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Developing a building-performance evaluation framework for post-disaster reconstruction: the case of hospital buildings in Aceh, Indonesia

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ABSTRACT

Developing countries have faced many problems regarding humanitarian reconstructed buildings, especially during occupancy when most donors have left. Hospitals are some of the most important buildings in the disaster-management cycle. Previous studies have shown that there is no specific tool for evaluating post-disaster hospital-building performance. This study aims to test the validity and reliability of a proposed framework of building-performance evaluation (BPE) in a disaster context for public hospitals based on partial least squares (PLS) analysis. The researcher distributed 405 questionnaires to building users in four rebuilt public hospitals in Aceh, Indonesia. The results showed that the hierarchical construct model (HCM) with reflective-reflective relationships and third-order framework comprises 16 criteria; 72 items were valid and reliable, and all path coefficients were considered highly significant. These results reflect the degree of explained variance of third-order in its second-order components: built environment and building user (89%), building system (93%), and disaster-risk management/DRM (85%). DRM as the new variable added to the BPE conceptual model for a post-disaster reconstruction (PDR) context is justified. The confirmed framework can be used to evaluate post-disaster hospital performance in the future. The BPE framework should also be tested in other types of post-disaster hospitals.

Abbreviations: AEDET: Achieving Excellence Design Evaluation Toolkit; AVE: average variance extracted; BPE: building-performance evaluation; BRR NAD-Nias: Reconstruction and Rehabilitation Bureau for the Nanggroe; Aceh: Darussalam and Nias Islands; CR: capability ratio; CRCs: Citizen Report Cards; CSFs: critical success factors; DRM: disaster-risk management; FEMA: The Federal Emergency Management Agency; GTZ: The German Organisation for Technical Cooperation; HCM: hierarchical construct model; PDR: post-disaster reconstruction; PLS: partial least squares; POE: post-occupancy evaluation; SEM: structural equation modelling; TEC: Tsunami Evaluation Coalition; UNCHS: The United Nations Centre for Human Settlements

KEYWORDS
Building performance evaluation (BPE); post-disaster reconstruction (PDR); hospital; disaster risk management (DRM); hierarchical construct model (HCM); partial least squares (PLS)

Introduction

There are many cases in which building users are unable to maintain and operate newly-rebuilt buildings that are the product of aid reconstruction projects (Kirkpatrick 1991; Jha et al. 2010; The Aceh Institute 2010). One example is the case from post-tsunami reconstruction in the Aceh province in Indonesia (Adamy and Abu Bakar 2011; Government of Aceh 2011). Based on the Aceh government's asset inventory report (Transition Sector 2009), there have been some issues related to reconstruction building, namely: administration problems faced by the local government, when not all the reconstructed assets were handed over (Adamy 2009; The Aceh Institute 2010); lack of budget for operation and maintenance (Hayat and Amaratunga 2014); unused assets (Bambang and Firdaus 2006); and lack of human capacity to maintain and operate these assets.

Tsunami Evaluation Coalition (TEC) explained that quality continues to be an issue in humanitarian projects, due to the fact that model quality control-driven in normal business by its costumers does not operate in the aid sector (Telford et al. 2006). Building performance evaluation (BPE), as one quality-control tool, has been proven, and used, for many years in many countries for commercial-business oriented projects (Preiser and Vischer 2005; Leaman et al. 2010; Shauna et al. 2012). Bordass et al. (2001) stated that one of the main drivers in building performance in the industry is commercial competitiveness: seeking to reduce costs in use and adding

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Figure 1. Countries affected by the Tsunami 2004 (source: Telford et al. 2006).

value through increased productivity. However, the business and the humanitarian sectors are two different entities. Humanitarian projects are non-profit oriented, with the aim of producing a unique product for a certain duration and of elevating the living conditions of people (Moe and Pathranarakul 2006).

This study aims to fill the gap of BPE as a business-driven tool, making it applicable in the humanitarian sector by developing a BPE framework in a post-disaster reconstruction (PRD) context and by assessing the validity and reliability of the proposed framework. According to Hair et al. (2012), reliability and validity assessment play a vital role in outer model assessment. This study categorizes the proposed framework as the hierarchical construct model (HCM), and it methodologically confirms that partial least-squares (PLS) path modelling can be used to estimate the parameter of a higher-order construct (Akter et al. 2010).

Post-tsunami reconstruction in Aceh, Indonesia

A deadly 9.0 magnitude earthquake struck the province of Aceh on the island of Sumatra in Indonesia on Sunday morning, 26 December 2004. It triggered a tsunami that quickly affected not only the areas in Aceh, but also some offshore areas in Malaysia, Myanmar and Thailand (Asian Development Bank 2005). The giant wave further extended to Bangladesh, India, the Maldives and Sri Lanka on the Asian continent, and even to Kenya, Somalia and Tanzania in Africa (Figure 1) (Shaw 2006). The unprecedented scale of the disaster of, and the humanitarian response from around the world for, the Indian Ocean tsunami of 2004 was a turning point in the history of PRD (Lyons and Boano 2010). With projects and programs worth US$7.7 billion allocated by almost 500 organizations, it became the largest reconstruction project in the developing world (Takahashi et al. 2007), Aceh's post-reconstruction experience may provide useful lessons (Masyrafah and McKeon 2008).

Table 1. The effects of the earthquake and Tsunami on health facilities in Aceh.

Health facilities	Destroyed	Damage
Hospitals	32	9
Local health clinics	259	64
Assisting local health clinics	830	174
POLINDES (village polyclinic)	2.283	700
Village polyclinics	21	5
Office of health services	4	1
Medical laboratories	3	3
Offices of harbour health	3	1

Source: Wibisana and Bitai (2009).

In response to the disaster, the central government of Indonesia formed a Reconstruction and Rehabilitation Bureau for the Nanggroe Aceh Darussalam and Nias Islands (BRR NAD-Nias) on 14 April 2005, to lead and coordinate both processes of post-disaster rehabilitation and reconstruction (BRR NAD-Nias 2009). The center is located in Banda Aceh (the capital city of the Aceh province), with another office on Nias Island and a representative office in Jakarta (Resosudarmo and Nazara 2007). The government receives US$2.6 billion funds and grants from international donations. The bureau was categorized as state expenditure income budget (BRR NAD-Nias 2008). The entire on-budget funds were implemented directly by the BRR NAD-Nias, and the projects were supposed to be finished by April 2009.

Hospital reconstruction in Aceh, Indonesia

According to the World Bank (Jha et al. 2010) and the Federal Emergency Management Agency (FEMA 2007), of all types of public buildings and facilities, hospitals are considered one of the essential assets in disaster management. As one of the poorest provinces in Indonesia (Evans 2010), and because of the long-term socio-political conflict (Soesastro and Atje 2005;

Figure 2. Map of Aceh province showing the location of four districts included in this study (source: adapted from http://en.wikipedia.org/wiki/File:Aceh_Regencies.png).

Reid 2006), health facilities in Aceh before the tsunami were far from adequate (BRR NAD-Nias 2009). Table 1 shows the number of health infrastructure and facilities in Aceh that was destroyed by the earthquake and tsunami in 2004.

After a four-year reconstruction period, the government and aid agencies were able to repair and build 276 local assisting health clinics, 211 local health clinics, and 395 village polyclinics and were able to revitalize 28 hospitals, all across Aceh (BRR NAD-Nias 2009). This reconstruction far exceeds the number of hospitals and health services damaged by the earthquakes and tsunami (Dinas Kesehatan Provinsi NAD 2006; Wibisana and Bitai 2009). Such a fact means that health facilities before the disasters were in a state of neglect, and that the need for health facilities substantially increased in the aftermath.

This study focuses on hospitals that were completely rebuilt, not just rehabilitated or renovated. In the case of post-tsunami reconstruction in Aceh, only four public hospitals with the same grade C fell into this category: Meuraxa Hospital, in Banda Aceh city; Aceh Jaya Hospital, in the Aceh Jaya regency; Nagan Raya Hospital, in the Nagan Raya regency; and Teuku Peukan Hospital, in the Aceh Barat Daya regency (see Figure 2).

Building performance evaluation (BPE)

BPE is defined as the process of systematically comparing the actual performance of buildings, places, and systems to explicitly-documented criteria of their expected performance (Preiser and Schramm 1998; Preiser and Vischer 2005; Shauna et al. 2012). Preiser and Vischer (2005) stated that BPE offers a broad and adaptable framework for professionals affiliated with the building industry at all levels, and has been proven as a universal evaluation concept and tool. It focuses on finding ways to implement a user-oriented, cost-effective and high-quality approach to produce all types of buildings. Originally, three dimension systems were interpreted with three visible variables that affected building performance: the performance or building system variable, the user or occupant variable and the built environment variable (Preiser and Vischer 2005). In 2005, Preiser and Vischer (2005) added a fourth, invisible variable: contextual.

Theoretical framework for post-disaster reconstruction BPE

BPE has gained credibility through a considerable amount of research and projects in the public and private sector. However, it is still rarely practiced in developing countries (Adewunmi et al. 2011), even though these are the ones who suffer more when disasters strike (Ofori 2001; Shafique and Warren 2016). While Thampi (2005) recommended Citizen Report Cards (CRCs) to evaluate public services, this study recommends BPE to evaluate reconstruction projects. In the humanitarian sector, the usually preferred

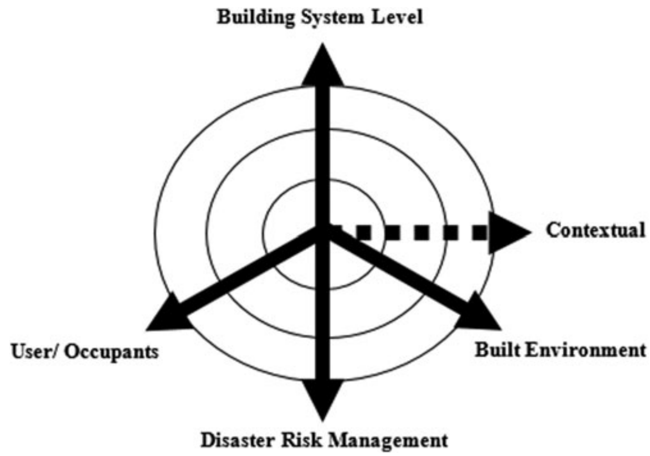


Figure 3. Post-disaster reconstruction BPE theoretical framework (adapted from Preiser and Vischer (2005)).

approach in evaluating aid effectiveness is to: (1) define the objective, (2) establish measurable performance indicators and (3) evaluate aid that is effective against the agreed indicators (Jayasuriya and McCawley 2010). As this approach is similar to the BPE concept (Preiser and Vischer 2005), it indicates that BPE can be applied in aid sectors as well. Haigh and Amaratunga (2010) stated that we should consider the nature and extent of the built environment 'discipline' and its potential contribution to the development of society's resilience to disaster.

Disaster management can be defined as the range of activities designed to maintain control over disaster and emergency situations, and to provide a framework for helping those who are at risk to avoid or recover from the impact of the disaster (Kelly 1996). Disaster risk management (DRM) is a series of actions (programs, projects and measures) and instruments expressly aimed both at reducing disaster risk in endangered regions and at mitigating the extent of disasters (GTZ 2002). The term DRM is used when referring to legal, institutional, and policy frameworks and administrative mechanisms and procedures related to the management of both risk (ex-ante) and disasters (ex-post) (UNCHS 2001). Assessing PDR building on disaster risk is part of disaster management. Therefore, DRM should arguably be included in BPE, since every stage of the building cycle can apply DRM, which also reflects the disaster timeline (Figure 3).

Because every reconstruction is unique, decisions in managing reconstruction are influenced by many factors, including the nature and magnitude of the disaster, the country and institutional context, the level of urbanization and the culture's (Jha et al. 2010). In this study, the researcher classified the BPE for post-disaster projects following the nature of the scope of study, as shown in Figure 4.

The proposed theoretical framework establishes five variables that, when applied to this study, are represented by:

1. Built environment variable – post-occupancy evaluation (POE), as this study conducted BPE during the occupancy period.
   This variable includes the aspects of workstations, rooms, buildings and entire complexes of facilities. It falls under the architectural system level as part of the supply dimension as well. The driving force behind this programme is to do something visually stunning, inventive or playful, to stand out in some way from contemporary buildings (Becker 1990).
2. Building system level variable – The local building regulations, as this study was conducted in the Aceh province in Indonesia.
   The performance variable is part of the supply dimension. The criteria under this variable are technical (health, safety and security), functional (functionality, efficiency and work flow), and behavioural (social, psychological and cultural) (Preiser and Vischer 2005). According to Becker (1990), operational cost, energy efficiency, service ability and flexibility compelled the programme's start.
3. User variable – As this study focuses on hospitals, the user scope is patients, visitors or hospital staff.
   This variable includes individuals, groups and organizational aspects. The user variable is categorized as the human system level, which is the demand dimension. Comfort, human dignity and the enhancement of personal and professional

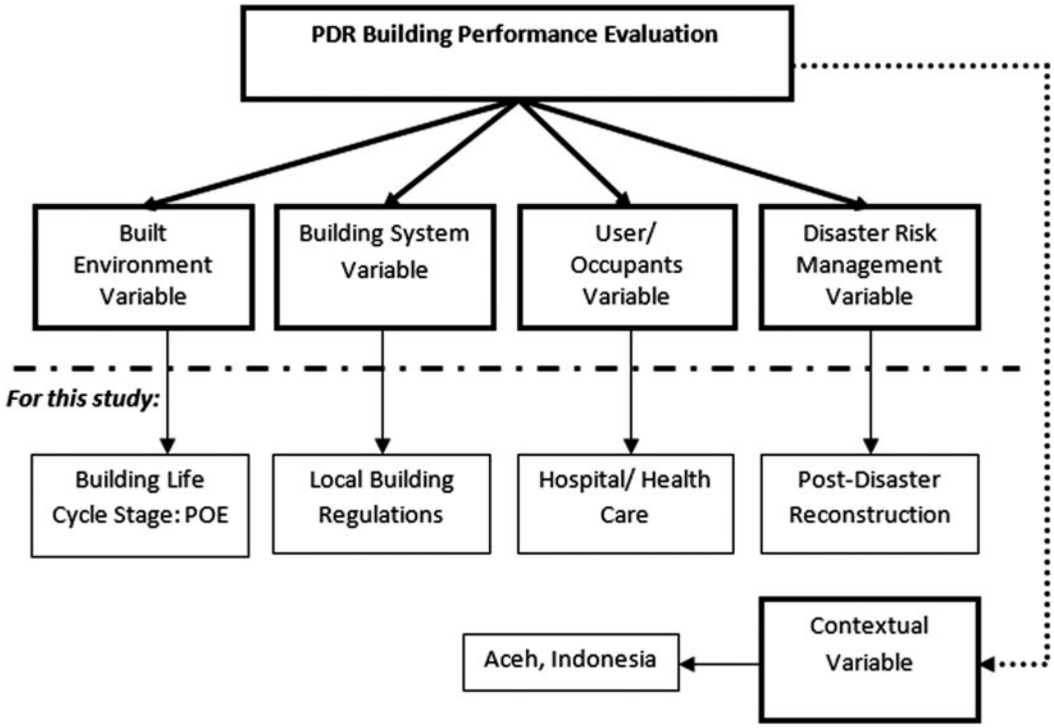


Figure 4. Interpretation of the post-disaster BPE framework with the scope of this study.

identity are the principal criteria in this programme, according to Becker (1990).

4. Disaster risk management variable – The researcher conducted this study on hospital buildings constructed during PDR.
   DRM is a series of actions (programs, projects and measures) and instruments expressly aimed at reducing disaster risk in endangered regions, and mitigating the extent of disasters (GTZ 2002).
5. Contextual (invisible) variable – this study should be considered in a local context as conducted in the Aceh province, Indonesia.
   According to da Silva (2010), understanding the local context in terms of geography, society, economics, politics, climate and hazards is a key consideration in developing an appropriate strategy for recovery and reconstruction. This fifth variable is the process-driven overarching category at the global or 'meta' level of context-related aspects (Preiser and Vischer 2005).

The built environment variable is represented by POE stage in the building evaluation life cycle, while user in the hospital building type represents user building variable. Many studies have developed literature of POE specifically for hospital-type buildings (Institute of Medicine 1999; Dorasol et al. 2012). Therefore, in this study, the two variables are compiled together as POE for hospital buildings. A conceptual framework is important for conducting further studies in the relevant knowledge bases, as it lays the foundation for the development of a theoretical base for the field (Haigh and Amaratunga 2010). Without such a framework, it is virtually impossible to codify existing knowledge in the field in a coherent manner (Amaratunga and Baldry 2003).

The criteria for PDR building performance

In a building performance evaluation perspective, a criterion or indicator is a parameter or value derived from the parameter that describes the state of a building and its impact on human beings and the ecosystem (Parida and Kumar 2006). Historically, separate performance indicators and benchmarks have been developed for a host of specific building characteristics, to serve the needs of relevant interest groups (Cole 1998). These days, there are several sources of performance indicators, and each has its use depending on the aspects of the building that is being evaluated (Douglas 1996).

For each setting and user group, specific quality-performance criteria need to be established (Preiser and Vischer 2005). The performance evaluation framework for BPE systematically relates buildings and settings to users and their environmental needs (Preiser et al. 2017). The next table shows the list of criteria under each variable based on the framework. There are 16 criteria and 72 items that measure four variables in the framework of BPE for PDR hospital buildings. These items and list of criteria are the basis for questionnaire development for the survey study (see Appendix D).

As explained earlier, DRM is the new variable added to the original BPE framework. Hence, there are five criteria under DRM: Sustainability (Potangaroa 2015; Lowe et al. 2017), operation and maintenance guidelines (Myeda et al. 2011), disaster resilience (Lavy et al. 2010; MacAskill and Guthrie 2015), functionality (FEMA 2007; Preiser et al. 2017) and local institution capacity (Jha et al. 2010; Arain 2015).

Research methodology

This study is categorized as a deductive approach, which emphasizes deducing ideas or facts from new theory, in the hope that it provides a better or more coherent framework than the theories that preceded it (Pathirage et al. 2008). The quantitative approach relies on a survey method, with individual questionnaire distribution. The researcher individually distributed the questionnaires and went through a face-to-face interview process. The sample units were individuals who are building users. Kernohan et al. (1992) stated that the people who really know about buildings in use are the people who use them; they are the experts in what the buildings have to-and actually-do. This study used probability sampling, a specifically stratified random sampling method. Stratified random sampling is one in which the population is divided into subgroups, and a random sample is then selected from each subgroup (Latham 2007). The respondent in the hospital combined with two groups: staff and non-staff (visitors and patients). Total number of staff and patients are available in each hospital during data collection. Whereas for visitors, the study used previous year of total number visitor as a prediction. Sample size in each hospital from the two groups of respondents was determined based on Krejcie and Morgan (1970) , with a 0.05 confidence level.

The questionnaire is a representation of the conceptual framework, which is comprised of three main variables: the built environment-adopted from Achieving Excellence Design Evaluation Toolkit (AEDET) is an evolution concept and questionnaires that have been used as health-care building evaluation through post-occupation stage (AEDET 2003); the building system variable-based on a summary of local regulations and building codes in Aceh, Indonesia (Appendix A); and disaster risk management variables-based on several references (detail in Table 2). The ordinal by Likert scale with five points scale is adapted from AEDET and later convert to continuous data which in this study. A five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), was adopted to capture the performance of hospital buildings in Aceh. A mean score method, with a 5-point scale to evaluate 'performance', is considered in construction industry a common method (Baird 2009).

Due to its large population compared to the other three hospitals, a small pilot survey was conducted at Meuraxa hospital two weeks before the main study was carried out. The respondents in the hospital filled out the questionnaire and the researcher collected 20 responses for the pilot study. These come from the top management level: director, deputy director and all head-of-division positions related to building and maintenance. There were some minor changes in terms of the format and language correction (the translation from English to Bahasa Indonesian). Necessary changes were made based on the feedback. The result of the reliability test, Cronbach's alpha showed the questionnaire to reach acceptable reliability, $\alpha = 0.96$ and the corrected item-total correlations (homogeneity index) were greater than 0.40 in all items (see Appendix B), suggesting that all criteria have relatively high internal consistency. Meanwhile, for the validity value, PLS path modelling can be used to estimate the parameters of higher-order construct and its association with outcome constructs (Akter et al. 2010), which are discussed as follows.

The researcher distributed a total of 670 questionnaires to four hospitals (Table 3). 107 respondents (48.6%) responded in Meuraxa Hospital, 90 respondents (75%) responded in Aceh Jaya Hospital, 100 respondents (67%) responded in Nagan Raya Hospital and 108 respondents (60%) responded in Teuku Peukan Hospital. Overall, the response rate was 60%, or 405 respondents (representing both groups). Non-staff respondents are divided into 116 visitors (28.6%) and 104 patients (25.7%). The rest of the respondents come from the hospital staff group, with 185 respondents (45.7%).

Hierarchical construct model (HCM)

Hierarchical constructs, or multidimensional constructs, can be defined as constructs involving more than one dimension (Edwards 2001; Jarvis et al. 2003). The researcher categorized the framework for BPE into an HCM, which is for PDR hospital building, with a three order level as shown in Figure 5. Most constructs in management research are multidimensional (MacKenzie et al. 2005). The first-order has 16 criteria (A to P), which are distributed under

Table 2. List of Criteria for PDR hospital building performance.

Variables		Criteria	Description	References
Built environment and building users	A	Building form and material	Although it deals with the materials from which the building is constructed, it is not concerned with these in a technical sense, but rather the way they will appear and feel throughout the life of the building	Zimmerman and Martin (2001); AEDET (2003); Preiser and Vischer (2005); FEMA (2007); Lavy et al. (2010); Myeda et al. (2011)
	B	Building quality	In terms of the technical performance of the building during its lifetime. It asks whether the components of the building are of high quality and fit for purpose.	Zimmerman and Martin (2001); AEDET (2003); FEMA (2007); Lavy et al. (2010); Myeda et al. (2011)
	C	Engineering	This criterion is concerned with those parts of the building that are engineering systems as opposed to the main architectural features.	AEDET (2003); FEMA (2007); Lavy et al. (2010); Myeda et al. (2011)
	D	Access	This criterion is concerned as to whether people can easily and efficiently get onto and off the site using a variety of means of transport and whether they can logically, easily and safely get into and out of the building.	Zimmerman and Martin (2001); AEDET (2003); Preiser and Vischer (2005); FEMA (2007); Lavy et al. (2010); Myeda et al. (2011)
	E	Staff and patient environment	This section deals with how well an environment complies with best practice.	AEDET (2003); Preiser and Vischer (2005); FEMA (2007); Lavy et al. (2010)
Building system	F	Safety	Includes requirements to support the capacity building payload (weight alone, wind load, earthquake stillborn), and building capacity to prevent and deal with fire hazards, building and rescue lines, and the danger of lightning.	Zimmerman and Martin (2001); Preiser and Vischer (2005); FEMA (2007); Lavy et al. (2010); Myeda et al. (2011) and Indonesia regulations.[a]
	G	Health	Includes system requirements temperature, lighting, sanitation, and the use of buildings.	Preiser and Vischer (2005); FEMA (2007); Lavy et al. (2010) and Indonesia regulations[a]
	H	Comfort	Includes comfort space and the relationship between space, air condition in the room, the view, and the level of vibration and noise level.	Zimmerman and Martin (2001); FEMA (2007); Lavy et al. (2010); Myeda et al. (2011) and Indonesia regulations.[a]
	I	Ease	Covering eases of connection to, from, and within the building, as well as the completeness of the utilization of infrastructure and facilities in the building.	Preiser and Vischer (2005); FEMA (2007); Lavy et al. (2010); Myeda et al. (2011) and Indonesia regulations.[a]
	J	Control environmental impact	Buildings that produce significant impacts must be preceded by including on environmental impact assessment.	Konara and Sandanayake (2010); Lavy et al. (2010) and Indonesia regulations.[a]
	K	Architecture	Covers performance requirements of the building; the spatial requirements, the requirements of the building layout that considers the balance, and the harmony of the building and its environment,	Preiser and Vischer (2005); FEMA (2007); Lavy et al. (2010); Myeda et al. (2011) and Indonesia regulations.[a]
Disaster risk management	L	Sustainability	How bad or good a building is in relation to sustainability. It predicates decisions of building performance in order to make it sustainable.	Preiser and Vischer (2005); Jha et al. (2010); Konara and Sandanayake (2010); Lavy et al. (2010); Green Building Council Indonesia (2012); Potangaroa (2015)
	M	Operation and maintenance guidelines	Statutory regulations and codes which make facility managers take preventive actions of and keep and restore or improve every facility.	FEMA (2007); Jha et al. (2010); Myeda et al. (2011)
	N	Disaster resilience	Elements considered with possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid or to limit the adverse impacts of hazards, within the broad context of sustainable development.	FEMA (2007); Jha et al. (2010); Lavy et al. (2010); Myeda et al. (2011)
	O	Functionality	In terms of being suitable for a particular use or function. The building's overall ability to perform a regular function designed or developed chiefly from the point of view of use.	Preiser and Vischer (2005); FEMA (2007); Jha et al. (2010); Lavy et al. (2010); Myeda et al. (2011)
	P	Local institution capacity	In terms of the capacity to solve problems. In the agencies that will take over the management of new facilities, training, staffing, and other institutional strengthening needs which should be identified and funded.	FEMA (2007); Jha et al. (2010)

[a]For the list of Indonesian regulations please refer to Appendix A.

Table 3. Questionnaire distribution.

	Meuraxa hospital	Aceh Jaya hospital	Nagan Raya hospital	Teuku Peukan hospital	Total
Respondents	452	147	193	271	1063
Sent	220	120	150	180	670
Reply	110	92	101	109	412
Usable	107	90	100	108	405
Response rate (%)	48.6	75	67	60	60

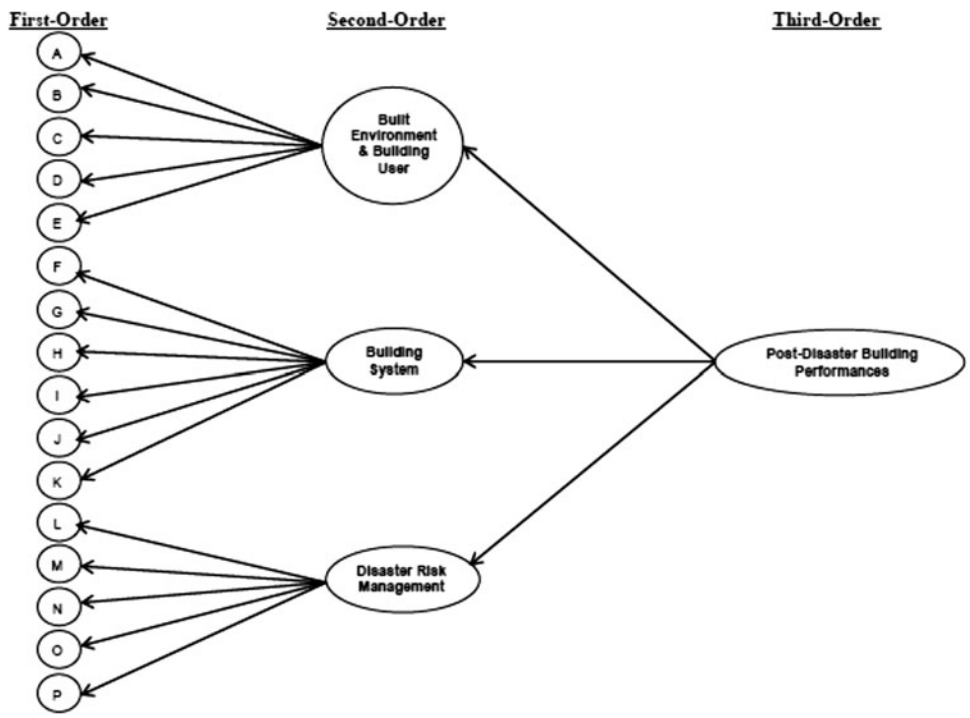


Figure 5. Post-disaster BPE framework for hospital building in Aceh.

second-order where there are four main variables: built environment, building user, building system and DRM. The researcher listed the main variables as the 'post-disaster building performance' variable, which he then categorized as third-order.

The measurement approach uses reflective measurement, since this study explores indicators from each construct and has no predictive relationship. The role of the 16 criteria is to measure four variables or to measure PDR building performance; its role is not to predict causes. Reflective indicators can be viewed as a representative sample of all the possible items available within the conceptual domain of the construct (Hair et al. 2013). Any single item can generally be left out without changing the meaning of the construct, as long as the construct has sufficient reliability (Martinez-Ruiz and Aluja-Banet 2009).

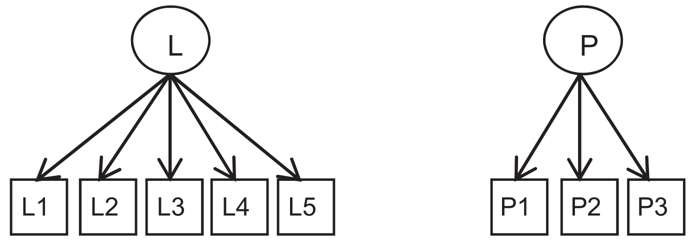
Partial least squares (PLS) path modelling analysis

Generally, HCM uses latent variables and can be estimated using structural equation modelling (SEM). Both covariance-based SEM and component-based SEM can be employed to estimate the parameters in a hierarchical model (Wetzels et al. 2009). However, covariance-based SEM has various constraints regarding distributional properties (multivariate normality), the measurement level, sample size, model complexity, identification and factor indeterminacy (Fornell and Bookstein 1982; Chin 1998). These limitations might be avoided entirely with the use of component-based SEM or PLS path modelling. Chin and Newsted (1999) observed that PLS path modelling is generally more suitable where the model is relatively complex (i.e. a large number of the manifest and latent variables).

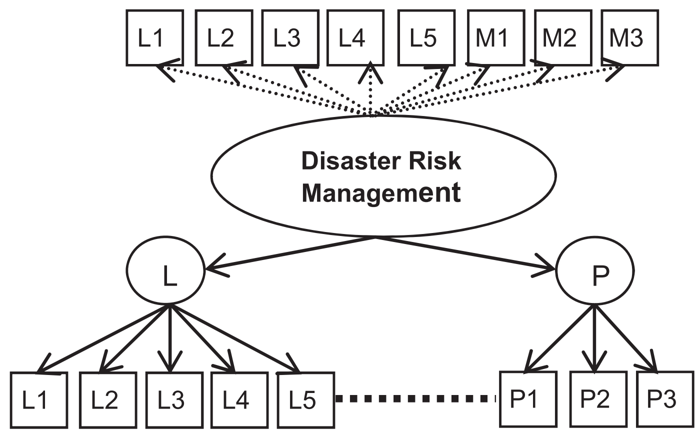
Before conducting the PLS path modelling analysis, the researcher assessed the data using distributional properties of manifest variables in IBM SPSS software version 20 (IBM SPSS Statistics, Armonk, NY). Kolmogorov–Smirnov statistics show that each latent variable was less than 0.5, which demonstrates that the assumption of multivariate normality was violated (Pallant 2005). Moreover, the skewness and kurtosis value were negatively distributed. However, PLS path modelling has a less strict distributional assumption

Table 4. Specifying hierarchical latent variables for post-disaster BPE using PLS.

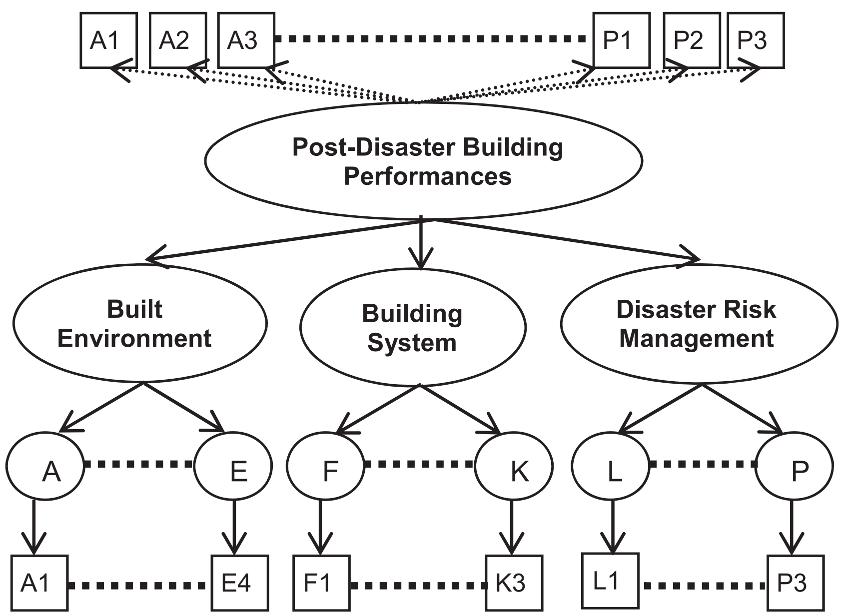
The figure shows the first-order latent variables (A until P) where in the figure shows only example from variable L and M and related to their respective block of manifest variables (e.g. L1 – L5 or M1 – M3) using reflective relationship.



The figure shows the second–order variables (Impact until Disaster Risk Reduction) where in the figure shows only example from variable Sustainable Development. The second-order variables are related to the block of the underlying first-order latent variables using reflective relationship. E.g. Sustainable Development variable is measured by L1 – M3.



The figure shows the third–order variables which is Post-disaster Building Performances. The fourth-order variables are related to the block of the underlying third-order latent variables using reflective relationship. Post-disaster Building Performances variable is measured by A1 until P3.



(i.e. does not satisfy the assumption of normality, large sample size and independence) (Chin 1998; Chin and Newsted 1999); therefore, it can cope with non-normality distributed data and multicollinearity between indicators (van Beuningen and Schmeets 2013).

This study used PLS path modelling version 2.0 (SmartPLS GmbH City: Boenningstedt, Germany) to construct the reflective HCM, using the three key steps outlined in Table 4. The last box in Table 4 indicates the final HCM after constructing the latent variables, by repeating the manifest variables.

Results

This study specified a null model for the first-order latent variables in order to assess the psychometric properties of the measurements, which included non-structural relationships. Table 5 shows that all items

Table 5. Psychometric properties for first-order constructs.

Building Performance Criteria		Items	Loading	AVE	CR
A	Building Form & Material	A 1	0.815	0.694	0.901
		A 2	0.779		
		A 3	0.878		
		A 4	0.855		
B	Building Quality	B 1	0.737	0.723	0.886
		B 2	0.896		
		B 3	0.907		
C	Engineering	C 1	0.859	0.716	0.910
		C 2	0.831		
		C 3	0.850		
		C 4	0.841		
D	Access	D 1	0.831	0.705	0.827
		D 2	0.848		
E	Staff & Patient Environment	E 1	0.824	0.648	0.936
		E 2	0.776		
		E 3	0.830		
		E 4	0.812		
		E 5	0.844		
		E 6	0.807		
		E 7	0.748		
		E 8	0.788		
F	Safety	F 1	0.810	0.706	0.923
		F 2	0.889		
		F 3	0.889		
		F 4	0.830		
		F 5	0.775		
G	Health	G 1	0.799	0.638	0.876
		G 2	0.790		
		G 3	0.810		
		G 4	0.795		
H	Comfort	H 1	0.857	0.711	0.880
		H 2	0.862		
		H 3	0.807		
I	Easiness	I 1	0.887	0.769	0.909
		I 2	0.915		
		I 3	0.826		
J	Control Environment Impact	J 1	0.877	0.778	0.913
		J 2	0.879		
		J 3	0.888		
K	Architecture	K 1	0.866	0.736	0.918
		K 2	0.887		
		K 3	0.848		
		K 4	0.828		
L	Sustainability	L 1	0.892	0.773	0.932
		L 2	0.891		
		L 3	0.869		
		L 4	0.864		
N	Disaster Resilience	N 1	0.863	0.762	0.906
		N 2	0.859		
		N 3	0.895		
O	Functionality	O 1	0.824	0.759	0.9401
		O 2	0.854		
		O 3	0.844		
		O 4	0.920		
		O 5	0.906		
P	Local Institution Capacity	P 1	0.921	0.850	0.944
		P 2	0.939		
		P 3	0.904		

which had CR exceeded 0.80, the AVE of all measures compellingly exceeded 0.50 and all items also had a loading number higher than 0.70.

Moreover, the square root of the AVE exceeded the inter-correlations of the construct with the other constructs in the model (Appendix C). Table 6 shows that the loadings of the first-order latent variables on the second-order factors exceed 0.8. However, the AVE values for the BPE variable in the third-order were less than the cut-point of 0.5 (AVE = 0.4470). Therefore, the researcher deleted all items with very small loading numbers in the second and third orders. As a result, the AVE values for BPE exceeded 0.5 (AVE = 0.5010). The elimination of items whose factorial loading were below 0.5 improved the AVE of the second- and third-order constructs (Bouaicha and Bouri 2013). Reflective measures are expected to be unidimensional, and if so, individual measures can be removed to improve construct validity without affecting content validity (Akter et al. 2010).

A non-parametric bootstrapping procedure was used, with 200 replications and construct level change pre-processing, to obtain the standard error and to calculate the t-statistic for inferential purposes (Wetzels et al. 2009). To assess the significance loadings, weights and path coefficients, standard error and t-values, the researcher computed the data by bootstrapping (200 samples; t-values >1.65 significant at the 0.05 level; t-value >2 significant at the 0.01 level) (Martinez-Ruiz and Aluja-Banet 2009). Table 7 shows the results of bootstrapping, where all the path coefficients beta in the model were considered to be highly significant ($p < .001$). The researcher considers the measurement model satisfactory with evidence of adequate reliability, convergent validity and discriminant validity.

Discussion

In order to analyse the HCM holistically, this study used the repeated-indicators approach (Wetzels et al. 2009; Akter et al. 2010) to estimate the higher-order latent variables and to confirm adequate measurement and structural properties for the proposed model by using PLS-SEM estimation. In general, PLS-SEM studies should provide information on (1) population and sample structure, (2) data distribution of the data, (3) the conceptual model and (4) the statistical results, in order to corroborate the subsequent interpretation and conclusion (Chin 2010), which the researcher has already discussed in the previous section.

Having deleted 14 items, the researcher considered the measurement model satisfactory, with evidence of adequate reliability, convergent validity and discriminant validity. The decision to delete 14 items is based on the items with very small loading in the third and second orders, together with rational analysis for not deleting the criteria. Some deleted items are D3, D4, D5, D6 and D7 (under Access). Other omitted items include A5 (under Building Form and Material), B4 (under Building Quality), M1, M2 and M3 (under Operational and Maintenance Guidelines).

Table 6. Reliability of higher order construct.

Construct			Loading	AVE	CR
Second-Order	Built Environment & Building User	Building Form Material	0.908	0.550	0.962
		Building Quality	0.873		
		Engineering	0.877		
		Access	0.509		
		Staff & Patient Environment	0.953		
	Building System	Safety	0.913	0.525	0.960
		Health	0.876		
		Comfort	0.852		
		Easiness	0.818		
		Control Environment Impact	0.852		
		Architecture	0.822		
	DRM	Sustainability	0.911	0.627	0.962
		Disaster Resilience	0.878		
		Functionality	0.893		
		Local Capacity	0.898		
Third-Order	BPE	Built Environment	0.942	0.501	0.983
		Building System	0.965		
		DRM	0.924		

Table 7. Path coefficient, standard error, and t-values.

Path	Beta	SE	t statistic
BPE -> Building System (0.931)	0.965	0.004	224.406***
BPE -> Built Environment& User (0.888)	0.942	0.007	128.485***
BPE -> DRM (0.854)	0.923	0.010	93.442***
Building System -> Architecture	0.821	0.018	45.625***
Building System -> Comfort	0.852	0.017	51.742***
Building System -> Control Environment Impact	0.824	0.017	48.963***
Building System -> Easiness	0.817	0.020	41.906***
Building System -> Health	0.876	0.013	66.125***
Building System -> Safety	0.913	0.009	107.523***
Built Environment& User -> Access	0.713	0.026	27.832***
Built Environment& User -> Building Quality	0.872	0.012	73.112***
Built Environment& User -> Building Form & Material	0.907	0.011	85.498***
Built Environment& User -> Engineering	0.877	0.015	59.628***
Built Environment& User -> Staff & Patient Environment	0.953	0.005	179.034***
DRM -> Disaster Resilience	0.878	0.014	62.045***
DRM -> Functionality	0.893	0.013	69.740***
DRM -> Local Capacity	0.898	0.011	79.673***
DRM -> Sustainable	0.911	0.010	89.818***

***$p < .001$.
n.s.: not significant; SE: standard error

Additionally, the researcher also deleted C5 (under Engineering), H4 (under Comfort), O6 (under Functionality) and L5 (under sustainability). In reflective relationship constructs, all indicators in the model share a common theme, and thus dropping indicators should not alter the conceptual domain of the construct (Hair et al. 2013).

According to Akter et al. (2010), the variance of the second-order constructs is reflected in its corresponding first-order construct. In addition, second-order components, including built environment and building user (89%), building system (93%), and DRM (85%), reflect the degree of explained variance of the third-order post-disaster building performance. The results from bootstrapping show that all the path coefficients in the model are considered highly significant ($p < .001$). Therefore, a significant reflective relationship and three order levels of HCM justifies DRM, the additional variable in the BPE theoretical model for post-disaster context.

As stated by Haigh and Amaratunga (2010), if researchers and practitioners can contribute to an inter-disciplinary strategy for disaster risk reduction through buildings, spaces, and places, then it is important that experts develop a suitable conceptual framework that explores the interaction between the built environment, its disciplines, and the disaster management process. Statistically, this study offers a holistic estimation of building performance in the context of PDR, through interaction among the hospital building environment, the post-occupancy phase, the building users, the local context, and the disaster paradigm.

The reconstruction process should be considered a developmental opportunity and should open the door to different types of innovative solutions (Shaw 2006). Proposing BPE as an evaluation system in PDR hospital buildings not only leads to vulnerability reduction but also enhances human security in the long term. Ismail et al. (2014) listed ‘continuous assessment and evaluation (performance measurement)’ as one of the 18 critical success factors (CSFs) for PDR. This is important, as many of the disaster management programs have failed to sustain at the local level after completing the project (Arain 2015).

The main challenge is lack of interest in conducting BPE. It is still mostly applied only in industrialized countries, as stated previously. Another challenge in Indonesia concerns the cost, where poor maintenance budget allocation and distribution exist (Hayat and Amaratunga 2014). Practically, individuals can apply BPE as part of a maintenance process that specifically focuses on post-occupancy evaluation (Preiser et al. 2017). Nevertheless, in Indonesia this lack is slowly being rectified, as stated by the maintenance regulation for the contractor that is considered compulsory for up to 10 years after the final handover (President 2017). Whether this regulation is also applied in PDR practice is also a challenge. As stated by MacAskill and Guthrie (2015) from the experienced of PDR in Christchurch, New Zealand, the process of introducing resilience into the infrastructure network is affected by who is prepared (and able) to pay for it, an issue that can result in lengthy negotiations. Therefore, disaster-affected communities should ideally be involved and supported by the joint strategy of government and humanitarian agencies (Abulnour 2014), to ensure that PDR really applies BPE, as well as a consensus of cost implication.

Conclusion

The new confirmed framework ‘PDR building performance evaluation’ is part of an inter-disciplinary strategy in built environment knowledge to contribute to disaster risk management practice. Theoretically, the research contribution added a new variable of DRM into the BPE conceptual framework. DRM is recommended to be included in the BPE conceptual model in future study, if the aim is to evaluate PDR buildings in any stage of the building life cycle and not only in the post-occupancy phase.

This study has identified the most important criteria for evaluating PDR hospital building performance. By including the key criteria, the BPE tool specific to post-disaster hospital reconstruction (which may be used as built-in-assessment tool in the PDR process) can be holistically used to assess, diagnose and enhance hospital building performance in a disaster resilience context.

There are at least three practical benefits related to BPE contribution to disaster context in this study: as a design aid, for improving building procurement for the future in PDR; as a management aid, a feedback method in relation to organizational efficiency for maintenance and operation; and as a benchmarking aid, in the transition to sustainable production and consumption of the built environment. Additionally, it serves as resilience building in disaster management.

The limitation of this study is that it is only applicable to hospital buildings, as the study size would have been too large if it aimed at simultaneously testing all types of public buildings. For the same reason, this study only applies the model in the case of post-tsunami reconstruction in Aceh, Indonesia. Therefore, studies of other types of buildings in other developing countries can apply the proposed model in the future. Eventually, the goal is to not only gain a general conclusion, but also to have a benchmark in PDR buildings for guidance in disaster management procurement.

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Appendix A

Indonesia national regulations and building codes are:

a. Ordinance No: 28 Year 2002 (National Act) — regarding Building Construction (Undang-Undang Republik Indonesia: No: 28 Tahun 2002);
b. Government Regulation No: 36 Year 2005 — regarding the Implementing Regulation of RI Act No:28/

2002 (Peraturan Pemerintah Republik Indonesia: No: 36 Tahun 2005);

c. Decree of State Minister of Public Works Ordinance No: 441/KPTS/1998 — regarding Technical Requirement of Building Construction (Keputusan Menteri Pekerjaan Umum: No: 441/KPTS/1998);

d. Decree of State Minister of Infrastructure and Settlements Ordinance (KIMPRASWIL) No: 332/KPTS/2002 — regarding Technical Guideline for State Building Construction (Keputusan Menteri Permukiman dan Sarana Wilayah: No 332/KPTS/2002);

e. Indonesian National Standard (SNI) (Standard Nasional Indonesia);

f. Decree of State Minister of Public Works Ordinance No: 10/KPTS/2000 — regarding Technical Provisions for Fire Hazard Safety in Building and Environment (Keputusan Menteri Pekerjaan Umum: No: 10/KPTS/2000);

g. Decision of the State Minister of Public Works No: 11/KPTS/2000 — regarding Urban Fire Management (Keputusan Menteri Pekerjaan Umum No: 11/KPTS/2000);

h. Regulation of the Minister of Public Works No: 29 year 2006 — regarding Technical Guidance for Building Requirements (Peraturan Menteri Pekerjaan Umum: No: 29 Tahun 2006);

i. Regulation of the Minister of Public Works No: 30 year 2006 — regarding Technical Guidance of Accessibility and Facilities for Building and Environment (Peraturan Menteri Pekerjaan Umum No: 30 Tahun 2006);

j. Regulation of the Minister of Public Works No: 6 year 2007 — regarding Building and Environment Arrangement Plan (Peraturan Menteri Pekerjaan Umum: No 6 Tahun 2007);

k. Government Regulation No: 6 year 2006 — regarding the Management of State/Region Property (Peraturan Pemerintah No: 6 Tahun 2006);

l. Provincial/local regulations for building constructions;

m. Building Code for NAD and Nias Island.

n. Decree of State Minister of Health No: 1204 year 2004 — regarding Requirement of Environmental Health Hospital (Keputusan Menteri Kesehatan No: 1204/MENKES/SK/X/2004).

Appendix B

Reliability for PDR hospital building performance.

No	Item	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
1	Building form and material	50.1487	110.415	.654	.964
2	Staff and patient environment	50.2636	107.937	.795	.961
3	Building quality	49.9979	109.804	.800	.961
4	Engineering	50.0810	108.567	.828	.961
5	Accessibility	50.0928	109.413	.826	.961
6	Safety	50.1501	106.760	.870	.960
7	Healthy	49.8209	110.853	.778	.962
8	Comfort	50.1389	108.651	.818	.961
9	Easiness	50.0434	109.460	.749	.962
10	Architecture	50.0628	110.316	.787	.962
11	Control and environment impact	50.1885	109.321	.794	.962
12	Operational and maintenance guideline	50.2551	108.024	.771	.962
13	Local institution capacity	50.3191	110.395	.673	.964
14	Functionality	50.3479	106.110	.797	.962
15	Sustainability	50.2272	109.296	.741	.962
16	Disaster resilience	50.2701	108.262	.792	.962

Reliability statistics Cronbach's alpha = 0.964; scale mean = 53.49; SD = 11.12.

Appendix C

Table for intercorrelations of the latent variables.

Construct	D	K	B	A	H	J	N	I	C	O	G	P	F	E	L
(D) Access	**0.840**	–	–	–	–	–	–	–	–	–	–	–	–	–	–
(K) Architecture	0.509	**0.858**	–	–	–	–	–	–	–	–	–	–	–	–	–
(B) Building quality	0.548	0.585	**0.850**	–	–	–	–	–	–	–	–	–	–	–	–
(A) Building form material	0.592	0.716	0.756	**0.833**	–	–	–	–	–	–	–	–	–	–	–
(H) Comfort	0.495	0.724	0.62	0.700	**0.843**	–	–	–	–	–	–	–	–	–	–
(J) Control environment impact	0.477	0.587	0.629	0.609	0.608	**0.882**	–	–	–	–	–	–	–	–	–
(N) Disaster resilience	0.477	0.672	0.590	0.658	0.650	0.598	**0.873**	–	–	–	–	–	–	–	–
(I) Easiness	0.511	0.614	0.583	0.629	0.655	0.607	0.556	**0.877**	–	–	–	–	–	–	–
(C) Engineering	0.619	0.601	0.754	0.731	0.607	0.612	0.615	0.598	**0.846**	–	–	–	–	–	–
(O) Functionality	0.479	0.639	0.611	0.590	0.680	0.633	0.69	0.559	0.614	**0.871**	–	–	–	–	–
(G) Health	0.557	0.618	0.670	0.710	0.698	0.687	0.665	0.690	0.631	0.639	**0.799**	–	–	–	–
(P) Local capacity	0.531	0.721	0.632	0.679	0.703	0.591	0.762	0.559	0.618	0.717	0.630	**0.922**	–	–	–
(F) Safety	0.596	0.650	0.712	0.748	0.719	0.750	0.709	0.677	0.753	0.690	0.781	0.692	**0.840**	–	–
(E) Staff & patient Environment	0.634	0.709	0.778	0.833	0.698	0.627	0.642	0.657	0.754	0.619	0.727	0.684	0.762	**0.805**	–
(L) Sustainability	0.519	0.707	0.647	0.693	0.741	0.620	0.768	0.613	0.666	0.717	0.674	0.778	0.717	0.692	**0.879**

Note: For strong discriminant validity, the diagonal elements should be larger than any corresponding row or column entry (Hulland 1999). The bold diagonal elements are the square root of the variance shared between the constructs. It shows that all exceeds the intercorrelations of the construct with the other constructs in the model and support of discriminant validity.

Appendix D

Questionnaire

Form II.A - Hospital profile

(Filled only by Hospital Director /Manager/ Person in Charge)

1. Name of Hospital : ....

2. Address : ....

   ...., Region: ....

3. Type of Hospital : Government ☐ Semi-government ☐ Private ☐

4. Class of Hospital : A ☐ B ☐ C ☐ D ☐

5. Number of bed capacity : ....

6. Number of staff : ....

7. Post-tsunami reconstruction main donors for the hospital reconstruction :

   1. .... 3. .... 5. ....

   2. .... 4. .... 6. ....

8. Asset has been transferred? Yes ☐ No ☐ Not Clear ☐ Don't Know ☐

   If yes, does the hospital have the document? Yes ☐ No ☐ Don't Know ☐

9. Main source of operational cost ? Central government ☐
   Provincial government ☐
   Regional government ☐
   Others ☐

10. Operational & Maintenance (O&M)

    a. Building inspection : Yes ☐ No ☐ Don't Know ☐
    b. Building records : Yes ☐ No ☐ Don't Know ☐
    c. Maintenance manual : Yes ☐ No ☐ Don't Know ☐
    d. As-built plans : Yes ☐ No ☐ Don't Know ☐
    e. Certificate Eligible Function : Yes ☐ No ☐ Don't Know ☐

Form II.B - Respondent Profile

Please choose one answer only and tick in the box

1. Gender?

   Female ☐ Male ☐

2. Age (years)?

   < 21 ☐ 21 - 35 ☐ 36 - 65 ☐ > 65 ☐

3. Academic background?

   ≤ Diploma ☐ Undergraduate ☐ Master ☐ PhD ☐

4. Your relation with the hospital?

   Worker ☐ Patient ☐ Visitor ☐ Others ☐

5. How long do you spend in the building during the day (hours)?

   1 - 2 ☐ 3 - 5 ☐ 6 - 8 ☐ > 8 ☐

Form II.C - Building Performance Evaluation Questionnaires

Please choose one answer only and tick in the box. The answers choices are represented by:

1- strongly disagree, 2- disagree, 3- neutral, 4- agree, 5- strongly agree.

II.C.1. POE for hospital

Access	
1. There is good access from available public transport including any on-site roads;	1 2 3 4 5
2. There is adequate parking for visitors and staff cars with appropriate provision for disabled people;	1 2 3 4 5
3. The approach and access for ambulances is appropriately provided;	1 2 3 4 5
4. Goods and waste disposal vehicle circulation is good and segregated from public and staff access where appropriate;	1 2 3 4 5
5. Pedestrian access routes are obvious, pleasant and suitable for wheelchair users and people with other disabilities / impaired sight;	1 2 3 4 5
6. Outdoor spaces are provided with appropriate and safe lighting indicating paths, ramps and steps;	1 2 3 4 5
7. The fire planning strategy allows for ready access.	1 2 3 4 5

Engineering	
1. The engineering systems are well designed, flexible and efficient in use;	1 2 3 4 5
2. The engineering systems exploit any benefits from standardisation and prefabrication where relevant;	1 2 3 4 5
3. The engineering systems are energy efficient;	1 2 3 4 5
4. There are emergency backup systems that are designed to minimize disruption;	1 2 3 4 5
5. During construction disruption to essential services is minimized.	1 2 3 4 5

Building quality performance		
1.	The building is easy to operate;	1 2 3 4 5
2.	The building is easy to clean;	1 2 3 4 5
3.	The building has appropriately durable finishes;	1 2 3 4 5
4.	The building will weather and age well.	1 2 3 4 5

Staff and patient environment		
1.	The building respects the dignity of patients and allows for appropriate levels of privacy and dignity;	1 2 3 4 5
2.	There are good views inside and out of the building;	1 2 3 4 5
3.	Patients and staff have good access to outdoors;	1 2 3 4 5
4.	There are high levels of both comfort and control of comfort;	1 2 3 4 5
5.	The building is clearly understandable;	1 2 3 4 5
6.	The interior of the building is attractive in appearance;	1 2 3 4 5
7.	There are good bath/toilet and other facilities for patients;	1 2 3 4 5
8.	There are good facilities for staff, including convenient places to work and relax without being on demand.	1 2 3 4 5

Building form and materials		
1.	The building has a human scale and feels welcoming;	1 2 3 4 5
2.	The design takes advantage of available sunlight and provides shelter from prevailing winds;	1 2 3 4 5
3.	Entrances are obvious and logically positioned in relation to likely points of arrival on site;	1 2 3 4 5
4.	The external materials and detailing appear to be of high quality;	1 2 3 4 5
5.	The external colours and textures seem appropriate and attractive.	1 2 3 4 5

II.C.2. Local Regulation – Aceh – Indonesia

Safety		
1.	The building structure meets the security requirements, feasibility, durability, and resistance to fire;	1 2 3 4 5

2.	The building has a good fire resistance system;	1 2 3 4 5
3.	The building has a good lighting system to protect from thunderbolt;	1 2 3 4 5
4.	The electricity has been securely installed in the building;	1 2 3 4 5
5.	Any mechanical or medical gas has been securely kept in the building.	1 2 3 4 5
Health		
1.	The building using safe materials;	1 2 3 4 5
2.	The building has good sanitation system including for clean and dirty water;	1 2 3 4 5
3.	The building has ample lighting either from the sunlight through the windows and from the lights;	1 2 3 4 5
4.	The building has good ventilation.	1 2 3 4 5
Control of environment impact		
1.	The building follows environment regulations required for hospital building (e.g. AMDAL);	1 2 3 4 5
2.	The building handles environment issues such as asbestos abatement, lead paint, air quality accordingly;	1 2 3 4 5
3.	The building has fulfilled basic and important regulations for building constructed in hazard zoning.	1 2 3 4 5
Easiness		
1.	The connection to and from the building is easy to access;	1 2 3 4 5
2.	The connection between rooms and facilities inside the building is easy to access;	1 2 3 4 5
3.	The building facilities and infrastructure are easy to access, including for the disabled and elderly.	1 2 3 4 5
Comfort		
1.	The circulation between rooms in the building either for vertical and horizontal connection is easy to access;	1 2 3 4 5

2.	The air condition in the rooms is comfortable;	1 2 3 4 5
3.	There is no disturbance of vibration;	1 2 3 4 5
4.	There is no disturbance of noisiness from inside or outside the building.	1 2 3 4 5
Architecture		
1.	The building façade is interesting and suitable for hospital identity as well adaptable with the surrounding ;	1 2 3 4 5
2.	The design interior considered esthetic elements and supports the healthcare function in the same time;	1 2 3 4 5
3.	There are enough green gardens within the hospital compound;	1 2 3 4 5
4.	Any signage inside and outside building is easy to understand.	1 2 3 4 5

II.C.3. Disaster Risk Management

Functionality		
1.	The building service (e.g. power, plumbing, telecom systems) is reliable and safe during emergency situation;	1 2 3 4 5
2.	The structural strength of the building is convincing to cope with disasters;	1 2 3 4 5
3.	The building is able to convert as an escape building if disaster such as tsunami or flood happens;	1 2 3 4 5
4.	There is a clear access for evacuation during emergency situation;	1 2 3 4 5
5.	The building system is efficient to operate during emergency situation;	1 2 3 4 5
7.	The building is possible for basic maintainability during emergency;	1 2 3 4 5

Operational & Maintenance (O&M) guidelines

**This section is specifically answer for respondents from hospital worker/ staff group*

1.	Since the hospital being occupied there have been building inspection (s) conducted;	1 2 3 4 5
2.	The hospital has proper building records documentation of the building condition during occupation;	1 2 3 4 5
3.	The hospital has complete maintenance manual.	1 2 3 4 5

Local institution capacity (technical, financial, & operational)

1.	The hospital has the technical capacity in functioning the building;	1 2 3 4 5
2.	The hospital is able to operate & maintain the building;	1 2 3 4 5
3.	The hospital have adequate financial to operate and maintain the building.	1 2 3 4 5

Disaster risk reduction (DRR)

1.	The building is not located in high alert disaster zone;	1 2 3 4 5
2.	There was hazard assessment conducted regularly;	1 2 3 4 5
3.	The building fulfilled the standard as a hospital built in disaster zone.	1 2 3 4 5

Sustainability

1.	The hospital consummate energy for the building efficiently and effectively;	1 2 3 4 5
2.	The hospital practices a sustainable system of water consumption;	1 2 3 4 5
3.	The building presents a sustainable innovation design;	1 2 3 4 5
4.	The hospital building is convenient;	1 2 3 4 5
6.	The hospital has a sustainable waste management system especially for medical waste;	1 2 3 4 5
7.	The building is easy to be access by public transportation available in the area.	1 2 3 4 5