaster waste management in Indonesia. Indonesian law number 26 in year 2007 was a spatial planning regulation. It was a guideline of development policy associated with land use. For general the guidelines govern location for residential, commercial, industrial area including building management, road, public facility and lifeline infrastructure. Spatial planning determined disaster waste management associated with the acceptable of access land and for handling waste.

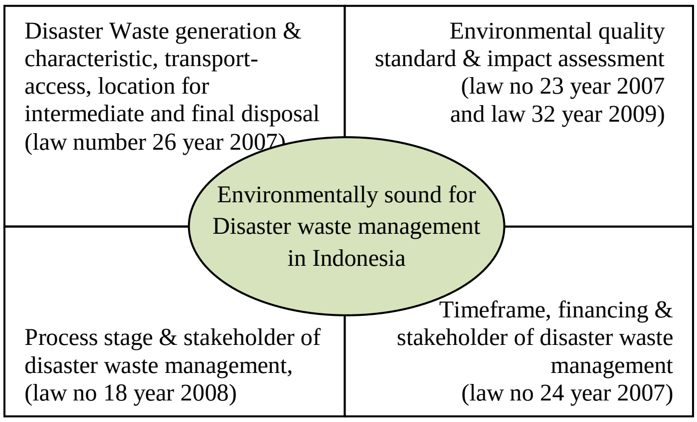


Figure 2.8. Basic legal framework of disaster waste management in Indonesia

Indonesian law number 18 in year 2008 was a major guideline of solid waste management. It is a fundamental guideline for environmental manner protection associated with waste service for people including industrial activities. The regulation establish pattern and regulate responsibility of waste management service for national, provincial and local state. This regulation enhance community participation including provide guidelines for individual and community to involve in waste management. Furthermore, this legal framework regulates comprehensive industrial waste management that applies polluter pay principles (UNEP, 2008).

Refers to Indonesia law number 18 in year 2008, there were two major Indonesia`s waste management guidelines. The first one is waste management of urban and rural activities including waste management in agriculture, forest and coastal and see. The second one was waste management for industrial activity. Waste management and operation were divided by two stage, first one was a guidelines for waste reduction and then following by waste handling and treatment. Waste reduction covers activities for fostering 3R (reduce, reuse and recycle), and waste handling or treatment cover activities for sorting, collecting, transfer, and final processing. Guide line for disaster waste management not yet issued, however in article 2(4) and 2 (5) of the this Indonesia`s law provide the general principles that government has been responsible for disaster waste management and handling (UNEP, 2008).

Indonesian law no 32 year 2009 issued for improving law no 23 year 2007 concerning environmental management. In this law, regulates the environmental standard for maintenance air, water and land due to the pollution and health associated with development and activities both human being as private-personal, informal organization and formal organization including government institution. This regulation was set to fostering preparedness due to environmental degradation especially associated with land use planning.

In year 2007, Indonesia has a principles legal framework of disaster management. In-line with the disaster management, the law regulates and covers time line for emergency respond, rehabilitation and reconstruction of disaster waste management. The regulation also cover the mechanism of institutional arrangement and budgeting at emergency respond, respond phase, rehabilitation and reconstruction.

(2) Institutional framework

As of disaster management, stakeholders that involve in disaster waste management was vary depending the type and scale of disaster in rural or urban. Generally, institutional framework were automatically construct due to the humanitarian such as debris clean up associated with search and rescue for life safety and bodies death management (Hu and Sheu, 2013). As the characteristic of pattern in developing countries, there was a formal and informal organization type. Formal organization associated with organization at which clearly declared in law number 24 year 2007, and other relevant regulation while non-formal organization associated with volunteer, waste picker and scavenger.

Figure 2.4. describe institutional framework possibilities for disaster waste management in Indonesia. There were many institutional formal and informal support for disaster waste management from local, national and international involvement in very stage on disaster waste management (Notodarmojo, 2007). Responsible institution in local state mostly overwhelmed to deliver service, for other examples in Jogja earthquake 2006, other local institution from Jakarta and Semarang support equipment such as 22 Excavator, 7 Loader , 38 Dump truck ,1 Trailer , 1 Tandem Roller and 1 Gen-set Hard tools be coming from other cities, Jakarta, Semarang (Ministry of public work, 2006).

Coordination between institutional also found in disaster waste management after flood in Jakarta flood 2007. Institutional coordination for disaster waste management was condected by local government in Jakarta, Ministry of Public Work and Indonesia chamber of commerce and industry (Widya, 2011). Coordination for disaster waste management after flood also conducted with institutional at out site of disaster affected for disposal waste at Bantargebang at which belong to the Bekasi District.

In Indonesia, there were two type of humanitarian pattern including debris cleanup, as non-formal institutional framework. The first one was organization to organization and the second one was organization to community or people. For example, non-government organization from Nederland support composting for community scale in tsunami 2004 waste management in Banda Aceh (Notodarmojo, 2007). For building back community life associated with Merapi Eruption 2010, a telecommunication company from Qatar, support permanent housing building back in Sleman Regency Yogyakarta, including social lifeline infrastructure such as water, sanitation and waste management for new village.

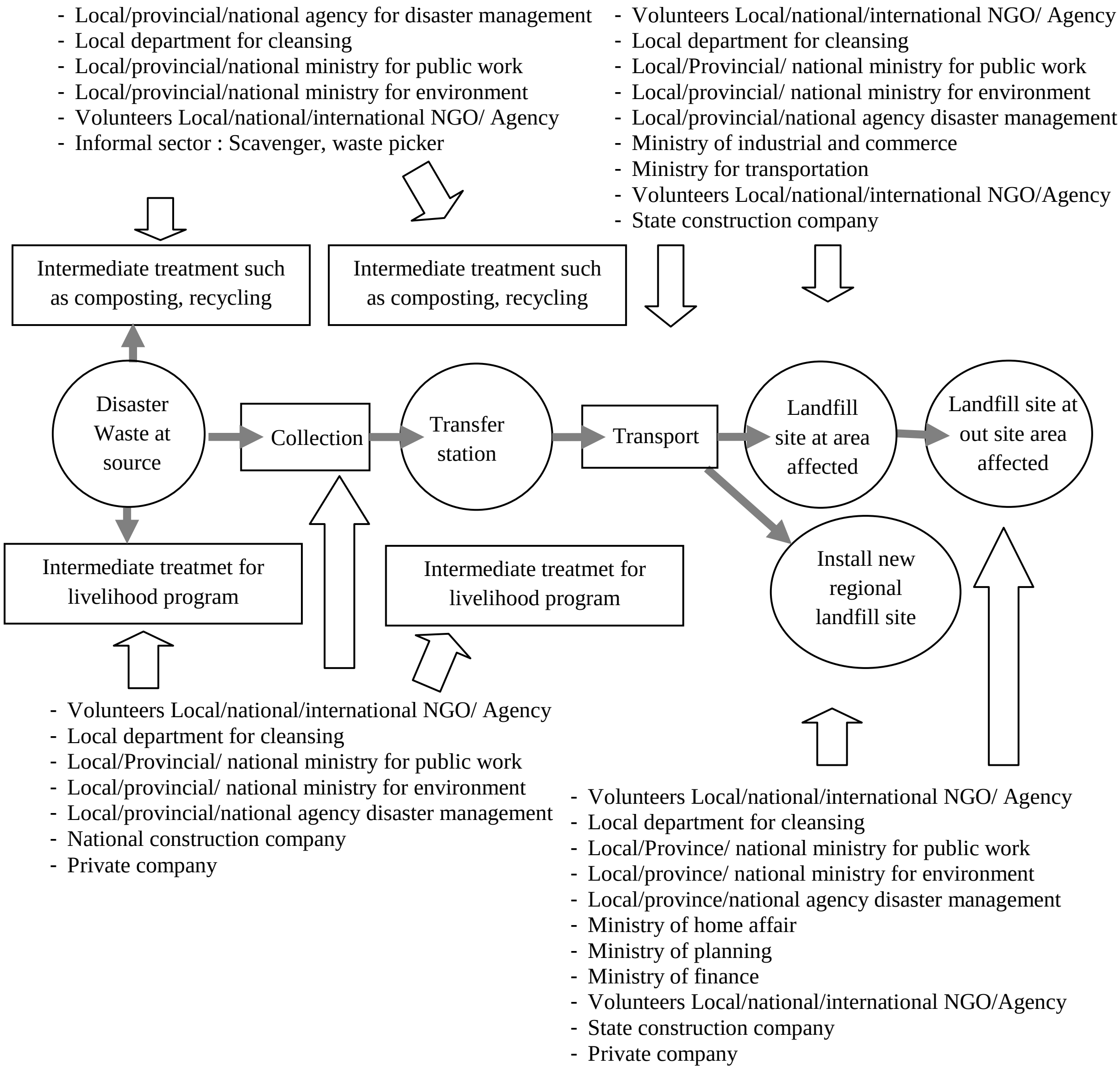


Figure 2.9. Institutional involvement for disaster waste management in Indonesia

Source: Modified from Notodarmojo, 2007; Asari et al, 2013

(3) Budgeting system

Mechanism funding was the third of sub system in Indonesia`s system of disaster management (previous discussed were the legal and institutional framework). As part of disaster management, resource funding for disaster waste management could classified s as formal funding from government and non-formal funding from donors both national and international. According the system of disaster management in Indonesia, there were several type of funding namely; national annual budget, provincial and local annual budget, Contingency budget, On-call budget, grant, community -participation and company and international donors.

UNDP estimated around $ 58.5 Million fund need run disaster waste following Indian tsunami earthquake 2004 in Aceh province (UNDP, 2008). Phase one, around $ 14. 4 Million allocated emergency respond and clean-up which carry out in Banda Aceh, West Aceh, Nagan Raya, Pidie, Aceh Jaya, Aceh Besar, Nias, South Nias, Lhokseumawe, North Aceh, Bireuen, Sabang and Simelue, which run for year December 2005- September 2007 (UNDP, 2008). Following step, in September 2007 – 2009, around $ 10.8 Million were used for collection, demolition waste, including recovery of facility (UNDP, 2008; multi donor fund-JRF, 2012). estimation budget around $ 14.99 were need to continuing disaster waste management in Banda Aceh which run in January 2009 – December 2010. Recovery facility of city waste management and regional landfill site development in Blang Bintang North Aceh was carry out with allocation budget around & 12. 46 Million.

Mostly budgeting system in disaster waste management using mechanism sharing cost between national, provincial and local state. for examples in Yogyakarta earthquake 2006, central government expensed 109.6 Billions Indonesian rupiahs for debris clean only (Bappenas, 2006a), while for other stage such as updating equipment and facility conducted by provincial and local state. However, there was still not yet clear such as at what condition, the budgeting requirement would be allocated from central, provincial and local government, for example, National disaster waste management agency rejected around 168 Million Indonesian rupiahs, a budget which proposed from Ambon local state to manage their flood waste cleanup in year 2012.

Mostly disaster waste management budgeting in Indonesia is incorporated with water and sanitation sector known as wash cluster in disaster management. Disaster waste budgeting mainly was allocated in the emergency responds to clean up debris which blocks road or access or open pathway to ensure operation for rescue and safety life as described by Fetter and Rakes, (2012). Although in emergency response, mostly waste management in shelter was operate by municipality, and it was account as daily waste management, a different way comparing with UNOCHA guidelines (2011). No clear statistical data record disaster waste budgeting in post disaster waste management except after tsunami waste recovery program 2004.

2.2.4 Result of Evaluation

(1) Planning for treatment and implementation

Planning for treatment and implementation of disaster waste management evaluated the availability of statistical data of disaster waste generation and the performance of disaster waste treatment at which associated to the type of activity for disaster waste treatment. The research founded that performance achievement of the planning and implementation for year 1990-2006, generally not yet clear getting better. Only disaster waste management in Banda Aceh the research founded the disaster waste management plan for treatment and the implementation.

Table 2.4 Performance achievement of planning for treatment and implementation of disaster waste management in Indonesia 1990-2006

	1 Tsunami-Earthquake Flores 1992	2 Flood Bengawan Solo 1998	3 Banda Aceh Indian Tsunami 2004	4 Nias Earthquake 2005	5 Yogyakarta Earthquake 2006
Statistical Data of DW Generation	(-)	(-)	(++)	(-)	(-)
System information and communication	(-)	(-)	(++)	(-)	(-)
Collection	(-)	(-)	(++)	(-)	(-)
Temporary storage	(-)	(-)	(++)	(-)	(-)
Transport and Transfer	(-)	(-)	(++)	(-)	(-)
Intermediate treatment	(-)	(-)	(++)	(-)	(-)
Final Disposal	(-)	(-)	(++)	(-)	(-)

- ❑ Condition at which (-):
- No statistical data for disaster waste generation (except
- No Clear reference, report, documentation for coordination between stakeholder
- ❑ Condition at which (+) for Indian tsunami 2004:
- UNEP (2008) estimated disaster waste generation in Banda Aceh (610,000 tonnes)
- There is a document (report) for disaster estimation
- ❑ Condition at which (+) for Jakarta Flood 2007:
- Disaster waste after flood estimated 32.000 Tonnes disposed in Bantar gebang landfill

In Jakarta flood 2007 shown that floods waste clean-up done by local state 59,227 meter cubic, with 130 truck and 70 wildfire car. Ministry of public work support 10 hard equipment, 50 truck. Indonesia chamber of commerce and industry help 327 hard tools from many type and clean flood waste 27,490 meter cubic, local government contract 200 private truck for clean 45,000 meter cubic. Three centre point in Bantargebang landfill site install special for treat flood waste. One of the centre point, around 2,1 hectare with capacity 500 – 1000 ton waste per day (Widya, 2011)

Table 2.5 Performance achievement of planning for treatment and implementation of disaster waste management in Indonesia 2007-2012

	6 Bengkulu earthquake 2007	7 Jakarta Flood 2007	8 West Sumatra 2009 Earthquake	9 Mentawai Tsunami 2010
Statistical Data of DW Generation	(-)	(+)	(-)	(-)
System information and communication	(-)	(-)	(-)	(-)
Collection	(-)	(+)	(-)	(-)
Temporary storage	(-)	(-)	(-)	(-)
Transport and Transfer	(-)	(+)	(-)	(-)
Intermediate treatment	(-)	(-)	(-)	(-)
Final Disposal	(-)	(+)	(-)	(-)

- ❑ Condition at which (-):
- No statistical data
- No clear reference, report, documentation
- ❑ Condition at which (+):
- There are statistical data and document report of process in collection, transfer and transport, intermediate treatment, and final disposal for disaster waste management cause by Indian tsunami 2004
- There are statistical data for disaster waste process after Jakarta flood 2007

(2) Planning for management

The research found that performance achievement of planning for disaster waste management was getting better year by year in 1990-2006. For example, there was a changing of responsible organization from the advisory board in 1990, changed into the coordination board by president degree no 106/1999.

Table 2.6. Performance achievement of planning for disaster waste management in Indonesia 1990-2006

	1 Tsunami-Earthquake Flores 1992	2 Flood Bengawan Solo 1998	3 Banda Aceh Indian Tsunami 2004	4 Nias Earthquake 2005	5 Yogyakarta Earthquake 2006
Regulation	(-)	(-)	(-)	(-)	(+)
Guideline	(-)	(-)	(-)	(-)	(-)
Responsible organization	(-)	(+)	(+)	(+)	(+)
Mechanism resource sharing	(-)	(+)	(+)	(+)	(+)
Budgeting system	(-)	(+)	(+)	(+)	(+)
Mechanism for sharing	(-)	(-)	(+)	(+)	(+)

- ❑ Condition at which (-):
- There were regulation President degree No.43/1990
  And President degree no 106/1999, in practical tend to accidental, only for emergency relief
- Law no 23/1997 environmental management not clearly state of disaster waste management
- No clear reference, report, documentation
- ❑ Condition at which (++):
- Pres degree no 8/2008 – Agency for disaster management
- Government degree no 21/2008 - NGO
- Government degree no No 22/2008- budgeting/funding
- Government degree no Degree no 23/2008 - operation
- Waste management law no 18/2008
- Degree no 7/2012 Data base system

Table 2.7 Performance achievement of planning for disaster waste management in Indonesia 2007-2012

	6 Bengkulu earthquake 2007	7 Jakarta Flood 2007	8 West Sumatra 2009 Earthquake	9 Mentawai Tsunami 2010
Regulation	(+)	(+)	(++)	(++)
Guideline	(-)	(-)	(-)	(-)
Responsible organization	(+)	(+)	(++)	(++)
Mechanism resource sharing	(+)	(+)	(++)	(++)
Budgeting system	(+)	(+)	(++)	(++)
Mechanism for sharing	(+)	(+)	(++)	(++)

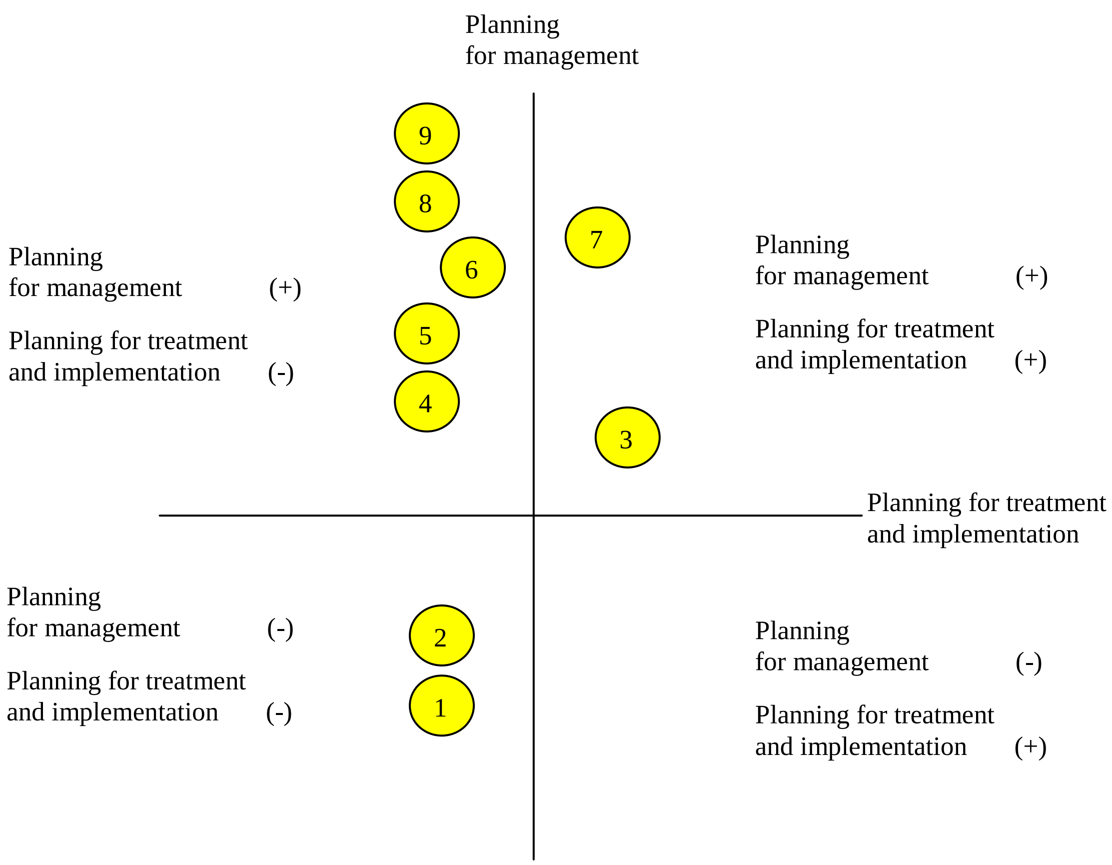
The updating of the responsible organization conducted in 2008 by developing of National disaster waste management agency. The new agency of disaster management in Indonesia introduced planning and system for disaster management including disaster waste management at which Ministry of Public Work decided as responsible organization for disaster waste management to conduct planning treatment and implementation before, during and after disaster.

- ❑ Condition at which (-):
- No clearly statistical data toward coordination and sharing resources between local, provincial and national government
- ❑ Condition at which (+):
- Coordination conduct by ad hoc committee before in 2004, board of committee for 2004-2008 and National disaster management agency cooperation with department of public work after 2008
- Multi stakeholder coordination (foreign agency, foreign NGO, National and local NGO
- ❑ Condition at which (-):
- No clearly statistical data toward budgeting system and sharing between National, provincial and local.
- ❑ Condition at which (+):
- Government degree No 22/2008- budgeting/funding for National, provincial, local and funding from foreign agencies.

(3) Performance achievement of disaster waste management in Indonesia 1990-2012

The research founded three condition of disaster waste management in Indonesia in 1990-2012. The performance of disaster waste management in Indonesia 1990-2012 classified as follow:

- There were two disaster management events classified at quadrant three
- There were two disaster management events classified at quadrant one
- And there were five disaster management events classified at two



Disaster waste management events:

1 Earthquake-tsunami Flores 1992
2 Flood Bengawan Solo 1998
3 Indian tsunami 2004
4 Tsunami-earthquake Nias 2004
5 Yogya earthquake 2006
6 Bengkulu earthquake 2007
7 Flood Jakarta 2007
8 West Sumatra earthquake 2009
9 Mentawai tsunami 2010

Figure 2.10. Performance achievement of selected previous disaster waste management in Indonesia 1990-2012

2.2.5 Model proposed for estimating disaster waste generation in Indonesia

(1) Development model

The basic coefficient for estimation of disaster waste generation in Indonesia especially for construction and demolition disaster waste was proposed by UNEP . The estimation per square area of wooden house in Indonesia was estimated by an Indonesian architect Y Haryono as shown in table 2.2 (Notodarmojo, 2007) for housing damage and building due to disaster. Refers to the coefficient in table 2.2, disaster waste generation in Banda Aceh was estimated by formulation as follow (UNEP, 2008):

$$Q = Cn\,(80 \sum_{i=1}^{n} W + 736 \sum_{i=1}^{n} SM + 746 \sum_{i=1}^{n} SCE + 817 \sum_{i=1}^{n} MCE) \qquad (2.1)$$

where ;

Q : Quantity of debris waste in tons

Cn : Constanta as characteristic of building and earthquake level

W : Wooden house damage

SM : Single modern brick house

SCE : Single storied commercial establishment

MCE : Multiple storied establishment

n : Number of building damage for each type of building

Other previous research for disaster waste generation developed by assessing the residential area, public area, commercial area and park or forest associated with the type of disaster. The US Army Corps Engineers (USACE) proposed the basic formulation to estimate the hurricane debris model. The Characteristic of the USACE estimation was strom and vegetation parameter for hurricane disaster. The USACE estimation of disaster waste generation describe as follow (USACE, 2005).

$$Q_t = h_n(Sc)(Vg_c)(B_i)(Sp_c) \qquad (2.2)$$

Where,

Q_t : Quantity of debris in cubic yards

h_n : Number of households

Sc : Strom category factor in cubic yards

Vg : Vegetation characteristic multiplier

B_i : Commercial/business/industrial use multiplier

Sp_c : Strom precipitation characteristic multiplier

US Federal Emergency Management Agency (FEMA) and California Management Agency (CEMA, 2010) investigates demolition and concrete waste in by dividing community according into their activity or location in residential, commercials and industrial area. Debris following disaster was estimated as follow (FEMA, 2007; CEMA, 2010):

$$Q_t = (L_i)\,(W_i)\,(h_i) \qquad (2.2)$$

Where,

Q_t : Quantity of debris in cubic feet

L_i : Length of each building or households type

W_i : Width of of each building or households type

h_i : Height of each building or households type

Shimaoka (1995), propose the estimation of disaster waste generation following by natural disaster especially in Japan by assessing the type of building structure. Hirayama, et al., (2010) extended the method by utilized the GIS associated with natural hazard map. Generally the formulation for estimate disaster waste generation as follow (Hirayama, et al, 2010)

$$Q_t = \sum q_i\, n_i \qquad (2.4)$$

Where,

Q_t : Total quantity of debris generation

q_i : Unit generation of debris for i-type of structure

n : The number of building damaged

Xiao et.al (2012), propose method to investigate disaster waste generation by earthquake disaster in China. The characteristic of the estimation Xiao et.al method was the assessing of debris associated with building grade, type and location of disaster. The formulation for estimating disaster waste generation following disaster as follow (Xiao et.al 2012):

$$Q_{ix} = R_i \text{ x } q_{ix} \qquad (2.5)$$

$$Q_x = \sum_{i=1}^{n} Q_{ix}\,, \qquad Q_i = \sum_{x=1}^{q} Q_{ix} \qquad (2.6)$$

$$Q_t = \sum_{x=1}^{q} Q_x\,, \qquad Q_t = \sum_{i=1}^{n} Q_i \qquad (2.7)$$

Where,

Q_{ix} : Total quantity of debris in the i-type of structure

R_i : Building area of the i-type of structure,

room for each type of building was 20 square meter

q_{ix} : Building waste amount per unit area for by x type materials in the i-type structure

Q_x : Total amount of x-type building waste generated

Q_i : Total amount of building waste from i-type structure

Q_t : The whole amount of building waste generated in the disaster area.

Recently, Indonesia registered as middle-low class country (World Bank, 2013). Estimation of disaster waste generation perform by considering the socio economic variables as main evaluation parameter. However, reassessment of others previous also conducted to measuring the characteristic in Indonesia such as spatial planning or policy, activity, community in Indonesia. Disaster waste estimation then developed according to the parameter as follow:

- the disaster waste generation was estimated with three group of construction; residential, office area or public building and commercial building
- Residential area classify according to the Indonesia condition, type 36, 45-60, and more than 60.This analysis modified the UNEP (2008) and Xiao, el (2012) estimation. Numbers of type associated with the area of floor. For example type 36 mean a house with area of floor 36 square meters.
- Office area and public building consist of social infrastructure; government office centre, education centre, health centre, religion and culture centre.
- Commercial area consist of economic infrastructure; traditional market, modern (mini and supermarket), hotel, private company building

Refers to the evaluation of parameter above, disaster waste generation in Indonesia is estimated by several equations as follow:

$$Q_r = \sum_{i=1}^{n} Q_{il} + \sum_{i=1}^{n} Q_{im} + \sum_{i=1}^{n} Q_{ih} \quad (2.8)$$

$$Q_p = \sum_{i=1}^{n} Q_{ip} \quad (2.9)$$

$$Q_c = \sum_{i=1}^{c} Q_{ic} \quad (2.10)$$

$$Q_t = Q_r + Q_p + Q_c \quad (2.11)$$

Where;

Q_{il} : Total amount of disaster waste in the residential area cluster 36

Q_{im} : Total amount of disaster waste in the residential area cluster 45-60

Q_{ih} : Total amount of disaster waste in residential area cluster more than 60

Q_r : Total amount of disaster waste in the residential area

Q_p : Total amount of disaster waste in the office or social centre area

Q_p : Total amount of disaster waste in the commercial area

Q_t : The whole amount of disaster waste generated in the all area of disaster

Spatial planning, such as land use and community activities arrangement determined the requirement of urban infrastructure (social and economic). Pre planning for debris management could be estimate from the spatial planning to provide additional parameter both for debris estimation or disposal landfill site preparation, especially for developing countries. By exploring the spatial planning possibility for additional the hazard map from Shimaoka (1995) and Hirayama (2010), procedure to estimate of disaster waste generation in Indonesia is depicted in figure 2.1

Previous disaster waste generation estimation

- USACE (2005)
- FEMA(2007) ;CEMA (2010)
- Shimaoka (1995) ; Hirayama et.al (2010)
- Notodarmojo, 2007;
- Y. Haryono cited in Notodarmojo (2007)
- UNEP, 2008
- Xiao et. al (2012)

Indonesia`s spatial policy

- Spatial planning
- Hazard map

✧ Estimation of housing according to type of cluster in Indonesia:
- Cluster 36
- Cluster 45-60
- Cluster More than 60

✧ Estimation of basic of social infrastructure :
- Education
- Health
- Religion

✧ Estimation of basic of economic infrastructure :
- commercial area (traditional market, mini market, supermarket, hotel, company or private office)

$$Q_r = \sum_{i=1}^{n} Q_{il} + \sum_{i=1}^{n} Q_{im} + \sum_{i=1}^{n} Q_{ih}$$
$$Q_p = \sum_{i=1}^{n} Q_{ip}$$
$$Q_c = \sum_{i=1}^{c} Q_{ic}$$
$$Q_t = Q_r + Q_p + Q_c$$

Estimation of disaster waste generation in Indonesia
(Case Indonesia major disaster 1990-2012)

Figure 2.11 Procedure of estimation of disaster waste generation in Indonesia

Souce: Modified from Shimaoka (1995); Hirayama et al. (2010)

(2) Disaster waste generation in selected disaster events in Indonesia 1990-2012

Earthquake and tsunami Flores attack in 1992 was registered as the first of national disaster with presidential decree no 66/1992 (Muryadi, et al 1992). The disaster cause economic losses and damage with total around 200 billion rupiahs and cause socio, economical infrastructure damage (Muryadi, et al 1992). According to the disaster, around 113 education building, 120 religion centre buildings, and 211 office building including government, market and other commercial was recorded damage (Muryadi, et al ,1992). The disaster also cause 1800 house damage with 79% of single masonry structure, 8% single masonry –frame (wood) structure and 2% of wood structure (Lasa, 2010).

After tsunami 2004, earthquake attacked in Nias North Sumatra Island in year 2005. The disaster cause two of hospital totally collapse with five other of hospital and 26 of health centre building was damage (Bappenas, 2007). Other damage registered were around 1488 of education centre damage with around 150.000 student, and around 1488 house damaged (Bappenas, 2007). Also just after one year, Yogyakarta-Central Java earthquake 2006 hit which cause more than 350,000 housing damage in Yogyakarta and Central Java Province (Bappenas, 2006a). West java earthquake 2006 cause around 2,422 house, around 1,490 traditional market building, and 61 hotel damage in Ciamis West Java (Bappenas, 2006b).

The research estimated disaster waste generation caused by Indian Tsunami 2004 in Banda Aceh were 780,000 tonnes. According to the investigation, disaster waste generation caused by west Sumatra earthquake, generated 1.5 million tonnes of disaster waste in Padang. Estimation of disaster waste generated by major disaster in Indonesia 1990-2012 was depicted in table 2.3.

Table 2.8 Estimation disaster waste of in Indonesian major disaster 1990-2012

NO	Earthquake and Tsunami Events	City most severely affected	Estimation Disaster waste (tonnes)	Estimation Disaster Waste in selected city (tonness)
1	Earthquake-tsunami Flores 1992	Maumere	180,000	90,000
2	Indian tsunami 2004	Banda Aceh	4,700,000	780,000
3	Tsunami-earthquake Nias 2004	Gunung Sitoli	1,100,000	150,000
4	Yogya earthquake 2006	Bantul	2,900,000	950,000
5	West Java Earthquake 2006	Ciamis	680,000	130,000
6	Bengkulu earthquake 2007	Nort Bengkulu	780,000	260,000
7	West Sumatra earthquake 2009	Padang	3,500,000	1,550,000
8	Mentawai tsunami 2010	Mentawai	250,000	50,000

2.3 Evaluation of disaster waste management in Thailand after flood 2011

2.3.1 Thailand flood 2011 time line and damages

During a 2011 monsoon in Thailand, floods caused enormous damage to the Chao Phraya Basin and the area around the Mekong River (The World Bank, 2012). More than six million hectares were inundated in 58 provinces ranging from Chiang Mai Province in the north to Bangkok in the center. The huge flood disaster lasted 175 days and caused damage costing 1,425 billion baht (THB) by December 1, 2011 (The World Bank, 2012).

A large amount of flood waste was generated, particularly in densely populated areas of Bangkok and its inundated surroundings. Flood waste included not only municipal waste (referred to as general waste in Japan) from submerged homes but also industrial waste from seven damaged industrial parks. Damage was concentrated in manufacturing industries, including automobile production and electronics, such as computer and hard disk drive manufacturing. Especially for the solid-waste infrastructure, the World Bank estimated that THB 4,714 million would be needed to manage flood waste, including the recovery and reconstruction of any damaged facilities, and THB 2,003 million for industrial waste [2]. More than 60% of the waste problem was centered in Bangkok and Ayuthaya.

The research examines the generation and disposal of flood waste related to Thailand floods using data obtained through field surveys and interviews with involved organizations. Field surveys were conducted by the joint research group of Kyushu University and Chulalongkorn University in December 2011, January 2012, and February 2012 in Bangkok and its surroundings: inundated districts in Bangkok, industrial parks in Rojana and Nava Nakorn, and a final disposal site in

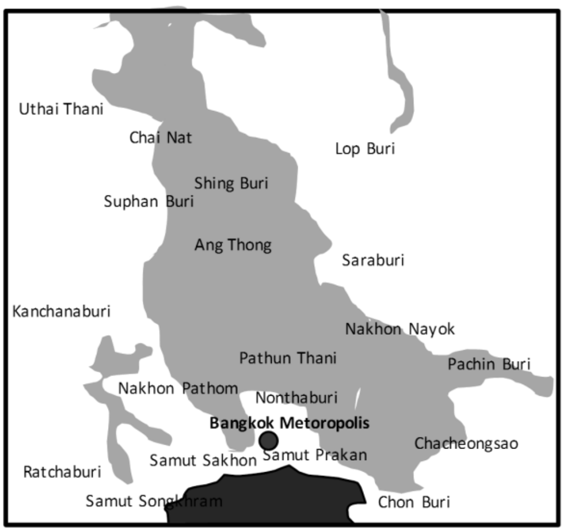


Figure 2.12 Map of maximum flood extent (the world bank, 2012)

2.3.2 Normal disposal of waste in Bangkok

(1) Organization of responsibility

Provincial authorities and the Bangkok Metropolitan Administration (BMA) have departments of public cleaning and a department of the environment to manage municipal waste treatment. Provincial administrations and the BMA also coordinate other aspects, such as technical, financial, legal, and public participation in waste treatment planning following national policy and regulations (Shook, 1997; Hongsakul, 2001).

There is specific structural responsibility for waste treatment under normal conditions in Bangkok. Because of the wide range of daily activities in waste treatment, the BMA Department of the Environment maintains specific technical treatment divisions. There are four divisions: solid-waste disposal planning, public cleaning, night soil control, and planning. The solid-waste disposal division is responsible for waste treatment and disposal, while control of waste collection, transfer, and transport to the disposal center is managed by the Public Cleaning Division. Night soil control manages night soil treatment in Bangkok, while the planning division manages overall strategies for improving waste treatment as well as for promoting sustainability and healthy living in Bangkok. BMA district offices, under the supervision of the BMA and the Department of the Environment, are responsible for daily waste collection. The BMA administers 50 district offices. Each district controls waste collection from households and streets for its resident area. Waste is also collected from households located along the river and canal banks in Bangkok. Responsibility for cleaning roads and bridges that cross rivers, however, belongs directly to the BMA Department of the Environment.

For industrial waste treatment, at least four main stakeholder groups are taken into account for usual industrial waste in Thailand, namely: waste generators, waste transporters, waste disposers and recyclers, and the Ministry of Industry is the competent authority for control waste treatment (Leungsakul, 2010).The rule mechanism among specific stakeholders includes determining technical procedures for industrial waste treatment. Relationships among industrial waste generators, transporters, disposers, and recyclers are managed by the Ministry of Industry, which is responsible for industrial waste treatment. Nomenclature requirements are used in daily handling, such as a transfer permits, yearly reports and waste code, and contract letters that describe the planned mechanism of treatment. A transfer permit, for example, is issued both for waste generators and for controlling transportation and disposal by waste collectors/transporters, who also get letter permits to collect and transport waste, including specification of transportation vehicles. Contract letters issued to waste disposers are also used by waste collectors as representatives of waste disposers when collecting or transporting industrial waste (Muttamara, 2004).

(2) Municipal solid-waste disposal

The BMA is responsible for the disposal of municipal waste in Bangkok. On the average, it collected 8,766 tons of municipal waste per day in 2010, according to BMA statistics [7]. Its collection service covers almost the whole area of the 50 districts of Bangkok, collecting 99% of all waste from the area. The population of Bangkok is approximately six million, but this is only the registered population and, in fact, more than ten million people live in Bangkok. That 8,766 tons divided by ten million gives 877 g, the amount of waste generated per person per day. Food scraps are the largest component of this waste, accounting for about 50%. Plastics follow at about 25%. Owing to the large proportion of food scraps, waste is 55.6% water.

Various types of waste collection vehicles are used, such as compaction trucks with a capacity of 2–10 tons, side-loading trucks with a capacity of 12 m3 and 1.5 tons for the collection of food waste (in green) and recyclable waste (in blue and white). There are also recycling trucks, container trucks, collection boats, and wood-shredding trucks. At present, the BMA has 2,031 vehicles, of which only 27% (554) are owned by BMA and the rest are covered by BMA contracts with private companies. For waste collection services across waterways around the river in Bangkok, the BMA is responsible for waste collection from households along canals, and the BMA Department of the Environment is responsible for solid-waste collection in the Chao Phraya River Basin. There are 53 boats and 6 waste collection trucks, with personnel on duty every day from 07:99 to 15:00 (BMA, 2011) In other cases, the BMA supports waste collection by contracting with private organizations during special ceremonies, such as the Loy Krathong Festival, to collect waste from these activities.

As shown in Fig. 2.9 collected municipal waste is transported to 3 transfer stations in On Nut, Nong Khaem, and Sai Mai, where, after debris and large wood chips are removed manually, waste is compressed to around one fifth of the original volume and wrapped in clear linear low-density polyethylene (LLDPE) film. It is then reloaded onto larger trucks and transported to final disposal sites in Kamphaeng Saen, Nakorn Pathom Province, or Phanomsarakam, Chacheongsao Province. Of collected waste, 89% is transported to final disposal sites and the remaining 11% is recycled, for example, through composting.

(3) Industrial waste treatment

Industrial waste composition in Thailand is divided into nonhazardous and hazardous waste. Annual industrial waste generation varied from 2003 to 2009. For 2003, total nonhazardous waste was around 2.1 million tons, increasing to 23.1 million tons in 2009. Hazardous waste generation was around 0.3 million tons in 2003, increasing to 2.2 million tons in 2009.

Industrial waste treatment and management facilities vary with the type of factory. There are at least three types of waste facilities in Thailand. For factory type 101, there are 140 treatment plants; for factory type 105, there are 1,096 plants at disposal facilities; and for factory type 106, there are 335 plants at recycling facilities. Every type of industry uses specific waste treatment facilities. Factory type 105, for example, has 5 hazardous waste landfill sites and 17 nonhazardous waste sites.

Map source: Google map

Figure 2.13 Location of waste transfer stations and landfill sites for municipal waste treatment in Bangkok

Table 2.9 Normal municipal waste properties in Bangkok (physical composition)

Waste type	Composition (%)
Food scraps	48.41
Plastics	24.83
Paper	7.67
Wood	6.46
Textiles	3.99
Glass	2.56
Metals	1.72
Styrene foam	1.55
Leather and rubber	1.40
Bones and shells	0.76
Stones, ceramics, and debris	0.65
Total	100.00

Source: BMA, 2011

Table 2.10 Normal municipal waste properties in Bangkok
(density, 3 components, heat value)

Item	Value
Density （kg/L）	0.38
Water content （%）	55.6
Volatile solids （%）	37.93
Ash （%）	6.47
Heat （kcal/kg）	1,373

Source: BMA, 2011

2.3.3 Bangkok waste disposal during flooding

(1) Disposal of municipal solid waste generated from submerged housing

Floodwaters approached from the north of Bangkok from September to October 2011, when provinces north of Bangkok had already been flooded. Although it was not certain whether Bangkok would be inundated, the BMA set about increasing capacity to collect waste in districts most likely to be inundated among the 50 in Bangkok.

At the end of October, floods started to inundate some districts in Bangkok, with water 1 to 1.5 m deep, making it impossible for waste collection trucks to collect garbage. Refuse collectors therefore parked trucks just outside of inundated districts, proceeded into districts on foot, collected garbage house to house, and brought it back to trucks. In some districts, they used small boats to collect garbage, which, although more efficient than on foot, could not reach all inundated areas due to a boat shortage.

To reduce the chance of infectious disease outbreaks cause by waste such as rotting garbage, the BMA tried collecting and disposing of flood waste as quickly as possible. At the end of November, when floodwaters started to recede, the BMA planned full-scale waste, but so much waste had been generated that waste could not be collected quickly enough using only BMA trucks. According to an interview with BMA spokespersons, the flood waste collection phase was very hard. All of the 2,031 collection vehicles, such as compaction trucks with 2–10 ton capacity, side-loading trucks with 12 m3 and 1.5 ton capacity, plus recycle trucks, loading container trucks, collection boats, and wood-shredding trucks, was very small compared to the huge amount of waste generated.

The BMA therefore asked private companies to provide trucks and drivers to collect waste. Note that the BMA did not ask for their voluntary cooperation and was prepared to pay for the provision of trucks and drivers. Some companies declined the request, however, saying, for example, they had to get on with their own businesses. Additionally, many truck drivers who lived in surrounding inundated provinces rather than in Bangkok had returned home during flooding, so their employers could not contact them. The BMA thus could not get a sufficient number of trucks, and needed around two months to finish collecting the large amount of waste after floodwaters receded.

There are normally waste transfer stations in three locations in Bangkok. During flooding, however, with even the six additional temporary transfer stations created to handle postflood waste, capacity was not sufficient. The permanent On Nut transfer station, with a disposal capacity of 4,000 tons per day, accepts 1,800–3,000 tons of waste per day — an average of 2,400 tons —which then, under normal conditions, is then manually sorted, compressed, wrapped, reloaded onto larger tracks, and transported to a final disposal site in Chacheongsao Province.

When districts within Bangkok were flooded, however, the amount of waste being brought to On Nut increased rapidly, exceeding 8,000 tons on peak days. The station could not keep up with this influx and temporarily placed overflowing waste in a vacant lot outside the station. Due to inappropriate truck entrance and exit placement at this overflow site, traffic backed up and drivers began complaining. In addition, according to an interview with a private waste-management company operating the On Nut transfer station, the company continuously feared that the station would be submerged during flooding. If that had happened, the ability to collect and transport waste in Bangkok would have been drastically reduced -- in the worst case, waste would have had to be transported directly to the final disposal site in Chacheongsao Province more than 100 km from Bangkok without being transferred. Such transport would have been extremely inefficient.

Estimated 3,25 Million ton disaster waste generation during three months flood in Thailand, or It were around 53, 240 tonnes per day in average (Piyapanpong, 2013). Means, responsible organizations must accelerate, increase their capacity for around six times compared the existing condition for three months. The BMA estimates that the additional amount of waste generated in Bangkok by floods was around 100,000 tons -- this is only the amount generated within Bangkok for which the BMA is responsible and does not include waste generated in provinces outside Bangkok -- so the actual amount of flood waste exceeded 100,000 tons. According to the BMA, about three million people live in inundated districts in Bangkok. Dividing 100,000 tons by three million people gives a rather rough estimate of 33 kg per person of flood waste generated per capita in affected districts. Since those living on upper floors of high-rise buildings were not affected by flooding, the amount of flood waste per capita was actually much larger.

Official statistics on flood waste composition have not yet been issued. According to an interview we conducted with the BMA, wood furniture accounted for 80% of flood waste and normal waste made up the remaining 20%. The interview also revealed that waste pickers salvaged discarded furniture that looked reusable. As part of the field survey in Bangkok in January 2012, we conducted simplified waste composition analyses at three locations thought to be flood waste collection sites, shown in Tables 2.6 and 2.7. Although there were large differences between locations, the average proportion of wood - mainly plywood or particleboard - amounted to 54.1% findings consistent with information obtained through the BMA interview. It is thus an important issue how large amounts of wood waste generated during flooding are handled. In the case of Thailand, almost all flood waste, except for furniture salvaged by waste pickers, was probably buried as is. It would be possible to efficiently use an enormous amount of wood waste if it were handled in separation and recycling processes.

Another problem is that, while studying flood waste in Bangkok, we frequently witnessed garbage being burned on streets, even in densely populated residential neighborhoods. It is unclear whether this practice is followed only during floods or also under normal conditions. In any case, residents should be directed to refrain from burning garbage in residential neighborhoods.

Table 2.11 Waste analysis findings at locations thought to be flood waste collection sites (results from simplified sampling)

Composition	Weight (kg)			
	Location A	Location B	Location C	Average
Food waste	-	-	-	-
Plastics	6.81	2.3	3.76	4.3
Paper	3.34	1.73	0.43	1.8
Wood	8.13	15.14	25.91	16.4
Textiles	1.45	1.44	1.39	1.4
Glass	1.36	2.08	0.23	1.2
Metals	2.11	0	0.42	0.8
Styrene foam	0	0	0	0.0
Leather, rubber	0	0	0.68	0.2
Bones and shells	0	0	0	0.0
Stones, ceramics and debris	4.04	1.43	6.78	4.1
Total	27.24	24.12	39.60	30.3

Figure 2.14 Disaster waste composition analysis after Thailand flood 2011
Foto in Bangkok, January 10, 2012

Table 2.12 Waste composition compared under normal and flooding conditions

Composition	Normal condition (%)	Flooding (%)
Food waste	48.4	-
Plastics	24.8	14.1
Paper	7.7	6.0
Wood	6.5	54.1
Textiles	4.0	4.7
Glass	2.6	4.0
Metals	1.7	2.8
Styrene foam	1.6	0.0
Leather, rubber	1.4	0.7
Bones and shells	0.8	0.0
Stones, ceramics and debris	0.7	13.5
Total	100.0	100.0

(2) Industrial waste disposal from submerged industrial park

During floods, seven industrial parks north of Bangkok were submerged, generating a huge amount of industrial waste (Fig.6). Businesses that generate industrial waste are responsible for its disposal, and the Ministry of Industry (MOI) and the Department of Industrial Works (DIW) are in charge of supervising and advising these businesses. Industrial waste is broadly divided into hazardous and other industrial waste. When waste is removed from a factory and a waste-management company is commissioned to dispose of it, the removal company needs to apply for permission from the DIW via the Internet, reporting the waste type, amount, and disposal method, the companies commissioned for its collection and transport, intermediate treatment, and final waste disposal. The disposal of hazardous industrial waste, in particular, is strictly supervised. While under normal conditions, it takes several days for the DIW to grant permission after receiving an application, the DIW said that during flooding it tried to reply within a day of receiving an application.

Photo in Bangkok, January 8, 2012

Photo in Bangkok, January 8, 2012

Photo in Bangkok, January 8, 2012

Photo December 10,2011

Figure 2.15 Disaster waste in industrial area after Thailand flood 2011

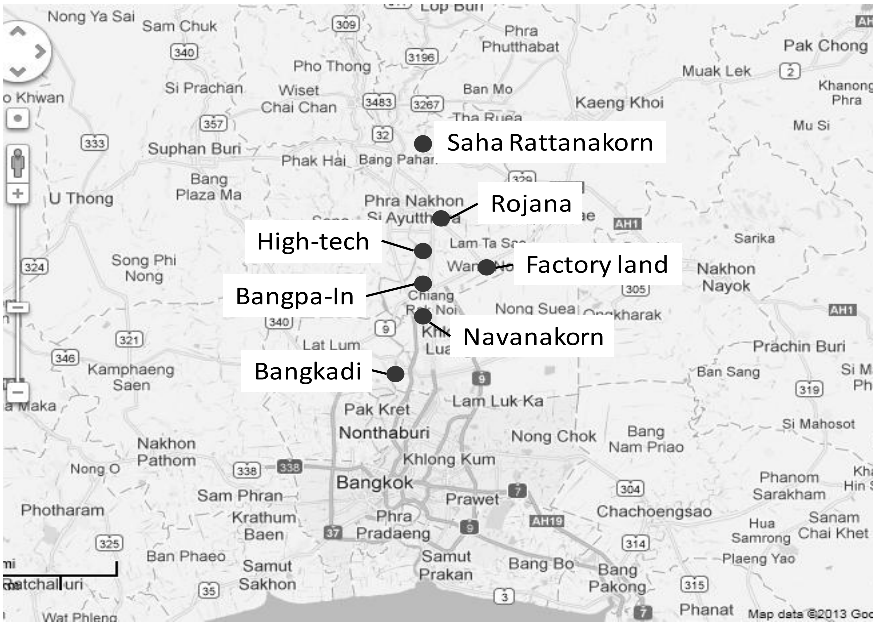


Figure 2.16 Submerged seven industrial parks in the north of Bangkok

During flooding, industrial waste from submerged industrial parks and municipal waste were generated simultaneously as mixed flood waste. After flooding, this mixed waste was moved from factories to places such as parking lots outside factories, where it was stored temporarily. Municipal waste collection trucks then came and collected the mixed waste without separation. Afterwards, this mixed waste seems to have been buried. Even if the mixed waste contained hazardous waste, it was not disposed of appropriately, so there is the possibility that contamination may have occurred. Officials in charge of municipal waste disposal were not familiar with types of hazardous waste, however, so they did not recognize this problem. The DIW recognized this problem, however, and directed submerged factories to handle industrial and municipal waste separately. It also dispatched a team of experts to advise the industrial parks not to dispose of hazardous waste inappropriately. Prior to this, however, a rather large amount of mixed waste was presumably collected by municipal waste collection trucks, and the DIW regards this as an area to be improved in the future.

2.3.4 Problems in flood waste treatment

Some findings on flood waste treatment gathered during observation and field investigations in Bangkok during December 2011 and January and February 2012 follow:

In the first stage, problems due to waste management arose related to how to collect waste during floods. Since flooding inundated areas for more than two weeks, most trash containers floated. Community members could not dispose of garbage as usual in bins. In addition, garbage was scattered everywhere. Workers found difficulty in collecting the garbage Because, for example, they could not use their vehicles in some areas or, using simple boats, went down inundated streets. To collect scattered waste, they used bucket filters and threw them into bins in the boats as, using megaphones they called residents to dispose of waste. BMA officials were overwhelmed trying to supply this “new” collection system. Besides limitations on boats due to high demand, other difficult conditions included the absence of workers and drivers kept away from their regular by flooding. A public campaign on how to dispose of and collect waste during flooding had not yet been run. Residents and the BMA were not yet prepared for solid-waste discharge and collection during flooding.

There was an additional 100,000 tons of municipal flooding waste during 2011 monsoon flooding in Bangkok. The BMA tried to get additional vehicles by contracting with private companies to collect and transport this huge amount of waste, but companies rejected plans for financial reasons -- not to mention the financial and other problems these companies faced on their own due to flooding! Planning for emergency municipal solid-waste transport, including memorandums of understanding with private companies, had not yet even been designed.

In the aftermath, the community simply disposed of waste by leaving on streets and sidewalks, leading to mountains of flood waste along every roadside. The nine -- –six temporary and three permanent -- storage sites available were too overwhelmed to handle the huge amount of postflood waste. Because of long lines and slow transport, many instances were found of direct flood waste burning in the streets. The preparedness of appropriate temporary storage to manage the disaster waste had apparently not yet been considered by BMA officials.

The dominant waste component was found to be furniture, wood, and trees. No recycling process or recycling machinery was introduced in the community to treat this wood, plus the plastic and other recyclable flood waste. Some waste pickers and solid-waste workers simply sorted through on their own and picked up flood waste economically value in their own estimation. No recycling, sorting, or reduction scenario had been planned to handle flood waste.

About four times the usual amount of waste was transferred from transfer stations to the On Nut station. With no traffic assessment and no good space arrangement to manage flood waste, traffic jams due to transport vehicles and flood waste led to driver stress and complaints. If On Nut had also been inundated, the transfer station could not have managed solid waste before final disposal. Direct transfer of flood waste from the source to final disposal is environmentally unfriendly and harmful.

Flooding also generated industrial waste, which municipal waste collection trucks came and collected as mixed industrial-municipal waste but without separating them. Afterwards, this mixed waste seems to have been buried. Especially if mixed waste contained hazardous materials, there is the possibility that contamination occurred if it was not disposed of appropriately.

Photo in Bangkok, December 9, 2011

Photo in Bangkok, December 9, 2011

Photo in Bangkok, December 10, 2012

Photo in Bangkok, January 10, 2012

Figure 2.17 Disaster waste after flood discharged to the street, and field incineration

2.4 Discussion

2.4.1 Discussion of evaluation of disaster waste management in Indonesia 1990-2012

(1) Planning for treatment and implementation

Estimation of disaster waste estimation

Modification of the disaster waste estimation by introducing type of housing in Indonesia conducted to administer type housing associated with ethnic in Indonesia. It was introduced to promoting statistical data according to the type of location and ethnic that disaster attack. Understanding type and characteristic of building and housing in every ethnic in Indonesia would help more precise of disaster waste estimation. The estimation was developed mostly for evaluate the disaster waste generation such as earthquake, earthquake tsunami. Estimation for disaster waste generation for flood and volcano eruption and other specific disaster hit in Indonesia need additional analysis.

There was no formal statistical data toward disaster waste generation in Indonesia. Since disaster event tend to increase, building database associated with disaster waste estimation was could be incorporated with development of local, provincial, national facility to improve disaster management. Availability statistical data and information waste very needed to execute emergency respond in handling and treatment. Providing data could be started from any type of disaster in any location. Step by step of registering disaster waste would lead a comprehensive data of disaster waste and for forecasting and estimating disaster waste generation to make more easily and effective respond in future event.

Disaster waste process

Disaster waste management was conducted to ensure that there was no public health disturbance and environmental impact or degradation cause by damage. Although there was no accident, negative impact recorded cause by un proper disaster waste management, fostering disaster waste process should be conducted. Within the informal process, volunteer and survivor community in Indonesia have been clean up debris to reuse and recycle. They mostly treat waste as usual waste (household waste), fostering community to understand disaster waste would help formal process of disaster waste more effective especially for bodies date management, hazardous waste management. Because of lack of understanding, volunteer and survivor community process the waste from industrial as household waste. It was need to foster mechanism of waste treatment from industrial activity including organization in internal industry.

Mostly intermediate treatment such as recycling and reuse any material that possible to recovery have been done by survivor community and volunteer within informal mechanism, since the over capacity of responsible organization. For example, in the Yogyakarta earthquake 2006 disaster community in Bantul Yogyakarta create temporary storage install machine to reducing size of construction and demolition waste. There was no statistical recorded intermediate process statistical data due to major disaster in Indonesia (except construction and demolition waste from Indian tsunami waste in Banda Aceh). However, responsible organization utilized especially for construction and demolition waste for disaster recovery such as land cover and other possible utilization.

Availability of equipment and tools to handling disaster waste was very essential. Determining of equipment and tools was vary, depend on the characteristic and composition of disaster waste. However, local government difficult to ensure standard minimum of equipment such as Bulldozer, excavator, crush stone and truck for transport and transfer of disaster waste. there were no statistical data recorded of additional equipment from other institution both government institution from outside area affected or additional equipment from private and non government organization. There no statistical data due to time waiting and delay of disaster waste handling for example, at what time after disaster minimum standard time acceptable for running the disaster waste service in Indonesia.

Final disposal of disaster waste was the most critical condition. There was no statistical data was recorded about acceptability of final disposal system. Furthermore final disposal of disaster waste mostly performed as similar with municipal waste final disposal. There was no statistical data describe method of industrial disaster waste disposal during Indonesia major disaster 1990-2012. Industrial waste disposal system was need to ensure that no disturbance to human and environmental. There was no statistical data recorded final disposal system of hazardous waste during Indonesia major disaster 1990-2012.

(2) Planning for management

Legal framework

There were four basic legal framework for insure environmental manner of Indonesia disaster waste management. The legal framework regulates four basic of disaster waste management issues. First associated with spatial planning regulation, that regulates the degree of activities in urban and rural, type of activities including building code. This regulation could be used to estimate disaster waste generation as previously discussed. Local state government should ensure the enforcement of this regulation. Local government need to ensure the system information associated with spatial planning was connected to the licensing section such as one stop or public services.

Legal framework associated with responsible organization and timeline of service including budgeting were regulated by Indonesia law number 18 in year 2008 and Indonesia law number 24 year 2007. Several point that should be considering for Indonesia case:

- Mitigation and preparedness of disaster waste management
- Emergency response for insure human safety and stage of disaster treatment option for post disaster management
- Rehabilitation and reconstruction of damage waste management facility

Legal framework associated with environmental safety including standard minimum of service is regulated by by Indonesia law number 23 year 2007 and Indonesia law number 32 year 2009. There several point that should be considering for Indonesia case:

- Type and number of guidelines that should be provide
- Standard minimum of services that should be provided by central, provincial and local government
- Standard minimum of disaster waste treatment

Institutional framework

Public private partnership and public private cooperation were the formal term of institutional framework associated with public services. In Indonesia characteristic, there was a pattern known as ``gotong royong``, a term of community humanitarian action to help each other in Indonesia, both daily life or in un-normal condition such as disaster event. Furthermore the pattern of ``gotong royong`` was elaborate in rehabilitation and reconstruction such as for community building back which govern only regulates the financial mechanism while community responsible for implementation. Merapi eruption 2010 rehabilitation and reconstruction for community housing, including waste management in small level such as village utilized this mechanism. Department of Environmental cleansing, department of public work, was the responsible organization in Indonesia should developed minimum standard of coordination and mechanism by refers to the coordination and mechanism that have been provide by National Disaster Management agency.

Budgeting system

Budgeting for disaster waste management mostly was incorporated within waste and sanitation sector (except tsunami waste management program in Banda Aceh). Depending type of disaster and location, budgeting for disaster waste management was vary. Budgeting mostly allocated for emergency respond to fostering safety life, clean-up roads from any debris. There was no formal data that published, according to the step and stage of disaster waste especially for recovery facility, so local, provincial and central government should initiate to administer budgeting allocation for recovery facility. Depending of type, degree of damage, scale government in central, provincial and local level determine proportion of funding and budgeting. By administering budget for every type disaster waste, annual data could be recorded in turn could be utilized to estimate minimum standard for planning and fostering preparedness.

2.4.2 Discussion of evaluation of disaster waste management in Thailand after flood 2011

(1) Municipal flood waste treatment

Waste management in inundated should cover waste from daily activity and waste that generated as impact of flood (disaster waste). In collection stage, first problem is founded such as the collection facility (dustbin) in community floating. Community cannot discharge the garbage as usual on their dustbin. garbage scatter everywhere due to inundate. Workers found difficulties to collect the garbage. In some area they cannot use daily vehicle. Collection waste by boat were limited. Collection in inundate condition conducted by :

- bucket filter, throw it to the bin in their boat,

- Microphone to call the people to discharge their waste.

Responsible organization overwhelmed to supply this new system collection. Beside the limitations of the boat due to peak demand, the worker and drivers absence since they suffer flooding. Public campaign especially on how to discharge and collect the waste during flooding not yet run before. Pre planning for waste management in flood situation not yet conducted.

There are Estimated 3,25 Million ton disaster waste generation during three months flood in Thailand, or It were around 53, 240 tonnes per day. Some additional vehicle try to get by contract with private company to collect and transport this huge waste, however the private company rejected, for financial reason, beside the private company also suffer from flood. Planning for emergency municipal solid waste transport, including MOU with private company not yet design.

In the aftermath, the community just discharged the waste on the streets and sidewalks, so mountains of flood waste were found along every roadside. Nine temporary storage sites were too overwhelmed to cover this huge waste. Because of long lines and slow transport, many instances were found of direct burning of flood waste in the street. The preparedness of proper temporary storage to manage the disaster waste had apparently not yet been considered by BMA officials.

The dominant component found was furniture/wood/trees. No recycling process and no recycling machine was introduced in the community to treat this wood, plastic, and other recyclable flood waste. Some waste pickers and solid waste workers simply sorted and picked up the flood waste of economic value in their own way. No scenario of recycling, sorting, or reduction had been planned to handle the flood waste.

About four six times of waste generated compare with daily waste generation. The disaster waste then transfer as usual, However, there was no traffic assessment and also no good space arrangement to manage the flood waste. The traffic jam created drivers' stress and complaints. Furthermore, If the transfer station also inundated, it was cause dangerous since the waste could not be managed before transfer to the final disposal. Transfer directly of waste from inundate area into the final disposal location was dangerous harmful.

(2) Industrial flood waste treatment

Flooding disaster for at least three months in Thailand cause inundate in industrial and generate industrial waste. and generate flooding waste. There were hazardous waste and non hazardous waste in industrial estate. Because of the inundation, the hazardous waste and non hazardous waste mostly scattered. Normal management for industrial waste very difficult to conduct, than possibility to merge with municipal waste was high. Drivers from municipal collect the industrial waste as municipal waste because of the location and the composition of industrial waste become similar with municipal waste that consist of metal, wood, paper, rubber, chair, desk, board, event there were many electronic equipment and damage machinery or cars.

Disaster waste management from industrial estate was vary depend on type of factory or industry and type of raw material. Government, responsible organization and company should insure that the waste industrial treatment and waste management facilities could handling the disaster waste generated by industry. Fostering mechanism and evaluation toward flood waste handling in industrial estate was need.

2.5 Conclusion and proposal for fostering disaster waste management

2.5.1 Conclusion and proposal for fostering disaster waste management in Indonesia

According to the study, some conclusion and proposal for fostering disaster waste management in Indonesia were summarized as follow:

- Pattern of disaster waste management in Indonesia for two decades (1990-2012) could be classified as three periods; First periods is condition before Indian tsunami disaster 2004; Second periods is condition after 2004 until 2008, and Third period is post 2008 conditions.
- Characteristic of disaster waste management pattern in the first periods as follow;
  - There is no plan for disaster waste management.
  - There no formal institution at which responsible to making a plan and evaluate disaster waste management performance.
  - Coordination between government institution is design to give emergency relief.
  - There is no statistical for disaster waste management such as formula to estimate disaster waste generation, intermediate treatment and and final disposal method.
- There is no disaster waste management mechanism issued such as plan, task force, financial mechanism, institutional network and sharing resources. In this period, disaster waste management conducted only for emergency response.
- This study proposed method to measure disaster waste generation by exploring characteristic of housing in Flores Island (estimated :180,000 tonnes) disaster waste generated in Flores tsunami 1992, with (estimated : 90,000 tonnes) generated in Maumere city.
- Second periods from 2004 to 2008 could be defined as is transition periods, at which as a part of Indian tsunami 2004 disaster recovery, there is a tsunami recovery waste management program (TRWMP), an importance experience of disaster waste management in Indonesia. Even though this activity fully support by international donors, several points could be emphasized according to the program:

- Disaster waste management is a process to treat lot of waste (huge) need acceleration of resources such as worker, facility, and financial.
- There is a procedural (stage of process) that should be plan and organized, different with daily waste management
- Disaster waste management requires a special coordination, especially for sharing facility, equipment, tools and resources.
- Collecting, transfer and transport need a lot of resources.
- Environmental, cost and psychological aspect should be considering to achieve ideal service of disaster waste. There are also complicated issues, because first goal of debris clean up is safety life, and bodies date management, that need a special capability. Moreover, waste from hospital including medicine, industrial waste and dangerous waste, household waste, waste from commercial area such as electronic, automobiles, rural urban damage facility including all construction waste also need special capability.
- Maximize of intermediate treatment such as reduce, reuse, recycle and reproducing reduce economic loss, provide opportunity for likelihood, and accelerate disaster recovery.
- Constructing final disposal such as landfill need special effort in resources and coordination between stakeholder.

• Although there is no formal organization for handling disaster waste, in the second period there is a pattern of coordination between central, provincial and local government for handling disaster waste. In this periods Indonesia government issued regulation on disaster management including disaster waste handling associated with timeframe, financing & stakeholder trough Indonesia law number 24 year 2007. Moreover, Indonesian government issued law number 26 in year 2007 concerning spatial planning, a guidelines to fostering preparedness in hazard associated with land use including landslide disaster at disposal site. The changing of institutional coordination explored in Yogyakarta-Central Java earthquake 2006, Jakarta flood 2007.
• Third periods is condition of disaster waste management in post 2008 could be defined as promoting and fostering proper disaster waste management system. In this third period promoting and fostering preparedness to achieve proper disaster waste management is signed as main goal. By establishment of national disaster management agency (BNPB) in year 2008, a significant pattern of organizational system is changed from ad hoc organization into formal agency. Department of public is determined as responsible organization in disaster waste management. pattern of planning for disaster waste management also change, from emergency respond to plan for mitigation and

preparedness. There is a straight line of coordination between national, provincial and local government

- Even though there is a significant changing in pattern of planning, a statistical record of disaster waste management in West Sumatra earthquake disaster 2009 not yet found.
- Flood disaster waste management in Thailand after flood 2011 gave evidence that preparedness for disaster waste management especially for city in south east Asia is very needed. Preparedness should be perform in all stages of disaster waste handling such as modification equipment for collection and transfer, prepare boat, making pre planning to anticipated worker and drivers absence, making alternative contract with private company to additional equipment. Prepare intermediate treatment, mechanism to open burning, prepare for transfer station, prepare for treatment industrial waste and alternative final disposal method.

While for the proposal for fostering disaster waste management in Indonesia, were summarized as follow:

(1) Plan for disaster waste treatment

Estimation of disaster waste generation

The study have proposed model to estimate disaster waste management according to the type of building in Indonesia. To increase the accuracy of disaster waste management responsible organization should conduct several program as follow:

- Developing a mechanism to sharing statistical data of disaster waste generation for each disaster events
- Developing a mechanism to sharing statistical data of disaster waste generation for each level of disaster (local, provincial and national scale).
- Maintenance statistical data of disaster waste generation for each disaster event in each type of disaster.

Disaster waste process

Building database in every stage and type of disaster waste management will help to construct comprehensive and advance knowledge of disaster waste management in developing countries. Application of the guideline in every stage of process should be ensure in every type of disaster waste event it was a small disaster. To foster effective and efficiency of disaster waste management, some proposal associated with disaster waste process were introduced as follow:

- Building statistical data in every stage of process, collection, shorting, recycle, reuse, reproducing, temporary storage and final disposal method base on type of disaster
- Fostering system data information and management in disaster waste management in disaster waste estimation, process and method for handling
- Evaluating and fostering capability of responsible organization regularly
- Design indicator to evaluate performance for all stage of process ; mitigation, preparedness, emergency respond, respond, rehabilitation and reconstruction regularly event for small scale disaster, with representative type and location

(2) Plan for management

Legal framework

To foster effective and efficiency of disaster waste management, some proposal associated with legal framework of disaster waste management were introduced as follow:

- Building guidelines for disaster waste management which ensure the role between central, provincial and local government
- Building any possibility of guide line associated with disaster waste process best on type and characteristic of disaster waste generation in Indonesia
- Evaluating and fostering regulation and guidelines regularly

Institutional framework

To foster effective and efficiency of disaster waste management, some proposal associated with institutional framework of disaster waste management were introduced as follow:

- Evaluate and Fostering coordination of responsible organization both formal and informal (networking) regularly
- Evaluate stakeholder awareness, concern and motivation to prepare disaster waste management with representative type, location in national, provincial and local level
- Evaluate community acceptability, preference and possibility to participate on disaster waste management

Budgeting system

To foster effective and efficiency of disaster waste management, some proposal associated with mechanism of budgeting of disaster waste management were introduced as follow:

- Building guidelines for construct standard cost in disaster waste management which ensure the role between central, provincial and local government

- Building any possibility of guide line to construct unit cost associated with disaster waste process best on type of disaster waste and location
- Evaluate mechanism of budgeting regularly.
- Fostering public participation in disaster waste financing.

2.5.2 Conclusion and proposal for fostering disaster waste management in Thailand (flood disaster waste)

There are three stages of preparedness planning for handling disaster waste such as that from floods (Manuta et al, 2016; Beraud, 2011). Proposals for improving the handling of flood waste disasters in Bangkok and surrounding areas and for fostering more appropriate management in the future, are as follows:

Pre-disaster

In this stage, major activities are planning for preparedness. This preparedness planning includes planning during normal conditions and planning for preparedness in response to an impending emergency response.

Major activities in the preparedness planning during normal times include the following:

- A basic statistical analysis to estimate flood waste based on a hazard map should be conducted.
- Preparation is needed to increase waste collection capacity during flooding. It is necessary to come to an agreement with companies owning trucks, such as building contractors, so that they can be asked for assistance with waste disposal during flooding. It is also necessary to enhance communication with truck drivers who are to be involved in the collection and transport of waste. In addition, boats necessary to make waste collection during flooding more efficient should be secured.
- Temporary site storage, including an alternative spatial design/arrangement for temporary storage, spatial arrangement for truck maneuver, recycle space, and untreated waste, which will be disposed of should be investigated. Stations transferring waste collected in Bangkok during flooding received waste exceeding twice their normal capacity. When the stations cannot keep up with the influx of waste, they store it temporarily at nearby locations. Appropriate plans must be made concerning locations of temporary stations and so that station truck entrances and exits are arranged, as must planning for how to separate waste. If transfer stations are submerged, the ability to collect and transport waste is drastically reduced. Alternative waste transfer locations must be planned to prepare for this.

- Analysis is needed for more precise prediction of flood waste. Such prediction should result from an estimation of damage during flooding and its aftermath. Using representative maps or system information architecture, prediction could clarify policy judgments. What the composition and estimated amount of flood waste are should have clearer answers at this stage.
- More detailed plans should be prepared for vehicle and boat procurement for waste collection.
- Dissemination of flood waste management rules, including schedules, procedures for transfer to temporary storage, and treatment possibilities in temporary storage should be conducted.
- Investigating methods for recycling wood waste such as chips and board is needed for recycling, because a large amount of wood waste is generated during flooding.

During disaster

When flooding occurs and areas are inundated for several weeks, activities to be implemented in flood waste treatment are as follows:

- It is important to conduct appropriate collection of flood waste using suitable equipment and tools, including boats and bucket filters,
- Assigning roles and direction for waste collection workers and implementing emergency planning for collecting waste is needed.
- Updating the estimation of flood waste correctly for flood waste treatment is vital.
- Implementing emergency plans for flood waste treatment and public information campaigns are needed, especially where industrial and municipal waste may be mixed and hazardous waste disposed of as municipal waste, causing potential contamination. It is thus necessary to ensure that hazardous waste be disposed of appropriately.
- Implementing temporary storage operations for handling of ongoing flood waste is necessary.

Disaster aftermath

Activities should be conducted after flooding to rehabilitate and reconstruct damaged waste management facilities. Possible activities are as follows:

- Rapidly assessing and checking damage to waste management facilities and equipment, including rapid assessment of technical facilities and the government’s official capability for handling flood waste aftermath

- Conducting and implementing possibilities of using facilities for cleaning up flood waste around inundated areas is needed.
- Integrated flood waste treatment in temporary site storage, including recycling and reduction of flood waste, must be improved and upgraded as much as possible.
- Implementing appropriate evaluation methods for fostering management for future flood events should be comprehensive, covering all management aspects, including technical, financial, public concern, public participation, organizational arrangement and coordination, roles, and resource mobilization.

CHAPTER 3

Designing Indicator for Evaluation of Disaster Resilience on Waste Management in Developing Countries

3.1 Introduction

Performance of disaster waste management is influenced by system capacity and vulnerability that are associated to the type of social environment and hazard. However, In developing countries, measuring performance in disaster waste management is very difficult to conduct because the standard mostly not yet constructed. Moreover, It is seem like in the ``grey area``. For example, because of the poor municipal waste services, so much waste were disposed into the drainage facilities and rivers, so that it caused the blocking of the water flow, then it would bring about flood (Beraud, et all, 2011). In Jakarta for example, it was estimated 2.6 ton of waste were disposed into the drainage facilities and rivers and more than 80 billion Indonesian rupiahs was allocated to clean-up waste from the rivers (Department of public work, Jakarta province, 2011).

This study proposed a model to evaluate the disaster waste management performance in developing counties. Disaster resilience index on waste management (DRWMi) is developed to measuring the capacity, preparedness and vulnerability in disaster waste management. DRWMi is constructed as a value at which represent the condition of waste management system. It is a comparison relatively between one location to another (Davidson, 1997; Simpson, 2006). Indonesia was selected as a case study due to the occurrence of many disaster events and a lot of effort needs to be conducted to improve disaster resilience on waste management. Several representative cities are also selected for detailed assessment.

Figure 3.1 Clean up municipal waste from a river
Photo: author, August 2012

DRWMi is proposed to introduce the disaster waste management planning for. There are a lot of disaster waste management issues for developing countries, which make it difficult to start planning (Brown, 2010; Brown, 2011 b). There were many possible issues such as in technical, financial, legal framework, organization where most of the issues have influence each other (Shekdar, 2009). Investigation of these issues especially in preparedness and achievement of disaster waste management would reduce the complexity of the plan. This study proposed a method that merge both qualitative and quantitative approaches to evaluate the performance of disaster waste management in developing countries. Moreover, this study developed approach to summarize the aspect of disaster waste management by using some selected representative parameters. In the perspective of impact to the environment, disaster waste impact is unpredicted and there are some possibilities such as at the local and regional scale or short term and long term (Berren, 1982; Srinivas, et al, 2008). This study provides initial assessment to predict the performance of some prevention effort to eliminate impact associated to scale, time and location.

Many indicators and parameter that should be considered for assessment, and social indicator is very complex (Cutter et, al, 2010; Brawn, 2011b). For example, the Indian tsunami disaster recovery studied as the post disaster learning according to the disaster waste management needed a model that assess the impact of process (Srinivas et al, 2008; Wiliam, 2008). This model provided an approach to assess the impact of disaster waste management process to ensure technical, economic, and social capacity. Moreover, this study provided a method to assess the resilience in disaster that was very needed to design the planning for fostering resilience in disaster waste management in developing countries (Brown, et al, 2010; Manyena, 2006). This study proposed a method to map composite and strategic issues in disaster waste management.

Comprehensive disaster waste management provide insight in mitigation, preparedness, response and recovery phase (FEMA, 2007; UNOCHA, 2011). There was no method introduced to assess the disaster waste management (Milke, 2011). This study select parameter that indicates the phases, however, preparedness such as preparedness in disaster waste management was featured to fulfill the lack of information (Milke, 2011; UNOCHA, 2011). However, measuring disaster waste management preparedness may rarely, exploring the basic condition needed to investigate the basic problem in planning for disaster waste management. For developing countries, this study is an initial process to develop the planning for disaster waste management for both local and regional. By understanding case by case of indicators, it would help to provide statistical data and record to foster disaster waste management. For examples if the index select the organization capacity as an indicator, it would be helpful to solve organization capacity that usually become a big issues in developing countries, (Karunasena et al, 2009). Organizational coordination also becomes a main problem for Haiti earthquake recovery (Hou and Shi, 2010).

3.2 Methodology

3.2.1 Development model for measuring disaster resilience index on waste management

Disaster resilience index on waste management ($DWRM_i$) is defined as the quality or performance of waste management system to manage disaster waste. Disaster resilience on waste management index is a number that describes capability and stakeholder achievement in preparing of disaster waste management. DWRMi was proposed to evaluate pre planning for disaster waste management. The evaluation result was utilized to perform planning for disaster waste management. Performance in DWRMi was determined by the capacity and preparedness and the ability to minimize the vulnerability. This study assumes that indicators of capacity and preparedness are the result of stakeholder effort to perform the planning for disaster waste management in the current situation. Furthermore, indicators for socio-economic vulnerability is effort of the development, while indicators for hazard using statistical data of previous events (Davidson, 1997; Simson and Katirai, 2006). Figure 3.1 depicts the procedure to construct DWRMi

1. EDRI: Urban earthquake disaster resilience index by Davidson, 1997
2. EVI : Environmental Vulnerability Index by South Pacific Applied Geoscience Commission
3. DRI : Disaster risk index by United Nations
4. Hurricane disaster risk by Davidson and lambert
5. Disaster risk and risk management by Cardona
6. Improvement disaster resilience in communities by Chang Shinozuka
7. Social flood vulnerability Index (Vulnerability flooding) by tapsell, Peuning-Rowsell, Tunstall, Wilson
8. SoVI: Social vulnerability to environmental Hazard by Cutter, Boruff, Shirly
9. Natural Hazard Index for Megacities by Munich re group annual review- natural catastrophes 2002
10. DPI: disaster preparedness index by Simpson & Katirai

1. Disaster waste management (develop countries)
2. Disaster waste management (developing countries)

Disaster resilience index on waste management

$$DRWM_i = \frac{\sum_i QW_i}{\sum_i V_i}$$

Figure 3.2 Procedure to determined the disaster resilience in on waste management ($DWRM_i$)

Disaster resilience index on waste management (DRWMi) is formulated by mathematical equation as follow:

$$\mathrm{DRWM_i} = \frac{\sum_i \mathrm{QW_i}}{\sum_i \mathrm{V_{xi}}} \quad (3.1)$$

$$\mathrm{DRWM_i} = \frac{(\sum_i \mathrm{C_{xi}})(\sum_i \mathrm{P_{xi}})}{\sum_i \mathrm{V_{xi}}} \quad (3.2)$$

The maximum value of DRWMi is 25 and the minimum value is 0. DRWMi is classified into five groups: very less (index value: 0-0.040); less (index value: 0.041-1.0); fair (index value: 1.1- 5); good (index value: 5.1-15) and very good (index value: 15.1-25.), Where,

$\mathrm{DRWM_i}$: Disaster Resilience Waste Management in location i (Nation/provincial/state)

$\mathrm{QW_i}$: Quality of service and performance of waste management system

$\mathrm{C_{xi}}$: Capacity

$(\mathrm{p_{xi}})$: Preparedness

$(\mathrm{V_{xi}})$: Vulnerability associated to the socio economic condition and hazard

xi : Type of indicators for capacity, preparedness and vulnerability.

3.2.2 Integrated indicator: criteria and description

The goal of disaster waste management mainly to ensure the safety of human being and to prevent environmental degradation (US EPA, 2005; UNOCHA, 2011;). In general, indicator is set to reduce and avoid negative impact to the environment (US EPA, 2005; UNOCHA, 2011;). However, indicator should reach economic and social condition of the community (Chaves,et al. 2011). There are several considerations for setting the indicator of waste management (Ristic, 2005). The system has to ensure to use unwanted material as much as possible; the system has to ensure the application of recycle, reuse and reduce as much as possible, the system has to ensure the application of the simplest technical application, and the system has to produce waste as a little as possible. Indicator assessment for evaluating the performance of disaster waste management was tend to be similar with the waste management concerning to stage of handling, however, the amount of waste, time allocation and psychology consideration toward ~~o~~ the affected people were determined by the performance of services.

In the context of resilience, the indicator of evaluation could be defined as an indicator to measure result and to measure the process of management (Manyena, 2006). Measuring result means to investigate degree of achievement, while measuring process means to explore achievement to ensure strategic issues of reconditioning and fostering the future events (Manyena, 2006). The indicator represents the cycles of evaluation and planning (Troachim, 1999; Manyena, 2006). To bridge both of measuring achievement and process to find strategic issues of resilience on waste management, this study accentuates the preparedness as an additional component in the assessment. Teixeira & Neves (2004) explored the general indicator to ensure that waste management include management entity, region and profile, personnel, physical, operational, quality of services and financial condition.

(1) Capacity

Technical capacity is a condition of existing system in waste management. (US EPA, 2005; FEMA, 2007, UNOCHA 2011) proposed general guideline for disaster waste management that cover from emergency respond, early recovery and recovery process. UNDP, (2005) issued general waste management indicator to evaluate waste management system and performance in normal condition such as condition of facility for collection and transport, facility to process waste, facility to dispose rest material of waste, including financial capacity. Shimaoka (1995); Hirayama (2010) Armijo et all (2011) introduced an indicator associated with condition of facility to handling waste and final disposal. JHA, et.all (2011) assessed the indicator for promoting sustainable waste management in low income group of cities such as waste generation, waste collection, waste facilities and municipal solid waste disposal. Aredze & Godfrey (2001) assessed the technical condition of waste management such as the landfill lifespan, general capacity to correctly dispose waste to landfill and rate of waste recycling.

Economic capacity is a condition associated with financial and cost for disaster waste management (FEMA, 2007). Luaritzen (1998) issued general consideration concerning the disaster waste process and financial needs to cover the process. Aredze & Godfrey (2001) introduced economic indicator as the ability of urban government to allocate the budget and any expenditure for waste management. Whiteman, et al (2001), explored the total cost for waste management for measuring the urban government capability. T.Silemou & Panagiotakopoulos (2005) identified the indicator of subsidies from government to community as a part of economic capabilities. Sittubak & Nitivattananon (2005) used capital investment cost and operation maintenance cost to assess economic and financial condition in Thailand which could be measured for disaster waste management. Armijo et all (2011) measured the condition of cost allocated for waste management to evaluate the economic condition. JHA, et.all (2011) assessed the indicators for promoting sustainable waste management that covers the per capita income, waste generation, waste collection, and recycling agent.

Organizational capability describes the ability of any responsible organization to cooperate with other institutions and to establish good networking (UNOCHA, 2011). In the perspective of government and organizational capacity, Whiteman, et al (2001) introduced some indicator that could be utilized for a setting indicator, such as the number of government institution that responsible in waste management JHA, et.all (2011) investigated recycling agent in low income countries to evaluate their networking. Kung (2008) investigated the need of communication system to ensure the networking system for waste and debris management. It was a track system to estimate the stakeholder availability and the community needs/complains concerning disaster and waste generation

Capacity to fulfill the environmental criterion is set to avoid environmental degradation because of the impact of waste generation (Ciffrian et al, 2013). In the simple environmental consideration, T.Silemou & Panagiotakopoulos (2005) introducing some indicators such as odor, visual impact, and convenience that were caused by waste generation. Armijo et al (2011) examined several indicator to reducing environmental impact due to waste generation by exploring the regulation in final disposal treatment, social participation, and social control in waste management. Ciffrian et al, (2013) proposed the alternative for waste monitoring at the final disposal process by assessing the capability of the biodegradable waste. Remaityte et al (2010) proposed the ability to sorting and classifying the type of waste as the basic requirement to reduce the environment pollution.

Table 3.1 Summary assessment of indicator and criteria of capacity

Indicator	Description	Author
Capacity		
Coverage area of service	First stage of DWM is collection and transport, while coverage area indicate the capability to collect and transfer DWM	US EPA (2005), FEMA(2007),
Percentage waste recyclable	Recycle was one of the main purpose of DWM, waste recycle rate and performance indicate stakeholder concern to optimize recycle	Nakamichi (1995); Harukaze (1997); JHA, et.all (2011)
Final disposal lifespan	Landfill site was the place of final process used in most of developing countries, lifespan of landfill site indicate the availability of place to conduct DWM	Shimaoka (1995); Hirayama (2010)
Proportion of waste fees collected	Performance of waste fees collection showed stakeholder concern associated with economic perspective of waste management, the higher fees collected the higher stakeholder concern will be.	Luaritzzen; (1998); UNEP (2005); Fema (2007), ; armijo et al, (2011)
Proportion of operational cost subsidies	Operational cost requirement indicates performance of equipment, tools in waste management, more higher cost associated with more complete process application since complete application need more technical support such as hard machine to reduce debris volume and recycle	Feter& Garry (2011) Fema (2007); Aredze & Godfrey (2001)
Availability of guidelines	Availability of guideline associated with stakeholder concern of legal framework, both of DWM and financial mechanism and planning for handling, more detail guide line means higher concern.	US EPA (2005), FEMA(2007), UNOCHA (2011)
Availability of institutional network	Availability of institutional network indicate organizational capacity, such as pattern for coordinating was handling, sharing tools requirement and process for of procurement.	FEMA(2007), Karunasena (2009); UNOCHA (2011)
Availability of system communication	System communication will improve the coordination and support of any additional equipment such as hard machine and truck.	Kung (2008); UNDP (2005)

(2) Preparedness

Brown, et al (2010) investigated general consideration factor such as availability of document planning as factors that influence the performance of preparedness on disaster waste management. In case of the planning for disaster management, social factors such as community enforcement, community resources, and coordination possibility with NGO should be considered to achieve an ideal performance of disaster waste management (UNDP, 2005; US EPA, 2005). Improvement in financial sector such as optimizing recycle in intermediate treatment were one of the option to enhance pre-contract agreement with other organization in handling waste management (Lauritzan, 1998; Feter &Garry, 2011)

Preparedness is an effort to ensure the readiness to take action (O`leary, 2004). Simple indicator of preparedness is by making a pre-planning for disaster waste management (Brown, et al, 2010). UNOCHA, (2011) issued the guideline that is ideal for preparedness was that the system has to ensure the coordination in internal and external organization, to ensure the availability of memorandum of understanding for procurement, until the alternative location for final disposal already prepared. FEMA, (2007) issued indicators of preparedness for disaster waste management such as the technical, economic including the component of payment and social consideration. Furthermore, FEMA, (2007) classified the component of payment into technical and organization need, and it affects both of private or community sector.

Preparedness is needed to describe the stakeholder effort to make better system of the disaster management (O`leary, 2004). In the context of disaster waste management, preparedness system covers general effort to construct the design plan, to develop a formula for estimation of disaster waste generation, to prepare possibility location for intermediate treatment, to prepare for final disposal (US EPA, 2005; FEMA, 2007; UNOCHA, 2011). It is also an effort to perform institutional and organizational networking (US EPA, 2005, FEMA, 2007, UNOCHA, 2011). While for economic component, it includes the effort to ensure the availability of financial mechanism on disaster waste management (FEMA, 2007)

JHA, et.al (2011) investigated the effort to fostering plan and the regulation to enhance the process of management. Mwai et al. (2008) incorporated preparedness with effort to achieve MGDs and sustainable waste management. (Mwai et al.; 2008 and JHA, et.al 2011)) proposed some indicators that could be utilized to enhanche preparedness such as possibility to run recycle, possibility to foster an intermediate treatment, possibility to track the disaster waste. Moreover, (Mwai et al., 2008, Arena et al. 2003) investigated stakeholder awareness to implement life cycle principles. Capacity building such as training could be defined as preparedness (Karunasena, 2009). (UNEP, 2009) issued a simple parameter to investigate the impact of capacity building such as increasing rate of recycling waste, increasing pollution control due to waste, enhancing cost efficiency, and waste reduction.

Table 3.2 Summary assessment of indicator and criteria of preparedness

Indicator	Description	Author
Preparedness		
Providing guidance to predict disaster waste generation	Statistical data of disaster waste generation will help to estimate the financial requirement that make it more efficient and effective in waste management	Brown, et al, 2010); USACE (2005); FEMA (2007); Chen (2007)
Identification of likely waste and debris types	The ability to estimate waste management characteristic will help stage of process and equipment requirement that make it more efficient and effective in waste management	Lautritzen (1998); Nakamichi (1995); Harukaze (1997)
Determine waste and debris tracking mechanism	Tracking of waste management indicate the area of damage caused by disaster. Disaster waste tracking also indicates the coverage area of service, improve the tracking and coordination, and providing provide the equipment to clean up.	Kung (2008); UNOCHA (2011)
Inventory current capacity for waste and debris management.	Providing statistical data associated with daily waste management performance will help the availability of equipments and tools for handling disaster waste.	Shimaoka (1995); Hirayama (2010)
Pre-select temporary waste and debris storage	Temporary storage make it easier to collect waste, furthermore if intermediate treatment of disaster waste could be conducted, it will help to provide material for recovery,	Lautritzen (1998); UNOCHA (2011)
List applicable national and local environmental regulation	Legal framework will help to ensure how the process of waste should be run, ensure institution and sharing budget	US EPA (2005); Fema (2007); UNOCHA (2011)
Establish government coordination including private company	Debris clean up for search and rescue, bodies date management and open block access to delivery living needs was essential and need coordination	(UNEP, 2009) Karunasena, 2009)
Identify equipment and administrative needs sites	Government outside area, was needed for handling, if final disposal cannot be conducted in the area affected	Mwai et al., 2008, Arena et al. 2003)
Pre negotiate contract	Procurement to provide additional equipment such as vehicle addition and land acquisition requires a long time	FEMA, 2007 UNOCHA (2011)
Develop a communication plan	In the stage of debris clean up such as for search and rescue to safety human life and delivery primarily life needed, it is better using communication system at which could be incorporated with disaster waste tracking	Kung (2008); UNOCHA (2011)
Create a debris removal strategy	Debris removal strategy was need to ensure process and location that required	Lauritzan, 1998; Feter &Garry, 2011)
Recycling options	Recycling options were needed to determine the method, location, and equipment to perform the recycle.	Mwai et al(2008) and JHA, et.al 2011
Open burning Options	Open burning mostly conducted due to the delay of service. Option of open burning scenario should be performed to ensure safety	FEMA, (2007) UNOCHA (2011)

(3) Vulnerability

Vulnerability could be defined as the potential loss of human at both the spatial or non spatial, according to the harm (Cutter, 1996). Vulnerability from the individual and societal group defined as potential loss; groups exposed to hazard, and hazard of place (Rygel et.al, 2006). Recently, vulnerability was widely explored in the context of climate change investigation that was associated to adaptation (Neil, 2006; Wongbusarakum & Loper, 2011). This study used vulnerability definition as a socio-environment condition with high risk of disturbance and the potential of loss (Cutter, 1996; Neil, 2006; Birkmann, 2007). Cutter et al,

(2003) divided vulnerability in two general clusters which are biophysical and social vulnerability. It was also associated with the condition of natural environment such as hazard, frequent with disaster and the influence of interdependence (Birkmann, 2005; Birkmann, 2007).

This study defined vulnerability as the likelihood and condition of community and their understanding to the hazard and disaster and their internal risk factor such as poverty (Neil, 1999; Adger, 2006; Birkmann, 2007). Cutter, (2003) introduced the characteristic of social status such as income, political power, prestige, gender, age, loss of employment, structure of family, education, population growth and special need to measure the vulnerability. Vulnerability indicator should be described as specific as possible; for example, the character of hazard giving a specific indicator for flood disaster such as timeline and high of inundated. (Birkmann, 2005), pointed out the difference between big and small islands in developing countries that has a lot of islands such as Indonesia (Turvey, 2007). Vulnerability was the general condition of population, social, and economic condition that were prone to disaster (Morrow, 1999).

Measuring vulnerability could be defined as the condition of community related to the housing and its facility, for example the earthen or wooden floor, not available or improper drinking water, share of public toilet, community with defecate in river/ponds/air, no electricity for lighting, traditional healer or birth attendant (Dhanani & Islam, 2002). Ben Wisner (1998) explored vulnerability in Tokyo by proposing indicator such as marginal condition of people with lack access of resources (income, asset, reserves, and social support). Based on the characteristic of study to measure social vulnerability, (Rygel et.al, 2006) proposed some indicators such as poverty, gender, ethnic, age and disabilities. Vulnerability associated with community also could be determined from the condition of social and economic circumstances such as the poor, the elderly people, communities and their knowledge to disaster (Morrow, 1999).

Cutter, et al (2004) used potential hazard and location affected as indicator of biophysical vulnerability to investigate the social vulnerability in Georgetown. The indicators were possible to be utilized to analyze the vulnerability in disaster waste management. In the waste and disaster waste management, it could be determined with general hazards that could be predicted to cause waste generation, such as flood, earthquake, and tsunami (Simpson and Katirai, 2006; Hirayama, 2010). Disaster waste generation were vary depending of the type of disaster, location, and frequency of hazard (Hirayama (2010), UNOCHA, 2011). By giving a proportion such as weighing in the assessment of vulnerability, would be increase the sensibility of the model (USACE, 2005; Chen et al (2007). In disaster waste management preparedness, vulnerability assessment covers community, facilities of waste management and location; Hirayama et al (2010).

Table 3.3 Summary assessment of indicator and criteria of vulnerability

Indicator	Description	Author
Vulnerability		
Social demography		
Population and density	Population degree determined the degree of activities and the degree of urban size, including waste facility. In normal condition, the degree of activities associated with the intensity of waste management generation. In disaster event, degree of population describe the calamities, possibilities of population affected, damage facilities and lifeline including waste management	Cutter, (1996), Neil, (2006); Birkmann, 2007, UN OCHA (2011)
Poverty degree (poor people)	Poverty was the basic parameter for powerless people. Poverty influences the unpreparedness of resources and equipment for waste handling that higher compared to the usual or normal condition.	Morrow, (1999), (Rygel et. al, 2006)
Children, elderly and infant mortality rate	Children, elderly and infant mortality rate were the people that are the most susceptible to the improper public health; Therefore, the infant mortality rate represents the condition of sanitation.	Cutter, (1996), Ben Wisner (1998) (Rygel et. al, 2006)
Ratio of slum area	Location of disaster was vary, rural-urban, coastal and mountain. Slum area was one of characteristic community in developing countries shown by improper neighborhood and basic facilities such as water access, sanitation access and defenseless.	Morrow, (1999), Dhanani & Islam, (2002), (Rygel et, al, 2006 (Turvey, 2007).
Unemployment	Although depending on the degree of disaster event, location, and type of activities in the communities; resilience in communities such as in economic condition could be represented by the degree of unemployment.	USACE, (2005); Chen et al (2007); Hirayama et al (2010)
Biophysical vulnerability		
Local, Regional and International	Disaster and it impact was vary depending on the classification and scale. According to the organization, there is local and regional and international scale disaster that were influencing international organization for respond and recovery, disaster waste management should ensure that there was zero impact for local, regional and international community, direct or indirect, current or future, and short, middle, or long time.	Berren et al, (1982); Rutherford and de Boer (1983); Cutter etal, (2003); Perry & quarantelli (2005).
Natural and Man mad disaster	frequency of earthquake, earthquake tsunami, eruption, flood and other duration was associated with degree of impact and calamities that was usually given by proportional weighting. Disaster waste management usually unpredicted and it was associated with impact. It was important to consider the degree of impact that was affecting individual or system, current or future, direct or not.	Berren et al, (1982); Rutherford and de Boer (1983); Cutter, (2003); Perry & quarantelli (2005).

3.2.3 Data collection

Data collection conducted at national level, provincial and local state institution. Two periods field survey administered in National Disaster Management Agency, Ministry of National Planning (Bappenas), Ministry of Public Work, Ministry of Environment, Provincial and 9 cities selected in Indonesia. Data collection started from August – October 2012. Second period of data collection continued on Mei-June 2013. Data assessment according to the secondary data by using metha analysis approach for structuring disaster waste management process in Indonesia (Hedges, Larry V, et all, 1985; Hartung, Joachim, et all, 2008). Questionnaire survey and interview conducted by using snowballing sampling technique (Joseph, J S, 2009). Detail methodology of this study and field survey shown in figure 3.3

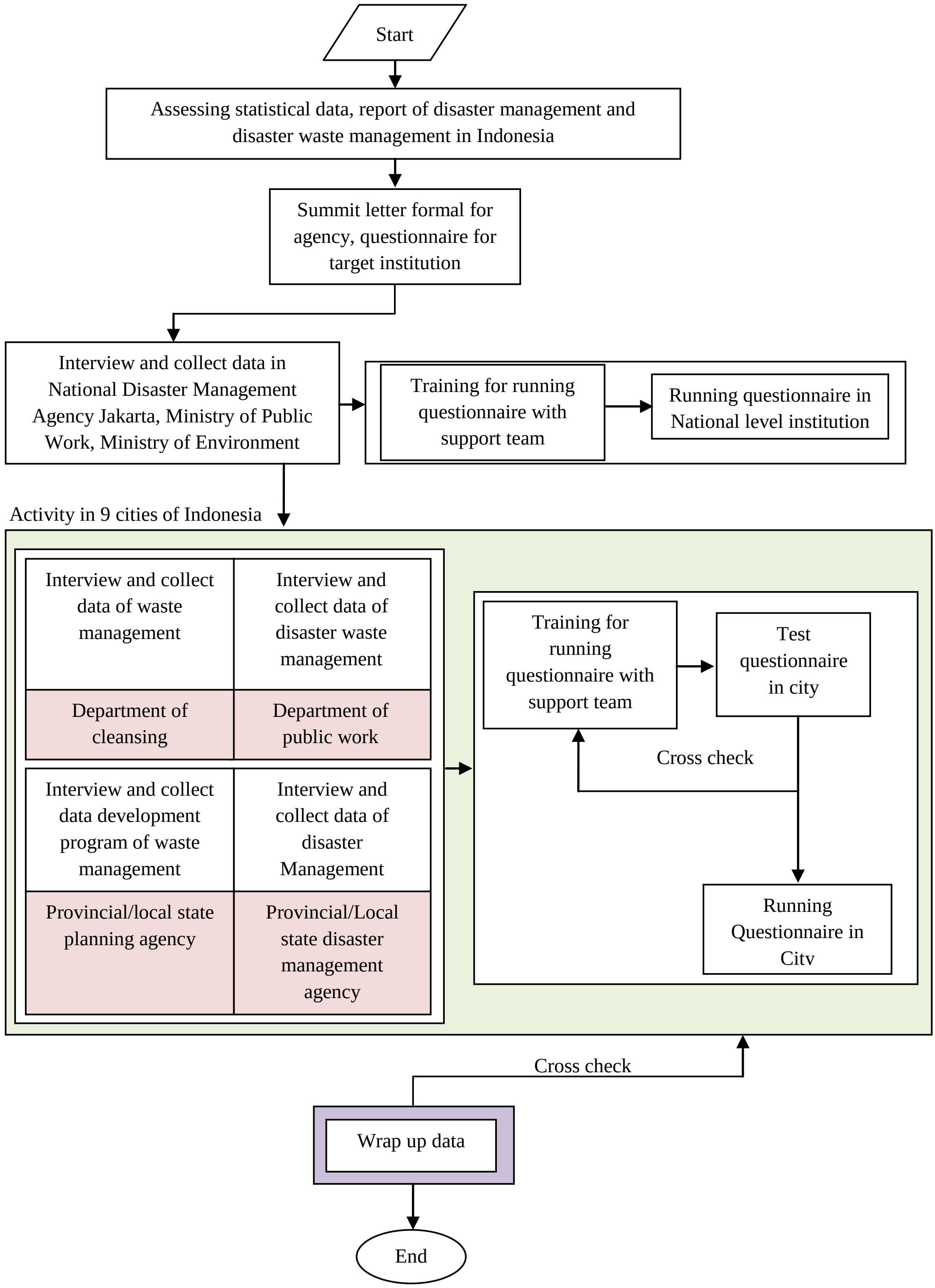


Figure 3.3 Method for data collection: measuring disaster resilience on waste management in Indonesian regions and 9 selected cities

3.2.4 Method for assessment and measurement

The research designed 5 step of data utilization for measurement and assessment the index of disaster resilience on waste management as depicted in figure 3.4. The raw data of each indicator from statistical data and questionnaire survey comparing according to minimum and maximum value. By using likert scale the individual data compared each other to indicate good or quite good condition. Index value was measured refers the individual index for each indicator by using the equation 3.2.

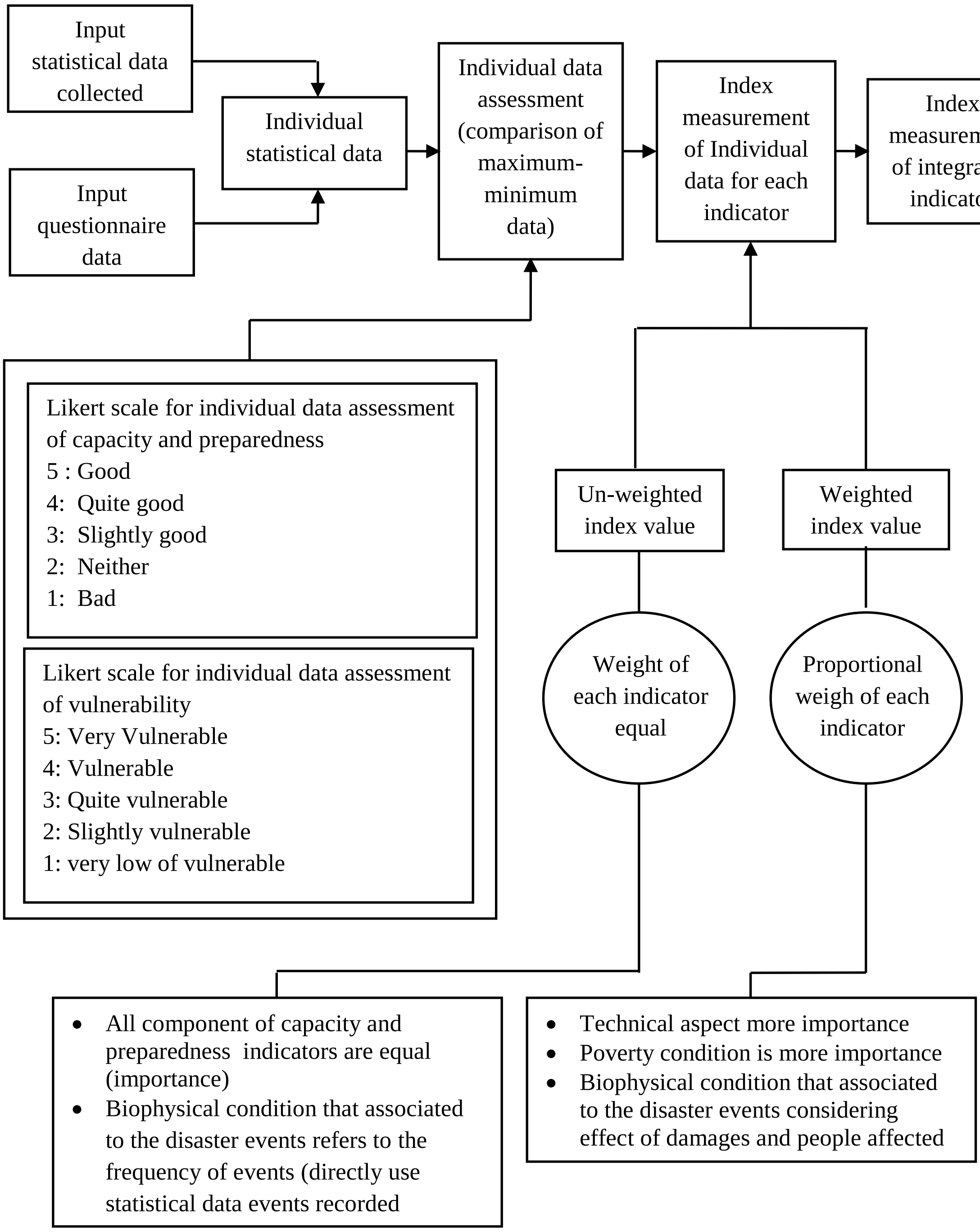


Figure 3.4 Method for data utilization: measurement and assessment index

3.3 Measuring disaster resilience on waste management in Indonesia

3.3.1 Capacity of municipal solid waste management in Indonesia regions and selected cities

(1) Municipal Waste generation and composition

Indonesia has 5 big Islands that are Sumatra, Java, Kalimantan, Sulawesi, and Papua Island. At 2010, Indonesia National Statistic Agency (BPS), administered 415 district and 93 cities in Indonesia with population of 237.56 Million, with estimated 112.88 Million (57.48%) lived in Java island. Indonesia Ministry of Environment, registered solid waste generation in Indonesia to be around 38,5 Million ton per year in 2008. Java Island with the highest density level of population was recorded as the highest of the solid waste generation (estimated : 21, 2 Million ton per year or 55.8%) .

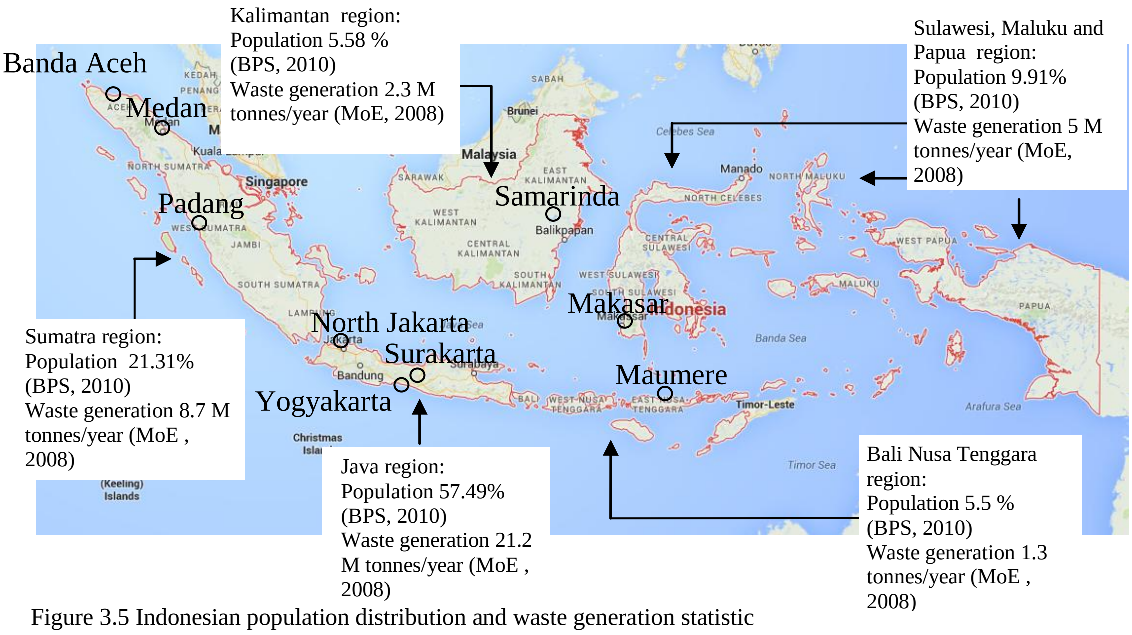


Figure 3.5 Indonesian population distribution and waste generation statistic
Source of map: Google map,
https://www.google.com/maps,

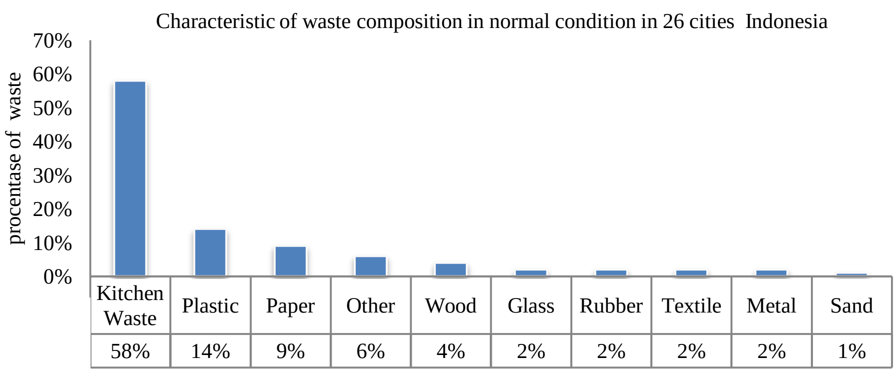


Figure 3.6 Indonesian waste composition estimation in year 2008
Source: Ministry of Environment, 2008

Indonesia was a middle-low countries, generally, waste composition and characteristic dominated with consumption waste such as kitchen waste or organic waste. Classification of waste statistic in Indonesia divided into organic waste such as kitchen waste and inorganic waste such as plastic waste. Mostly waste characteristic in Indonesia consist of organic waste (composition 58%). Plastic waste (composition 14%) and paper (composition 9%) were the highest of an inorganic waste generation in Indonesia (MoE, 2008). Waste management performance in Indonesia, in normal condition, generally was middle tend to low. According to the ministry of environment survey in year 2008, coverage area of service ~~of~~ waste management in community based on activities, where resident area waste was the highest (coverage of service 16.7%), while industrial area has the lowest of service (coverage of service 2.3%). Coverage of service in market was 7.7%, coverage of service of waste management in street clean up was 3.5%, public facility was 3.4% and in public office was 3.1% (MoE, 2008).

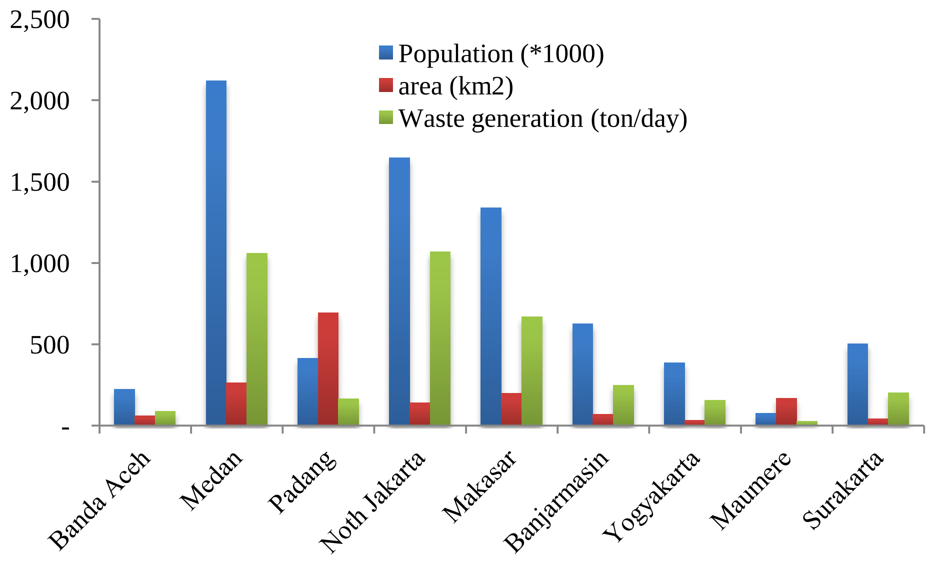


Figure 3.7 Population, area and waste generation in each selected cities of Indonesia (estimation for 2010)

Refers to the regionalization of waste mapping by the Indonesian ministry of Environment, this study selected several cities in Indonesia as the representative for small and big cities from west to east of Indonesia. Figure 3.5 depicts population, area, and waste generation for 2010. North Jakarta, as the one of the highest density of population in Indonesia estimated to generate solid waste of around 1,061 ton/day for 2010, while for total waste generation in Jakarta estimated 6500 ton/day (Department of Cleansing Jakarta, 2012). Medan was the biggest city with population 1.4 Million in 2010, generated solid waste 800 tonnes per day. Banda Aceh was one of many suffering cities at Indian tsunami disaster on 2004 with population of around

230,000 and town area of 61 km^2 (Banda Aceh statistic agency, 2010), had estimated solid waste generation to be 90 tonnes per day. Maumere, one of the cities in East Indonesia with population around 78.000 generated waste around 30 tonnes per day ton/day

(2) Coverage of service

General condition of technical capacity on waste management in Indonesia for average was at the middle–low. Ministry of environment on 2008 stated that the administered coverage of service was 56%. Sulawesi-Maluku-Papua Island was the biggest of service condition that the responsible organization could cover 68% of their population. Coverage service in Java Island was the second (59%) while Kalimantan island was the lowest (46%). Coverage service in Sumatra island (48%) and coverage service in Bali-Nusatenggara island (47%); most of them were lower compared with the national average. Coverage of service was one of the important indicator for technical capacity to assess the performance condition of waste management.

In 2010, selected cities of study have been provided waste management service more than national and regional achievement. Coverage of service of waste management was around 50%-80%. Banda Aceh and Medan, as representative cities of Sumatra Island have been provided services that has around 80% coverage. North Jakarta, Yogyakarta and Surakarta as representative cities of Java Island have been able to serve around 75-80% of their community. Samarinda city, the capital city of East Kalimantan, provided around 60% waste service. Collection and transport of the waste service in Makasar has been collected around 75% of the waste generated. provide Muamere as a representative cities of Bali-Nusatenggara Island has been provide waste service for their community

(3) Transportation facility

Transport and transfer of waste management was the next step after waste collecting to be transferred to the final disposal. In national scale, Indonesian ministry of environment recorded that there were of around 7,600 trucks support waste transportation in Indonesia for 2008 (ministry of environment, 2008). Around 2,000 trucks were distributed in Sumatra island (estimated: 26% of national). In Java Island, there were around 3,600 trucks to transport the waste (estimated 47% of national). Waste management at Kalimantan was supported with of around 400 trucks (estimated 5 % of national). Transportation facility of waste management in Bali-Nusatenggara Islands were of around 200 trucks (estimated 3% of national), while in Sulawesi Maluku Papua there were of around 1400 trucks (estimated 18% of national). Figure 3.6 depicts Vehicle type support in transportation of waste management in Indonesia.

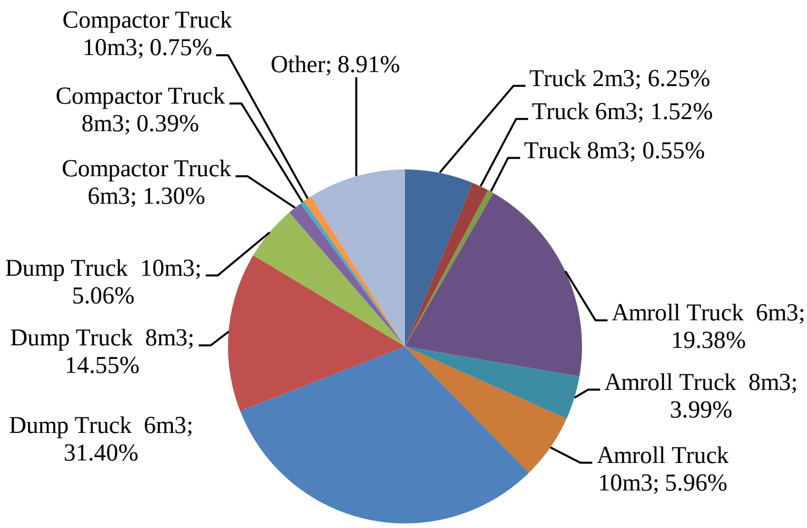


Figure 3.8 Vehicle type of solid waste transport in Indonesia
Source: Ministry of Environment, 2008

(4) Recycle rate

Recycling rate of solid waste in Indonesia generally has been growing. Since more than 60% of municipal waste Indonesia was organic waste (Helmi, et al, 2006, cited in Chairul, 2007), composting mostly applied to reduce organic waste in Indonesia (MoE 2008) , more than 50% of community in Indonesia conduct recycling. However, the recycling rate of solid waste in Indonesia is not more than 4%, estimated for 2008 only 2.5% (Ministry of environmental, 2008). Generally recycling of solid waste was conducted by community and by informal sector. Solid waste that have been recycled such as paper, metal, plastic. Recycle was conducted in three locations according system collection and transport of municipal waste in Indonesia. Recycle in the origin of waste was the highest rate in Indonesia, and then recycling was run in temporary storage and in final disposal area. Figure 3.4 depicts recycling rate in Indonesia for 2008.

Banda Aceh was one of the city selected in this study that received support for recycling waste such as composting from international and national agencies. Around 50% of villages in Banda Aceh involved composting program that supported by Calgap or Canadian local government assistance program in 2007. There were around 50 of small middleman (lapak) accommodated independent waste picker on informal waste recycling in Banda Aceh (department of cleansing Banda Aceh, 2012). Formal program to encourage recycling, was conducted by central government trough bank of waste program. Bank of waste (garbage bank) was the government program to improve recycling rate in Indonesia. People store recyclable waste and administered by officer, while they will get money in return. According to the system such as in the bank, community could use the money to buy daily needs.

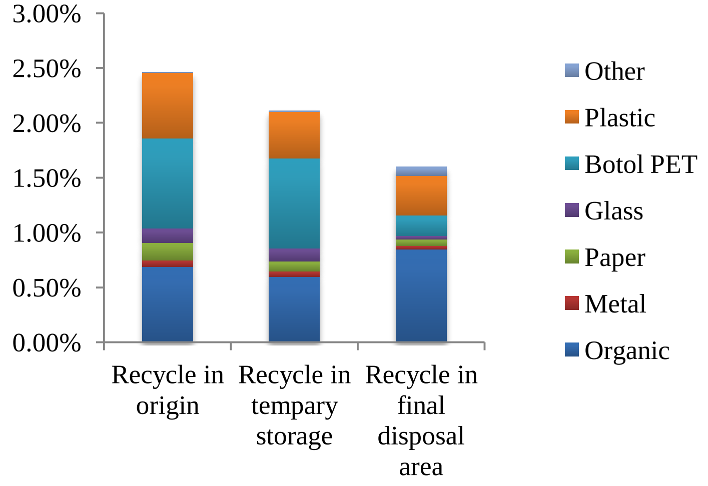


Figure 3.9 Proportion and recycling rate of solid waste management in Indonesia
Source: Ministry of Environment, 2008

(5) Landfill lifespan

Generally landfill lifespan in Indonesia was divided by four classification (MoE, 2008); the first one is landfill that the capacity already full in 2010, landfill estimated to be full capacity in year 2015, landfill estimated to be full capacity in year 2020 and landfill estimated to be full capacity in year more than 2021. Gampong Landfill was the final disposal of waste management in Banda Aceh. The landfill was broken by Indian tsunami disaster in 2004. By tsunami waste management recovery program, this landfill recovered. Moreover, trough the tsunami waste management recovery program, Banda Aceh city constructed regional landfill in Blang Bintang, that operated by North Aceh local state in 2012 with lifespan 15 years. Ministry of environment estimated that 12 % of landfill site was belong to outside, and 88% was inside the area of cities. MoE (2008) estimated around 6% of landfill in Indoensia was operated under cooperation (joint management) with other local government and 94% was operate by own local government.

Final disposal of waste management in Medan city conducted in Terjun, Medan Deli with area of around 14Ha and Namo Bintang, Pacur Batu with area 25Ha (DJCK, 2001). Padang is one of the city attacked by earthquake in 2009 that used landfill system for final disposal with existing area around 30.3 Ha, started in 1989 (DJCK, 2001). Final disposal of municipal waste in North Jakarta use Bantargebang landfill in Bekasi, an area outside of Jakarta. Bantargebang landfill site applied integrated waste disposal management by setup composting with estimated 2000 ton municipal waste, and by waste to energy technology with estimated 2000 ton of municipal waste to produce electric power. Private company operated Bantergebang landfill, as well as final disposal system in Bangkok Thailand. Putri Cempo was the final disposal of municipal waste in Surakarta with area around 17Ha (DJCK, 2002). System of final disposal in Putri Cempo was open dumping.

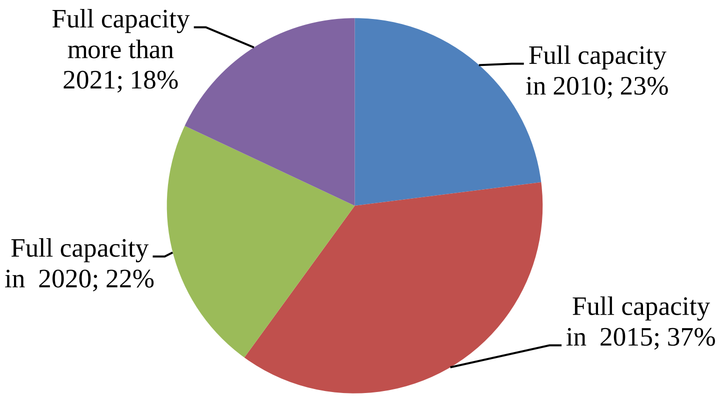


Figure 3.10 Lifespan of final disposal system in Indonesia
Source: Ministry of Environment, 2008

(6) Waste management fee (retribution) and operational cost

Budgeting or financial procurement for municipal waste handling was supported by community and government subsidies. According to the MoE statistical report of waste management in Indonesia, around 152,8 Billion Indonesian rupiahs (estimated: 22% of national) was allocated for waste management in Sumatra region and around 370,1 Billion Indonesia rupiah (estimated: 35% of national) was allocated for Java region (MoE, 2008). Waste management budgeting in Kalimantan region was around 16.1 Billion Indonesian rupiahs (estimated: 16% of national), while in Bali-Nusatenggara region was around 50,2 Billion Indonesia rupiahs (estimated 13% of national). Municipal waste management budget allocated in Sulewesi-Maluku-Papua was around 41.1 Billion Indonesian rupiahs for 2008, (estimated: 8% of national). In average, waste management fee (retribution) that collected from community estimated 10,070 Indonesian rupiahs, or estimated 2.3 Billion Indonesian rupiahs (MoE, 2008).

Department of public work administered that the waste management operational cost was estimated around 60.000-100.000 Indonesia rupiahs per ton waste. However, for average, local government budget only covers around 40.000 Indonesian rupiahs. Department of cleansing and beautiful in Banda Aceh recorded that for 2008, retribution fee around 1.1 Billion Indonesian rupiahs. The fee contributed to the operational cost waste management around 6.3%. With operational cost of around 17.6 Indonesian rupiahs, Banda Aceh city government subsidies 16.3 Billion Indonesia rupiahs for waste management operation cost. Department of cleansing in Jakarta province allocated budget of around 543 Billion for waste management operation at 2008, with increasing rate of annual budget for waste management operation was 6% for five years on 2006-2010 (Department of cleansing Jakarta, 2011). Department of cleansing in Makasar city administered annual operation cost growth for 2007-2008 increased to be 14.84%, however for year 2010-2011 it decreased to be of around 1.63%.

Waste management cost and retribution in Kalimantan and Bali-Nusatenggara region was relatively low compare to other regions. For example, waste management cost in Maumere city was of around 0.96 Billion to collect and transfer around 17,4 tonnes per day. With this budget, waste collection coverage of around 62 % compared to the waste generated of around 28 ton per day. Local agency of monetary fund in Banjarmasin city in 2012 administered waste retribution collection in Banjarmasin South Kalimantan that was estimated to be 6.1 Billion, and the allocation budgeting for cleansing service was of around 9 Billion. Local government of Banjarmasin city supported the municipal waste management with the limitation of budget so the coverage of service is limited. Moreover, sanitation taskforce of Banjarmasin city administered the waste management coverage to be of around 60% at 2008.

(7) Integrated indicator of capacity of municipal waste management in Indonesia regions and selected cities

The research proposed integrated indicator for measuring capacity of municipal waste management in Indonesia regions and selected cities. The integrated indicator covered technical economic and organizational capacity. Technical capacity covered the current condition of municipal waste management at which described:

- Coverage area of service of waste management,
- Recycling rate,
- Final disposal lifespan.

Economic capacity covered the composite indicator that described the condition of economical aspect in municipal waste management in Indonesia region and selected cities. The research selected economic capacity indicator as follow:

- Growth of waste fees (retribution) collection
- Growth of operational cost

Organizational capacity covered the composite indicator that described the condition of organizational aspect on municipal waste management in Indonesia and selected cities. The research selected organizational indicators as follow:

- Availability of guidelines
- Availability of institutional network
- Availability of system communication

Description of each composite indicator in Indonesia region and selected cities in Indonesia summarized in table 3.4.

Table 3.4 Assessment of capacity`s indicators in each selected cities of Indonesia

Capacity`s Indicators	Description capacity`s indicators in selected cities of Indonesia (Banda Aceh, Medan, Padang, North Jakarta, Yogyakarta, Surakarta, Maumere and Makasar)
Coverage area of service	Coverage area of service in average was middle to high with range of service from 64.5% to 79.9%. It was shown that in the normal condition, collection and transport facility needed to be increased.
Percentage waste recyclable	Bank of waste was the formal program from Indonesian government to enhance the recycling rate, this program was tend to grow~~ing~~ and could enhance the recycling rate of domestic waste event but it still needed more effort to achieve the ideal condition. For example, Banjarmasin city proposed 15% waste recyclable in their white paper program of sanitation.
Final disposal lifespan	All cities selected, used landfill method for final disposal of municipal waste. Lifespan of the landfill mostly has passed. Updating, scale up,(intensification) and extension of area done by the utilization of areas surrounding the landfill. North Jakarta conducted public private partnership in waste management for both collection–transport and final disposal system.
Growth of waste fees (retribution) collection	Condition of waste fees (retribution) collection in each selected cities was different with each other. Collection growth for Banda Aceh and Jakarta has been in good condition with the value of growth more than 5% in average for 2005-2009 period, however for Makasar the growth was lower and tend to decrease for 2005-2009 period.
Growth of operational cost	Several cities (Banda Aceh, North Jakarta, Yogyakarta) shown that their operational cost were increase more than 5% for 2005-2009 period. While other cities operational cost were tend to be similar with previous year, without any additional budget
Availability of guidelines	National, provincial and local state government had issued general guideline for disaster waste management. Central government in 2008 issued the classification of the disaster waste as a ``specific waste``. Provincial and local government followed the classification of disaster waste management as of national pattern. Formal guidelines associated with disaster waste management not yet constructed in detail. Banda Aceh case issued by UNEP, 2008 was the first document for Indonesia's disaster waste management had been issued.
Availability of institutional network	National Agency for disaster management (BNPB) was developed by Indonesian government in 2008, to handle some issues in disaster management in all stages (mitigation, preparedness, respond, rehabilitation and reconstruction). Recently each province and local government has already developed local disaster management agency for disaster coordination management .
Availability of system communication	Communication system and database for disaster management already established. Support by local and national budget, communication system has been developed by using the current system of communication.

Current condition of municipal waste management capacity in Indonesia region and selected cities in Indonesia summarized in table 3.5 and table 3.6

Table 3.5 Integrated indicators value of capacity in Indonesian regions

Capacity	Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Maluku Papua
Coverage of Service	0.48	0.59	0.47	0.46	0.68
Recycling rate	4.60	8.30	4.80	4.90	4.60
Landfill lifespan	2.50	1.90	0.80	1.50	1.80
Availability of guidelines	2.00	2.00	2.00	2.00	2.00
Availability of institutional network	5.00	5.00	5.00	5.00	5.00
Availability of system communication	4.00	5.00	4.00	4.00	4.00

Table 3.6 integrated indicator value of capacity in each selected cities of Indonesia

Capacity	Banda Aceh	Medan	Padang	North Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
Coverage of service	76.50	74.30	79.80	89.90	68.20	64.5	72.90	63.80	81.40
Recycling rate	2.20	2.40	2.80	3.50	2.40	1.50	2.90	1.20	1.80
Final disposal lifespan	14.00	0.00	0.00	0.00	2.00	0.00	3.00	10.00	2.00
Growth of waste fees collected	2.90	1.60	0.90	8.70	-15.20	0.20	5.20	0.00	2.80
Growth of operational cost	3.10	2.40	1.20	6.50	1.61	0.84	0.14	0.08	0.09
Availability of guidelines in local state	3.00	2.00	3.00	3.00	1.00	1.00	3.00	1.00	1.00
Availability of institutional network	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Availability of system communication	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

3.3.2 Preparedness of disaster waste management in Indonesian regions and selected cities

Indonesia government has been fostering preparedness in disaster management by applying the Hyogo framework. Indonesian government has been fostering to minimize impact and reduce possibility of damage as early as possible (Riyanti,et all, 2012). Disaster waste management was one of the critical sectors in early respond. Stakeholder efforts to foster preparedness on disaster waste management were as follow.

Table 3.7 assessment of preparedness`s indicators in each selected cities of Indonesia

Preparedness Indicator	Description preparedness`s indicators in selected cities: Banda Aceh, Medan, Padang, North Jakarta, Yogyakarta, Surakarta, Maumere and Makasar.
Providing guidance to predict disaster waste generation	Local government issued regulation for disaster waste management by classified the disaster waste as a ``specific waste``. Local government has issued general procedure ~~to~~ for debris cleanup and has established responsible organization in debris clean up.
Identification likely waste and debris types	Local government not yet conducted a statistical method including regular administration. Disaster waste composition was dominated by construction and demolition of waste that mostly directly used to recovery.
Determined waste and debris tracking mechanism	With supporting provincial and national disaster agency, debris tracking was conducted to estimate the damages and losses. Mapping area by using GIS method mostly applied to accelerate efforts such as searching and rescuing for life saving and provision of facility needed to evacuate people
Inventory current capacity for waste and debris management,	Local government not yet constructed any method to provide statistical data associated with disaster waste management. However, every local government developed master plan for sanitation and waste management.
Pre select temporary waste and debris storage	Immediately when the disaster waste management generated, people making temporary site to store disaster waste. For example, in the case of disaster waste generated by flooding, the waste on the street then be transferred to the landfill
List applicable national and local environmental regulation	Disaster waste management mostly conducted inline with the disaster management. For local scale disaster, local regulation would be applied in management. For national scale disaster, national regulation would be applied. Mostly, local regulation was constructed referring to the national regulation.
Establish government coordination including private company	Government coordination was conducted depending on the situation. However, there was a regulation that control procurement and coordination with private company.
Identify equipment and administrative needs sites	Government in local, provincial and national level would identify administrative procedure to support facilities in disaster management and disaster waste management.
Pre negotiate contract	Government would apply regulations to conduct pre-contract with private company to support additional equipment and tools.
Develop a communication plan	Government in local, provincial and national scale, had constructed mechanism for coordination and preparation of administrative procedure such as sharing resources and budgeting for disaster management.
Create a debris removal strategy	By coordination with survivors, community and stakeholder, local government set the procedure to handling disaster waste.
Recycling options	Local government mostly have not yet developed formal mechanism in recycling, however, recycling automatically run by waste pickers and scavenger in normal condition.
Open burning Options	Local government mostly have not yet prepare for open burning. Usually open burning waste are conducted by community.

Preparedness on disaster waste management in Indonesia was vary. Table 3.8 and table 3.9 summarized current condition of preparedness in Indonesian regions and selected cities.

Table 3.8 Integrated indicator value of preparedness of disaster waste management in Indonesia regions

Preparedness	Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Maluku Papua
List applicable national and local environmental regulation	2.00	3.00	2.00	2.00	2.00
develop a communication plan	5.00	5.00	5.00	5.00	5.00
create a disaster debris prevention strategy	2.00	2.00	2.00	2.00	2.00

Table 3.9 Integrated indicator value of preparedness of disaster waste management in each selected cities of Indonesia

Preparedness	Banda Aceh	Medan	Padang	Noth Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
Establish government coordination including private company	5.00	5.00	5.00	5.00	4.00	3.00	5.00	3.00	5.00
Identify likely waste and debris types	5.00	3.00	2.00	3.00	2.00	2.00	3.00	3.00	2.00
Forecast amount of waste and debris	5.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00
List applicable national and local environmental regulation	5.00	3.00	3.00	3.00	3.00	3.00	2.00	3.00	4.00
Inventory current capacity for waste and debris management	4.00	2.00	2.00	2.00	2.00	2.00	2.00	3.00	2.00
Determined waste and debris tracking mechanism	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Pre select temporary waste and debris storage	4.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Identify equipment and administrative needs sites	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Pre negotiate contract	2.00	2.00	2.00	3.00	2.00	2.00	3.00	3.00	3.00
develop a communication plan	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
create a disaster debris prevention strategy	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
create a debris removal strategy	3.00	2.00	3.00	2.00	2.00	2.00	3.00	3.00	2.00
recycling options	4.00	2.00	3.00	2.00	2.00	2.00	2.00	2.00	2.00
Waste to energy options	2.00	2.00	4.00	4.00	2.00	2.00	3.00	2.00	4.00
disposal options	5.00	3.00	4.00	1.00	3.00	2.00	3.00	4.00	3.00
Open burning Options	2.00	2.00	2.00	1.00	2.00	2.00	3.00	4.00	2.00

3.3.3 Socio demography and biophysical vulnerability in Indonesian regions and selected cities

(1) Socio demography vulnerability

Poverty was one of the indicators that usually be used as a basic criteria in vulnerability assessment (Cutter, 1996). National taskforce for poverty reduction acceleration (TNP2K, 2010) at 2010 administered that 13.8 % of Indonesia population were poor (TNP2K, 2010). With population 237.65 Million people (BPS, 2010), there were around 32.96 Million Indonesian people were vulnerable. Kalimantan (Borneo) is a region with smallest number of poor people (estimated: 17.05 Million), while Sumapapua are the region with number of highest poor people (estimated: 48.88 Million). The smallest degree of poverty was on Aceh province at 2010, which was estimated to be 2.1%, while highest degree of poverty was on Papua province, which was estimated to be 36.8 % (TNP2K, 2010).

Selected cities in Sumatra region shown that the poverty indicator is less than national condition. The degree of poverty in Banda Aceh city at 2009 is 8.64 %, the degree of poverty in Medan City is 9.58% and the degree of poverty in Padang City on West Sumatra province is 9.58%(TNP2K, 2010). Surakarta`s degree of poverty was high, estimated to be 14.99% while other selected cities are lower than national, where the degree of poverty in North Jakarta was 4.5%, and the degree of poverty in Yogyakarta was 10.05% (TNP2K, 2010). The degree of poverty in Sika district as the selected city of Bali-Nusatenggara region in this study was 15.35%. Degree of poverty in Banjirmasin, one city in Kalimantan region was 4.8%, while the degree of poverty in Makasar city was 5.52% (TNP2K, 2010).

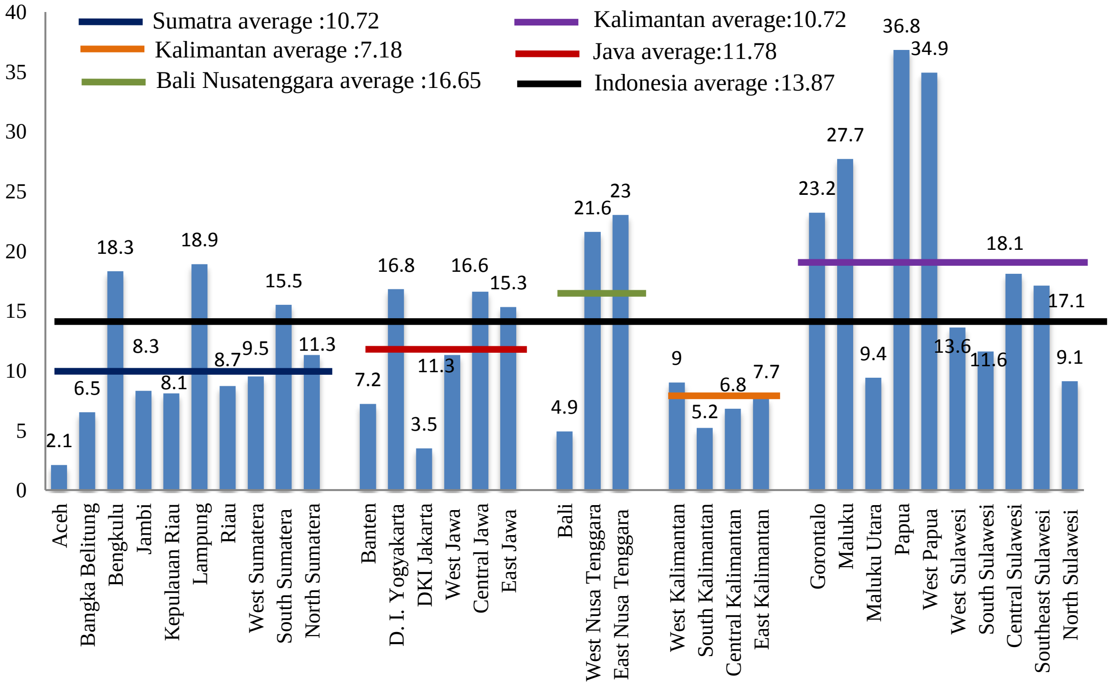
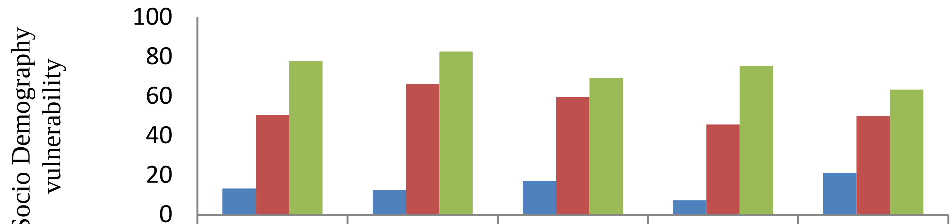


Figure 3.11 Degree of poverty in Indonesia (in percentage population at 2010)
Source : TNP2K (2012)



	Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Papua Maluku
Poverty (%) population	13.2	12.47	17.07	7.28	21.21
Clean Water Access (%) household	50.57	66.18	59.57	45.63	50.01
Sanitation Access (%) household	77.66	82.55	69.3	75.23	63.25

Figure 3.12 Socio demography vulnerability condition in Indonesian regions 1990-2012

Table 3.10 Socio demography vulnerability assessment in selected cities of Indonesia

Vulnerability Indicator	Description preparedness`s indicators in selected cities: Banda Aceh, Medan, Padang, North Jakarta, Yogyakarta, Surakarta, Maumere and Makasar.
Poverty degree	As developing countries, poverty is one of the critical issues suffered in Indonesia. for Sumatra and Java region, they has relatively better economy condition compared to Nusatenggara region. Kalimantan was the region with the best economy condition, however, the willingness to pay was management fee is less than Sumatra region. Makasar has a high degree of poverty index, however, the waste management collection fee rate was decrease for 2005-2009 period.
Infant mortality rate	Infant mortality rate could represent the condition of public health. Region with low degree of infant mortality, it would represent the better public health compare to other regions. With low infant mortality condition, the sanitation facility generally also better compare with other regions.
Unemployment	Unemployment represent the degree of welfare that associated to the willingness to pay for sanitation facility. Although the degree of disaster event, location, type of activities communities, and unemployment also influencing the process of disaster management, including disaster waste management. For example, program cash for work in Banda Aceh was very important to fostering likelihood and to reducing unemployment event at a limited time.
Local, Regional and International	Mostly disaster waste management at developing countries are conducted and supported by international aid. Coordination with international community was different with local or regional community. The quality of coordination would affect the effectiveness of disaster waste management.
Natural and Man mad disaster	There were several types of natural disaster in Indonesia which administered regularly. Landslide, earthquake, earthquake tsunami, eruption, flood, flood and landslide, strong wind, and forest fire could generate disaster waste. Each type of disaster could generate a specific disaster waste.

(2) Biophysical vulnerability

Many definition of hazard was constructed based on the field and goal of assessment. For example, Deery (1999) was using a concept associated with risk. However, mostly hazard assessment always associated with risk and damage (Davidson, 1997, Kumpulainen, 2006). In this study, hazard is defined based on the definition of ADPC; however, the assessment of natural event is stressed in comparison to the natural disaster. So hazard was defined as potential harm, loses and damage of natural and man-made environment caused by disaster event (ADPC). Harm, loses and damage of natural and man-made environment would generate disaster waste (FEMA, 2006; UNOCHA, 2011)

BNPB as National Agency of disaster management in Indonesia registered around 500-1000 disaster events hit in Sumatra island during 1979-2009. Aceh province is one of prone province in Indonesia which has been attacked by more than 500 disaster events (BNPB, 2012). Java Island is the highest prone island in Indonesia which has been attacked by more than 1000 disaster events during 1979-2009 (BNPB, 2012). Refers to the BNPB record Kalimantan Island has been attacked by more than 100 disaster events until 2009, except in central Kalimantan. Region Bali-Nusatenggara was also an island with high hazard potential that has been attacked by more than 100 disaster events. Region Sulawesi-Maluku-Papua (Sumapapua) relatively less compared with Java Island. However, Sulawesi island had a high potential of hazard such as Nusatenggara with more than 130 disaster events.

In Indonesia. For year 2010, Java Island was the highest region that has been attacked by flood In Java region BNPB recorded that Jakarta is one of the highest city attacked by flood disaster with 92 estimated events. Moreover, it was also the highest number of recorded events compared with other cities in Indonesia. Sumatra region was the second top region with flood disaster that estimated to have more than 80 events.

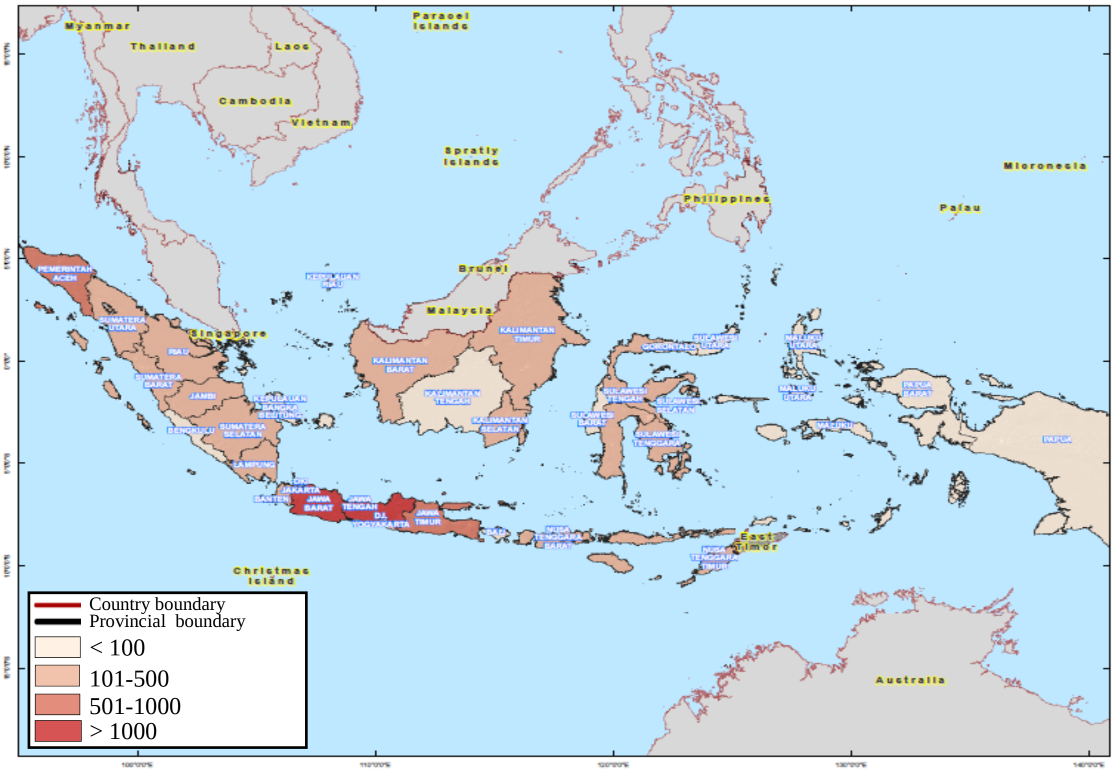


Figure 3.13 Map of disaster events in Indonesia 1979-2012
Source of map: BNPB (2012)

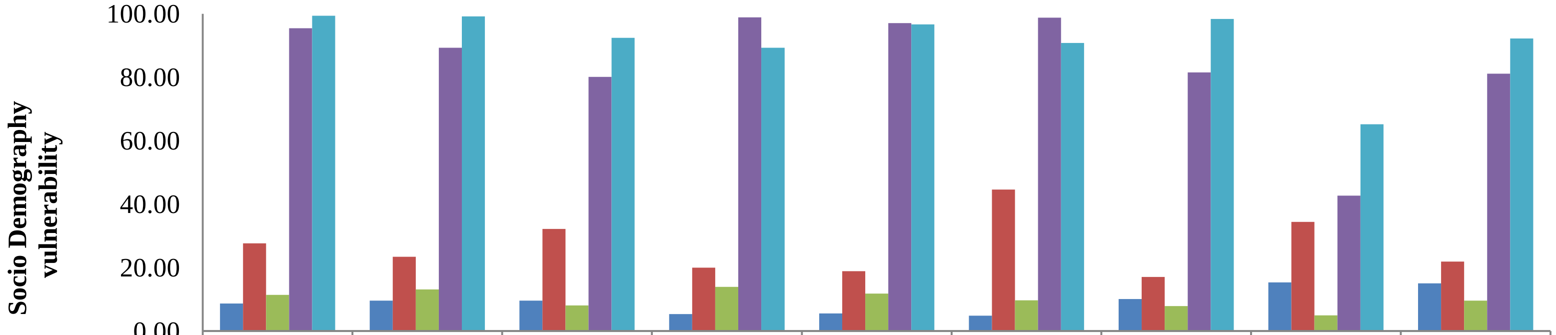
Medan is the second top cities hit by flood that estimated to have around 25 events (BNPB, 2012). Sumapapua was the third region has been attacked by flood disaster that estimated to have more than 50 events (BNPB, 2012). Makasar was the highest city has been attacked by flood disaster until 2010 with estimated around 25 events (BNPB, 2012). Bali-Nusatenggara was the least compared with other region that has been attacked by flood disasters that estimated to have around 30 events (BNPB, 2012).

This study defined five vulnerability indicators, three indicators for social demography which are poverty degree, infant mortality, unemployment, and two type of biophysical indicators which are vulnerability associated with type of control and vulnerability associated with type of disaster. Condition and characteristic of community and their understanding to the hazard and disaster would influence the degree of resilience. Assessment of the social demography characteristic such as status income, employment, and infant mortality rate would help to measure vulnerability. Characteristic of poverty, infant mortality and unemployment condition in selected cities of Indonesia was vary, for example in Banjarmasin city, the degree of poverty is high, but the degree of infant mortality was very low.

Hazard potential in Indonesia also vary, and there were many possibilities of causing impact and damage. Flood disaster was a hazard with high frequency attacked Indonesia. Earthquake and earthquake tsunami also the biophysical hazard with highest degree impact. Volcano eruption was a geological disaster frequently attacked Indonesia regions. Flash flood, flood and landslide was other hazards with high potential impact hit Indonesia. Forest fire was a hazard which usually attacked Kalimantan region and Riau province in Sumatra. Java was the region with highest frequent disaster events refers to the National Disaster Management Agency recording for year 1990-2012. Disaster waste management agency administered 3618 disaster events attacked in the regions. Bali Nusatenggara region was the lowest of biophysical vulnerability at which Disaster waste management agency recorded 667 disaster evens. Disaster waste management developed index of hazard at which for Java regions has the highest (estimated 241). Biophysical vulnerability in Indonesia regions summarized as follow.

Table 3.11 Biophysical vulnerability in Indonesia regions for year 1990-2012

Vulnerability	Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Papua Maluku
Hazard Disaster frequency recorded of flood, eartquake, eartquake-tsunami and volcano eruption, (1990-2012) Hazars index by national disaster management agency, 2010-2011	1713	3618	667	865	1047
Hazard	115	241	152	106	113



	Banda Aceh	Medan	Padang	North Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
Poverty % population	8.64	9.58	9.54	5.34	5.52	4.80	10.05	15.35	14.99
Infant mortality rate (per 1000)	27.66	23.43	32.21	20.00	18.90	44.60	17.08	34.40	21.90
Unemployment	11.43	13.08	8.04	13.90	11.80	9.70	7.90	4.90	9.60
Water access (% House hold)	95.40	89.30	80.10	98.90	97.00	98.80	81.50	42.70	81.10
Sanitation access (% House hold)	99.40	99.20	92.40	89.30	96.60	90.80	98.40	65.20	92.20

Figure 3.14 Socio demography vulnerability condition in each selected cities of Indonesia 1990-2012

Table 3.12 Biophysical vulnerability in selected cities of Indonesia

Biophysical vulnerability	Banda Aceh	Medan	Padang	North Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
Hazard									
Disaster frequency recorded of flood, Earthquake, Earthquake-tsunami and volcano eruption, (1990-2012)	9	26	24	22	15	3	7	1	17
Hazard index by national disaster management agency, 2010-2011	111	100	119	80	63	58	97	123	60

3.3.4 Indicators assessment in Indonesia regions and selected cities

(1) Capacity

Indicator assessment was stages of statistical data calculation in the index measurement. The research utilized likert scale to classified capacity condition by 5 category from ideal capacity (good condition). The stages of the indicator assessment described as follow:

(1) Entry data statistical
(2) Measurement of maximum and minimum of each data in each indicator
(3) Result of step 2 , the difference of maximum-minimum raw data divided by 5
(4) Comparing data with minimum data, and divided by the value resulted from step (3)
(5) The result of measurement in step 4 was scored as follow

- Value of 4.10 s/d 5.00, was given score of 5.00 at which represent of the good.
- Value of 3.10 s/d 4.00, was given score of 4.00 at which represent of the quite good.
- Value of 2.10 s/d 3.00, was given score of .003 at which represent slightly good,
- Value of 1.10 s/d 2.00, was given score of 2.00 at which represent of neither,
- Value of 0.00 s/d 1.00, was given score of 1.00 at which represent of bad condition.

For examples according to the indicator assessment, the difference of max-min statistical data on the coverage of waste service was 0.22, and the value divided by 5 was 0.044. The difference of minimum value of data with value in Java region and then divided by 5 was 2.95. the range of value then classified with score of 3.0. Table 3.12 and table 3.13 depicted the result of capacity indicator assessment in Indonesian regions and selected cities.

Table 3.13 Result of data assessment of capacity condition in each Indonesian regions

Capacity	Max-Min	(Max-Min)/5	Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Maluku Papua
Coverage of service	0.22	0.044	0.45	2.95	0.23	0.00	5.00
			1.00	3.00	1.00	1.00	5.00
Landfill lifespan	1.70	0.34	5.00	3.24	0.00	2.06	2.94
			5.00	4.00	1.00	3.00	3.00
Recycling Rate	3.70	0.74	0.00	5.00	0.27	0.41	0.00
			1.00	5.00	1.00	1.00	1.00
Availability of guidelines	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.00	1.00	1.00	1.00	1.00
Availability of institutional network	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.00	1.00	1.00	1.00	1.00
Availability of system communication	1.00	0.20	0.00	5.00	0.00	0.00	0.00
			1.00	5.00	1.00	1.00	1.00

Table 3.14 Result of data assessment of capacity condition in each selected cities of Indonesia

Capacity	Max-Min	Comparing (Max-min)/5	Banda Aceh	Medan	Padang	North Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
Coverage area of service	26.10	5.22	2.43	2.01	3.07	5.00	0.84	0.13	1.74	0.00	3.37
			3.00	3.00	4.00	5.00	1.00	1.00	2.00	1.00	4.00
Percentage waste recyclable	2.30	0.46	2.17	2.61	3.48	5.00	2.61	0.65	3.70	0.00	1.30
			3.00	3.00	4.00	5.00	3.00	1.00	4.00	1.00	2.00
Final disposal lifespan	14.00	2.80	5.00	0.00	0.00	0.00	0.71	0.00	1.07	3.57	0.71
			5.00	1.00	1.00	1.00	1.00	1.00	2.00	4.00	1.00
Growth of waste fees collected	23.90	4.78	3.79	3.52	3.36	5.00	0.00	3.22	4.27	3.18	3.77
			4.00	4.00	4.00	5.00	1.00	4.00	5.00	4.00	4.00
Growth of operational cost	6.42	1.28	2.35	1.81	0.87	5.00	1.19	0.59	0.05	0.00	0.01
			3.00	2.00	1.00	5.00	2.00	1.00	1.00	1.00	1.00
availability of guidelines in local state	2.00	0.40	5.00	2.50	5.00	5.00	0.00	0.00	5.00	0.00	0.00
			5.00	3.00	5.00	5.00	1.00	1.00	5.00	1.00	1.00
availability of institutional network	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
availability of system communication	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

(2) Preparedness

Framework and paradigm of disaster management have been change from response towards preparedness. The research conducted interview and questionnaire survey to assess the preparedness. The basic question was utilized the component of Phase 4 contingency planning (UN OCHA, 2011) especially for public official in cities targeted. The research utilized likert scale for both questionnaire and for comparison of each other in selected cities. Data assessment to measure preparedness index for each selected cities in Indonesia described as follow:

(1) Entry questionnaire data and statistical data for regions assessment
(2) Measurement of maximum and minimum of each data in each indicator
(3) Result of step 2 and 3 , the difference of maximum-minimum raw data divided by 5
(4) Comparing data with minimum data, and divided by the value resulted from step (5)
(5) The result of measurement in step 6 was scored as follow
    - Value of 4.10 s/d 5.00, was given score of 5.00 at which represent of the good.
    - Value of 3.10 s/d 4.00, was given score of 4.00 at which represent of the quite good.
    - Value of 2.10 s/d 3.00, was given score of 3.00 at which represent slightly good,
    - Value of 1.10 s/d 2.00, was given score of 2.00 at which represent of neither,
    - Value of 0.00 s/d 1.00, was given score of 1.00 at which represent of bad condition.

For examples, the difference of max-min statistical data on environmental regulation was 1.00, and the value divided by 5 was 0.20. The difference of minimum value of data with value in Java region and then divided by 5 was 5.00. The range of value then classified with score of 5.0. Table 3.14 and table 3.15 depicted the result of preparedness assessment

Table 3.15 Result of data assessment of preparedness condition in each Indonesian region

Preparedness	Max-Min	(Max-Min)/5	Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Maluku Papua
List applicable national and local environmental regulation	1.00	0.20	0.00	5.00	0.00	0.00	0.00
			1.00	5.00	1.00	1.00	1.00
Develop a communication plan	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.00	1.00	1.00	1.00	1.00
Create a disaster debris prevention strategy	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.00	1.00	1.00	1.00	1.00

Table 3.16 Result of data assessment of preparedness condition in each selected cities of Indonesia

Preparedness	Max-Min	comparing (Max-Min)/5	Banda Aceh	Medan	Padang	Noth Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
Establish governmental coordination including private company	2.00	0.40	5.00	5.00	5.00	5.00	2.50	0.00	5.00	0.00	5.00
			5.00	5.00	5.00	5.00	3.00	1.00	4.00	1.00	4.00
Identify likely waste and debris types	4.00	0.80	3.80	1.30	0.00	1.30	0.00	0.00	1.30	1.30	0.00
			5.00	1.00	1.00	2.00	1.00	1.00	2.00	2.00	1.00
Forecast amount of waste and debris	3.00	0.60	5.00	0.00	0.00	0.00	0.00	0.00	1.67	0.00	0.00
			5.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00	1.00
List applicable national and local environmental regulation	3.00	0.60	5.00	2.00	2.00	2.00	2.00	2.00	0.00	2.00	3.00
			5.00	2.00	2.00	3.00	2.00	2.00	1.00	2.00	3.00
Inventory current capacity for waste and debris management	2.00	0.40	5.00	0.00	0.00	0.00	0.00	0.00	0.00	2.50	0.00
			5.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	1.00
Determined waste and debris tracking mechanism	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pre select temporary waste and debris storage	2.00	0.400	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			5.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 3.17 Result of data assessment of preparedness condition in each selected cities of Indonesia (continued table 3.16)

Preparedness	Max-Min	comparing (Max-Min)/5	Banda Aceh	Medan	Padang	Noth Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
Identify equipment and administrative needs sites	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
			1.00	1.00	1.00	1.00	1.00	1.00	1	1	1
Pre negotiate contract	1.00	0.20	0.00	0.00	0.00	5.00	0.00	0.00	5	5	5
			1.00	1.00	1.00	5.00	1.00	1.00	5	5	5
Develop a communication plan	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
			1.00	1.00	1.00	1.00	1.00	1.00	1	1	1
create a disaster debris prevention strategy	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
			1.00	1.00	1.00	1.00	1.00	1.00	1	1	1
Create a debris removal strategy	2.00	0.40	2.50	0.00	2.50	0.00	0.00	0.00	2,5	2,5	0
			3.00	1.00	3.00	1.00	1.00	1.00	3	3	1
Recycling options	2.00	0.40	5.00	0.00	2.50	0.00	0.00	0.00	0	0	0
			5.00	1.00	3.00	1.00	1.00	1.00	1	1	1
Waste to energy options	2.00	0.40	0.00	0.00	5.00	5.00	0.00	0.00	2,5	0	5
			1.00	1.00	5.00	5.00	1.00	1.00	3	1	5
Disposal options	4.00	0.80	5.00	2.50	3.75	0.00	2.50	1.25	2,5	3,75	2,5
			5.00	3.00	4.00	1.00	3.00	2.00	3	4	3
Open burning Options	3.00	0.60	1.67	1.67	1.67	0.00	1.67	1.67	3,33	5	1,67
			2.00	2.00	2.00	1.00	2.00	2.00	4	5	2

(3) Vulnerability

The assessment of the vulnerability indicator was inversely proportional to assessment of the capacity and preparedness indicators. The research defined socio demography and biophysical vulnerability by assessing the poverty, access toward water supply and sanitation. The research defined biophysical vulnerability according to the disaster events and hazard. Data assessment collected from the statistical data for socio demography. Data collected from national and local disaster management agency for biophysical vulnerability. The indicator assessment of vulnerability condition for each regions and selected cities in Indonesia described as follow:

(1) Entry data statistical
(2) Measurement of maximum and minimum of each data in each indicator
(3) Result of step 2 , the difference of raw data divided by 5
(4) Comparing data with maximum data, and divided by the value resulted from step (3)
(5) The result of measurement in step 4 was scored as follow

- Value of -1.00 s/d 0.00, was given score of 1.00, represent of the good vulnerability.
- Value of -2.00 s/d -1.10, was given score of 2.00, represent of the quite good.
- Value of -3.00 s/d -2.10, was given score of 3.00, represent of the slightly good.
- Value of -4.00 s/d -3.10, was given score of 4.00 at which represent of neither.
- Value of -5.00 s/d -4.10, was given score of 1.00 at which represent of bad.

Table 3.18 Result of data assessment of socio demography vulnerability in each Indonesian region

Vulnerability	Max-Min	(Max-Min)/5	Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Maluku Papua
Poverty (%) population	13.94	2.79	-2.13	-1.86	-3.51	0.00	-5.00
			3.00	2.00	4.00	1.00	5.00
Clean Water Access (%) household	20.56	4.11	-3.80	0.00	-1.61	-5.00	-3.93
			4.00	1.00	2.00	5.00	4.00
Sanitation Access (%) household	19.30	3.86	-1.27	0.00	-3.43	-1.90	-5.00
			2.00	1.00	4.00	2.00	5.00

Table 3.19 Result of data assessment of biophysical vulnerability in each Indonesian region

Vulnerability	Max-Min	(Max-Min)/5	Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Maluku Papua
Hazard							
Hazard (2009) (un-weighted)	2951	590.20	-1.80	-5.00	0.00	-0.30	-0.60
			2.00	5.00	1.00	1.00	1.00
Hazard (2009) Weighted BNPB score 2010	134.50	26.90	-0.32	-5.00	-1.70	0.00	-0.26
			1.00	5.00	2.00	1.00	1.00

The basic principle of the vulnerability assessment indicator was that data with high value associated with high vulnerability. For examples, the difference of max-min statistical data on poverty was 13.94, and the value divided by 5 was 2.79. The difference of the value of data in Java region with the maximum value, and then divided by 5 was -1.86. The range of value was classified with score of 2.00. Table 3.17 and 3.18 described the result of vulnerability assessment in Indonesian region. Table 3.19 described the result of vulnerability condition in selected cities of Indonesia.

Refers to the indicator assessment, the condition of the capacity, preparedness and vulnerability in Indonesia regions and selected cities were vary. The indicator assessment was developed to compare each indicator in each region or cities before measuring the integrated index. It is an assessment to verify current condition of the regions and cities. The indicator assessment was developed to simplified the complex condition of the capacities, preparedness and vulnerability, and to avoid the `zero value` in the assessment refers to the model proposed as depicted with mathematic in equation (3.2). Moreover, according to the statistical data the minimum and maximum value of data was very contras. There was an indicator which very low and very high, for example frequency of disaster event, likert scale was used to standardize of the contras value.

There were two type of assessment of biophysical vulnerability, un weighted and weighted assessment. un weighted assessment conducted by comparing statistical data of disaster events according to the frequency of events. The weighted assessment of biophysical vulnerability developed by utilized the hazard value index from National Disaster Management Agency in Indonesia 2010-2011. The hazard index considering the impact of disaster events such as victims, impact associated to housing and facility.

Table 3.20 Result of data assessment of socio demography and biophysical vulnerability in each selected cities of Indonesia

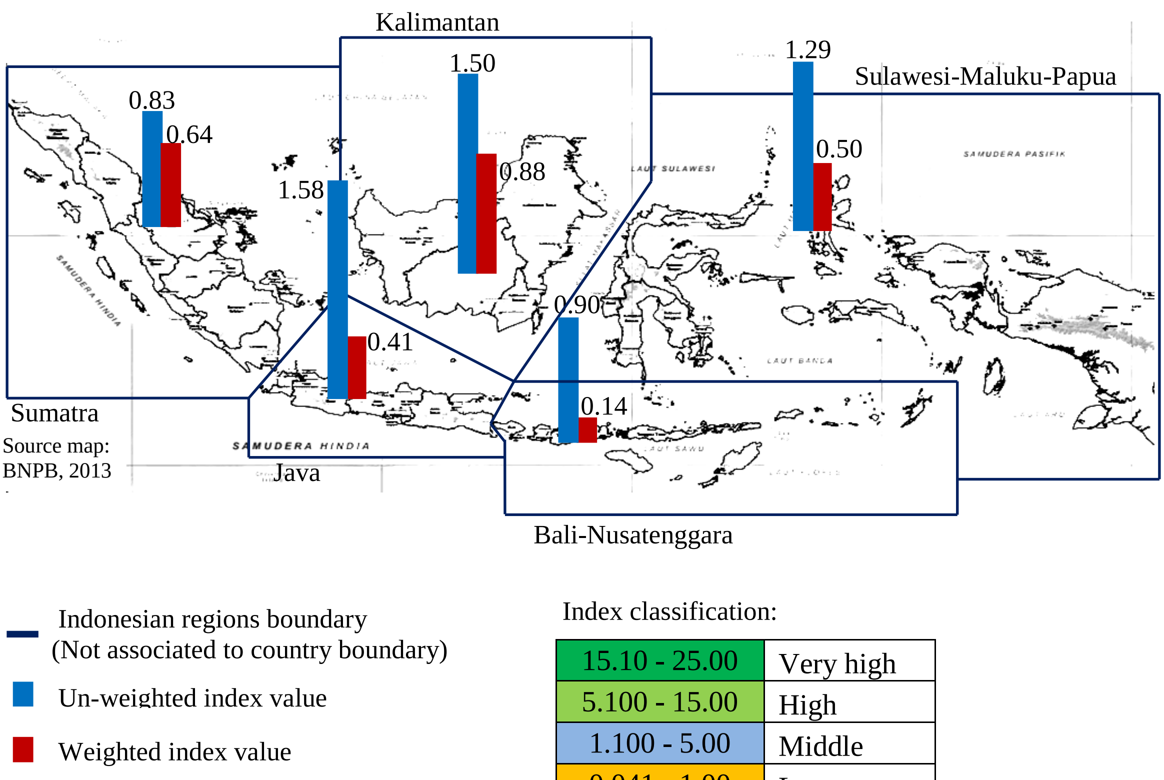
Vulnerability	Max-Min	comparing (Max-Min)/5	Banda Aceh	Medan	Padang	Noth Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
Poverty	10.55	2.11	-1.82	-2.27	-2.25	-0.26	-0.34	0.00	-2.45	-5.00	-4.83
			2.00	3.00	3.00	1.00	1.00	1.00	3.00	5.00	5.00
Infant mortality rate	27.52	5.50	-1.92	-1.15	-2.75	-0.53	-0.33	-5.00	0.00	-3.15	-0.88
			2.00	2.00	3.00	1.00	1.00	5.00	1.00	4.00	1.00
Unemployment	9.00	1.80	-3.63	-4.54	-1.74	-5.00	-3.83	-2.67	-1.67	0.00	-2.61
			4.00	5.00	2.00	5.00	4.00	3.00	2.00	1.00	2.00
Water Access	56.20	11.24	-0.31	-0.85	-1.67	0.00	-0.17	-0.01	-1.55	-5.00	-1.58
			1.00	1.00	2.00	1.00	1.00	1.00	2.00	5.00	2.00
Sanitation Access	34.20	6.84	0.00	-0.03	-1.02	-1.48	-0.41	-1.26	-0.15	-5.00	-1.05
			1.00	1.00	2.00	2.00	1.00	2.00	1.00	5.00	2.00
Hazard											
Flood											
Earthquake											
earthquake tsunami	25.00	5.00	-1.60	-5.00	-4.60	-4.20	-2.80	-0.40	-1.20	0.00	-3.20
eruption (volcano)			2.00	5.00	5.00	5.00	3.00	1.00	2.00	1.00	4.00
un- weighted											
Weighted (use index hazard by National disaster management agency, 2010-2011	65.00	13.00	-4.08	-3.23	-4.69	-1.69	-0.38	0.00	-3.00	-5.00	-0.15
			5.00	4.00	5.00	2.00	1.00	1.00	3.00	5.00	1.00

3.3.5 Result of measurement of disaster resilience index on waste management

(1) Disaster waste management index in Indonesia regions

Resilience measurement of waste management was conducted by normal assessment and weighting assessment. Normal assessment means all indicators was calculated as a given value according to the field condition, especially in hazard, the normal assessment assumes that all hazard cause similar impact. While for the assessment with weighting, the indicator was weighted according to the degree of impact. As recorded by national disaster management agency in Indonesia, the disaster events such as earthquake, tsunami, and flood; where earthquake gave worse impact compare to flood, although flood disaster was the highest event.

In general, according to the index assessment, Indonesia is in the lower middle level; where in the five classes (groups), Indonesia is in the third and fourth class. The system of disaster waste management can provide basic service such as collecting, transport, and disposal of disaster waste management; however, the system is not yet covered the high level of disaster waste management issues such as running the intermediate treatment. According to the normal assessment, Java region has the highest index (estimated index: 1.58) and Sumatra region was the lowest index (estimated index: 0.83). By using the weighting assessment, Kalimantan region has the highest index (estimated index: 0.84) and Bali Nusatenggara has the lowest index (estimated index: 0.14).



15.10 - 25.00	Very high
5.100 - 15.00	High
1.100 - 5.00	Middle
0.041 - 1.00	Low
0.00 - 0.04	very low

Figure 3.15 Disaster resilience index on waste management in Indonesian regions

Table 3.21 and table 3.22 depicted the process of integrated index measurement by using the model proposed as equation 3.2. The un-weighted method indicated that all indicator was equal each other, while for weighted method, in Indonesia condition as follow

- Technical aspect more importance
- Poverty condition is more importance
- Disaster events considering effect of victims and damage

Table 3.21 Measurement integrate index on disaster waste management (Indonesian regions)

Capacity		Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Maluku Papua
Un-Weighted		1.67	3.17	1.00	1.33	2.00
Coverage area of service Percentage waste recyclable Final disposal lifespan	0.70	1.63	2.80	0.70	1.17	2.10
availability of guidelines in local state availability of institutional network availability of system communication	0.30	0.30	0.70	0.30	0.30	0.30
(Weighted)		1.93	3.50	1.00	1.47	2.40

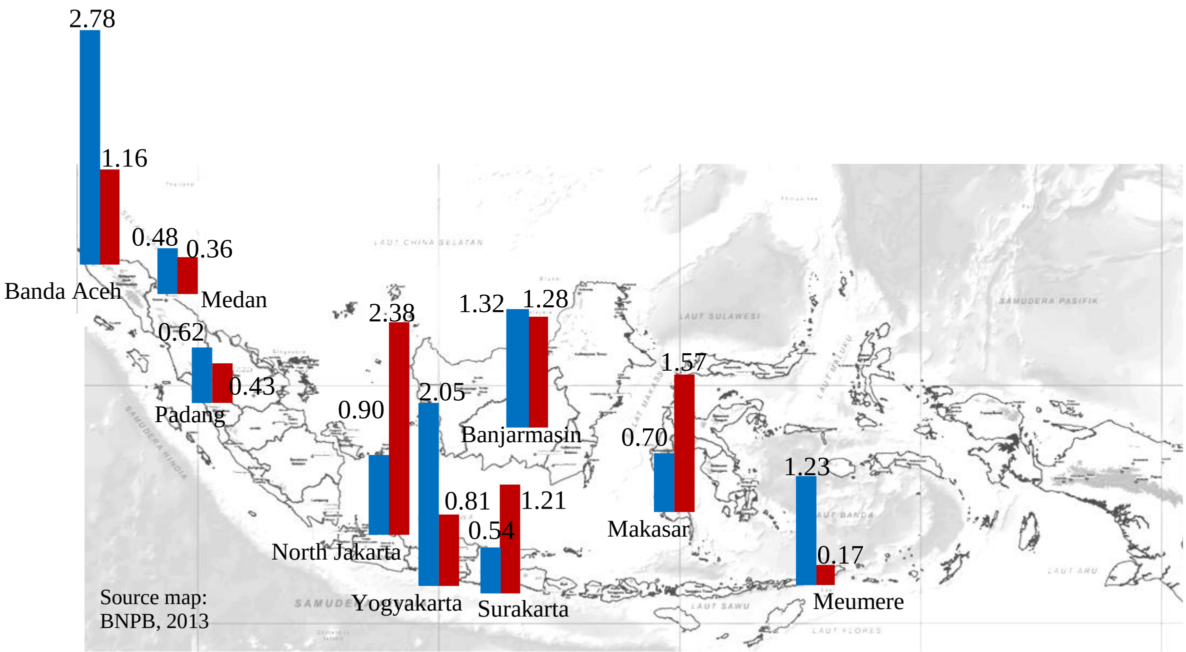
Preparedness	Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Maluku Papua
P (un-Weighted) As score	3.00	3.33	3.00	3.00	3.00
P weighted (Min-Max)	1.00	1.00	1.00	1.00	1.00

Vulnerability		Sumatra	Java	Bali Nusatenggara	Kalimantan	Sulawesi Maluku Papua
un weighted		3.00	1.33	3.33	2.67	4.67
V weighted Poverty	0.70	2.10	1.40	2.80	0.70	3.50
Water Access Sanitation Access	0.30	0.90	0.30	0.90	1.05	1.35
weighted		3.00	1.70	3.70	1.75	4.85
Hazard un-weighted)		2.00	5.00	1.00	1.00	1.00
H (weighted)		1.00	5.00	2.00	1.00	1.00

(2) Disaster waste management index in selected cities of Indonesia

Selected cities Indonesia classified in the middle-low level index. Banda Aceh city has the highest index (index estimated: 2.0) and Medan has the lowest index (estimated index: 0.48) according to the normal measurement. North Jakarta has the highest index (index estimated: 2.38) and Maumere/Sika district has the lowest index (estimated index: 0.17) according to the weighted assessment. According to the normal assessment, other cities that in the third class are Yogyakarta (estimated index: 2.05), Banjarmasin (estimated index: 1.32), and Maumere (estimated index: 1.23). By using weighted assessment other cities in the third class are Makasar (estimated index: 1.57), Banjarmasin (estimated index: 1.28), Surakarta (estimated index: 1.21) and Banda Aceh (estimated index: 1.16).

By using weighting assessment, the index values for some cities changed, where the index values for Yogyakarta and Maumere become lower and for North Jakarta, Makassar and Surakarta the index values become Higher. However, Padang and Medan are stay in the forth level. For weighting assessment, this study weighted the technical capacity of 0.5, economic capacity of 0.3 and organizational capacity of 0.2. For the vulnerability indicator, this study weighted the poverty of 0.5, Infant mortality and un-employment of 0.2 and access to water and sanitation of 0.3.



Un-weighted index value

Weighted index value

Index classification:

15.10 - 25.00	Very high
5.100 - 15.00	High
1.100 - 5.00	Middle
0.041 - 1.00	Low
0.00 - 0.04	very low

Figure 3.16 Disaster resilience index on waste management in selected cities of Indonesia

Table 3.22 Measurement integrate index on disaster waste management (selected cities in Indonesia)

Capacity		Banda Aceh	Medan	Padang	North Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
Un-weighted		3.13	2.25	2.63	3.50	1.38	1.38	2.63	1.75	1.88
Coverage area of service Percentage waste recyclable Final disposal lifespan	0.50	1.83	1.17	1.50	1.83	0.83	0.50	1.33	1.00	1.17
Growth of waste fees collected Growth of operational cost	0.30	1.05	0.90	0.75	1.50	0.45	0.75	0.90	0.75	0.75
Availability of guidelines in local state Availability of institutional network Availability of system communication	0.20	0.47	0.33	0.47	0.47	0.20	0.20	0.47	0.20	0.20
Weighted		3.35	2.40	2.72	3.80	1.48	1.45	2.70	1.95	2.12

Preparedness	Banda Aceh	Medan	Padang	North Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
P (un-Weighted) As score	3.56	2,563	2,813	2,563	2,438	2,313	2,813	2,813	2,750
P weighted (min Max)	3.13	1,4375	2	1,9375	1,375	1,1875	2,125	2,0625	2

Vulnerability		Banda Aceh	Medan	Padang	North Jakarta	Makasar	Banjarmasin	Yogyakarta	Maumere	Surakarta
Un-weighted		2.00	2.40	2.40	2.00	1.60	2.40	1.80	4.00	2.40
Poverty	0.50	1.00	1.50	1.50	0.50	0.50	0.50	1.50	2.50	2.50
Infant mortality rate Unemployment	0.20	0.50	0.60	0.40	0.60	0.50	0.40	0.40	0.60	0.40
Water Access Sanitation Access	0.30	0.30	0.30	0.60	0.45	0.30	0.45	0.45	1.50	0.60
V weighted		1.80	2.40	2.50	1.55	1.30	1.35	2.35	4.60	3.50

3.4 Discussion

Disaster resilience index on waste management is developed to describe the capacity and preparedness in developing countries such as Indonesia. This study merged both qualitative and quantitative approach to evaluate the performance of disaster waste management in developing countries. However, the model could be applied to assess preparedness in developed countries by modifying the indicators. Assessment and selection of indicator could be determined by assessing alternative indicator as proposed by Davidson, (1997) or Simpson and Katirai (2006). This study developed an approach to summary the performance condition of any aspect that influence the disaster waste management achievement. In the context of evaluation and planning program, this model helps to find strategic issues of disaster waste management especially in developing countries. There were many possibilities of parameters and indicators that could be measured by this model, qualitative approach would help to justify the value of indicators due to some difficulties to collect the data series, which is an usual problem in developing countries.

A comprehensive disaster waste management provides step by step ~~of~~ planning such as mitigation, preparedness, respond and recovery. There was many indicators to be applied in every step, in this study some selected parameters in the mitigation and preparedness stage have been examined. However, there were still lack of information such as service performance for daily service and achievement performance associated with mitigation and preparedness to disaster waste management. Stakeholder assessment such as developing model to understand factor that affect stakeholder intention to promote preparedness is needed to ensure what parameter necessary to describe the degree of preparedness. For developing countries, development of waste management facility is conducted to achieve standard ideal of service, it is not to prepare and plan disaster waste management. However, both ~~of~~ increasing waste management performance and preparing for disaster waste management could be constructed together, inline of program.

This model help to map and explore the initial condition of disaster waste management preparedness achievement in developing country to foster the pre-planning for disaster waste management. This model could evaluate the performance achievement of municipal waste management and map the problems. However, for developing countries, the assessment of indicator should be adjusted with local condition. In developing countries, the availability of statistical data is rare, and it is very difficult to access. This study model could be developed to perform statistical data and administered regularly, by incorporating into the disaster management program or waste management program in local, or regional state. By exploring and selecting indicator possibilities, it would help step by step to prepared ideal disaster waste management application. By applied this model, case by case of disaster waste management could be summarized. It would help local stakeholder to increase their understanding

3.5 Conclusion and proposal for improving preparedness on disaster waste management

Indonesia is one of the countries that prone to disaster because Indonesia has suffered a lot of disaster attacks. Therefore, a disaster waste management should be prepared in line with the fostering of waste management performance. The national agency of disaster management, the ministry of public work, and the ministry of environment had issued a mechanism to prepare disaster waste management. Several points to improve the preparedness for disaster waste management in Indonesia are proposed as follow:

- By supporting regional and national government, initial guideline to predict disaster waste management generation for each local state should be performed. By predicting as early as possible, automatically a preventive action have been done by the local government.
- Building databases and statistical records for disaster waste generation and composition is needed, even though disaster waste generation is not so high, and could be handled directly, statistical records and databases are really needed to mitigate the impact.
- By incorporating existing system or by installing new system, providing the system such as GIS application was proposed to setup in local state to ensure the condition of waste management facility and to ensure maintenance or controlling condition. Moreover, setting method to tracking disaster waste generation, such as after flood, was need to increase preparedness.
- Regular fostering evaluation was needed for local government to ensure the condition of waste management performance. Moreover, inventory situation associated with disaster waste management experience was needed to evaluate the performance achievement, evaluate the step of handling and mitigate the impact including preparing alternative temporary storage.
- Fostering coordination with regional and national level was needed to evaluate the performance of waste management and to share the information of waste management and disaster waste management for fostering and evaluating alternative regulations that are needed in emergency situation for effective and efficient in disaster waste management handling .
- Fostering coordination and sharing resource with regional and national government including fostering mechanism to cooperate with private company was needed to ensure the waste management and disaster waste management in disaster situation.
- Preparing mechanism contract and administrative procedure for any additional equipments and tools in disaster event was needed, especially for cooperation with other institution and private company.

- Fostering capability for local state employment was needed to foster the capability to handle the disaster such as collection, transport, and final disposal including open burning, recycling and removal option in final disposal.

CHAPTER 4

Identification of Factors Affecting Stakeholders' Intentions to Promote Preparedness in Disaster Waste Management: A Structural Equation Modeling Approach

4.1 Introduction

This research defines promoting preparedness in disaster waste management (DWM-P) as stakeholders measures or efforts to anticipate the failure of a waste management system when handling disaster waste (O`leary, 2004; Brown et al., 2011b). Hence, DWM-P is defined as a status or condition of a DWM system for a waste needs long time to manage normally (Carson et al., 2012; Brown et al., 2011b). In DWM, an adequate degree of resilience depends on the speed at which a system can initiate a clean-up response in order to reduce, reuse, recycle and reproduce for recovery and then discharge the remaining material in environmentally manner. DWM-P thus requires redesigned program such as pre-planning post DWM (Tajima et al., 2013; Karunasena et al., 2009) and capacity building (Karunasena et al., 2013). This research examines the factors of a hierarchical structural model that affect the promotion of DWM-P.

A high level of DWM-P is not only influenced by detailed programs for pre-planning and capacity building. Paton (2001) introduced a general conceptual model of disaster preparedness as a process of public education that aims to enhance community awareness. However, research on DWM-P is generally limited (Milke, 2011). Despite the psychological aspects, stakeholder participation has been introduces to overcome the challenges of DWM, however, this has only focused on operational efficiency (Yi & Yang, 2014). Moreover, research on stakeholders' intentions to promote preparedness not yet been conducted (Yi, & Yang 2014, Altay & Green, 2006).

Shimaoka (1995) proposed a foundation model for investigating disaster waste generation and disposal measures by exploring the Great Hanshin-Awaji Earthquake, of 1995. This line of research was continued by Hirayama et al., (2010), who utilized advanced GIS methods. Foundation models provide data on disaster waste generation. This method could also be used to formulate mitigation plans. However, even though developing countries receive training programs from international donors, most cannot maintain sustainability. This study evaluates stakeholders' responses to and awareness of the adaption of this method for waste management services.

Nakamichi (1995) investigated an initial system for managing 3R (reduce, reuse and recycle) and used the possibility method to explore the Great Hanshin-Awaji earthquake. Harukaze (1997) extended this model by proposing an intermediate treatment for DWM. A comprehensive model that evaluates intermediate treatment and the 3R methodology was then established by Hu and Sheu (2013), who examined waste from the Great Hanjin Earthquake. The model assessed the effectiveness of comprehensive-disaster waste handling, from collection, reduce, reuse, recycle, reproduce and discharge of the remaining material and integrated three essential issues, namely cost, environmental considerations, and waiting time. This present study determines stakeholders' perceptions, awareness and preparation by applying this method in developing countries.

Asari et al.(2013) considered issues related to the coordination of stakeholders at the central, prefectural and local government levels when sharing resources such as collection, transfers, and final waste disposal[17)], while Tajima et al (2014), explored institutional changes in coordinating and handling waste from the Great East Japan Earthquake 201. Readiness to coordinate, and willingness to accept waste and provide disposal sites indicate a high degree of preparedness. This study measures stakeholders' preparedness toward public-private cooperation problems in developing countries.

Extending Harukaze's studies, Feter and Rakes (2012) expanded the notion of intermediate treatment by proposing a conceptual framework incorporating temporary sites and a recycling process, while Lauritzen (1998) proposed an economic model for assessing the effectiveness of the emergency construction of disaster waste treatment plants. Because of the procurement processes in developing countries, purchasing equipment can take a long time. This study thus evaluates the impacts of previous experience on fostering DWM-P.

The Indian tsunami of 2004 was one of the hugest calamities suffered by developing countries. This study utilized the subsequent waste management program in Banda Aceh, Indonesia in order to design the factors that affect promoting DWM-P. Two main questions are thus addressed in this research: what factors influenced promoting DWM-P? and how was the causal correlation between these factors constructed?

4.2 Development model of factors affects DWM-P

4.2.1 Identification factor

(1) Post tsunami waste 2004 management in Banda Aceh

Tsunami recovery waste management program was one of the significant disaster waste management exercises for developing countries. It was a comprehensive program for handling Indian tsunami waste in Banda Aceh Indonesia. This Program took a long time started from 2005 and finished in 2012. Many international agencies supported in Indian tsunami waste management program, such as UNDP, GTZ, JICA, VNG, Apeldoorn, CALGAP, CRS, UNDP, Unicef, Citynet-SWM Cluster, IOM Turk-World Vision (Notodarmodjo, 2007; UNEP, 2008). There were several programs of disaster waste management in Banda Aceh.

The first activity demonstrated in disaster waste management was collecting, sorting, and reuse of disaster waste. In this stage, cash work program launched to encourage community involvement. The cash work program aimed to support community likelihood such as economic opportunity. Since the major equipment for collecting was damaged, the clean-up responded very slowly. Government budgeting for emergency respond such as debris clean up was very limited. Furthermore, Additional equipment to accelerate clean-up respond very hard to be done by their own resources.

Logistic and equipment mobilization for collect and transfer waste to temporary storage was the second stage of disaster waste management in Banda Aceh. Providing trucks, bulldozer, excavator, mostly supported from foreign donors. Cooperation and sharing resources from other local or provincial government could not be achieved. Procurement of logistic and equipment, understanding of alternative high technical machine and method, understanding to operate and maintain machine, become significant issues in this stage program. Even though acceleration of knowledge implemented such as capacity building and workshop, a sustainable motivation and awareness, become a potential issues to foster preparedness.

Demolition building was the other section of disaster waste management run in Banda Aceh. It was a process to tearing-down a damage building and structure with a high technological application such as wrecking ball or building implosion. It is new experience of disaster waste management for community in Banda Aceh. Stakeholder in Banda Aceh did not have an experience and including tools and equipment to conduct the activities. Conventional procurement usually held to provide waste facility could not covered the task. Demolition civil structure also involved foreign countries assistance.

Intermediate treatment realized by install hard machine such as stone crusher to reduce volume construction waste. With the proportion size, the construction waste reuse for recovery such as street and other facility. Process such as reuse, recycle were demonstrated to promote community understanding especially to perform reduce, reuse, recycle and reproduction of disaster waste. In this stage they produced furniture for public facility such as government office, public school. The characteristic of disaster waste was vary depend on the type of disaster.

Final treatment of disaster waste conducted with increase capacity of Gampong Java Banda Aceh landfill site. The activity was follow by constructing the regional landfill in Blang Bintang outside area of Banda Aceh City. This regional landfill site developed to accommodate waste disposal from Banda Aceh and North Aceh local. The process of negotiation among local government, provincial government, and ministry of forestry is one of the importance experiences in this program. Moreover, the process of negotiation for land acquisition is one of the importance achievement for setting regional landfill site. The result shown the process of coordination between all level of government such as central, provincial, and local government.

(2) Affiliation each factors by using logic model framework

Tsunami waste management program is initiated by outside stakeholder, especially from international funding as previously discussed. Logic model is a framework to evaluation at which the assessment and measurement the impact of program setup for proposed the new appropriate intervention (Brousselle & champagne, 2011). Furthermore, in recent decades, comprehensive evaluation was a process and mechanism to construct causal mechanism of the input, output, outcome as depictions of the targeted program (McLaughlin, et.al., 1999; Brousselle & Champagne, 2011). Logic model also measure the changing of stakeholder belief and perception (McCawley; Brousselle & Champagne, 2011).

Identification of stakeholders' intentions to promote and their behavior to developed disaster waste management preparedness was a study associated with the individual human behavior. This study was explore individual personality and motivation, perception and perceived according to the ideal planning for disaster waste management. Ajzen (1991), has proposed conceptual framework to assess and measure individual behavioral, then well known as the theory of reason action and theory of plan behavior. The theoretical framework could described individual attitude, personality trait then predict and explained their influence into the degree of their behavior Ajzen (1991). This study would explore the theoretical framework to described the stakeholders' intention and behavior on disaster waste management preparedness.

According to the cycle of the logic model in the evaluation program, to assess the input output and outcome of the program this study utilized qualitative and quantitative analysis method. Table 4.1 described the impact expected from the running program of post tsunami 2004 waste management in Banda Aceh Indonesia. According to the logic model the impact of program could be defined as the cycles of input, output, outcomes (McCawley; McLaughlin, et.al., 1999). This study identified the impact of post tsunami program previously discussed especially for the stakeholder understanding, and then their preference and motivation to promote preparedness in disaster waste management. Identification aspect expected then utilized as the basic framework for developed factor model of disaster waste management preparedness. The identification aspect summarized from the serial interview was conduct at the national level Jakarta, provincial level and local level of government.

As an evaluation of the program, according to the logic model, this study defined that the result of Tsunami waste management program in Banda Aceh consist of short term outcome, medium term outcome and long term outcome. Measurement of short-term outcome was associated with stakeholder motivation to updating knowledge of disaster waste management, stakeholder concern to the plan for disaster waste treatment. Measurement of medium term outcome was associated to stakeholder awareness of insufficient of facility, and measurement of long-term outcome was associated to stakeholder intention in promoting preparedness.

Table 4.1 Effect expectation from Indian tsunami 2004 waste management program

Process /program	Effect expectation	
Input/activities: • Financial aid from internal, external-foreign donor fund • Logistic, Equipment (vehicle, other facility) Output: • Technical Demonstration on Disaster waste process • Workshop and training common waste and disaster waste management[5,11)]	Outcomes (Short-term): • Motivation to updating knowledge, skill of waste and disaster waste - Methods and architecture database management - Methods identification impact and mitigation • Concern on disaster waste process: - Stage of process - Availability equipment - Operation and procedure • Awareness associated with previous experience : - Consequences negative impact from disaster waste - Likelihood, opportunity to get benefit in disaster waste management	Outcomes (Medium-term): • Awareness toward common waste management associated with safety and mitigation: - Level of service - Facility performance • Awareness toward situation of bureaucracy: - Bureaucracy operation and system - Equipment mobilization and shareholder in stakeholder • Intention to promote disaster waste management preparedness Outcomes (Long-term): • Stakeholders' role in fostering disaster waste management preparedness

Source: author, modified from (McCawley; McLaughlin, et.al., 1999).

4.2.2 Structural equation model

Structural equation modeling (SEM) is a method that usually use to analysis variables that cannot measured directly (Joreskog, 1993). Structural equation model raised to incorporating regression analysis and factor analysis (Savalei & Bentler, 2010). According to the he simple regression, for example dependent variable y is which influenced by p dependent variable, then described as mathematic formulation; $y= a +b_ix_i + e$, there four part component from the regression principles which expand by structural equation modeling (Savalei & Bentler, 2010). The first one is the additional of latent variables, could be predictors (x) or independent variable. Second extension is concerning to the latent regression. The third expansion is that structural equation modeling could measure simultaneously of several multiple equations. The last of expansion is the changing of the status of dependent variable that could to be dependent variable in another equation.

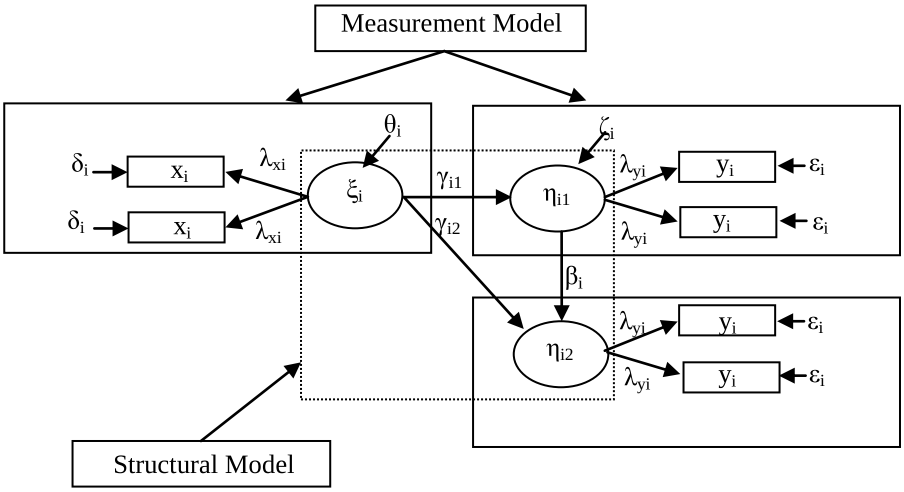


Figure 4.1 A structural equation model demarcated into measurement model and structural component

As depicted in figure 4.1, a structural equation model consists of two main model, measurement model and structural model. For an illustration, the figure 4.1 give three unobserved factor oar latent variables (ξ_i), (η_{i1}),(η_{i2}). Here factor (ξ_i) is a dependent variables, and which then observed by variable x_i, as sign by two arrow from (ξ_i) to x_i (Joreskog, 1993; Savalei, 2010). Factor of (η_{i1}),(η_{i2}) were dependent variables which then observed variable y_i, as sign by two arrow from (η_{i1}),(η_{i2}) to y_i (Joreskog, 1993; Savalei & Bentler, 2010). There were also three latent regression, (γ_{i1}), (γ_{i2}), and β_i as a structural model. Regression of (γ_{i1}) describes the causal correlation from factor (ξ_i) and factor (η_{i1}). Regression of (η_{i2}) describes the causal correlation from factor (ξ_i) and factor (η_{i2}), and Regression of (β_i) describes the causal correlation from factor (η_{i1}) and factor (η_{i2}).

The analysis factor or measurement of the factor model of predictor or independent latent variable describe by the mathematic formula as below (Joreskog, 1993; Savalei, 2010):

$x_i = \lambda_{xi}\xi_i + \delta_i$ (4.1)

$x_i = \lambda_{xi}\,\xi_i + \delta_i$ (4.2)

The analysis factor or measurement of the factor model of dependent latent variable describe by the mathematic formula as below (Joreskog, 1993; Savalei, 2010):

$y_i = \lambda_{yi}\eta_1 + \varepsilon_i$ (4.3)

$y_i = \lambda_{xi}\eta_2 + \varepsilon_i$ (4.4)

The causal correlation or regression equation of (γ_{i1}), (γ_{i2}), and β_i describe as the mathematic formula as below (Joreskog, 1993; Savalei & Bentler, 2010).

$\eta i_1 = \xi_i\,\gamma_{i1} + \zeta_{i1}$ (4.5)

$\eta i_2 = \xi_i \gamma_{i2} + \zeta_{i2}$ (4.6)

$\eta i_2 = \eta i_1 \beta_i + \zeta_{i2}$ (4.7)

Where,

x_i : Observed variable of ξ

y_i : Observed variable of η

ξ : Predictor latent variable (factor)

η : Dependent latent variable (factor)

λ_{xi} : Loading factor, a relation/path between predictor or dependent latent variable and observed variable

λ_{yi} : Loading factor, a relation/path between dependent latent variable an observed Variable

γ_i : Regression/path predictor latent variable & dependent latent variable

ζ_i : Regression/path one dependent latent variable to others

β : Error Measurement ξ

δ_i : Error Measurement for x

ε_i : Error Measurement for y

θ : Residual/Error for η

4.2.3 Stakeholders' intentions and initial model of factors

Stakeholders' intentions to promote and their behavior to developed disaster waste management preparedness was a study associated with the individual human behavior. As of the definition of theory of plan behavior, that the individual`s intention is a central factor that influence to perform a given behavior (Ajzen, 1991). He stated that the behavior was affected by attitude toward behavior, subjective norm. In 2002, he proposed variable of perceived behavioral control to covers the limitation of his theoretical previously. Perceived behavioral control could be defines as a general condition then it makes a certain action is easy to do or very difficult to do (Ajzen, 2002).

Many factors that influence the individual intentions to perform a certain behavior could be assess and measured. Moreover, the theory of plan behavior could be evaluate the impact of program and training such as capacity building to perform organizational and employment productivity (Shah & Goldstein, 2006). Savalei & Bentler (2010), summarizes the theory of plan behavior with of structural equation modeling to describe the causal correlation between latent variable of attitude toward behavior, subjective norm, and perceived behavioral control. This model also could be utilized for evaluation of disaster waste management preparedness, at which in this study, promoting of preparedness was designed as behavior achievement.

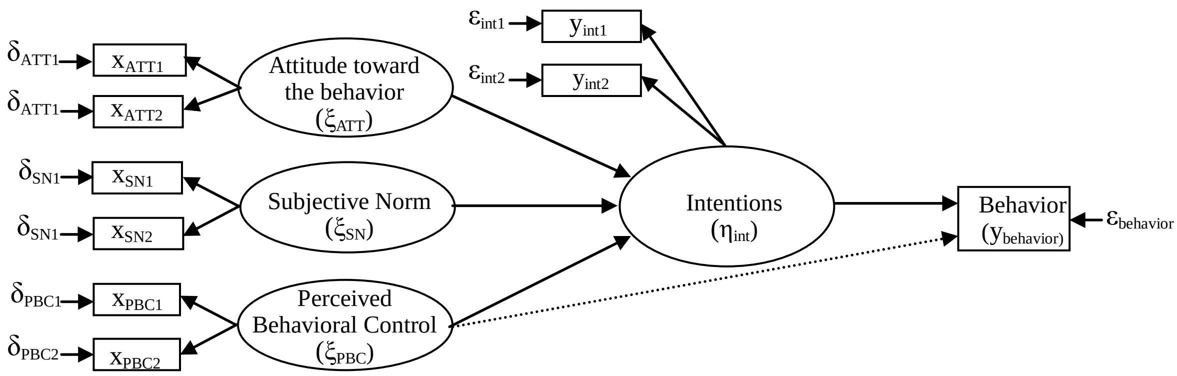


Figure 4.2 A diagram for the theory of plan behavior (TPB), hybrid with mathematic symbol
Source: modified Ajzen 2002, Savalei & Bentler 2010

Figure 4.2 depicts theory of plan behavior model. The intentions (η_{int}) is a factor model which was influenced by three factor; attitudes (ξ_{ATT}), subjective norm (ξ_{SN}), and factor perceived behavioral (ξ_{PBC}). The causal correlation is depicted as arrow from the left to the right. The intentions then in turn predicts the degree of behavior ($y_{behavior}$). The behavior here is described as observed variable, while the intentions is a latent variable which was measured by two observed variables (y_{int1}, y_{int2}). Error of measurement depict as (ε_{int1}) and (ε_{int2}) for latent variable of intention and ($\varepsilon_{behavior}$) for measurement of behavior observed variable. Factor of attitudes (ξ_{ATT}), subjective norm (ξ_{SN}), and factor perceived behavioral (ξ_{PBC}) were also latent variable, which each of factor measured by two latent variables. The error of measurement of the factor depict as (δ) depict with arrow from right to left. Error Actually the measured of latent variables could be more than two observed variables.

Figure 4.3 described a hierarchical of structural equation model of DWM-P. This model is an extension of construct latent variable of perceived behavioral control from the theory of Plan behavior. The DWM-P model proposed five factors, as the predictor of the latent factor of intentions, at which in turn predicts DWM-P as final goal (the end of hierarchical). According the logic framework previously, the predictor and dependent variable is the cycle mechanism. The construct of DWM-P was measured by observed variable y_1 and $y_{2..}$ The construct of intention was measured by two indicators or observed variables y_3 and y_4 . Two factors were constructed to be higher factor model (become second order factor model) to make the factors more meaningful and closer to the variation aspect of increasing DWM-P. The factors were factor awareness to difficulty to run 3R and proper final disposal and factor concern to the knowledge of disaster waste. All factor as predictor or independent factor measured by 14 observed variables x_1-x_{14}.

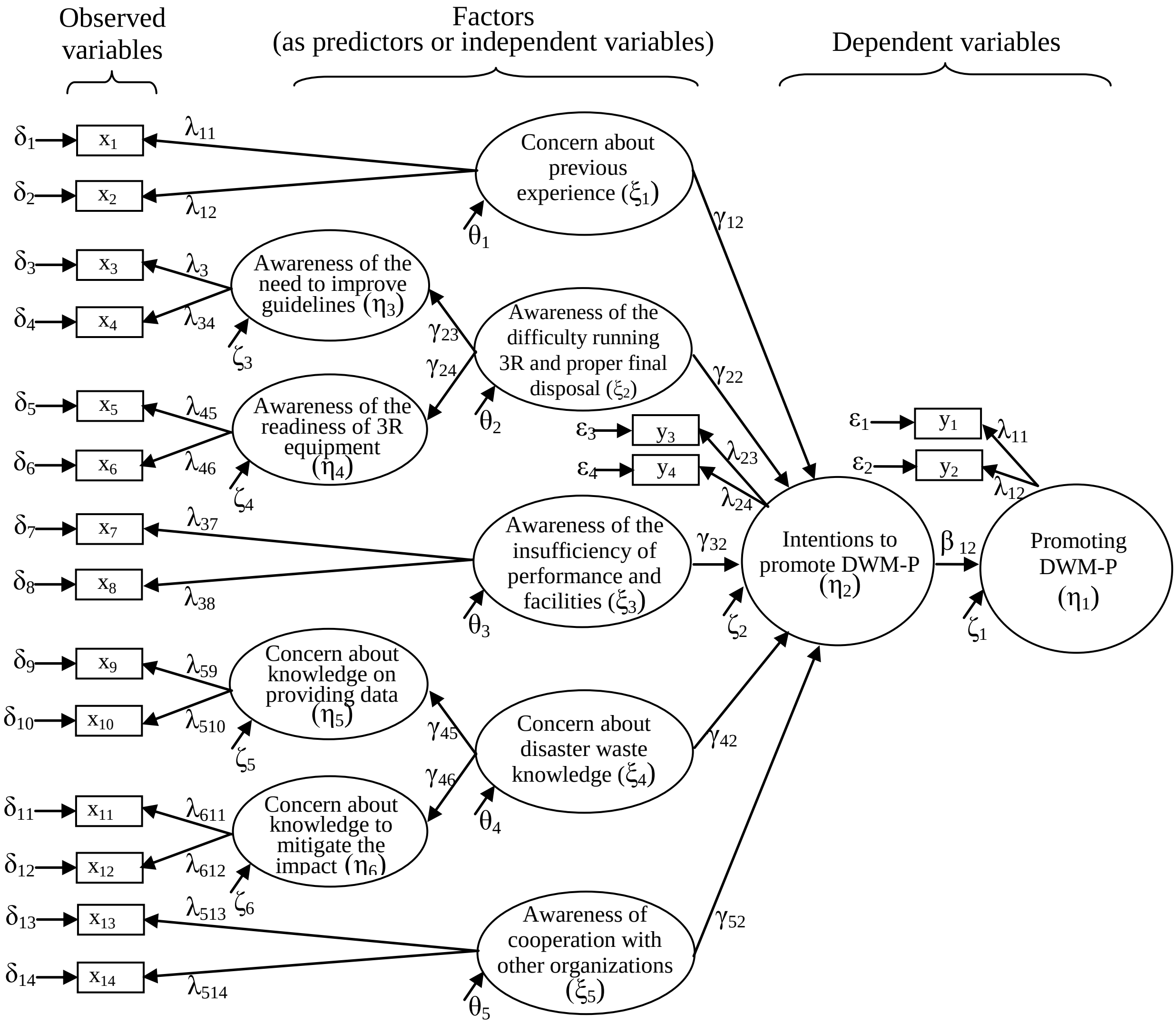


Figure 4.3 Full hierarchy structural equation model of DWM-P, depicted as a path diagram, hybrid with mathematical symbols.

In developing countries, to foster preparedness for disaster waste management, it should be conducted in line with community education and development of daily waste management service due to the poor condition such as technical, financial, legal, organizational (Paton, 2001; Shekdar, 2009). Planning and introducing program also should be considering at which that the program inherent within all public services (Trochim, 1986). There was organizational goal that should be delivered at which that it also influence and then increase personal employee motivation in the organization (Ajzen, 2002; Perry, 2000). This study proposed the main hypothesis that action to promote preparedness in disaster waste management (DWP-P) is determined by the degree of stakeholder intentions. Hence, this primary hypothesis of this latent factors then formulated as correlation follow:

$$\eta_1 = \eta_2\ \beta_{12} + \zeta_1 \qquad (4.8)$$

Fostering preparedness of disaster waste management was not only of personal action, because it was a process to increase the degree of organizational and governance capacity (Chang, 2013). Refers to this theoretical framework, for further investigation, this research proposed five unobserved latent factor that affect stakeholder intention for promoting DWM-P. The factors are (1) factor of concern about previous experience, (2) factor of awareness of the difficulty running 3R and proper final disposal, (3) factor of awareness of the insufficiency of performance and facilities, (4) factor of concern about disaster waste knowledge, and (5) factor of Awareness of cooperation with other organizations. The hypothesis of the five factors then formulated as correlation as follow:

$$\eta_1 = \xi_1\ \gamma_{12} + \xi_2\ \gamma_{22} + \xi_3\ \gamma_{32} + \xi_4\ \gamma_{42} + \xi_4\ \gamma_{42} + \xi_5\ \gamma_{52} \qquad (4.10)$$

4.2.4 First order factor model

(1) Factor of concern about previous experience

Factor of concern about previous experience is associated with personal belief of consequences both of positive and negative. Argote et al (2000) stated that previous experience able to leverage the learning process in the organization and situation and system coordination in the organization will influence the transfer of previous experience in the organization. Applying this conceptual framework have been done by the Terptra (2013) for analysis of the previous experience for flood management preparedness in Nederland. Chan et al. (2012) also explored the influence of previous experience preparedness of disaster management in China.

Previous experience was a stakeholders' understanding by the events that happen before. Mostly previous experience directly proportional to the stakeholders' perception of risk, however, for some case of disaster, previous experience not yet provided significant effect for improving preparedness Terptra (2013). There positive and negative previous experience affects the degree of preparedness. Stakeholder would be easier to understand when they were exposed. The first one is belief of negative impact of disaster waste. it was describe the stakeholder perception associated to the unwanted condition according to the disaster waste management generation. For negative previous experience, this study exploring parameter such as disturbance of public health and environmental pollution. Rahardian et al, (2004) assessed the environmental disturbance according the un proper of waste management. The environmental health disturbance and negative impact was due to generating rodent, insect, and flies.

The second one was belief positive impact on proper disaster waste management. It was an understanding of the truth that refers the good things. Tang (2006), investigate the positive impact of receiving of social support in Thailand when Indian tsunami attack. This observed variables measure stakeholder understanding associated with benefit when disaster waste could be manage as well as ideal guidelines. Identification of observed variable to measure latent factor of perceived likelihood such the stakeholder understanding of the program to increasing value of disaster waste material. In Banda Aceh the program run by introducing recycling process to reproducing tsunami wood become furniture.

The correlation negative observed variables and the positive observed variable of factor of concern about previous experience then formulated as below:

$x_1 = \lambda_{12}\, \xi_1 + \delta_2$ (4.11)

$x_2 = \lambda_{12}\, \xi_1 + \delta_2$ (4.12)

(2) Factor of awareness of the insufficiency of performance and facilities

It was unobserved factors model is proposed to define the stakeholder awareness associated the day to to condition of solid waste management in normal condition. An aggregate and cumulative behavior such as disaster waste preparedness was determined by small exercise workout (Ajzen 1991, Paton, 2001). For simplification, the meaning of this conceptual, when applying to the disaster waste management was that capability to handling a huge disaster waste, determined by how the stakeholder manage small disaster waste that generate by small disaster. There are two observed variables for measuring the factor model, the first is observe variables associated to the insufficiency of performance in waste management and second is observe variables associated with insufficiency facilities.

The stakeholder behavior in handling the disaster management in local scale will influence the behavior in handling disaster waste generate by disaster as provincial scale, and then the behavior will determined the behavior on handling disaster waste management in national scale. This conceptual framework also could be interpreted as with the making best performing and handling ideally of every disaster waste generation, it would automatically increasing the capability. Refers to the conceptual framework, determining of observed variables for insufficiency performance determined by constructing observed variables associated with stakeholder understanding of complain centre and possibility or opportunity when complain centre was build in ward level (shekdar, 2009).

Adequate facilities were the critical component in waste management. Indicator of sufficient facilities determined by constructing the observed variables of sufficiency facilities of waste management stage of waste management that stakeholder understanding. The evaluation of stakeholder understanding was started constructed from the initial stage, collection, then transfer and transport, intermediate treatment, and final treatment. Simples facilities describe by assess the stakeholder understanding of daily waste management and comprehensive facilities describe by assess the stakeholder understanding such as planning program for improving facility (shekdar, 2009). For further assessment, the observed variable then formulated as mathematic equation follows:

$x_7 = \lambda_{37}\,\xi_3 + \delta_7$ (4.13)

$x_8 = \lambda_{38}\,\xi_3 + \delta_8$ (4.14)

(3) Factor of awareness of cooperation with other organizations

The advance parameter of resilience in organization aspect for disaster waste management is that responsible organization could handle any disaster waste without any support from other institution from out site area that disaster hit (Chang, 2013; Charlson et al., 2012). Kapucu (2006) state that mostly in disaster emergency respond, always constructed a many form of public-nonprofit organization relation due to search and rescue for humanitarian consideration. Disaster management, including disaster waste management mostly need any support from other institution both formal and informal, et least coordination between internal institution and organization on the system of disaster management. Furthermore, as a legal framework, the cooperation within other organization was need for public procurement in rehabilitation and reconstruction for better social outcomes (McCruden, 2004)

In Indonesia there was an organization issues for disaster waste management at local level. For the normal condition, the responsible institution was department of cleaning and then for disaster waste management the responsible institution was the department of public work. So, fostering coordination with other organization was very needed for all level state organization in central, provincial and local government. For fostering preparedness, cooperation also need within the private organizations to prepare the equipment and facilities. For economic and employment enhancement, especially in developing countries, public procurement involving affected communities ((McCruden, 2004). The measurement of this factor model, then formulated as mathematic equation below:

$x_{13} = \lambda_{513}\,\xi_5 + \delta_{13}$ (4.15)

$x_{14} = \lambda_{514}\,\xi_5 + \delta_{14}$ (4.16)

4.2.5 Higher order factor model

Factors would be more meaningful if they covered the hole of problems. Sometimes factor that proposed could not described the real problem, however, too many of factors tend to senseless (Yung, 1999; Koufteros et al., 2009). So, the need of higher order factor identification determined by the sufficiency at which the factors represent the strategic solution for increasing preparedness. Evaluation first order factor and then constructed to the higher order factor associated with the effectiveness of intervention needed (Yung, 1999; Koufteros et al., 2009). There are two factors that developed in the higher order factors , factors of awareness of the difficulty running 3R and proper final disposal, and factor concern about disaster waste knowledge.

(1) Factor of awareness of the difficulty running 3R and proper final disposal

In developing countries, stakeholders cannot implement 3R and organize a proper final disposal because of complex issues such as poor facilities and low skills (Shekdar,2009). The principal goal of promoting DWM is to optimize 3R implementation. Furthermore, 3R implementation is the main activity in every stage such as collection, intermediate treatment, and final disposal. Awareness of the need to improve guidelines and readiness of 3R equipment were significant issues in performing the level of disaster waste management quality. Two latent factor were add as derivative factors, the first latent factor was awareness to improve guidelines and then second latent factor was awareness of the readiness of 3R equipment.

Factor of awareness to improve guideline was condition that described stakeholder effort to make more understandable of 3R guidelines in handling disaster waste management. As discussed previously, the guideline was need to provide direction and control the responsibility between state. The basic principle of the guideline was a clear description of task between central government, provincial and local government to deliver service. It was not yet clearly state in the UN-OCHA guidelines. This need to improve guidelines also associated to the need to improve method of 3R. latent factors was proposed to describe stakeholder effort to provide method for run 3R because there were many possibilities of disaster waste composition and characteristic (UN-OCHA, 2011).

Factor of awareness toward readiness 3R equipment was a condition described stakeholder effort to make more easy to get equipment and tools for run 3 R. Assessment of this issues could be examined by how stakeholder effort to insure the availability of basic equipment for debris clean-up such as excavator and vehicles should be provided by responsible institution. Other observed variable was the stakeholder effort to maintenance the availability of network system between stakeholder, which described mechanism for additional equipment

Model of factor Awareness of the difficulty running 3R and proper final disposal (ξ_2) then formulated as with the mathematic equation as follow

$$x_3 = \lambda_{33} \eta_3 + \delta_3 \quad (4.17)$$

$$x_4 = \lambda_{34} \eta_3 + \delta_4 \quad (4.18)$$

$$x_5 = \lambda_{45} \eta_4 + \delta_5 \quad (4.19)$$

$$x_6 = \lambda_{46} \eta_4 + \delta_6 \quad (4.20)$$

$$\eta_3 = \gamma_{23} \xi_2 + \theta_2 \quad (4.21)$$

$$\eta_4 = \gamma_{24} \xi_2 + \theta_2 \quad (4.22)$$

(2) Factor concern about disaster waste knowledge

Knowledge to handling disaster waste was the principle key to achieve resilience in disaster waste management. Capacity building was a strategic program to accelerate the understanding and knowledge (Karunasena, 2013). There were two aspect of knowledge which very essential for disaster waste management, first associated with providing data and second associated with impact mitigation (milke, 2011).

Factor of concern to the knowledge to provide data was refers to the stakeholder effort to making readiness of information and statistical data of disaster waste. Stakeholder effort on providing data could be determined by evaluated their system communication performance, such as the utilized of GIS (Hirayama et al., 2010) to evaluate the damage such as psychical infrastructure and other build environment cause by calamities. Other observed variable could be determined by the stakeholder effort to enhance pre planning disaster waste management (Tajima et al, 2013).

Factor of concern to the knowledge to mitigate impact refers to stakeholder effort to making readiness of information, skill to reduce the negative impact of disaster waste. As investigate Srinivas and Nakagawa (2008), major environment degradation in Banda Aceh was cause by unproper of disaster waste management. The stakeholder concern associated with the mitigation impact could be evaluate by the availability of pre planning to hazardous waste and industrial waste (Brown et al, 2011b). The measurement model of this higher order factor Model factor Concern about disaster waste knowledge (ξ_4) then formulated as mathematic equation follow:

$$x_9 = \lambda_{59}\, \eta_5 + \delta_9 \qquad (4.23)$$

$$x_{10} = \lambda_{510}\, \eta_5 + \delta_{10} \qquad (4.24)$$

$$x_{11} = \lambda_{611}\, \eta_6 + \delta_{11} \qquad (4.25)$$

$$x_{12} = \lambda_{612}\, \eta_6 + \delta_{12} \qquad (4.26)$$

$$\eta_5 = \gamma_{45}\, \xi_4 + \theta_4 \qquad (4.27)$$

$$\eta_6 = \gamma_{46}\, \xi_4 + \theta_4 \qquad (4.28)$$

4.3 Testing of factors model: measuring causal correlation between factors

4.3.1 Field survey and sample characteristics

The first field survey administered interviews with the stakeholder groups responsible for disaster management including DWM, such as the national, provincial and Banda Aceh governments, the army and NGOs. A memorandum of understanding between Banda Aceh City, Aceh North Regency, and Provincial Aceh for the Blang Bintang regional landfill management was in preparation when this field survey was organizes. Furthermore, one of tsunami waste management program related to community empowerment for running 3R for plastic and using wood to rebuild furniture waste encountered in this field survey, which ran between September and October 2012. The questionnaire was distributed in October and November 2012.

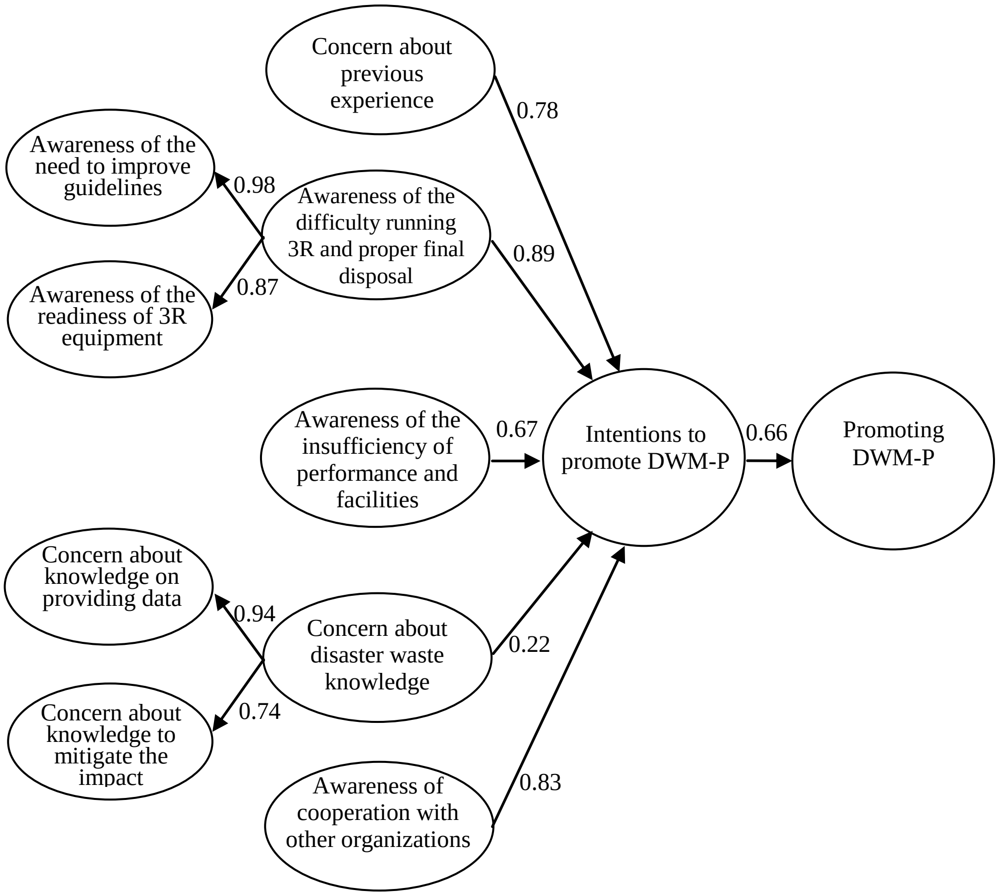
A second field survey was run in January and February 2013 to gain a representative sample for the testing model. Bentler and Chou (1987) suggested that a sufficient sample is five time the parameter to be estimated[32)]. Tabachinick and Fidell (2007), recommended 10 times the parameter to be estimated[33)], while Byrne (2001) suggested 100 times[34)], and Kline (2005) more than 20[35)]. To fulfill the sample criteria, the second stage of the questionnaire was distributed in January and February 2013.

Stakeholders, involved in DWM consist of governmental bodies, formal agencies (both national and international), NGOs (both national and international), private companies, communities, and volunteers. In this study, sample was designed to covers all stakeholders in Banda Aceh. Under normal conditions, the Department of Public work of the provincial government, and Department of Cleansing of the Banda Aceh City government are responsible for waste management. However, in a disaster event, the main responsibility with the Department of Public Works.

The questionnaire was administered to 161 respondents for the testing model. the sample consisted of 32 respondents from the provincial government, 49 from the local government in Banda Aceh, 14 from NGOs and two from industrial companies in Banda Aceh. The rest of the data came from the local government, with 5 respondent from parliament and 21 from Indonesia`s sub-district army. Hence, the further assessment of the model`s sample classified five groups; all stakeholders (integrated), provincial government, local government, sub-district, army and NGOs.

4.3.2 Evaluation of causal correlation between factors

This study utilizes LISREL program student version 8.8 to examine the model and resolve equation depicts the model(widjayanto, 2008; Laten, 2012). Figure 5 describe the causal correlation result between factors affect DWM-P. The degree of correlation for all factor was positive, meant that all hypothesis of factors were validated. Model testing result shown as a path diagram in fig 3. From the perspective of multiple regression, the correlation coefficient path diagram indicates the degree of influence38). Awareness of the difficulty running 3R was the most significant factor with correlation coefficient of 0.89. Two other factors also had a significant effect on performing DWM-P: awareness of cooperation with other organizations (correlation coefficient:0.83) and concern about previous experience (correlation coefficient:0.78). Concern about knowledge had a smaller correlation coefficient (0.22). The correlation coefficient of the factor of awareness of the insufficiency of performance and facilities was 0.67.



Chi-square = 9.36; p value = 0.60; RMSEA = 0.043

Figure 4.4 Structural equation model of DWM-P,

Table 4.2 Statistical criteria and results of evaluating model

Stakeholder Group	Evaluation criteria							
	$\chi 2$	GFI	RMSEA	p value for RMSEA	AGFI	CFI	PNFI	PGFI
Provincial government	9.24	0.99	0.038	0.52	0.97	0.98	0.33	0.20
Local government	9.19	0.92	0.039	0.29	0.84	0.98	0.57	0.44
Sub-district Army in	8.12	0.98	0.035	0.30	0.96	0,20	0,14	0,49
NGO	9.85	0.71	0.001	0.83	0.62	0.92	0.63	0.53
All stakeholders	9.36	0.98	0.043	0.60	0.98	1.00	0.49	0.30
Statistical criteria*)**)		> 0.9	< 0.05	> 0.05	> 0.8	> 0.9	0.6-0.9	> 0.6

*) Byrne (2001), Kline (2005) cited in Bortoleto et al., (2012)

**) Byrne (2001); Kline (2005) cited in Laten, (2012)

Table 4.2 described the statistical results of evaluating the model for each stakeholder group. The eight criteria used were those proposed by Byrne (2001) , and Kline (2005) which cited in Bortoleto et.al (2012) and cited in Laten (2012). As depicted in Table 4.2, the factors in the model meet more than 70% of the criteria, except the model for the sub-district army (60% of criteria). This result was sufficient to estimate the model. For illustration, a good result of criteria such as GFI had a value of 0.99 when assessed for the provincial government, while a bad result of criteria found on PNFI, which had a value of 0.14 when the assessment of the subdistrict army. Another un-expected value was found for PGFI (0.20) in the assessment of the provincial government

Table 4.3 described the distribution of the correlation coefficient for each stakeholder group. These values were used to determine the factor affecting DWM-P for each stakeholder group. Degree of causal correlation was used to validate the hypothesis. Positive value of result of causal correlations mean the hypothesis was validated and negative value of causal correlation mean hypothesis not validated. All of the degree of causal correlation was positive, mean all hypothesis was validated. The correlation coefficient of intention for each group tended to be similar, with a range from 0.12 to 0.89. The smallest correlation coefficient was for the factor of concern about disaster waste knowledge for the assessment of the sub-district army (correlation coefficient: 0.12). The highest correlation coefficient was the derivative factor from awareness of the of the difficulty running 3R to awareness of the need to improved guidelines for the NGO measurement

The first hypothesis proposed, the correlation between promoting DWM-P and intention to promote preparedness for all and each group of stakeholder was validated with the smallest coefficient correlation was resulted from provincial stakeholder (correlation coefficient: 0.58) and the highest coefficient correlation was resulted from NGO assessment (correlation coefficient: 0.82).

Stakeholders from the army force level in sub-district of Banda Aceh argued all the factors that hypothesis was not yet significantly influence to the stakeholder intentions to promote disaster waste management preparedness. The coefficient of causal correlation between all factors were less then 0.5. The factors the most significant was factor of awareness to cooperation with other organization (correlation coefficient: 0.43). NGO also argue that factor of concern to previous experience and factor of concern about knowledge of disaster waste were not significantly influence to the promoting disaster waste management preparedness. NGO also argue that The factors the most significant was factor of awareness to cooperation with other organization (correlation coefficient: 0.76). Stakeholder from NGO and army force argued that cooperation with other organization was a significant factor that should be introducing in program for fostering disaster waste management preparedness.

Table 4.3 Correlation coefficients of the model for each stakeholder group

Path diagram		Correlation coefficient for each group of stakeholder				
From	To	Provincial	Local	Army	NGO	All
Concern about previous experience	Intentions to promote preparedness	**0.76**	0.61	0.26	0.48	0.78
Awareness of the difficulty running 3R and proper final disposal	Intentions to promote preparedness	0.71	0.65	0.33	0.58	**0.89**
Awareness of the insufficiency of performance and facilities	Intentions to promote preparedness	0.50	**0.73**	0.29	0.56	0.67
Concern about disaster waste knowledge	Intentions to promote preparedness	0.25	0.14	0.12	0.40	0.22
Awareness of cooperation with other organizations	Intentions to promote preparedness	0.61	0.52	**0.43**	**0.76**	0.83
Intentions to promote preparedness	Promoting DWM-P	0.58	0.65	0.73	0.82	0.66

Stakeholder in Banda Aceh argued that the most significant of factor were awareness of the difficulty running 3R and proper final disposal (correlation coefficient: 0.89). The other significant factor were factor of awareness of cooperation with other organization (correlation coefficient: 0.83), factor of previous experience (correlation coefficient: 0.78) and factors awareness of the insufficiency of performance and facilities (correlation coefficient: 0.67). Factor of concern about disaster waste knowledge was relatively not significant to affect stakeholder intention for promoting preparedness (correlation coefficient: 0.22)

Stakeholder from the provincial government justified that the factor of concern about previous experience was the most importance (correlation coefficient: 0.76). The model evaluation also found that factor were awareness of the difficulty running 3R and proper final disposal (correlation coefficient: 0.71) and factor of awareness of cooperation with other organization (correlation coefficient: 0.61) were relatively significant to influence their preparedness in disaster waste management. Factor awareness of the insufficiency of performance and facilities (correlation coefficient: 0.52) and factor of concern about disaster waste knowledge (correlation coefficient: 0.25) were relatively not significant to affect stakeholder intention for promoting preparedness

Stakeholder from the local level in city of Banda Aceh clime that the factor of awareness of the insufficiency of performance and facilities was the most importance (correlation coefficient: 0.73). Comparing with other factors, factors of The model evaluation also found that factor were awareness of the difficulty running 3R and proper final disposal (correlation coefficient: 0.65) and factor of concern about previous experience (correlation coefficient :0.65) was the importance factor in promoting preparedness. Factor of awareness of cooperation with other organization (correlation coefficient: 0.52) were relatively not significant to influence their preparedness in disaster waste management. Factor of concern about disaster waste knowledge was the less significant factor to affect stakeholder intention for promoting preparedness (correlation coefficient: 0.14)

Of the derivative factors, concern about knowledge to mitigate the impact (correlation coefficient: 0.86) was the principal factor. According to stakeholders from the local government, the factor of concern about knowledge to provide data was the principal one. Awareness of the need to improved guidelines was the most significant for the sub-district army with correlation coefficient of 0.92 and NGOs with a correlation coefficient of 0.98. The overall stakeholder assessment also found that awareness of the need to improved guidelines was the most significant derivative factor with a correlation coefficient of 0.98. Table 3 depicts the results of models for each stakeholder group.

Table 4.4 Causal correlation coefficient of higher factor for each group stakeholder

Path diagram		Correlation coefficient for each group of stakeholder				
From	to	Provincial	Local	Army	NGO	All
Awareness of the difficulty running 3R and proper final disposal	Awareness of the need to improve guidelines	0.23	0.23	0.92	0.98	0.98
Awareness of the difficulty running 3R and proper final disposal	Awareness of the readiness of 3R equipment	0.58	0.62	0.81	0.83	0.87
Concern about disaster waste knowledge	Concern about knowledge on providing data	0.59	0.89	0.79	0.96	0.94
Concern about disaster waste knowledge	Concern about knowledge to mitigate the impact	0.86	0.76	0.92	0.75	0.74

4.4 Discussion

4.4.1 Identification factors affecting disaster waste management by using SEM

This research used SEM to determine the factors in the model and develop the causal correlations between them. This study determined the factors affecting stakeholders' intentions to promote DWM-P by exploring Banda Aceh tsunami waste management program. Model result showed that coefficient correlation for all factor were positive. It means that all factors validated. All factors affect stakeholders' intention in promoting preparedness for disaster waste management. The research used degree of correlation proportional with the hierarchy off affect. This terminology was used to comparing factor each other at which associated with program priority proposed.

The research determined five factors and developed causal correlations between them. The five factors were concern about previous experience, awareness of the difficulty running 3R, concern about the disaster waste knowledge, awareness of the insufficiency of performance and facilities, and awareness of cooperation with other organizations. The study also validated the factors by exploring each group of stakeholders. Stakeholders from provincial government argued that the factor of concern about previous experience was the most importance. Stakeholder from the local government stated that factor of awareness of the insufficiency of performance and facilities was the most influential. Stakeholder from the sub-district army and NGOs argued that concern about coordination with other stakeholders was the most important.

The factors concern about previous experience dominated with a negative effect, such as environmental pollution. However, Srinivas (2008) study of the impact of the Indian tsunami on Banda Aceh indicated that stakeholder did not clearly understand how to solve environmental pollution such as air, water and soil pollution. Furthermore, stakeholder understanding of the consequences of environmental pollution on public health, the multilayer negative impacts of disaster waste, and lack of control of hazardous waste were also un-clear in the programs run by both environmental agency and the DWM agency. For example, there was no specific program for improving environmental concerns in the White Paper or master plan of waste management.

Awareness of the difficulty running 3R, includes the availability of a contingency plan or guide-lines when disaster waste is generated. The challenge for developing countries is to incorporate the plan into the annual waste service, since under normal conditions this is very poor. Other indicator of these factors included the availability of equipment and logistics to collect, transfer, and transport waste to intermediate treatment, and final disposal. Since the condition of service was is very poor, DWM waste went un-noticed despite the proposed White Paper or master plan to improve waste management.

Stakeholders' motivations to update their understanding of disaster waste such as waste generation, impact, including information system to deliver were resulted from the higher order factor assessment. According to the result, figure 3 and table 1, the response of variables or issues could not described significantly by the factors of concern about knowledge to provide data and to mitigate the impact. The correlation here was very low. According to the studies by Shimaoka (1995), Hirayama (2010) and Takatsuki, et al (2010), this issues are fundamental for developing countries.

The indicators of the accuracy of service in developing countries are mostly similar. For example, under normal conditions, the accuracy of service is judged by the total amount of waste transferred to final disposal. The vehicle by the total amount of waste transferred to final disposal. The vehicle transfer time is not accurately compare with the maximum amount of waste. Further, cooperation with private companies is inefficient, while the performance of vehicles associated with the maximum amount of waste and facility number (number of trucks, excavator, etc) should be prepared in detail. One Problem associated with performance and facilities was indicated by the investigation into Bangkok flood waste management in Thailand in 201140) to address this issue, two first order factors were proposed by dividing the second-order factor into performance and facilities.

In developing countries, cooperation with private companies and other governments in waste management rarely occurs under disaster conditions. Furthermore, the procedures for asking for cooperation from private companies or other governments typically need a long time, for example, the construction of the Blang Bintang Regional landfill site took more than three year. Similarly, in an emergency response, the reconstruction and rehabilitation of the disaster zone mostly only three years. To foster preparedness within this time limitation and improve the likelihood of cooperating with other organizations, first order factors were examined directly

4.4.2 Implication to planning for waste management

Waste management policy in developing countries tends to be very poor, making it impossible to introduce DWM-P program. According to the stakeholders` intentions identified herein, giving the best service for daily waste management is part of preparedness. Moreover, fostering preparedness is not only associated with constructing an annual program, preparedness should gradually increase the level of service of daily waste and absorb any DWM challenges from any level of disaster.

Fostering DWM-P was a process of increasing system of waste management. For illustration, during data collection in Banda Aceh, the following statement was recorded in an interview: after the tsunami waste program in 2012, we began to forget how to handle disaster waste efficiently. We have not yet introduced a special program for preparedness. according to the interview the understanding the importance for introducing and fostering disaster waste management preparedness, however the not yet proposed program in the annual planning and budgeting. This stakeholder understood the importance of DWM-P, but did not know how to introduce such a program. Several key stakeholders perceived that introducing a program needs special budgeting, special effort, and different waste management approaches. DWM-P could thus be designed with simple actions such giving punctual service to complex actions such as preparing regional landfill sites.

With the average cost 27% of the total budget in an emergency response[19)], DWM has significant issues in the disaster recovery program. By fostering preparedness this cost is expected to decrease. According to the factors identified, the policy and program of fostering DWM-P in developing countries have several issues. The redesign of capacity building is the first program to be evaluated. Further, running programs such as improving knowledge, understanding DWM, and incrasing skills could build habits according the position and responsibility. Improving equipment and sharing information by using GIS as well as adopting a methodology for service provision are other significant programs. Sharing information encourages the development of skills related to delivering information, waste mapping, delivering previous experience in DWM and encouraging local networks.

Improving performance, facilities and cooperation with other organizations are other critical points in fostering DWM-P. Cooperation should be both horizontal (i.e with other government and institution at the same level) and vertical (with governments at the provincial and national level). Several programs were identified such as improving performance facilities and improving guidelines to reduce the difficulty of running 3R (as well as improving method for running 3R). Other potential programs for fostering preparedness need cooperation with other institutions, such as improving data provision methods, mitigate the impact, procedures for asking for public-private cooperation, and procedures for asking other governments to cooperate.

4.5 Conclusion and proposal for fostering disaster waste management preparedness

This study demonstrated the problems and examined the issues of promoting DWM-P. By mapping factors that may affect stakeholder preparedness in Banda Aceh, the following conclusions of study are:

- Five factors affect stakeholders` intentions to promote preparedness. The significant factor were awareness of the difficulty running 3R and proper final disposal (correlation coefficient: 0.89), awareness of cooperation with other organization (correlation coefficient: 0.83), previous experience (correlation coefficient: 0.78). Other factors identified are awareness of the insufficiency of performance and facilities (correlation coefficient: 0.67) and concern about disaster waste knowledge (correlation coefficient: 0.22).

- Stakeholders from provincial government argued that the factor of concern about previous experience was the most importance (correlation coefficient :0.76)
- Stakeholder from the local government stated that the factor of awareness of the insufficiency of performance and facilities was the most influential (correlation coefficient :0.73)
- Stakeholder from the sub-distric army and NGOs argued that concern about coordination with other stakeholders was the most important (correlation coefficient 0.43 and 0.76, respectively).
- Concern about disaster waste knowledge was the factor with the smallest correlation coefficients with a range from 0.12 to 0.40
- Although the factor of concern to disaster waste knowledge was less influential, the derivative factor of increase knowledge on providing data was necessary. This can be performed by constructing archival data on previous experience, such as on disaster waste characteristics and on the method applied. Transferring knowledge between employees in the responsible organization should also be encouraged in order to anticipate future events.

According to the mapping factors that may affect stakeholder preparedness in Banda Aceh, proposal for fostering disaster waste management preparedness are:

- Increase stakeholder capability of to run 3R for municipal waste and industrial waste in disaster events
- Increase stakeholder capability to manage disposal of municipal waste and industrial waste in disaster events
- Increasing stakeholder capability manage disaster waste, especially for collecting and designing temporary site
- Providing statistical data for every state of disaster waste management event with a simple method.
- Transferring the disaster waste management process internal and external organization
- Fostering coordination for each institutional in disaster management for each stages of management especially for mitigation and preparedness.
- Fostering coordination with non formal organization in disaster waste management
- Promote program to address insufficient performance and facilities line within increasing waste management service by encouraging the regular maintenance of facilities, providing a delivery services on time, and anticipating complex issues when cooperating with other organizations

- Avoid cooperation program at which tend to asking for help as much as possible.
- Propose and evaluate guidelines and pre-planning for disaster waste management for national, provincial and local level.

CHAPTER 5

Summary and Conclusions

Disaster events such as earthquakes, tsunamis, floods, volcano eruptions generate tremendous amount of waste and debris causing considerable waste removal and disposal challenges for local public officials. Proper disaster waste management would reduce the economic losses, and help quick emergency response and recovery. To achieve resilience on disaster waste management, it requires acceleration of facility and personnel, organization and communication including legal frameworks. However, many obstacles are found because the waste generation and its characteristics are difficult to predict. Moreover, for developing countries, because of the poor municipal waste management system and lack of management plan, it is very difficult for stakeholders to implement proper waste treatment in disaster events. Researches that describe achievement of proper disaster waste management are not mature. Towards better disaster waste management in developing countries:

- The research evaluated the development on disaster waste management system learning from past experience of the disasters and evaluated the accuracy of disaster waste estimation.
- The research proposed model to measure resilience on disaster waste management by proposed model that considering the current performance and capacity of equipment, preparedness and vulnerability to the disaster in a region and city.
- The research Identified and validated factors that affect to stakeholder’s motivation and implementation to improve disaster waste management

5.1 Evaluation of disaster waste management in Indonesia

Indonesia is one of prone country of disasters in the world. Information and about the estimation of disaster waste generation, performance of facilities are very limited. The research proposed two main components to evaluated disaster waste management, first was evaluation of the performance achievement of disaster waste treatment plan and implementation and second was evaluation of plan for disaster waste management

The research proposed indicators to evaluate performance achievement of disaster waste treatment plan and implementation. The indicators covered issues in disaster waste management in developing countries such as, the accuracy of disaster waste estimation and the performance achievement of disaster waste management treatment associated to the composition and characteristic of disaster waste generated. The research measure development and performance achievement of system to record statistical data of disaster waste generation, system to deliver statistical data of disaster waste between responsible organization to accelerate facility and personnel required. The research also measured development and performance achievement of plan and implementation of disaster treatment such as process for collection and shorting at area of affected, process of temporary storage development, process of, transfer and transport disaster waste, process of intermediate treatment and process of final disposal.

The research proposed indicator to evaluate performance achievement of plan for disaster waste management at which covered of legal framework development such as development of regulation and guideline, Institutional framework development such as responsible organization and mechanism for resource sharing to manage disaster waste generation, budgeting system development and mechanism to share the cost.

The research proposed four quadrants (quadrant I, II, III, IV) to measure performance achievement of disaster waste management development. Horizontal and vertical axis (line), used the boundary the quadrants, and utilized to describe performance achievement of plan for disaster waste management and plan for disaster waste treatment and implementation. for examples quadrant I used to describe condition at which performance achievement of plan for disaster waste management was (+) and plan for disaster waste treatment and implementation was also (+).

The research utilized likert scale by using sign as (-) to , (+) and (++) to assessed the difference performance achievement of each indicator in each disaster waste management events. Sign of (-) means there was no clear statistical data and information recorded of the indicator at which assessed. Sign of (+) means there was statistical data and information of of the indicator at which assessed but not issued by formal or responsible organization, and Sign of (++) means there was statistical data and information of the indicator at which assessed and issued by responsible organization.

The research measured 9 disasters waste management events in Indonesia 1990-2012, including Tsunami waste management recovery program in Banda Aceh 2004. By using the method, the research showed that:

- Two disaster events assessed in quadrant III, at which performance achievement of disaster waste plan for treatment and implementation was (-), and plan for disaster waste management was also (-). The disaster waste management events assessed were disaster waste management in Flores Earthquake 1992 and Bengawan Solo flood 1998.
- Five disaster events assessed in quadrant II, at which performance achievement of disaster waste plan for treatment and implementation was (-), and plan for disaster waste management was also (+). Disaster waste management events assessed were; Earthquake Nias 2005, Yogyakarta Earthquake 2006, Bengkulu Earthquake 2007, West Sumatra Earthquake 2009 and Mentawai Tsunami 2010

- Two disaster events assessed in quadrant I, at which performance achievement of disaster waste plan for treatment and implementation was (+), and plan for disaster waste management was also (+). Disaster waste management events assessed were Indian Tsunami 2004 and Flood Jakarta 2007

The research also showed that the trend of performance as follow achievement of plan for disaster waste management was tend to getting better year by year in the last two decades 1990-2012 however it was not proportional with the performance achievement of plan for disaster waste treatment and implementation because the performance achievement was not yet clear getting better.

The research proposed recommendation to foster evaluation method of disaster waste management performance as follow:

- Design system to register and administer of disaster waste management for each type of disaster (local, provincial and national level).
- Design and evaluate regularly communication system and implementation of plan of disaster waste management between responsible (disaster waste management agency at which responsible in budgeting in all level and department of public work at which responsible organization in planning for treatment.
- Design system to accelerate equipment and personnel for : collection and shorting disaster waste generation, transfer and transport disaster waste, conducting intermediate treatment plan associated to the generation and composition of disaster waste, conducting proper disaster waste final disposal, including effective and efficient of the method for treatment and control of pollution impact.

5.2 Model proposed to fostering accuracy of estimation of disaster waste generation in Indonesia (earthquake-tsunami)

The research proposed model to fostering the accuracy of disaster waste estimation in Indonesia.. Disaster waste estimation model was developed according to the parameter as follow:

- Disaster waste generation was estimated with from three main land use planning in Indonesia, residential, office and public facility and commercial such as market and economic centre.
- Residential area classify according to the Indonesian housing type, housing with area of floor 36 m2, (45-60) m2, and housing with more than 60 m2 .
- Office area and public building consist of social infrastructure such as, government office, education facility, health facility, religion and culture centre.

- Commercial area consist of economic infrastructure such as traditional market, modern (mini and supermarket), hotel, private company building

The research utilized superimposed method between map of land use planning and map of affected area. By using the method, the research estimating disaster waste generation generated from 7 major disaster events in Indonesia in 1990-2012. For example, Yogyakarta earthquake 2006 generated 2.9 million tons; West Sumatra earthquake 2009 generated 3.5 million tons.

5.3 Evaluation of plan and implementation for disaster waste management in inundated area (Bangkok –Thailand flood 2011)

Flood was the disaster that most frequent attack in cities in recent decades. Plan for disaster waste treatment after flood is limited and not clear. Moreover, poor municipal waste management in developing countries increase flood hazard.

The research found that the highest component of the disaster waste composition after flood in Bangkok was wood (estimated 54.1%). The research also investigated other component of disaster waste after flood as follow; plastics (estimated 14.1%), paper (estimated 6.0%), textiles (estimated 4.7 %), glass (estimated 4.0%), Metals (estimated 2.8%), rubber (estimated 0.7%), stones, ceramics and other debris 13.5%).

The research found several problem for disaster waste management in inundated area as follow:

- Difficulty in waste collection, because there was no preparation and equipment to collect floating waste in in inundated area.
- Difficulty in transport of waste since the responsible organization (private company was absent).
- Over capacity in transfer station.
- Long queuing in waste transport such as trucks in transfer station.
- People burned waste in the street.
- No recycling process or recycling machinery was introduced in the community to treat the wood waste.
- Some waste pickers and solid-waste workers simply sorted through on their own and picked up flood waste economically value in their own estimation.
- No recycling, sorting, or reduction scenario had been planned to handle flood waste.
- Many industrial waste mix with municipal waste, and treat as municipal waste.

The research proposed some effort to fostering proper disaster waste management associated with the flood disaster as follow:

Before flood

- Modified accuracy of waste generation after flood.
- Create MOU with private company for providing vehicles.
- Provide boat for collect municipal waste
- Increasing industrial waste regulation.
- Provide alternative plan for transfer station.

During flood

- Modified plan to anticipate insufficiency of workers.
- Updating the estimation of flood waste.
- Propose and Implementing emergency plans for flood waste treatment.
- Implementing temporary storage plans .

After flood

- Checking damage facilities and equipment.
- Assessing government's official capability.
- Conducting possibility treatment using existing facilities.
- Run 3 R as much as possible.
- Record and transfer knowledge for future event

5.4 Model for measuring disaster waste management preparedness: disaster waste management resilience index model.

The research proposed method to measure disaster waste management resilience on waste management by using integrated indicator because, there were limited method the combining resilience on disaster waste management and performance achievement in municipal waste management in developing countries. Moreover, proper disaster waste management is needed to accelerate disaster recovery. Framework and paradigm for disaster management (including disaster waste management) have been changed from response towards preparedness. There was limited information about preparedness such as current condition, and method to measuring the preparedness.

The research proposed method to measure disaster waste management resilience on waste management by using integrated indicator that covers:

- Technical, economic and organizational capacity,

- Current performance achievement of preparedness and
- Vulnerability condition to the disaster in regions or cities.

The research utilized likert scale with value, 1, 2, 3, 4, 5, to assess and compare bad condition until good condition of capacity and performance achievement of preparedness. vice versa, the research also utilized liker scale 5,4,3,2,1 to assess and compare each indicator indicators of vulnerability in regions and cities.

- According to the method, Indonesia`s regions and several selected cities were classified in the middle - low level of resilience.
- Among regions, the highest index was Java region (estimated 1.58) and the lowest was Sumatra region (estimated 0.83).
- Among cities, Banda Aceh was the highest (estimated 2.78) and Medan was the lowest (estimated 0.48).
- Indonesian region and selected cities were not sufficient to achieve resilience in disaster waste management.

The research proposed recommendation to fostering disaster waste management preparedness in Indonesia regions and cities as follow:

- Designing pre planning for post disaster waste management at regional level, Provincial and local state , including annual program for fostering waste management capacity
- Designing mechanism for regular monitoring and evaluation of the plan

5.5 Stakeholder intention`s to promote and fostering disaster waste management preparedness

Preparedness in disaster waste management is a critical stage to achieve resilience. Stakeholders in developing countries find it very difficult to formulate preparedness plans because of complex issues and poor management. They perceive that introducing such a program would need special budgeting and efforts that differ from those used for day-to-day waste management, not realizing that the principal factor is their degree on intention. By using structural equation modeling, this study examines the factors that affect stakeholders` intentions. By exploring the waste management program in Banda Aceh following the Indian tsunami in 2004, we find that the factor of awareness of the difficulty running a 3R (reduce, reuse, and recycle) program was the most important factor to preparedness with a correlation coefficient of 0.89. Other factors that have a significant effect are awareness of cooperation with other organizations (correlation coefficient: 0.83) and concern about previous experience affecting stakeholders’ intentions (correlation coefficient: 0.78). Other factors identified are awareness of the insufficiency of performance and facilities (correlation coefficient: 0.67) and concern about disaster waste knowledge (correlation coefficient: 0.22).

Stakeholders from provincial government argued that the factor of concern about previous experience was the most importance (correlation coefficient: 0.76). Stakeholder from the local government stated that the factor of awareness of the insufficiency of performance and facilities was the most influential (correlation coefficient: 0.73). Stakeholder from the sub-district army and NGOs argued that concern about coordination with other stakeholders was the most important (correlation coefficient 0.43 and 0.76, respectively). Concern about disaster waste knowledge was the factor with the smallest correlation coefficients with a range from 0.12 to 0.40.

To fostering preparedness on disaster waste management in Banda Aceh, several aspect should be considered as follow:

- Although the factor of concern to the disaster waste knowledge was less influential, transferring knowledge between employees in the responsible organization should be encouraged.
- Conducting simple actions such as encourage the regular maintenance of facilities, provide a delivery services on time, automatically increasing resilience to covers complex issues such as cooperating with other organizations.
- Proposing cooperation with other organizations does not mean asking for help. Promoting program should be designed to avoid additional external support and resources, as much as possible.
- Guidelines and pre-planning advice for disaster waste management should be proposed in line with the responsibilities of the national, provincial and local governments.
- However, strengthening the role of local government is more important, high-level government (both provincial and central) must ensure the performance of service is depend on the local government.

5.6 Overall conclusion and recommendation

<u>Overall conclusion</u>.

- Resilience in disaster waste management in developing countries were determined by two main of aspect first was planning for treatment and implementation and second was planning for management.
- To evaluate resilience in disaster waste management in developing countries, following point must be considered

- Performance achievement of disaster waste management in previous event
- Challenge to improve current capacity that associated to the vulnerability condition

So, indicator to evaluate disaster waste management could be vary, one regions or cities not similarity and have a specific indicator due to disaster type and scale.

- The research validated the factors that affect stakeholder intention`s to foster disaster waste management resilience such as stakeholder motivation to: reduce the difficulty of running 3R and proper final disposal, increase cooperation with other organization, utilize previous experience, increase insufficiency facilities and improving their knowledge.

Recommendation for future research.

- Designing model to quantify the stakeholder difficulties to running 3R in disaster waste management.
- Designing model to quantify the acceleration of facility needed to running proper disaster waste management according to the location type, and scale of disaster.
- Designing model to sharing equipment, and sharing cost to running proper disaster waste management between local, provincial and national institution according to type and scale of disaster, including mechanism for sharing resource to setup new landfill site according to the location type, and scale of disaster.

References

Abbasi, M. A., Kumar, S., Andrade Filho, J. A., & Liu, H. (2012). Lessons learned in using social media for disaster relief-ASU crisis response game. InSocial Computing, Behavioral-Cultural Modeling and Prediction Springer Berlin Heidelberg, pp. 282-289.

Ajzen, I., (1991), The Theory of Planned Behavior, Organizational Behavior and Human Decision Processes Vol.50, pp.1979-211

Ajzen, I., (2002)., Perceived Behavioral Control, Self–Eficacy, Locus of Control, and the Theory of Planned Behavior, Journal of Applied Social Psychology, Vol 42(4). pp.665-683

Allen, I. E., & Seaman, C. A. (2007). Likert scales and data analyses, Quality Progress, Vol. 40(7), pp. 64-65

Altay, N., green, W.G., (2006), OR/MS research in disaster operation management, European Journal of Operational Research. Vol 175. pp. 475-493

Andrews, R., Boyne, G. A., Meier, K. J., O'Toole, L. J., & Walker, R. M. (2005). Representative bureaucracy, organizational strategy, and public service performance: An empirical analysis of English local government, Journal of Public Administration Research and Theory, Vo.15(4), pp. 489-504.

Arena, U., Mastellone, M. L., & Perugini, F. (2003). The environmental performance of alternative solid waste management options: a life cycle assessment study. Chemical Engineering Journal, 96(1), pp. 207-222.

Arendse, L., & Godfrey, L. (2001). Waste management indicators for national state of environment reporting. CSIR, Pretoria. http://www.unep.or.jp/ietc/kms/data/2010.pdf first access, July 4, 2013, second acces November 26, 2014.

Argote, L., Ingram, P., Levine, J. M., & Moreland, R. L. (2000). Knowledge transfer in organizations: Learning from the experience of others. Organizational Behavior and Human Decision Processes, Vol. 82(1), pp. 1-8.

Armijo, C., Puma, A., & Ojeda, S. (2011). A set of indicators for waste management programs. In 2nd International Conference on Environmental Engineering and Applications , Vol. 17.

Asari, M., Sakai, S. I., Yoshioka, T., Tojo, Y., Tasaki, T., Takigami, H., & Watanabe, K. (2013). Strategy for separation and treatment of disaster waste: a manual for earthquake and tsunami disaster waste management in Japan. Journal of Material Cycles and Waste Management, Vol.15(3), pp. 290-299.

Bappenas (2006a), Preliminary damage and losses assessment, Yogyakarta and Central Java earthquake 2006

Bappenas (2006b), action plan for rehabilitation and reconstruction post earthquake disaster in Yogyakarta and Central Java.

Bappenas (2007a), action plan for rehabilitation and reconstruction in Nias Island Post Eartquake, March 2005 for year 2007-2009

Bappenas (2007b) action plan for rehabilitation and reconstruction post earthquake disaster in West Sumatra and Bengkulu, 2007-2009.

Bappenas and the International Donor Community (2005), Indonesia: Preliminary damage and loss assessment, the December 26, 2004 Natural Disaster

Bentler, P. M., & Chou, C. P. (1987), Practical issues in structural modeling, Sociological Methods & Research, Vol. 16(1), pp. 78-117.

Beraud Helene (2011), Assessment and characterization method for flood waste- MECaDePi Projec/Global Platform for disaster Risk Reduction.

Beraud, H., Barroca, B., & Hubert, G. (2012). Functional analysis, a resilience improvement tool applied to a waste management system–application to the" household waste management chain". Natural Hazards and Earth System Science, Vol. 12(12), pp. 3671-3682.

Berren, M. R., Beigel, A., & Barker, G. (1982). A typology for the classification of disasters: Implications for intervention. Community Mental Health Journal,Vol. 18(2), pp. 120-134.

Bhargava, H. K., Power, D. J., & Sun, D. (2007). Progress in Web-based decision support technologies. Decision Support Systems, Vol. 43(4), pp.1083-1095.

Bierkman, Joern, (2005), Measuring Vulnerability, Working Paper No.1, Expert Workshop in Kobe Japan, UNE-EHS, incorporation with ADRC,

Bjerregaard, Martin, 2012, Disaster Waste Management In Practice and Beyond.

Bortoleto, A. P., Kurisu, K. H., & Hanaki, K., (2012), Model development for household waste prevention behaviour. Waste management, Vol. 32(12), pp.2195-2207.

Brousselle, A., & Champagne, F. (2011). Program theory evaluation: Logic analysis. Evaluation and Program Planning, Vol.34(1), pp.69-78.

Brown, C., & Milke, M. W. (2009). Planning for disaster debris management.

Brown, C., Milke, M., & Seville, E. (2010). Waste management as a “Lifeline”? A New Zealand case study analysis. International Journal of Disaster Resilience in the Built Environment, Vol. 1(2), pp. 192-206.

Brown, C., Milke, M., & Seville, E. (2011a). Disaster waste management following the 2009 Victorian bushfires. Australian Journal of Emergency Management, Vol. 26(2),

Brown, C., Milke, M., & Seville, E. (2011b), Disaster waste management: A review article, Waste management, Vol. 31(6), pp.1085-1098.

Brown, Charlote O, 2012, Disaster Waste Management : a system approach Phd Thesis, University of Canterbury.

Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., ... & von Winterfeldt, D. (2003). A framework to quantitatively assess and enhance the seismic resilience of communities. Earthquake spectra, Vol.19(4), pp. 733-752.

Byrne, B.M., (2001) Structural Equation Modeling with Amos, Basic Concepts, Aplication and Programming, New Jersey, Lawrence, Earlbaum associates Inc.

Carlson, J. L., R. A. Haffenden, G. W. Bassett, W. A. Buehring, M. J. Collins III, S. M. Folga, F. D. Petit, J. A. Phillips, D. R. Verner, and R. G. (2012.) Whitfield.Resilience: Theory and Application. No. ANL/DIS-12-1. Argonne National Laboratory (ANL).

CEMA (2010), California Emergency Management Agency: debris forecasting and estimation

Chaerul, M., Tanaka, M., & Shekdar, A. V. (2007). Municipal solid waste management in Indonesia: status and the Strategic actions. Journal of the Faculty of Environmental Science and Technology, Vol. 12(1), pp. 41-49.

Chan, E. Y., Kim, J. H., Lin, C., Cheung, E. Y., & Lee, P. P. (2014). Is previous disaster experience a good predictor for disaster preparedness in extreme poverty households in remote Muslim minority based community in China?. Journal of Immigrant and Minority Health, Vol.16(3), pp.466-472.

Chang, S. E., & Shinozuka, M. (2004). Measuring improvements in the disaster resilience of communities. Earthquake Spectra, Vol. 20(3), pp. 739-755.

Chavez, A., de Vega, C. A., & Benitez, O. (2011). Measuring Progress of Waste Management Programs. Int. J. Environ. Sci. Develop, Vol. 2, pp. 372-376.

Chen, J. R., Tsai, H. Y., Hsu, P. C., & Shen, C. C. (2007). Estimation of waste generation from floods. Waste management, 27(12), pp.1717-1724.

Cifrian, E., Andres, A., & Viguri, J. R. (2013). Estimating Monitoring Indicators and the Carbon Footprint of Municipal Solid Waste Management in the Region of Cantabria, Northern Spain. Waste and Biomass Valorization, Vol.4(2), pp. 271-285.

Crawford, L., Landston, C., and Bajrachcarya, B., (2012), Building Capability for disaster resilience, 28 Annual conference of association of reasercher in contruction management, pp. 123-132.

Cutter, S. L. (1996). Vulnerability to environmental hazards. Progress in human geography, 20, 529-539. http://webra.cas.sc.edu/hvri/docs/Progress_Human_Geography.pdf

Cutter, S. L., Boruff, B. J., & Shirley, W. L. (2003). Social vulnerability to environmental hazards*. Social science quarterly, Vol. 84(2), pp. 242-261.

Cutter, S. L., Burton, C. G., & Emrich, C. T. (2010). Disaster resilience indicators for benchmarking baseline conditions. Journal of Homeland Security and Emergency Management, 7(1).

D.S Chang, (2013), Tsunami resilience: Multi-level institutional arrangements, architectures and system of governance for disaster risk preparedness in Indonesia. Environ, Sci. Policy http://dx.doi.org/10.1016/j.envsci.2012.12.009

Damanhuri, E. and T. Padmi (2009), Current Situation of Waste Recycling in Indonesia, in Kojima, M. and E. Damanhuri (eds.), 3R Policies for Southeast and East Asia. ERIA Research Project Report 2008-6-1, pp.23-52. Jakarta: ERIA.

Damanhuri, Enri, and Tri Padmi (2010), Waste management, ITB Bandung, Indoneisa [In Bahasa Indonesia] available on http://kuliah.ftsl.itb.ac.id/wp-content/uploads/2010/09/diktatsampah-2010-bag-1-3.pdf

Damanhuri, Enri, Padmi, Tri, (2008), Waste management, colleges textbooks for class TL3104, http://www.kuliah.ftsl.itb.ac.id/wp-content/uploads/2008/08/bagian-2.pdf, access Desember 1, 2014

Davidson, Rachel, (1997), ERRI Annual student paper award, A multidisciplinary urban earthquake disaster risk index, earthquake spectra, Vol. 13(2).pp. 211-223.

Deegre of Presiden Republic Indonesia, Number 66 Year 1992 Determination of Natural Disaster in Flores as National Level Disaster

Departement of Environment, Bangkok Metropolitan Authority, 2011: Bangkok State of The Environment 2010-2011.

Departement of Environmentt, Bangkok Metropolitan Authority, 2007, Thailand Country Report, Solid waste Manegement: case study of Bangkok, Slide Presentation, available on http://www.asianhumannet.org/db/datas/Country_en.pdf, access on March 26, 2012

Department of Environment, Bangkok Metropolitan Administration (BMA) (2011): Bangkok State of the Environment 2010-2011.

Depertemen of public work, 2006, Rehabilitation and reconstruction for earthquake in Yogyakarta –central Java, http://www1.pu.go.id/uploads/berita/ppw270606bd.htm, access July 2013

Desouza, K. C., & Flanery, T. H. (2013). Designing, planning, and managing resilient cities: A conceptual framework. Cities, Vol.35, pp. 89-99.

Dhanani, S., & Islam, I. (2002). Poverty, vulnerability and social protection in a period of crisis: the case of Indonesia. World Development, Vol.30(7), pp.1211-1231.

DJKP (Directorat Jendral Cipta Karya), Ministry of Public Work, (2001), Profile City of Padang, http://ciptakarya.pu.go.id/profil/profil/barat/sumbar/padang.pdf

DJKP (Directorat Jendral Cipta Karya), Ministry of Public Work, (2001), Profile City of Medan.

FEMA, 2007, Public Assistance, Debris Management Guide

Fetter, G. and Rakes, T., (2012), Incorporating recycling into post-disaster debris disposal, Socio-Economic Planning Sciences, Vol.46(1), pp.14-22.

Gao, H., Barbier, G., Goolsby, R., & Zeng, D. (2011). Harnessing the crowdsourcing power of social media for disaster relief. ARIZONA STATE UNIV TEMPE.

Gilbert, S. W. (2010). Disaster resilience: A guide to the literature. NIST Special Publication, 1117.

Guha-Sapir D, Hoyois Ph. , Below. R. (2014) Annual Disaster Statistical Review 2013: The Numbers and Trends. Brussels: CRED. available on http://www.cred.be/sites/default/files/ADSR_2013.p

Hartung, Joachim, et all, 2008, Statistical Meta-Analysis with Application, Wiley-Inerscience, John Willey and Sons.

Hartung, Joachim, et all, 2008, Statistical Meta-Analysis with Application, Wiley-Inerscience, John Willey and Sons.

Harukase, T., Kito, M (1997), Separation, Recycle and Disposal of Waste Derived from Great Hanshin-Awaji Eartquake, Proc. Of the 19th Symposium of association of Environmental and Sanitary Engineering Research, Vol.11(3), pp. 67-72.

Hedges, Larry V, et all, 1985, statistical method for meta-analysis, academic press

Hirayama, N., Shimaoka, T, (2010), Establishment of Disaster Debris Management Based on Quantitative Estimation Using Natural Hazard Maps, In: Popov, V., Itoh, H., Mander, U., Brebbia, C.A. (Eds.), Fifth International Conference on Waste Management and the Environment, 12–14 July Tallinn, Estonia.

Hirayama, N., Shimaoka, T., Fujiwara, T., Okayama, T., & Kawata, Y. (2010). Establishment of disaster debris management based on quantitative estimation using natural hazard maps. Waste management and the Environment Vol. 140, pp. 167-178.

Holling, C. S. (1973). Resilience and stability of ecological systems. Annual review of ecology and systematics, pp.1-23.

Holling, C. S. (1996). Engineering resilience versus ecological resilience.Engineering within ecological constraints, pp. 31-44.

Hongsakul, Jakarin (2001), Disaster and Risk Reduction in Thailand, Department of Disaster Prevention and Mitigation in Thailand Ministry of Interior, Thailand

Hou, L., & Shi, P. (2011). Haiti 2010 earthquake—How to explain such huge losses?. International Journal of Disaster Risk Science, Vol. 2(1), pp. 25-33.

Hu, Z. H., and Sheu, J. B. (2013), Post-disaster debris reverse logistics management under psychological cost minimization. Transportation Research Part B: Methodological, Vol. 55, pp.118-141

Hurricane Isabel project summary, City of Chesapeake, VA, 2004

Idris, A., Inanc, B., & Hassan, M. N. (2004). Overview of waste disposal and landfills/dumps in Asian countries. Journal of Material Cycles and Waste Management, Vol.6(2), pp.104-110.

Indonesian Government Regulation Number 21 year 2008 concerning disaster management operation

Indonesian Government Regulation Number 22 year 2008 concerning disaster management budgeting

Indonesian Government, 2005, Master Plan for The Rehabilitation and Reconstruction of the regions and communities of the Province of Nanggroe Aceh Darusalam and The Islands of Nias Province of Nort Sumatra, http://www.preventionweb.net/files/2167_VL323117.pdf, acces August 2013

Indonesian law Number 32 year 2009 concerning Environmental Protection and Management

Indonesian law Number 18 year 2008 concerning Waste Management

Indonesian law Number 24 year 2007 concerning Disaster Management

Indonesian law Number 26 year 2007 concerning Spatial Management

Irajifar, L., Alizadeh, T., & Sipe, N. G. (2013). Disaster resiliency measurement frameworks state of the art. In CIB World Building Congress 2013. Queensland University of Technology.

ISDR, UN. (2005). International strategy for disaster reduction "Hyogo framework for action 2005–2015: building the resilience of nations and communities to disasters. In extract from world conference on disaster reduction, Kobe, Hyogo, Japan (pp. 18-22).

Jha, A. K., Bloch, R., & Lamond, J. (2012). Cities and flooding: a guide to integrated urban flood risk management for the 21st century. World Bank Publications.

Jha, A. K., Singh, S. K., Singh, G. P., & Gupta, P. K. (2011). Sustainable municipal solid waste management in low income group of cities: a review.Tropical Ecology, Vol. 52(1), pp. 123-131.

Joreskog K, G, and sorborn.D, (1993), Lisrel® 8:Structural Equation Modeling with the simplisTM Commond Language, Uppsala University, Scientific Software International, Inc 7383 North Lincoln Avenue, Suite 100 Lincolnwood, USA,

Joseph, Joan Castilo, 2009 Snowball sampling: chain referral sampling. http://explorable.com/snowball-sampling, access June 2013

Joseph, Joan Castilo, 2009 Snowball sampling: chain referral sampling. http://explorable.com/snowball-sampling, access June 2013

Kapucu, N. (2006). Public-Nonprofit Partnerships for Collective Action in Dynamic Contexts of Emergencies. Public Administration, Vol 84(1), 205-220.

Karunasena, G., Amaratunga, D., Haigh, (2013), Approaches For Capacity Building For Disaster Waste Management, available on line at http://dl.lib.mrt.ac.lk/handle/123/9029, Karunasena, G., Amaratunga, D., Haigh, R., Lill, I.,(2009) Post Disaster Waste Management Strategies in Developing Countries: Case Of Sri Lanka, International Journal of Strategic Property Management, Vol.13(2), pp. 71-190.

Klang, A., Vikman, P. Å., & Brattebø, H. (2003). Sustainable management of demolition waste—an integrated model for the evaluation of environmental, economic and social aspects. Resources, Conservation and Recycling, Vol. 38(4), pp. 317-334.

Kline, R.B., (2005) Principles and Practise of Structural Equation Modeling, 2 edition, London, guidford press,

Koufteros, X., Babbar, S., & Kaighobadi, M. (2009). A paradigm for examining second-order factor models employing structural equation modeling.International Journal of Production Economics, Vol.120(2), pp.633-652.

Kovács, G., & Spens, K. M. (2007). Humanitarian logistics in disaster relief operations. International Journal of Physical Distribution & Logistics Management, Vol. 37(2), pp. 99-114.

Kung, H. Y., Ku, H. H., Wu, C. I., & Lin, C. Y. (2008). Intelligent and situation-aware pervasive system to support debris-flow disaster prediction and alerting in Taiwan. Journal of Network and Computer Applications, Vol. 31(1), pp. 1-18.

Lasa, Jonatan, 2010, A history of Community Based management in Indonesia (Sebuah sejarah pengetahuan PRBBK di Indonesia), Buletin Kawasan, Badan Perencanaan Pembangunan Nasional, Vol.25. 2010. http://www.zef.de/module/register/media/1c56_a-history-of-cbdrm-in-Indonesia.pdf, access, June 25, 2013

Laten, H., (2012) Structural Equation Modeling, concept and application, With CD Program for Student Version, Alfa Beta, Indonesia. (in Bahasa Indonesia).

Lauritzen, E., (1998), Emergency construction waste management, Safety Science, Vol. 30(1), pp.45-53

Lee, J., Bharosa, N., Yang, J., Janssen, M., & Rao, H. R. (2011). Group value and intention to use—A study of multi-agency disaster management information systems for public safety. Decision Support Systems, Vol. 50(2), pp. 404-414.

Leungsakul, Sirakarn (2010), Status and issues related to industrial solid waste management in Thailand, Department of Industrial work, Thailand, 2010

Lubis Taufik, (2009), Transportation, Waste generation and Isues, available on http://dinaskebersihan.blogspot.jp/, access June 2013, re-access November 30, 2014

Manuta, Jesse, Khrutmuang Supaporn (2006), Institutionalized Incapacities and Practice in Flood Disaster Management in Thailand, Science and Culture, Vol 7. pp. 10 -22,

Manyena, S. B. (2006). The concept of resilience revisited. Disasters, Vol. 30(4), pp. 434-450.

McCawley. P. F., (xxxx), The Logic Model for Program Planning and Evaluation, University of Idaho extention available on url. http://www.d.umn.edu.Readings The Logig Model.pdf

McCrudden, C. (2004, November). Using public procurement to achieve social outcomes. In Natural Resources Forum Vol. 28, No. 4, pp. 257-267. Blackwell Publishing Ltd.

McLaughlin, J. A., & Jordan, G. B. (1999). Logic models: a tool for telling your programs performance story. Evaluation and program planning, Vol. 22 (1), pp. 65-72.

McLeod, F., & Cherrett, T. (2008). Quantifying the transport impacts of domestic waste collection strategies. Waste Management, Vol. 28(11), pp. 2271-2278.

Milke, M, (2011), Disaster Waste Management Need, Waste Management Vol. 31(1) pp. 1.

Ministry of Environment Indonesia (MoE) (2010), Waste Management Statistic.

Ministry of Environment Japan, 2011, Guidelines (Master Plan) for disaster Waste Management after the Great East Japan Earthquake, http://www.env.go.jp/jishin/attach/haiki_masterplan-en.pdf, access September 2012.

Ministry of Public Work, 2006, rehabilitation and reconstruction stages of Yogyakarta –Central Java Earthquake 2006, http://www1.pu.go.id/uploads/berita/ppw270606bd.htm, access July 2013

Morrow, B. H. (1999). Identifying and mapping community vulnerability. Disasters, Vol. 23(1), pp. 1-18.

Multi donor fund – JRF, 2012, note of MDF – JRF awareness , lesson learn from disaster reconstruction in Indonesia http://www.multidonorfund.org/doc/pdf/mdf_kn_03_bahasa.pdf, access, July 2013

Multidonorfund – JRF, 2012, Notice for knowledge of MDF – JRF, learning from the disaster waste recovery in Indonesia http://www.multidonorfund.org/doc/pdf/mdf_kn_03_bahasa.pdf, access, July 2013

Muryadi.W, Abidien. Z, Hadad. T, (1992) Two weeks after Tsunami Earthquake in Flores 1992, Tempo, December 1992, , http://www.inimaumere.com/2011/12/dua-minggu-setelah-gempa-tsunami-1992.html, access August 2013.

Muttamara S, Leong Tet, Shing , (2004), The Evolution of Solid Waste Management in Bangkok: Implications for the Future, Thammasat International Journal Science and Technology .Vol. 9, No. 1

Mwai, M., Siebel, M. A., Susanne, R., & Piet, L. (2008). Integrating MDGs in the Formulation of Strategies for Solid Waste Management–A Life Cycle Approach.

Nakamichi,T., Inoue, M., (1995), Treatment Systems and Technologies for Disaster Waste, J.Waste management research, Vol. 6(5), pp. 394-401.

Nakayama, H. , Shimaoka, T., Kiyoshi.O., Maryono., Patsaraporn, Plubcharoensuk., Siriratpiriya, Orawan., (2013), Solid Waste Management in Bangkok at 2011 Thailand Floods, Disaster Research, Vol (8).3,pp. 456-464.

National Disaster Management Agency (BNPB), 2011, Indonesia Hazard Index,

National Disaster Management Agency, 2013, Data and Disaster Information. http://dibi.bnpb.go.id. Aces June, 2013

National Disaster Management Agency, 2013, History. http://www.bnpb.go.id/page/read/1/sejarah, access July 2013

National Official Statistics Thailand Government, 2012. Population Sencus, 2010, http://www.nso.go.th/, acces on march 19 2012.

Neil Adger, W. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. World Development, Vol. 27(2), pp. 249-269.

Ngoc, U. N., & Schnitzer, H. (2009). Sustainable solutions for solid waste management in Southeast Asian countries. Waste Management, Vol.29(6), pp.1982-1995.

Notodarmojo, Suprihanto 2007, Report on Tsunami-generated Debris,United Nations Environment Program, http://www.unep.or.jp/Ietc/Publications/DEBRI/DEBRI_3_Report_on_Tsunami-generated_Debris.pdf, Acces april 2012

Notodarmojo, Suprihanto 2007, Report on Tsunami-generated debris, United Nations Environment Program, http://www.unep.or.jp/Ietc/Publications/DEBRI/DEBRI_3_Report_on_Tsunami-generated_Debris.pdf, access April 2012

Nuortio, T., Kytöjoki, J., Niska, H., & Bräysy, O. (2006). Improved route planning and scheduling of waste collection and transport. Expert Systems with Applications, Vol.30(2), pp. 223-232.

O`leary. M, (2004), Measuring Disaster Preparedness, A Practical Guide to Indicator Development and Application, iuniverse, Inc. Lincoln USA, pp. 1-28.

Paton, D., Johnston,D., (2001) Disasters and communities: vulnerability, resilience and preparedness, Disaster Prevention and Management. Vol 10 (4), pp. 270-277.

Pearl. J, (2014), The causal foundations of structural equation modeling. Vol. 370. CALIFORNIA UNIV LOS ANGELES DEPT OF COMPUTER SCIENCE, PDF Url : ADA557445.

Perry, R. W., & Quarantelli, E. L. (2005). What is a disaster?: New answers to old questions, International Research committee on disaster (2005). http://www.saarc-sadkn.org/downloads/what%20is%20disaster.pdf, access, November 30, 2014

Piyapanpong, Sunee (2013), Disaster Waste Management in Thailand, Department of Pollution Control, Ministry of Natural Resources and Environment THAILAND joint with UNEP, KOICA, Chulalongkorn University

Rimaitytė, I., Denafas, G., Martuzevicius, D., & Kavaliauskas, A. (2010). Energy and environmental indicators of municipal solid waste incineration: Toward selection of an optimal waste management system. Polish Journal of Environmental Studies, Vol.19(5), pp. 989-998.

Ristić, G. (2005). Basic indicators of integrated solid waste management. Facta universitatis-series: Working and Living Enviromental Protection, 2(5), 383-392.

Rushbrook, P. E., & Finnecy, E. E. (1988). Planning for future waste management operations in developing countries. Waste management & research, Vol. 6(1), pp. 1-21

Rutherford, W. H., & De Boer, J. (1983). The definition and classification of disasters. Injury, Vol. 15(1), pp. 10-12.

Rygel, L., O’sullivan, D., & Yarnal, B. (2006). A method for constructing a social vulnerability index: an application to hurricane storm surges in a developed country. Mitigation and Adaptation Strategies for Global Change, Vol.11(3), pp.741-764.

Sasaki, S., & Araki, T. (2013). Employer–employee and buyer–seller relationships among waste pickers at final disposal site in informal recycling: The case of Bantar Gebang in Indonesia. Habitat International, Vol.40, pp.51-57.

Savalei, V., & Bentler, P. M. (2010). Structural equation modeling. Corsini Encyclopedia of Psychology, http://onlinelibrary.wiley.com/doi/10.1002/9780470479216.corpsy0953/full

Schapper, P. R., Malta, J. V., & Gilbert, D. L. (2006). An analytical framework for the management and reform of public procurement. Journal of public procurement, Vol.6(1/2),pp. 1.

Shekdar, A. V. (2009). Sustainable solid waste management: an integrated approach for Asian countries. Waste Management, Vol.29(4), pp. 1438-1448.

Shi, J., & Xu, Y. (2006). Estimation and forecasting of concrete debris amount in China. Resources, Conservation and Recycling, Vol. 49(2), pp. 147-158.

Shimaoka. T, (1995), An Investigation on Solid Waste Generations by Natural Disasters and Disposal Measures, Journal of Management Research, Vol.6(5), pp. 360-372 [in Japanese]

Shook Garry (1997), An Assessment of Disaster Risk and its Management in Thailand, Disasters, Vol 21 (1), pp. 77-88

Simpson, D. M., & Katirai, M. (2006). Indicator issues and proposed framework for a disaster preparedness index (DPi). University of Louisville.

Srinivas, H., & Nakagawa, Y. (2008). Environmental implications for disaster preparedness: lessons learnt from the Indian Ocean Tsunami. Journal of Environmental Management, Vol. 89(1), pp. 4-13.

Statistik, B. P. (2009). Poverty profil in Indonesia, Maret 2009, formal news for Indonesia Statistic, BPS No. 43/07/Th. XII (in Bahasa Indonesia)

Suttibak, S., & Nitivattananon, V. (2005). Enhancing solid waste management capacity of local government authorities: review of current status in Thailand. in Southeast Asian Cities, 105.

Tabachnick, B.G., Fidell, L S., (2007), Using Multivariate Statistics, Pearson , ULB Darmstadt.

Tajima, R., Hirayama N., Osako, M.,(2014), Impact of institution on the management of disaster waste in the Great Easth Japan Earthquake, Journal of the Japan Society of Material Cycles and Waste Management, Vol.25. pp.1-15.

Tajima,R., Hirayama, N., M.Osako, M.,(2013), Theory and practice of pre-disaster planning for disaster waste management. Internet Journal of Society for Social Management Systems.

Takatsuki, H., Sakai, S., (1995), Disaster and Waste Problem-per unit Generation of the Disaster Waste and the Composition Changes of Municipal Solid Waste, Journal of Waste management research, Vol. 6(5), pp.360-372

Tang, C. S. K. (2006). Positive and negative postdisaster psychological adjustment among adult survivors of the Southeast Asian earthquake–tsunami.Journal of Psychosomatic Research, Vol. 61(5), pp. 699-705.

Teixeira, Carlos Afonso and Neves Eduarda Beja, 2009, Municipal Solid Waste Performance Indicator. http://www.iswa.org/uploads/tx_iswaknowledgebase/1-265.pdf, first access June, 2013, and second acces November, 25, 2014.

Tempo (2008), Operational cost for waste management.

Terpstra, T. (2011). Emotions, trust, and perceived risk: Affective and cognitive routes to flood preparedness behavior. Risk Analysis, Vol. 31(10), pp. 1658-1675.

Thailand: Administrative division, available on http://www.citypopulation.de/php/thailand-admin.php, acces on March 23,2012

The World Bank, (2012), Thai flood 2011, Rapid Assessment for Resilient Recovery and Reconstruction Planning, 2011

The World Bank, 2012, Thai Flood 2011 Rapid Assesment For Resilient Recovery and Reconstruction Planning, The Word Bank, Bangkok Thailand.

TNP2K (2011), National committee for accelerate poverty reduction [in Bahasa Indonesia]http://www.tnp2k.go.id/

Tokgoz, B. E., & Gheorghe, A. V. (2013). Resilience quantification and its application to a residential building subject to hurricane winds. International Journal of Disaster Risk Science, Vol.4(3), pp.105-114.

Tsilemou, K and Panagiotakopoulos, 2005, Sustainability indicator for solid waste management system, Proceeding of the 9th International Conference on Environmental Science and Technology, pp.A-1489-1495.

Turvey, R. (2007). Vulnerability assessment of developing countries: the case of small island developing states. Development Policy Review, Vol.25(2), pp. 243-264.

UN OCHA, 2011, Disaster Waste Management Guidelines.

UNDP, 2008, Project facts: tsunami recovery waste management programme (TRWMP)

UNEP, (2008), Disaster Waste Management Mechanism A Practical Guide for Construction and Demolition Wastes in Indonesia, available online on http://www.unep.or.jp/Ietc/Publications/DEBRI/DEBRI 8 Disaster Waste Management.pdf

UNEP, (2009). Developing Integrated Solid Waste Management Plan.prepared by United Nations Environmental Programme, Vol.3 Target and Issuesf for ISWM

UNEP, 2005, Solid waste management, United Nation Environmental Program division of technology, industry and economic-Intenational environmental technology centre, Japan and Cal recovery Inc USA. http://www.unep.org/ietc/Portals/136/SWM_Vol-II.pdf, first access June, 2013, and second access November 25, 2014.

UNEP, 2008, Disaster Waste Management Mechanism: A practical guide for construction and demolition wastes in Indonesia.

UNEP, 2012, Managing post disaster debris: the Japan experience, http://postconflict.unep.ch/publications/UNEP_Japan_post-tsunami_debris.pdf, access June, 2013

United Nation Thailand, 2012, Thailand info Geografi overview,

US EPA, 2005, Planning for disaster Debris, US environmental protection agency, office of solid waste

USACE, 2005. USACE Hurricane debris estimation model, US army of Enginners.

USGS, 1992, Earthquake Information for 1992, http://earthquake.usgs.gov/earthquakes/eqarchives/year/1992/ , access June, 2013

Whiteman, A., Smith, P., Wilson, D. C., Whiteman, A., Smith, P., & Wilson, D. C. (2001, June). Waste management: an indicator of urban governance. In UK DFID submitted for the Global Habitat conference on Urban Development.

Widjayanto. S. H, (2008), Structural Equation Modeling With LISREL 8.8: Concept and Tutorial, With CD Program for Student Version, Graha Ilmu Jakarta. (in Bahasa Indonesia).

Widya, Nengah 2011, Impact and Issues of Flood in Jakarta, http://nengah-widya.blogspot.jp/2011/11/dampak-dan-penyebab-banjir-di-jakarta.html; access September 2012

Williams, S. (2008). Rethinking the nature of disaster: From failed instruments of learning to a post-social understanding. Social Forces, Vol. 87(2), pp. 1115-1138.

Wilson, D. C., Araba, A. O., Chinwah, K., & Cheeseman, C. R. (2009). Building recycling rates through the informal sector. Waste Management, Vol. 29(2), pp.629-635.

Wilson, D. C., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. Habitat international,30(4), pp. 797-808.

Wisner Ben, 1998, Marginality and Vulnerabililty: Wy the homeless of Tokyo don`t `caunt` in disaster preparations, Aplied Geography, Vol.18, No.1, pp. 23-33

Wongbusarakum, S., & Loper, C. (2011). Indicators to assess community-level social vulnerability to climate change: An addendum to SocMon and SEM-Pasifika regional socioeconomic monitoring guidelines. The Nature Conservancy and the NOAA Coral Reef Conservation Program.

World Bank (2013), world development indicator, http://data.worldbank.org/sites/default/files/wdi-2014-book.pdf

Xiao, J., Xie, H., & Zhang, C. (2012). Investigation on building waste and reclaim in Wenchuan earthquake disaster area. Resources, Conservation and Recycling, Vol. 61, pp. 109-117.

Yates, D., & Paquette, S. (2011). Emergency knowledge management and social media technologies: A case study of the 2010 Haitian earthquake.International Journal of Information Management, Vol.31(1), pp. 6-13.

Yi, H., and Yang, J.,(2014), Research trends of post disaster reconstruction: The past and the future, International Habitat, Vol.42, pp.21-29

Yung, Y. F., Thissen, D., & McLeod, L. D. (1999). On the relationship between the higher-order factor model and the hierarchical factor model. Psychometrika,Vol. 64(2), pp. 113-128.

Zakiya, Zika, 2012, tsunami waste management in Aceh and resilience, National Geograhy-Indonesia, http://nationalgeographic.co.id/berita/2012/11/pengelolaan-sampah-tsunami-aceh-lahirkan-kemandirian, access July 2013

Zurbrugg, C. (2002). Urban solid waste management in low-income countries of Asia how to cope with the garbage crisis. Presented for: Scientific Committee on Problems of the Environment (SCOPE) Urban Solid Waste Management Review Session, Durban, South Africa, 1-13.

Appendices

A. Questionnaire survey for assessing disaster waste management preparedness in selected cities of Indonesia

Questionnaire	Answer with choose appropriate number						
In my local state has been establish government coordination for disaster waste management	True	1	2	3	4	5	False
In my local state Identify likely waste and debris types	Likely	1	2	3	4	5	Un likely
In my local state responsible organization have been developed method to forecast amount of waste and debris	True	1	2	3	4	5	False
In my local state, there was a list applicable national and local environmental regulation to manage disaster waste management	True	1	2	3	4	5	False
In my local state, responsible organization have been inventory current capacity for waste and debris management, and determined waste and debris tracking mechanism	True	1	2	3	4	5	False
In my local state, responsible organization have been developed and pre select temporary waste and debris storage	Likely	1	2	3	4	5	Un likely
In my local state, responsible organization have been identify equipment and administrative needs sites	Likely	1	2	3	4	5	Un likely
In my local state, responsible organization have been developed a communication plan for disaster waste management	Likely	1	2	3	4	5	Un likely
In my local state, responsible organization have been created a disaster debris prevention strategy	True	1	2	3	4	5	False
In my local state, responsible organizations have been create a debris removal strategy	True	1	2	3	4	5	False

In my local state, responsible organization have been developed recycling options for disaster waste management	Likely	1	2	3	4	5	Un likely
In my local state, responsible organization have been developed a process to utilized such as waste and disaster waste to energy options	Likely	1	2	3	4	5	Un likely
In my local state, responsible organization have been developed disposal options for disaster waste generation	Likely	1	2	3	4	5	Un likely
In my local state, responsible organization have been developed a plan to anticipate an open burning options for disaster waste management	Likely	1	2	3	4	5	Un likely

B. Questionnaire survey for identification factor affect stakeholder intention to promote disaster waste management preperadness

Symbol	Observed variables (questionnaire)	Answer with choose appropriate number						
x_1	Disaster waste management need special treatment because they needs many year if managed with normal equipment	true	1	2	3	4	5	false
x_2	I believed the negative impact of disaster waste management for public health such as generating of rodent, and insect.	true	1	2	3	4	5	false
x_3	I am worry, there were no clearly guideline to handling was management in my town	likely	1	2	3	4	5	unlikely
x_4	I am sure that the responsible institution will choose the best method to handling disaster waste for safety life and environmental consideration including psychological stress	likely	1	2	3	4	5	unlikely
x_5	I am not sure that the responsible institution could be ensure the equipment, tools to collecting, transfer and fostering 3 R in treatment of disaster waste properly	likely	1	2	3	4	5	unlikely
x_6	I am not sure that the responsible institution could be ensure the equipment and tools for handling final disposal of disaster waste properly	likely	1	2	3	4	5	unlikely
x_7	I am not sure that department of park and beautiful design a method to evaluate the performance of their facility while deliver waste management services	agree	1	2	3	4	5	disagree
x_8	I am not sure that department of park and beautiful design a mechanism to ensure additional facility in daily waste management	agree	1	2	3	4	5	disagree
x_9	I am not sure responsible institution have a mechanism and system to ensure hazard of disaster waste generation	agree	1	2	3	4	5	disagree
x_{10}	I am not sure responsible institution have a good system for sharing information of disaster and disaster waste management	agree	1	2	3	4	5	disagree

x_{11}	I am not sure that my local disaster agency or responsible department have mechanism an system to monitoring the impact of disaster waste generation	agree	1	2	3	4	5	disagree
x_{12}	I am not sure that my local disaster agency or responsible department have a guide line to reduce impact of disaster waste	agree	1	2	3	4	5	disagree
x_{13}	I am not sure that my local disaster agency or responsible department have a good mechanism to ensure additional facility in emergency respond for handling disaster waste	agree	1	2	3	4	5	disagree
x_{14}	I am not sure that my local disaster agency or responsible department have an emergency plan with other organization such as MOU to handling disaster waste	agree	1	2	3	4	5	disagree
y_1	I will active, participate to improving skill, knowledge of disaster waste management	agree	1	2	3	4	5	disagree
y_2	As of my position, I will active to update and improving any facility to treat waste and enhance maintenance facility with regular schedule	agree	1	2	3	4	5	disagree
y_3	As of my position, I will ensure that activity associated to increasing and promoting preparedness of disaster waste always registered in annual program list in my department	agree	1	2	3	4	5	disagree
y_4	As of my position, I will introducing policy design to encourage disaster waste management preparedness	agree	1	2	3	4	5	disagree

Acknowledgements

I wish to express my sincere thanks and profound gratitude to my supervisors, Professor Takayuki SHIMAOKA, and Associate Professor Hirofumi NAKAYAMA for introducing me to ``Urban Environmental Strategist especially associated to the Solid Waste Management System and for their advice, kindness and expert guidance during the period of my study since October 2011. My supervisors are men of great ideas and with gentleness, during my stay in Japan, they acted my teachers, advisors and above all as best friends. Without their relentless effort in teaching and equipping me with several principles and techniques of Waste Management System, and comments and high level academic waste management in their chair, I could have not accomplished this dissertation and reached this point. I am highly indebted to my supervisors.

I would like to thanks to my close defense examiner committee: Professor Kenichi TSUKAHARA and Profesor Hiroki TANIKAWA for their support and valuable inputs during close defense examining.

My gratitude also goes to my parents, Sumardi (deceased), Suparmi, Sukardi, my lovely wife Winuryanti Puji Rahayu, my angels: Phaedra Phalosa Mariono and Pallas Priyasava Mariono, My parents-in-law, Tjaryani and Sri Suharti. My brother Sriyanto, Mardada, Marsidik, Dian Eny Sunarni for their great support during my entire studies

I thanks to Ministry Education of Indonesia (DIKTI) which has provided scholarships so that I can continue my studies in Japan. Futher, I would like to Enviromental System Analysis and Control Engineering laboratory member, , Arizono-San, Teppei KOMIYA-San, Amir-San, Irwan-San, Shigementsu-San, Mitali-San, Nithiya-San, Ashiyanti-San, Pavel-San, and especially for KANAWUT, Darma ANDHIKA, ADI Saputra, Agus Elia Nova and Bustami in Banda Aceh without our help would be difficult to complete my studies. My friend of the student council Indonesia member who have been willing to be a place to share information, experiences.

I would like to thanks to National Disaster Management Agency Jakarta, especially for Data Information Centre and Public Relation division, Ministry of Environmental, Ministry of Home affair, Ministry of National Planning for their data and information of disaster management and disaster waste management

I would like to thanks to provincial disaster management agency, and provincial department of Public work in Aceh, North Sumatra, West Sumatra, Jakarta, Yogyakarta, Central

Java, South Kalimantan, South Sulawesi, East Nusatenggara for their data and information of disaster management and disaster waste management

I would thanks to city and district government especially for city waste management agency, disaster management agency and public work in Banda Aceh, Medan, Padang, North Jakarta, Yogyakarta, Surakarta, Banjarmasin, Makasar and Maumere (Sika) for their data and information of disaster management and disaster waste management.

And most of all gratitude give to Allah SWT who has given the grace and strength to complete my studies, as well as the Allah SWT messenger Muhammad SAW and his family.

Biography

Maryono was born in Boyolali, Central Java, Indonesia to Sumardi (deceased) and Suparmi. He has older brother, Mardada, Marsidik and younger sister, Dian Eni Sunarni.

Maryono conducted his entire elementary until high school in Boyolali Central Java, Indonesia . He continued study at Bandung Institute of Technology (ITB) in 1993, and received a bachelor degree in Environmental Engineering in 1998. Maryono began his career as an Employee of Bank BNI 46 in 1998. In August of 1999 Maryono joint a special program and scholarship from Ministry of Education Indonesia. According to the program, Maryono started as a lecture at Department of Urban and Regional Planning Diponegoro University, Semarang, Indonesia. In 2001, Maryono received a master degree in Urban and Regional Planning, Bandung Institute of Technology (ITB).

Maryono married in 2005 with Winuryanti Puji Rahayu; they have a beautiful daughter, Phaedra Phalosa Mariono and a handsome son Pallas Priyasava Mariono.

Maryono began pursuing his Ph.D at Kyushu University from 2011. During his stay in Japan, he had learnt many urban and environmental engineering knowledge.