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COLLABORATIVE DESIGN FOR RESILIENT KAMPONG UPGRADING: EVALUATIVE CONFIGURATIONAL APPROACH FOR SAFE EMERGENCY EVACUATION IN URBAN RIVERBANK KAMPONGS OF YOGYAKARTA, INDONESIA

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Abstract. This research explores the influence of the kampong upgrading plan on flood evacuation route choice behavior by evaluating the morphological scenarios from two urban riverbank kampongs in Yogyakarta City, Indonesia. The author employed a collaborative design workshop with a map to harness stakeholders' knowledge of design/planning ideas and as dialog to develop morphological scenarios of the kampong upgrading. Further, we evaluated and compared the accessibility parameters for each morphological scenario using the space syntax technique to understand the influence of path network configuration and flood evacuation route choice. Four morphological scenarios, namely 1) baseline morphology, 2) street network under flooding, 3) M3K project, and 4) grid-based morphology, have been developed through collaborative workshops. The results suggest that grid-based morphology (comprehensive upgrading) appears to have better accessibility value, which favor better evacuation route choice behavior. However, most stakeholders consider the project utopian, considering the financial, time, and social costs. The M3K project (partial upgrading) has decent accessibility value with slightly improved evacuation from riverbank areas and is generally accepted by all stakeholders. Comparing all morphological scenarios shows differences in the implication of partial/incremental upgrading and comprehensive upgrading on the effectiveness of evacuation route choice. In addition, the research demonstrates and advocate the use of collaborative design workshops as inclusive approaches to planning informal/slum upgrading projects that is geared towards resilience and responsive settlements.

Keywords: *flood emergency evacuation, kampong upgrading plan, space syntax, collaborative design workshop, scenario planning, emergency evacuation plan.*

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1. Introduction

The success of disaster evacuation depends on the robustness of the emergency system (*e.g.*, preparedness and response plan) of the built environment. For riverbank kampongs, a high-density organic/unplanned urban settlement poses significant challenge to pedestrian evacuation, which can be attributed to physical–morphological risk (e.g.,

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narrow street line, irregular street configuration) and vulnerability to its population (Guevara Arce *et al*., 2021; Hutama & Nakamura, 2022). Factors such as human behaviors, community organization/coordination, and human–space interaction have been identified as a key determinant for predicting the required pre-travel, travel behaviors of the evacuation (Wang *et al*., 2021). Without diminishing the significance of these equally crucial factors, this paper assumes the role of spatial configuration and morphology of the built-up environment in defining the degree of accessibility that matters for movement (Hiller & Lida, 2005; Lamíquiz & López-Domínguez, 2015), and more specifically, for an emergency evacuation (Maureira & Karimi, 2017).

Upgrading is an effort to improve the housing quality through provision of basic infrastructure and services targeted to human habitats that are considered slum, deprived, and sometimes included settlement that developed illegally (e.g., squatter/informal settlement) (Satterthwaite, 2012). The impact of settlement upgrading through physical intervention in global south cities evidence to be improved in quality of life, has positive effect on perceived safety (Naceur, 2013), as well as promote sustainable society and environment (Uzun & Celik Simsek, 2015). However, the current upgrading plan often neglect disaster risk reduction effort particularly a resilience of emergency system that govern safe evacuation. Planning and designing neighborhood spaces focusing on the emergency system can promote better preparedness and readiness for disaster events (Fisher *et al*., 2012). An emergency system of a neighborhood is broadly used to refer to the operability of a neighborhood's social and physical strategic infrastructure to assist in an emergency (Giuliani *et al.,* 2020). Efforts to build robust emergency system required planning and design strategies such as connecting or rearranging street network, provisioning of multipurpose open space, defining place for shelter/emergency center, and route planning for evacuation.

In line with the popularity of community disaster resilience, urban resilience theory, and vow to pursue SDGs chapter 11, the upgrading policy have been transformed from a typical incremental upgrading to reduce slum settlement to upgrading policies that embed a mindset to shape sustainable community and resilience neighbourhood (Du *et al.,* 2022). Scholars advocates that upgrading policies must address hazard, risk, and vulnerability of population to define the scope of upgrading and types of spatial intervention to reduce risk and vulnerabilities (Abunyewah *et al.*, 2018; Menshawy *et al*., 2011) . Accordingly, Satterthwaite et al., (2020) conceptualize the seven ladders of different form of informal settlement upgrading from eviction (bottom ladder/level one) to transformative upgrading (the top ladder/level seven). To achieve resilience, it is suggested that the upgrading form level six, namely "the comprehensive community-led upgrading with resilience lens", is needed because it covers upgrading that not only possible to make social change but also spatial arrangement improvement that aimed at disaster risk reduction.

Integrating resilience of emergency system onto "Kota Tanpa Kumuh" or KOTAKU for short (translated to *city without slum*) are urgent for constructing the resilient kampong. KOTAKU is an Indonesian national policy that targets to develop, improve the housing infrastructure and basic services, and reduce the informal/slum settlements through collaborative project (KOTAKU, 2021). However, the planning and design process toward project implementation lacks deliberate participatory process with local actors who possess spatial knowledge of the community and the uniqueness attributes of the kampong space (Akbar *et al*., 2020). Prior to the initiation of kampong upgrading the plan to designated case, conducting collaborative design process is necessary for inquiring the stakeholders' knowledge regarding the types of

planning/design strategies and selecting the possible scenarios based on the consensus disaster evacuation among stakeholders. By embedding the context of disaster resilience within the collaborative workshop, the KOTAKU projects can be streamlined to reduce the slum area as well as develop resilience and more responsiveness to the kampongs through place-based design projects.

The objective of the paper is to explores the implication of the kampong upgrading plan has on flood evacuation route choice behavior by evaluating the morphological scenarios from two urban riverbank kampongs in Yogyakarta City, Indonesia. This research build based upon the assumption that the network effect of the spatial configuration (kampong's morphological scenarios) influences different levels of accessibility that govern how evacuees choose evacuation route and exit gates. We employed a collaborative design workshop as a method to harness the planning and design ideas to develop morphological scenarios for kampong upgrading plan by soliciting the stakeholder's knowledge on specific inquiry themes (*e.g.*, flood evacuation, route choice preference, and resilience kampong). Twelve participants representing the governments, lecturers, and practitioners in urban planning and architecture, as well as the local actors involved in one-day workshop, yielded one baseline morphology, one spatial morphology under flooding, and two morphological proposal namely M3K project and land readjustment project. In addition, we compared accessibility analysis of each morphological scenarios using space syntax technique to provide evidence on how spatial layout might influence the evacuation route choice behavior and robustness of spatial resilience during emergencies.

2. Research Method

This research conducts qualitative evaluation on the implication of morphological scenarios of kampong upgrading plan has on the route choice behavior on flood evacuation. Saving human life is the utmost important effort in saving human life that needs to be addressed in the planning process of kampong upgrading. The prediction of people's movement during evacuation requires further attention as it has a close relationship with the spatial configuration (arrangement of kampong's street network) that matters in kampong upgrading plan. The development of morphological scenarios is based on various considerations such as planning policy and regulations, and various references (e.g., studies, design, planning documents) and it is built upon the empirical survey on existing street network and physical condition in kampong. As illustrated in methodological framework in figure 1, the process start with generalization of scenarios through collaborative design workshop that produce narrative (text/transcription data) and spatial data. The method encompasses two analysis: first qualitative (narrative) analysis to understand the associated or implication of planning and design strategies of kampong upgrading on route choice behavior. Second, quantitative analysis on the comparison of accessibility parameters underlying morphological scenarios and interpretation of accessibility map (as results of space syntax) to understand the implication of route choice behavior on kampong upgrading scenarios. The approaches provide robust evidence that could support the decision-making process whether the kampong upgrading plan is shifted to more or less resilient and responsive kampong.

2.1. Description of Case Study

In Indonesia, urban kampongs refer to self-organized community that emerged gradually and organically in interstitial or marginal urban spaces (*e.g.*, riverbanks, along railway lines), which are often typically stigmatized as a place for low-income dwellers and sub-standard quality of housing infrastructure (Kusno, 2020). The condition is true, especially for riverbank kampongs, which have been grown informally over time through a process of collective adaptation and assemblage (Dovey & Raharjo, 2010; Hannigan *et al.*, 2018). In addition, the dearth of an appropriate development plan and inadequate disaster mitigation infrastructures exposes riverbank kampongs to recurrent disaster risk (Jousset *et al*., 2013).

This research conducted two case studies of urban riverbank kampongs in the city of Yogyakarta, Indonesia to elucidate the similarities and differences in planning and design strategies pertaining to the emergency system for evacuation. The first case, Kampong Terban, is recognized as an informal riverbank kampong situated in code riverbank and is registered as a slum settlement by municipality. Owing to its strategic location in between major university and business district, the kampong is highly populated with 4057 settlers residing in 15.47 ha, among which 4.14% (168 settlers) are disabled (*i.e.*, physical, visual impairment, mental illness). The kampong is not just a settlement. It is a vibrant kampong with mixed functions, mainly from an informal home-based business where activities often encroach over the street spaces. These informal kampongs are characterized by high population density (262 settlers/ha), irregular street patterns, 2–3 floor houses with small plots, and narrow paths less than 2 m in width. This physical pathology of the kampong space creates a mobility issue during emergency evacuation, especially for the vulnerable segment of the demographic (elderly and disabled settlers).

The second case, Kampong Bener, is a semi-planned riverbank kampong situated at the north-west outskirts of Yogyakarta. In contrast to the previous kampong, Kampong Bener initially emerged as a rural village with vernacular houses, and gradually integrated with the city's spatial structure. Kampong is a settlement of 3824 people and comprises areas of 19.23 ha. In total, 118 people (3.08%) disabled individuals have been recorded by the local authorities. The prominent characteristics of this urban fringe riverbank kampong is that it exhibits low population density (193 settlers/ha), houses with large plots and yard, adequate open space, and grid-like street layout, with wider streets (3–5 m). Although this kampong is relatively more developed, the absence of any local authority controlling and regulating the riverbank areas, new settlers occupied and erected permanent houses in low-lying areas that are prone to flood.

2.2. Data Collection and Analysis

We employed a mixed method to collect ground truth data and stakeholders' knowledge. This method included a 1) semi-structured interview, 2) collaborative design workshop, and 3) computational space syntax analysis.

2.2.1. Semi-structured interview

Prior to initiating the design workshop, we conducted semi-structured interviews of 16 stakeholders and community members to acquire first-hand information pertaining to the present and future plan of the kampong. We employed purposive sampling to select appropriate respondents based on the interviewee's role (e.g., head of kampong's

neighborhood and community unit) and knowledge related to complexities of emergency issues of riverbank settlement (e.g., government official in relevant divisions). As the data source, we used open-ended questions to obtain the elaborate information from the settlers' perspective (Bryman, 2012). In particular, inquiring the kind of design/planning strategies, considerations, and consequences over the designs were major questions in which stakeholders should elaborate either in direct explanation (*e.g.*, researchers record their answer) or in a map (respondents manually sketch onto a printed map). Interviews sections are essential because it can create a feeling of openness through which respondents can express their ideas without a sense of reluctancy over other's sentimental judgment.

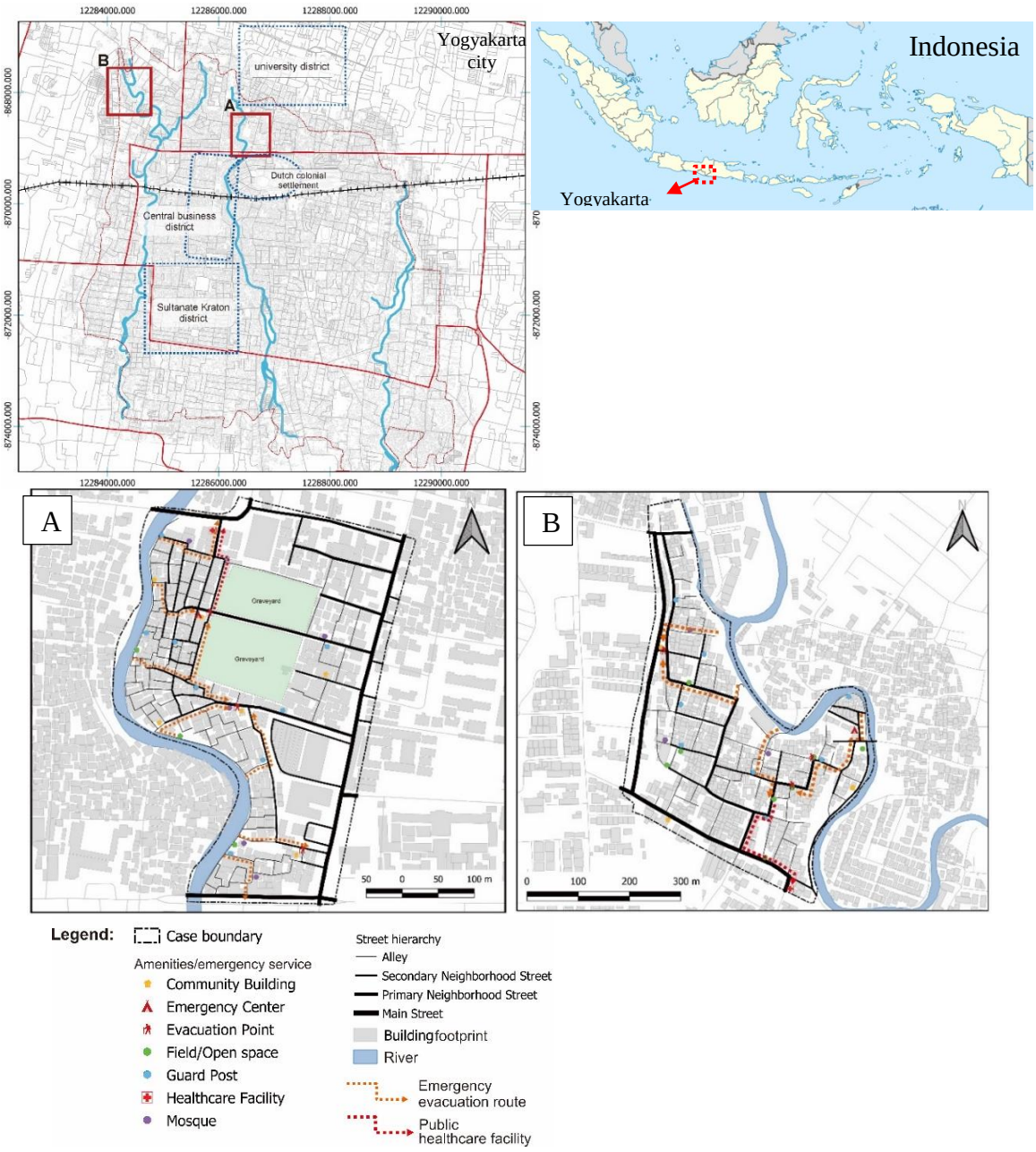

Figure. 1. Case study area of urban riverbank kampongs with an existing emergency function and evacuation plan for riverine and lahar flood disaster. A) Kampong Terban and B) Kampong Bener

The acquirement of responses was transcribed into text. We applied a qualitative content analysis with coding techniques to scrutinize the interviews and enumerated the minutes of the meeting of the workshop and interview (Bryman, 2012). The participants' excerpts were contextually used to support the evidence for developing the scenarios and illustrating the dynamic interactions among the stakeholders.

2.2.2. Collaborative design workshop

We adopted a collaborative design workshop to generate a wide array of ideas of an ideal design and plan the kampong upgrading program. Prior research has implemented workshops in the field of planning and design with contextual design and collaborative/participatory design (Beyer & Holtzblatt, 1998; Kunze *et al*., 2011; Ørngreen & Levinsen, 2017). Specifically, the workshop is advantageous because it provides means to understand complex process of design and planning by developing collaborative and consensus between the participants and researcher. The interactive distribution and production of thoughts through contextual inquiries can significantly increase the success of the design proposal, especially for dealing specific socioeconomic group or space settings such as informal kampongs (Satterthwaite, 2012; Some et al., 2009). The negotiation of planning and design proposal for KIP needs considerations from stakeholders as well as community members, wherein the workshop excels in streamlining the ideas into developing multiple scenarios.

Figure. 2. Process of conducting design workshop in UGM (left images), hand-drawn conceptual sketch of the design and planning proposal (right image), and semi-structured interview (bottom images)

On 8 November 2022, a one-day hybrid workshop was conducted in Universitas Gadjah Mada (UGM), Yogyakarta, Indonesia. The first author acted as the workshop leader, guiding workshop activities with the assistance of two final-year college students to record and type the minutes of the meeting of the workshop, which were employed in further analysis. Materials such as A0 printed base map, sticky notes, projectors, and colour pens were used to directly express the design ideas onto the map. The workshop participants were pre-selected based on the representativeness of each group of

stakeholders (refer to Table 1). The selection of participants represents the interest and power of the KIP toward government sectors (participants ID.01–06), professional/academician in the field of architecture/planning/urban design (ID.07–09), and local actors as member of kampong's community (ID 10–12).

During the workshop, the author introduced the participatory design for upgrading the kampong and cited the examples of best practices (design & planning precedents), which elucidated the results from the previous research (Hutama & Nakamura, 2022) to provide the overall idea and objectives of the current research with the goals of the present workshop: 1) inventorying design and planning strategies for kampong upgrading; 2) assessing the degree of acceptance or rejections; 3) developing scenarios for kampong upgrading plan. Furthermore, to facilitate the generation of ideas from participants, we employed an appreciative inquiry approach (Reed, 2007) by inquiring the opportunities and aspirations of the stakeholders for improving the quality of life at the respective kampongs instead of focusing on the problem-based solutions. After inventorying design and planning strategies, the participants were inquired for their response using the Likert scale (+2 for totally agree, 0 for neutral, and −2 for totally disagree), expressing their level of agreement and disagreement toward the ideas (refer to Table 2). These assessments were used to evaluate the creation of design scenarios.

Table. 1. List of Design Workshop Participants for Kampong Upgrading Plan

Partici-pant ID	Initial name	Position	Organization
01.	D.Y.S.	Head of spatial planning division	Land and Spatial Planning Office of Yogyakarta
02.	S.N.I.	Head of regional infrastructure and development	Regional Development Planning Agency of Yogyakarta
03.	B.W.	Head of disaster preparedness and response	Municipal Disaster Management Office of Yogyakarta
04.	S.S.	Head of housing and settlement division	Public work, housing, and settlement office of Yogyakarta
05.	R.A.N.	Head of open space management	Environmental agency office of Yogyakarta
06.	E.R.	Urban and regional planner/consultant	Certified urban planner of Indonesian Planning Association
07.	A.H.	Urban planning lecturer	Universitas Gadjah Mada
08.	A.F.G.	Architect and urban designer/consultant	Private consultant
09.	W.C.Y.	Architect lecturer	Yogyakarta University of Technology
10.	A.R.	Head of Disaster Resilience Kampong Terban	Resident of riverbank kampong
11.	S.P.	Head of RW 05 of Kampong Terban	Resident of riverbank kampong
12.	W.S.	Former head of RW 03 of Kampong Bener	Resident of riverbank kampong

2.2.3. Configurational analysis by means of space syntax

Four scenarios comprising various spatial configurations of the kampongs were analyzed using the space syntax technique. Space syntax evaluates the relation between a space to any other spaces in a set of spatial network configuration, inferring the degree of centrality known as *connectivity*, *integration*, and *choice* (Karimi, 2012; van Nes & Yamu, 2021). Research tradition in space syntax demonstrates that spaces/streets with

high degree of accessibility are correlated with actual movement (both pedestrian and vehicular) (Hiller & Lida, 2005; Ozbil *et al.*, 2016). In disaster research, the syntactic values of space syntax can highlight potential route choice of movement from complex street configurations, which suggest alternative evidence for improved decision-making of evacuation scenarios. In addition, the syntactic value of space syntax can be regarded as a near proxy to understand the resilience of a neighborhood's spatial system (Cutini & Pezzica, 2020).

Accordingly, four space syntax parameters were used to evaluate the accessibility of street network configuration. Furthermore, we employed angular segment analysis (ASA) to measure the *angular integration* and *angular choice*. The adoption of ASA to the street as an intersecting segment (segment map) measures the angular changes as cumulative cost for moving from one segment to the other (Turner, 2003). The least angular deviation of the street configuration is correlated with the conscious tendency of citizens traveling and selecting routes by conserving the linearity of the street network (Dalton, 2003; Hillier, 2012). This underlying idea supports the evaluation of the emergency spatial system in which dwellers can safely and accurately evacuate through a set of network configurations in kampong. The syntactic parameters of space syntax are explained as follows (refer to van Nes & Yamu (2021) for formulation and calculation):

a. *Connectivity* (C): count the number of immediate access (streets/spaces) in direct vicinity; higher connectivity indicates higher potential of space to be accessed from the nearby vicinity.
b. *Mean Connectivity:* measures the mean value of a path with immediate connection with other paths segment.
c. *Normalized angular integration* (NAIN): measures the shortest distance of street segment with relation to other street segments. The street segment with higher integration could be easily accessed from all possible points of origin and destination. The integration map can express the potential of street segments as destinations within the spatial configurations.
d. *Normalized angular choice* (NACH): measures the likelihood that selected street segments will be traveled as route choices with relation to other street segments based on the shortest path between all possible pairs of segments within the selected distance. NACH map can identify the potential route choices for pedestrian/ or vehicular movement. In this research, we measured global metric radii (the kampong's spatial system).
e. Frequency index (*f*): measures the ratio between the maximum actual choice in the set of the segment map and the maximum value that can be virtually reached. The (*f*) index ranging between 0 and 1 represents the resilience of the spatial system as (*f*) tends to 0; otherwise, it is vulnerable if the value tends to 1. The system tends to be resilient by diffusing the shortest paths all over the spatial grid rather than concentrated through limited network elements. The frequency index was evaluated using the formula originally developed by Cutini (2013).

In this research, both angular integration and angular choice values were normalized to avert the dispersion of geographic size effect of spatial configurations (Hillier et al., 2012), thereby enabling the comparison of syntactic results for both kampongs. The street network configurations for all scenarios were analyzed using Depthmap-X on a GQIS platform.

3. Results

3.1. Stakeholder's ideas towards planning and design strategies for kampong upgrading plan

Planning and design strategies for KIP can be categorized into spatial (tangible planning and design) and nonspatial (intangible). In total, 11 spatial and 4 nonspatial planning/design strategies were generated from design workshop. Each strategy exhibited various sentiment as perceived by stakeholders in green to red color (refer to Table 2). Among the spatial strategies, creating new street network to the riverbank areas, revamping street network layout, creating river buffer zone as flood mitigation strategies as well as a space for social activities, placing evacuation route sign in main streets and intersection, and rehousing riverbank settlement to low-rise row houses (*kampong deret)* are certain approaches that can be implemented. These strategies concern the transformation of physical fabric of kampong's space for better response and preventing shock during emergency. For nonspatial strategies, certain ideas focus on strengthening the community organization of disaster resilience kampong, which are responsible for managing and activating the emergency preparedness and response plan, allocating a special budget allocation for disaster risk reduction, and rejuvenating the early warning system. Although both strategies are equally important, for the purpose of this research, we focused more on the spatial design/planning strategies for the development of the kampong upgrading scenarios.

Table. 2. Inventories of kampong upgrading/redevelopment strategies based upon collaborative workshop and its sentiment analysis

Upgrading/Redevelopment strategy	Actors/Stakeholders									Types of strategy
	Planner / lecturer	Architect and urban design	Gov: (Disaster Management Authority)	Gov: (Land and Spatial Planning Authority)	Gov: (Public work, housing and settlement)	Gov: (Environmental agency)	Gov (Regional and Development Planning Agency)	Local actors: Kampong Terban	Local actors: Kampong Bener	
Land readjustment (re-layouting into grid pattern , and organized building footprint)	✓	✓	~	✓✓	✓	~	✓	×	××	Spatial design /plan
Re-housing riverbank settlers to high-rise/vertical social house	✓	✓✓	~	×	×	~	~	××	××	
Re-housing riverbank settlers to low rise row house ("kampong deret")	~	✓	~	✓✓	✓	✓	~	✓	~	
Extending and widening the riverbank path for 3 meter width and orienting building facing to the river (river front)	~	✓✓	✓✓	✓	✓✓	✓✓	✓	✓✓	✓✓	
Creating an evacuation corridor for 3 meter width without changing existing spatial laout	✓	✓	✓✓	✓	✓✓	~	✓	✓	✓	
Evacuation signage at crucial coridor and intersection	✓	✓	✓✓	✓	✓	~	~	✓✓	✓✓	
River naturalization with 10-15 meter buffer zone and built dike	✓✓	✓	~	~	~	✓✓	~	××	××	
Raising the height of embankment wall to protect from riverine flood and lahar flood	✓	✓	✓	✓	✓	~	~	×	××	
Adopt universal design for people with disability/difficulties to perform better evacuation	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	
Manage the maximum of 3 storeys building heigh in kampong, especially in riverbank areas	~	✓	~	✓✓	✓✓	~	~	✓	✓	
Improve connection by adding short-cut to high ground and built bridge to neighbouring kampong	✓	✓	~	~	~	~	~	✓	✓✓	
Reinforce the existing flood barier (gabion) and the protect the cliff to mitigate potential landslide	✓	✓	~	~	✓	~	~	✓✓	✓✓	
Rejuvenate emergency action (evacuation) plan with map	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	Non-spatial plan
Rejuvenating and improving creadibility of early warning system	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓✓	
Strengtening community based organization (KTB) with training	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	
Allocating special budget allocation from "Dana Istimewa" to improve KTB performace in DRR	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	

Note = ✓✓: completely agree; ✓: agree; ~: no opinion/ neutral; x: disagree; xx: completely disagree

The sentiment analysis exhibited that the majority of government stakeholders agree to various strategies given the ideas mostly emerged from the government side and it is supported by planner and architect. Moreover, the local stakeholder heavily opposed certain programs such as land readjustment approach, rehousing to high-rise vertical public housing (5-story public walk-up flats called RUSUNAWA), river naturalization, raising the height of embankment wall as the primary barrier for flood/lahar flood. Interestingly, the government side from spatial planning and public work offices displayed a negative sentiment toward rehousing strategy from low-rise landed houses to high-rise housing tower. This in line with Jones (2017) elaborated that this housing typology are incompatible with the dwellers' current lifestyle which strongly rooted with an informal and highly adaptable space for socioeconomic purposes.

3.2. Scenarios analysis and stakeholders' perspectives

The present-day kampong's spatial configuration was used as starting point to generate design ideas for kampong upgrading based upon the design workshop. A new map has been created by adding, removing, and altering the streets layout and geometry based on the stakeholders' decision during the workshop. Apart from this, the development of scenarios considered wide range considerations consisting of city planning document and law, housing policy, land-use regulation in riverbank areas, and disaster mitigation and contingency plan. Four scenarios are described as follows: (refer to black and white upper image in Figure 4 and 5):

1. Scenario 0: Baseline morphology

The present-day spatial configuration portrays the intrinsic risk of streets for emergency evacuation (e.g., narrow paths, irregular dendritic pattern). For informal kampong, Kampong Terban is observed as a slum and irregular/chaotic space by government officials, but from the perspectives of local actors, it's lively and self-sufficient. In comparison, Kampong Bener exhibits a contrasting spatial configuration with a clearer grid-like pattern.

2. Scenario 1: Street network configuration under disruptive event.

Scenario 2 covers at the kampong's space under disruptive event caused by riverine flood and lahar flood hazard and human activities. Riverine flood and lahar flood extend map were used to delineate the dysfunctional street network (Hutama & Nakamura, 2022). In addition, for Kampong Terban, spontaneous social activities and regular cultural events are often held on streets, blocking certain street segments, and urging dwellers to reroute through other streets. These conditions were not an issue in Kampong Bener as it includes adequate open space for hosting sociocultural events. All street segments affected by the flood/lahar flood were removed/disconnected from whole spatial system under scrutiny.

3. Scenario 2: Connecting riverbank paths to main road through M3K project.

The M3K project literally translates to *step-back, going up, and overlooking the river*; it is a community/grassroot idea that has currently been adopted by municipal government as a part of the KOTAKU. The M3K project is currently implemented in Kampong Terban and is planned for Kampong Bener in 2025. The main design consideration for the M3K project are as follows: 1) provides new access to nearby riverbank with 3 m width of paths ("*Step-back*"); 2) if houses block the construction of riverbank paths, the house owner must surrender a portion of their housing space, and in return, the government will erect the portion of house into upper floor as a compensation ("*going*

up"); 3) the houses must face the river ("overlooking the river"). In terms of spatial configuration, this plan will provide two major accesses from the main arterial road to the riverbank paths, which can improve accessibility and disaster preparedness.

However, the irregularities and narrowness of street width within the kampong may still hinder pedestrian evacuation. Providing 3 m of paths near the riverbank in a way might improve the access but considering the proximity to the river, this path poses its imminent risk to riverine and lahar floods. As elaborated by ID.08: *"the plan and design of riverbank path and riverfront areas must consider the mobility during emergency, the access to riverbank paths will not sufficiently support mobility for evacuation, especially for vulnerable people—government can alternatively support with agile small vehicle such as three wheels cargo motorbike which can roam and carried away vulnerable evacuees through narrow alleys."* As realized by other participants, a safe and reliant evacuation path is an essential design proposal for the upgrading program. As suggested by the ID.03 and ID.04: *"widening the main evacuation path for 3-5 m width for primary neighborhood street is the win–win solution for both parties to cope with the mobility issue and promote disaster resilience in the kampong as dictated by national housing street guideline*[†]*."* All workshop participants including the local actors agreed to this M3K project as it is a moderate scenario with consensus.

4. Scenario 3: Spatial re-configuration through land readjustment project.

Upgrading the riverbank kampong through land readjustment project aims to revitalize the kampong space quality and strengthen its disaster resilience. This plan was initialized by the government (especially Land and Spatial Planning office) as a comprehensive approach of resolving land-use problems (e.g., illegal status of land ownership), formalizing slum settlement, and disaster mitigation in the kampong. To implement the project, the local government conducted a pilot study as a case study on the informal riverbank kampong to examine the potential location, dweller's perception, and behavior of the kampong's residents toward land readjustment. The results suggested that one community unit of riverbank kampong in Yogyakarta city is willing to commit land readjustment as part of the kampong upgrading scheme. As such, vital points from the study included 1) re-configuration of kampong spatial layout into gridiron pattern; 2) provide an adequate green open space for multiple purposes; 3) provide open space for river buffer zone for flood risk reduction (Public Work, Housing and Settlement Office, 2021). Based on the workshop, "t*he project is seen as pioneer applied for high-density riverbank kampong which not only fix the slum/informality issues of the settlement but also as a means to implement spatial planning of the city*" (participant ID.03; ID.04). The initial study of kampong revitalization became a major reference for the development of the fourth scenario.

The dynamic interactions between the stakeholders during design workshop displays agreement and disagreement toward land readjustment. The government mostly agreed that the project will benefit the dwellers in terms of social and spatial capital. However, disputes were encountered from local actors (dwellers representatives) that believed the project as radical because revamping the spatial layout and building footprint that has been erected for decades are financially expensive, involves time constraints, and social cost (e.g., loosen social bond). Furthermore, the majority of Kampong's residents should be temporarily relocated to affect their livelihoods. As responded by ID.10 & ID.11: *"The plan seems great, but I would say that most of the dwellers will reject the*

[†] Ministry of Public Work and Public Housing law no:16/SE/DC/2020 regarding the technical street design guideline for housing and settlement development.

project immediately since they know that it sacrifices a lot of things (e.g., livelihood) and it required a long period of time to implement–during the implementation we need to be relocated somewhere somehow." The planner and lecturer support this idea with caveats that the land readjustment must be viewed as a collective goal by which the community must be prioritized over the physical design and without violating the planning regulation (ID .07).

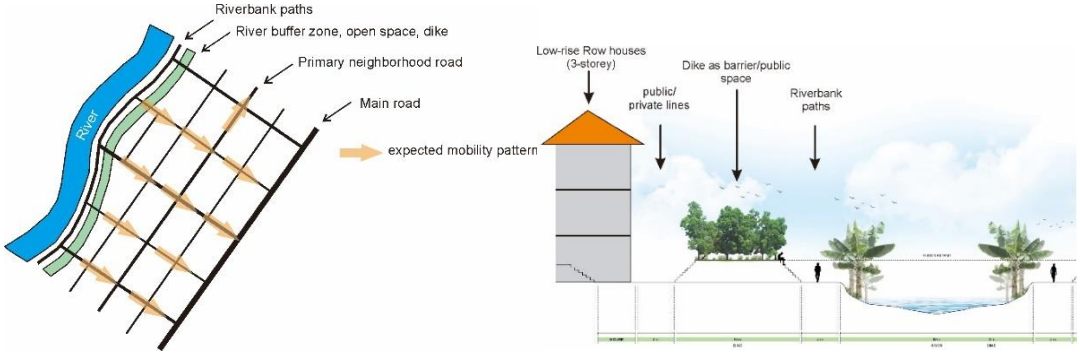

Figure. 3. Digitized conceptual design sketch of scenario 3: gridiron street layout improves accessibility and direct movement from riverbank path to main street

For a planner and architect, land readjustment is a way to controlling the riverbank and creating river buffer zones with a dike to reduce the flood risk and provide open spaces for social activities (ID 07; 08; 09). As such, all stakeholders agreed to control the building code after land readjustment and reshape the high-density single house to low-rise row houses (3-story row houses or in local term it called "*kampong deret*"). The local actors supported this idea because the kampong' dwellers were not motivated to live in high-rise social housing that confines their seamless social interaction and the use of land for informal economic activities. Ultimately, the proposal for land readjustment adopted a gridiron design pattern with wide alleys/paths, e.g., 3 m for secondary and 5 m for primary neighborhood street (Figure 3). This scenario was applied only for Kampong Terban, but no such urgency was observed for Kampong Bener. In summary, proposing the spatial re-configuration through land readjustment applied to informal kampongs will eventually improve accessibility and facilitate the pedestrian movement required for disaster emergency evacuation.

3.3. Morphological analysis of kampong upgrading using Space Syntax

Four scenarios considering multiple street network configurations were evaluated using space syntax accessibility parameters, namely, connectivity (CONN), NAIN, NACH, and frequency index (*f*). We compared the syntactic values of all scenarios to describe the variations in spatial morphology into a potential evaluative approach to facilitate more informed decision-making for emergency evacuation planning (Table 3).

For informal Kampong Terban, the present-day configuration (T-Sc0) highlights the potential movement (*mean* NACH: 0.841) and degree of integration (*mean* NAIN: 0.801), which are mostly shaped from the primary neighborhood street connecting the inner territory to the exit/entrance of the kampong. The alleys and riverbank path exhibit the least NACH and NAIN value in actual condition, which portrays the segregated spaces between the riverbank and inner areas of the kampong. Connectivity as a form of

local accessibility is nonuniformly distributed, despite the greater number of street segments in the kampong. Although a higher number of segments connected to each other, most segments eventually connect to the main street segments (core streets), which can be related to the resilience issue of the spatial system. The street configuration under the disruption (T-Sc1) indicates that the impassability of the street network near riverbank regions significantly reduced the actual accessibility, as indicated by *mean* NACH: 0.797 and *mean* NAIN: 0.683. Nonetheless, the value of NACH *max*: 1.475 under disruptive events implies the highest syntactic value compared to all scenarios. This signifies that the street networks requiring to be removed for space syntax analysis (i.e., street network that disrupted/impassable owing to flood/lahar flood) are the types of streets that are composed from short-sharp turn segments and branch-like lines depicting the dendritic street pattern. These streets near the riverbank areas are segregated street segments that are commonly part of the characteristic informal settlement (Alghatam, 2019; Hutama, 2018). Compared to all scenarios, T-Sc1 exhibited the lowest *mean CONN* value by 3.282, indicating the reduced to immediate neighboring access of segment to another segments for movement selection. This explained that the *frequency index* accounted for the highest value (*f*: 0.594), indicating the vulnerability of the street system under flooding.

For T-Sc2, the implementation of M3K project will improve the overall accessibility value (*mean* NACH: 0.865 and *mean* NAIN: 0.851). These values suggest that more riverbank street segments will likely be selected for pedestrian movement, given that the least angular complexity of street network has been established as a new direct connection from the riverbank to the main streets. Lastly, the land readjustment scenario (T-Sc3) results in the highest accessibility value (*mean* NACH: 0.997 and *mean* NAIN: 1059), which can be addressed to the correction of the street layout from the dendritic to gridiron pattern enabling the pedestrians or evacuees to traverse in a straight direction to the exit/entrance gate, in addition to fixing the segregated line segments typically located at the neighboring riverbanks. This scenario resulted in the highest *mean connectivity* value by 4.218, thereby enabling multiple route choice from one street segment to any other adjacent streets. Both T-Sc2 and T-Sc3 possessed lower *frequency index* (*(f):* 0.300 and *(f):* 0.299) suggesting that the expanding street network to the riverbank and or re-adjusting the spatial layout can yield a more resilience spatial system.

Table. 3. Syntactic value of space syntax analysis for all scenarios

SSX configurational parameters	Kampong Terban				Kampong Bener		
	T-Sc0	T-Sc1	T-Sc2	T-Sc3	B-Sc0	B-Sc1	B-Sc2
street segments (N)	355	262	353	320	209	168	225
Connectivity (*min*)	1	1	0	1	1	1	0
Connectivity (*max*)	6	5	6	6	6	6	6
Mean connectivity	3.500	3.282	3.500	4.218	3.416	3.480	3.387
NAIN (*min*)	0.443	0.378	0.467	0.693	0.425	0.446	0.418
NAIN (*max*)	1.165	0.993	1.197	1.388	1.019	1.199	1.116
NAIN (*mean*)	0.801	0.683	0.851	1.059	0.779	0.848	0.795
NACH (*min*)	0	0	0	0	0	0	0
NACH (*max*)	1.454	1.475	1.430	1.460	1.386	1.458	1.374
NACH (*mean*)	0.841	0.797	0.865	0.997	0.870	0.857	0.886
Frequency index (*f*)	0.366	0.594	0.300	0.299	0.328	0.424	0.311

Move to semiformal Kampong Bener, the space syntax analysis for all scenario map results in various syntactic values with the most noticeable differences are the scenario of street network under disruption of flood (B-Sc1) and the implementation of M3K project (B-Sc1). Under disruptive event, the impassable street network reduced the accessibility value of mean NACH: 0.857 suggesting that the linearity of streets segments to be selected for movement decreased owing to flooding. In contrast, the accessibility value in terms of *mean* NAIN increased slightly to 0.848 compared to present configuration (B-Sc0). For the M3K project (B-Sc2), the idea of connecting riverbank paths directly to either higher ground or dead-end street segments resulted in slightly increased accessibility value of *mean* NACH: 0.886 and *mean* NAIN: 0.795. For the *frequency index*, the spatial configuration of B-Sc1 exhibited the lowest value (*(f): 0.311)*, indicating that the resilience of spatial system increased after expanding the connection through the riverbank paths. All scenario maps of the space syntax analysis for both cases (map in max values with divergent color palate from blue to red color indicating weaker and higher accessibility) are depicted in Figures 4 and 5.

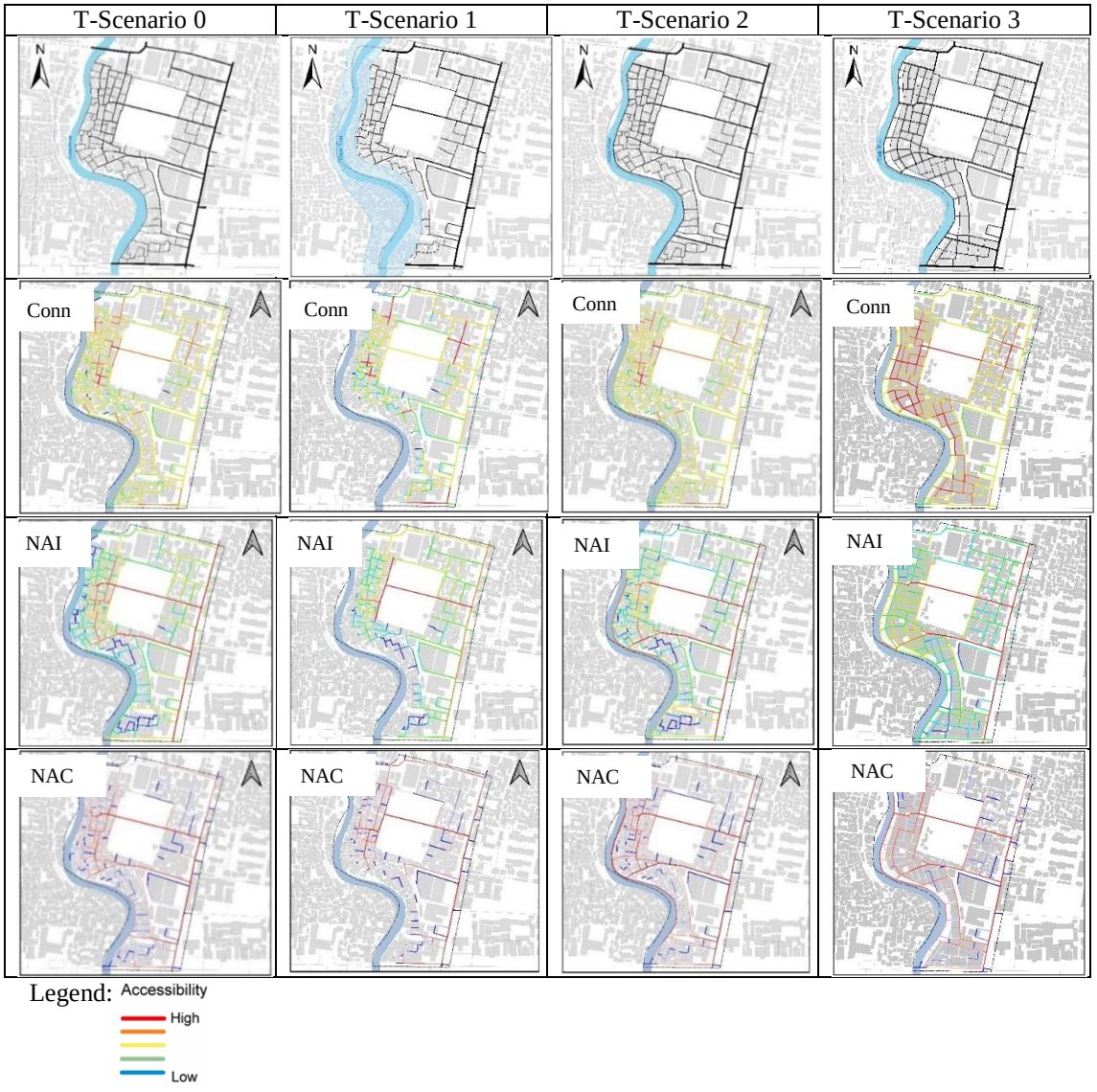

Figure. 4. Syntactic map of Scenario Analysis for Kampong Terban
(shows Connectivity, NACH, NAIN indices)

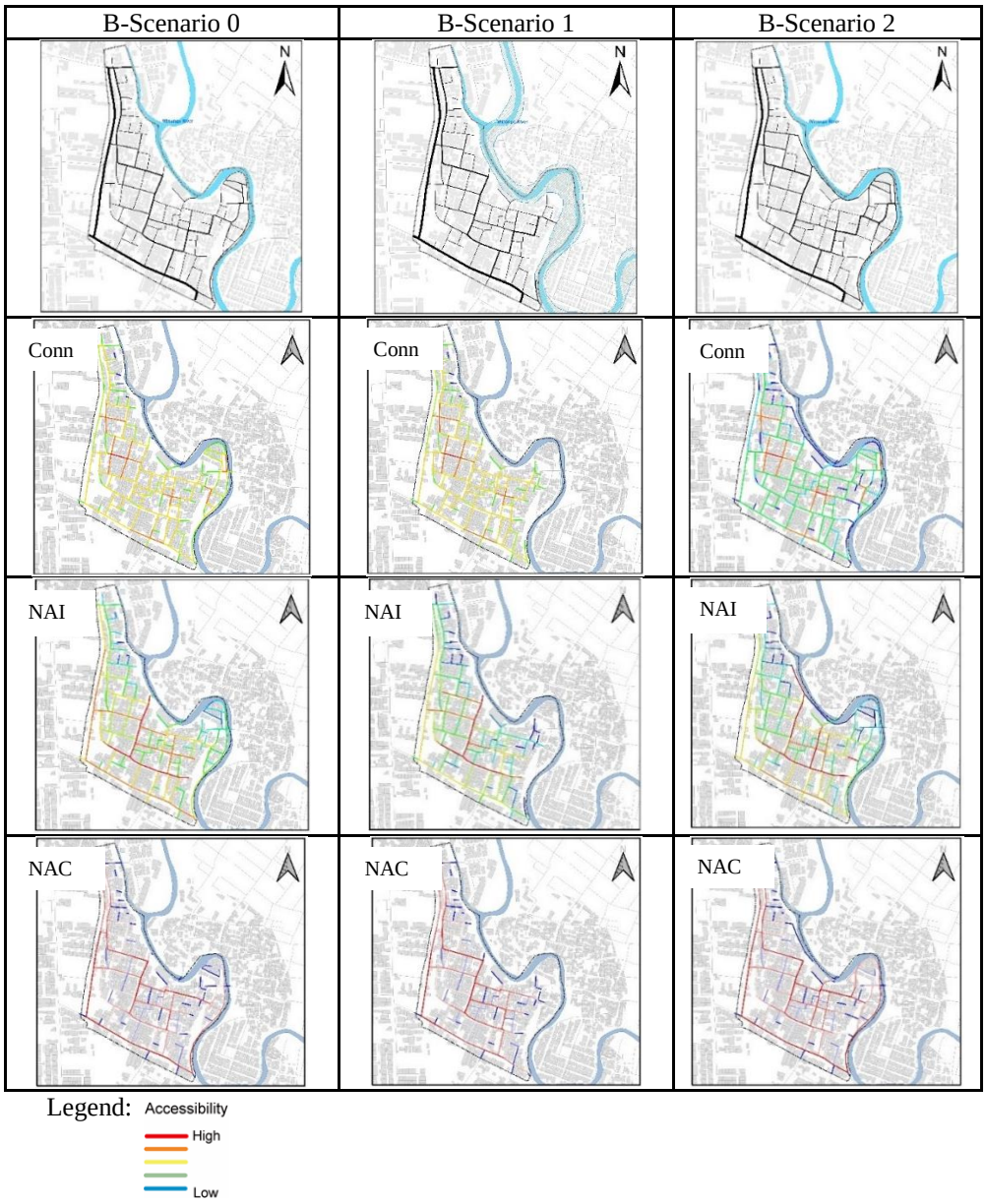

Figure. 5. Syntactic map of Scenario Analysis for Kampong Bener
(shows Connectivity, NACH, NAIN indices)

4. Discussion

The investigation to the case studies, implementation of collaborative design workshop, and evaluation of design and planning scenarios provided a process of participatory planning for the kampong upgrading plan concerning the resilience of emergency system for strategic evacuation planning. The discussion entails planning strategic evacuation route planning with the inclusion of configurational analysis and benefits of the adoption of collaborative workshop to stimulate planning/design ideas.

Kampong upgrading program focusing on the physical transformation face challenges on upgrading, expanding, or replacing the major spatial elements (e.g., streets/paths, block, open spaces) such that the planned configurations can accommodate effective evacuation plan. Compared to all scenarios from both cases, the scenario in

which the street network under flood/lahar flood event exhibited the weakest accessibility and more vulnerability. As certain streets that are supposed to connect to the higher street hierarchy are impassable, this scenario serves to illustrate the policymaker concerning the important role of multiple evacuation path selection and flood warning signal to be issued before the advent of flood hazards. The scenario 2 (T-Sc2 & B-Sc2) and scenarios 3 (T-Sc3) portrays various approaches of upgrading the spatial configuration of kampongs. The entire spatial re-configuration with land readjustment approach (T-Sc3) with gridiron pattern demonstrated higher syntactic accessibility value compared to the partial spatial upgrading (T-Sc2). Thus, the configuration of grid pattern offers more accessibility by allowing multiple route choices if certain segments are disrupted (Yoo & Lee, 2017). The findings of the configurational analysis support the evidence for resilience characteristics of redundancy and robustness of the street networks to promote the resilience of the emergency system (Giuliani *et al*., 2020).

Although the scenario 3 (T-Sc3) seems promising and evident of higher resilience in terms of spatial configurational design, the plan itself is justified as utopian to be implemented. The radical transformation of kampong space may receive significant resistance from the local population and can dissipate their existing social bonds. The high financial and social cost of implementing the project coupled with the land tenure issue of the riverbank area limit the development of such projects in Indonesia (Supriatna & Van Der Molen, 2014). Here scenarios 2, T-Sc2, and B-Sc2 (M3K project under KOTAKU policy) are regarded as appropriate on-site upgrading that were welcomed by the majority stakeholders including the local community. The key success is the initiation of a plan that promotes collaboration between locals, offers multiple avenues of negotiation, and more importantly, involves minimum spatial transformation.

The adoption of spatial configuration analysis for the strategic evacuation plan started with the identification of street segments with higher to highest syntactic accessibility value (red-colored distribution in Figures 4 and 5). The NACH map exhibited a potential route choice used as a reference for determining a proposal for strategic evacuation routes based on the principle of natural movement. The street segments with higher NACH value tend to be selected for daily movement and used it as an evacuation route for reducing the uncertainty in the way finding process (Maureira & Karimi, 2017). Moreover, the use of NAIN map can exhibit street segments as a potential destination, in which the disaster manager can use the map to locate the emergency facilities (e.g., evacuation points and emergency support centers) in segments with higher integration value. Using the combination of NACH and NAIN map, the strategic evacuation plan for flood/lahar flood hazard can be proposed as follows (see Figure 6):

a. Given that the river is the epicenter of flood/lahar flood hazards, the evacuation route plan must directly move farther from the riverbank areas to the east direction following on route suggested by the NACH map.
b. Establishment of multiple route choices by following the combination of NACH and NAIN map to avoid the accumulation of evacuees on single segments (this problem apparently still appears for T-Sc2).
c. Widen primary neighborhood streets to 3 - 5 meters as instructed by national regulation for road planning on residential neighborhoods.
d. Design evacuation paths that are sensitive to vulnerable people such as diffable and older adults who require support to walk (e.g., handrails, incline ramps).
e. Manage the use of street segments with highest NACH and NAIN value as these segments typically found to be occupied with social, informal business activities,

and motorcycle parking on streets. Regulation should take place to control or limit these activities to minimize disturbance on emergency evacuation path.

f. Installation of evacuation signage at crucial intersections on evacuation route as suggested by NACH map.
g. Swift evacuation for vulnerable people that lived nearby riverbank paths can be done using three-wheel motorbikes. This should be activated before the advent of flood hazard.

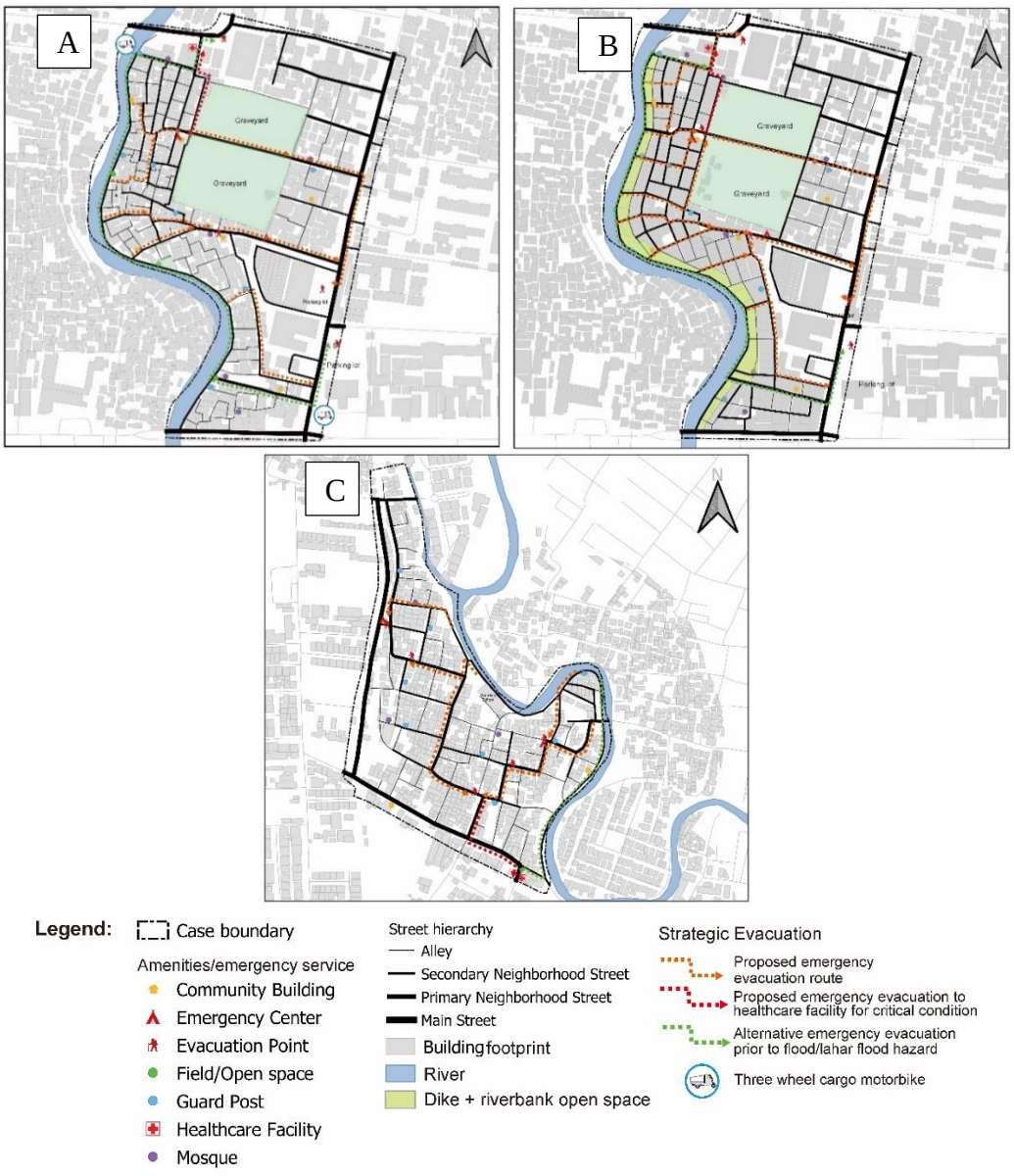

Figure. 6. Example of proposal for strategic evacuation plan considering the role of spatial configuration in guiding route choice. A) Kampong Terban T-Sc2; B) Kampong Terban T-Sc3; C) Kampong Bener B-Sc2

The collaborative workshop presented in this research can be an exemplary practice to initiate similar workshops hosted by government officials envisioning ideal participatory planning with accurate selection of participants (e.g., government, local

actors, experts, and practitioners) considering the local context and disaster issue in selected kampongs. This support and expected to refine previous work in participatory planning in Indonesia (Some *et a*l., 2009). In addition, the use of collaborative workshop with toolkits (e.g., printed maps, drawing tools, and exemplary of ideal neighborhood design) is advantageous for stimulating an in-depth discussion while harnessing spatial knowledge to enrich the brainstorming of ideas among the stakeholders (Akbar *et al*., 2020; Goldstein *et al*., 2015). As discussed herein, multiple scenarios should not be sought as sole efforts from physical upgradation as the ultimate objective for achieving resilience, but as echoed by Dhellemmes et al. (2021) and Paton (2003), the role of nonspatial/physical strategies, such as empowering locals and its community-based organization (e.g., disaster resilience kampong squad) with training, knowledge, and proper budget allocation is primary essential for building sustainable and resilience kampong.

5. Conclusion

This study explores the implication of the kampong upgrading plan has on flood evacuation route choice behavior by evaluating the morphological scenarios from two urban riverbank kampongs in Yogyakarta City, Indonesia. It assumes that morphological scenarios of kampong upgrading plan associated with accessibility performance that influence evacuation behavior especially route choice pattern. The study put forwards collaborative design workshop as inclusive approach in generation two morphological proposal of kampong upgrading plan. In addition, the integration of qualitive (i.e., narrative analysis from workshop) and quantitative analysis (comparison of space syntax parameters and map) provide triangulation of results that serve as evidence into on the implication of upgrading to the robustness of network resilience in guiding evacuation route choices.

The comparative accessibility analysis from space syntax suggest that the slight increases in overall accessibility parameters value between existing morphology and M3K project raises skepticism whether it influence towards the effectiveness of evacuation performance. However, the accessibility space syntax map and results from qualitative analysis highlight the importance of change of the morphological changes in the M3K project on the evacuation behavior. In the same manner, the land readjustment with grid pattern stands out with better accessibility value compared to all other scenarios.

The use of space syntax for evaluation of upgrading plans (e.g., by comparing spatial indices of different scenarios) can support and complement the workshop in term of decision-making support to attain consensus among stakeholders. The evidence from space syntax can serve as spatial information on the outcome of each scenario pertaining to the performance of spatial system in guiding and planning evacuation route choice as well as placing emergency support facilities in more accessible spaces.

While policy and strategies toward informal and slum settlement upgrading have evolved, there is urgency to redesign the strategies and approaches that emphasize collaborative action to better understand local context. Lesson can be learned from this paper are there is an urgency to integrated disaster mitigation and management thinking into the existing national slum upgrading/redevelopment program which currently receive less attention in the planning and implementation of the project. This integration is in line with the sustainable development goal which attempt to achieve sustainable cities and communities.

The result of this paper is significantly important for future research in the field of disaster evacuation research, such as follows: 1) developing of multi-agent-based model that can interact with different types of spatial configuration to evaluate the impact of kampong upgrading scenarios toward the effectiveness of flood evacuation plan; 2) considering the social behaviors of community into agent for mutual assistance model on rapid evacuation in informal and formal kampong's space (Chasanah & Sakakibara, 2022). To conclude, this study contributes to the existing collaborative planning practices in Indonesia focusing on the slum reduction and settlement upgrading plan which not only focus on improving resident's quality of life but also better concern on improving disaster resilience of riverbank community by bringing together local stakeholders into an actual planning/design practice.

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