Governing a Low Carbon Transition in Bogor's Transport and Residential Sectors: Tests and Applications of a Theory of Planned Behavior

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Abstract: Following the 2015 Paris Agreement, Indonesia joined a growing list of countries pledging to mitigate its greenhouse gases (GHGs) in a nationally determined contribution (NDC). Whether Indonesia will be able to achieve its proposed NDC reduction target of 29 percent (against a 2020 baseline) by 2030 will hinge on how effectively governments at different levels persuade consumer to purchase energy savings technologies or alter energy-intensive behaviors. In short, it will depend on how Indonesia governs its low carbon transition in fast-growing cities like Bogor. The Theory of Planned Behavior (TPB) can shed light on how governments and other stakeholders can help elicit these desired behavioral changes. The TPB holds behavioral change requires the intent to change behavior; intent is then triggered by 1) positive attitudes towards the behavior; 2) social norms promoting that behavior; and 3) a sense of control over that behavior. The article then employs structural equation modelling (SEM) to determine whether the constructs in the TPB hold on the intent to purchase energy savings appliances or use public transport for an original data set of 600 respondents from Bogor, Indonesia. The results suggests that the TPB generally holds on both energy savings options, with attitudes and control playing a greater role for appliances and social norms having a bigger effect on public transport. The policy implications of these findings for Bogor and other cities undergoing low carbon transitions in Indonesia are discussed in the conclusion.

Keywords: energy efficiency, public transport, structural equation modeling, behavioral change

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1 Introduction

Following the 2015 Paris Agreement, Indonesia pledged a nationally determined contribution (NDC) to mitigate its greenhouse gases (GHGs) by 29 percent against a business-as-usual (BAU) baseline by 2030. Indonesia's NDC also noted that the reduction target could increase to 41 percent with international technological and financial support. Indonesia has successfully achieved reductions in rates of deforestation and peat loss that are its largest national sources of GHGs. However, population and economic growth have increased energy consumption from the residential and transportation sectors. This growth raises important questions about what actions should Indonesia's government adopt in the transport and residential sectors to achieve the NDC targets.

A growing body of literature on low carbon development has pointed to the significant technical and economic potential from the consumer purchase of energy savings technologies and increased use of public transportation. In fact, these options are often not only technologically feasible but economically attractive. Some of this literature has also suggested that the most significant barriers to the successful adoption and widespread use of these options involve what kind of governance arrangements shape the behavior of actors at different levels of decision making. Governance is particularly important in the case of residential energy use and public transport because persuading end-use consumers to purchase or use energy savings options is not a costless exercise. Rather it can require investing significant resources and time to bring about the behavioral changes for the savings in estimated in low carbon modelling.

The article draws upon the Theory of Planned Behavior (TPB) to determine how governments and other stakeholders can help elicit desired behavioral changes. The TPB holds behavioral change requires the intent to change behavior; intent is then triggered by 1) positive attitudes towards the behavior; 2) social norms promoting that behavior; and 3) a sense of control over that behavior. The article then employs structural equation modelling to determine whether the constructs in the TPB hold on the intent to purchase energy savings appliances or use public transport for an original data set of 600 respondents from Bogor, Indonesia. The results suggests that the TPB generally holds on both energy savings options, with attitudes and control playing a greater role for appliances and social norms having a bigger effect on public transport. The policy implications of these for Bogor and other cities undergoing low carbon transitions in Indonesia.

The remainder of the paper is divided into six sections. The next section reviews relevant literature and presents the hypotheses. The third section presents the methods that will be used to test those hypotheses. A fourth section discusses results. A fifth section offers policy implications. A final section concludes.

2 Literature review

Almost ten years ago, the growing realization that developing countries would need to mitigate GHGs to keep temperature changes within two degrees of pre-industrial levels led to the extension of low carbon modelling to developing countries in Asia. With increasing empirical rigor and analytical precision, studies demonstrated that China, India, Indonesia, and other emerging economies possesses the technical and economic potential to move down a low carbon development path (Jiang 2009, Shukla, Dhar, and Mahapatra 2008, Shrestha, Pradhan, and Liyanage 2008, Retno and Kobashi 2010). Drawing from this research, many of these developing countries formulated climate policies and action plans that provided for concrete actions in key sectors. Indonesia was one of the country's willing to take early actions that were consistent with low carbon modelling.

A good example of this work in Indonesia focused on potential energy saving technologies. For example, Gunningham (2013) notes that electrical retrofits and other energy saving projects could increase efficiency by 25-40 percent in Indonesia. This kind of analysis has more recently looked at potential changes in cities in Indonesia (Colenbrander 2015; Batih and Sorpiputana, 2016). To illustrate, studies

have demonstrated that the following sets of interventions that could, in turn, bring significant reductions in energy from cities: 1) fuel switching in vehicles; 2) minimum energy performance standards of electric appliances; 3) green building standards; and 4) expansion of bus rapid transit (BRT) programs. Further, models showed that many of these actions have negative costs or cost savings in transport and residential sectors as many of the investments costs are less than capital-intensive with high sunk costs and could bring other desirable social (new jobs) and environmental benefits (less pollution) (Batih and Sorpipantana 2016).

As low-carbon research moved on from the national to subnational levels, it has uncovered at least three important insights about the potential for cost-effective mitigation. The first such insight involves the context-specific nature of the sectors with the greatest mitigation potential. For example, in the mid-sized Indonesian city of Palembang opportunities were not only available in the energy and transport sectors but also the waste sector (Colenbrander, et al 2015). Second, there was a growing need to acquire locally appropriate data to understand the scope of those opportunities; macro-level top-down analyses were likely to render an inaccurate picture of the magnitude and costs of mitigation (Papargyropoulou et al 2015). Third, the chief constraint in capitalizing on these opportunities was typically neither financial nor technological in nature; rather it frequently involved the lack of governance arrangements that would persuade policymakers at different levels and energy consumers to act on the potential cost-savings from transitioning to low carbon technologies. This research concluded that there is "a need for more effective energy governance to drive the transition to a low-carbon economy" (Sudmant, 2017).

There has in fact been a sizable literature on multi-level governance that has similarly underlined the importance of interactions within and between different levels of decision-making. Much of this literature has been more optimistic about the prospects of cities to take climate actions. This is because cities can be flexible and innovative, learning from each other through networks that facilitate peer-to-peer exchanges of knowledge and good practices (Corfee-Morlot et al 2009. Marks and Hooghe, 2001). At the same time, literature on vertical integration has been slightly more even-handed about the prospects for translating the global climate agenda into local actions. This line of reasoning stresses the back-and-forth interplay between national and local governments, highlighting that national governments can potentially motivate local governments to adopt locally appropriate innovations with finance, technology and capacity building resources. At the same time, a lack of supportive finance, technology, and capacity could lead local governments to relabel existing policies and measures as low carbon while struggling to move meaningfully away from business-as-usual practice (Michele and Bulkeley 2006).

While studies on multi-level governance and vertical integration shed important light on intergovernmental dynamics, they do not reflect deeply on the interactions between government agencies and consumers that are make many of the key decisions about low cost energy savings. This area of inquiry is critical because the reason that low-cost mitigation are indeed affordable is that they require altering behaviors that are costless in a purely economic sense. It is nonetheless evident that costless behavioral changes are not frictionless in the sense that they involve interactions between multiple actors. They often require, *inter alia*, initiating a process with possibly significant transaction costs that could convince people to abandon purchasing practices and decision-making routines. One of the keys to breaking away from these practices and routines is to provide information on the different benefits of energy savings. Filling information gaps relates to final branch of study, the aforementioned TPB.

The TPB (Ajzen and Fishbein 1980), one of the most widely cited and applied behavioral theories, nicely summarizes informational opportunities and constraints to change harmful behaviors. Initially applied in policy areas such as public health, TPB notes that different kinds of individual, social and

information factors lead to the intention to change behavior. That intention can then is the result of 1) a favorable (or unfavorable) individual attitude towards a behavior; 2) pressure to conform to social norms; and 3) sense of self-efficacy that changing behavior achieves an intended result. The theory therefore suggests that 1) positive attitudes about a behavior; 2) social norms; and 3) a sense of efficacy lead to intentions that bring about change behavior in that can result in the desirable divergence from standard practices (Figure 1).

As such, interventions that aim to induce behavioral may need to influence attitude about a behaviors; social norms; and/or the sense of control. Further, it is unlikely that these changes will happen by themselves; rather they often require different levels of governments working with other actors to persuade consumers of the attractiveness of different behavourial change. Finally, the types of information and awareness raising offered by governments will likely to be most effective if it worked on the three different constructs mentioned in the TPB. The next section begins to look at whether the dynamics described in the TPB apply to the city of Bogor, Indonesia.

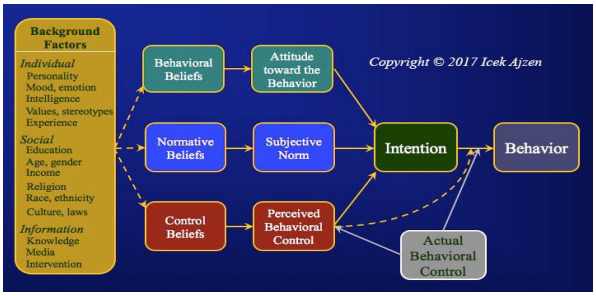


Figure 1: Theory of Planned Behavior

Source: Icek Ajzen 2017

3 Setting the scene

Bogor is a fast-growing city located approximately an hour via train and traffic-free car travel from Jakarta. Through the 1990s, Bogor's population grew at average 10.25 percent before holding at a more moderate 2.8 percent pace in recent decades. While many of those people are concentrated in Bogor's densely populated center (12,000 persons/km$_2$) (as dense as Tokyo's metropolitan area) growing pockets of residents in the city's six districts have created several sub-centers. Bogor's tropical climate (avg. temperature 33℃, avg. humidity 90%), appealing landscape, and proximity to Jakarta have led to not only population growth but significant lifestyle and purchasing pattern changes over the past 30 years. These shifts in livelihood and consumer preferences have, in turn, increased energy use and demand for motorized transport. Nighttime satellite imagery of the Jabodetabek region and Bogor clearly demonstrates the city's ongoing transformation. (Figure 3).

Figure 2: Map of Bogor

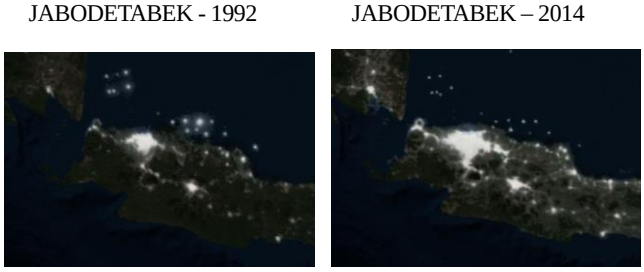


Figure 3: Night-time satellite imaging

Source: NOAA

At present, some constraints on Bogor's growth are becoming evident due to this transformation: fluctuation of voltage is reducing the lifetime of electrical appliances. At the same time, sharp increases in land prices and commuting costs in central Bogor are creating gridlock and traffic in many parts of the city. In the future, these constraints could become even more difficult to manage. For instance, end-use electricity consumption seems likely to rise with the

purchase of larger houses, air conditioners, computers and other energy-intensive appliances. Traffic may also become worse as an expansion of the city's road network will take time due to investment requirements and possible tensions with residents concerned over the removal of historical and culturally significant architecture and existing building tenants.

The good news is that Bogor has already introduced several measures that can help address immediate and future energy needs while lowering GHG emissions (in line with the NDC target). These include several policies and measures intended to increase energy efficiency. For example, the revised National Energy Policy (KEN) (2014) sets energy efficiency targets for multiple sectors, including the transport and residential sectors (Table 1). KEN further mandates regional and local governments to develop energy conservation plans (RIKED) based on overarching central plans. The national government has also sought to expand the development of energy efficiency standards and labelling for electric appliances with enforcement starting initially with ballasted lamps in 2015 followed by air conditioners in 2016 (IEA 2017); further plans for additional appliances (e.g. rice cookers, refrigerators and fans) are likely to follow. Bogor (public transport, walking and cycling) is also aiming to expand the use of non-motorized modes of transport and expand the coverage of its Bus Rapid Transit (BRT) program. These efforts are being supported by the German overseas development agency Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) since 2016 as part of a seven city project that will serve as a model for other cities. Table 2 lists other policy priorities based upon a scoping of relevant policies and measures.

While many of the proposed policies and measures will help moderate the adverse impacts of Bogor's growth, implementing these interventions will not be costless. Some of the costs will involve investing in infrastructure; and these can best be assessed by using low carbon modelling that initially gained traction at the national level in Asia and is now making its way to cities such Palembang. Another set of costs will require working with government and other stakeholders at different levels to adopt and adapt innovative solutions to common problems; these can be analysed using some of the insights from the multi-level governance and vertical integration literature.

A third set of costs—and the ones most relevant to this study--involve persuading consumers to change their purchasing patterns and use alternative modes of transport. Reducing these third set of costs could involve working on the three main constructs in the TPB—that is, individual attitudes, social norms, and self-efficacy. The next section of the paper examines whether there is indeed in relationship between the intention to save energy in the residential and transports sectors and those three main constructs.

Table 1 National regulations and plans on energy conservation / efficiency

Year	Legislation	Measures	Target
2005	National Masterplan for Energy Conservation (RIKEN)	Identifies the energy savings potentials through fiscal incentives, training, energy audits. Saving potentials are: Industry: 15-30%, Commercial buildings: 25%, Households: 10-30%.	Decrease energy intensity by 1% annually until 2025
2009	Government Regulation no 70	**Standard and labelling** for energy efficient products are introduced	
2010	Vision 25/25 of the Ministry of Natural Resources and Energy	Aims to reduce energy consumption by saving energy and diversifying energy	Decrease energy consumption by **15.6% by 2025 from BAU**
2011	Presidential Instruction No. 13	Instructions to measure water and energy saving are shared with national and local leaders	20% off electricity; 10% off fuel;10% off water
2012	MEMR Ministerial Regulation no. 12	Regulations are phased in to improve fuel quality in government and state owned enterprise vehicles, freight and logistics vehicles, and cargo ships	
2012	MEMR Ministerial Regulation no. 13	Electricity savings targets are introduced for national and local government offices (air-conditioner, lighting etc) and state-owned companies' offices.	20% off electricity
2014	New National Energy Policy (KEN)	Decreasing energy elasticity as a function of GDP to below one by 2025 and **a focus on energy efficiency measures.**	

Table 2. Bogor's policy priorities related to energy

conservation / efficiency

Bogor City RPJMD (2015-2019)	West Java Province (RIKED)
Mobility and public transport management	
• Improve urban infrastructure • **Enhance public transportation (i.e. BRT)** • Enhance pedestrian walkways, park and ride • Promote non-motorized transport	• Traffic control and engineering on roads under provincial jurisdiction • Traffic control and engineering at intersections • Railway construction in West Java
Waste service and sanitation management	
• Integrated waste management • Improve 3R activities	
Disaster risk and climate change responsiveness	
• **Green buildings** • Green space	• Implementation of energy audits, energy-saving audits, and energy management audits • Improvement of energy efficiency (by 25% by 2030)

Note: The RPJMD is the city's five year development. The RIKED is the subnational energy conservation plan.

4. Survey Data and Tests

To test whether the relationship does indeed exist the section draw upon survey data collected over a two-month period in the fall of 2015. The data was gathered through in-person interviews for 600 respondents (response rates were relatively high at 81 percent) in collaboration with the Agriculture University of Bogor. A team of surveyors from the Agriculture University of Bogor received a standard set of instructions on the substance of the questions and targeted households based on a sample that represented the diversity of residents in Bogor.

Table 3. Demographic constructs

Category		Number	Percentage
Gender	Male	300	50%
	Female	300	50%
Age	Below 19	2	0.33%
	20s	91	15.17%
	30s	154	25.67%
	40s	132	22.00%
	50s	96	16.00%
	60s +	51	9.00%
Location	Central Bogor (Total population)	66 (103,719)	10.27%
	West Bogor (Total population)	131 (224,963)	22.27%
	Tanah Sareal (Total population)	118 (209,737)	20.77%
	North Bogor (Total population)	110 (179,615)	17.78%
	East Bogor	59	9.95%
	(Total population)	(100,517)	
	South Bogor (Total population)	116 (191,468)	18.96%
Household size	1 person	23	3.9%
	2 people	65	11.0%
	3 people	132	22.3%
	4 people	155	26.2%
	5 people	114	19.3%
	6 people or more	102	17.3%
Education level	College graduate or above	95	15.8%
	High school graduate or above	155	25.8%
	Entered high school but have not graduated	229	38.2%
	Did not reach high school	117	19.5%
	Other_____	4	0.7%
Home ownership	Own a home	514	85.7%
	Renting a home	79	13.2%
	Others	7	1.2%
Vehicle ownership	0	520	86.7%
	1	73	12.2%
	2	6	1.0%
	Over 2	1	0.2%
Motorcycle Ownership	0	136	22.7%
	Over 1	564	77.3%

In distributing the survey, the research team made considerable efforts for geographic representativeness and gender balance although the representation of high income households might be slightly low than reality due to the difficulty of approaching them. Respondents were selected in proportion to the city's population in six districts and their 68 villages (Table 3). Further, the same proportion of men to women was preserved across Bogor's 68 villages making up the six districts (Table 3)--though the statistical data shows there is an average of 2 percent more women than men in Bogor (Bogor City Socioeconomic Data, 2014). There was a tendency to

Other important characteristics of sample were as follows. The modal response for the age of respondents was in the 30s with the next highest concentration of respondents in the 40s (the mean age was 43). When it came to household size, the highest percentage of responses was for households with four people (26.2 percent), followed by three people (22.3 percent), and five people (19.3 percent). Few respondents lived in households with only one (3.9 percent) or two people (11 percent). The vast majority of respondents—over 85 percent—owned a home; only 13 percent rented a residence.

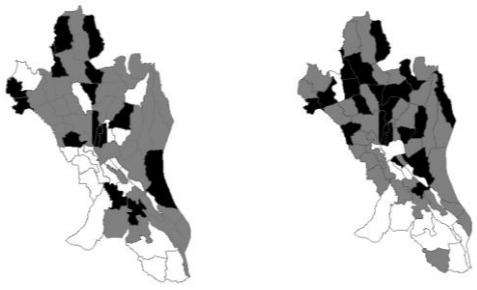
We would like to add this is 2015 and Bogor is increasingly becoming more urbanized but at the time

of the survey, for energy use, the majority of the households owned basic appliances such as lights with these numbers generally increasing with income. The number of refrigerators were also revealing: most households owned at least one but that number grew when income exceeded 5.1 million IDR. Somewhat surprisingly given Bogor's tropical climate, over 70 percent of respondents did not own an air conditioner (Table 4). The number of households without a car was 86 percent; most of the motorized transport owned by citizens were motorcycles (Table 3). When looking at the per capita income level, the survey responses showed that respondents beyond an income of approximately over 5.1 million IDR would own cars (Table 4). Citizens below that income level, typically owned two wheelers. This arguably reflects both the flexibility and affordability of motorcycles in Bogor's congested streets. The majority of respondents were employed in the private sector (54.3 percent) with the next highest proportion indicating they were housewives (22.7 percent). Education levels followed an approximate normal distribution, with the plurality of responses belonging to the "entered high school but did not graduate" category (38.5 percent).

Table 4. Appliance and vehicle ownership by income

		Monthly income level (IDR)			
Equipment	Units	0-2.5 million	2.6-5million	5.1-7.5 million	Above 7.6million
Air conditioners	0	97%	85%	87%	71%
	1	2%	12%	13%	12%
	2	0%	2%	0%	12%
	3	0%	1%	0%	6%
Refrigerators	0	21%	7%	13%	0%
	1	71%	82%	60%	82%
	2	4%	9%	27%	18%
	3	0%	1%	0%	0%
	4	0%	1%	0%	0%
Lighting	1-5	35%	16%	20%	6%
	6-10	55%	61%	53%	29%
	11-15	5%	16%	20%	47%
	15-	0%	7%	7%	18%
Cars	0	96%	79%	67%	35%
	1	3%	9%	27%	53%
	2	0%	1%	7%	6%
	3	0%	0%	0%	6%
Motorcycles	0	30%	11%	27%	24%
	1	52%	54%	47%	41%
	2	13%	27%	27%	24%
	3	5%	8%	0%	12%

As shown in Figure 4, the spatial distribution for electric appliances and motorcycles were similar with both concentrated in central and central northern side of Bogor: the affluent residential district closest to Jakarta had the highest concentration.



Motorcycle ownership Electric appliance ownership

Figure 4: Distribution of ownership

Note: The colors indicate the different levels using the average number of units per household in each respective district. Black is the highest, grey the next highest and white is the lowest.

4.2 Structural equation model

To examine the relationship between the main constructs in the TPB in Bogor, the paper employs a structural equation model. SEM is a methodology for representing, estimating, and testing a relationship between latent or unobservable constructs using observable variables. The model combines techniques familiar to confirmatory factor analysis and multivariate regression to determine whether aggregate or groups of observed variables of similar characteristics represent unobserved constructs. It then oys an approach known as confirmatory factor analysis (CFA) to see how the different constructs/latent variables relate to each other. The latent variables constructed through a combination of two different models: 1) the measurement of an individual's views and responses to a question in a measurement model; and 2) the individual's socioeconomic characteristics in a structural model. The following formula denote both models.

[Measurement model] $\mathbf{y}_i = \mathbf{K}\boldsymbol{\eta}_i + \boldsymbol{\Lambda}\mathbf{x}_i + \boldsymbol{\varepsilon}_i$ (1)

[Structural model] $\boldsymbol{\eta}_i = \mathbf{B}\boldsymbol{\eta}_i + \boldsymbol{\Gamma}\mathbf{x}_i + \boldsymbol{\zeta}_i$ (2)

For each individual i, $\boldsymbol{\eta}_i$ is the latent variable, $\mathbf{x}_i$ is an objective variable $\mathbf{y}_i$ is the observed variable that indicates subjective views, $\mathbf{B}$, $\boldsymbol{\Gamma}$, $\mathbf{K}$, $\boldsymbol{\Lambda}$ stand for unknown parameters, $\boldsymbol{\zeta}_i$, $\boldsymbol{\varepsilon}_i$ represent for residuals.

Table 6: Measurement model

Latent construct	Observed variables	Public Transport	LED
Norms	Have you received energy savings training?	**1.05 ***	**1.00 ***
	How much do you participate in energy savings campaigns?	**1.00 ***	**0.97 ***
Attitude	Indonesia has pledged to reduce emissions by 26% to 41% through cooperation with other countries. How aware are you of this pledge?	**1.00***	**1.00 ***
	Bogor promotes the use of biofuel for public transportation by recycling cooking oil from the city's shopping centers and eateries. How aware are you of this policy?	**0.98***	**1.31 ***
Control	How aware are you of the benefits of energy savings?	**1.00***	**1.00 ***
	The main source of energy in most countries are fossil fuels. Have you ever heard of renewable energy?	**1.08***	**1.18 ***
	Do you check your monthly costs of energy use for both electricity and fuel?	**1.46***	**1.44 ***
Intention	Would you choose to use the BRT instead of your own vehicle to reduce fuel cost?	**1.00***	
	Would you choose to use the angkot instead of your own vehicle to reduce your fuel cost?	**1.35***	
	Would you replace your conventional lightings to LED in your house to reduce your electricity bills?		**1.00 ***
	An energy efficiency labelling program exists for electric appliances. Do you select appliances based on this program?		**1.15 ***

The asterisks * indicate that the coefficients are statistically different from zero at the 5 percent level

Part of the logic for using SEM is it can help determine whether the factors that determine citizen's choice and behaviors are respondents' "attitudes" about a behavior; social "norms"; and a sense of "control" (efficacy); that would then lead to "intentions" that bring about behavioral change. These constructs are therefore the latent variables.

The coefficients between the subjective views and the latent variables are presented in Table 6. As shown, all of the path coefficients are statistically different from zero. The aforementioned CFA is used to group the eleven answers into four latent constructs.

Table 7: Structural model

Predictors	Attitude	Norms	Control	Intention
Public transport				
Gender				
Male	-	-	-	-
Female	-0.01	-0.01	**0.01 ***	**0.25 ***
Age	0.00	0.00	0.00*	0.01
Income	0.08	0.05	0.07	-0.02
Education	**0.15 ***	0.12	0.13	**0.02 ***
Car number		**0.11 ***	**0.01 ***	**-0.35 ***
Motorcycle number		0.04	0.03	-0.28
Energy efficient appliances				
Gender				
male	-	-	-	-
female	-0.26	0.14	0.00	0.00
Age	0.06	-0.02	0.00	0.00
Income	1.10	0.48	**0.07 ***	0.00
Education	1.97	-0.99	**0.13 ***	-0.05
Car number	-	-5.96	0.01	0.00
Motorcycle number		0.04	0.03	-0.28

The asterisks * indicate that the coefficients are statistically different from zero at the 5 percent level

The structural model in Table 7 presents the relationship between key observed demographic variables such as gender, income and education and their impacts on energy-related decisions. These decisions will be explored in greater detail in the remaining sections of the article.

As shown in Table 5, Bogor citizens were asked questions about their knowledge of energy and climate-related policies, energy saving benefits, and willingness to choose energy efficient technology or switch to energy savings transport modes. The results showed that residents were generally well informed about climate and energy policies (55% were aware of the national target for emissions reduction, and 71% were aware of the city's model project to use biofuel for public transport). Most had not participated in public awareness raising events (93.7%) or campaigns

(91.8%) on energy savings; so while over 68% indicated they were aware of the energy savings benefits, a much smaller number participated in the kind of training activities that would provide detailed instructions on how to save energy.

The TPB constructs related to intensions to save energy involved the decision to select light emitting diode (LED) and two forms of public transport (BRT or traditional angkots). In terms of the former, 85% of respondents said they would choose LEDs over conventional lights. Meanwhile, only half the respondents indicated that they would switch from personal vehicles to either BRTs or angkots.

Table 5. Percentage Breakdown of Responses

Questions	Answers	Ratio
How aware are you that Indonesia has pledged to reduce emissions by 26% to 41% through cooperation with other countries?	0: No 1: Not interested 2: Have heard 3: Yes aware	31.7% 12.2% 21.2% 34.5%
Have you received energy savings training?	0: No 1: Yes	93.7% 6.3%
How much do you participate in energy savings campaigns?	1. Never 2. Yes, sometimes 3. Yes routinely	91.8% 7.0% 1.2%
How aware are you of the benefits of energy savings?	1. I do not know 2. I have heard 3. I am aware of the benefits	31.2% 29.1% 39.7%
In many countries, the main source of energy are fossil fuels. Have you ever heard of renewable energy?	1: Yes 2: No	66.3% 33.7%
Do you check your monthly costs of energy for both electricity and fuel?	1. Never 2. Sometimes 3. Yes	26.0% 22.0% 48.2%
Bogor promotes the use of biofuel for public transportation by recycling cooking oil from the city's shopping centers and eateries. How aware are you of this policy?	0: No 1: Not interested 2: Have heard 3: Yes aware	21.5% 6.6% 31.5% 40.4%
Would you choose to use the BRT instead of your own vehicle to reduce fuel costs?	1: No 2: Yes	46.5% 53.5%
Would you choose to use the angkot instead of your own vehicle to reduce fuel costs?	1: No 2: Yes	45.1% 54.9%
An energy efficiency labelling program exists for electric appliances. Do you select appliances based on this program?	0: No 1: No interest 2: Probably yes 3: Definitely yes	16.8% 20.5% 41.2% 21.5%
Would you replace your conventional lights with LEDs in your house to reduce electricity bills?	1: No 2: Yes	15.0% 85.0%

For the transport options, the role of social norms were measured with questions about respondent's level of participation in energy saving activities (Table 6). The attitudes about switching to public transport were assessed through a question on their knowledge of policy promoting locally sourced biofuel for public buses and national target for GHG emission reductions. The level of control (or ability) to switch to public transport were measured by whether they received information to reduce "fuel" consumption by regularly checking energy bills—that is, whether they felt that they could have some effect on energy savings.

One way of evaluating whether there was indeed the postulated relationship between the latent constructs is to look at the goodness of fit. Root Mean Square Error of Approximation (RMSEA) helps to measure the level of the residuals in the model. RMSEA values vary from 0 to 1; smaller value are indications of better model fit. The RMSEA was 0.087 and goodness to fit index reaching 0.94.

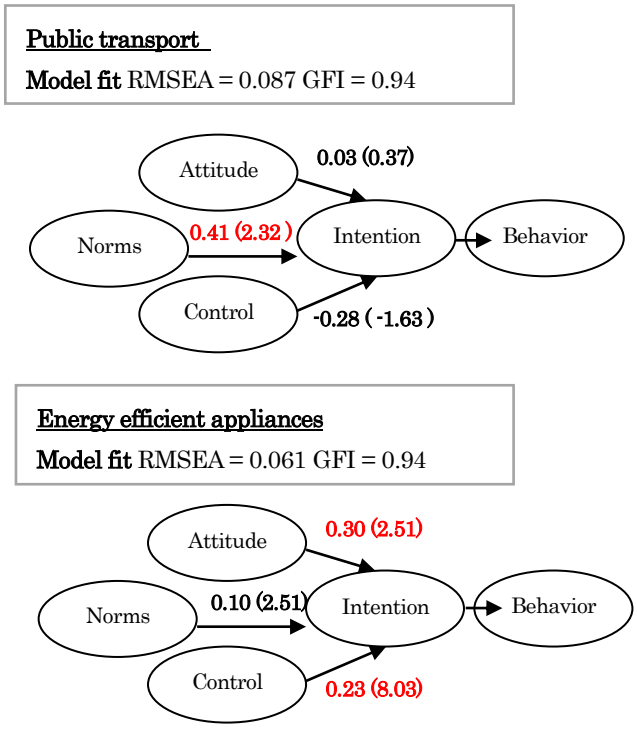


Figure 5: Factors on intentions for behavioral change

Note: The figures shown here are factor loadings that indicate the correlation between the latent variables.

Another way to evaluate the results of the modelling by showing the relation between the latent variables represented by Figure 5. It shows that the "norm" is a stronger predictor of "intentions" to choose BRTs and angkots "attitudes" and "control." This

suggests the more frequently the respondents participate in energy saving training, the greater the belief that that there is a social norm to select public transport. Furthermore, a comparison between intentions to switch to angkots (path coefficient 1.35 in Table 6) were larger than BRTs (path coefficient 1.0 in Table 6); this is not surprising given the shortage in the number of existing and functioning BRT corridors. Current intentions were greater for female respondents, negative for people with high-income levels, as well as those with cars and motorcycles (Table 7).

4.2.1 Energy efficient appliances

A similar set of techniques to those used for the transport options were applied for the energy savings technologies. The "intent" construct was represented by responses to questions on the intent to use energy efficient appliances in the form of LEDs; and by examining whether respondents used energy saving labels making a purchase. The CFA was employed here as well to group the responses into one of the three factors.

In this model, the role that social pressure might exert on respondents' probability to switch to energy efficient appliances was based on the same question for the transport sector: level of participation in energy saving activities. Respondents' belief that switching to energy efficient appliances was in line with social norms was assessed by their support to two policies: the national labelling system for energy efficient appliances; and the national target for reducing GHG emissions. The level of control (or ability) to switch to energy efficient appliances was measured by whether they received information that allowed them to reduce fuel consumption: or through regularly checking energy bills. The model fit was even better than those for transport with Root Mean Square Error of Approximation (RMSEA) RMSEA at 0.061 and GFI at 0.96.

Figure 5 shows the strongest determinant is a favorable "attitude" towards using energy savings appliance. Respondents who were aware of the consequences on the environment (i.e. climate change) as well as their own economic benefits, indicated a stronger intention to choose more efficient appliance. Currently, respondents with higher income and education levels fit that category and choose more energy savings options. (Table 5); attitudes for people with less income or education were less likely to fit into that category.

5 Policy implications

Interestingly, the results show determinants of energy savings might vary between energy savings appliances and public transport in Bogor. To promote a modal shift from passenger vehicles to public transportation, social pressure to influence behavior is the greatest determinant. This suggests spending time with others who are also inclined to use save energy would be most persuaded to take this option. Meanwhile, to promote use of energy efficient appliances, a clear understanding and better communication of the consequences of one's action on the environment is critical. In diffusing a new technology, it is hence essential to communicate to potential users the benefits of new technology. Users would also choose to use the new technology when they perceive it can enhance productivity and used effortlessly.

These findings have several real-world implications for Bogor and other cities. For example, the introduction of the BRT in Bogor has not been as rapid as in Jakarta; Indonesia's poster city for BRTs. This suggests a technological lock-in exists preventing it from being socially accepted. Research shows BRTs are facing resistance because it could possibly destabilize and promote the decline of the incumbent industry, angkots, who employ political, social, and cultural pressure over the government. Another reason could be because while Jakarta made sure BRTs had a dedicated bus lane, those in Bogor did not. This offered little incentive for vehicle owners and motorcycle owners to switch to BRTs since rates for parking was affordable. Parking rates in the central business areas will be raised to offer disincentives to use vehicles.

To remove such social tensions and promote transitions to BRTs the message communicated by the government could brand them as a positive means that offers universal access, by targeting passengers that are elderly, children and especially woman who the survey results show had intentions to use the BRTs. Their action range tends to be limited to their residential district and immediate surroundings. An introduction of a community bus by the city government which circulates around locations frequently visited; the closest shopping center, the local schools, the closest transit station for long distance buses under short and regular patterns; could prove to be a useful tool. Monitoring and verification should be made of how such efforts remove vehicles off the streets; improve air quality; and increases safety for non-drivers. This would increase the social status of the BRT, and create a social norm that supports the means. It will also be in tune with the BRT initiative promoted by the national government (SUTRI NAMA 2016).

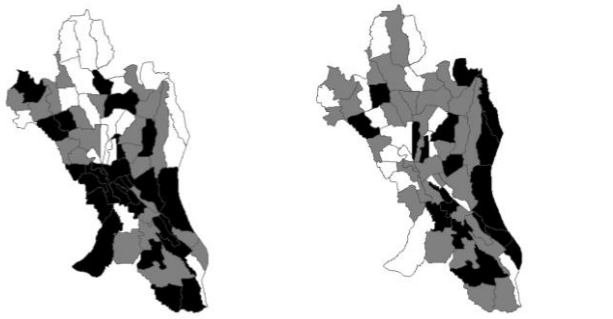
Recent studies on Indonesia's similar policies, "ekolabels" introduced in 2006, show the low influence on citizens' behavior government agencies and authorities possess in changing a social norm. It suggests the label on its own would not promote behavioral intentions, and recommends a subsidy or reward to be used in parallel (Nadlifatin et al, 2016). This article suggests the government's role is to target districts at which intentions to use the suggested technologies were prominent compared to the surrounding areas. These were regions where residents' level of ownership was still low and have the potential to rise as the economy grows (Figure 6).

The next appliance after lightings that has the potential to grow are air-conditioners once the price drops sufficiently for it replace the dominant incumbent technology, fans. Considering the speed in which demand spread widely in Singapore due to it resemblance of high social status, the same could happen in Indonesia which enjoys the same tropical climate. Discussions with a local citizen in 2018 reveals this is already occurring in Bogor.

Being socially responsible is an urge that is rising among citizens in general and climate change mitigation and adaptation should be one important message that could trigger demand for low carbon technology as it is supposed to counter this universal problem.

Structured education on monetary and social benefits and consequences of not making a selection based on energy savings is required preferably before consumptions surge upward. A majority seeks information from television programs (Bogor city socio-economic data 2017) but while this measure is suitable for widely dispersing uniform information, behavioral change should be induced through repeated and regular communication, a two-way stream with financial incentives or a target developed into the system.

Such efforts should be developed as initiatives / programs relevant to plans, policies and regulations developed and implemented by formal vertical platforms between central – regional – local governments to gain political and financial support. More important, however, is the establishment of an informal platform that consists of international and local actors of non-government officials (i.e. citizens, communities) that complements those efforts to which innovative cities are already reaching out to.



Intentions to use the BRT to reduce fuel costs

Intentions to save energy by looking at energy efficiency labels

Figure 6: Distribution of intentions

Note: The colors indicate the different levels using the average number of units per household in each respective district. Black is the highest, grey the next highest and white is the lowest.

6 Conclusions and way forward

These findings are useful for environment policymakers in cities of developing countries at

which: supply side planning and management (i.e. infrastructure development) is decided by the national government which strongly adheres to the vested interests for resources and land from primary and secondary industries; and regional and local governments are hoped to set new examples for an energy transition under a nascent decentralized governance system using demand side management. It is also a timely topic as Indonesia removes its subsidies on fuel and electricity for end-use that had until recently limited incentives to save energy.

The study is, however, just one part of a bigger picture on how to promote energy savings behaviors and technology diffusion with some suggestions for possible institutional arrangements. Further studies are required on how to overcome additional constraints and technical risks that can undermine transitions at multiple levels. Comparative case studies across rapidly growing cities might offer useful insights into how these barriers can be overcome. They could also complement some of the findings from this research.

Reference

[1] Government of Indonesia 2016. First Nationally Determined Contributions Republic of Indonesia

[2] Jiang K. 2009. Energy and Emissions Scenarios up to 2050, Presentation at the IGES-ERI Policy Dialogue, Toward a Sustainable, Low Carbon Asia: Policies and International Cooperation, 22-23 September 2009. Beijing, China.

[3] Shukla, P. R. Dhar, S. and M., Diptiranjan. 2008. Low-Carbon Society Scenarios for India Climate Policy, 8, supplement 1: S156-S176

[4] Shrestha, R. M., Pradhan S. and M. Liyanage. 2008. Effects of Carbon Tax on Greenhouse Gas Mitigation in Thailand. Climate Policy, 8, supplement 1: S140-S155.

[5] Retno, G. D. and T. Kobashi. 2010. Low Carbon Scenario 2050 Case: Indonesia Energy Sector, Presentation at Sustainable and Low-Carbon Development (LCD) in Indonesia and Asia: Dialogues between Policymakers and Scientists on Green Growth (GG) 16 February 2010, Bogor, Indonesia.

[6] Gunningham 2013. Managing the energy trilemma: The case of Indonesia. Energy Policy. Volume 54, March 2013, Pages 184-193

[7][10] Colenbrander, Sarah, Andy Gouldson, Andrew Heshedahl Sudmant, and Effie Papargyropoulou. 2015. The economic case for low-carbon development in rapidly growing developing world cities: A case study of Palembang, Indonesia. Energy PolicyVolume 80, May 2015, Pages 24-35

[8][9] Batih and Sorapiputana 2016. Characteristics of urban households′ electrical energy consumption in Indonesia and its saving potentials. Renewable and Sustainable Energy Reviews. Volume 57, May 2016, Pages 1160-1173

[11] Papargyropoulou, E., Colenbrander, S., Sudmant, A.H., Gouldson, A. and Tin, L.C., 2015. The economic case for low carbon waste management in rapidly growing cities in the developing world: The case of Palembang, Indonesia. Journal of environmental management, 163, pp.11-19.

[12] Sudmant, A.H., Gouldson, A., Colenbrander, S., Sullivan, R., McAnulla, F. and Kerr, N., 2017. Understanding the case for low-carbon investment through bottom-up assessments of city-scale opportunities. Climate Policy, 17(3), pp.299-313.

[13] Corfee-Morlot, Jan, Lamia Kamal-Chaoui, Michael G. Donovan, Ian Cochran, Alexis Robert and Pierre- Jonathan Teasdale, 2009, “Cities, Climate Change and Multilevel Governance”, OECD Environmental Working Papers N° 14, 2009, OECD publishing, © OECD

[14] Marks and Hooghe, 2001, “Types of Multi-Level Governance”. European Integration online Papers (EIoP), Vol. 5, No. 11, October 12, 2001.

[15] Michele M. Betsill, Harriet Bulkeley. 2006, Cities and the Multilevel Governance of Global Climate Change. Global Governance: A Review of Multilateralism and International Organizations: April 2006, Vol. 12, No. 2, pp. 141-159.

[16] Ajzen and Fishbein 1980. Understanding attitudes and predicting social behaviour.

[17] IEA. Accessed on Jan 2018. http://www.iea.org/
[18] SUTRI NAMA. Accessed on Dec 2017. http://www.transport-indonesia.org/sutri-project-framework.html
[19] [21] Bogor City Socioeconomic Data. Accessed on Jan 2018. https://bogorkota.bps.go.id
[20] Nadlifatin et al. A Pro-Environmental Reasoned Action Model for Measuring Citizens' Intentions regarding Ecolabel Product Usage. Sustainability 2016, 8(11), 1165