Flood Management Model In Digital Era, Using SAST (Strtategic Assumption Surfacing and Testing) and the Exponential Comparison Method (ECM) : A Case Study in Jakarta

Abstract

Flooding is an annual disaster in Jakarta, the capital of Indonesia especially in December to February. Geographical position of Jakarta which is 40% below sea level, causes flooding not only from rain, but also from rob due to rising sea levels. In the last 5 years the impact of flood more and more serious, not only economic losses, but also human victims.

This study aims to determine the right strategy of flood mitigation by public involving in the digital era. The method used is combination of experts based . representing BNPB (National Disaster Agency), Local Goverment, Academics, Community Leaders, Businessman, and Practitioners; and vulnerable field research . Data analysis uses the ECM (Exponential Comparison Method) and SAST (Strategic Assumption Surfacing and Testing).

The result of the study indicates that the most appropriate strategy to mitigate flood disaster is establishment "Disaster Information Center" and "Disaster alert groups" involving every community element.   Utilizing social media especially WhatsApp, Facebook, and Instagram are very helpful way to share information of flood, how to prepare and emergency action to reduce losses and human victims.

Keywords: Flood, Mitigation, Disaster management, Digital Community

Introduction

Jakarta faces a very devastating routine flood almost every year. The height of the water flooding Jakarta in the last 5 years (2013-2017) has reached 2-4 meters, with a length of time between 4-8 days. The most terrible flood occurred in 2013 with a maximum water height of 4 meters for more than 5 days, with losses of more than 20 trillion (BNPB, 2015). Floods claim human lives. R. Osti and Nakasu (2014) state that one of the causes of human casualties was drowning (44%). Flood come without warning and they take lives of tens, hundreds and thousands of people. The resulting loss depends on the vulnerability of the affected population to resist the hazard, also called their resilience. If these disasters continue it would be a great danger for the people. The flood conditions in Jakarta are getting worse because 40% of the   Jakarta area is below sea level. There are 3 types of Jakarta floods: (1) overland flooding (2) flooding due to rain, and (3) Rob flooding. Overland flooding usually originates in Bogor and the surrounding areas in the upstrerm. So, although it is not raining in Jakarta,   the run off water from Bogor will flow to Jakarta via the Ciliwung River and making Jakarta flooding. Overland flooding usually occurs only in certain areas near the Ciliwung River. Floods due to rain have a wider impact, usually   around December-February, the impact can reach more then 50% of area

submerged. Whereas rob floods are floods that occur when rising sea level, which usually occurs in northern Jakarta.

Besides the condition of the area which is partially below sea level, there are also 13 rivers enter to Jakarta, including the Ciliwung River, Pesanggrahan river, Kali Baru river, Krukut River, and others. When the rain falls, the overflow of water from the 13 rivers submerges most of the area of Jakarta, especially several densely populated villages.

Of the 13 rivers surrounding Jakarta, Ciliwung has the most extensive impact during the rainy season, because it flows through the center of Jakarta and crosses many villages, crowded halls, and slum residential areas.

The floods in Jakarta are getting worse in last 5 years, in addition to the damaged watershed (DAS) in the upstream of Puncak and Bogor, the watershed in Jakarta has also experienced a narrowing and siltation due to illegal buildings along the river. Flooding in 2013 was the worst and extencive impact; average inundation height 1-3 meter with duration 20 days. Lost of economic potential reach IDR 20 trillion, 20 people died and 33,500 people were displaced (National Disaster Agency, 2017).

To anticipate flooding, the Government of Jakarta has built East Flood Canal (BKT) and West Flood Canal (BKB). BKT with a length of 23.5 km was built with the aim of protecting the East Jakarta and North Jakarta areas from the overflow of Ciliwung, Cipinang, Sunter, Buaran, Jatikramat, and Cakung rivers, due to water flow discharges at the peak of the rainy season which was not accommodated. Whereas BKB, with a length of 17.4 km, was built to drain water through the Angke River through the Krukut Canal to accommodate water overflows from Ciliwung, Krukut River and Cideng River which will then be channeled to the sea.

Along with the development of the city of Jakarta and its surroundings, the construction of the two canals to drain rainwater is not yet adequate. Water overflows caused by overland floods or ones due to heavy rains still submerge some parts of Jakarta. In addition there are around 400 business activities that directly or indirectly dispose of their wastewater into Ciliwung River that allwys throws waste toCiliwung river (Ministry of Environment, 2012). There are 26,818 heads of households who inhabit the banks of the Ciliwung River also throwing garbage into the river every day. This causes sedimentation, narrowing of the river, and high rates of pollution in the river. To handle flooding in Jakarta, government have built western canal flood, and east canal flood. But the increase of population and urban development, the two canals are no longer able to accommodate the flow of water when it rains.

A major problem facing Jakarta residents is the handling of yearly floods have not been integrated and well planed, so that people do not know what to do, hundreds of human lives were lost and millions of infrastructure's damage was resulted by flood. The people are allways confused when they facing flood, and govenrment has a dificulty building shelter home. Therefore it needs the right mitigation strategies and well planned so that the impact of the flood can be reduced. Along with the development of digital technology, anticipation of flooding by involving the community can be improved through social media. If flood disaster occurs, the public must immediately get information about the condition of floods,

what must be done quickly and where the shelter is. These can be provide quickly by social media.   Chang Ngai Weng (2010) states that social media   can be used to support flood mitigation, so the people are quickly informed of the status and actions that must be taken. Social media has become a valuable means of communication in many places affected by a natural disaster, which allows people to keep in touch with family and friends and access important information. Velev,D and Plamena Zlateva (2018) state that   social media has emerged as a popular medium for providing new sources of information and rapid communications, particularly during natural disasters .

This study aims to determine the most appropriate mitigation strategy by involving the community in accordance with objective condition of the peoples, in digital era.

Methods

This research is expert based, data collection through expert discussions, including policy makers, disaster experts from BNPB (National Disaster Agency), Academics and Community Leaders; and Interviews to 75 representative respondents who were randomly selected to find out the types of social media used in flood disaster communication and their perception to disater management system.

Data analysis uses SAST (Strategic Assumption Surfacing and Testing) and ECM (Exponential Comparison Method). SAST and ECM are experts based method. SAST selected for mapping the most important and Certainty aspects through the picture,   while ECM method   selected for determining   priority strategy based on multi criteria, the formula of ECM as below:

$$\text{Value Total (TN}_i) \ = \sum_{J=1}^{m} (RK_{ij})^{TKK}{}_{J}$$

Where :
TN$_i$: Total alternative value to - i
RK$_{ij}$: The degree of relative interest jth in choice decisions i
TKK$_j$: Degree of interest of criteria jth decision; TKKj> 0; even
N   : Number of decision choices
M   : Number of decision criteria

Literature Review

Disaster can be defined as a source of danger, and its consequences can adversely affect humans in terms of life, property and environment when the level of danger, and the consequences, exceed the ability of the affected society to cope using its own resources (Alexander 1997). The Flood disaster is a puddle in an area due to overflow of water which causes material and non-material losses (Indonesian Law No. 24 of 2007).

Mitigation means reducing risk of loss from the occurrence of any undesirable event. (BNPB, 2015). There are two types of mitigation structual an and structural (Indonesian Geography   Center, 2016).   Structural   mitigation mean flood

138 perevention with phisical development (dam, levees, reservoir), while non structural
139 mitigation is an effort to reduce the impact of flood other than structural , it included
140 public awareness, establishment of flood alert group, zoning and mapping of
141 flood prone area.
142   There are 6 important aspects of mitigation strategy : (1) prevention (planning
143 and zoning, drainage system maintenance, beach maintenance); (2) property protection
144 (elevation, relocation, flood proofing, storm shutters, insurance) ; (3) public education
145 and awareness (Real estate disclosure, hazard information center, flood map and data)
146 ; (4) natural resources protection (sediment and erotion control, stream corridor
147 restortion, watershed management); (5) emergency services measure (emergency
148 response planning, evacuation, and critical facilities protection) ; (6) structural project
149 (flood walls, levees, dams); Wetmore and Jamieson (1999).   Grigg (1996) stated
150 there are 4 aspects of flood control: (1) Modification of flood vulnerability and losses
151 by determining of zones of land use arrangements, (2) Normalization of reservoir or
152 river (3) Modification of the impact of flooding with the use of technical mitigation
153 such as insurance, flood proofing, and (4) regulation of maintaining natural capacity,
154 including reforestation.
155   Indonesia is one of the countries with the high disaster risk, as several types
156 of disasters are most likely to arise include: floods, landslides, volcanic eruptions,
157 forest fires, etc. National Disaster Agency (2017) has identified   disaster events in
158 2016 as the following table:
159
160 Table 1. Disaster events in Indonesia in 2016
161

| No	Type of Disasters	Number of events	Damage Facilities		
			Education	Worship	Health
1	Flood	850	1.119	265	81
2	Tornado	687	62	36	4
3	Landslide	626	49	47	18
4	Forest fire	178	na	na	na
5	Tidal Wave	23	1	na	na
6	Earth quake	13	254	258	127
		2384			

162   National Disaster Agency (2017)
163   The table displays flooding is the highest occurrence with the most severe
164 impacts on education, religious and health facilities. Floods can be classified into
165 several types: (1) Flash flooding, which is large and occurs suddenly and lasts only
166 for a short period of time; (2) Groundwater flooding occurs due to the overflow of
167 very heavy rainwater, especially if the riverbanks are fragile and unable to withstand
168 enough water; (3) River/overland flooding, which occurs due to water delivery from
169 other regions, and may lasts for a long time; (4) Coastal flooding (ROB), due to
170 rising tides in areas near the coast; and (5) Headwaters flooding, which occurs in
171 residential area near the upper reaches of the river. Flooding usually occurs due to the
172 high flow of water which can have destructive effects. Some of the factors that cause
173 flooding include: (1) Illegal logging leading to deforestation, (2) Waste dumped

174 carelessly into rivers, (3) Residential area on river banks, (4) Dense rainfall, (5) Poor
175 drainage system, (6) Broken dams, (7) Spatial errors and (8) Tsunamis. Floods can
176 cause damage to infrastructure, buildings, and the environment, which causes huge
177 economic losses and human casualties (BNPB, 2016). One of the causes of flooding
178 is changes in land use, and low community participation (Kodoatie et al, 2002; and
179 Aminudi, 2013). The role of the community in handling floods is very much needed
180 (BNPB, 2015), both in planning, implementing and supervising the development.

181 Disasters occur rapidly, instantaneously and indiscriminately. Generally there
182 are four steps of disaster. Disaster allways closed with civilization and poverty, the
183 way the people respond and deal with disaster depends on local culture . There are
184 four phases disaster management (Khan, 2017) : Mitigation, preparation, response,
185 and rocevary. The four disaster management phases is not   occur sequentially and
186 separately.   Often phases of the cycle overlap and the length of each phase greatly
187 depends on the severity of the disaster.   From these 4 stages , mitigation is an
188 important stage before disaster (Sutopo, 2015), as figure below :

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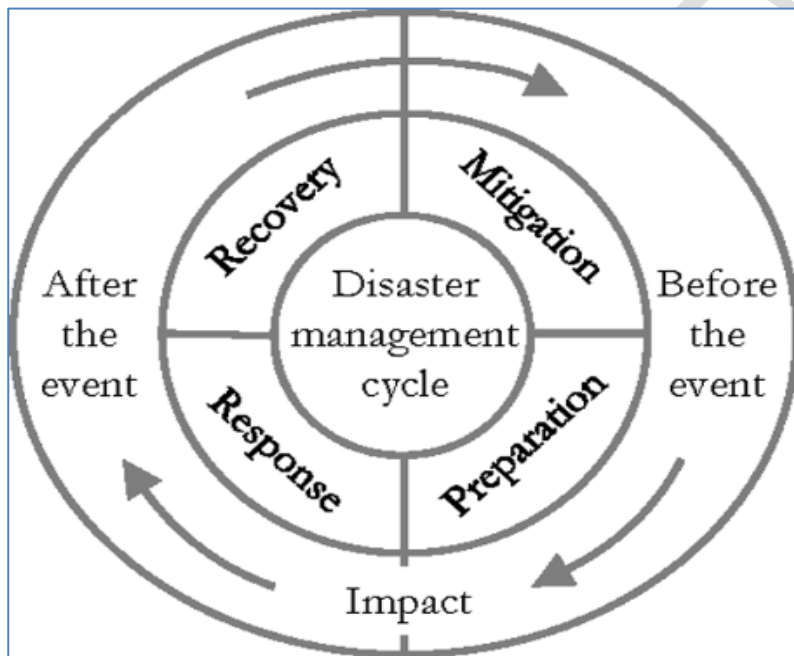
193 Figure 1. Disaster management cycle (Khan, 2017)

194
195

196 In general, there are two approaches to the problem discussed, including the
197 structural and non-structural methods dealing with flood mitigation (BNPB, 2016).
198 The core of structural method is a physical approach, such as normalization, dam
199 building, channel construction and others, while the non-structural method is a non-
200 physical approach, such as socialization, erosion control, watershed utilization
201 arrangements, and so on. Included in non-structural approach is the use of
202 information technology for disaster mitigation, to involve the wider community.

203   Flood handling in several developed countries has used information
204   technology, including in Japan. Disaster management in Japan is under the Ministry
205   of Land, Infrastructure and Transportation (MLIT/Ministry of Land, Infrastructure,
206   Information and Technology) which oversees the problem of flooding (irrigation
207   problems), sediment deposits, volcanic eruptions, earthquakes, by using information
208   technology (IT) for reducing the impact of natural disasters in Japan. The
209   infrastructure handled includes rivers, roads, sea and airports, sewage systems and
210   parks. Similar to what already exists in Indonesia, the basic elements of disaster
211   management in Indonesia consist of regulatory aspects, management systems, plans,
212   preparation, emergency response and recovery. Information technology greatly helps
213   disaster mitigation management (Mukhopadhyay, Buddhadev Bhattacherjee. 2015),
214   especially in terms of public awareness and education.

215   There are five priorities of Hyogo Framework for Action/ HFA 2005-2015
216   (Apec, 2009) : 1) Make Disaster Risk Reduction as Priority; 2) Know The Risk and
217   Take Action; 3)Build Understanding and Awareness; 4) Reduce Risk; 5) Be Prepared
218   and Ready to Act. While Sendai Decleration for disaster mitigation (2015-2030)
219   stated four important aspecs : (1) Understanding disaster risk; (2) Strenghtening of
220   risk governance (3) Investment for Resilience; and (4) strenghtening of risk
221   management (BNPB:2015).

222   Flood preparedness needs to be done in stages, starting from prevention,
223   handling during flood (response/intervention), and recovery after flood. These stages
224   are cycles of continuous flood preparedness, including several types of activities as
225   shown in Table 1.

226

227   **Table 1 Stages of Flood Preparedness**

Cycle	Activities
Prevention	Structural strategies
	. In-Stream strategies
	. Off-Stream strategies
	Non-structural strategies
	. Long-term flood prevention strategies
	. Short-term management strategies of floods
Intervention /Response	Notification and information with regard to forecast of floods
	Immediate Reaction and Emergency Support when floods occur
	Handling of the flood
Recovery	Immediate Assistance for Daily Life Needs and Repair of Facilities and Infrastructure
	Post-Flood Mop-up and Reconstruction
	Rehabilitation and Recovery of Physical and Non-Physical Conditions
	Damage/Loss Assessment and Flood Disaster Insurance
	Review of the Causes of Floods

228   Source: Directorate of Research and Community Service – UI (2006) ,

229

230   Flood prevention activities follow a life cycle which begins at flooding, then
231   studies it as input for prevention before a flood occurs. Prevention is carried out
232   thoroughly, in the form of physical activities such as the construction of flood control

233 in river areas (in-stream) to floodplain areas (off-stream), and non-physical activities
234 such as land use management to early flood warning systems. The result of R. Osti
235 and T. Nakasu (2014) study in Japan showed that 44% human casualties were caused
236 by drowning. Flood mitigation can be done not only by physically protecting
237 buildings through the construction of dams, but also by making appropriate spatial
238 plans.
239   There are 3 the most famous social media in Indonesia : facebook (41 %),
240 WhatsApp (40 %), and Instagram (38 %); (Supratman, 2018). Most of social media
241 users are for gaining information (46 %), virtual communication (25%), on line
242 shopping (15 %), culture adoption (8 %) and others (6%), Mulawarman, Aldila Dyas
243 Nurfitri,(2017). Social media has a very significant role iin disaster mitigation (
244 Lestari , B. Ramadhaniyanto , and D. Wardyaningrum, 2017).
245   Stakeholders in flood prevention are grouped into three: (1) beneficiaries,
246 communities that receive benefits/impacts directly or indirectly; (2) intermediaries,
247 community groups or individuals who can provide consideration or facilitation in
248 flood mitigation, including: consultants, experts, NGOs, and professionals in the
249 natural resources sector; (3) decision/policy makers, institutions authorized to make
250 decisions and legal basis, such as government institutions and water resources
251 councils. The type and level of community participation will differ depending on the
252 type of policy or activity.
253   Digital era has changed the whole situation of people's lives, even including
254 social life and behaviour (Rahma, 2015). The impact of digital age on the social life
255 of the society today is connected with one's position in the society, his social class
256 and also his social background, nowadays, there are so many changes in the social
257 aspect of our lives. What's up, Instagram, facebook, line, email are the most popular
258 for dissemination of news, information, images and video (Ministry of Informatic,
259 2016), so this social media is also possible to support mitigation of flood.
260
261
262 **Result and Discussion**
263   As the capital of Infonesia, flood handling in Jakarta involves many agencies ,
264 they are : BMKG (Bureau of meteorology, Climatology and geophysics) ,
265 BNPB(National disaster agency) , BASARNAS (National Search and receu agency),
266 BPBD (Regional disaster agency), PMI (Indonesian Red Cross), Local governments,
267 and Community Organizations (Youth groups, religious groups, students, and the
268 general public). BPBD is local disaster agency that is organizationally responsible
269 to the governor. Over laping between agencies always occurs every flood, there is no
270 coordination, each carry out their main duties but do not cooperate with each other.
271 As a results flood disaster management ineficient and costly. As the institution that
272 responsible for meteorological and geophysical information, the BMKG only informs
273 about the weather and the possibility of heavy rain, but save place for evacuation,
274 level of water and flooded area is not included. While PMI and BASARNAS are
275 almost the same task of helping victims, but there is no mutual coordination, so that is
276 overlaps with community gorup and youth. Based on experts interviews involving
277 BNPB, BMKG, PMI , community leaders, and academics; a disaster information
278 center needs to be established that involves all compnents, to provide and share an

279 official information of flood disaster online. Only information released by this center
280 can be used as a reference. Most respondents (68.9 %) stated that they need official
281 information from the government which is distributed digitally, so that the
282 community will quickly access through mobile phone via WA, facebook or
283 instragram to get the latest information about flood.
284
285 Based on experst discussion, there are 8 important aspects that need to
286 concidered in flood control in Jakarta : (A) Facilities; (B) Collaboration; (C)
287 Coordination; (D) information; (E) Public Involvement ; (F) Public awareness; (G)
288 Technology; (H) Institution; and (I) Disaster management. The results of SAST
289 analyisis showed that Important and certanty aspects based on experts discussion is
290 showed in figure 3 .
291
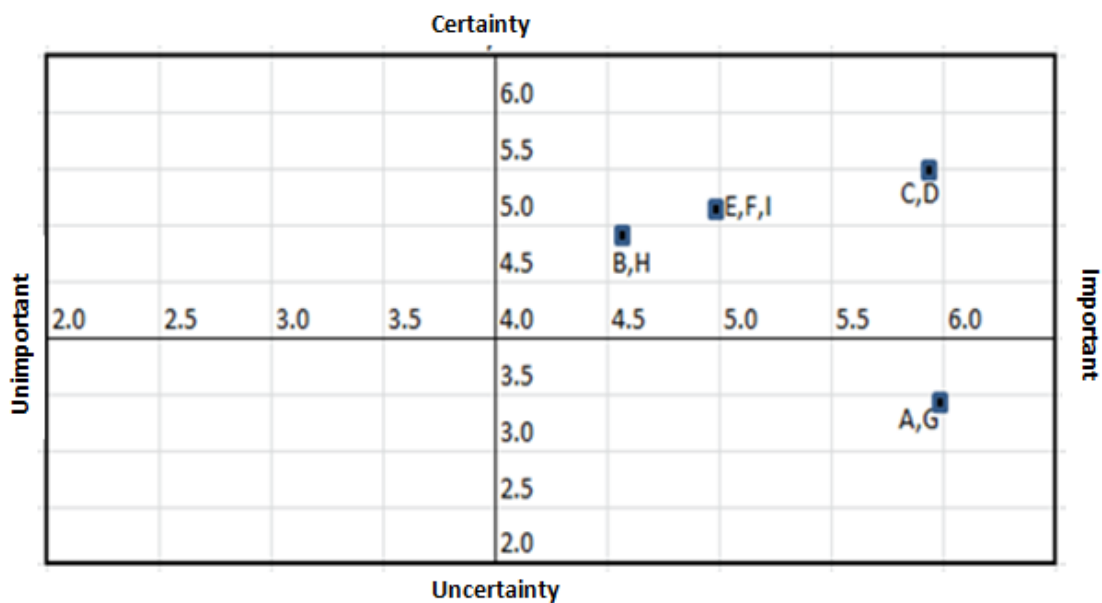
294 Figure 3. Certanty and important aspects of flood management in Jakarta
295
296 Descriptions :
297 A : Facilities   D : Information   G : Technology
298 B : Collaboration   E : Public involvement H : Institution
299 C : Coordination   F : Public awareness   I : Disaster Management
300
301
302 The most strategic assumption (figure 3) are coordination (C) and information
303 (D). This two aspects have the highest level of certanty and important. Coordination
304 is the bigest problem. Various agencies work with their own methods and expertise,
305 there is no cooperation and certain competency standards that must be possessed; so
306 there are often misunderstandings and even increase property damage that must be
307 saved. This mean that coordination is very important aspect. The involvement of
308 various agencies will cause overlap with out good coodination. This is confirmed by

309   the opinion of most respondents (78.6 %), that flood handling in Jakarta always
310   overlaps from the various institution involved.
311   Disaster information is a very importance thing in disaster management, 84.3 %
312   respondents said that they don't know how to save themselves when flooded, only a
313   small percentages (15.7 %) can save themselves because they have information how to
314   save and what to do, information technology is very important for the distribution of
315   disaster information to reduce disaster risk (Vyas and Aneri Desai, 2007).
316   Other strategic assumption in flood handling are Facilities (A) and Technology
317   (G). Flood handing requires a lot of equipment such as boats, water suction machines,
318   transport vehicles, communication equipment etc. Without adequate facility and
319   technology support, handling floods is difficult to well running.
320   Strategic priority based on multi criteria (Economic, Social, Environment and
321   institution) according to ECM analysis results showed in table 1.
322
323   Tabel 1. Strategic priority to flood handling in Jakarta (ECM analysis result)

No	Strategy	Weight (1-5)	Indikator (1-5)				Total	Ranking
			Economic	Social	Environment	Institution		
1	Development of disaster alert groups	(4,1)	(3,2)	(2,9)	(3,8)	(3,3)	568,4	2
2	Public awareness Development	(3,6)	(3,3)	(3,4)	(3,5)	(3,1)	305,1	5
3	Revitalization of the West and East Flood Canals	(3,6)	(3,4)	(3,4)	(3,4)	(3,4)	327,6	3
4	Public Involvement	(3,5)	(3,3)	(3,5)	(3,5)	(3,5)	305,9	4
5	Development of Disaster Information Center	(4)	(3,6)	(4,2)	(4)	(4)	991,2	1
6	Construction of Flood Control Center	(3,5)	(3,1)	(3,4)	(3,4)	(3,4)	269,9	6

324
325   The table above showed that the highest priority of flood handling in Jakarta is
326   the development of Disaster Information Center (ranking-1), and then development
327   of disaster alert groups. Through this center all of information about flood disaster
328   and the role of each group/ elements : BMKG (National Agency of Metereology
329   and Geophisics), BNPB (National Agency of Disaster Management), BPBD (Local
330   Agency of Disaster Management), BASARNAS (National Agency of Reach and
331   Resceu) and PMI (Indonesian RedCross); community groups and local government
332   can be coordinated. So the people can receive official information about the flood
333   in a complete and reliable manner. In addition overlaping between groups can be
334   avoided. Community involvement is done by utilizing social media. Local leadership
335   have to provide an SOP (standar operating Procedure) how to distribute information
336   about flooding to the community through social media. Most respondents (87.6%)
337   stated that communication through social media is very effective in disseminating
338   information on disasters faced. the most common social media uses for disater
339   communication are WA (45.4 %), Youtube (32.5 %), Instragram and Line. The use

of social media will be very effective if the news delivered is accurate and pictures are attached. Through social media, the public can find out about the current conditions, so that they can quickly anticipate what to do. Broadly speaking, the utilization of information technology in disaster mitigation can be described as follows:
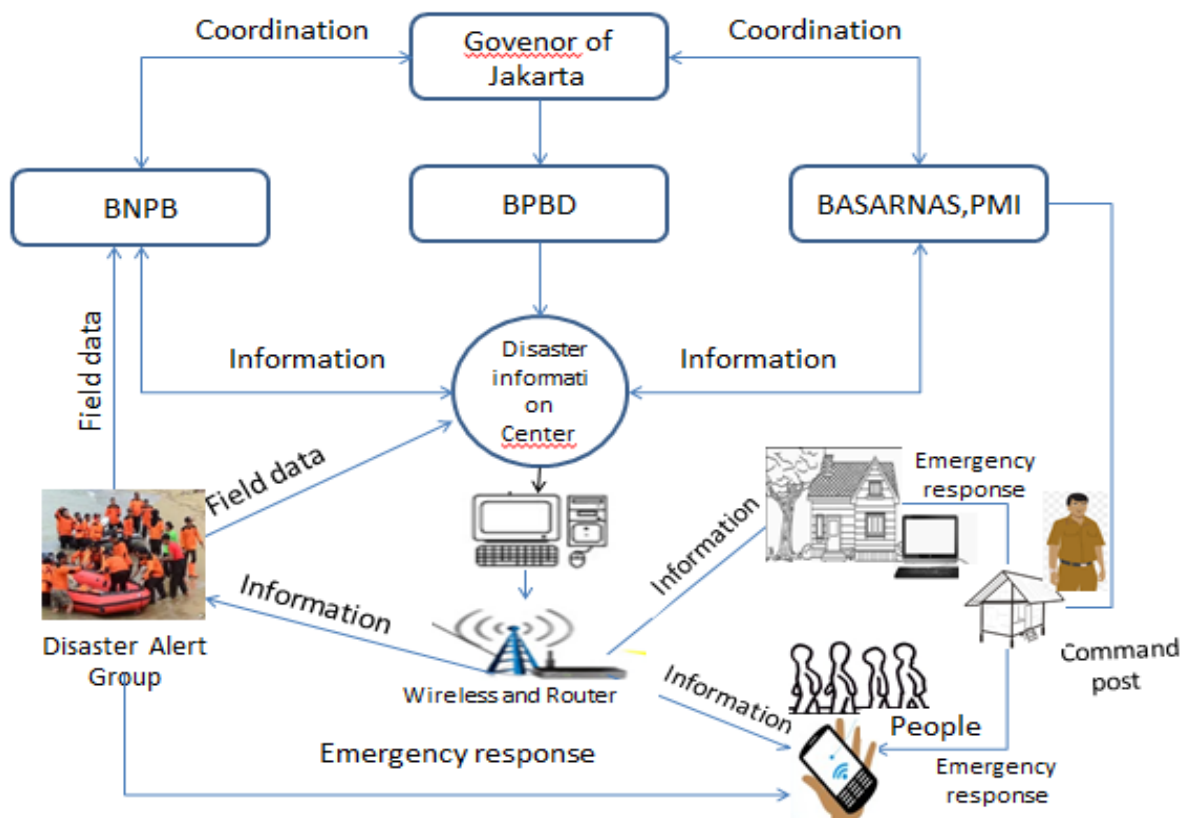
Figure 4. Disanter Information Center Model

Actions that must be taken in this center are includes:
- Update information about flood profile and affected area
- Distribute information online to affected community, and Disaster alert groups
- Provide direction to disaster alert groups to rescue victims and secure areas with security forces

Disaster alert groups is a flood concious group that formed in each region under supervision sub-district. This group consists of young people and some community members who must be trained in disaster management and action to save victims. So that it can be deployed when the annual disaster flood comes. Disaster information center model as the following picture. In order for activities to run optimally, a management organization needs to be developed, taking into account the organization's structure, functions and governance.

Based on the reality, the most crucial phase is the emergency response, including the rescue of goods and the people. Therefore, community groups need to

364 be identified to be able to contribute their best. So they have to be trained how to
365 save human live and help the victims, and they also must also know how to manage
366 and distribute aid effectively.
367
368
369 **Conclusion**
370 a) The priority strategy for flood mitigation according to the objective conditions of
371 Jakarta is development of disaster information center and Formation of Disaster
372 Preparedness team (disaster alert groups), involving all components of society
373 b) Community involvement becomes a key success factor in flood disaster mitigation
374 c) The use of digital technology through social media will increase the effectiveness
375 of the flow of information about floods, so that people can find out the current
376 situation.
377 d). Official information from the government is very important when flooded, to
378 avoid hoak news which actually confuses the public
379
380 **Suggestion:**
381 a) It is necessary to map the potential and capability of the community in
382 their respective regions, and to socialize the plan to involve the
383 community in mitigation through the formation of disaster preparedness
384 team.
385 b) To avoid overlapping and emerging conflicts from community groups,
386 disaster information center   need to be formed by involving relevant
387 agencie
388
389

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