Identifying House Owners' Decision Making Factors in Adopting Earthquake Resistant Construction for Removing Obstacles in Reducing Earthquake Disaster Risk in Bandung City

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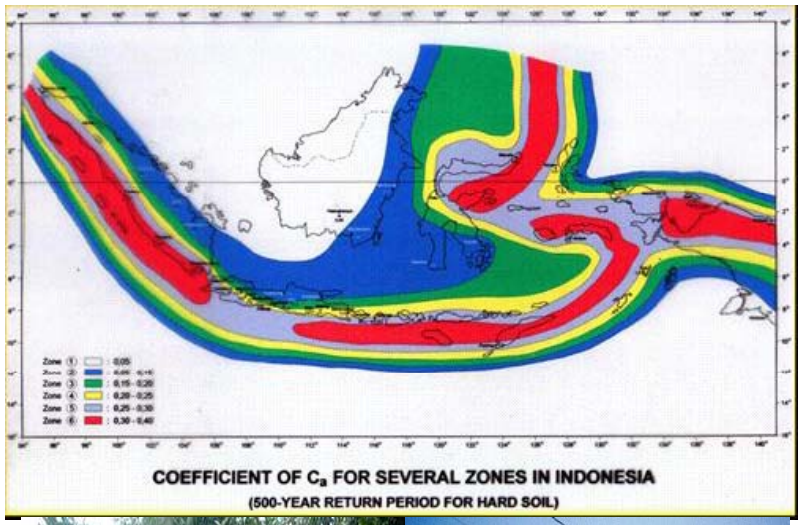
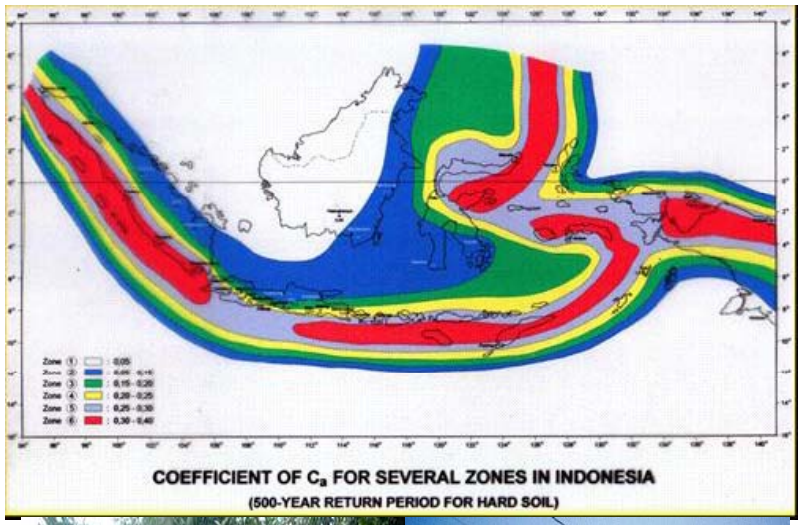
Background

- Indonesia is an archipelago where four global tectonic plates meet
- 50% of its population (~ 100 milions) live in urban areas, cities and towns which are vulnerable to earthquakes.
- Bandung city (capital of West Java province), medium seismic hazard but high seismic risk due to lack of public awareness and high vulnerability of a large part of its housing stock.
- Many houses, mostly non-engineered buildings, do not adhere to earthquake resistant building requirement.
- Dire need to promote earthquake resistant construction to reduce earthquake risks

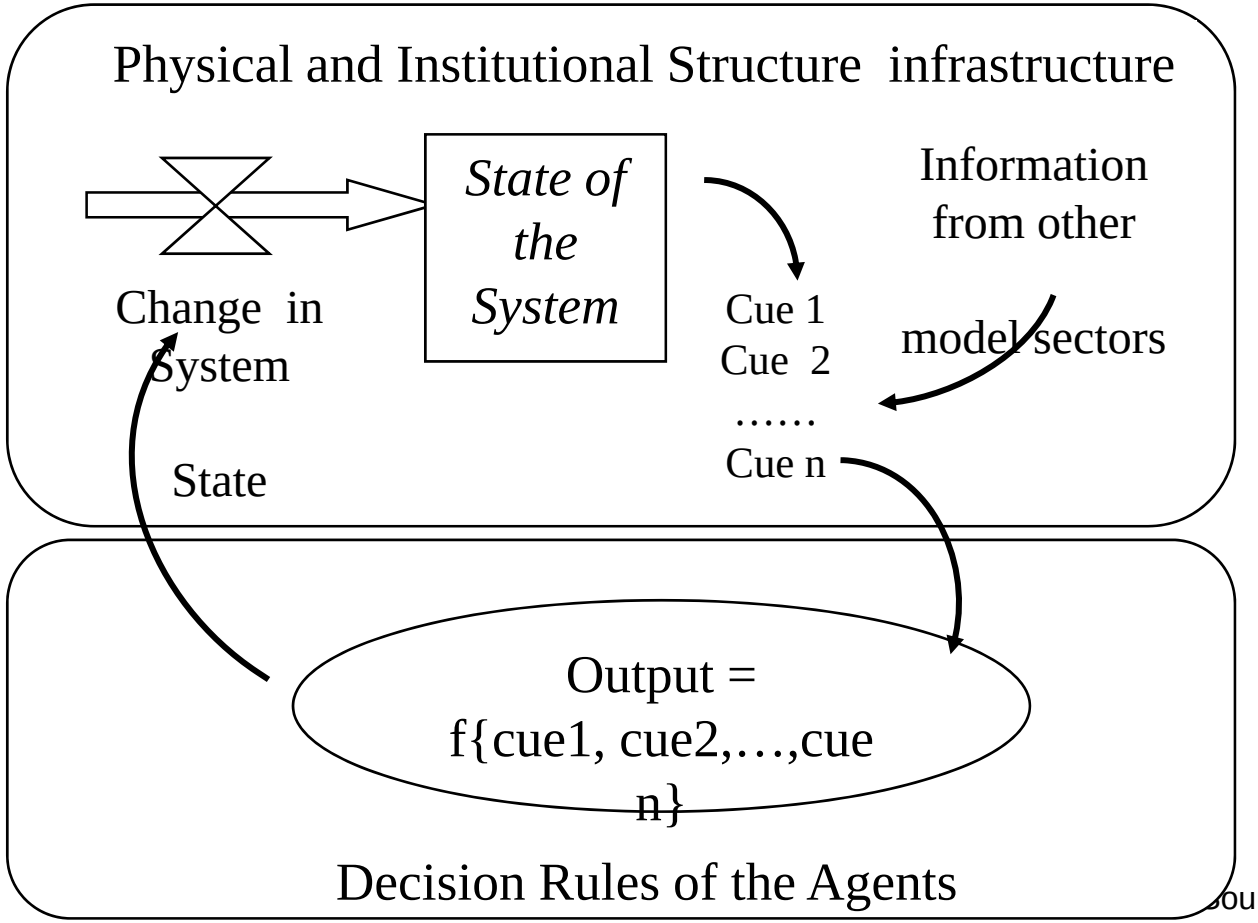


Background

- Many factors influence the community or house owners in making decisions on the adoption of earthquake resistant house construction.
- The study aims to develop a system dynamic model of interaction between the factors
- System dynamic model is used for simulation to understand which factors are stronger in influencing the decision of home owners for building earthquake resistant houses (case study Bandung City)
- Effort to reduce obstacles can be focused on the most influencing factor(s)



Dynamic of a Feed-back loop System
(Sterman, 2000)



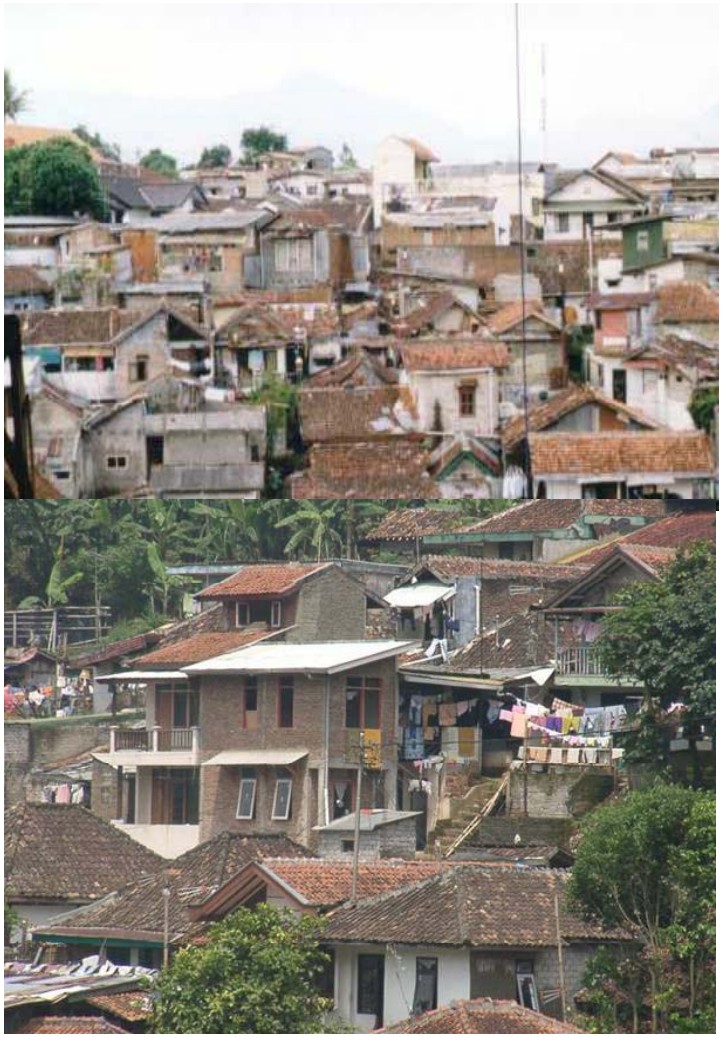
Source: Sterman, 2000

Concept of System Dynamic

- change of state as the dynamic of the system,
- decision rules applied to cues generated by the state, combined with the cues from the system environment, produce decisions , which are then fed-back into the system to produce a new dynamic state
- causal-loop diagram combined with stock-flow model will be developed to represent policy and decisions and their environmental reactions
- computer simulation to understand the system behaviour.

Study Area

- Bandung earthquake hazard : PGA from 0.18g (in the north) to 0.235g (in the south) (RADIUS Project, 1999)
- Population density quite high (13.505 pop/km2)
- Vulnerable structure of houses (mostly non-confined and confined masonry type, reinforced concrete framed houses, wooden and bamboo houses)
- The study considers social economic condition, common education level, human development index, house building vulnerability



Earthquake impact in Bandung

- the risk of a destructive earthquake in Bandung should not be overlooked.
- Example of a recent earthquake is the West Java M7.0 earthquake on 2 September, 2009, 14.55:01 local time, epicenter at 7.809°S, 107.259°E, depth at 46.2 km epicenter, 100 km south-south west of Bandung.

Source : Pikiran Rakyat Newspaper, www.pikiranrakyat.com

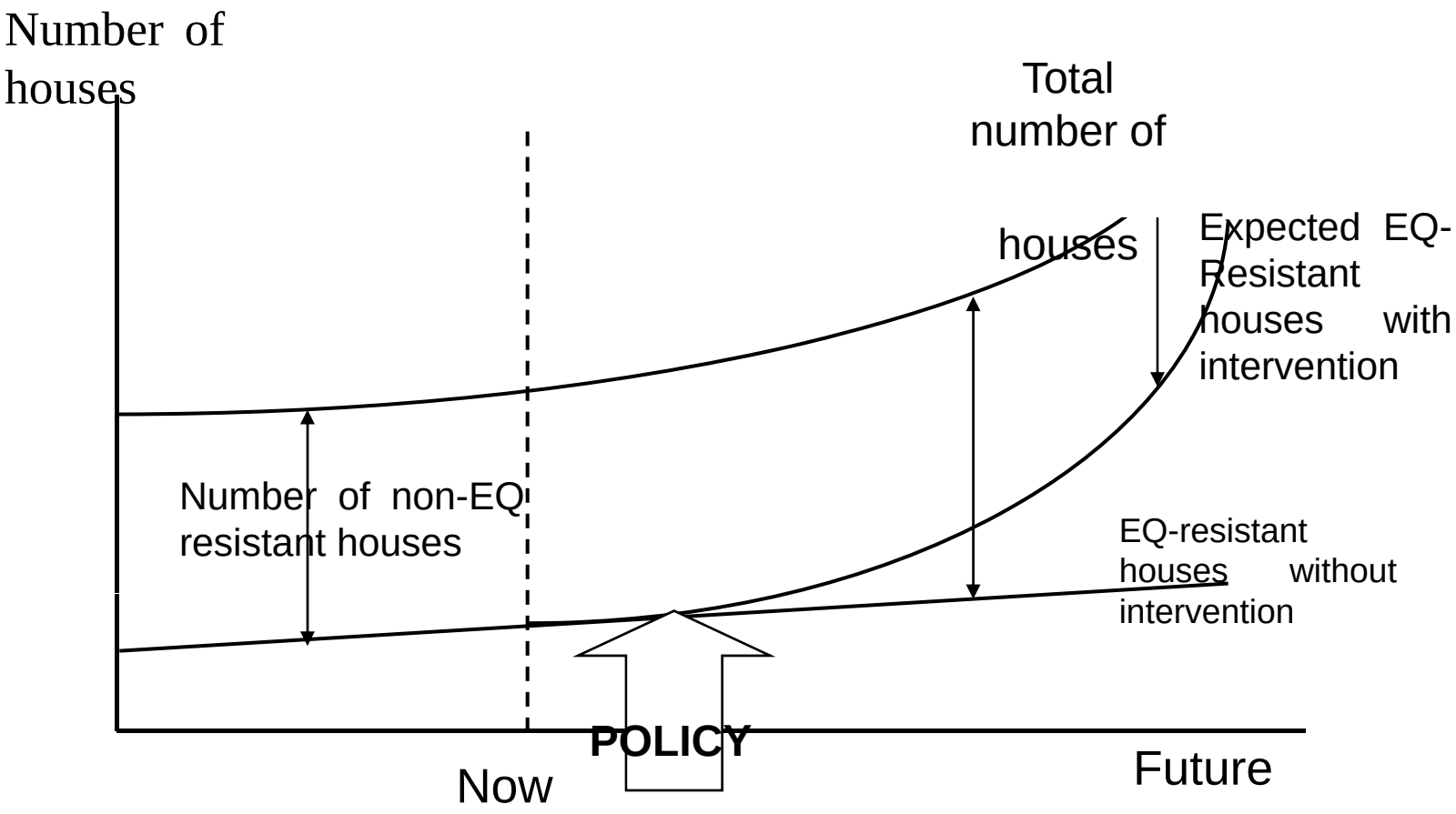
system dynamic modeling

- development cycle of a dynamic model, combining qualitative and quantitative approach, proposed by Wolstenholme (1990, in Yuliani 2003)
- Qualitative model is used to interprete the result of quantitative model so there will be agregate explanation with regard to how the system work, and as basis for further research.
- mix of qualitative and quantitative ideas → strength of system dynamic, accomodating more users while still being rigorous in the approach.
- human judgement can be used to quantify the qualitative information in modeling the social system (Nuthman, 1994), i.e.: (1) nominal, (2) ordinal, (3) interval, and (4) ratio.

Assumptions and hypothesis in the model building

- empirical facts that the housing need grows in line with the population growth,
- the understanding of seismic hazard in Bandung will motivates people to adopt earthquake resistant strategy
- in actual situation the growth in housing construction is not followed significantly by the growth of earthquake resistant houses (EQRH)(through new construction or retrofitting/strengthening).
- a certain policy intervention will increase the number of EQRH

Hypothesis

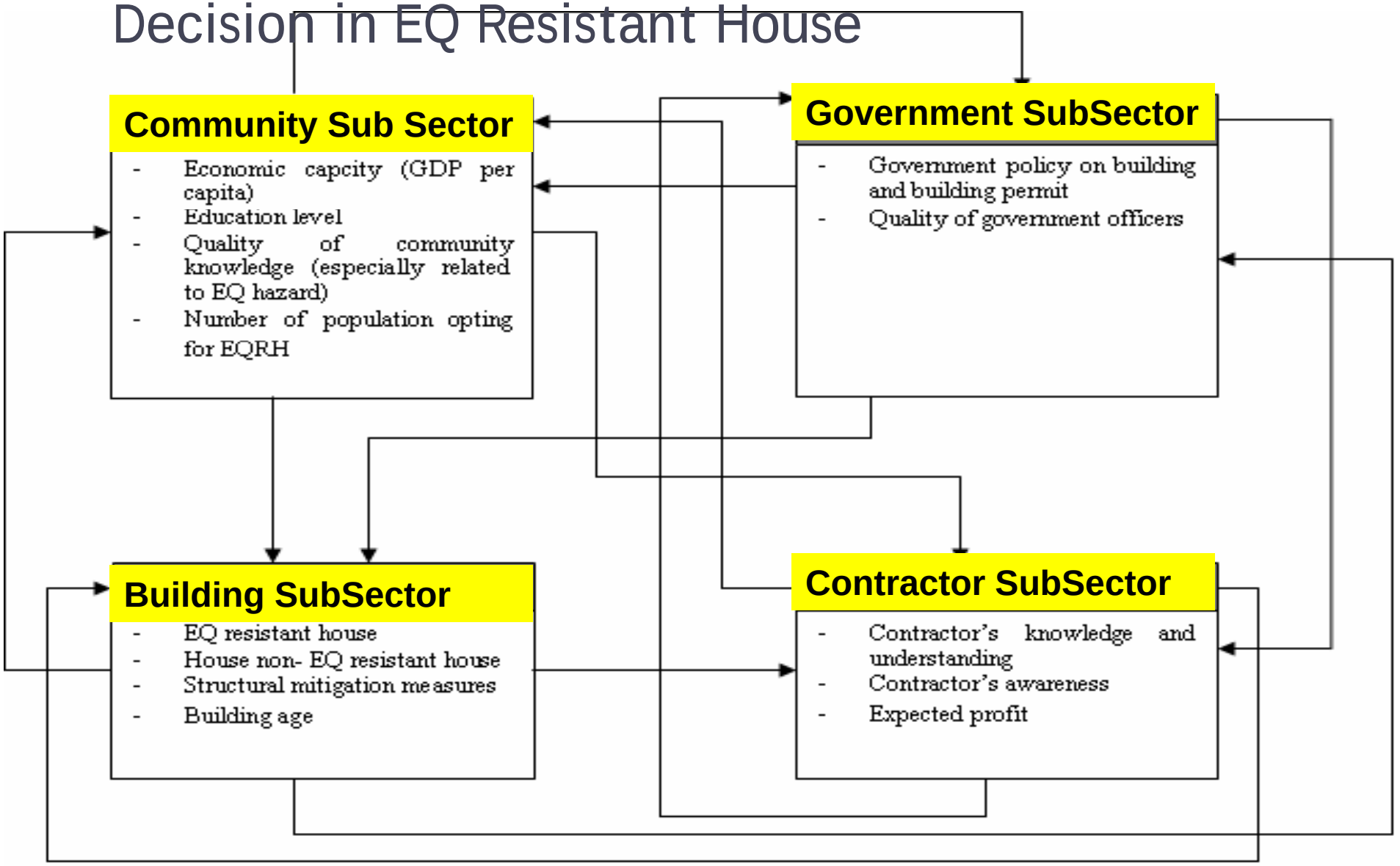

Number of houses
Total number of houses
Expected EQ-Resistant houses with intervention
Number of non-EQ resistant houses
EQ-resistant houses without intervention
POLICY
Now
Future

[11] Kebijakan bangunan tahan gempa mencakup peraturan terkait dengan bangunan dan bangunan tahan gempa, implementasi, serta penegakan hukumnya, termasuk insentif dan disinsentif-nya.

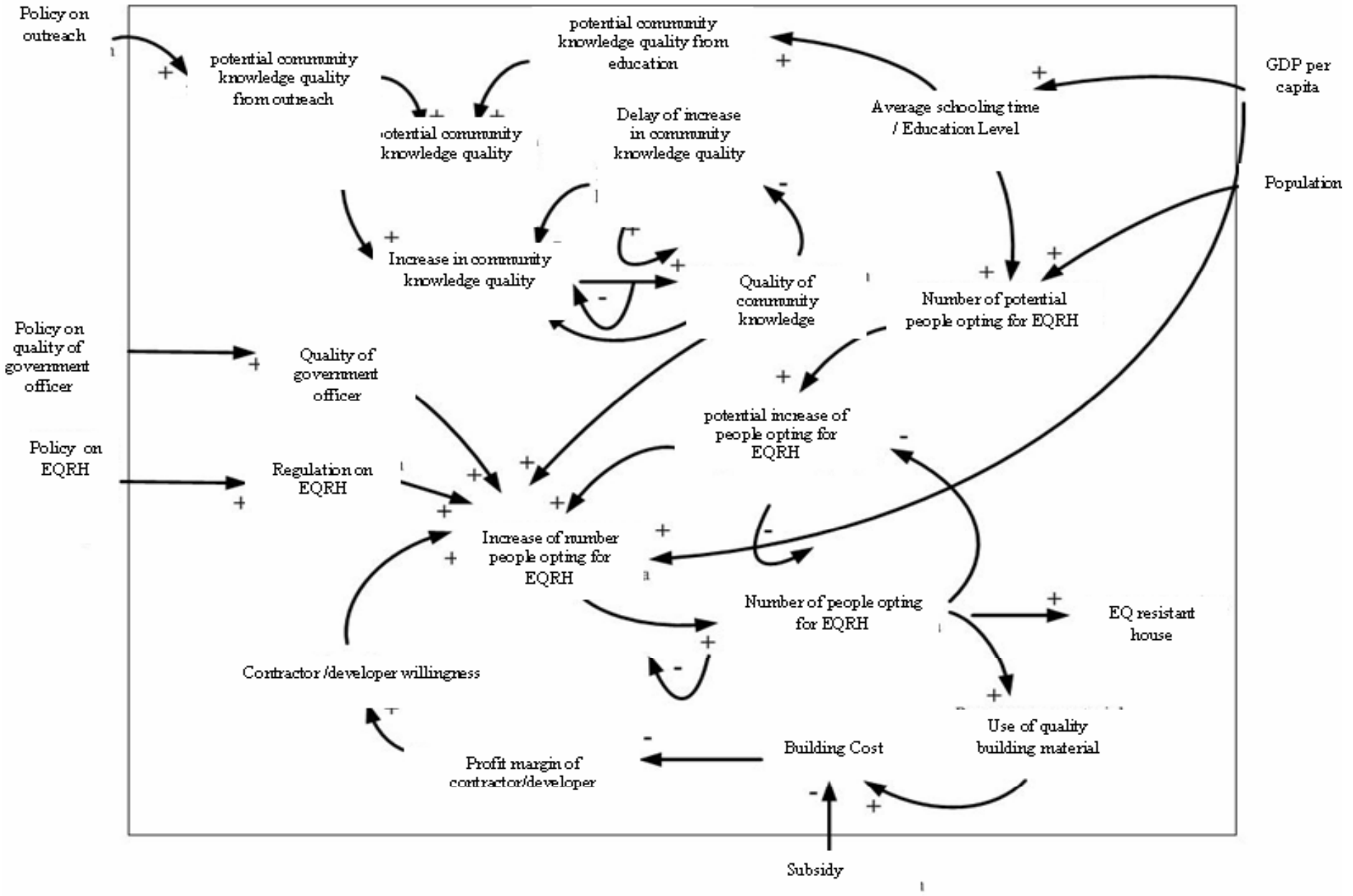
MODEL BOUNDARY AND VARIABLES

Endogenous Variables	Exogenous Variables	Neglected
Quality of knowledge of house owners/community	Outreach	Historic citizen
Education of House owners/community	Quality of government officers	Historic EQRH
Number of house owners adopting EQRH	Policy on EQRH	Historic Non-EQRH
Use of good quality material	Population	Historic total number of houses
Developers/contractors' profit margin	GDP	
Number of EQRH		
Number of Non-EQR House		

Global Model of Factors that Influence Community Decision in EQ Resistant House



Causal Loop Diagram



Policy Scenario

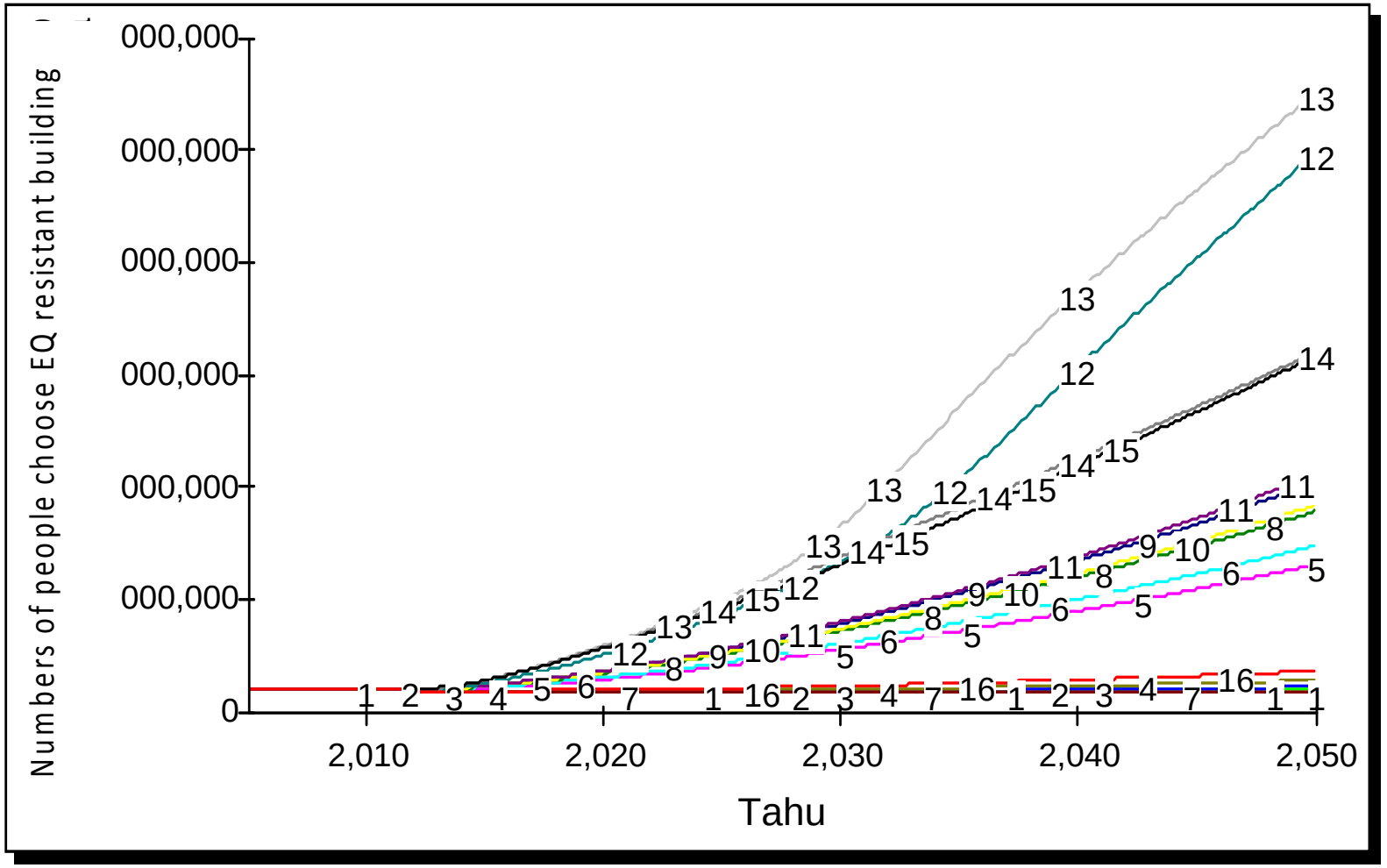
- Community Outreach → Quality of community knowledge
- Government officer quality
- Policy with regard to EQ resistant house
  - Regulation regarding EQ resistant house
  - Law enforcement→ sanction, insentive, disinsentive
- GDP per capita→ level of community income
- Profit Margin of contractor (policy with regard to subsidy of house development)
- Various policy scenarios (16) were developed using different level of intervention measured in qualitative and quantitative level of performance, normalized to values between 1% to 100%.
- Simulation with POWERSIM

16 Scenarios

No	Scenario	Description
1	Basic scenario (1)	Based on field finding : outreach 1 %, quality of government officials 60%, building regulation 1 % from ideal value, GDP per capita growth 6 %/year.
2	Scenario I (2)	Intervention on outreach, 50% from ideal
3	Scenario II (3)	Intervention on outreach, 80% from ideal
4	Scenario III (4)	Intervention on government officers quality, 80% from ideal
5	Scenario IV (5)	Intervention on buildfing regulation, 50% from ideal
6	Scenario V (6)	Intervention on buildfing regulation, 80% from ideal
7	Scenario VI (7)	Intervention on economic level, per capita GDP growth up to 8%per year
8	Scenario VII (8)	Intervention on outreach and regulation (each up to 50% from ideal)
9	Scenario VIII (9)	Intervention on outreach and regulation (up to 50% and 80% respectively from ideal)

No	Scenario	Description
10	Scenario IX (10)	Intervention on outreach and regulation (up to 80% and 50% respectively from ideal)
11	Scenario X (11)	Intervention on outreach and regulation (each up to 80% from ideal)
12	Scenario XI (12)	Intervention on outreach (50%), government officers quality (80%), regulation (50%)
13	Scenario XII (13)	Intervention on all factors: outreach (80%), government officers quality (80%), regulation (80%), and economic growth(8%)
14	Scenario XIII (14)*	Intervention on all factors: outreach (80%), government officers quality (80%), regulation (80%), and economic growth(8%). The difference with Scenario 13 : contractor's profit margin maksimum (50%) all the time
15	Scenario XIV (15)**	Intervention on all factors: outreach (80%), government officers quality (80%), regulation (80%), and economic growth(4%)
16	Scenario XV (16)***	Intervention on outreach (80%), government officers quality (80%)

Number of Population Deciding to choose EQ resistant house with different Scenarios



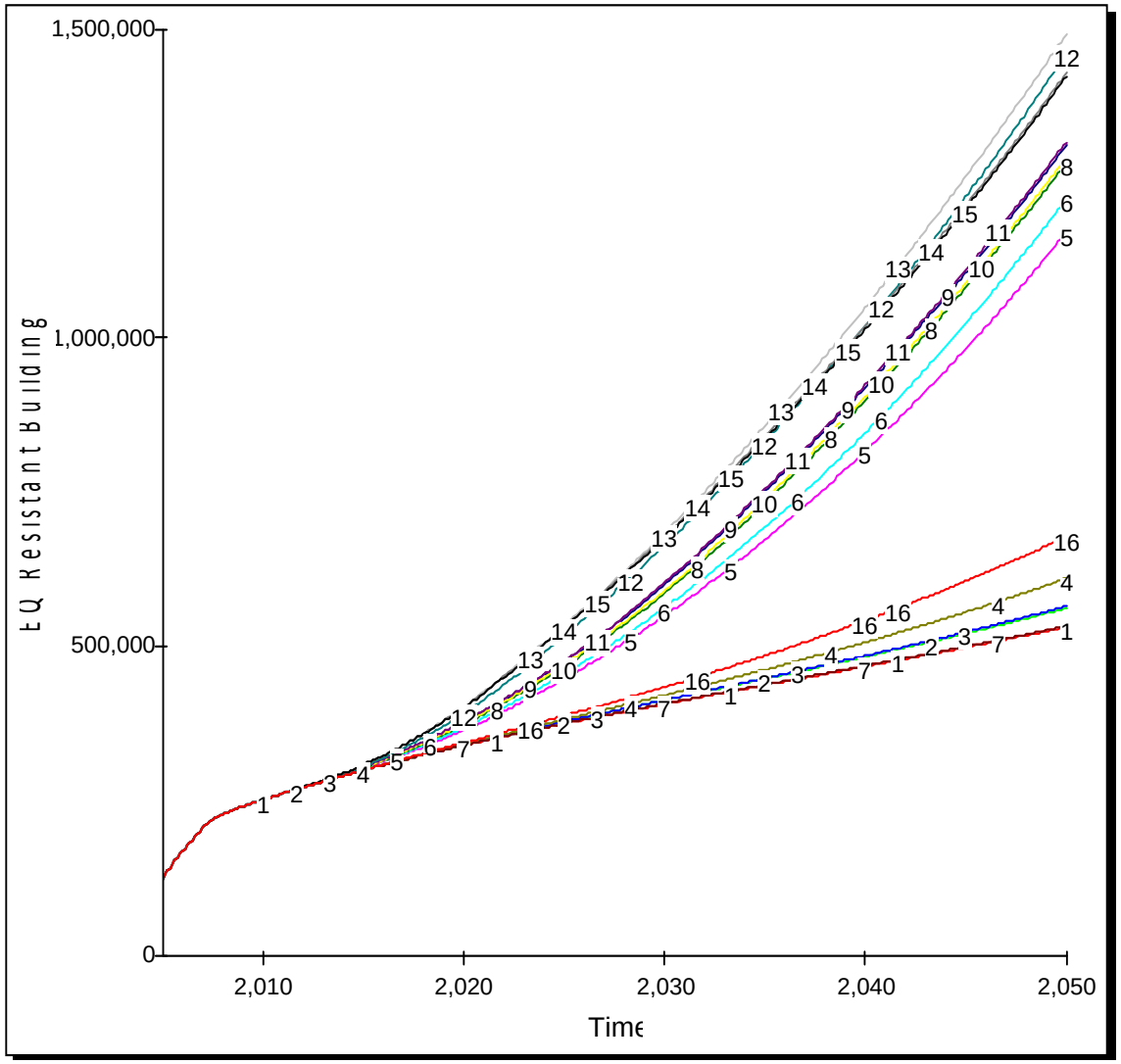
Number of population opting for EQRH

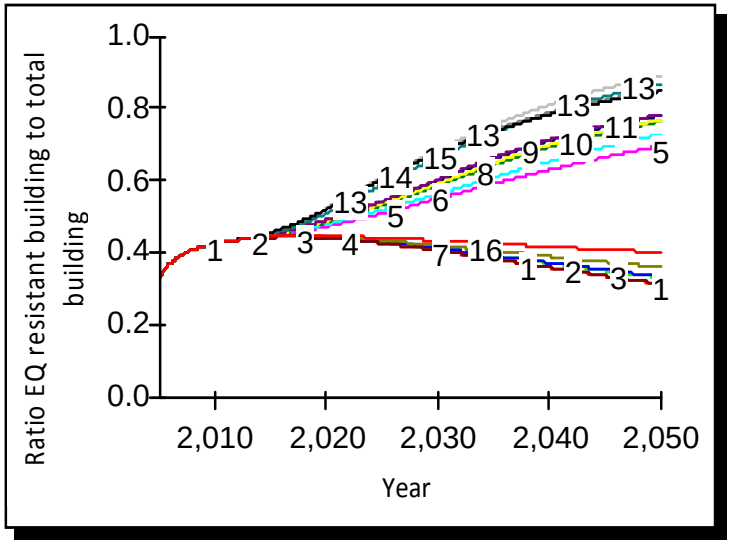
- Number of population deciding to opt for EQRH will increase significantly when building policy and regulation are improved

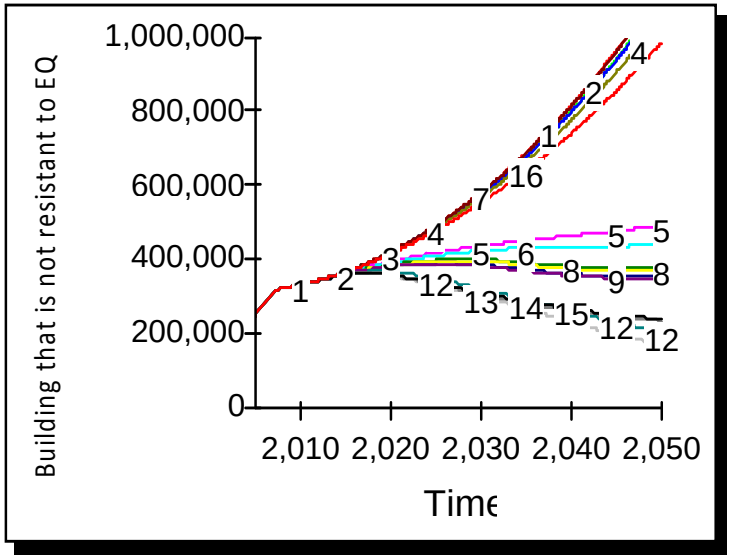
- It will increase drastically if the policy with regard to outreach to improve quality of community knowledge, quality of government officer (to increase community trust), and regulation on EQRH are improved in paralell (Scenarios 12, 13 , 14, 15)

- Other factors do not affect significantly the number of people opting for EQRH

Number of EQRH, Ratio EQRH to the total , and Non -EQRH



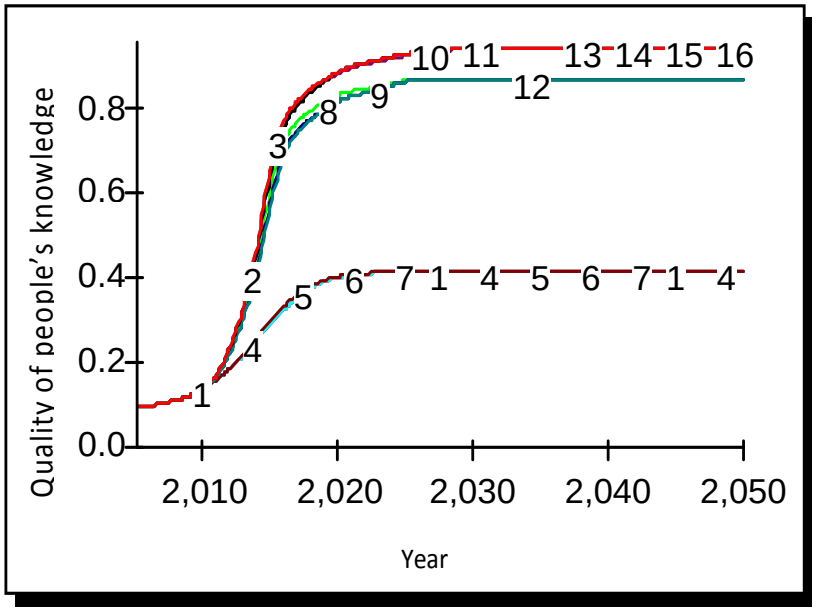




Number of EQRH

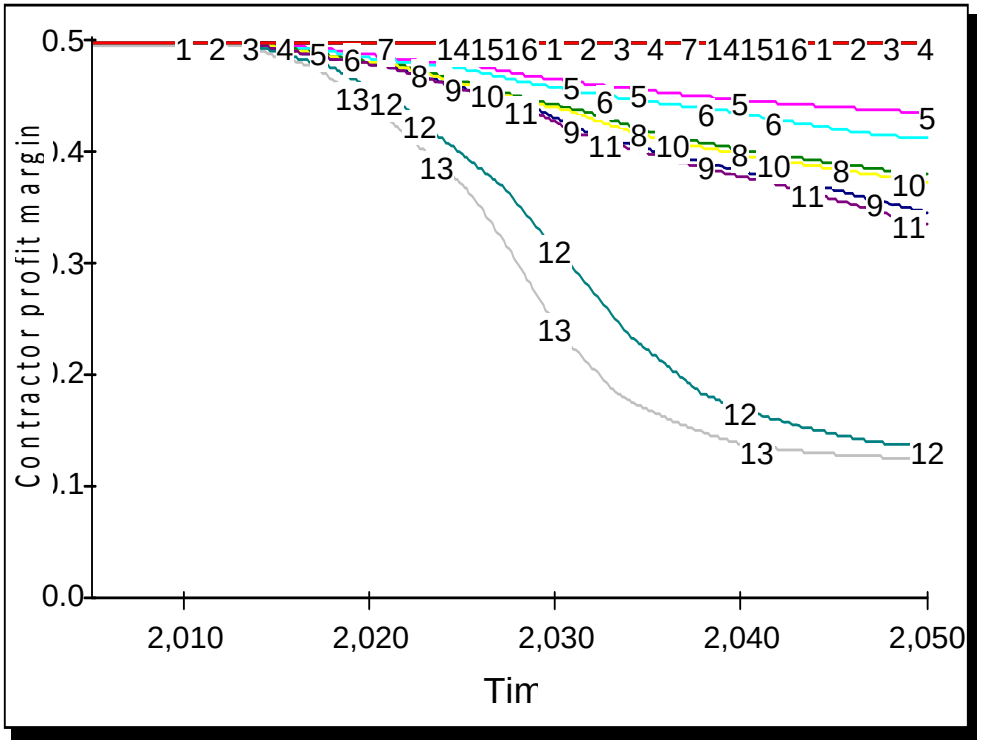
- Number of EQRH will increase if proper policy interventions are implemented
- Number of non resistant houses will decrease with the proper policy interventions

Quality of community knowledge and contractor/developer's profit margin



- Quality of community knowledge improved with policy intervention on outreach

Developer may reduce profit margin when policy interventions are to improve community income level, building regulation, and government officer quality



Concluding Remarks

- Most significant and influencing factor among various factors affecting the decision of community (house owners) in choosing earthquake resistant house is the government policy on building regulation.

- Other factors are also significant only when building and earthquake resistance regulations are improved first (quality of regulation, enforcement, and control, incentive and disincentive system) :
  - improving outreach activities (training and education for house owners and craftsmen),
  - improving government officers' quality and
  - improving the income per capita of the population

Prospects

- The approach could provide policy makers with useful new insights on what are the obstacles to promote earthquake resistant building to existing or future house owners, in order to reduce earthquake risk.
- The investigation found that the lack of adequate government policy and regulation on earthquake resistant buildings is the main obstacle to the promotion of earthquake resistant building among house owners and community.
- Need to develop better way to improve and iplement effectively regulation on earthquake resistant buildings/houses

Limitations

- number of earthquake resistant building are associated only to those having building permit, without looking at the actual fact that building permit does not always guarantee that the house will perform well in an earthquake.
- Limitation of number of respondents for determining existing performance level of the variables
- It also assumes that an EQRH is only based on good quality material and adequate cost/budget, without considering other characteristics.
- No variables on land availability related to the growth of house numbers

Recommendation

- Model Boundary:
  - There are no land varaibel to limit the development of house number increasing (include EQ resistant house and the house that is not resistant to EQ), due to house development will be limited by land availability
- Data source (primary and secondary):
  - Limited secondary data, there is not research with regard to number of existing EQ resistant house yet
  - Primary data is very limited, for example need more respondent

Thank You