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Aligning community and public priorities in informal settlement upgrading: Evidence from discrete choice experiments in Indonesia

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Abstract:

This study employs two discrete choice experiments (DCEs) conducted with two sample groups in Indonesia to investigate the informal settlement upgrading priorities of residents (sample 1) and explore how they align with public taxpayers' preferences (sample 2). The first DCE explores the relative importance placed upon common planning and public health priorities, such as water security, drainage, and diarrhoea in children, alongside local economic development priorities. The second DCE investigates the relative importance placed upon project implementation design considerations, including project completion time and community consultation. Our findings reveal that residents particularly prioritise improvements in water quality and economic development. While informal settlement upgrading interventions often prioritise improving water, sanitation and hygiene (WaSH) to reduce diarrhoea and other water-borne disease, our study highlights that residents also highly value economic empowerment, underscoring the need for integrated upgrading approaches that address both health and livelihood concerns. Taxpayer perspectives were well-aligned on upgrading outcome priorities, but diverged slightly on project implementation. Whereas residents prioritized minimizing project duration and were less concerned with significant community consultation, taxpayers emphasized generating employment opportunities for residents within project designs. Both groups expressed an aversion to residents bearing full responsibility for resourcing ongoing operations and maintenance, preferring government or shared responsibility, highlighting the need for sustainable funding models. The study highlights the value of DCEs as a tool to support locally-led development, informing upgrading strategies that are more likely to be both politically feasible and successfully appropriated into urban livelihood practices of residents.

Keywords: informal settlements, slum upgrading, infrastructure appropriation, locally-led development, discrete choice experiment.

JEL: O18, H41, I15, O12

Introduction

1.1 Background & aims

Upgrading informal settlements is a global development priority (Sustainable Development Goal (SDG) 11.1), with the potential to improve the lives of more than 1 billion residents globally, as well as create positive health and social externalities for surrounding communities (Henson et al., 2020; Lilford et al., 2017; Turley et al., 2013; UN-Habitat, 2018; UN-Habitat, 2020). Characterised by extreme poverty, informal settlements are frequently located in urban areas least suited for housing development. Residents face challenges such as inadequate access to basic utilities (water, sanitation, waste management, and electricity), insecure tenure, and overcrowded, substandard housing (Alzamil, 2018; Ezeh et al., 2017; Marx et al., 2013; UN-Habitat, 2020). These conditions threaten the physical and mental health, and well-being of residents (Escobar Carías et al., 2022; Ezeh et al., 2017; French et al., 2021; McGee et al., 2017; Henson et al., 2020; Jorgenson et al., 2012; UN-Habitat, 2020). Children are particularly vulnerable; where poor sanitation and water supply, often combined with undernutrition, predispose them to chronic diarrhea and stunting (Ezeh et al., 2017; French et al., 2021).

Informal settlement upgrading projects vary in scope and may include improvements to water, hygiene and sanitation (WASH), waste management, housing, energy access, drainage and flood mitigation, green spaces, street lighting, roads, and pathways (Corburn and Sverdlik, 2017; Henson et al., 2020; Turley et al., 2013). Evaluations have demonstrated upgrading can reduce communicable disease, and improve transport infrastructure, safety, security, and quality of life (Corburn and Sverdlik, 2017; Turley et al., 2013).

In line with SDG-6 on clean water and sanitation, providing access to basic WASH infrastructure is a common focus of informal settlement upgrading projects, with reductions in childhood diarrhoea frequently serving as a key outcome indicator (Ezeh et al., 2017; Henson et al., 2020). From a public health perspective, the adverse effects of chronic diarrhoea and malabsorption related to chronic intestinal inflammation in children justify this prioritisation. However, residents also face a range of other threats to wellbeing, including flooding and heat stress (Escobar Carías et al., 2022; Ramsay et al., 2021), as well as persistent social and economic pressures that characterise informal settlements (Cities Alliance, 2021; Marx et al., 2013; Shah et al., 2020; Szabó and Ujhelyi, 2017). The upgrading needs within these communities are therefore extensive – as is the number of informal settlements in Indonesia,

the focus of this study, where an estimated 20 percent of the urban population (around 30 million people) live in such areas (Shah et al., 2020). Addressing this challenge requires substantial public and external (aid) investment, alongside effective priority-setting (Cities Alliance, 2021).

Priority-setting for community upgrading is ultimately determined by funders and planners, and their priorities do not always align with residents (Nikuze et al., 2022). Inadequate community consultation and limited understanding of community priorities have been identified as key factors contributing to the failure of many community development projects, including those focused on WASH (Minnery et al., 2013; Pratama et al., 2020; Sindall et al., 2023; Tournee and Van Esch, 2001). Not coincidentally, contemporary development frameworks and urban planning research emphasise the importance of 'alignment with local priorities', 'locally-led development' and developing upgrading approaches that recognise local socioeconomic and institutional conditions (OECD, 2005; Minnery et al., 2013, Yeboah et al., 2021; GPEDC, 2022). Further, recent research by Wainaina and Truffer (2024) demonstrates that even when participatory planning successfully identifies local priorities, infrastructure often fails to improve livelihoods because planners do not anticipate how residents will actually appropriate and integrate new infrastructure into their daily livelihood practices.

Related, developing sustainable strategies for funding the ongoing operation and maintenance of new infrastructure is another persistent challenge. Inadequate planning has resulted in the breakdown of many upgrading projects (Barrington, 2021; Sindall et al., 2023). Communities are more likely to take ownership of such systems when upgrading projects respond directly to their felt needs (Ariana, Fajrin et al., 2024; Barrington, 2021; Pratama et al., 2020; Sindall et al.,2023; Tournee and Van Esch, 2001).

This paper elicits the community upgrading and development preferences of residents of informal settlements in Makassar, a city of South Sulawesi, Indonesia. We employ two connected discrete choice experiments (DCEs). The first DCE elicits priorities for potential community upgrading outcomes, for example improving water security, drainage and reducing diarrhea, as well as creating local economic opportunities (henceforth *DCE1-Outcomes)*. The second DCE explores preferences for how upgrading projects are designed and implemented, examining the importance of community consultation, project completion time, and employing residents in upgrading works (henceforth *DCE2-Implementation)*. The two DCEs are

connected, in that both DCEs include a common attribute - *who is responsible for resourcing ongoing operations and maintenance (government, residents or shared)*. This design enables an indicative exploration of the relative importance of attributes across the two DCEs (discussed further in Methods Section).

We also recruited a general sample of working-age Indonesians (aged 18–65 years) to complete the DCEs. Making progress towards SDG6 and SDG11.1 in Indonesia through initiatives such as the National Slum Upgrading Program (2016-2022) is heavily reliant on public expenditure. These analyses provide insight into the political acceptability of these investments, particularly into what taxpayers think should be prioritised with public funding on informal settlement upgrading (Ariana et al., 2024; Pratama et al., 2020; Shah et al., 2020). The rest of this paper is set out as follows, section 1.2 provides an overview of the relevant literature and highlights the contributions of this paper. Section 2 describes the development of attributes and levels included in the DCEs. Section 3 describes sampling and data collection and Section 4 describes the designs for the DCEs and analyses undertaken. Results are presented in Section 5, discussed in Section 6, with conclusions offered in Section 7.

1.2 Overview of existing literature

DCEs are grounded in random utility theory and Lancaster's characteristics model, where individuals derive utility from the attributes of a product, program, or service (Lancaster, 1966; Louviere and Swait, 2000). Typically, respondents complete a series of choice tasks, selecting between alternatives defined by varying attribute-levels. This allows estimation of part-worth utilities (preference weights) for included attribute-levels, assuming people choose the alternatives that maximize their utility.

DCEs are well-suited as a tool to identify local priorities in support of locally-led development. Further, they can help anticipate community appropriation of new infrastructure and bridge the planning-to-impact gap that threatens success of informal upgrading projects (Wainaina and Truffer, 2024). Yet, there has been limited application of DCEs or other stated preference methods to understand upgrading priorities for residents of informal settlements. Existing DCEs have typically focused on single upgrading domains, such as willingness to pay for improved water supply (quality and accessibility) in Ghana and Ethiopia (Adams and Vásquez, 2019; Entele, 2022; Vásquez and Adams, 2019), cooking fuel preferences in Kenya (Yonemitsu et al., 2015), or latrine use in peri-urban Ethiopia, though this was not specifically in informal settlements (Goddard et al., 2018). However, these offer little insight into how

residents prioritize potential upgrading works and outcomes across multiple domains, which is important as addressing all community development needs is unrealistic for most settings.

Other research has explored preferences for in-place upgrading versus relocation. In Kenya, residents were willing to trade off house size and service improvements for greater tenure security and communal green space (Kim et al., 2019). In South Africa, residents preferred in-place upgrading over relocation and prioritised household sanitation over house size and road paving (Del Mistro and Hensher, 2009). Studies from Asia are especially uncommon, despite the region being home to around 65% of the world's informal settlement residents (UN-Habitat, 2018). Notable exceptions include studies on flood protection and relocation incentives in Vietnam and Bangladesh (Hagedoorn et al., 2021; Rashid et al., 2007), and housing (improvements) preferences in Indonesia, which residents prioritised over landscaping of riparian areas and river access (Fitri et al., 2017; Vollmer et al., 2016).

DCE1-Outcomes contributes to this sparse literature examining upgrading priorities across multiple domains in informal settlements in the Asian context. *DCE2-Implementation* contributes to an even more sparse literature. Very few choice experiments have included project implementation attributes such as project duration or community consultation (Del Mistro and Hensher, 2009; Mao et al., 2020), and we are unaware of any that focus on the importance of consultation, co-design, and resident employment in development practice, despite their long recognised importance in development practice (Majale, 2008; Tournee and Van Esch, 2001; UN-Habitat, 2004). In an additional novel contribution, we examine how residents trade off between outcome and implementation attributes, using an attribute-in-common to compare across the two DCEs. Finally, we uniquely consider alignment of resident's upgrading preferences alongside those of general taxpayers to inform more inclusive and politically feasible upgrading strategies.

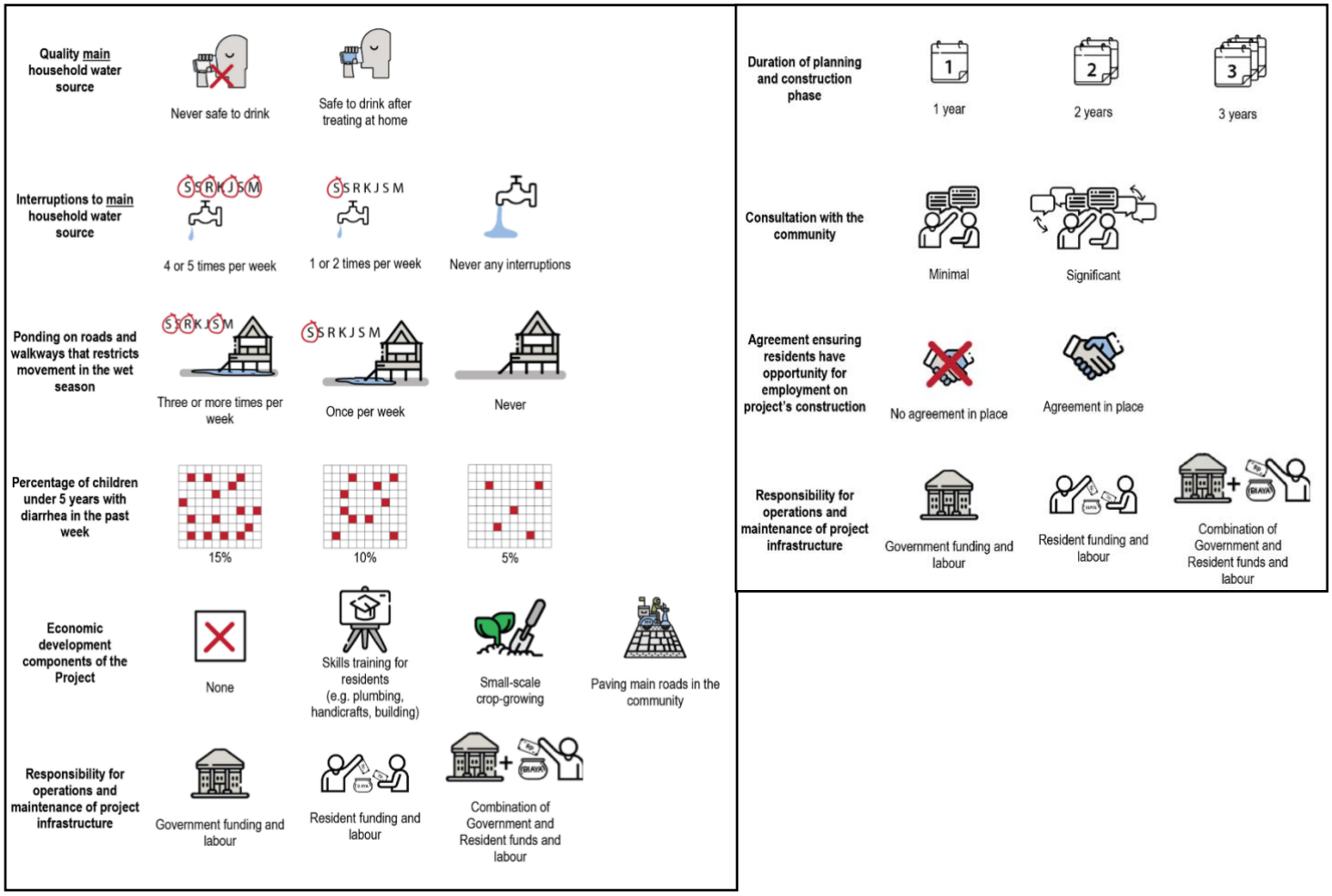
2. Identification of attributes and levels

We identified potentially relevant attributes from (i) a comprehensive literature search of electronic databases (August - September 2019), and (ii) four focus group sessions with residents of two informal settlements, which culminated in a voting exercise for potential attributes (October 2019). This produced a list of important potential attributes considered for inclusion by our interdisciplinary research team (economics, public health, epidemiology, and

landscape architecture and planning). Further details of this process are provided in Appendix A.

Attributes and levels for each DCE are shown in Figures 1 and 2 and discussed below. The rationale to separate attributes into *DCE1-Outcomes* and *DCE2-Implementation* was twofold: (i) reducing cognitive burden and risk of heuristic behaviour from too many attributes, (Heidenreich et al., 2018), and (ii) focus group voting suggested planning and implementation attributes might be dominated by upgrading project outcome attributes, reducing potential insights. Attribute-levels were informed by literature, expert opinion and where appropriate, data from household surveys of 12 informal settlements collected as part of the *Revitalising Informal Settlements and their Environments (RISE)* Project baseline assessment (French et al., 2021). This present study was an add-on to the RISE Project, a community upgrading randomised controlled trial described in detail in Leder et al. (2021) and French et al. (2021). This ensured best- and worst-case attribute-levels were realistic.

Figure 1. Attributes and levels for *DCE1-Outcomes* & *DCE2-Implementation*



Improving general water supply was a top priority in focus groups, which cited convenience, affordability, reliability, safety, and taste. Our first two attributes, *quality of main household water source* and *interruptions to main household water source*, capture these concerns. Reflecting patterns common in informal settlements globally, residents in Makassar rely on various water sources depending on use and availability, including bottled water, reticulated mains, rainwater, and wells (Adams and Vásquez, 2019; French et al., 2021; Vásquez and Adams, 2019). While 36% of households have access to reticulated water, only 20% use it as their main drinking source, and around two-thirds use bottled water from depots (French et al., 2021). Both reticulated and depot sources are recommended to be treated before drinking. Improving drinking water quality was also a KOTAKU priority (Shah et al., 2020).

Flooding and ponding were key focus group concerns in the more flood-prone community. It can affect mobility, health, and livelihoods (De Risi et al., 2013; Escobar Carías et al., 2022). While drainage was raised in the less flood-prone community focus groups, it ranked lower. However, given 50% of RISE survey respondents reported flooding outside their homes, and 31% inside, we included the attribute *ponding on roads and walkways that restricts movement in the wet season*, with attribute levels based on survey data (French et al., 2021).

Although diarrhoea was not voted a top focus group priority, it remains a critical outcome, especially given high baseline prevalence in the study sample and its relevance to WASH infrastructure goals (French et al., 2021; Henson et al., 2020). The attribute *percentage of children under 5 with diarrhoea in the past week* was included to compare its salience against other priority outcomes.

To reflect opportunities in upgrading projects to improve livelihoods, we included an *economic development component* attribute (Brakarz and Jaitman, 2013; Cities Alliance 2021; Shah et al., 2020; Natakun, 2015). Focus groups prioritised skills training, while paving roads (to facilitate access to hubs and local trade) and growing crops (enabled by land improvements) were considered valuable, though not top-ranked. All were retained to inform policy decisions.

Operations and maintenance responsibility is a global challenge (Natakun, 2015; Pratama et al., 2020; Sindall et al., 2023; Yeboah et al., 2021). A willingness-to-pay attribute for upgrading works risked confusion for our residents sample participating in the funded RISE trial (Leder et al., 2021). Instead, we asked about preferred *responsibility for funding ongoing operations and maintenance* (government, resident, or shared). A "community maintenance

tax" attribute was piloted and dropped after respondents judged that realistic tax levels were too minor to affect choices.

Attributes raised in the literature but not included (as they were not top priorities in focus groups) included housing quality and tenure (Celhay and Undurraga 2022; Del Mistro and Hensher, 2009; Fitri et al., 2017; Goddard et al., 2018; Kim et al., 2019; Shah et al., 2020), urban greening (Ariana et al., 2024; Kim et al., 2019), sanitation infrastructure and waste management (Goddard et al., 2018; Sarkhel and Banerjee 2010; Shah et al., 2020).

As previously raised, we found no choice studies focusing on project implementation processes, with only a couple including attributes related to project duration or community consultation (Del Mistro and Hensher, 2009; Mao et al., 2020). Attributes for *DCE2-Implementation* - project duration, community consultation, and employment agreements - were informed by these studies, as well as practitioner guidelines and project evaluations (Del Mistro and Hensher, 2009; Majale, 2008; Mao et al., 2020; Moschonas, 2025; Pratama et al., 2020; Tournee and Van Esch, 2001; UN-Habitat, 2004).

3. Data Collection

We recruited a sample of adult residents of informal settlements (N=156) in October 2021 and a general Indonesian, working-age (18-65 years), "tax-payer" sample (N=1,011) in October 2020. Ethics approval was received through The Health Research Ethical Committee, Faculty of Public Health, Hasanuddin University (No. 10359/UN4.14.1/TP.02.02/2020). The Indonesian "taxpayer" respondents were recruited via the online survey panel company Dynata. This project was an add-on to the *Revitalising Informal Settlements and their Environments (RISE)* Project (Leder et al., 2021). The informal settlement adult residents sample was recruited from households across 11 of 12 informal settlements participating in the larger RISE Project. Five of the communities had engaged in some community participatory design discussions as part of the RISE Project at the time of this DCE survey, though no upgrading works had commenced. Participants were invited to participate via a text message, which contained a link to the online survey. Follow-up phone calls were also employed to invite participation. Participants were compensated with a mobile data credit voucher for 20,000 Indonesian Rupiah (IDR) (about 1.5USD), and as a further incentive, respondents went into a random lottery within their community to win a further 100,000IDR of credit (about 7.5USD).

Frequent phone number changes and population movements in this setting make recruitment challenging and also calculations of precise recruitment and response rates difficult. At the time of recruitment, we believed we had about 300 active phone numbers for about 500 households across 11 communities. It was estimated that the 500 households recruited to the RISE Project represented over 95% of all households in the catchments (French et al., 2021). This suggests our study had a recruitment rate of around 31% (156/500) of all households in targeted communities and a response rate of 52% (156/300).

For our main analyses, we excluded 24 (15%) residents and 231 (23%) general "taxpayers" for completing the survey concerningly quickly (speeders) or failing a test DCE question, where one scenario objectively dominated the other. Sensitivity analyses including the full samples are provided in Appendix B.

4. DCE design & analyses

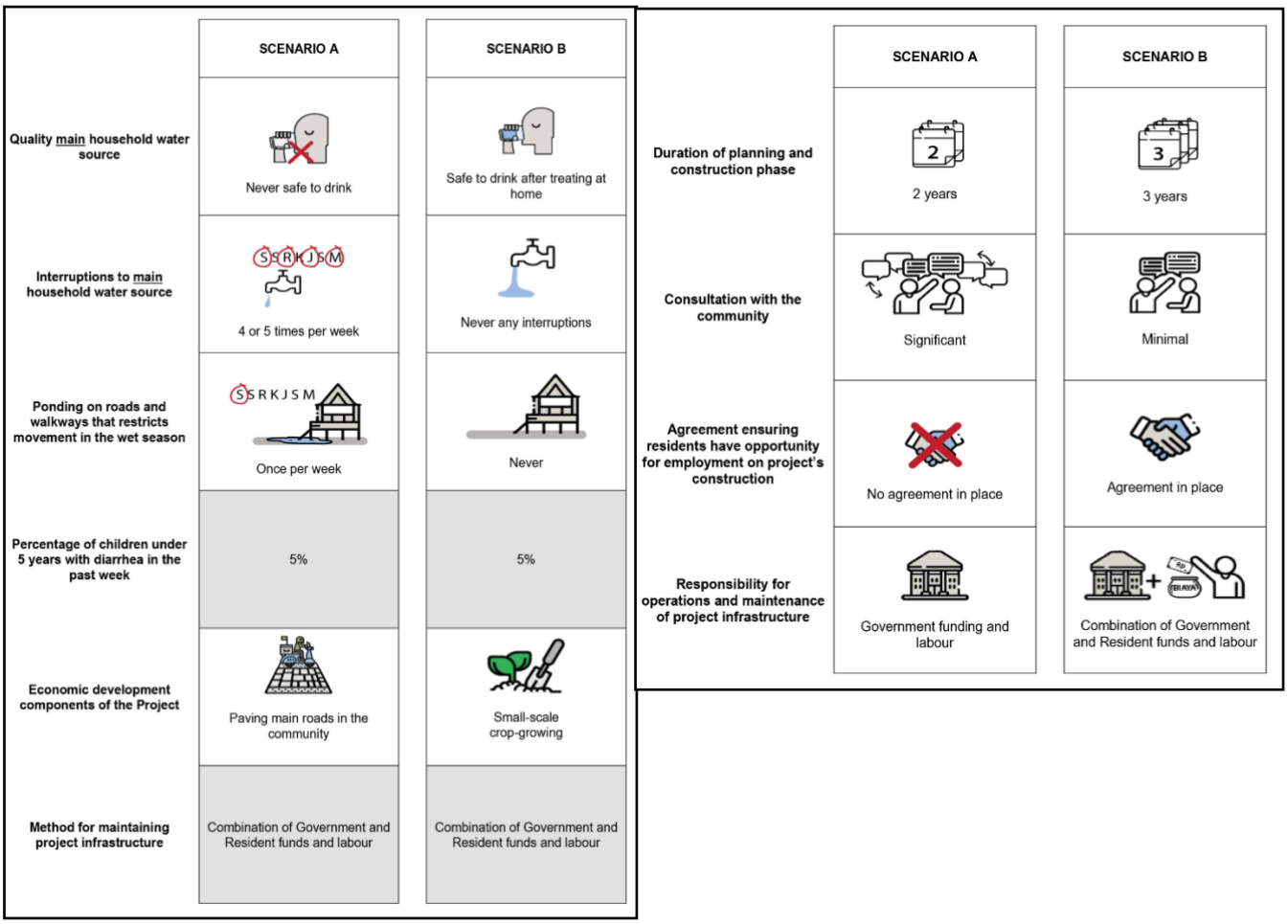
4.1 Experimental & survey design

D-efficient design was used to create a manageable number of pairwise tasks for each DCE using Ngene software (www.choice-metrics.com). *DCE1-Outcomes* contained 12 blocks asking each respondent 6 choice tasks (i.e. a total of 72 choice tasks was generated). *DCE2-Implementation* contained 12 blocks asking 4 choice tasks (i.e. a total of 48 choice tasks was generated). Figure 2 shows sample choice tasks for the two DCEs. A combination of text and images were employed to aid respondent understanding. To further minimise respondent burden we employed an explicit partial profile design for *DCE1-Outcomes,* where overlapping attribute-levels were "greyed out" with images withheld to signal where options did not differ on that attribute. This had an additional benefit of reducing the extent of up-down scrolling required for respondents completing the survey on mobile phones. All surveys were pilot tested and delivered in Bahasa Indonesian.

The preamble to the DCEs for the resident sample said, *"imagine the government was considering investing money into community environmental improvement projects for informal settlement communities like yours, across the country. We want to know what you think the priorities for this should be".* For the general taxpayer sample the preamble said, *"imagine your government is planning to upgrade informal settlements across the country. We want to know what you think the priorities for this should be".*

The DCEs were presented as forced choices (i.e. they had to choose scenario A or B), however for *DCE1-Outcomes,* the resident sample were subsequently asked if they were able to choose "neither of these", would they? These unforced choice results are presented in Appendix B.

Figure 2: Sample choice tasks for *DCE1-Outcomes & DCE2-Implementation*



4.2 Model Specifications

For both DCEs and samples, we conducted a conditional logit model. Standard errors are clustered at the respondent level. For the general taxpayer sample, which had a much larger sample size, we also adopted a latent class conditional logit model (LCM) to explore preference heterogeneity (the residents sample size was too small to analyse preference heterogeneity). We compared 2-, 3-, and 4-class models and selected the 2-class model based on the BIC and CAIC. We explore what observable respondent characteristics could predict latent class membership, including binary indicators for age group (18–39 years vs. 40–58 years), gender, low income (<2 million IDR/month), higher education (beyond senior high school), recent flood exposure, and water interruptions (>3 times in 4 weeks).

5. Results

Appendix Table B1 provides some descriptive statistics of our two samples. In summary, compared to the resident sample, the taxpayer sample had more education (62% versus 50% had completed senior high school), were less poor (36% versus 61% had monthly income below Rs 2 million) and were more likely to be employed (97% versus 91% had at least one household member working regularly). Note, the resident sample was largely female (74% compared to 53% in the taxpayer sample). This was expected given the RISE Project prioritised female caregivers in their survey sample design (Leder et al., 2021).

5.1 *DCE1-Outcomes*

The final model specifications for *DCE1-Outcomes* are presented in Table 1. Coefficients are dummy-coded and each attribute contains a reference attribute-level. In *DCE1-Outcomes* we observe that both groups had a strong preference for improvements in water quality and reliability. For residents, the conditional logit model (Table 1, column 1) estimated the attribute-level *safe to drink after treating* had the highest preference weight (0.984). This can be interpreted as the increase in utility gained from moving from the attribute's reference level (*never safe to drink).* It underscores the critical importance of access to clean and reliable water sources.

Incorporating economic development components into upgrading projects, particularly *skills training*, were also highly prioritized by residents, with a preference weight of 0.667. This was ranked above more common upgrading priority outcomes of reducing child diarrhea (0.294) and ponding, which were not statistically significant. This indicates poverty reduction and enhancing economic well-being is front of mind for residents. Of interest, child diarrhea only became significant when diarrhoea prevalence attribute-level was *5%*, suggesting that achieving moderate reductions in *diarrhoea prevalence in children* (from *15%* to *10%*) has limited value from their perspective.

For the taxpayer sample, the conditional logit attribute rankings were similar (Table 1, column 2), with the exception of prioritising managing water interruptions over economic opportunities. Unlike residents, taxpayers did care (statistically significantly) about reducing disruptive *ponding* episodes, though it was ranked the same. The taxpayer sample still ranked economic development components highly (3rd), but unlike residents, there was much less difference in the marginal utility gained from moving from *crop-growing* to *road paving* to *skills training* as there was for residents.

Table 1: Regression Results *DCE1-Outcomes*

Project Outcome Priorities	**Informal Settlements**	**General Taxpayers**		
	Conditional Logit	Conditional Logit	Latent Class 1	Latent Class 2
Water quality				
safe to drink after treating	0.984***	0.756***	2.841***	0.397***
	(0.162)	(0.061)	(0.465)	(0.096)
never safe to drink	-	-	-	-
Water interruptions				
Never	0.603***	0.674***	3.089***	0.209**
	(0.137)	(0.061)	(0.583)	(0.097)
1-2 per week	0.222*	0.262***	1.457***	-0.051
	(0.133)	(0.055)	(0.312)	(0.087)
4-5 per week	-	-	-	-
Ponding restricting movement				
Never	-0.060	0.216***	1.249***	-0.024
	(0.154)	(0.055)	(0.318)	(0.083)
1 per week	-0.051	0.121**	0.517**	0.041
	(0.149)	(0.054)	(0.210)	(0.080)
3+ per week	-	-	-	-
Child diarrhoea %				
5%	0.294**	0.340***	1.156***	0.131
	(0.133)	(0.056)	(0.210)	(0.090)
10%	0.160	0.194***	0.388*	0.158**
	(0.121)	(0.051)	(0.202)	(0.074)
15%	-	-	-	-
Economic development components				
skills training	0.667***	0.639***	1.292***	0.590***
	(0.147)	(0.060)	(0.282)	(0.085)
pave main roads	0.349**	0.587***	1.564***	0.457***
	(0.137)	(0.060)	(0.356)	(0.083)
small scale crops	0.191	0.505***	0.909***	0.478***
	(0.143)	(0.055)	(0.204)	(0.080)
None	-	-	-	-
Funds & labour for operations & maintenance				
Government	0.544***	0.463***	1.572***	0.292***
	(0.141)	(0.059)	(0.377)	(0.096)
Shared responsibility	0.479***	0.433***	0.989***	0.447***
	(0.131)	(0.055)	(0.297)	(0.081)
Resident funds & labour	-	-	-	-
Observations	1,584	9,360	3,182	6,178
% of sample	-	-	34%	66%

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In terms of responsibility for *providing funds and labour for ongoing operations and maintenance*, residents had a clear preference for *government* (0.544) or *shared responsibility*

(0.479), with residents expressing a strong aversion to bearing full responsibility themselves. This highlights the importance of sustainable funding and support structures for the long-term success of upgrading projects. The taxpayer respondents were well-aligned in this regard, also preferring *government* (0.463) or *shared responsibility* (0.433) compared to *residents* taking responsibility alone.

Conditional logit attribute rankings and preference weights for both samples were robust to the inclusion of speeders and respondents who failed the dominant choice test question (Appendix Tables B2 and B3). This was also the case for the unforced choice *DCE1-Outcomes* results for residents.

To investigate preference stability in our larger taxpayers sample who likely have less familiarity with the contexts of informal settlements, we embedded a priming experiment in our survey. The experiment randomly showed (or not) before-and-after photos of drainage and paving related upgrades (Appendix Figure B1). We hypothesised that taxpayer respondents shown these photos would place larger preference weights for ponding and paving attribute-levels in *DCE1-Outcomes* (Appendix Table B3). This experiment did not change attribute importance ranking for taxpayers, but it did find taxpayers placed a higher weight on smaller improvements in ponding, which very much related to the photos shown. This suggests preferences of non-residents may be somewhat malleable to priming and messaging.

The latent class model estimated for taxpayers explored preference heterogeneity (Table 1, Columns 3 & 4). We identified two distinct classes. Respondent education was the only significant predictor of class membership, where people who have higher education are more likely to belong to Class 1 (accounting for 34% of the sample). Class 1 prioritized eliminating *interruptions to the main water supply* (3.089) and *improving water quality* (2.841). They placed relatively similar weights across other attributes, but had a strong preference for *government* over *shared responsibility in operations and maintenance*. Class 1 could be described as supporters of "water-first upgrading and government funded ongoing maintenance".

People in Class 2 (accounting for 64% of the sample) were less likely to have higher education. They prioritized *economic development opportunities* above all other attributes and strongly preferred residents and government *shared responsibility for operations and maintenance*. They did not believe residents should take full responsibility though. Class 2 could be described

as "supporters of helping residents become more economically self-reliant, and to share ongoing responsibility for maintaining upgrades".

5.2 *DCE2-Implementation*

DCE2-Implementation examined preferences for the planning and implementation of settlement upgrading projects. The conditional logit model found residents ranked *responsibility for ongoing operations and maintenance (shared responsibility=0.512)*, slightly above minimising *project duration* (0.472), indicating a strong desire for timely project completion (Table 2, Column 1). While *employment agreements for residents to work on construction* were significantly valued (0.284), it was a lesser priority. Perhaps most notably and surprisingly, *significant* versus *minimal community consultation* did not significantly influence residents' choices. This may be due to sample size limitation, but identifies it as less important than other included attributes of *DCE2-Implementation*.

In contrast, taxpayers prioritized *employment agreements* (0.604) more highly than *project duration* (0.384), but also ranked *shared responsibility for ongoing operations and maintenance* (0.679) highest, over *government responsibility* (0.498). Community consultation (0.365), was significant (i.e. important), but as for residents ranked as the least important of the included project planning and implementation attributes. Again, attribute rankings were robust to inclusion of the full samples (Appendix Table B4).

For the taxpayer sample the latent class model identified two distinct classes (Table 2, Columns 3 & 4). Respondents with higher income and education were more likely to be in Class 1 (65%). The most notable preference difference between the two classes was that Class 1 (Column 3) strongly prioritised the inclusion of an *employment agreement for residents (*1.140), whereas Class 2 did not (Column 4). Additionally, Class 2 preferred a shared approach to ongoing operations and maintenance, rather than placing sole responsibility on the government. Taken together with the latent class model findings for DCE1-Outcomes, this suggests there is a small subset of lower-income, less-educated taxpayers who have a strong preference that *responsibility for ongoing operations and maintenance* should at a minimum, be shared between residents and government.

Table 2: Regression Results for *DCE2-Implementation*

	Informal Settlements	**General Taxpayers**		
	Conditional Logit	Conditional Logit	Latent Class 1	Latent Class 2
Duration of planning & construction phase				
1 year	0.472***	0.384***	0.767***	-0.026
	(0.143)	(0.057)	(0.134)	(0.184)
2 years	0.206	0.244***	0.365***	0.182
	(0.126)	(0.059)	(0.114)	(0.148)
3 years	-	-	-	-
Consultation with the community				
Significant	0.130	0.365***	0.592***	0.214**
	(0.092)	(0.042)	(0.095)	(0.108)
Minimal	-	-	-	-
Employment agreement with community				
Yes	0.284***	0.604***	1.140***	-0.120
	(0.107)	(0.045)	(0.153)	(0.161)
No	-	-	-	-
Funds & labour for operations & maintenance				
Gov't funds & labour	0.474***	0.498***	1.024***	-0.133
	(0.141)	(0.061)	(0.140)	(0.232)
Shared responsibility	0.512***	0.679***	0.999***	0.405**
	(0.145)	(0.063)	(0.140)	(0.162)
Resident funds & labour	-	-		-
Observations	1,080	6,240	4,075	2,165
% of sample			65%	35%

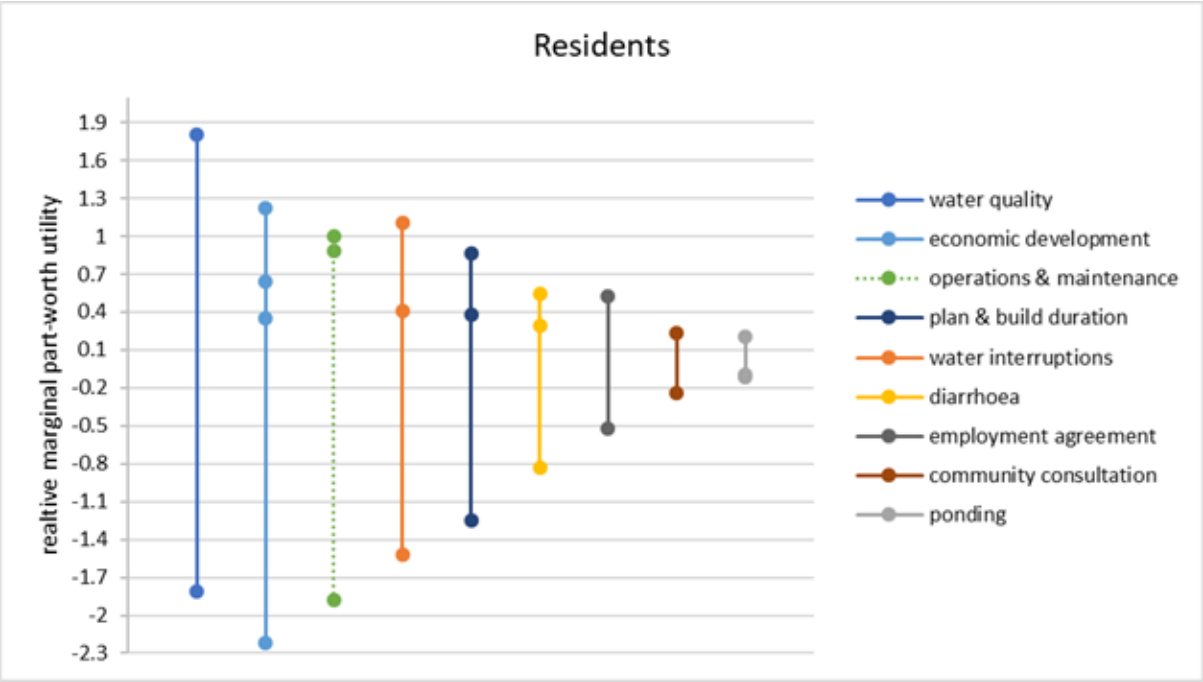
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.3 Relative importance residents place across from both DCEs

Our focus groups suggested planning and implementation features of projects would be less important than upgrading outcomes. To investigate if this holds for the broader sample, Figure 3 graphs the relative preference weight for each attribute-level (Tables 1 & 2) compared to *government responsibility for ongoing operations and maintenance* for both DCEs. For example, the importance of *water is safe to drink after treatment* relative to *government responsibility for ongoing operations and maintenance* is 1.81 (0.984/0.544), and the importance of having an *employment agreement* in place relative to *government responsibility for ongoing operations and maintenance* is 0.60 (0.284/0.474). This analysis assumes that the relative weights derived across the two DCEs would be the same if all included attributes were included in a single larger DCE, so findings should be viewed as intuitive only. For the most

part, upgrading outcomes do appear more important, though there appears some evidence suggesting that reducing *duration of planning and building*, specifically from *3 years* to *1 year* may be a higher priority for residents than reductions in diarrhoea and ponding (0.99 = 0.472/0.474).

Figure 3. Resident attribute & level importance relative to *government responsibility for operations and maintenance*



Note: Line length indicates attribute importance ranking, where longer lines are higher ranked attributes. Dots represent ratio of attribute-level preference weights relative to weight for *government responsibility for ongoing operations and maintenance*. For example, the importance of *water is safe to drink after treatment* relative to *government responsibility for ongoing operations and maintenance* is 1.81 (0.984/0.544). Ordering of dots match attribute-level weight ordering in Tables 1 & 2.

6. Discussion

This study highlights the importance of gaining a nuanced understanding of local priorities when planning and implementing community upgrading of informal settlements. The strong preference for improvements in water quality and reliability reflects a fundamental need for access to clean and safe water, which aligns with global development priorities such as Sustainable Development Goal 11.1 and reinforces this as a common focus of upgrading projects (Henson et al., 2020). However, while residents saw reducing diarrhoea in children as important, this was a lesser priority, suggesting that water improvements are likely motivated by other benefits such as convenience and cost-savings, which also emerged in focus group discussions. This is consistent with Devoto et al. (2012), who found urban Moroccans had a

high willingness to pay to be connected to mains water not because it improved health, but because it freed up time and reduced household conflict.

This finding also aligns with Wainaina and Truffer's (2024) insight that residents evaluate new infrastructure not on isolated health outcomes, but on how it affects their complete 'infrastructure-livelihood nexus'—whether it extends rather than disrupts their existing spatial, temporal, transactional, and organizational patterns. Their study of Kenyan informal settlements showed that even functionally sound infrastructure failed when it disrupted residents' livelihood practices. Our finding that residents prioritize water quality and economic development likely reflects an implicit understanding that these interventions are more likely to extend their existing livelihood patterns, making them more amenable to successful appropriation.

DCE1-Outcomes also highlighted that economic and financial challenges are a more pressing issue for residents than other common community upgrading priorities. Upgrading projects, including in Indonesia, increasingly seek to integrate economic empowerment components in upgrading project designs (Cities Alliance, 2021). This can address immediate financial stresses and is clearly valuable for gaining community support for upgrades, which will contribute to sustained community development (Pratama et al., 2020).

Resourcing ongoing operations and maintenance of upgrading infrastructure is a major development challenge, including for Indonesia's recent "KOTAKU" National Slum Upgrading Program (Ariana, Fajrin et al., 2024; Pratama et al., 2020; Sindall et al., 2023). Our DCEs perhaps unsurprisingly find residents on average preferred that government take full responsibility for this, but identified many residents would be willing to share the burden with government. Wainaina and Truffer (2024) provide further insight demonstrating that residents only invest in maintaining infrastructure after successfully appropriating it into their livelihood practices. Our finding may reflect residents' awareness that successful long-term maintenance requires infrastructure that aligns with their livelihood nexus, not just their stated preferences.

Importantly, we also found the taxpayer sample largely shared the perspective that the government should take either full or shared responsibility with residents. Trialling different approaches for government funded and community co-funded management of ongoing operations and maintenance remains an important exercise for development planners and researchers alike. This finding has support in the literature. For example, Kobel and Del Mistro (2012) and Kobel and Del Mistro (2015) found non-poor residents in formally established

developments in Kampala, Uganda and Cape Town, South Africa were willing to pay higher water bills or taxes to improve WASH services and related health outcomes (e.g. reduced diarrhoea infections) for residents of informal settlements in their cities, specifically identifying positive externalities from reduced river pollution and public health expenditure. This should give Indonesian governments confidence in allocating resources to support ongoing operations and maintenance in informal settlements. Though, the presence of preference heterogeneity identified amongst the taxpayer sample, suggests tailored communication and engagement strategies may be needed to manage the preferences of the identified smaller segment of less-supportive taxpayers.

The alignment between residents and taxpayers priority preferences went beyond agreement that government should (co-)fund ongoing operations and maintenance, with close alignment across all attributes in *DCE1-Outcomes*. Whilst we did not explicitly investigate taxpayers' willingness to increase taxes to fund large-scale upgrading of informal settlements across Indonesia, we did ask respondents if they felt the government spent 'too little', 'about right', or 'too much' across a number of public spending domains. Assistance to the poor, halting rising crime, and increasing employment opportunities were all identified as being relatively underfunded compared to national defence, social security, health and education (see Appendix Figure B2). Our findings suggest that taxpayers are aligned with at least a reallocation of current public spending levels towards informal settlement upgrading that prioritises improving water quality and supply and creating economic opportunities for residents, then reducing flooding and diarrhoea in children.

DCE2-Implementation, identified less alignment between residents and taxpayers preferences as to how informal settlement upgrading projects should be planned and implemented. Most notably, residents had a strong preference for project duration, clearly wanting to minimise delay and disruption, in-line with (Del Mistro and Hensher, 2009; Mao et al., 2020). This was less important for taxpayers, possibly because residents have more experience with delayed or cancelled development projects (Moschonas, 2025). Taxpayers on the other hand re-iterated the importance they placed on planners taking the opportunity to generate economic (employment) opportunities for residents within upgrading project design – as revealed in *DCE1-Outcomes*.

Our study of course has limitations. The challenge in recruiting a large sample of residents has hampered our ability to explore interactions between attribute-levels and preference

heterogeneity. Also, our resident sample was predominantly female, raising concerns that these priorities may not be generalisable to the full adult resident population. Though, capturing the female perspective for community upgrading priorities does have clear value in and of itself. Further, we made the decision to separate planning and implementation attributes in *DCE2-Implementation* from those presented in *DCE1-Outcomes* to minimise respondent cognitive burden, reduce risk of heuristic behaviours and improve survey interface on mobile phones. Whilst our attribute in common allows some insights into the relative importance of attributes across DCEs, these insights should be viewed as intuitive only. This research contributes evidence for understanding how resident preferences can inform upgrading strategies that are more likely to be successfully appropriated into urban livelihood practices. Future research can strengthen the evidence base for participatory urban planning in informal settlements, by combining ex-ante preference elicitation with longitudinal studies of appropriation of new infrastructure and ongoing operations and maintenance strategies.

7. Conclusions

In-line with locally-led development, this study underscores the value of using discrete choice experiments to aid planning for informal settlement upgrades that address priorities of residents themselves. Consistent with earlier research, we find that improvements in water quality and reliability remain top priorities. However, residents also place significant value on economic development opportunities, highlighting the importance of integrated upgrading approaches that address both health and livelihood concerns. Preferences for government or shared responsibility for operations and maintenance suggest the need for sustainable funding models supported by public funds. While resident and taxpayer preferences are broadly aligned on key outcome priorities, differences in preferences for implementation processes point to the importance of clear and targeted communication strategies to manage diverse expectations. These findings offer practical guidance for policymakers and development partners seeking to design upgrading strategies that are not only consistent with global development goals but also responsive to the lived realities of informal settlement communities.

8. References

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SUPPLEMENTARY MATERIALS

APPENDIX A – ATTRIBUTE DEVELOPMENT AND SELECTION

Attribute and level identification

We first conducted a comprehensive search of Scopus and Web of Science electronic databases (August - September 2019) to identify studies that employed DCE and related stated preference methods to elicit community upgrading priorities of informal settlements. An updated search was conducted in 2023 (post data collection) for the purposes of positioning this paper. The search string used was: (upgrad* OR construct* OR develop* OR improve* OR regenerat* OR "water and sanitation" OR environment* OR hous* OR relocat* OR drainage OR road* OR "cooking fuel" OR stove OR light* OR diarrhea OR diarrhoea OR "green space" OR greening OR "urban green*"), the setting of interest ("informal settlement" OR "slum" OR "urban poor"), and study design ("stated preference" OR "choice experiment*" OR "discrete choice" OR "discrete rank" OR "stated choice" OR "conjoint analysis" OR "best worst scaling" OR "best scaling" OR "attribute importance" preference* OR priorit* OR willingness).

From this search, we extracted a list of potential attributes and levels for inclusion. Then, in October 2019, we conducted four focus group sessions, two female and two male, with 27 adult residents from two informal settlements in Makassar, Indonesia. One settlement was selected as it was particularly flood-prone, the other less so. Participants brainstormed community upgrading and development priorities under three predetermined categories: (i) new/improved infrastructure; (ii) project outcomes/benefits; and (iii) planning and implementation processes. After brainstorming, the focus group facilitators (study co-authors) asked if any attributes from the literature review generated list, not yet raised in discussions, were also relevant. Finally, each participant voted on which three attributes from any of the categories they deemed most important to them. This identified the most important priorities for each focus group.

The priorities arising from the focus groups were then reviewed for inclusion as DCE attributes or attribute levels by our interdisciplinary research team (economics, public health, epidemiology, and landscape architecture). This included expanding or collapsing potential attributes and levels as agreed appropriate. The following inclusion criteria was applied for final attribute inclusion: (i) they described feasible components or outcomes of a community upgrading and development project, (ii) they offered insights into the alignment of community priorities with those of public health and development practitioners, (iii) they were important to residents as identified by focus group voting, and (iv) they could be traded off (de Bekker-Grob et al., 2012; Clark et al., 2014; Trapero-Bertran et al., 2019)[1].

[1] Clark MD, et al., (2014) Discrete choice experiments in health economics: a review of the literature. *Pharmacoeconomics* 32:883-902. de Bekker-Grob et al., (2012). Discrete choice experiments in health economics: a review of the literature. *Health Economics* 21(2):145-172. Trapero-Bertran et al., (2019). What attributes should be included in a discrete choice experiment related to health technologies? A systematic literature review. *PloS One* 14(7):e0219905.

APPENDIX B – RESULTS & ADDITIONAL ANALYSES

Table B1: Descriptive statistics of respondents

Variable	Residents (N=132)	Taxpayers (N=780)
Age (years)	37.09	34.56
Female	74%	53%
Completed Senior High school	50%	62%
Household Monthly Income (<Rs 2 million or USD 135)[a]	61%	36%
Households with at least one member working regularly	91%	94%
Households with at least one child under 5 years	51%	53%
Flooding outside/ under the house in the last 3 months	15%	20%
Water interruptions (>3 in the past 4 weeks	15%	15%

[(a)] equates to the 2017 World Bank poverty line for lower-middle income countries (Jollife, Mahler et al. 2022).

Table B2: Residents Sample - sensitivity of conditional logit models for *DCE1-Outcomes*

Project Outcome Priorities	**Unforced-choice[a] (main sample)**	**Full sample[b]**
Water quality		
safe to drink after treating	0.770***	0.764***
	(0.133	(0.143)
never safe to drink	-	-
Water interruptions		
Never	0.564***	0.564***
	(0.138)	(0.126)
1-2 per week	0.151	0.261**
	(0.127)	(0.122)
4-5 per week	-	-
Ponding restricting movement		
Never	-0.088	-0.065
	(0.172)	(0.135)
1 per week	-0.008	-0.002
	(0.144)	(0.125)
3+ per week	-	-
Child diarrhoea %		
5%	0.266*	0.274**
	(0.136)	(0.115)
10%	0.187	0.260**
	(0.129)	(0.107)
15%	-	-
Economic development components		
skills training	0.672***	0.550***
	(0.156)	(0.127)
pave main roads	0.420***	0.289**
	(0.150)	(0.123)
small scale crops	0.380**	0.211*
	(0.162)	(0.123)
None	-	-
Funds & labour for operations & maintenance		
Government	0.484***	0.444***
	(0.154)	(0.123)
Shared responsibility	0.466***	0.392***
	(0.132)	(0.114)
Resident funds & labour	-	-
Opt-out dummy	0.811***	-
	(0.277)	
Observations	2232	1,920

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. [a] This analysis has more observations because each unforced choice task choice contains three rather than 2 observations (scenario A, scenario B and "neither of these"). 10 respondents who subsequently chose "neither scenario" after every choice were excluded. [b]Full sample including 'speeders' and respondents who failed the dominant choice test question.

Table B3: Taxpayers sample – sensitivity to inclusion of full sample, and photo priming experiment for *DCE1-Outcomes*

Project Outcome Priorities	Full sample[a]	Randomly shown photos[b]	
		Yes	No
Water quality			
safe to drink after treating	0.610***	0.638***	0.578***
	(0.052)	(0.075)	(0.073)
never safe to drink		-	-
Water interruptions			
Never	0.552***	0.568***	0.532***
	(0.052)	(0.076)	(0.072)
1-2 per week	0.235***	0.185**	0.276***
	(0.048)	(0.071)	(0.067)
4-5 per week		-	-
Ponding restricting movement			
Never	0.201***	0.209***	0.203
	(0.048)	(0.067)	(0.069)
1 per week	0.125***	0.205***	0.041
	(0.047)	(0.067)	(0.067)
3+ per week		-	-
Child diarrhoea %			
5%	0.224***	0.261***	0.181***
	(0.047)	(0.066)	(0.066)
10%	0.105**	0.088	0.118*
	(0.043)	(0.062)	(0.061)
15%		-	-
Economic development components			
skills training	0.562***	0.460***	0.656***
	(0.051)	(0.074)	(0.069)
pave main roads	0.529***	0.475***	0.585***
	(0.051)	(0.073)	(0.072)
small scale crops	0.436***	0.418***	0.444***
	(0.047)	(0.068)	(0.066)
None		-	-
Funds & labour for operations & maintenance			
Government	0.332***	0.331***	0.351***
	(0.051)	(0.075)	(0.069)
Shared responsibility	0.341***	0.390***	0.300***
	(0.046)	(0.066)	(0.065)
Resident funds & labour		-	-
Observations	12,132	6,060	6,072

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ [a] Full sample includes speeders and respondents who failed the dominant choice test question. [b] We embedded a simple priming experiment imbedded in the taxpayer online survey. Respondents were randomly allocated to be shown (or not) photos of before and after upgrading works focused on ponding, drainage and paving upgrades. The photos are displayed below in Appendix Figure B1. We wanted to test preference stability, hypothesising that taxpayer respondents shown these photos would have more precisely estimated and larger preference weights for ponding and paving attributes-levels in *DCE1-Outcomes*. It appears that respondents randomly shown the photos, were more likely to significantly weight reducing *ponding to once per week*, than those not shown photos. This suggests taxpayers preferences may be somewhat malleable to priming and messaging.

Figure B1. Before and after upgrade photos – embedded randomised experiment.

Note: Sebelum = Before, Setelah=After.

Table B4: Conditional logit results of *DCE2-Implementation* with full sample

	Informal Settlements Full sample[a]	**General Taxpayer** Full sample[a]
Project duration		
1 year	0.371*** (0.128)	0.315*** (0.049)
2 years	0.103 (0.116)	0.182*** (0.050)
3 years	-	-
Consultation with the community		
Significant	0.124 (0.084)	0.268*** (0.035)
Minimal	-	-
Employment agreement with community		
Agreement in place	0.324*** (0.097)	0.497*** (0.038)
No agreement	-	-
Funds & labour for operations & maintenance		
Government	0.429*** (0.126)	0.427*** (0.052)
Shared responsibility	0.391*** (0.129)	0.535*** (0.052)
Residents fund & labour	-	-
Observations	1,280	8,088

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ [a] Full sample includes speeders and respondents who failed the dominant choice test question. b Weighted sample to account for predominantly female respondents.

Figure B2: Taxpayer views on government spending levels