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URBAN MOBILITY DURING THE PANDEMIC IN YOGYAKARTA CITY

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ABSTRACT

The urban situation has changed during COVID-19 pandemic since 2020. The swift of mobility behavior happened in all over the city in the world. The WHO’s suggestion to maintain NPIs; the physical distancing is a push factor for people to reduce traveling and mobility. The slogan ‘stay at home’ became part of the new normal until nowadays, because publication of it was spread on all media to reach out the society. Yogyakarta City responds to the pandemic issue with the same strategy, minimizing mobility and travel. However, there is uniqueness in the practice on minimizing mobility and travel in 2020 and 2021. In 2020, the control of mobility and travel is based on community and in 2021 the control of mobility and travel is based on government policy. The security level of travel in 2020 is housing and urban kampung, and in 2021 is on the city level. The research is focused on the perception of respondent on minimizing travel and mobility between these two years. The data was analyzed using the Principle Component Analysis method. The quantitative result will be compared with observation, so it shows the important value to respond during uncertainty on travel and mobility issue. The study will give how local wisdom and public policy collaborate to produce urban resilience in Yogyakarta City.

Keywords:

Yogyakarta City, COVID-19, Uncertainty, Urban mobility, NPIs, Urban resilience

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1. Introduction

The World Health Organization (WHO) declared the status of COVID-19 as an international pandemic, and this declaration has had a huge impact on global health. All nations followed non-pharmaceutical interventions (NPIs) to limit the spread of COVID-19 over the past 2 years. NPIs were standardized and categorized into 5 groups: Social Distancing, Movement Restrictions, Public Health Measures, Social – Economic Measures and Lockdown (Points and Thomas, 2022).

Social distancing and lockdown are 2 factors that are related to urban mobility. Limitation of mobility has been widely demonstrated as a health campaign to slow down the transmission of the virus, with several suggestions for public health safety; hand-washing, reducing face touching and wearing mask (Snoeijer *et al.*, 2021). To reach the goal of this health campaign, it also means to restrict or prohibit activities in high-density urban centers, including closing schools, offices and other public venues. These are NPIs applications over the past 2 years, enforced most to the size of social gatherings and business activities (Djalante *et al.*, 2020; Snoeijer *et al.*, 2021).

Lockdown is chosen to minimize urban mobility in 2020, and the effects of lockdown policies on mobility have been

studied in several developed countries, but there is less evidence on how mobility has responded to lockdown in developing countries (Karatajev, Anand and Bauch, 2020). The same situation happened in Indonesia. The government did not implement a city lockdown policy as found in Europe. To reduce urban mobility, they utilized PSBB (*Pembatasan Sosial Berskala Besar*; Large-scale social restriction). The central government of Indonesia released *Instruksi Presiden* (President’s Directives) No.4/2020 for refocusing national development in economic, goods and accelerate the response to COVID-19, on March 2020 (Djalante *et al.*, 2020; Aritenang, 2021; Hizbaron, Ruslanjari and Mardiatno, 2021). However, geographically, Indonesia is an island country so it is difficult to apply national imperatives to rapidly end the spread of COVID-19, even though both the central and local governments are working together with stakeholders to execute the President’s Directive.

Yogyakarta City is the capital of Yogyakarta Special Region (province). It was only a week after Jakarta, Yogyakarta reported the first confirmed positive for the disease (Hizbaron, Ruslanjari and Mardiatno, 2021). In line with national direction, the Government of Yogyakarta also formed a task force to handle the highly contagious

COVID-19. Yogyakarta City has empirical experience to handle natural disasters, such as volcanic eruptions, floods, cold lava flood, earthquakes and landslides (Damanik *et al.*, 2017). The city has built community-based risk reduction as an integral part of social and economic development. Urban kampung is a big part of the city, grows as an informal settlement and becomes a high risk of disaster. The city government had mapped the vulnerability and had set accompaniment the urban kampung from National Disaster Management Agency – Yogyakarta City (BNPB Kota Yogyakarta). Local community kampung have trained as local disaster agency, known as KTB – *kampung tangguh bencana* (urban kampung resilience) (Suyuti, 2014).

The local resilience built a higher participation level, and awareness to act together for local mitigation during a disaster. It could be seen from the response of the community during the first wave of COVID-19 2020, with kampung lockdown (local lockdown) as an act to prohibit people entering the settlement and limit mobility. But in 2021, there was a different approach, limiting urban mobility by closing the city road and re-directing the traffic flows.

This paper will explain the perspective of how is security level in the local community and security level on the city level to understand urban mobility according to the pandemic COVID-19. The rationale of the research is to understand the principle aspects of the value of urban mobility to build resilience in the pandemic context.

2. Literature Review

The SDGs, especially the Disaster Risk Reduction issue got its challenge during the pandemic COVID-19. On March 11, 2020, World Health Organization (WHO) declared COVID-19 a global pandemic. There is a change in behavior significantly on living after the declaration. As social human beings, social distancing is a new norm and needs to adjust some values for interaction in society. On city scale, urban mobility also has to be changed because of the spreading of COVID-19 by reducing mobility (Fatmi, 2020).

Urban mobility is an important issue for sustainable cities, because it promotes a harmonious relationship between humanity and nature in 3 aspects: (1) social inclusion, (2) economic development, and (3) environmental balance (UNIECE, 2020). The restriction of mobility, social distancing and lockdown have greatly impacted a number of different economic sectors, including transport, travel and mobility circulation. Authorities and operators all over the world had to act quickly and find rapid and efficient solution to guarantee safe mobility (The International Association of Public Transport, 2019; Kakderi, Oikonomaki and Papadaki, 2021).

The movement of people within the city is linked to specific activities and land use, every of it, involving an array of movements. Some factors impact mobility i.e: income, urban form, density, development level, and technology. The character is divided into two types: obligatory, linked to scheduled activities, and voluntary if they are free to decide on their schedule. The taxonomy of urban mobility types can be divided into (Rodrigue, Comtois and Slack, 2019):

1. Pendulum movements, which involve commuting between locations of work and residence.
2. Professional movements are linked to professionals such as meetings, repairs, maintenance, etc.
3. Personal movements, which are voluntary such as shopping and recreation.
4. Touristic movements, which involve interaction between landmarks and amenities.
5. Distribution movements, are concerned with the distribution of stuff to satisfy retail consumption and manufacturing requirements.

The COVID-19 pandemic has affected internal mobility in the city. In Santander, Spain, an overall fall of 76%. Public transport use has fallen the most with 93% less use. Mobility during morning and midday has dropped less than in the afternoon. The effect of confinement has logically modified the people's journey purposes (Aloi *et al.*, 2020).

In Sapporo, Japan, in the time of refraining from traveling implemented, the city's residents have been more likely to stay home and less likely to travel to the center area, which led to a decrease of up to 90% in the population density in crowded areas. The contact between people has decreased up to 70-80% in line with the purpose of the emergency declaration (Arimura *et al.*, 2020).

People became more aware of their health, social interaction, and mobility. That is why somehow, the usage of non-motorized vehicles i.e. bicycles increase significantly during the lockdown period compared to the situation before the lockdown and the pandemic in general (Bouhouras *et al.*, 2022).



Figure 1. Mobility Restriction and Health Measure at Kampung Klitren Yogyakarta City in 2020

Yogyakarta City faces a similar threat due to the pandemic. The value of Yogyakarta City is its image as an academic city, cultural tourism and art & craft handmade. The President's Directives No.4/2020 regulated only for good distribution, but the schools, universities, exhibition space, souvenir industries and historical places are secondary needs, so the government prohibited unnecessary mobility for those activities. The constraints of mobility on disease reduction are clear, and obviously have negative consequences on education, tourism and local-global economic.

In terms of social cohesion, urban kampung in Yogyakarta City also has a rapid reaction to reduce and

control urban mobility. In 2020, some of the kampungs set their own lockdown, and take control as a local lockdown. This kind of restriction for entry and exit of the settlement is detectable in some kampung and they manage the supervisory guards onsite by the local community. The Vice Mayor of Yogyakarta City mentioned that cooperation among all bureaus of government and society is important to overcome the pandemic. There are three main areas to handle: (1) prevention, (2) medication treatment, and (3) economic recovery. The action of the kampung set the local lockdown is part of prevention with a participatory approach (https://corona.jogjakota.go.id/web_article/index/511#).

A model of local lockdown simulated in Ontario Canada, showed that the county-by-county approach causes fewer days of closure and impacts fewer people than a strategy that opens or closes the entire province. The county-by-county strategy is most effective when the criteria are coordinated. Spectator magazine (Wise, 2020) mentioned that lockdowns are to buy you time, to reorganize, regroup, rebalance the resource and protect healthcare workers.

England shared information about the timeline of action of lockdown from March 2021 to March 2022 (IFS, 2021). It shows the lockdown policy has been changed according to the updated situation; national lockdown and local lockdown with specific reasons and approaches. The second national lockdown in October 2020 worked as a medical and moral disaster. It has the same aims as the Spectator magazine statement. Local leaders meet local needs in other hand also comprehensive national scale needs.



Figure 2. Guarding the Local Access to the Main Street of City

Yogyakarta City has a timeline for mobility limitation in 2020-2021. In 2020 the term is PSBB (*Pembatasan Sosial Berskala Besar*, Large-scale Social Restriction) on a national scale and local lockdown in urban kampung as action on local scale. During 2021, the term is PPKM (*Pemberlakuan Pembatasan Kegiatan Masyarakat*, Enforcement of Restrictions on Community Activities) on a national scale and road closures and traffic diversion as action on city scale. The community of urban kampung may lack resources to have restriction while keeping them locked, the government city encouraged all bureaus of city and non-government association to socialize the program NPIs, and the community to help their own neighborhood who suspect of corona virus.

3. Research Method

The perception of urban mobility in Yogyakarta City during pandemic COVID-19 2020-2021 is collected by using questionnaires. The respondents are the person who has stayed on the urban area of Yogyakarta City from March 2020 – March 2022. The research focused on the urban mobility of the respondents; (1) push factors that

minimize their mobility, (2) public spaces that they reduce to access, (3) periods/months that they were active on WFH-Online School and WFO-Offline School, (4) period/months they start to actively go to office or school and (5) the first public space they decided to access. The second part of questionnaire is the Likert scale (Risnita, 2012), to collect the perception of respondents of their mobility during the pandemic in 2020 and 2021, for their daily activities in the city scale and local scale (kampung).

Table 1. The variables and indicators of urban mobility aspect in Yogyakarta City

Att.	Variables	Indicators
S1.1.	Local lockdown 2020	Awareness
S1.2.	Urban mobility 2020	Frequency
S1.3.	Reaction to local lockdown 2020	Awareness
S2.1.	City lockdown 2021	Awareness
S2.2.	Urban mobility 2021	Frequency
S2.3.	Reaction to local lockdown 2021	Awareness
S3.1.	Personal adaptation to pandemic	Awareness
S3.2.	Access to public facilities	Frequency
S3.3.	Outdoor activities	Frequency
S3.4.	Traveling time	Time consumed
S3.5.	Public transportation	Frequency
S3.6.	Pedestrian	Frequency
S3.7.	The importance to reduce mobility	Awareness
S3.8.	Reduction on transit	Frequency
S3.9.	Transit access to public facilities	Frequency
S3.10.	Traveling inner the city	Frequency
S4.1.	Work meeting point	Awareness
S4.2.	General mobility from one to another public facility	Frequency

The respondents' requirement had to stay in the urban area of Yogyakarta City during the pandemic in 2020 and 2021. There are 191 respondents: ≤17 years old=15 respondents, 18-22 years old=129 respondents, 23-35 years old=57 respondents, 36-45 years old=4 respondents, ≥46 = 0. The variables with the Likert scale were filtered with Principle Component Analysis (PCA) and were used to build relatedness of their perception of the pandemic COVID-19 in 2020 and 2021 especially on urban mobility; as seen in Table 1. The PCA method calculated the number of Likert scales on each variables and the result is the most related and influential variables and creates the principle component (PC) (González *et al.*, 2018). The new PC will arise the aspects that relates to respondents perspective's scale based on Likert. The PCA method used Kaiser's criterion on total variance, to filter the eigenvalues to find the sum component matrix.

Table 2. The Result of PCA

Att.	PC1	PC2	PC3	PC4	PC5	PC6
S1.1.	-0,045	0,317	-0,051	0,323	0,291	0,436
S1.2.	0,111	-0,020	-0,007	0,800	0,324	0,114
S1.3.	0,060	0,753	0,252	0,021	0,258	0,011
S2.1.	-0,074	0,282	-0,049	0,671	-0,093	-0,101
S2.2.	0,178	0,091	0,016	0,193	0,807	0,003
S2.3.	0,125	0,776	-0,055	0,212	0,069	-0,108
S3.1.	0,576	-0,053	0,077	0,354	-0,041	0,103
S3.2.	0,385	0,401	0,049	-0,112	0,147	0,611
S3.3.	0,131	0,196	0,400	-0,423	0,513	0,133
S3.4.	0,228	0,003	0,747	-0,018	0,181	0,142
S3.5.	0,174	0,327	0,669	0,094	-0,333	-0,196
S3.6.	0,276	0,654	0,296	-0,034	-0,381	0,129
S3.7.	0,601	0,097	0,285	0,142	0,139	0,197
S3.8.	0,722	-0,003	0,147	-0,069	0,045	0,055

S3.9	0,782	0,196	-0,088	-0,273	0,019	-0,099
S3.10	0,821	0,213	0,009	0,039	0,117	-0,131
S4.1.	0,084	0,297	0,191	0,016	0,092	-0,768
S4.2.	-0,055	0,074	0,765	-0,097	0,023	-0,240

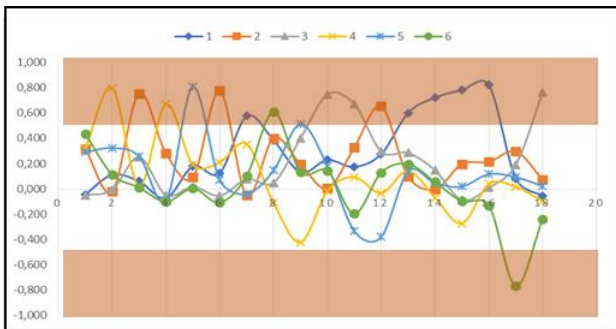


Figure 3. Scatter of Rotated Component Matrix, the Significant Value Is More Than 0.5 as Positive and Negative Value

The PCA result (Table 2), is a rotated component matrix, defined by Varimax with Kaiser Normalization that calculated the weight of variables that form the new principle component. The significant value to build the PC is more than 0.5 as positive and negative values of calculation. The result of PCs are:

$$PC1 = S3.1. + S3.7. + S3.8. + S3.9. + S3.10.$$

$$PC2 = S1.3. + S2.3. + S3.6.$$

$$PC3 = S3.4. + S3.5. + S4.2.$$

$$PC4 = S1.2. + S2.1.$$

$$PC5 = S2.2. + S3.3.$$

$$PC6 = S3.2. + S4.1.$$

4. Results and Discussions

4.1. Work from Home and Urban Mobility

The public has understood the symptom of COVID-19 since the beginning of 2020, but that period was uncertain for all nations. During the first wave of the pandemic COVID-19 in 2020, Work from Home (WFH) started in March and it still accrued until 2021 and 2022. The paper is focused on the 2020 and 2021 WFH issues in Yogyakarta City. Figure 1 shows the months that the respondents chose WFH.

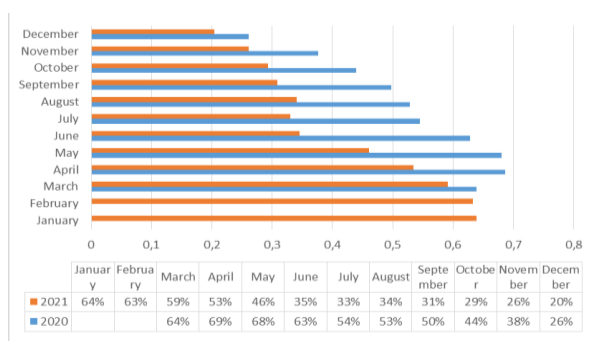


Figure 4. WFH Period of Respondents on 2020-2021

The respondents who choose to WFH the most is in April (69%) – May 2020 (68%) and reduce gradually from June – November 2020 (63%-38%) and significantly go down in December (26%). The result shows that ±30% of respondent was active and still mobile in the urban area. The reason for being mobile was working, and reasons for them to keep WFH were (1) prevention of COVID-19 infection, (2) living in vulnerable neighborhoods, (3) less

information of the pandemic, (4) self-protection, (5) following the government rules (NPIs).

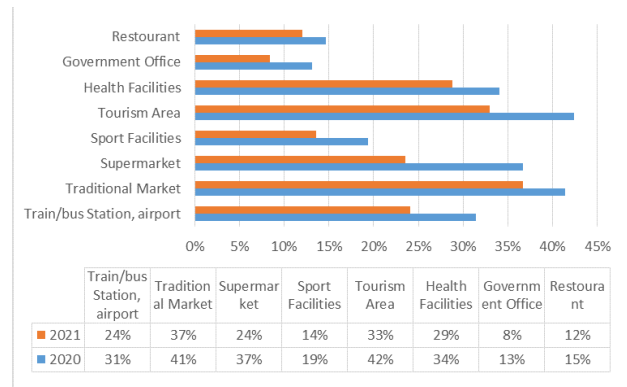


Figure 5. Avoiding Public Facilities during Pandemic COVID-19 2020 and 2021

The respondents mention that they need to access some of the public facilities, to supply daily needs, such as food and ingredients and better internet quality. Figure 3 shows the avoiding public spaces according to the respondent. The most avoided public space is tourism area (42% in 2020 and 33% in 2021) and the reason is crowded, uncontrolled interaction with random people and organic urban mobility. The government office is the least avoided public space because the citizen needs to update their administrative information to access NPIs facilities, in the household scale to the kampung scale. The traditional market (42% in 2020; 37% in 2021) was much avoided than the supermarket (37% in 2020; 24% in 2021). This situation happened because of the age of the most of respondents, the category 18-22 years old is 129 respondents (67.5%). This age was on the senior high school and undergraduate students, they still stay with family and some of them stay in the boarding house and because of this condition, it is rare for them to go to the traditional market. They access supermarket to fulfill their tools for work or study such as stationery, while they buy ingredients for food.

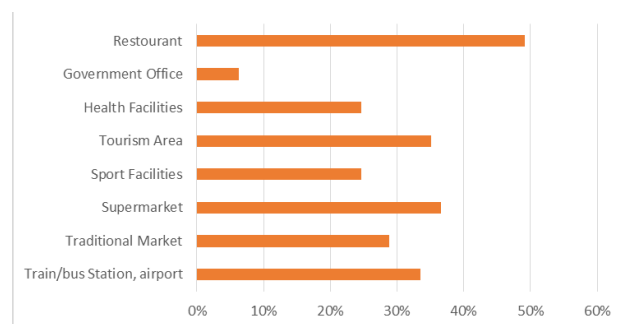


Figure 6. 1st Visited Public Space during Pandemic COVID-19

The chosen destination after WFH is in Figure 4 which shows that the restaurant (49%, 94 respondents) is the most chosen to visit, then supermarket (37%, 70 respondents) and tourism area (35%, 67 respondents). The restaurant is not only for buying food and meals, but also to get better internet quality for working and studying. Surprisingly, train/bus stations and airports also have a high score (34%, 64 respondents); this situation is related to the image of Yogyakarta as an academic city; undergraduate students came from all over Indonesia.

They went home by bus, train and plane especially in December 2020 and 2021 (see Figure 2) and came back to Yogyakarta City in January 2021 and 2022. They came back because they were in the last semester of their degree (Senior High School/University).

4.2. Local Closing Access and City's Traffic Diversion

Yogyakarta City is surrounded by urban kampung. Each kampung has its own rules to interpret the local government policy, especially to gather social cohesion. In 2020, small district leader sent an official letter with general information on NPIs, especially social distancing, movement restriction and public health measurement. Each urban kampung has its action to implement the letter. It reflected the respondent's opinion that during 2020, they had different situation in their neighborhoods.

Table 3. Opinion of NPI's on Urban Kampung Yogyakarta in 2020

No.	NPIs	Respondents		
		Yes	No	Un-confirmed
1.	<u>Health Measure</u> : Clean water and soap in the open/public space around kampung.	45%	44%	11%
2.	<u>Movement restriction</u> : Closed border/junction of the secondary access of kampung to the city's roads.	55%	20%	25%
3.	<u>Social Distancing</u> : Closed all public space in kampung, guarding the main access of kampung to control entry and exit to the kampung.	39%	34%	27%

Even though the kampung has different action in interpreting the letter, the respondents agree that local action is focused on reducing urban mobility. But the actions that had an impact on reducing the dispersion of Corona Virus were still debated, because 56% of respondents agreed that reducing urban mobility has reduced the spreading of the virus; 7% of respondents disagreed about that, and 37% of respondents uncommitted (neutral).

The reasons that make the action is not reducing the dispersion of the virus are: (1) the local passageway because kampung is informal settlement development, (2) the behavior of society was still in progress to be 'new normal stage', (3) the rise of the COVID-19 cases. The reason stated the action is uncommitted to reduce the dispersion of the virus are (1) uncertain information, (2) no COVID-19 cases during 2020 in kampung, (3) not updated on the news and (4) not extremely reducing urban mobility.

The situation in 2020 did not satisfy the terminology of local lockdown, because the implementation is on a small scale of the city, based on community commitment. So, the result of the action is still at a debatable stage in terms of reducing COVID-19 cases, but have a significant impact on reducing urban mobility.

During the 2nd wave of COVID-19 in 2021, the NPIs were enforced at the city level. Some city streets were closed for avoiding mobility to the city centre, and the people who

wanted to go to the city centre need to find open access and move further and cross the officer to report the purpose to the CBD.

Table 4. Opinion of NPI's on Yogyakarta City in 2021

No.	NPIs	Managed by	
		Government	Stakeholders
1.	<u>Health Measure</u> : Clean water and soap and hand sanitizer. Wearing mask	V	V
2.	<u>Movement restriction</u> : Closed border/junction main road, traffic diversion to city center, central Business District	V	
3.	<u>Social Distancing</u> : set the mark for the measurement distance for public.	V	V

In general, the respondents' point of view on the situation is debatable; on the opinion on reducing urban mobility and opinion on reducing dispersion of the virus.

Table 5. Opinion on Urban Mobility & Dispersion of the COVID-19 in 2021

No.	Opinion	Respondents		
		Yes	No	Un-confirmed
1.	The NPIs city level, <u>NPIs reduce urban mobility</u>	32%	10%	58%
2.	The NPIs city level, <u>NPIs reduce dispersing of the COVID-19</u>	37%	20%	43%

The situation in 2021 was different, the NPIs were managed by the government and stakeholders. The government set the official procedure of NPIs. The reason of result on table 5 are: (1) people need to work for economic/financial reasons, (2) different kinds of viruses (delta), (3) people set their appropriate personal NPIs, and (4) the government set a reliable source of information for COVID-19. From the result is seen that the closing and diversion of the road in 2021 is not the lockdown. Same stage as 2020, but on a different level of authorization.

4.3. Principle Component of Urban Mobility during Pandemic 2020 and 2021

Calculations using PCA have been produced 6 Principle Component (see Table 2), and the rotated component matrix according to the weight of connectivity. The 6 PC (Table 6) are (1) Pandemic Mitigation, (2) Urban Access and Circulation, (3) Transportation Access, (4) Urban Activities and Mobility, (5) Community Copying Strategy, and (6) Access to Public Facilities.

Table 6. Principle Component Urban Mobility & Dispersion of the COVID-19 in 2020-2021

PC1: Pandemic's Mitigation	
S3.1	Personal adaptation on pandemic
S3.7	The importance to reduce mobility
S3.8	Reduction on transit
S3.9	Transit access to public facilities
S3.10	Traveling inner the city

PC2: Urban access - circulation	
S1.3	Reaction on local Lockdown 2020
S2.3	Reaction on local Lockdown 2021
S3.6	Pedestrian
PC3: Transportation access	
S3.4	Traveling Time
S3.5	Public Transportation
S4.2	General mobility from one to another public facilities
PC4: urban activities and mobility	
S1.2	Urban mobility 2020
S2.1	City Lockdown 2021
PC5: communities copying strategy	
S2.2	Urban mobility 2021
S3.3	Outdoor activities
PC6: access to public facilities	
S3.2	Access to public facilities
S4.1	Work meeting point

Pandemic mitigation is essential after COVID-19 dispersed around the world. The questionnaire and from PCA, both mention that the mitigation can be built bottom up and top down. In the case of Yogyakarta City, the mitigation was pushed by experience caused by natural disaster, such as flood, earthquake, and eruption of Mouth Merapi. Collaboration between the community of urban kampung, stakeholders and the government happened to support one another. The scheme of collaboration can be seen in Figure 7.



Figure 7. Collaboration during Pandemic on 2020-2021

Urban mobility has a significant impact because of approach of NPIs; social distancing, movement restriction and public health measurement, but it has a low impact on reducing COVID-19 cases. The infection process has a different dispersion method because the character of the virus is a very fast infection, transferred from the air. The NPIs is for limiting connection among human, but once the air is infected, the next is a medical approach. Based on Figure 4, the highest rank of public facilities which have been affected much by the lock down policy are supermarkets, tourism areas, train/bus stations and airports. Based on the taxonomy of urban mobility, it is indicated that the urban mobility in the category of personal movements is significantly decreasing. On the other hand, the amount of people moving to the government office just have a few differences. It shows that the movement categorized as a professional movement that required physical interaction is still done by the people. If it is ranked from the lowest to the highest

amount level of movement of the mobility types within the urban area during the pandemic are: professional movements - pendulum movements - distribution movements - touristic movements - personal movements.

5. Conclusion

Yogyakarta city has local wisdom and works as local mitigation during a disaster emergency. It has been built since the city has a vulnerability to natural disasters. Once again, the collaboration of government, urban kampung and stakeholders (industries, academics and NGO) worked simultaneously to support one another. The action to fulfill the NPIs from WHO are very indigenous, each kampung has its own rules, depending on their local resilience. For the next year, in 2021, the virus can't hold the basic need for living. People went to work, earn and redeem financial distress in 2020.

From the research, the activities and the order of urban mobility are mapped. The reason is also mentioned clearly. These facts can be used as material for urban planning in general, urban mobility planning, urban health planning and structure for mitigation planning. The mobility types frequency decrease from the less to the most: professional - pendulum - distribution - touristic - and personal movements.

The pandemic COVID-19 2020-2021 shows that the uncertain era has come, the readiness is not only for the government system, but it should be built from the grass road, from the potential community of urban kampung. Copying strategy is to work together, people - technology - nature.

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