Recurring Design Concepts for Resiliency in Asia

Heru Wibowo Poerbo
School of Architecture, Planning and Policy Development, Institut Teknologi Bandung, Ganesha Street No 10, Bandung, Indonesia

Email: heru@ar.itb.ac.id

Abstract. Community resiliency has not been a topic that consciously applied in architectural design, although it may have been addressed as other design aspects. Ten leading universities from around the world undertook design competition and conference focusing on designing resilience. Cases for the competition were village or district in Asia that are prone to natural disaster. This paper investigates most common design concepts proposed by the participating universities. The investigation is performed on the design proposals in the 2015, 2016 and 2017 Designing Resilience in Asia competition using theme analysis method. Concepts like protecting the main production facility and providing shelter for the residence during the peak of the natural disaster might be common to several of the participants. The identification of recurring design concepts in the competition entries can help us understand the important issues that have to be dealt with in designing resilience in settlements in our region. New design concepts for resilient community can be learnt from the settlement design by participants from ten countries around the world.

1. Introduction
Architects have not been designing for resilience until now, because architectural design principles mainly concern the conception of building shape and space for its aesthetic and functional use. Newer design principle of green building for environmental conservation has been adopted and generally accepted by architects. In designing larger area, such as site plan of a residential compound or a village, the ecological consideration in design is translated into sustainable design. However, resilient design calls for more than just sustainability because by definition a resilient place must be able to recover and resume its life after being hit by catastrophe.

Architects still need to learn more about designing resilience due to the scarcity of design theory about this subject. Moreover, designing resilience that entails community involvement in strengthening their living place might be different from one region to the other. Therefore it is imperative to study the issues that have to be dealt with in designing resilience in settlements in our region. The annual design competition and conference focusing on designing resilience in Asia provides an excellent opportunity to learn more about this subject.

The Designing Resilience in Asia event is organized by the National University of Singapore. Ten leading universities from Asia, Europe, America and Australia participated in the closed design competition since 2015. The participating universities are: Bangladesh University of Engineering and Technology (BUET), Center for Environmental Planning and Technology University, India (CEPT), Institut Teknologi Bandung, Indonesia (ITB), Louisiana State University, USA (LSU), National Cheng Kung University, Taiwan (NCKU), National University of Singapore (NUS), Royal Melbourne
Institute of Technology, Australia (RMIT), South China University of Technology, China (SCUT), Technische Universität Darmstadt, Germany (TUD), University of Pennsylvania, USA (UPENN), Université de Montréal, Canada (UDM). Cases for the competition were village or district in Asia that are prone to natural disaster.

This paper investigates most common design concepts as well as the winning team’s design concept proposed by the participating universities. The investigation is performed on the design proposals in the year 2015, 2016 and 2017 Designing Resilience in Asia competition using thematic analysis method.

2. Theory on Resilience
In the DRIA International Research Programme, ‘resilience’ is viewed as a model for anticipating, preventing and preparing for the effects of climate change. Due to the global climate change such as sea level rise, flooding, typhoons, coastal erosion, storm surges, subsidence or droughts, resilience is not only timely but critical under the exigencies of those environmental effects.

The objective of the design is to return the original environmental qualities to the urban milieu. This is done by designing practical actions to adapt to the impacts of climate change, protecting communities and reducing vulnerability, while mitigating the causes of global warming and climate change through specific solutions that actively contribute to the environmental recovery. DRIA uses the definition by Cutter [1]: “Resilience is the ability of a social system to respond and recover from disasters and includes those inherent conditions that allow the system to absorb impacts and cope with an event (...) adaptive processes that facilitate the ability of the social system to reorganize, change, and learn in response to a threat.”

The 100RC (Resilient Cities Network) defines urban resilience as “the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.” Building urban resilience requires looking at a city holistically: understanding the systems that make up the city and the interdependencies and risks they may face. By strengthening the underlying fabric of a city and better understanding the potential shocks and stresses it may face, a city can improve its development trajectory and the well-being of its citizens. [2]

3. Research Method
Thematic analysis is used to examine the theme within data (Boyatzis 1998) [3]. Data is collected from the design proposals in the 2015, 2016 and 2017 Designing Resilience in Asia competition. Each year there were 17 to 19 entries in the competition, as each participating university may submit one or two proposals. Altogether there were 54 design proposals in the three years of competition. Coding of the data is done with regard to the resilience theory and particularly to the brief of each year’s competition. The next phase is combining the codes into overarching themes that accurately depict the data. Analysis looks at how the themes support the data and the main theoretical perspective. Finally, the conclusion of this research is presented as design issues that should be taken into consideration when we design for resilience in Asian countries.

The objective of the design is to return the original environmental qualities to the urban milieu. This is done by designing practical actions to adapt to the impacts of climate change, protecting communities.

3.1. Method for Data Collection
The data collection is done by archive study available in the repository of DRIA international contest website at http://www.designingresilience.com. The contest entries of each participating team are documented in the form of high resolution panel images, short narratives on proposed draft concepts and presentation files. Archive studies can be performed on DRIA competitions in 2015 and 2016, whereas in 2017 it can only be done by taking note directly during the presentations because the
archives for the 2017 competition were not available at the time of writing of this article. In 2015 and 2016 the author followed the presentation of all participants as well as in the year 2017.

3.2. Analysis Method
Analysis is done by reading the concepts of planning and design of the proposed area of each participant. Coding and classification of data are made into tables for each participant in each competition year. The frequency of concepts put forward by each participant is an indicator that the concept is important for the design's resilience of the location.

4. The Designing Resilience in Asia Competition Case
The 2015 DRIA case was Xinxing Harbour Village. The village is located in the Hainan Province, China. There are 350-370 household in the village, with the main local culture and livelihood is premised on small scale farming and shallow ocean fishing. The village is located in a typhoon-prone region.

![Figure 1. Map of Xinxing Harbour Village.](image)
Source: local government of Chengmai Prefecture, Hainan Province, China

In 2016 the case was Valenzuela City, located north of Manila, the Philippines. It has access to Manila Bay via some wetlands. The site is 3.2 Km long area along the Polo River. It is still affected by flooding episodes during light and heavy rain, and has been touched by several typhoons in the last years. Livelihood of the population here is from the fish ponds and working in nearby city.

![Figure 2. Map of Valenzuela City](image)

The competition site for 2017 is Kampung Kali Bahru located in the Kelurahan Bandarharjo on the northern part of Semarang, Indonesia. About a third of the population living in the area is dependent on some kind of manufacturing or industrial activity for their livelihood. There are fish smoking (bandeng asap) industry in this village, as well as some heritage buildings. The village faces
land subsidence problem due to excessive ground water extraction. It also suffers from tidal flooding that regularly rises into this site.

![Figure 3. Map of Kampung Kali Bahru. [5]](image)

The competition brief calls for preventive design paradigm for an Asian community’s resiliency that integrates urban design/planning, architecture and building technology that particularly addresses the following issues:

1. URBAN DESIGN / URBAN PLANNING
   - Strategy - The relevance and significance of the preventive urban design/planning strategy to promoting and fostering resiliency locally, regionally and globally
   - Plan - The relevance and significance of the preventive urban design / urban planning plan in assuring resiliency through an engagement with topography, resources management, site planning, urban morphology, building typology and infrastructural management
   - Policy - The relevance and significance of the preventive urban design / urban planning policy in promoting and fostering resiliency through novel forms of community engagement and innovative decision and policy making strategies

2. ARCHITECTURE
   - Program - The relevance and significance of the architectural program in promoting everyday community engagement while also fostering the community’s resiliency
   - Morphology - The relevance and significance of the architectural form and structure as exemplars of artistic innovation while equally assuring technical resiliency
   - Tectonics - The relevance and significance of the architectural constructability in light of the local community’s cultural, social and technical assets

3. BUILDING TECHNOLOGY
   - Materiality - The relevance and significance of the materials for construction in light of the community’s access to material resources
   - Technology - The relevance and significance of the construction methods as exemplars of creativity and innovation, as well as, of the community’s traditions and conditions
   - Performance - The relevance and significance of the construction methodology to assuring a building’s performative resiliency.

5. Analysis of Design Proposals
   Analysis of the design entries is performed for each year to allow differences in the coding of the proposal due to variations of the environmental challenge that the location faces each year. Table 1 shows the summary of the main concepts in the 2015 DRIA competition. Most of the teams focus on reforestation of mangrove area as protection from the storm surge. Architectural design concept includes redesign of the existing houses and new community hall that also serves as shelter during the storm. Peculiar of the 2015 competition is the proposal for power or electricity generation to make the Xinxing village more resilient after a storm attack.
| Table 1. Design concept of DRIA 2015 |
|-------------------------------------|
| BUET  | CEP  | ITB  | LSU  | NCK  | NU  | RMI  | SCU  | TUD  | UD  | su  |
| T     | U    | S    | U    |      | M   |      |      |      | M   |     |
|-------|------|------|------|------|-----|------|------|------|-----|-----|
| Reforestation (upstream)            | 1    | 1    | 1    | 1    | 1   | 1    | 1    | 1    |     | 10  |
| Reforestation (downstream/mangrove) | 1    | 1    | 1    | 1    | 1   | 6    |      |      |     |     |
| Wetland (natural, constructed)      | 1    | 1    | 1    | 1    | 1   | 6    |      |      |     |     |
| Pond, reservoir, bioswales          | 1    | 1    | 1    | 1    | 1   | 5    |      |      |     |     |
| Water treatment & management        | 1    | 1    | 1    | 1    | 1   | 4    |      |      |     |     |
| Rainwater harvesting, groundwater recharging | 1    | 1    | 1    | 1    | 1   | 6    |      |      |     |     |
| Sea wall (natural), coastal protection | 1    | 1    | 1    | 1    | 1   | 6    |      |      |     |     |
| Drainage, canal, waterway           | 1    | 1    | 1    | 1    | 1   | 1    | 1    | 1    | 15  |
| House: floating, cantilever, stilt, vertical, modular    | 1    | 1    | 1    | 1    | 1   | 1    | 1    | 1    | 10  |
| Architectural, cultural heritage    | 1    | 1    | 1    | 1    | 1   | 10   |      |      |     |     |
| Community shelter                   | 1    | 1    | 1    | 1    | 1   | 10   |      |      |     |     |
| Natural bldg material               | 1    | 1    | 1    | 1    | 1   | 1    | 1    | 1    |     | 12  |
| Raised platform for public place    | 1    | 1    | 1    | 1    | 1   | 1    | 1    | 1    | 10  |
| Open space, community               | 1    | 1    | 1    | 1    | 1   | 6    |      |      |     |     |
| Mixed use                           | 1    | 1    | 1    | 1    | 1   | 5    |      |      |     |     |
| waste                              | 1    | 1    | 1    |      |     | 3    |      |      |     |     |
| management/recycling                | 1    | 1    | 1    | 1    | 1   | 4    |      |      |     |     |
| Tourism                            | 1    | 1    | 1    | 1    | 1   | 3    |      |      |     |     |
| Skill, craft for economy            | 1    | 1    | 1    | 1    | 1   | 3    |      |      |     |     |
| Fishery economy                     | 1    | 1    | 1    | 1    | 1   | 4    |      |      |     |     |
| Agriculture, livestock              | 1    | 1    | 1    | 1    | 1   | 4    |      |      |     |     |
| fishery/oyster                      | 1    | 1    | 1    | 1    | 1   | 8    |      |      |     |     |
| Community participation             | 1    | 1    | 1    |      |     | 3    |      |      |     |     |
| Education                          | 1    | 1    | 1    |      |     | 2    |      |      |     |     |
| Power/electricity                   | 1    | 1    | 1    |      |     | 4    |      |      |     |     |

Main concepts of the 2016 DRIA competition are presented in Table 2. Most of the proposals focus on reforestation of the mangrove, canal and drainage improvement, as well as transportation network (to connect the Valenzuela site with nearby city as place of work). Community center as shelter is often proposed for this location, along with improvement of housing design.
## Table 2. Design concept of DRIA 2016

| Concept                                    | BUET | DLS | ITB | LSU | NCKU | NUS | RMIT | SCUT | TUD | UDM | sum |
|--------------------------------------------|------|-----|-----|-----|------|-----|------|------|-----|-----|-----|
| Reforestation (upstream)                   | 1    | 1   | 1   | 1   | 1    | 1   | 1    | 1    | 1   | 1   | 9   |
| Reforestation (downstream/mangrove)        | 1    | 1   | 1   | 1   | 1    | 1   | 1    | 1    | 1   | 1   | 6   |
| Wetland (natural, constructed)             |      |     |     |     |      |     |      |      |     |     | 1   |
| Pond, reservoir, water retention basin     |      |     |     |     |      |     |      |      |     |     | 1   |
| Water treatment & management               |      |     |     |     |      |     |      |      |     |     | 4   |
| Rainwater harvesting, groundwater recharging |      |     |     |     |      |     |      |      |     |     | 3   |
| Dike, coastal protection                   |      |     |     |     |      |     |      |      |     |     | 5   |
| Drainage, canal, waterway                  |      |     |     |     |      |     |      |      |     |     | 9   |
| House: float, stilt, vertical, modular, flexible |      |     |     |     |      |     |      |      |     |     | 15  |
| Architectural, cultural heritage           |      |     |     |     |      |     |      |      |     |     | 0   |
| Composite material (concrete, bamboo, recycled) | 1    |     |     |     |      |     |      |      |     |     | 17  |
| Natural bldg material (bamboo, coconut trunk) |     |     |     |     |      |     |      |      |     |     | 3   |
| Raised platform for public place           | 1    | 1   | 1   | 1   | 1    | 1   | 1    | 1    | 1   | 1   | 7   |
| Open space, community space, marketplace   | 1    | 1   | 1   | 1   | 1    | 1   | 1    | 1    | 1   | 1   | 7   |
| Community shelter (Multi function)         | 1    | 1   | 1   | 1   | 1    | 1   | 1    | 1    | 1   | 1   | 7   |
| Manual power generation + electrical network | 1    |     |     |     |      |     |      |      |     |     | 1   |
| waste management/recycling                 |      |     |     |     |      |     |      |      |     |     | 3   |
| Transportation network                     | 1    | 1   | 1   | 1   | 1    | 1   | 1    | 1    | 1   | 1   | 10  |
| Emergency evacuation, medic                |      |     |     |     |      |     |      |      |     |     | 3   |
| Tourism for economy                       | 1    |     |     |     |      |     |      |      |     |     | 2   |
| Enterpreneurship, trade                    |      | 1   | 1   | 1   | 1    | 1   | 1    | 1    | 1   | 1   | 3   |
| Paddy field, roots vegetation, agriculture, fishery |      |     |     |     |      |     |      |      |     |     | 5   |
| Information, public participation/awareness |      |     |     |     |      |     |      |      |     |     | 5   |
| Coop, community mortgage                   |      |     |     |     |      |     |      |      |     |     | 2   |
| Education, training                       | 1    | 1   | 1   | 1   | 1    | 1   | 1    | 1    | 1   | 1   | 5   |
| Application (GRAB, sproud)                 |      |     |     |     |      |     |      |      |     |     | 0   |

In 2017, DRIA competition proposals are focused on housing design as a response to the sinking houses in the Semarang site. Environmental concepts include natural or constructed wetland, reforestation of mangrove and water retention basin. Rainwater harvesting is proposed mainly as a way to reduce groundwater extraction that has accelerated the land subsidence process. Revitalization of drainage and canal is proposed as part of waterway transportation. Adaptive reuse of historic warehouse and the creation of public open space as market are proposed in relation to community’s economic improvement. Some proposal includes tourism to complement the traditional fish smoking industry in the community. Different from the DRIA 2015 and 2016, in 2017 some participants propose education and online application (such as GRAB) as part of the way to enhance the population’s socio economic resilience. There is a change in the participating universities in DRIA.
2017, with the Louisiana State University, USA (LSU) replaced by the University of Pennsylvania, USA (UPENN).

Table 3. Design concept of DRIA 2017

|                        | BUET | CEPT | ITB | NCKU | NUS | RMIT | SCUT | TUD | Upenn | UDM | sum |
|------------------------|------|------|-----|------|-----|------|------|-----|-------|-----|-----|
| Reforestation          | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 9   |
| (upstream)             |      |      |     |      |     |      |      |     |       |     |     |
| Reforestation          | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 9   |
| (downstream/man grove) |      |      |     |      |     |      |      |     |       |     |     |
| Wetland (natural)      | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 5   |
| constructed            |      |      |     |      |     |      |      |     |       |     |     |
| Pond, reservoir,       | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 8   |
| water retention        |      |      |     |      |     |      |      |     |       |     |     |
| basin                  |      |      |     |      |     |      |      |     |       |     |     |
| Water treatment &      | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 5   |
| management             |      |      |     |      |     |      |      |     |       |     |     |
| Rainwater              | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 5   |
| harvesting,            |      |      |     |      |     |      |      |     |       |     |     |
| groundwater recharging |      |      |     |      |     |      |      |     |       |     |     |
| Sea wall, coastal      | 1    | 1    | 1   | 1    |     |      |      |     |       |     | 3   |
| protection             |      |      |     |      |     |      |      |     |       |     |     |
| Drainage, canal,       | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 7   |
| waterway               |      |      |     |      |     |      |      |     |       |     |     |
| House: floating,       | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 13  |
| cantilever, still,     |      |      |     |      |     |      |      |     |       |     |     |
| vertical, modular      |      |      |     |      |     |      |      |     |       |     |     |
| Architectural,         |      |      |     |      |     |      |      |     |       |     |     |
| cultural heritage      |      |      |     |      |     |      |      |     |       |     |     |
| Warehouse              | 1    | 1    |     | 1    |     | 1    |      |     |       |     | 4   |
| (heritage) activity    |      |      |     |      |     |      |      |     |       |     |     |
| Natural bldg material  |      |      |     |      |     |      |      |     |       |     | 1   |
| (bamboo, coconut trunk)|      |      |     |      |     |      |      |     |       |     |     |
| Raised platform        | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 12  |
| for public place       |      |      |     |      |     |      |      |     |       |     |     |
| Open space,            | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 7   |
| community space,       |      |      |     |      |     |      |      |     |       |     |     |
| marketplace            |      |      |     |      |     |      |      |     |       |     |     |
| Mixed use              | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 1   |
| waste recycling        | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 14  |
| (Plastic -> brick)     |      |      |     |      |     |      |      |     |       |     |     |
| Transportation         | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 5   |
| network                |      |      |     |      |     |      |      |     |       |     |     |
| Emergency evacuation,  | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 5   |
| medic                  |      |      |     |      |     |      |      |     |       |     |     |
| Tourism for economy    | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 5   |
| Fish smoking economy   | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 5   |
| Paddy field, duck,     | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 5   |
| fishery                |      |      |     |      |     |      |      |     |       |     |     |
| Information,           | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 5   |
| public participation   |      |      |     |      |     |      |      |     |       |     |     |
| (all levels)           |      |      |     |      |     |      |      |     |       |     |     |
| Education              | 1    | 1    | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 3   |
| Application            | 1    |     | 1   | 1    | 1   | 1    | 1    | 1   | 1     | 1   | 2   |
| (GRAB, sproud)         |      |      |     |      |     |      |      |     |       |     |     |

Honorable Honorable Winner Architecture Winner Planning
The three year design competition shows that designing resilience encompasses broad perspective such as regional ecology, economy and transportation down to technical detail of house unit design, construction and its material. The broad viewpoint is also dictated by the competition brief in urban design/planning, architecture and building technology. However, the recurring concepts can be grouped into three or four categories. First is the environmental concept that addresses nature and infrastructure, the second category is building or architectural design and the third category pertains to the community’s social and economic resilience. The most common design concept in the environmental category is reforestation in mangrove area and other concepts such as sea wall (in Xinxing), drainage/canal (in Valenzuela) and water retention pond (in Semarang). In building or architectural design category the most common design concept is the house design, whether floating, on stilts, using cantilever, modular, vertical etc. Another building that is often proposed by the participants is the community hall, either as mixed-use building for education and economy or as shelter during the storm (in Xinxing and Valenzuela). The third category of social and economic resilience is improved by providing public space for the community, education and training, community participation and information. Economic resilience is strengthened by focusing more in the community traditional activity in fishery and agriculture, or introducing new activity such as tourism or improved skill by training.

Figure 4. DRIA 2015 Winner in Overall Design Excellence [6].

6. Conclusions
There are three categories need to be considered in designing resilience. The aspects in each category are selected to suit the problems faced, e.g. typhoon/storm with community shelter that serves as a place for education and training to improve skills, provision of clean water from rain water storage to reduce land subsidence in Semarang. In general water management is crucial in all cases as water is
the source of life. The three DRIA cases are in the coastal region, so that shore protection is necessary with mangroves and wetlands. If necessary, protection of water supply is conducted in upstream region. Community resilience requires cohesiveness of the people to utilize their natural resources and skill wisely.

A combination of physical, natural and socio-economic considerations can maintain community resiliency. The winning proposal in the overall category (planning + architecture) shows the integration of the concept, for example, building with natural ingredients of bamboo which is easy to grow.

References
[1] Cutter SL, Barnes L, Berry M, Burton C, Evans E, Tate E, Webb J. A place-based model for understanding community resilience to natural disasters Global Environmental Change Volume 18, Issue 4, October 2008
[2] http://www.100resilientcities.org
[3] Boyatzis, R E 1998. Qualitative Information: Thematic Analysis and Code Development. (Thousand Oaks, CA: Sage Publications)
[4] School of Design and Art. De La Salle – College Saint Benilde, the Philippines 2016. DRIA data prepared by Ar. Harry Joseph R. Serrano
[5] Department of Architecture, the National University of Singapore 2017 Designing Resilience in Asia. Brief unpublished.
[6] http://www.designingresilience.com