POST-CONSERVATION EVALUATION (PCE) FRAMEWORK FOR ADAPTIVE REUSE MUSEUMS: CASE STUDIES OF GEORGE TOWN, MALAYSIA

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POST-CONSERVATION EVALUATION (PCE) FRAMEWORK FOR ADAPTIVE REUSE MUSEUMS: CASE STUDIES OF GEORGE TOWN, MALAYSIA

ABSTRACT

The trend of converting historic buildings to museums has been found prevalent in the historic cities of Melaka and George Town, among the UNESCO World Heritage sites of Malaysia. However, adaptive reuse approach has not always brought in positive conservation impacts as some historic buildings turned dysfunctional after their conversion to museums. This scenario has called upon the needs for having an evaluation framework focusing on the post-conservation impacts of historic buildings converted to museums (adaptive reuse museums) within the UNESCO World Heritage of Malaysia context. Criteria of physical appropriateness, functional effectiveness and financial efficiency were scrutinised through literature review to conceptually form the Post-Conservation Evaluation (PCE). Case studies obtained through purposive sampling involving five historic buildings in the historic city of George Town were then used to test the operational and empirical capabilities of the conceptual PCE. Field work conducted at the case studies then led to the findings that the post-conservation impacts of adaptive reuse museums have been not convincing in the sense of physical appropriateness and also functionally ineffective in the sense of preserving sensitive collections. This evaluative research then contributed a PCE framework focusing on the impacts of adaptive reuse museums in the context of UNESCO World Heritage of Malaysia, based on validation via Delphi survey involving experts and stakeholders in the field of built heritage conservation.

Keywords: adaptive reuse, historic building, museum, Post-Conservation Evaluation (PCE), UNESCO World Heritage

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ABSTRAK

Tren penyesuaigunaan semula bangunan bersejarah kepada muzium didapati banyak dilakukan di bandar-bandar bersejarah Melaka dan George Town, antara tapak Warisan Dunia UNESCO Malaysia. Namun didapati kaedah penyesuaigunaan semula bangunan tidaklah sentiasa menjurus kepada impak pemuliharaan yang positif kerana adanya bangunan-bangunan bersejarah yang tidak berfungsi setelah ditukarguna menjadi muzium. Senario ini menjurus akan keperluan suatu rangka kerja penilaian terhadap impak pasca pemuliharaan bagi bangunan bersejarah yang telah disuaigunasemula menjadi muzium (muzium penyesuaigunaan semula) berdasarkan konteks Warisan Dunia UNESCO Malaysia. Menerusi sorotan literature, kriteria kesesuaian fizikal, keberkesanan fungsi dan kecekapan kewangan diteliti untuk membentuk konsep penilaian pasca-pemuliharaan (PCE). Kemampuan konsep PCE tersebut kemudian diuji secara operasi dan empirik melalui kajian kes melibatkan lima buah bangunan bersejarah yang diperoleh menerusi persampelan bertujuan. Kerja lapangan ke atas kajian kes menghasilkan penemuan bahawa impak pasca pemuliharaan bagi muzium penyesuaigunaan semula adalah tidak memberangsangkan dari segi kesesuaian fizikal serta tidak efektif dari segi pemeliharaan koleksi muzium yang sensitif. Menerusi kaedah Delphi melibatkan para pakar dan pemegang taruh di dalam bidang pemuliharaan warisan, kajian berasaskan penilaian ini akhirnya menyumbang kepada sebuah rangka kerja PCE yang khusus untuk menilai impak-impak penyesuaigunaan semula muzium di dalam konteks Warisan Dunia UNESCO Malaysia.

Kata kunci: bangunan bersejarah, muzium, penyesuaigunaan semula, Post-Conservation Evaluation (PCE), Warisan Dunia UNESCO

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Batik Painting Museum	BPM
Building Performance Evaluation	BPE
Celsius Degree	°C
Carbon Dioxide	CO_2
City Council of Penang Island	MBPP
Dark Mansion- 3D Glow in the Dark Museum	DM
Department of Museums Malaysia	JMM
Department of National Heritage	JWN
George Town World Heritage Incorporated	GTWHI
Heritage Assessment Impact	HIA
Historic Melaka City Council	MBMB
Indoor Environmental Quality	IEQ
International Centre for the Conservation and Restoration of Monuments	ICCROM
International Council of Museums	ICOM
International Council on Monuments and Sites	ICOMOS
Made in Penang Interactive Museum	MIPIM
Melaka Museums Corporation	PERZIM
Melaka World Heritage Sendirian Berhad	MWHSB
Ministry of Tourism and Culture	MOTAC
Operating Expense Ratio	OER
Outstanding Universal Value	OUV
Post-Conservation Evaluation	PCE
Penang State Museum	PSM
Department of Public Works	JKR
Penang State Museum Board	LMNPP
Sun Yat Sen Museum	SYSM
Total Volatile Organic Compound	TVOC
United Nations Educational, Scientific and Cultural Organization	UNESCO
World Tourism Organization	WTO
Willingness-to-pay	WTP

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CHAPTER 1: INTRODUCTION

1.1 Research Background

This thesis is concerned with the realm of built heritage conservation, specifically in the adaptive reuse of historic buildings to museums (adaptive reuse museums) located within the UNESCO World Heritage of Malaysia. The following discourses briefly convey the contextual background of the current research:

1.1.1 UNESCO World Heritage

Notably, the act of heritage conservation is not an avant-garde agenda. The urge to protect perilous heritage assets has already existed since yesteryears ago. The emergence of global consciousness to safeguard heritage has eventually brought upon the introduction of UNESCO World Heritage in 1972. Ever since, worldwide heritage properties carrying international significance, officially termed as Outstanding Universal Value (OUV), will be subjected for nomination and inclusion into the UNESCO World Heritage List. This scheme recognises and protects valuable and unique heritage comprising cultural and natural categories embodied in an international treaty called the Convention Concerning the Protection of the World Cultural and Natural Heritage (Lai & Ooi, 2015),.

As the core principle of this global advocacy is permanent protection, destruction and extinction of heritage assets available across the globe are thus prevented and prohibited for good. The intergovernmental World Heritage Committee (representing countries that have ratified the World Heritage Convention) has revered numerous places, from many countries all over the continents, as UNESCO World Heritage (Roders & Oers, 2011). Once established as UNESCO World Heritage, many opportunities and possibilities follow suit to listed places. As such recognition shapes tourists' perception and evaluation of the recognised localities, those places tend to transform into major attractions and icons of national identity, besides eventually hold the international accountability concerning tourism industry (Shackley, 2006; Freya & Steiner, 2011; Poria, Reichel , & Cohen, 2011; Maghsoodi Tilaki, Abdullah, Bahauddin, & Marzbali, 2014).

As seen countrywide, the enhanced marketability to international audience gets advantageous in fostering sustainability. This is because, the growth in tourism industry would indirectly bring in physical revitalisation, sociocultural development as well as economic improvement to UNESCO World Heritage localities. Yet, the underlying process required to earn the much-desired status is never an easy task. Lai and Ooi (2015) reasoned that by explaining that the title is not a mere commercial gimmick. It apparently cannot be developed nor created by marketing experts. In fact, stringent evaluation from professional heritage experts is much required for the status entitlement.

1.1.2 Malaysian Context

Malaysia is a developing Southeast Asian country, geographically divided into Malaysian Peninsula (West) and Malaysian Borneo (East) comprising 13 states and three federal territories. It is renowned as one of the hot tourism spots within Southeast Asian countries made famous by its unique tourism slogan "Malaysia truly Asia" (Akasah, Abdul , & Zuraidi, 2011; Sodangi, Idrus, & Khamidi, 2013). By far, Malaysia has managed to get four of its remarkable heritage assets recognised as UNESCO World Heritage as shown in Table 1.1:

Table 1.1: The UNESCO World Heritage Sites of Malaysia
(BERNAMA, 2012; UNESCO, 2014)

Categories	UNESCO World Heritage Sites	Years Inscribed
Cultural Heritage	Archeological Heritage of the Lenggong Valley, Perak	2012
	Historic Cities of the Straits of Malacca, Melaka and George Town	2008
Natural Heritage	Gunung Mulu National Park, Sabah	2000
	Kinabalu Park, Sabah	2000

Malaysia apparently has evolved into a unique place which is rich in cultural diversities due to its people of multiple races and religions (Mohd Yusoff, Dollah, & Kechot, 2011). There are numerous tangible and intangible heritage assets available across the country. Different ethnicities in Malaysia are reflected to its colourful heritage and amalgamated culture as well as different local knowledge expressed through architecture, handicrafts, traditional attire as well as music and dance (Ismail , Masron, & Ahmad, 2014). Besides, rich tapestry of both traditional and colonial evidences in the country offers historical uniqueness and cultural diversities to visiting tourists (Mohamed B. , 2002; Mohd Yusoff, Dollah, & Kechot, 2011).

The growth of tourism industry resulting from the impact of UNESCO World Heritage status is no exception for the case of Malaysia. Inclusion of Melaka and George Town into the UNESCO World Heritage List in 2008 has made the Malaysian tourism industry turned more palpable on the subsequent year as evident in Figure 1.1:

Figure 1.1: The rise of Malaysia as top 10 international tourist destinations in 2009
(WTO, 2010)

Figure 1.2 illustrates the number of tourists and income pattern made through the local tourism industry, spanning across before and after of UNESCO's recognition year in 2008. Implying from the graph, it is reasonable to agree that historic buildings channel positive impact to Malaysian economy by bringing in foreign tourists and creating job opportunities via tourism agenda (Mohd Yusoff, Dollah, & Kechot, 2011; Sodangi, Khamidi, Idrus, Hammad, & Umar, 2014).

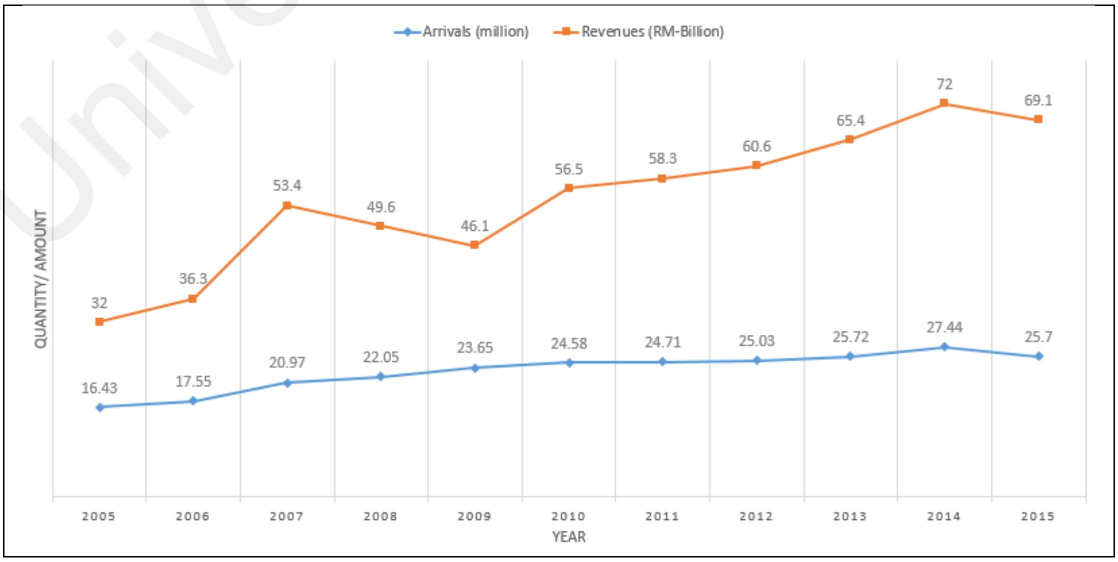


Figure 1.2: Tourist arrivals and revenue generation to Malaysia
(Tourism Malaysia, 2016)

Geographically, Melaka is located at the southern part of Malaysian peninsular region whereas George Town is located at the northern part, within Penang Island (*Pulau Pinang*) as shown in Figure 1.3. Concerted efforts by both state governments as well as the Federal Government were fruitful in seeking the approval from UNESCO World Heritage Committee (Harun S. N., 2011; Omar, Muhibudin, Yussof, Sukiman, & Mohamed, 2013).

Figure 1.3: Location of Melaka and George Town in Malaysia
(Houben , 2015)

Recognised under the cultural category of UNESCO World Heritage, Melaka and George Town have been branded together as the UNESCO Historic Cities of the Straits of Malacca, named upon the 15th to 18th century geographical trail trade between Europe and Asia (Harun S. N., 2011). The two cities are culturally significant for their:

i. Geographical link with the Straits of Malacca which was once an internationally renowned trading port at Southeast Asia. The Straits of Malacca was glorified as a strategic business hub where trade activities happened with the Arabs, Chinese and Indians as well as other Southeast Asian countries since the fifth century and later developed as a strategic port to the East and West on the 15th to 18th century.

ii. Rich historical legacies as the genesis on the formation of Malaysia as a country. Formerly known as *Tanah Melayu* (Land of the Malays), Malaysia has gone through a series of occupations and colonisation starting as early as the year 1409 to the year 1945. Over a decade later, the country reached its independence on 31th August 1957. There was a series of nationally important historical timelines involving the era of Malay Sultanate of Melaka from the year 1409 to 1511, the Portuguese occupation from the year 1511 to 1641, the Dutch occupation from the year 1641 to 1826 and the British occupation from the year 1826 to 1957.

The cultural strength of Melaka and George Town lies upon both of its tangible and intangible heritage, comprising historical and multi-cultural elements as imprinted from the Malay Archipelago, China, India, and Western colonialists namely the Portuguese, the Dutch, and the British. Both cities basically met three OUV criteria as following:

- *Criterion II: Exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design*
- *Criterion III: Bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared*
- *Criterion IV: Be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history*

1.1.3 Adaptive Reuse of Historic Buildings in Melaka and George Town

The importance of safeguarding historic buildings is testified by the introduction of appropriate legislations and technical guides by UNESCO, who governs the global cultural heritage (Bernat, Janowski, Rzepa, Sobieraj, & Szulwic, 2014). The value of historic cities lies in the collective value of its buildings, streets and spaces which form the character of old township (Sodangi, Khamidi, & Idrus, 2013). Conservation of historic buildings is thus mission-critical for the local stakeholders especially when tangible heritage is an imperative cultural element of Melaka and George Town's OUVs.

Moreover, Melaka and George Town possess astonishing historic buildings scattered throughout the two cities, which represent a superior quality of Malaysian built heritage scenery originated from both traditional and colonial architecture.

As the gems from the past and a quintessential cultural evidence in the physical form, historic buildings within Melaka and George Town testify and reminisce old nostalgia, offer a unique sense of place, and play a central role in capturing worldwide tourists' interests through their unique architecture and wide-ranging typologies. Adaptive reuse carries the primary goal of rejuvenating old buildings (Bullen P. , 2007), Apart from preservation and restoration approaches, it is apparent that many historic buildings in Melaka and George Town have been adapted to boutique hotels, cafes and restaurants, pubs and bars, museums and galleries and so on, mostly to cater for the growing tourism industry (Samadi & Mohd Yunus, 2012; Ab Wahab, 2013). Out of these examples, Mok (2013) reported that conversion of historic buildings to museums is the most trending latterly which involve both government and private premises.

1.1.4 Research Motivation

Museums play a pivotal role in preserving the cultural heritage of Malaysia, along other mediums such as oral communications, printed publications and traditional practices (Ahmad A. T., 2010). In Malaysia, museums have become the representative instruments of the state or bodies governing them, oriented for nation building based on their common projection of shared experiences from the past (Ahmad A. , 2015). However, there are several dilemmas raised by some influential figures in relation to the local museum industry as such:

i. Younger generations perceived museums as old and dull repositories which are not worth of attention- Datuk Seri Mohd Shafie Apdal (Mokhtar & Kasim, 2012)
ii. Museums rarely being listed as a family trip destination in comparison to other holiday destinations- Datuk Ibrahim Ismail (Abdul Razak, 2011)
iii. Malaysian museums have always been disregarded by financial providers due to their low capability in generating economic revenue to the country- Dato' Dr Adi Taha (Taha, 2009)

There is a stiff competition between museums with other leisure and tourist attractions nowadays (Rowley, 1999). Hence, the status of museum institutions in Malaysia in the current age should goes beyond a mere repository for historical collections to a significant institution that deals with tourism and education industries. The existence of museum function strongly supports the mission of UNESCO World Heritage in preserving and protecting cultural and natural heritage (ICOM, 2013). This has motivated the current researcher to explore further on the adaptive reuse topic focusing on the scope of historic buildings converted to museums.

1.2 Problem Statement

Transformation of a building to cater a new different use is inherently complex as certain alterations are required to be made to the existing fabric (Malhis & Al-Nammari, 2015). Adapting historic building to museum demands an establishment of new set of relationships between the old and new. It enhances the complexity of the project especially when the museum fabric itself is a cultural item that is protected by certain conservation laws, having multiple use requirements, while the collections stored within it necessitated protection against external environment (Ikonomidis-Doumbas, 1990; Cassar, 1994; Ladkin, 2004; Babor & Plian, 2008; Günçe & Misirliso, 2014).

Thus, adaptive reuse of historic building to museum incurs various challenges in the aspects of physical (construction, structural, legal etc.), functional (cultural, museology, safety etc.) and financial (feasibility, maintenance etc.) (Ikonomidis-Doumbas, 1990; Günçe & Misirliso, 2014). Historic buildings have a higher risk of operational failure and physical vulnerability compared to modern buildings, owing to factors such as age, climatic conditions, poor maintenance, negligence, as well as, wear and tear process (Brereton, 1991; Syed Mustapa , Kamal, Zaidi, & Abd Wahab, 2007; Sodangi, Idrus, & Khamidi, 2011; Ahzahar, Karim, Hassan, & Eman, 2011). In this regard, physical interventions made to historic building can lead to negative post-conservation impacts when executed with lack of knowledge and skills, absence of comprehensive guidelines, and insufficient funding (Brereton, 1991; Syed Mustapa , Kamal, Zaidi, & Abd Wahab, 2007; Sodangi, Idrus, & Khamidi, 2011; Ahzahar, Karim, Hassan, & Eman, 2011).

The George Town's Draft of Special Area Plan reported that built heritage of the two historic cities have been affected with issues on strong presence of dilapidated and vacant buildings (APUDG, 2011). The issues seem to have persisted despite the allocation of RM50 millions conservation fund by the Malaysian Federal Government to both State Governments in 2008 (Ahmad Badawi, 2008). More worrying, the scenario continues to prevail involving historic buildings that have been adapted to museums. Through observation in the conservation Core Zone of George Town alone, the Penang Islamic Museum (also known as Syed Al-Attas Mansion) in Lebuh Acheh has been found in poor physical conditions while the Jawi Peranakan Museum and Gallery (also known as *Rumah Teh Bunga*) in Jalan Hutton has been found closed for the public. As shown in Figure 1.4 and 1.5, both museums remain non-operational and have remained closed for the public.

Figure 1.4: The Penang Islamic Museum is closed for rehabilitation due to poor physical conditions

Figure 1.5: The Jawi Peranakan Museum and Gallery mostly closed for the public and rarely accessible

Such scenario thus is incongruent with the requisition of UNESCO World Heritage that demands historic cities to be in a good physical state of repair (Stovel, 2007). Associating with adaptive reuse, the observation also conformed with Yaacob's (2010) revelation that many buildings in Malaysia have been under-used or wrongly used by the occupants which led to dilapidation. Undeniably, factors such as age, climatic conditions, poor maintenance, negligence, as well as, wear and tear process are contributory to the higher risk of operational failure and physical vulnerability of historic buildings (Brereton, 1991; Syed Mustapa , Kamal, Zaidi, & Abd Wahab, 2007; Sodangi, Idrus, & Khamidi, 2011; Ahzahar, Karim, Hassan, & Eman, 2011).

It is imperative to note that each World Heritage has the responsibility to conserve and manage its heritage properties (UNESCO, 2005). Sensitising that, architectural heritage has been explicitly mentioned as a significant component (criterion IV) that formed Melaka's and George Town's OUVs. In this sense, dilapidated and dysfunctional historic buildings clearly would threaten the representation of tangible heritage for UNESCO World Heritage localities. As stipulated in Section II. F (no.96) of the Operational Guidelines for the Implementation of the World Heritage Convention, the OUVs of any World Heritage must be maintained as at its time of inscription or enhanced in the future. Violation and negligence of such matters would jeopardise the received honour.

On a serious note, the World Heritage Committee would consider deleting any properties from the UNESCO World Heritage List if the OUV found destroyed (UNESCO, 2005). This therefore means failure in retaining the OUVs would mean that both Melaka and George Town status as UNESCO World Heritage will be at stake and worst-case scenario, become void. The essentiality of yielding positive impacts from the implementation of adaptive reuse, and conservation in general, has calls upon the needs for having a pertinent and specific evaluation framework. Inherently, conservation by process is dynamic and cyclical, which differs from planning process that merely circumscribed to a beginning, middle and end phases (Margoluis, Stem, Salafsky, & Brown, 2009a).

Conservation is not limited to protective regulation and property inventories (Griffith, 2010; Griffith, 2012) and theoretically covers an ongoing series of planning, implementing and evaluating activities (Margoluis, Stem, Salafsky, & Brown, 2009a). However, evaluation is reportedly still lagging on both quantitative and qualitative terms in conservation industries in relative to other areas such as medical, education, business, community etc. (Kleiman, et al., 2000; Margoluis, Stem, Salafsky, & Brown, 2009b; Howe & Milner-Gulland , 2012). Various literature has discussed the gap pertaining conservation evaluation besides its passive exploration by conservation communities (Kleiman, et al., 2000; Margoluis, Stem, Salafsky, & Brown, 2009a; Margoluis, Stem, Salafsky, & Brown, 2009b; Zancheti & Similä, 2012). The practice of evaluation has been apparent in other industries such as health, education and business as well as in community development programmes.

In the field of built heritage conservation, Morris (1877) since the time of Manifesto of the Society for the Protection of Ancient Buildings has pointed that conserved buildings have not been evaluated as much as new buildings. In the attempt to enhance the Malaysian conservation practice to a better standard, the preliminary study done by Abdul Aziz, Keumala and Zawawi (2014) emphasised the needs to address the rarity and demand of evaluation pertinent to post-conservation of built heritage by advocating the integration of Post-Conservation Evaluation (PCE) concept into the existing Malaysian built heritage conservation framework as shown in Figure 1.6:

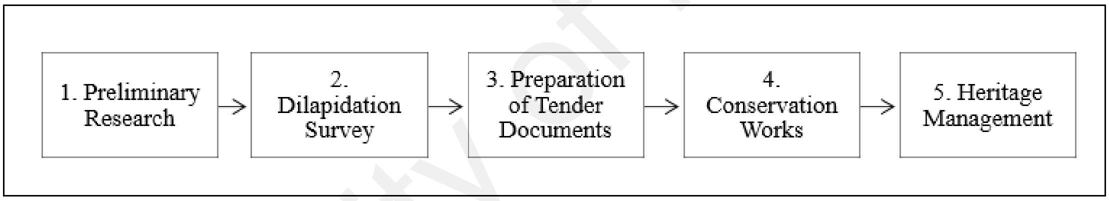


Figure 1.6: The existing Malaysian built heritage conservation framework
(Jabatan Warisan Negara, 2012; Department of National Heritage, 2015)

The study found that Malaysian built heritage conservation framework merely comprises of five sequential phases as stated in the official website of the Malaysian Department of National Heritage (JWN) and in the section of *Proses Pemuliharaan* of the *Garis Panduan Pemuliharaan Bangunan Warisan* (Jabatan Warisan Negara, 2012; Department of National Heritage, 2015). The final phase which is heritage management as stated in the framework merely circumscribed to management of physical, social and economic aspects that involves responsible agencies, stakeholders and local authorities. It basically caters on the establishment of conservation committee, cyclical maintenance programme, financial grants and aids as well as marketing through heritage tourism and product promotion (Ahmad A. , 2010; Harun S. N., 2011). However, the evaluation dimension that revisit the conservation works implemented was absence.

In contrary to the myriad of theories supporting evaluation as a powerful tool in achieving further improvements and future betterments of any programme interventions, evaluation on heritage buildings prior conservation in Malaysia are merely circumscribed to assessment measures in the preliminary investigation and dilapidation survey stages. As conservation evaluation can guide future interventions, maximise benefits and avoid negative impacts, development of new approaches and methodologies are therefore necessary to enable the assessment of conservation performance and to enrich the existing body of knowledge of evaluation (Alonso & Meurs, 2012).

Owing to that, Abdul Aziz, Keumala and Zawawi (2014) advocated in the setting up of PCE to complement the incipient Malaysian built heritage conservation framework following their interviews with five key conservation stakeholders in Malaysia. The interviews basically revealed the Malaysian built heritage conservation framework is lacking in a standardised yet comprehensive evaluation framework to evaluate historic buildings pertinent to post-conservation phase. Local authorities from both Melaka and George Town informed that their typical building assessment form is of ad hoc basis, case specific and updated occasionally. They perceived historic building evaluation merely through the compliance check made with the local guidelines and building requirements prior to the issuance of Certificate of Completion and Compliance (CCC).

The World Heritage Office (WHO) on the other hand merely monitor heritage properties within the confined sites against inappropriate and illegal interventions, focusing more onto the larger urban context rather than onto a specific building unit. Theoretically, built environment is composed with multi-components entailing products, interiors, structures, landscapes, cities, regions and earth (Bartuska, 2007). Thus, evaluation focusing on the scope of building-level is deemed imperative as historic building forms an integral part of Melaka and George Town's OUVs.

The interview found on the essentiality of having a PCE framework which can indicate the conservation merit of historic buildings after their conservation undertakings, with comprehensive considerations on building typology, material, period of construction, place and intervention types. More recently, the result of a preliminary study by Firzan, Keumala, and Zawawi (2017) has re-emphasised the needs of having PCE due to the unavailability of evaluation tools focusing on:

i. Microscale evaluation for individual historic building unit; macroscale evaluation tools that focus on the larger urban context are presently available such as UNESCO's Reactive Monitoring and Periodic Reporting and Cultural Heritage Impact Assessment (HIA).
ii. Evaluating conservation performance (applied interventions) on historic buildings; available building evaluation tools such as Building Performance Evaluation (BPE) and Post-Occupancy Evaluation (POE) commonly focus on new buildings which evaluation basis are merely based on users' feedback and environmental data.

In this regard, evaluation on the impacts of adaptive reuse focusing on historic buildings converted to museums in the context of UNESCO World Heritage of Malaysia is deemed crucial following few explorations and studies have been carried specifically on the topic.

1.3 Research Questions

As a praxis to develop Post-Conservation Evaluation (PCE), the main research question emerged is: How to evaluate the post-conservation impacts of historic buildings converted to museums (adaptive reuse museums) within the UNESCO World Heritage of Malaysia context? The following are the research questions (RQs) that needs to be addressed through this research (within the UNESCO World Heritage of Malaysia context):

- RQ 1: What are the criteria for evaluating the post-conservation impacts of adaptive reuse museums?
- RQ 2: How appropriate, effective and efficient are the post-conservation impacts of adaptive reuse museums?
- RQ 3: What is the relevance of the conceptual evaluation framework to the actual conservation practise for adaptive reuse museums?

1.4 Aim and Objectives

The current research aim is to establish a Post Conservation Evaluation framework for historic buildings converted to museums (adaptive reuse museums) within the UNESCO World Heritage of Malaysia context. The existence of this framework is necessary for a proper sustenance of tangible heritage and OUVs that are crucial elements of the UNESCO World Heritage status for Melaka and George Town. In the quest to achieve the research aim and answering the research questions, three research objectives (ROs) have emerged as follows (within the UNESCO World Heritage of Malaysia context):

- RO 1: To review the relevant criteria for evaluating the post-conservation impacts of adaptive reuse museums.
- RO 2: To evaluate the post-conservation impacts of adaptive reuse museums (using the identified criteria).
- RO 3: To establish the relevance of the conceptual evaluation framework to the actual conservation practise for adaptive reuse museums.

1.5 Research Structure

The following Figure 1.7 depicts the research structure:

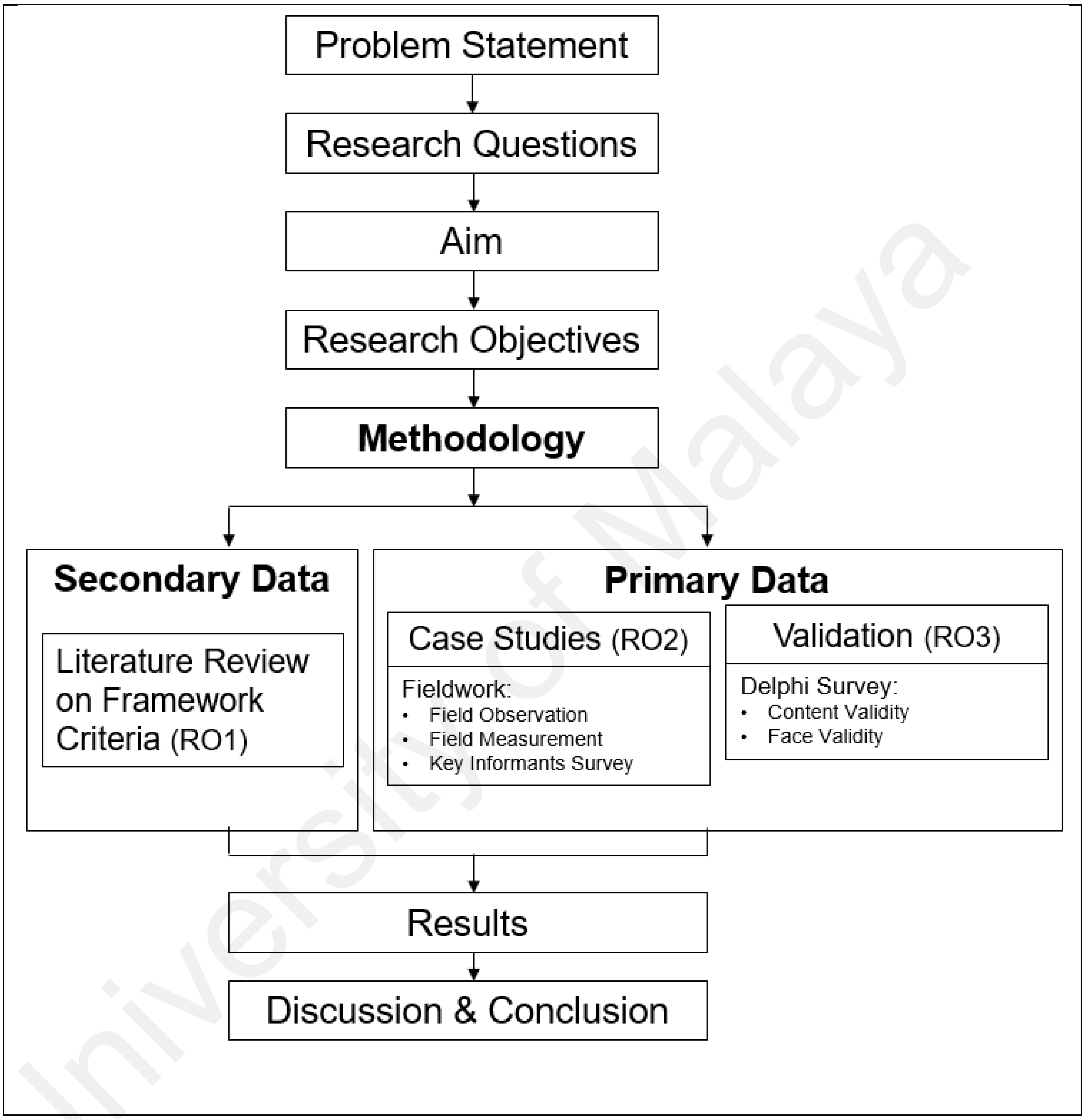


Figure 1.7: The research structure

1.6 Research Significance

Research on evaluation can contribute to the general knowledge of professional evaluation practice (Lewis, Harrison, Ah Sam, & Brandon, 2015). With this realisation, the current research would expand the existing body of literature pertinent to evaluation of conserved historic building by merging and contextualising seminal research into a conceptual evaluation framework pond to the lack of evaluation on post-conservation phase. The current research would also be significant for exploring and evaluating the post-conservation impacts of adaptive reuse museums available and operational in the UNESCO World Heritage of Malaysia which has never been done before.

The results obtained from the case studies would be suggestive to the respective museum owners, managers, and curators in rectifying their building physical conditions and optimising their building performance. Indirectly, the current research would nurture them in understanding on their respective heritage premises in tune with Davidson's (2005) remark that evaluation allows us to evolve, develop, improve, and survive in an ever-changing environment by yielding specific insights and findings that can change current practices, build capacity and trigger further learning and improvement. The originality and nobility of the current research meanwhile lies in its contribution of a framework to evaluate the post-conservation impacts of adaptive reuse focusing on the prevalent case of historic building to museum, in the context of UNESCO World Heritage of Malaysia. As research in general contributes to the practical and theoretical advancement (Kumar, 2011), the output to be produced is expected to be useful among Malaysian conservation stakeholders comprising the local authorities, the World Heritage Office (WHO), heritage consultants and evaluators, facility managers, and other researchers alike.

1.7 Thesis Outline

The current thesis is organised into six chapters. Chapter One provides an overview of the research background. The chapter briefly narrates the contextual background of the UNESCO World Heritage, then channelled the reader's attention to the research locale of Malaysian context. The motivation to undertake the research in relation to the adaptive reuse of historic buildings to museums is also informed in this chapter. Chapter One then articulates on the research constructs comprising the gap and research questions followed with the research aim and objectives. It finally emphasises the research significance towards conservation discipline.

Chapter Two contains comprehensive literature review to derive the relevant criteria for the conceptual evaluation framework. It initially reviews on the agenda of global heritage protection through the UNESCO World Heritage concept in general and subsequently zooms into the research locale in Malaysia namely the UNESCO Historic Cities of the Straits of Malacca comprising the historic cities of Melaka and George Town. The chapter then elaborates on philosophical and practical dimensions of built heritage conservation to deepen the understanding on issues relating to historic buildings with special emphasis on the scope of adaptive reuse. Chapter Two also includes museum-based literature to foster understanding on museum definition, principles, significance, functions, and aspects of importance prior to includes substantial review on the topic of building performance in relation to museum Indoor Environmental Quality (IEQ). This chapter finally explores on validation approaches available for the meta-evaluation purpose of the conceptual evaluation framework.

Chapter Three explains on the methodological dimension of the current research. It includes the explanation on the two main stages of the current research involving primary data namely the case studies and validation process. This chapter draws out the sampling approach, research methods, duration and period of data collection, tools used, procedural matters, analysis methods, and participants involved in the current research. This chapter also elicits on ethical considerations complied throughout the research undertakings.

Chapter Four presents detailed descriptions of the adaptive reuse museums in historic city of George Town, the UNESCO World Heritage of Malaysia involved in the current research. It narrates the essential past and present background of the five case studies' buildings which comprises of two non-shophouse buildings and three shophouse buildings. Chapter Five analyses the data obtained from the field observation, field measurement and key informants survey conducted, presented in a comparative manner based on inter-and intra-case studies. This chapter then examines the content and face validity tests performed on the conceptual evaluation framework which has been formed earlier using literature review and tested using the case studies.

Chapter Six discusses the implication of the findings on post-conservation impacts of adaptive reuse museums within the UNESCO World Heritage of Malaysia context, drawing from the physical appropriateness, functional effectiveness and financial efficiency criteria. This chapter also discusses on the establishment of the proposed evaluation framework upon its validation process involving conservation experts and stakeholders. This chapter finally concludes the accomplishments of the research constructs and revisits the main thesis contribution. Research limitations and recommendations for future researchers are also provided in this last chapter.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Acknowledging the importance of context in shaping evaluation (Vo & Christie, 2015), this chapter reviews seminal literature on the topics of UNESCO World Heritage, conservation and adaptive reuse of historic buildings, museum and cultural heritage tourism, as well as building performance and Indoor Environmental Quality (IEQ). In attempting to achieve RO1, this chapter then synthesises the reviewed materials to form the relevant criteria for evaluating the post-conservation impacts of adaptive reuse museums within the UNESCO World Heritage of Malaysia context.

2.2 Global Agenda of Heritage Protection: The UNESCO World Heritage

Ostensibly, 'heritage' is a vague term and may invite varying interpretations and different assumptions. In fact, many countries such as Australia, Canada, New Zealand, and China have their very own unique definitions of 'heritage', due to the absence of standardisation and streamlining of a uniform heritage terminology at the international level (Ahmad Y. , 2006). Another issue commonly raised is regarding the ambiguity on what and which heritage that will be valued by the upcoming generations (Phillips & Truman, 2002).

Noting so, understanding on the general understanding of heritage would be essential. As mentioned by Dawson (2005), the word 'heritage' has originated from 'inheritance' which refers to tangible properties or items passed via will or gift to new generation from its previous ones. English Heritage (2008) meanwhile added further notion on heritage, clarifying it as all inherited resources which people value for reasons beyond mere utility.

Further literature scrutiny to understand heritage has broaden the scope of heritage into several categories as shown in Figure 2.1. Available in tangible and intangible forms, heritage is the legacy from our past, what we live with today, and what we pass onto our inheritance. Since heritage embodies the relics and ethos from the yesteryears, its sustainment thus carries utmost importance and benefits for the current and future time.

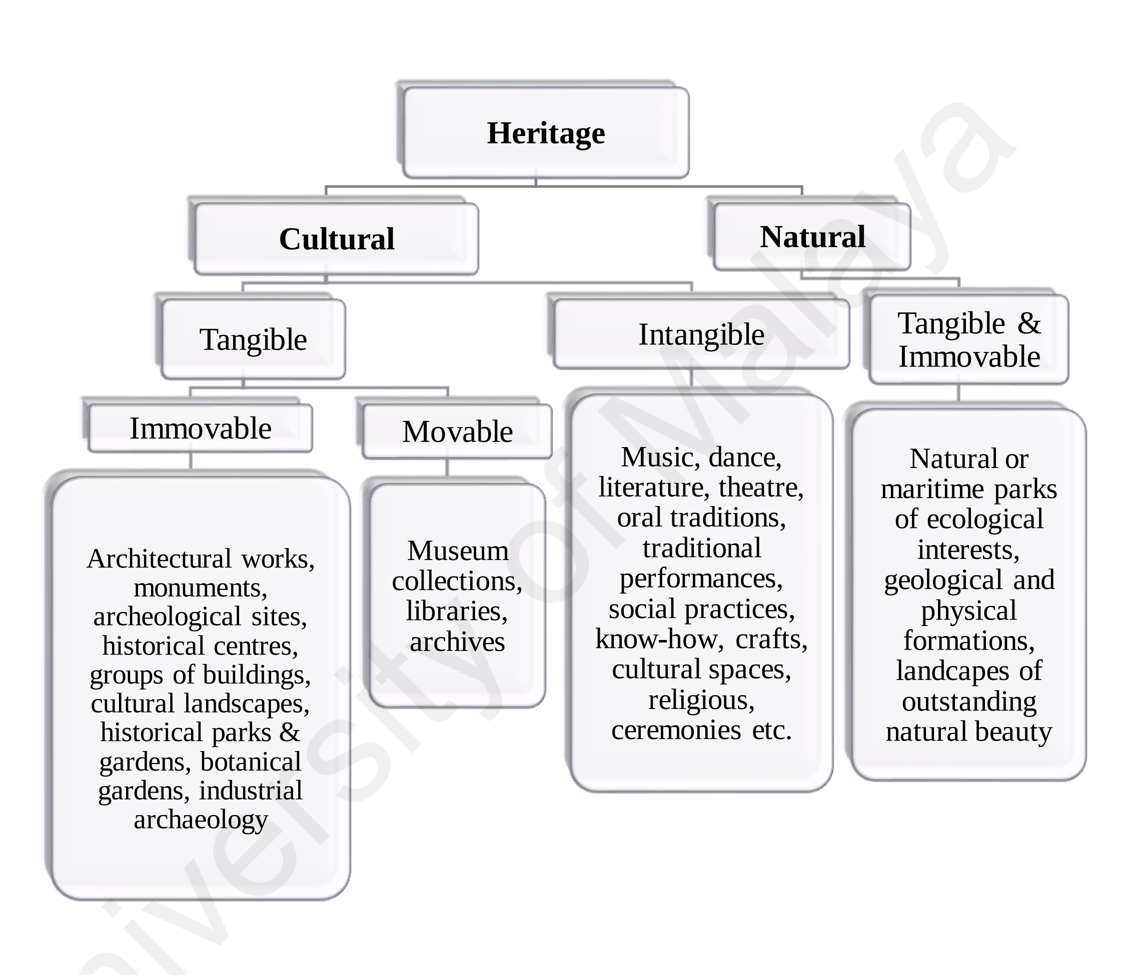


Figure 2.1: Heritage categories (Aslan, 2006)

In the context of UNESCO World Heritage, the dual categories of heritage emphasised are natural heritage and cultural heritage (Jokilehto, Cameron, Parent , & Petze, 2008). The constituents for each natural heritage and cultural heritage are explained in the Article 2 and Article 1 respectively in the World Heritage Convention (UNESCO, 1972). The World Heritage Convention refers cultural and natural heritage in its Article 1 and Article 2 respectively as summarised in the following Table 2.1:

Table 2.1: UNESCO World Heritage categories (UNESCO, 1972)

Categories	Constituents	Description of the Properties
Natural Heritage	Natural Features	*Consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view.*
	Geological and Physiographical Formations	*Precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation.*
	Natural Sites	*Precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.*
Cultural Heritage	Monuments	*Architectural works, works of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings and combinations of features, which are of outstanding universal value from the point of view of history, art or science.*
	Groups of buildings	*Groups of separate or connected buildings which, because of their architecture, their homogeneity or their place in the landscape, are of outstanding universal value from the point of view of history, art or science.*
	Sites	*Works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.*

2.2.1 Genesis of the UNESCO World Heritage

Deterioration or disappearance of heritage properties in any localities is regarded as a global loss. It is more worrying that global heritage are constantly threatened with destruction, due to traditional causes of decay as well as dynamic social and economic activities (UNESCO, 2005). Moreover, mere protection of heritage at national level is always inadequate due to the demand of economic, scientific, and technological resources. Realising this issue, UNESCO has formed the movement for protecting heritage around the world considered to be of Outstanding Universal Value (OUV) to humanity.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) is a specialised agency of the United Nations (UN) established in 1945. Covering wide areas such as education, natural sciences, social and human sciences, culture, heritage, and communication and information, UNESCO has created the idea of World Heritage and OUV which strives to build intercultural understanding through protection of heritage and support for cultural diversity respectively.

UNESCO mission is to strive to build networks among nations that enable solidarity based on the value that peace must be established for humanity's moral and intellectual solidarity. The four main objectives of UNESCO are (UNESCO, 2015):

i. Mobilising for education: so that every child, boy or girl, has access to quality education as a fundamental human right and as a prerequisite for human development
ii. Building intercultural understanding: through protection of heritage and support for cultural diversity. UNESCO created the idea of World Heritage to protect sites of outstanding universal value
iii. Pursuing scientific cooperation: such as early warning systems for tsunamis or trans-boundary water management agreements, to strengthen ties between nations and societies
iv. Protecting freedom of expression: an essential condition for democracy, development and human dignity

From history, Egypt decided to built the Aswan High Dam in 1954. Realising that the dam would flood a valley of ancient Egypt treasures, particularly the temples available at the site, UNESCO launched a worldwide Safeguarding Campaign. Through this campaign, UNESCO managed to collect half of the overall cost of USD 80 million from 50 countries to remove and relocate the temples, by putting them back together piece by piece.

UNESCO then launched another Safeguarding Campaign, saving places such as Venice in Italy, the ruins in Pakistan, and the Borobudur in Indonesia. UNESCO initiated a draft convention to protect the common cultural heritage of humanity which later combined with natural heritage through initiation by the United States. The proposals was developed by the International Union for Conservation of Nature (IUCN) in 1968. Two years later, the proposals were presented to the United Nation (UN) conference on Human Environment held in Stockholm, Sweden. By 16th September 1972, UNESCO adopted the Convention Concerning the Protection of the World Cultural and Natural Heritage.

This international treaty marked the genesis of heritage protection and conservation at the global level, held in Paris during the 17th UNESCO's General Conference from 17th October until 21st Nov 1972. During the event, the UNESCO World Heritage Convention was formed to promote international collaboration in protecting cultural and natural heritage (Hussin, Salleh, & Ariffin, 2011, p. 8). In 1992, the secretariat for the World Heritage Convention was established in Paris. It is known as the World Heritage Centre which acts as the focal point and coordinator within UNESCO for all matters related to World Heritage. The functions of the World Heritage Centre are as following (UNESCO World Heritage Centre, 2018):

i. *Organises annual sessions of the Committee and its Bureau*
ii. *Provides advice to States Parties in the preparation of site nominations*
iii. *Provides international assistance from the World Heritage Fund upon request*
iv. *Coordinates the reporting on the condition of sites*
v. *Reports the emergency actin undertaken when a site is threatened*
vi. *Organises technical seminars and workshops*
vii. *Updates the World Heritage List and database*
viii. *Develops teaching materials to raise awareness*
ix. *Keeps the public informed of World Heritage issues*

In conjunction to that, the concept of 'World Heritage List' was introduced. Basically, the UNESCO World Heritage List is an international-based listing of heritage properties that goes beyond national boundaries (Jokilehto, Cameron, Parent , & Petze, 2008). Apart from the World Heritage Centre, the establishment of the World Heritage Committee was also made. It serves as an intergovernmental system that collaborates and cooperates in protecting both cultural and natural heritage registered in the UNESCO World Heritage List.

Reportedly, the World Heritage Committee consists of representative from 21 States Parties in particular, Angola, Australia, Azerbaijan, Bahrain, Bosnia and Herzegovina, Brazil, Burkina Faso, China, Cuba, Guatemala, Hungary, Indonesia, Kuwait, Kyrgyztan, Norway, Saint Kitts and Nevis, Spain, Tunisia, Uganda, United Republic of Tanzania and Zimbabwe (UNESCO World Heritage Centre, 2017). Each of the State member shall be represented by one delegate, that can be assisted by alternates, advisers and experts, selected from qualified individuals in the field of cultural or natural heritage (World Heritage Committee, 2015). The World Heritage Committee is responsible for (UNESCO World Heritage Centre, 2018):

i. *The implementation of the World Heritage Convention*
ii. *Defines the use of the World Heritage Fund*
iii. *Allocates financial assistance upon requests from the States Parties*
iv. *Has the final say in whether a property is inscribed on the World Heritage List*
v. *Can defer its decision and request further information on properties from the States Parties*
vi. *Examines reports on the state of conservation of inscribed properties*
vii. *Asks State Parties to take action when properties are not being properly managed*
viii. *Decides on the inscription or deletion of properties on the List of World Heritage in Danger*

2.2.2 Supranational Advisory Bodies

Together with UNESCO, there are three international entities that pose strong interests, influence and impact in managing and protecting global cultural and natural heritage namely the International Union for the Conservation of Nature (IUCN), the International Council on Monuments and Sites (ICOMOS) and the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM). They are counterparts of UNESCO, formed by conservation bodies or stakeholders at global level who actively advocate the protection and conservation of worldwide heritage properties.

a) The International Union for the Conservation of Nature (IUCN)

Established in 1948, IUCN is an international, non-governmental organisation (NGO) that provides technical evaluations of natural heritage properties to the World Heritage Committee. Based in Gland, Switzerland, IUCN reports on the state of conservation for listed properties through its worldwide network of specialists.

b) The International Council on Monuments and Sites (ICOMOS)

ICOMOS is a global NGO established in 1965 comprising a network of interdisciplinary experts whom are dedicated in promoting theory, methodology and scientific techniques application to conservation and protection of cultural heritage places. Closely linked to UNESCO, ICOMOS plays important roles in contributing to cultural heritage preservation in the world today and for the future, through the five main areas of activity of training, information, research, cooperation and advocacy. ICOMOS objective is to improve the quality of conservation practice as well as raising awareness about the importance of preserving cultural heritage. Reportedly, ICOMOS members includes interdisciplinary professions such as architects, town planners, demographers, archaeologists, geographers, historians, conservators, anthropologists, and heritage administrators amounted up to 5000 individuals in total (ICOMOS, 2000). ICOMOS evaluate sites for inclusion into the UNESCO World Heritage List besides monitors their condition and preservation efforts (ICOMOS, 2011).

c) **The International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM)**

ICCROM is an intergovernmental organisation (IGO) established in 1959 whom is dedicated with a worldwide mandate to promote the conservation of cultural heritage by improving the quality of conservation practice and raising awareness through activities such as training, information, research, cooperation and advocacy. In relation to UNESCO World Heritage, ICCROM concentrate on research and documentation besides providing technical assistance (ICCROM, 2014).

2.2.3 Outstanding Universal Value (OUV)

The status as UNESCO World Heritage is special as it cannot be created nor developed by marketing experts through commercial gimmicks (Lai & Ooi, 2015). Entitlement for receiving the UNESCO World Heritage status depends on OUV assessment, which final decision is based on the consensus of the intergovernmental World Heritage Committee. It basically consists of 21 elected officials to represent countries which have ratified the World Heritage Convention (Roders & Oers, 2011). In 1998, Jokilehto, Cameron, Parent and Petze (2008) informed that participants of the Global Strategy Natural and Cultural Expert Meeting in Amsterdam formulated the concept of OUV as following:

"The requirement of outstanding universal value should be interpreted as an outstanding response to issues of universal nature common to or addressed by all human cultures. In relation to natural heritage, such issues are seen in bio geographical diversity, in relation to culture in human creativity and resulting cultural process"

Officially, the Operational Guidelines for the Implementation of the World Heritage Convention in its Article 49 refers OUV as (UNESCO, 2005):

"Outstanding universal value means cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity"

There are several criteria that form the OUV. In 2004, the criteria for OUV were separated per categories of cultural and natural heritage. The six criteria for cultural heritage were criteria (i), (ii), (iii), (iv), (v) and (vi) whereas the four criteria for natural heritage were criteria (i), (ii), (iii) and (iv). However, since 2005, only one set of 10 criteria was used. The criteria for cultural heritage include criterion (i) to (vi) whereas the criteria for natural heritage include criterion (vii) to (x). The 10 criteria used to assess the OUV are presented in Table 2.2 (UNESCO, 2005):

Table 2.2: Criteria for the assessment of OUV (UNESCO, 2005)

Criteria	Description
(i)	*represent a masterpiece of human creative genius*
(ii)	*exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design*
(iii)	*bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared*
(iv)	*be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history*
(v)	*be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change*
(vi)	*be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (The Committee considers that this criterion should preferably be used in conjunction with other criteria)*
(vii)	*contain superlative natural phenomenon or areas of exceptional natural beauty and aesthetic importance*
(viii)	*be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features*
(ix)	*be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals*
(x)	*contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation*

2.2.4 Significance of UNESCO World Heritage List Inscription

There are several benefits for places inscribed in the UNESCO World Heritage List. Ayop (2013) informed that the UNECSO World Heritage List is deemed as magnet for international cooperation and financial assistance for heritage conservation projects. This would enable conservation stakeholders to receive financial support to safeguard their local heritage assets. Listed sites can obtain the UNESCO World Heritage Fund, to be allocated by the World Heritage Committee based upon the urgency of requests.

Emergency assistance for urgent action to repair damage caused by human-made or natural disasters is under the coverage of this fund. However, priority of funding will be given to the most threatened sites. The World Heritage Fund basically acquired from contributions from State Parties and voluntary contributions as well as private donations. Apart from that, it is also derived from profits via sales of World Heritage Publications. About USD 4 million is made available to assist State Parties in identifying, preserving and promoting sites of UNESCO World Heritage. The two types of funding through the UNESCO World Heritage Fund identified are the Funds-in-Trust and Rapid Response Facility.

Besides funding, places inscribed in the UNESCO World Heritage List will benefit from the implementation of a comprehensive management plan. Through this, permanent conservation of heritage will be possible to achieve. Besides, state members of the UNESCO World Heritage will have an increase global visibility in the sense of receiving shared international concern and assistance. The support from global experts hence offer technical training and advice to the local site management team. Eventually, such privileges will enable a better practice of physical conservation for heritage properties.

As the inclusion into the UNESCO World Heritage List testifies the global significance of a place, the gains of worldwide reputation and fame can be anticipated. The earned status will boost tourism industry via the agenda of heritage tourism. Through an increase public awareness, it is apparent that many localities have been leveraging their heritage attractions which benefit economically (Ahmad & Badarulzaman, 2004; Wan Ismail & Shamsuddin, 2005; Zuraidi, Akasah, Mohammed Rum, & Kiong, 2010).

It is profound that representation of heritage assets to global audience brings upon a significant growth in local economy and revenue generation to many countries. Besides, it brings an increase awareness to the public to protect and preserve their very own heritage, through encouraging their engagement and participation in heritage related activities or events. Succinctly, the significance associated with the World Heritage status includes the benefits in partnership, social capital, civic pride, funding, conservation, learning and education, regeneration and tourism (PwC, 2007).

2.3 Cultural Heritage Conservation in Malaysia

Cultural heritage is unique and irreplaceable, important for conveying diverse messages and values that give meaning to people's life, understanding diversity of people, developing policy for peace and mutual comprehension, and triggering economic development (Aslan, 2006). It is concerned with a locality's culture such as the lifestyle, history, art, architecture, religions and other aspects that have shaped the people's way of life based on their geographical areas (Sudipta, Sarat, & Babu, 2010). Heritage cities available in the Malaysian peninsular are George Town (Penang), Kota Bharu (Kelantan), Melaka as well as Taiping and Ipoh (Perak) (Mohamed, Ahmad, & Badarulzaman, 2001). However, only Melaka and George Town have been recognised as the cultural heritage sites of UNESCO World Heritage, sharing the label of the UNESCO Historic Cities of the Straits of Malacca.

2.3.1 UNESCO Historic Cities of the Straits of Malacca

Melaka and George Town have been revered as the UNESCO World Heritage under the cultural heritage category, after twice dossier submissions for the much-sought status. The first dossier submitted in 2004 was rejected due to formatting flaws and considered incomplete by UNESCO. The second dossier submitted in January 2007 however turned to be fruitful. It was verified by UNESCO in March 2007 thus entitling both cities to claim the prestigious status on 7th July 2008. Together, Melaka and George Town shared the brand of UNESCO Historic Cities of the Straits of Malacca. Ever since, the two cities marketability as a touristic destination has significantly enhanced. Melaka and George Town basically met three out of the 10 criteria listed in the Operational Guidelines for the Implementation of the World Heritage Convention as presented in Table 2.3 (APUDG, 2011; Harun S. N., 2011):

Table 2.3: The criteria and OUVs of Melaka and George Town

Criterion	Outstanding Universal Value (OUV)
II. Exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design	 *Melaka and George Town represent exceptional examples of multi-cultural trading towns in East and Southeast Asia, forged from the mercantile and exchanges of Malay, Chinese, and Indian cultures and three successive European colonial powers for almost 500 years, each with its imprints on the architecture and urban form, technology and monumental art. Both towns show different stages of development and the successive changes over a long span of time and are thus complementary.*
III. Bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared	 *Melaka and George Town are living testimony to the multi-cultural heritage and tradition of Asia, and European colonial influences. This multi-cultural tangible and intangible heritage is expressed in the great variety of religious buildings of different faiths, ethnic quarters, the many languages, worship and religious festivals, dances, costumes, art and music, food, and daily life.*
IV. Be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history	 *Melaka and George Town reflect a mixture of influences which have created a unique architecture, culture and townscape without parallel anywhere in East and South Asia. They demonstrate an exceptional range of shop houses and townhouses. These buildings show many different types and stages of development of the building type, some originating in the Dutch or Portuguese periods.*

The honour as UNESCO World Heritage received by Melaka and George Town needs to be perpetuated to remain them at the pinnacle of heritage status (Pendlebury, Short, & While, 2009; Omar, Muhibudin, Yussof, Sukiman, & Mohamed, 2013). Owing to the UNESCO reverence, conservation endeavour has become an indispensable agenda for upkeeping Malaysian heritage. As cultural heritage will only remain intact with proper management (Wan Ismail, 2012), Melaka and George Town were required to have a management plan by UNESCO. The document is a prerequisite for inclusion of areas into the World Heritage List since the year 2000 (Arslan, 2015).

Responding to that demand, the State Government under the provision of Section 16B, Town and Country Planning Act 1976 (Act 172) has prepared the management plan. By 21st January 2011, a conservation management plan and a special area plan of Melaka and George Town were updated and sent to the UNESCO World Heritage Committee (Zakaria & Bahauddin, 2015). The two cities were also required to demarcate boundaries for site zoning areas of significance as mentioned in UNESCO (2005):

For properties nominated under criteria (i) - (vi), boundaries should be drawn to include all those areas and attributes which are a direct tangible expression of the outstanding universal value of the property, as well as those areas which in the light of future research possibilities offer potential to contribute to and enhance such understanding.

Consequently, the two cities were divided into Conservation Zones which consists of Core Zone and Buffer Zone. The Core Zone is the primary site with prominent cultural heritage strength. The Buffer Zone meanwhile surrounds the Core Zone, serving as protection layer for the Core Zone. Both zones play vital role in retaining the UNESCO World Heritage status. Coordinated at N2 11 30.00 E102 15 45.00, the Conservation Zone of Melaka covers 45.3-hectare Core Zone land and 242.8-hectare Buffer Zone land meanwhile the Conservation Zone of George Town, coordinated at N5 25 17.00 E100 20

45.00 covers 109.38-hectare Core Zone land and 150.04-hectare Buffer Zone land as shown in Figure 2.2:

Figure 2.2: Conservation Zones of Melaka (left) and George Town (right)
(APUDG, 2011)

2.3.2 Historic Buildings in Melaka and George Town

Malaysia possesses a rich collection of architectural heritage in the myriad forms, with the six common types of shophouse, religious buildings, residential buildings, institutional buildings, commercial buildings, and monuments located throughout the country. Collectively, they form a lucrative asset for the Malaysian heritage tourism industry (Abdul Rashid & Mohd Isa, 2005; Ahmad A. , 2008; Akasah, Abdul , & Zuraidi, 2011). Within the historic cities of Melaka and George Town alone, there are thousands of historic buildings ranging from traditional Malay houses, Malayan bungalows, shop houses and townhouses, mosques, churches, Chinese temples, Hindu temples, administrative buildings from colonial periods, commercial buildings, godowns as well as clan jetties that form water villages as shown in Figure 2.3:

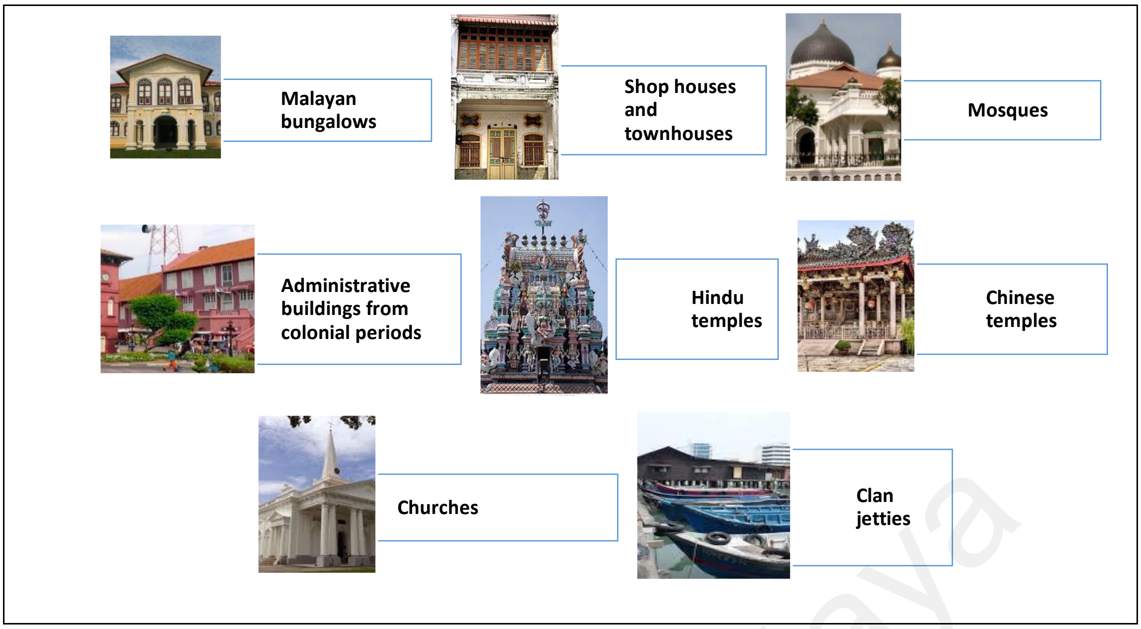


Figure 2.3: The various building typologies available in Melaka and George Town (APUDG, 2011)

As reported in the Draft of Special Area Plan 2011, there are 3,050 buildings available within the Conservation Zone of the historic city of Melaka, with 1,075 buildings located in the Core Zone while 1,975 buildings located in the Buffer Zone. Whereas, there are 4,665 buildings available within the Conservation Zone of the historic city of George Town with 2,344 buildings located in the Core Zone while 2,321 buildings located in the Buffer Zone (APUDG, 2011). Historic buildings in George Town have been classified into four categories as presented in Table 2.4 (APUDG, 2011):

Table 2.4: Categorisation of built cultural heritage in George Town (APUDG, 2011)

Category	Description
I	Monuments of exceptional interest. Buildings and monuments declared as ancient and gazetted under formerly under the Antiquities Act 1976 now under the National Heritage Act 2005. Buildings registered as National Heritage under the National Heritage Act 2005.
II	Buildings of special interest that warrant every effort being made to preserve them.
Infill	Existing empty land or temporary structure where compatible re-development is permitted.
Replacement	Existing building without any significant value where sensitive re-development is permitted.

Notably, the OUV criterion IV of Melaka and George Town explicitly mentioned shophouses and town houses, indicating their unique architectural superiority in Southeast Asia In turn, shophouse buildings have gained extra attention from the local conservation stakeholders as apparent in George Town. Shophouse buildings have been actively documented and publicised eversince, as can be seen through information leaflets commonly showcasing Penang's historic buildings as exemplified in Figure 2.4 and Figure 2.5 which have been co-published by the Community-based Arts and Culture Education (Arts-ED), Cultural Heritage Action Team (CHAT) and GTWHI.

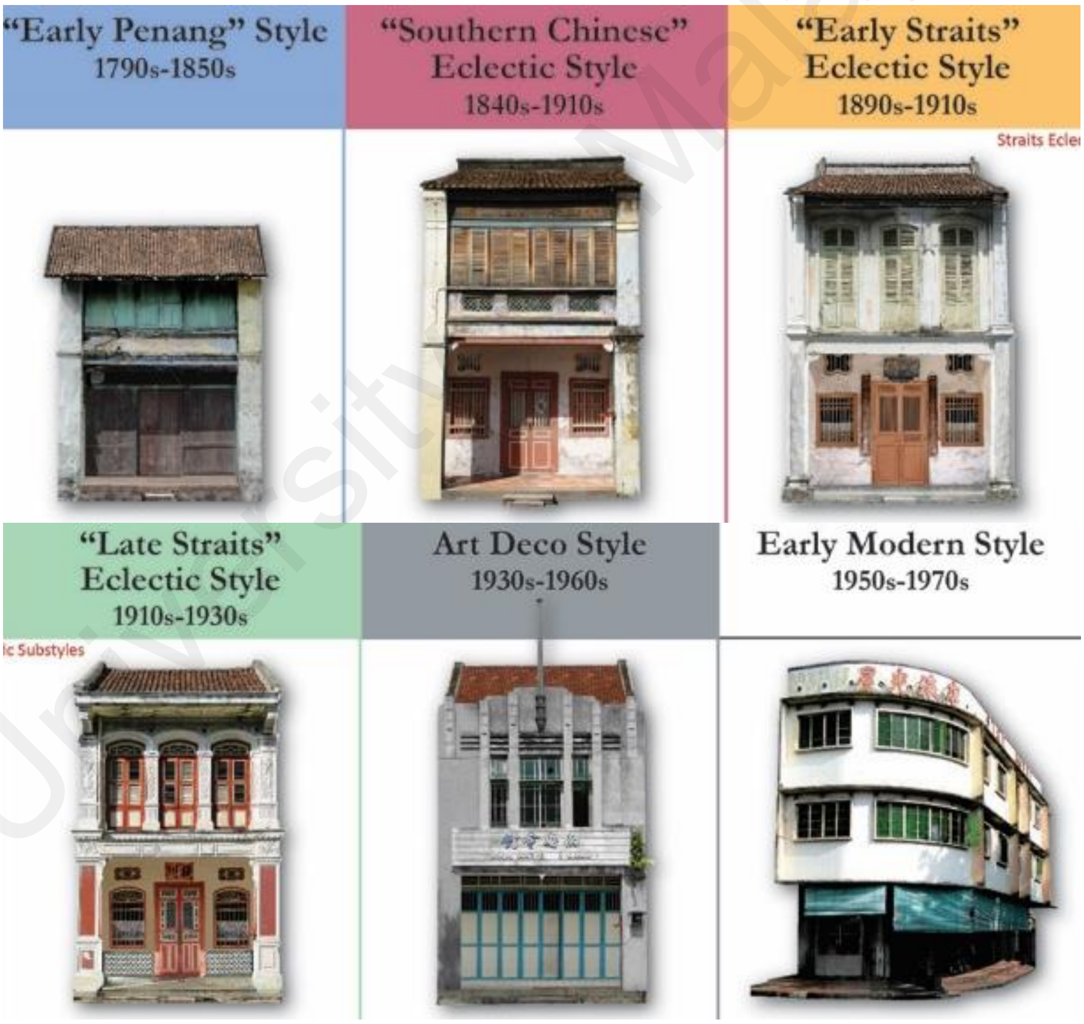


Figure 2.4: Prominent architectural heritage styles and era in Penang
(Arts-ED & CHAT, 2009)

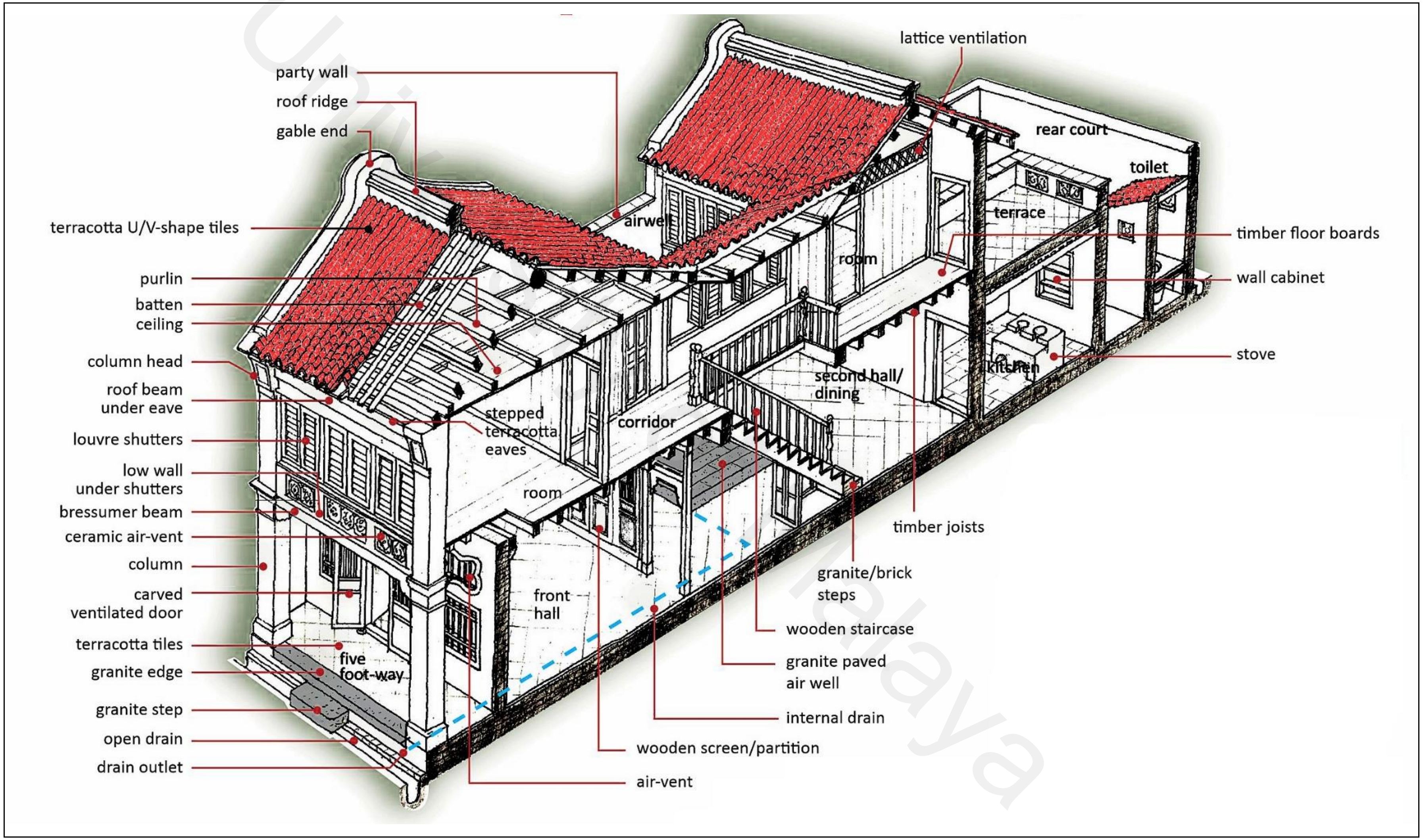


Figure 2.5: The pamphlet on historic shophouse features (GTWHI, 2016)

2.3.3 Conservation Authorities and Related Policies

Despite conservation industry in Malaysia is relatively new compared to other developed countries, proper conservation practice and implementation are imperative as the country aspires to be a fully developed nation in economic, political, social, spiritual, psychological, and cultural aspects by the year 2020 (Syed Mustapa , Kamal, Zaidi, & Abd Wahab, 2007; Federal Department of Town and Country Planning, 2010; Syed Mohamad, Akasah, & Abdul Rahman, 2014). Towards achieving the status of a developed nation as stipulated in the Vision 2020 (Shamsuddin K. , 2009), conservation of the Malaysian built heritage should be in efficient, equitable, and sustainable manners as emphasised in the Malaysian National Physical Plan which serves as a guidance for the country's overall development. Built heritage conservation in Malaysia falls under the jurisdiction of various parties at differing levels (Said, Aksah, & Ismail, 2013). The jurisdiction structure involves three-tier of governmental hierarchy namely the federal, state, and local levels (Nooi, 2008).

a) Federal Level

In May 2013, the tourism and culture portfolios of Malaysia have been merged under a single ministry namely the Ministry of Tourism and Culture (MOTAC) (PEMANDU, 2013). The Department of National Heritage (JWN) that plays the role as the primary body governing the local conservation endeavour in Malaysia, is one of the sub-divisions of MOTAC. JWN is strategically concerned with the long-range aim and direction of the local conservation works in relation to planning, modelling, outcome and funding activities (Sodangi, Khamidi, & Idrus, 2013; Hasbollah, 2014). Among the major functions of JWN are (Kamal K. S., Ab Wahab, Ahmad, & Shabri, 2007; Abdul Rashid

& Ahmad, 2008; Zahari & Bahari , 2011; Mohd Yusoff, Dollah, & Kechot, 2011; Ab Wahab, 2013):

i. Mandating conservation policy namely the National Heritage Act 2005 (Act 645) and other general conservation guidelines
ii. Declaring the status of heritage and protection through law
iii. Conduct and publish research on heritage and conservation related matters
iv. Plan, implement and organise heritage and conservation related activities
v. Establish rapport and networking with local and international heritage and conservation related agencies

Under MOTAC, there are also two other entities relating to conservation namely the World Heritage Sites Department, that is responsible for receiving and managing the World Heritage Fund, and the Malaysia Tourism Centre (MaTiC) that is responsible for providing fund and having promotions concerning tourism agenda (Said, Aksah, & Ismail, 2013). The Malaysian government has formulated and enforced a few acts pertaining conservation of built heritage which include (Hussin, Salleh, & Ariffin, 2011, p. 15):

i. The Town and Country Planning Act 1976 (Act 172)
ii. The Local Government Act 1976 (Act 171)
iii. *Kanun Tanah Negara 1965* and *Akta Pengambilan Tanah 1960 (Act 486)*
iv. National Heritage Act 2005 (Act 645)

b) State and Local Level

Moving to the state level, Said, Aksah and Ismail (2013) informed that the Town and Country Planning Department (JPBD) together with the State Planning Committee are the responsible parties to prepare the State Structure Plan, District Local Plan and

Special Area Plan under the enabling laws of Town and Country Planning Act 1976 (Act 172). In the context of the research locale, as Melaka and George Town are the sparring partners in retaining their World Heritage status (Samadi & Mohd Yunus, 2012), conservation agenda for both cities heavily demand the role of their respective State Government and Local Authority.

In Melaka, the State Preservation and Conservation Committee which is established under the State Enactment of 1988 together with the Historic Melaka City Council (MBMB)'s Conservation Committee play an integral role in advising conservation agenda. MBMB and Melaka Museums Corporation (PERZIM) basically administer and manage the historic city of Melaka with abidance to the Preservation and Conservation of Cultural Heritage Enactment 1988 (Said, Aksah, & Ismail, 2013). Meanwhile, the State Planning Committee and the City Council of Penang Island (MBPP) are the responsible parties pertaining conservation in the historic city of George Town (Harun & Ismail, 2011).

Together with the special area plan, the currently in-use protocol of conservation in manoeuvring historic building conservation works by MBPP is the Guidelines for Conservation Areas and Heritage Buildings 2009 which reflects the State Government's aspiration of making George Town as a truly "Living Heritage City". This guideline supersedes and cancels the earlier Design Guidelines for Conservation Areas in Inner City of George Town, Penang 1987. It provides the State Government's policy for the identification and protection of heritage buildings, conservation areas and other elements of the historic environment. It is not merely for MBPP usage but also for other stakeholders such as other public authorities, property owners, developers, amenity bodies and all the members of the public (Abdul Aziz, 2012).

c) World Heritage Office (WHO)

Apart from that, WHO has been established in both cities in the effort to manage, monitor, protect, conserve and promote the sites of UNESCO World Heritage (Harun & Ismail, 2011). Branding, promotion, tourism, and liaison between the state, federal, and international organisations which are the matters beyond the purview of current statutory system, are managed and liaised cooperatively by both states WHOs and local authorities (Said, Aksah, & Ismail, 2013).

The Melaka World Heritage Sendirian Berhad (MWHSB), a subsidiary of Melaka Chief Minister Department, was formed in December 2011 in Melaka (Melaka World Heritage Office, 2011). MWHSB was driven by the mission to protect, conserve and promote the historic city of Melaka (Melaka Historic City Council, 2015). However, MWHSB has discreetly stopped operating and no longer in existence since 2016 due to authoritative challenges and political reasoning (R. Nor, personal communication, May 10, 2016). Today, the defunct MWHSB has been integrated under the umbrella of MBMB's Conservation Unit (Chin, 2016).

Whereas in George Town, an independent body was formed on the 30th April 2009 in the name of George Town World Heritage Office which was later established as the George Town World Heritage Incorporated (GTWHI) on the 21st April 2010. GTWHI functions in managing, monitoring and promoting the historic city of George Town (GTWHI, 2014). Table 2.5 summarises the stakeholders and pertaining policies concerning the research locale:

Table 2.5: Conservation stakeholders and related policies in Malaysia
(APUDG, 2011)

Level	Key Agency	Related Legislations
Federal	The Department of National Heritage (JWN)	• Federal Constitution • *Kanun Tanah Negara 1965* • *Akta Pengambilan Tanah 1960* (Act 486) • National Heritage Act 2005 (Act 645) • Town and Country Planning Act 1976 (Act 172) • Street, Drainage and Building Act 1974 (Act 133) • Uniform Building by Laws 1984 (UBBL) • *Garis Panduan Pemuliharaan Bangunan Warisan 2012* • The Local Government Act 1976 (Act 171) • MBMB By-Laws • MBPP By-Laws • Melaka Preservation and Conservation of Cultural Heritage Enactment 1988
State/ Local	State Government, Local Authorities (MBMB, MBPP), World Heritage Office (GTWHI)	
Other Relevant Stakeholders	UNESCO, ICOMOS, ICCROM etc. (International) Penang Heritage Thrust, Badan Warisan Malaysia etc. (Local NGOs) PERZIM, JMM etc. (Government agencies)	

d) International Charters Affecting Local Conservation

Conservation practices are guided via the “do’s and don’t’s” apparently through various charters and recommendations. Apart from the local conservation doctrines pointed out earlier, there are 12 international conservation charters which have been influential to the conservation policy in Melaka and George Town as listed by Ab Wahab (2013) namely:

i. The Charter for the Conservation of Places of Cultural Significance (Burra Charter 1999)

ii. The Charter for the Conservation of Places of Cultural Heritage Value (New Zealand Charter 1992)

iii. The International Charter for the Conservation and Restoration of Monuments and Sites (Venice Charter 1964)

iv. The Charter for the Preservation of Quebec's Heritage (Canada Deschambault Declaration 1982)

v. The Charter for the Protection and Enhancement of the Built Environment (Appleton Charter 1983)

vi. The Nara Document on Authenticity 1994

vii. The Principles for the Preservation of Historic Timber Structures (1999)

viii. The Australian Institute for Conservation of Cultural Material (AICCM)

ix. The Declaration of San Antonio 1996

x. The Council of Europe the Declaration of Amsterdam 1975

xi. The International Cultural Tourism Charter (1999)

xii. The Charter for the Conservation of Historic Towns and Urban Areas (Washington Charter 1987)

2.4 Conservation of Historic Buildings Trough Adaptive Reuse

The act of heritage appreciation has brought upon the conservation industry (Said, Aksah, & Ismail, 2013) which primary aim is for the longevity of heritage properties (Kamal, Ab Wahab, & Ahmad, 2008; Alonso & Meurs, 2012). The following sections discuss conservation in general followed with topics on adaptive reuse of historic building.

2.4.1 Conservation Definitions and Approaches

Understanding of conservation definitions as provided in pertinent international charters and by renowned experts is deemed essential. The Washington Charter 1987 provided the meaning of conservation in the scope of conserving historic towns and urban areas as following (ICOMOS, 1987):

"…'the conservation of historic towns and urban areas' is understood to mean those steps necessary for the protection, conservation and restoration of such towns and areas as well as their development and harmonious adaptation to contemporary life."

The New Zealand Charter 1992 stipulated in its Article 13 that conservation may involves, an increasing extent of intervention, non-intervention, maintenance, stabilisation, repair, restoration, reconstruction or adaptation. Re-creation, which refers to the conjectural reconstruction of a place, as well as replication, which refers to make a copy of an existing place, are not considered as conservation (ICOMOS, 1992). The Nara Document on Authenticity (1994) meanwhile defines conservation as (ICOMOS, 1994):

"…all efforts designed to understand cultural heritage, know its history and meaning, ensure its material safeguard and, as required, its presentation, restoration and enhancement".

The Burra Charter 1999 apparently stresses on cultural significance by succinctly describes conservation as all the processes of looking after a place for retaining its cultural significance. Article 1.4 of the charter mentioned that (ICOMOS, 1999):

"Conservation may, according to circumstance, include the processes of: retention or reintroduction of a use; retention of associations and meanings; maintenance, preservation, restoration, reconstruction, adaptation and interpretation; and will commonly include a combination of more than one of these."

Scholars such as Feilden B. (2000) meanwhile pointed out that conservation aims to avoid defects occurrence thus makes cultural and natural heritage presentable and artistically astonishing to others. Burden (2004) described conservation as the management activities to prevent defect, destruction, misuse and negligence on buildings, monuments and sites. Operationally, conservation can be understood as the technical activities which involve physical actions to upkeep the cultural fabric and material of built heritage (Harun S. N., 2011). In the Malaysian context, the country's main doctrine for conservation namely the Malaysian National Heritage Act 2005 (Act 645) includes the acts of preservation, restoration, reconstruction, rehabilitation and adaptation or any combination of those in the conservation terminology.

2.4.2 Degrees of Conservation Interventions

Conservation covers a wide spectrum of activities. Based on intrusiveness of interventions to historic fabrics, Feilden B. (2000) sorts the degrees of conservation interventions as shown in Figure 2.6 and further explained below:

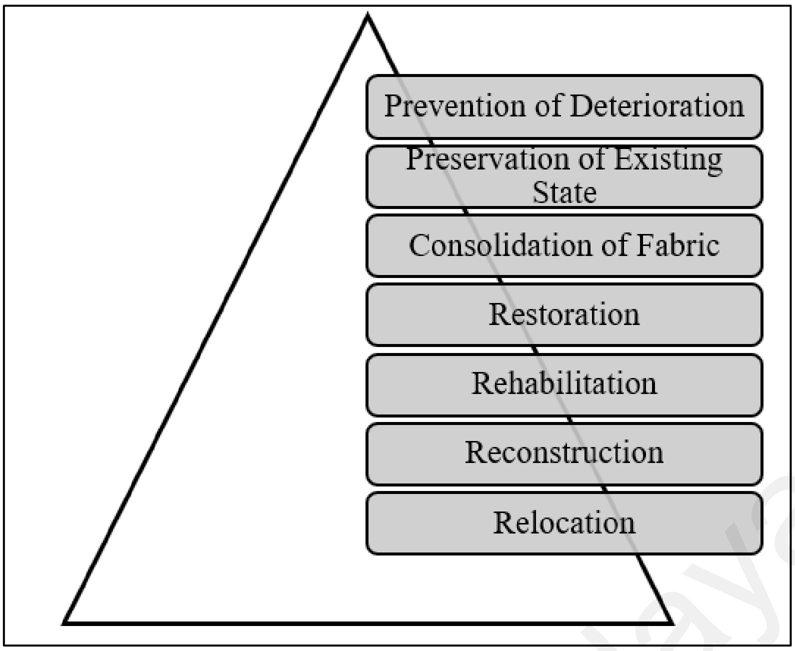


Figure 2.6: The degrees of conservation interventions (Feilden, 2000)

Prevention of deterioration means to control or protect the environment of cultural property. This approach is deemed as the lowest degree in intervention hierarchy (Feilden, 2000). It also stresses on inspecting, maintaining and cleaning activities as well as halting agents of decay and damage from becoming active. Generally, prevention is preparatory to other work. Although a historic building will usually require more extensive work, an overall evaluation of its physical condition should always begin at this level.

a) Preservation

Preservation means retaining fabric of a place in its existing state and halting deterioration process. It basically stresses on preserving original architectural styles and materials of historic buildings as much as possible.

b) Consolidation

Aim to make old buildings stay structurally intact and continually durable by physical addition or application of material into the actual fabric of an object or building. Being generally more invasive than preservation, the consolidation of structural system and building materials must be done with a high sensitivity to the heritage authenticity as well as full understanding on implications of actions to be taken. Modern approach can also be considered over no longer available traditional skills and materials, nevertheless it must be done proportionately in scale and harmless towards properties originality. Consolidation of building fabrics is imperative to ensure long term integrity of building structure.

c) Restoration

The process of bringing back the legibility and originality of a building concept by putting back certain parts of an object to achieve completeness. The main idea of restoration is about reviving building. Therefore, conservators may refer to many sources such as old photos, archaeological evidence, working drawings, authentic materials and original documents to acquire information. In some cases, when missing or damaged design features requires replacement, new substitutions must be harmoniously contrast with the existing features to ease identification and avoid falsification. Moreover, in this stage, periodic contributions and revelation on underlying state of superimposed work of different periods must be justifiable. Although using the same kind of material is always the preferred option, substitute material is acceptable if the form and design as well as the substitute material itself convey the visual appearance of the remaining parts of the feature and finish.

d) Rehabilitation

Many terms have been associated with rehabilitation such as adaptive reuse, alteration, renovation and compatible use. Rehabilitation is the act of making old buildings usable again (Ahmad A. , 2008). It is about giving a new breath to a building by prolonging its use and sustaining its physical fabrics. This approach is a solution to utilise a building which is out of usage. Yet, rehabilitation process must be done with a certain degree of adaptive alteration that respect the building significant values.

e) Reconstruction

Restoration is the process of duplicating original materials, form and appearance that have vanished at certain era. It is done based on historical research. Both traditional and modern methods are allowable. The new material may include recycled material salvaged from other places. Restoration most often happened at original site. Unquestionably, conjectural assumption or fantasy invention is unacceptable as authentic restoration requires complete and detailed documentation. This form of intervention is only justifiable only in exceptional circumstances such as buildings affected by natural calamity aftermath for instances; fire, earthquake, *Tsunami*, war, and floods (Butcher, 1996; ICOMOS, 1999; UNESCO, 2005).

f) Relocation

Deemed as the most intrusive degree of intervention, relocation of building to a new site is only necessitated in case of disturbance at existing site such as frequent floods, soil erosion, and development pressures. This approach however is only applicable to certain types of built heritage.

2.4.3 Adaptive Reuse and Sustainability Benefits

Conservation in general has long been associated with sustainability through reaping the trifold environmental, social and economic benefits (Godwin, 2011). Conservation scholars such as Feilden (2000) and Bullen P. (2007) meanwhile regarded adaptive reuse as the most relevant and acceptable conservation approach in meeting the demands for sustainable development. This is because, adaptive reuse perpetuates both retention and utilisation of built heritage in the contemporary age by making old buildings physically intact and socially purposeful (Langston, Wong, Hui, & Shen, 2008; Bullen & Love, 2011; Kamal & Ab Wahab, 2014). In turn, adaptive reuse has been considered as the most important aspect in conservation movement (Yildirim & Turan, 2012). Sustainable development benefits of adaptive reuse are shown in Figure 2.7:

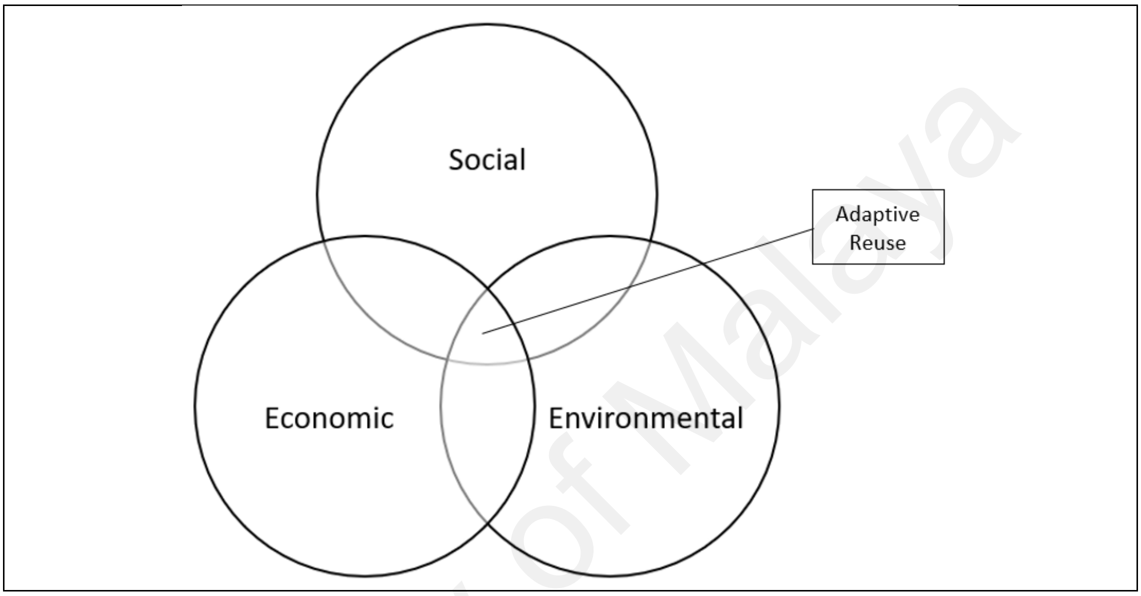


Figure 2.7: Sustainable development benefits of adaptive reuse (Bullen P. , 2007)

Due to constant pressure and continuous deterioration to the global environment, the concept of sustainable development has ever since received worldwide acceptance (Hegazy, 2015). As for Snyder (2005), adaptive reuse and sustainable design possess an imperative role in the future of architecture. From the environmental perspective, adaptive reuse of built heritage is imperative in reducing carbon dioxide (CO_2) emissions while simultaneously ensuring that the building functionality is kept, and their cultural significance is preserved. Adaptive reuse promotes sustainable development through retaining the embodied energy within built heritage, by reducing energy usage as commonly associated with demolition, waste disposal, and new construction (Sodangi, Khamidi, & Idrus, 2013).

On the social aspect, conservation via adaptive reuse is essential to upkeep local heritage which is the source of pride for most nations. Adaptive reuse is contributory in sustaining historical and architectural expression, retaining nostalgic sense, promoting education, shaping the mind of younger generations, fostering patriotism, stimulating balance development, and boosting tourism industry and generating economic gain (Feilden, 2000; Kamal K. S., Ab Wahab, Ahmad, & Shabri, 2007; Zuraidi, Akasah, & Abdul Rahman, 2011).

In economical term, adaptive reuse is inherently more prudent in comparison with full restoration, owing to the less financial demand for the process execution. Through functional updates made on built heritage to cater modern uses, the functionality of existing building is made relevant thus responds to the economic principle of sustainability (Hein & Houck, 2008). Righteously, premises that are vacant, derelict and unsuitable with the existing use should be prioritised for adaptive reuse. In this way, the functionally transformed built heritage will carry the potential to stimulate a balance development, by generating economic gain as apparently seen through tourism industry.

2.4.4 Adaptive Reuse and Post-Conservation Impacts on Historic Buildings

Apart from OUV, the two qualifying conditions emphasised for UNESCO World Heritage inscription are the authenticity and integrity conditions. Retention of the two conditions are central in safeguarding the OUV of UNESCO World Heritage, as emphasised in the Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO, 2005). UNESCO has clarified that the objective to maintain both authenticity and integrity conditions should be based upon sites' OUV (Pendlebury, Short, & While, 2009; Nezhad, Eshrati, & Eshrati, 2016). The meanings on both conditions' constituents nevertheless have been debated over the course due to lack of clarity. For instance, Stovel (2007) contended that both authenticity and integrity conditions have not been well understood and recommended them to be restructured for a more effective application on UNESCO World Heritage properties.

It is imperative to note that identifying and maintaining the authenticity and integrity conditions of cultural heritage sites are challenging (Alberts & Hazen, 2010). To increase the practical use of the two qualifying conditions among World Heritage Committee in preparing nominations as well as for post-inscription operations of cultural heritage, Stovel (2007) proposed a new framework for authenticity and integrity analysis based on heritage typologies (uniquely for archaeological sites, historic towns, architectural monuments and complexes as well as cultural landscapes) instead of inscription criteria. Seems relevant for the case of historic building conservation, his framework constitutes the aspects of wholeness, intactness, material genuineness, genuineness of organisation of space and form, continuity of function and continuity of setting.

In connecting to this sense, adaptive reuse, as a prevailing means of conservation effort in the current time, should legitimately conform to the benign philosophical criteria comprising minimal intervention, minimal loss of fabric, reversibility and legibility as mandated in various charters such as the New Zealand Charter 1992 (Article 4ii, 4iii), Bura Charter 1999 (Article 1.10, 3, 19-23) Deschambault Declaration 1982 (Article V-C), Appleton Charter 1983 (Article D) and Venice Charter 1964 (Article 12).

Whilst adaptive reuse is implied as the best possible option for achieving the twofold conservation philosophy: to simultaneously preserve and develop built heritage (Keromo, 2000), it can also be either a boon or bane for historic buildings through its post-conservation impacts on the authenticity and integrity conditions. Without adhering to those principles, the implementation of adaptive reuse can surely lead to the violation of authenticity and integrity conditions of heritage properties. Acknowledging that the implementation of adaptive reuse incurs the application of physical interventions and can potentially affects the building conditions of historic buildings in Melaka and George Town, the following discussion elaborate such issues in pertinence with authenticity and integrity conditions.

a) Physical Interventions and Authenticity

The authenticity condition is stressed on six OUV criteria specifically from criteria (i) to criteria (vi), for nomination of properties into the UNESCO World Heritage List. Authenticity remains the main principle for worldwide conservation works as advocated by numerous international charters, albeit its definition and concept have been controversial worldwide due to vagueness and embedded cultural assumptions (Alberts & Hazen, 2010; Alho, Morais, Mendes, & Galvão, 2010). The term 'authenticity' has originated from the Greek word *authenticos* which means genuine and original (Harun S. , 2010, p. 4). As Jamal and Hill (2004) denoted that authenticity depends on value judgements as it is related on the idea of truth or falsehood, Bell (1997) provoked that an original fabric can be authentic but an authentic fabric is not necessarily original.

Before the year 2005, Denyer (2011) informed that the test of authenticity for tangible heritage were referred to four attributes stressed by ICCROM (1982) comprising design, material, workmanship and setting. Then, the meaning of authenticity has been deepened to include further contexts. In particular, authenticity is understood when cultural values of properties are truthfully and credibly expressed through attributes such as (UNESCO, 2005): i. Form and design, ii. Materials and substance, iii. Use and function, iv. Traditions, techniques and management systems, v. Location and setting, vi.

Language, and other forms of intangible heritage, vii. Spirit and feeling and viii. Miscellaneous internal and external factors.

Adaptive reuse of historic buildings hence should sensitise in accomplishing authenticity. Yet so, the conflicting demands of physical interventions (for meeting contemporary uses and expectations) with authenticity retention (for retaining cultural heritage values) required has caused the complexity in adaptive reuse of historic buildings. The process of transforming a building system originally designed for a different use is not an easy task (Malhis & Al-Nammari, 2015). As the 'adaptive' word came from the base word of 'adapt' which could be interpreted as the means of adjusting, modifying, altering, redoing, revising and reconciling (Omar & Ishak , 2009), adaptive reuse requires certain extent of alterations to be done on existing building fabric, be it external, internal or both aspects (Bullen & Love, 2011). Bullen and Love even (2011) typified that in adaptive reuse, the most affected space and environment is on the building interior. Besides, the conversion process for historic buildings typically involves restoration, renovation, repair, preservation and maintenance (Harun S. , 2010).

Presumably, investigation on physical interventions made on historic buildings would enable in the understanding of authenticity condition. To gain familiarity with physical state of buildings, relevant materials and information such as architectural plans and drawings, old photos, historical documents and conservation reports (either from the building owners or local authorities) are imperative sources (Ramly, 2004). Based on review of seminal research regarding the application of conservation principles for the adaptive reuse of historic buildings in Malaysia has led to the finding of Ab Wahab's (2013) work which specifically developed to assess historic buildings which have undergone adaptive reuse in the UNESCO World Heritage of Melaka and George Town. Specifically, she contributed an approach to assess the post-conservation compliance of historic buildings in Malaysia using a guideline developed by merging conservation principles from both local and international contexts. Her guideline mainly emphasises the four criteria of authenticity stressed by ICCROM (1982) as following:

i. Material; authentic material is regarded as priority as the historic building fabrics are embedded with past cultural evidences. Hence, materials source, type, composition, colour, feature and texture are of the essence.

ii. Design; authentic design is stressed upon historic building earliest era or year built. Architectural style, structure, construction era and the surrounding environment are the central considerations.

iii. Workmanship; authentic workmanship is based upon the reverence towards former craftsmen who have produced and construct the building. In the quest to sensitise their contributions, any interventions necessitated must be respectful towards the original workmanship.

iv. Setting; authentic setting is crucial to foster the understanding on the original building layout. This would avoid conjecture to be made on the building regarding its intended original function and use as well as its historical events.

Meanwhile the approach that Ab Wahab's (2013) has used consists of visual assessment on 16 building elements accentuating: i. Front façade, ii. External wall, iii. Internal wall, iv. Lower floor, v. Upper floor, vi. Columns structure, vii. Staircase structure, viii. Roof structure, ix. Doors, x. Windows, xi. Roof finishes, xii. Ceiling finishes, xiii. Wall finishes, xiv. Floor finishes, xv. Building services and xvi. Architectural decorations. Looking at the individual building element collectively can assist in judging the overall authenticity of a building, by referring to the scales used in HIA for impact grading as shown in Table 2.6:

Table 2.6: Scale on impact grading used to indicate authenticity condition (ICOMOS, 2011)

Impact Grading	Built Heritage Attributes
Major	Change to key historic building elements that contribute to OUV such that the resource is totally altered. Comprehensive changes to the setting.
Moderate	Changes to many key historic building elements, such that the resource is significantly modified. Changes to the setting of an historic building, such that it is significantly modified.
Minor	Change to key historic building elements, such that the asset is slightly different. Change to setting of an historic building, such that it is noticeably changed.
Negligible	Slight changes to historic building elements or setting that hardly affect it.
No change	No change to fabric or setting.

b) Building Conditions and Integrity

The integrity condition is stressed for all the 10 OUV criteria for nomination of properties into the UNESCO World Heritage List. The concept of integrity has gained worldwide concern in the selection, assessment and codification process, for a comprehensive conservation and management plan of urban UNESCO World Heritage sites (Nezhad, Eshrati, & Eshrati, 2016). Integrity refers to the measure of wholeness and intactness of the properties, either cultural, natural, or both, and its attributes (UNESCO, 2005). In other words, all the necessary elements that express the OUV of the nominated properties must be present (OWHC, 2016). To examine this condition which should be presented in the statement of integrity, assessment of integrity within a property is done based on (UNESCO, 2005):

i. All elements that are necessary in representing OUV

ii. Adequacy of the size of features and process that convey the significance of the property to ensure its complete representation and

iii. The extent of adverse effects from development and/or negligence that the property is suffering.

The notion of 'wholeness' of property refers to its ability to continually convey the OUV over a passage of time while 'intactness' focuses on property's surrounding physical fabric (Stovel, 2007). Besides Stovel's (2007) notions on wholeness and intactness criteria for integrity condition, Jokilehto (2007) developed three main criteria of integrity for recognising and evaluating heritage places constituting:

i. Historical-structural integrity; all remained components of the current situation of historic structures remain are documented. The amount and type of connections between components and historical structures form the meaningful totality and convey messages from past societies.
ii. Social-functional integrity; Recognition of functions and processes that have gradually developed the place.
iii. Visual-aesthetic integrity; The more artistic quality, architectural features and aesthetic values of the property being conserved, the better the condition of visual integrity would have. Visual integrity in the past indicated the unique identity of a region.

The concept of integrity is crucial to strike a balance between conservation and development approaches (Nezhad, Eshrati, & Eshrati, 2016), which apparently shares a commonality with the aim of adaptive reuse. Ensuring the integrity of heritage properties at building-level through the physical state of historic buildings is critical through adaptive reuse. This is because, the notion of integrity carries the goal of securing all critical elements for site intactness (Alberts & Hazen, 2010) and property's ability to guarantee, maintain and continue its cultural significance over the passage of time (Nezhad, Eshrati, & Eshrati, 2016). Post-conservation conditions of historic buildings resulting from adaptive reuse implementation should meet the integrity concept mentioned by Talebian (2005) which refers to something that has no missing, broken or divided parts.

Historic buildings would be paying the price of getting physically and functionally affected with poor adaptive reuse implementation, when executed with the absence of comprehensive guidelines, lack of knowledge and skills or insufficient funding for instances (Brereton, 1991; Syed Mustapa , Kamal, Zaidi, & Abd Wahab, 2007; Sodangi, Idrus, & Khamidi, 2011; Ahzahar, Karim, Hassan, & Eman, 2011). The threat towards integrity of heritage properties at the building-scale lies in the physical problems affecting historic building conditions, which should be prevented and cured as they are equally harmful as disease to human being (Khuncumchoo, 2007). Presumably, inspection on the physical conditions of historic building would enable in the understanding of integrity condition.

Building defects and failures are known to be the common troubling phenomenon in construction industry (Ahzahar, Karim, Hassan, & Eman, 2011). Building defects is defined as the failing or shortcoming in the function, performance, statutory or user requirement of a building, and might manifest itself within structure, fabric, services or other facilities of the affected building (Watt, 1999). Building failure meanwhile is understood as the cessation of proper functioning or performance (Kaminetzky, 1991). From the time of installation or construction, buildings gradually lose their performance as decaying process begins over time albeit at differing speeds (Khuncumchoo, 2007; Flores-Colen & de Brito, 2010).

Kayan (2010, p. 41) categorised building defects into major defects and minor defects. The former means physical failure to comply with safety standards resulting the building occupation to be unsafe and risky for the end-users. The latter refers to minor physical flaws that do not directly affect the performance of the building materials, use and quality, with minimal impact on the building operation. The physical vulnerability of historic buildings is more critical in tropical countries for they have a relatively higher temperature and receive heavy rainfall annually (Sulaiman R. , Kamaruzzaman, Rao, & Pitt, 2011).

Malaysia as one of the tropical countries in Southeast Asia is no exception in relation to physical problems of its historic buildings. Kayan (2006) identified 11 common dilapidation problems affecting building maintenance in Malaysia in the likes of fungus stain, harmful growth, peeling of paint, poor installation of building services equipment, defective plaster renderings, cracking of walls, defective rainwater goods, decayed floorboards, insect or termite attack, roof or ceiling defects and dampness penetration through walls. Such building defects occurs rapidly, at various locations with different types of causes and symptoms (Syed Mustapa , Kamal, Zaidi, & Abd Wahab, 2007). Table 2.7 lists the nine causes of defects as observed by Fee (2003) in the Malaysian conservation scenario:

Table 2.7: Causes of defects at historic buildings (Fee, 2003)

Causes		Examples
i.	Structural weakness	constant natural gravity force
ii.	Human interventions	negligence, vandalism, nearby fire or construction work
iii.	Weather/ climate	radiation heat, humidity, air, rain, high level of underground water and salt content
iv.	Natural calamity	flood, hurricane and earthquake
v.	Botany	spreading tree roots
vi.	Biology	acidic reaction from bacteria and moss which chemically react to structural materials
vii.	Fungal growth	mold and mildew
viii.	Pests	termites, bats, birds
ix.	Economy	demolition works to give way for new development to take place

Ramly (2004) meanwhile identified two types of defect agents namely natural agent which refers to agent for naturally occurring defects and artificial agent which refers to the agent that exacerbate natural defects due to reaction with external factors. Natural agent commonly caused defects for buildings that are abandoned or had no maintenance. Artificial agent on the other hand affects both in-use and out-of-use buildings. Figure 2.8 summarises both natural and artificial agents:

Natural Agent

- **Water** reaction through rain, absorption of underground water and humid climate
- **Air** reaction through movement of hot, dusty, polluted wind
- **Sunlight** reaction through direct heat, radiation, ultraviolet, and temperature shift
- **Biological** reaction through the presence of fungus, trees, pests, birds etc.
- **Chemical** reaction through the presence of sulfuric acid, nitrate, alkaline etc. at the immediate or within the materials itselves
- **Mechanical** reaction through pressure on dead load or live load of the building's structure or fabric

Artificial Agent

- **Water** reaction through condensation, leakage, overflow and erosion
- **Heat** reaction through expansion, increase temperature and drying of material
- **Chemical** reaction through cleaning, fading, acidification, erosion and detachment
- **Mechanical** reaction through vibration etc.
- **Human** activities such as vandalism, pollution, misuse, demolition, fire, carelessness and absence of maintenance

Figure 2.8: Agents of defects (Ramly, 2004)

As the overall integrity of historic building conditions would be negatively affected through the presence of defective and dysfunctional elements, diagnosing historic building elements is thus essential (Syed Mustapa , Kamal, Zaidi, & Abd Wahab, 2007). Collings (2004) asserted that defects occurring partially or throughout the main building elements would weaken the structure and fabric of historic buildings. Further literature exploration has led to the 10 most defective elements inflicting Malaysian historic buildings as identified by Kamal and Ab Wahab (2014) which includes: i. External wall, ii. Ceiling, iii. Door and fixtures, iv. Internal wall, v. Roof, vi. Window and fixtures, vii. Building services, viii. Lower and upper floors, ix. Staircase and x. Miscellaneous.

Among the common processes for identifying defect involve detecting its occurrence, localising its areas and estimating its extent (Moaveni, Xianfei, Jose, & Jole, 2010). Sodangi (2012) informed that visual condition surveys have been mostly conducted based on qualitative approach using descriptive method of evaluation. Yet to cater the needs of quantitative approach, surveys which employ ratings to report building conditions are gaining wide acceptance over the traditional longhand survey description (Che-Ani, Mohd Tazilan , & Kosman, 2011).

Walton (2003) provided a method for assessing built structures through his publication on the methods for monitoring the condition of historic places. Walton's (2003) assessment focused on four aspects of surrounding area, exterior cladding, interior spaces and building services using monitoring forms, which involves rating on the seriousness of problems for each aspect. Walton's (2003) approach however requires baseline data and longitudinal effort following its monitoring basis.

Che-Ani, Ramly, Mohd-Zain, Mohd-Tawil and Hashim (2008) meanwhile developed a defects priority ranking approach which requires the rating on physical data comprising physical condition, fabric effect and user effect as well as the rating on risk data comprising potential risk and risk effect to arrive at the point of concluding whether a building is in good, fair or poor condition. Yet, this approach is only applicable to survey timber-built buildings.

On the same year, the Portuguese method for building condition assessment was developed based on the inspection of individual building element and aggregation with a formula to generate a numerical score (João António Costa Branco de Oliveira Pedro, José Ângelo Vasconcelos de Paiva António, & José Dâmaso Santos Matos Vilhena, 2008). The said method which specifies weightage for each building element, has been designed to not affected by the age and type of building. More recently, Che-Ani, Mohd Tazilan and Kosman (2011) introduced the condition survey protocol (CSP) 1 matrix which covers the twofold criteria of condition and priority assessments for building defects. It is reportedly suitable for all types of buildings which such adoption carries the advantages such as:

i. Time-saving as it enables shorter period of data collection during fieldwork compared to descriptive longhand system
ii. Comprehensive as it records existing building defects through assessing condition and assigning priority and repair to each defect recorded
iii. Conclusive in terms of providing an overall rating of a building's condition
iv. Measurable as it uses numerical ratings acquired during fieldwork for performing statistical analysis

The said CSP1 matrix then was fine-tuned by the Malaysian Department of Public Works Department (JKR) through the development of Building Condition Assessment (BCA) system (PWD, 2013; Yacob, Ali, & Cheong Peng, 2016). This system has been used by JKR to inspect and assess the conditions of existing public buildings in Malaysia. Yacob, Ali and Cheong Peng (2016) supported that the system is reliable for producing accurate rating. In fact, it is also appropriate to be utilised for different types of buildings, given that the building assessor(s) involved possess proper training and adequate experience in identifying defects and their reporting procedures.

2.5 Significance of Museum as a Product of Cultural Heritage Tourism

Since the second World War, tourism has arisen as one of the world largest industries and became a major economic element in the world market (Chambers, 1997). Tourism is understood as the set of activities engaged in by people temporarily away from their usual environment within less than a year period, for a broad range of purposes such as leisure, business, religious, health, and personal reasons, excluding the pursuit of remuneration from within the place visited or long-term change of residence (Smith, 2004). By far, coastal tourism records the most significant flow of tourists and income generation compared to other tourism categories such as urban tourism, island tourism, rural tourism and mountain tourism (E.U. Committee of the Regions, 2006).

However, cultural heritage tourism has become prevalent nowadays due to the increasing volume of tourists seeking upon adventure, culture, history, archaeology and interaction with local people (Chourasia & Chourasia, 2012). In fact, the World Tourism Organization (WTO) anticipates that cultural heritage tourism would be one of the five key tourism market segments in the future. As cited in Ismail , Masron and Ahmad (2014), the National Trust for Historic Preservation (2014) defined cultural heritage tourism as travelling to experience the places, artefacts and activities that authentically represent the stories and people of the past and present.

One of the main attractions of cultural heritage tourism is museum. Museums are socially useful for educational purposes through dissemination of historical evidence and past treasures by exhibiting contents to the contemporary audience (Kechot, Hassan, & Yunos, 2010; Kechot, Hamid, Aman, Hassan, & Daeng Jamal, 2012). As museums are intertwined with cultural and historical materials, visitors can immerse themselves in both environments and be able to experience a different time and place, learning to enjoy intellectual experience besides sharing with or teaching their little ones some contemporary or historical knowledge (Peterson, 1994).

Typically, museums either become an important part of a destination or the actual destination themselves (Nazrin, 2014). Museums document who we were, who we are now, and tell us about what we may become and have long served as the cultural bridge between the past, present and future (Museums and Galleries Foundation of NSW, 2004; Nazrin, 2014). They serve as the sanctuary to various important old and valuable artefacts, in which objects and collections are accessioned, numbered, measured, catalogued, stored, preserved, conserved, exhibited, repatriated and de-accessioned (Kurin, 2004). The four core functions of museum as listed by Davies, Paton and O' Sullivan (2013) are:

i. Preserving cultural collections (materials or objects) through rescuing, collecting and conserving activities,
ii. Understanding the collections through study and research activities,
iii. Communicating the collections through presentation and interpretation in exhibitions, publications or events,
iv. Contributing to civic society by developing sense of belongings, foster community cohesion and help in the creation of national identity

The institutional roles of museum and the listings of properties as UNESCO World Heritage apparently project a likewise agenda- promoting cultural knowledge and protecting tangible and intangible heritage. This is seen through the cooperation of UNESCO with the International Council of Museums (ICOM), which is the only international organisation representing museums and museum professionals. Rooted from Greek mythology, the word 'museum' has emerged from a temple in Athens called *Museion* which was used for worshipping the patroness of culture, religion, arts, tragedy, and astronomy called *Museus (*the nine daughters to the father of gods and man, Zeus and the goddess of memory, Mnemosyne*)*. *Museion* and the notion of museums combined the meaning of place, imaginative human endeavour and collective memory (Bojic, 2012). The official terminology of museum as provided by ICOM (2013) is:

"a non-profit making permanent institution in the service of society and of its development, open to the public, which acquires, conserves, researches, communicates and exhibits, for purpose of study, education and enjoyment, the tangible and intangible evidences of people and their environment"

ICOM establishes minimum standards for museums and their employees' professional practices and achievements specifically on design, management and collections organisation (Abdul Karim, Talib, & Sujak, 2012). The eight principles of minimum standards for museums as dictated in the Code of Ethics for Museums (ICOM, 2013) are:

i. *Principle 1; Museums preserve, interpret and promote the natural and cultural inheritance of humanity- Museums are responsible for the tangible and intangible natural and cultural heritage. Governing bodies and those concerned with the strategic direction and oversight of museums have a primary responsibility to protect and promote this heritage as well as the human, physical and financial resources made available for that purpose.*

ii. *Principle 2; Museums that maintain collections hold them in trust for the benefit of society and its development- Museums have the duty to acquire, preserve and promote their collections as a contribution to safeguarding the natural, cultural and scientific heritage. Their collections are a significant public inheritance, have a special position in law and are protected by international legislation. Inherent in this public trust is the notion of stewardship that includes rightful ownership, permanence, documentation, accessibility and responsible disposal.*

iii. *Principle 3; Museums hold primary evidence for establishing and furthering knowledge- Museums have particular responsibilities to all for the care, accessibility and interpretation of primary evidence collected and held in their collections.*

iv. *Principle 4; Museums provide opportunities for the appreciation, understanding and management of the natural and cultural heritage- Museums have an important duty to develop their educational role and attract wider audiences from the community, locality, or group they serve. Interaction with the constituent community and promotion of their heritage is an integral part of the educational role of the museum.*

v. *Principle 5; Museums hold resources that provide opportunities for other public services and benefits- Museums utilise a wide variety of specialisms, skills and physical resources that have a far broader application than in the museum. This may lead to shared resources or the provision of services as an extension of the museum's activities. These should be organised in such a way that they do not compromise the museum's stated mission.*

vi. *Principle 6; Museums work in close collaboration with the communities from which their collections originate as well as those they serve-Museum collections reflect the cultural and natural heritage of the communities from which they have been derived. As such, they have a character beyond that of ordinary property, which may include strong affinities with national, regional, local, ethnic, religious or political identity. It is important therefore that museum policy is responsive to this situation.*

vii. *Principle 7; Museums operate in a legal manner- Museums must conform fully to international, regional, national and local legislation and treaty obligations. In addition, the governing body should comply with any legally binding trusts or conditions relating to any aspect of the museum, its collections and operations.*

viii. *Principle 8; Museums operate in a professional manner- Members of the museum profession should observe accepted standards and laws and uphold the dignity and honour of their profession. They should safeguard the public against illegal or unethical professional conduct. Every opportunity should be used to inform and educate the public about the aims, purposes, and aspirations of the profession to develop a better public understanding of the contributions of museums to society.*

2.6 Building Evaluation

Evaluation generally is very important as it allows us to evolve, develop, improve, and survive in an ever-changing environment (Davidson, 2005). In fact, the practice of evaluation has gained worldwide acceptance and its utilisation is apparent in various domains such as in the health, education, business, and community development programmes. Ironically, various literature denoted that evaluation is passively explored by conservation communities (Kleiman, et al., 2000; Margoluis, Stem, Salafsky, & Brown, 2009a; Margoluis, Stem, Salafsky, & Brown, 2009b; Howe & Milner-Gulland , 2012; Zancheti & Similä, 2012).

Development of new approaches and methodologies in the assessment of conservation performance is thus necessary to enrich the existing body of knowledge pertinent to evaluation in the domain of built heritage conservation (Alonso & Meurs, 2012). Exploration on seminal theories in the field of building evaluation however has led to the discovery that much attention has been given to evaluate on the aspects of building performance in the likes of Facility Performance Evaluation (FPE), Building Performance Evaluation (BPE) and Post Occupancy Evaluation (POE). Notably, POE is one of the constituents of FPE as shown in Figure 2.9:

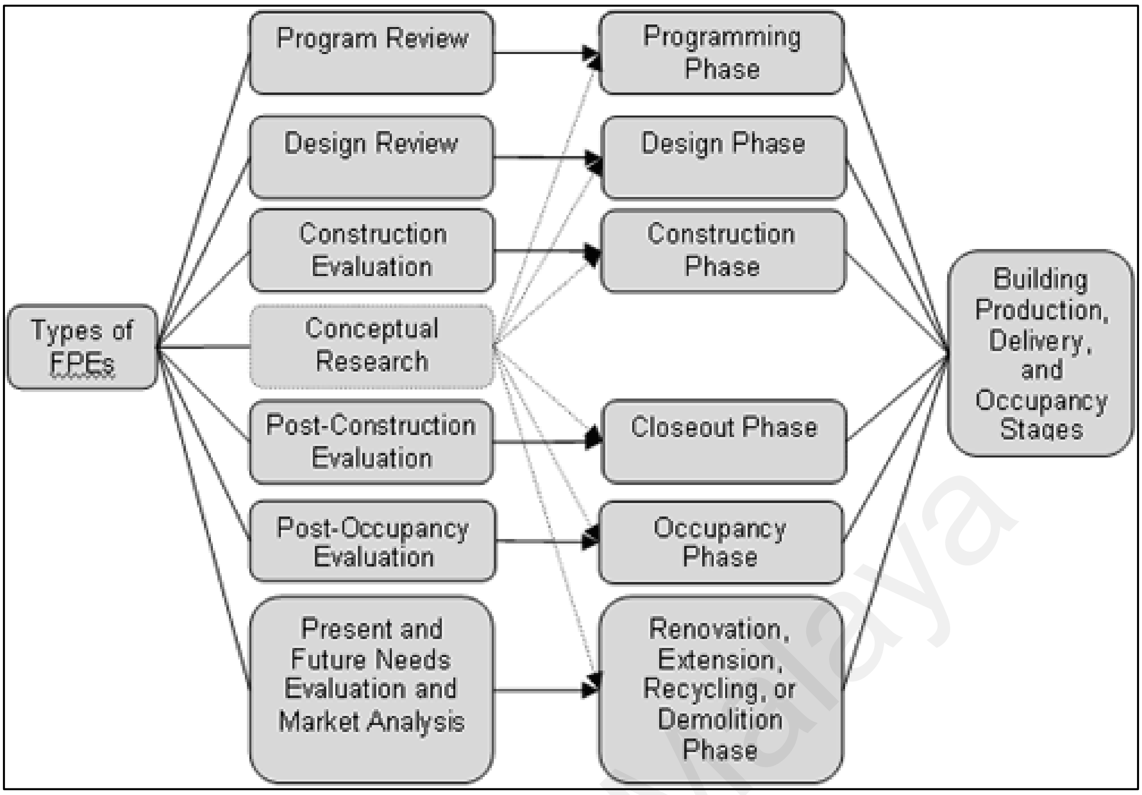


Figure 2.9: The types of FPE (Zimring, Rashid, & Kampschroer, 2010)

Building performance is contributory in achieving sustainable development. Alexander (2011) denoted that the terminology of building performance comprises of many interpretations. According to Williams (1993), the context of performance is related to a building's ability in fulfilling the functions of its intended use. Building performance has also been defined as the behaviour of product in use (Douglas, 1996; Almeida, Sousa, Alves Dias, & Branco, 2010). It depends on how the building performs in meeting the identified requirements, and how the end-users perceived it.

The criteria of building performance are dependent on evaluation objectives since the elements can be pervasive in nature such as technical (fire, insulation, heat), functional (applicability, adaptability, functionality), social (comfort, health, safety), economic (life-cycle costs, cash flow, market value), or environmental (energy use, materials) (Preiser W. , 2005; Khalil, Kamaruzzaman, & Baharum, 2016). The aspects of facilities that are measured, evaluated and used to improve buildings are known as indicators of building performance (Preiser, Rabinowits, & White, 1988). Figure 2.10 shows the common facets of building performance comprising physical, functional and financial aspects (Bernard Williams Associates, 1994):

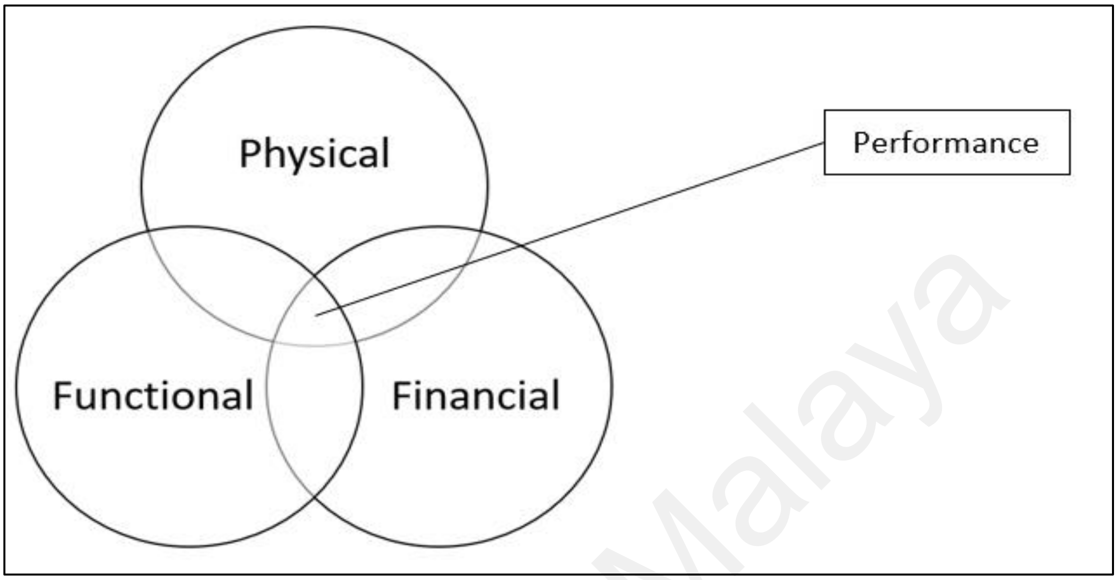


Figure 2.10: The facets of building performance
(Bernard Williams Associates, 1994)

Building Performance Evaluation (BPE) which recommends performance improvement, used for feedback and feed forward the performance of similar buildings is significant in the quest to achieve good and services efficiency, quality of building outputs and effectiveness of building operations (Amaratunga & Baldry, 1999; Amaratunga & Baldry, 2003).

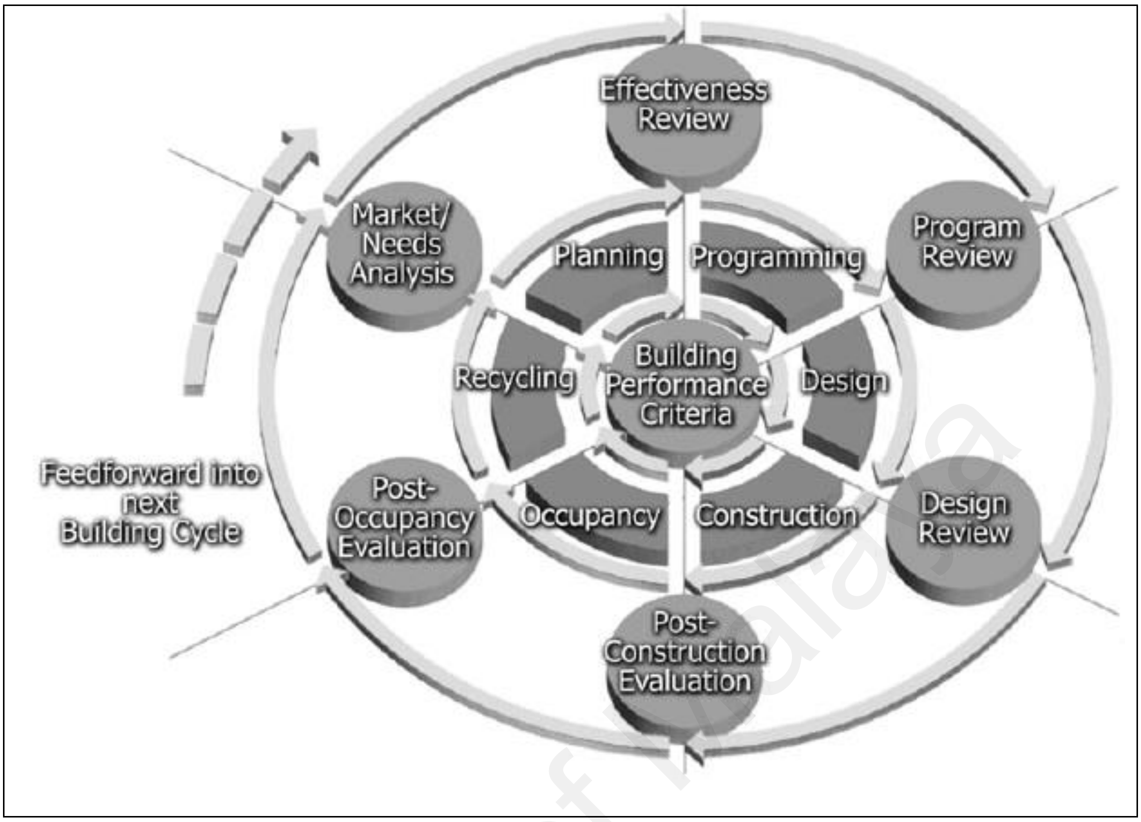


Figure 2.11: BPE process model (Preiser & Vischer, 2005)

Figure 2.11 and Figure 2.12 show the BPE process model and performance concept respectively adopted from the experts in the building evaluation field that encompasses six cyclical evaluation stages of effectiveness review, programme review, design review, commissioning, POE and market needs analysis with their respective planning, programming, design, construction, occupancy and recycling (adaptive reuse) performance criteria (Preiser & Vischer, 2005; Pavlogeorgatos, 2003). Figure 2.13 meanwhile presents the three types of performance measurements (comprising perceived, observed, and measured) and their respective methods commonly used in the practice of BPE.

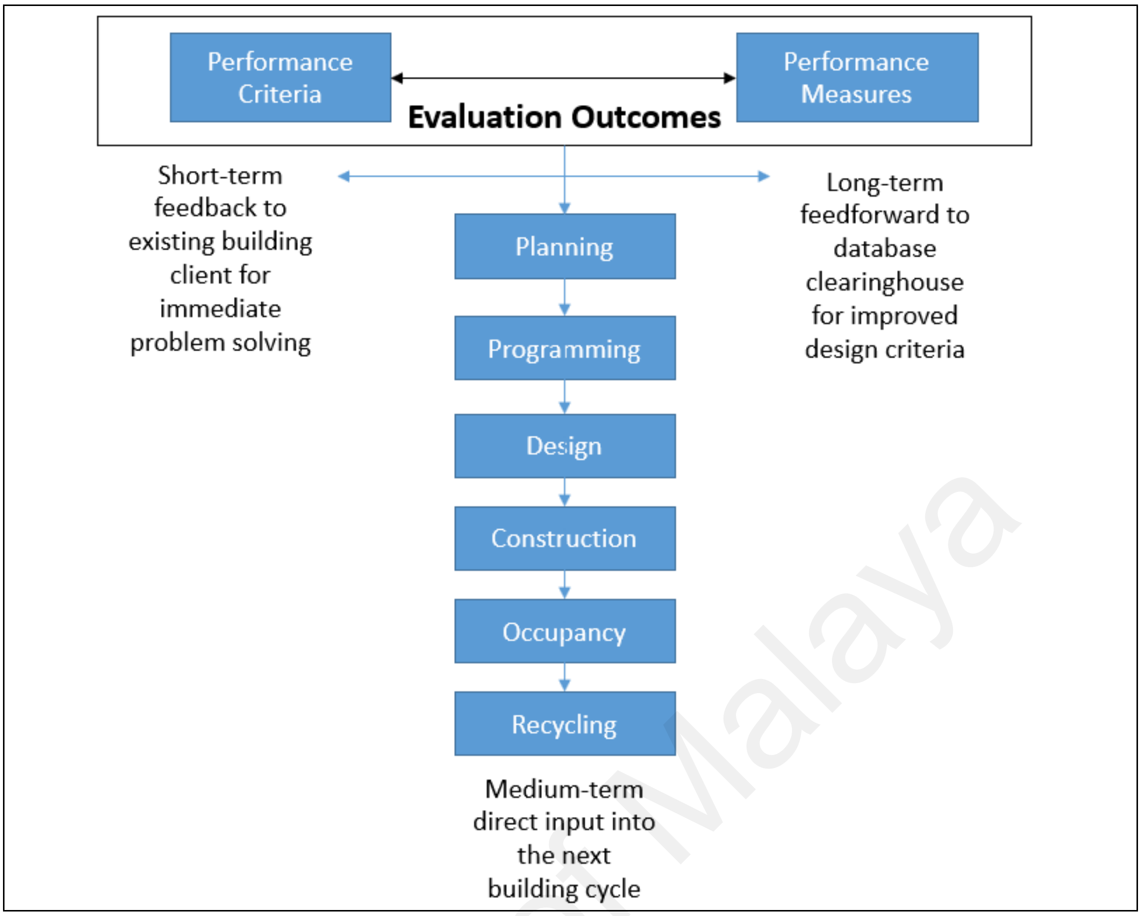


Figure 2.12: The performance concept in the building process
(Preiser & Nasar , 2008)

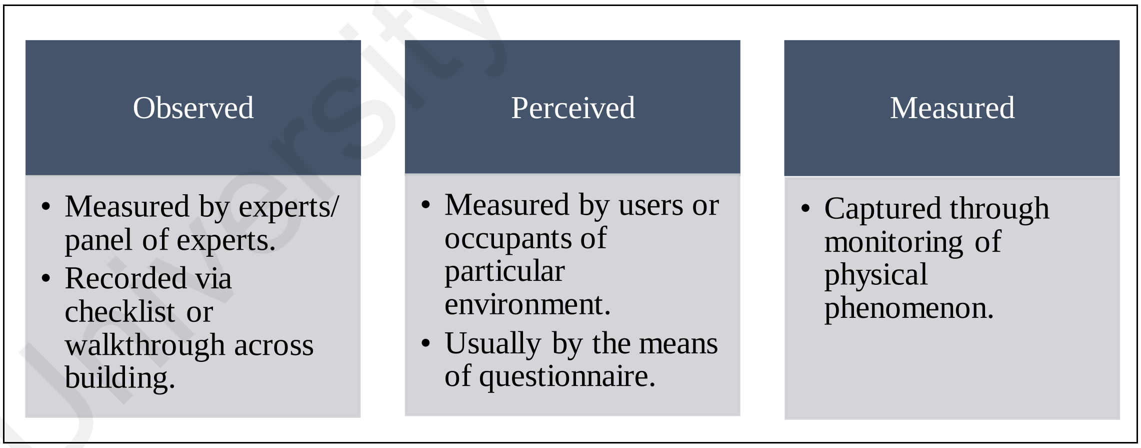


Figure 2.13: Performance measurements (Mahgoub, 1999)

Imperatively, an integral part of a building total performance is the Indoor Environmental Quality (IEQ) (Wong, Mui, & Hui, 2008). The significance of IEQ towards achieving sustainability is testified by its integration in many green building assessment tools, which include Malaysian Green Building Index (GBI) (Sarbu &

Sebarchievici, 2013; Kamaruzzaman & Zulkifli, 2014). The measurement of IEQ performance in the service industries has already began since the 1980s (Rowley, 1999).

POE meanwhile has been regarded as the most common and widely used form of building evaluation (Firzan, Keumala, & Zawawi, 2017). First published in a book in late 1970 (Akman, 2002), POE is a systematic evaluation procedure on the performance of occupied buildings that is useful for existing and future projects (Mastor & Ibrahim, 2010). POE can be categorised into three levels namely indicative (indicate success or failure of overall building performance), investigative (finding solutions to problems) and diagnostic (focusing on any critical element or aspect of a building).

POE depends on its key procedural components of the processes, participants, documentations, tools and technology (Mastor & Ibrahim, 2010).. The essence of POE in studying building performances lies in the understanding on the extent of occupants' satisfaction and expectation (Vischer, 2008; Woon, Mohammad, Baba, Zainol, & Nazri, 2015). POE promotes improvements through lessons learned and feedback gained (Mastor & Ibrahim, 2010). Arguably, POE has been focusing more on building end-users' feedback for benchmarking, and apparently its contexts are more to the aspects of post-occupancy of new buildings. In this regard, it is imperative to have an evaluation system that caters for the contexts of historic building, focusing on the conservation aspects and interventions once the building has been conserved.

PCE meanwhile has been introduced to facilitate a comprehensive evaluation of conserved historic building, focusing beyond the aspects of building performance as well as end-users' feedback (Abdul Aziz, Keumala, & Zawawi, 2014). Realising that there is a limited availability on the forms of evaluation focusing on individual historic building units, Firzan, Keumala and Zawawi (2016) asserted that further devotion to address the rarity and demand of evaluation in the realm of conservation is required. The needs of having PCE to cater built heritage conservation has been re-emphasised by Firzan, Keumala, and Zawawi (2017) to foster microscale evaluation (for individual historic building unit instead or the larger urban or site contexts) besides to focus on evaluating conservation performance (on applied interventions rather than focusing solely on building performance and users' perception).

The advocacy of having PCE is in line with the needs to enrich the existing body of knowledge of evaluation in the domain of built heritage conservation, since development of new approaches and methodologies are necessary to enable the assessment of conservation performance (Alonso & Meurs, 2012). Furthermore, the Burra Charter 1999 has made evident that evaluation paradigm is central in conservation process, as outlined in the monitor and review segment as shown in Figure 2.14:

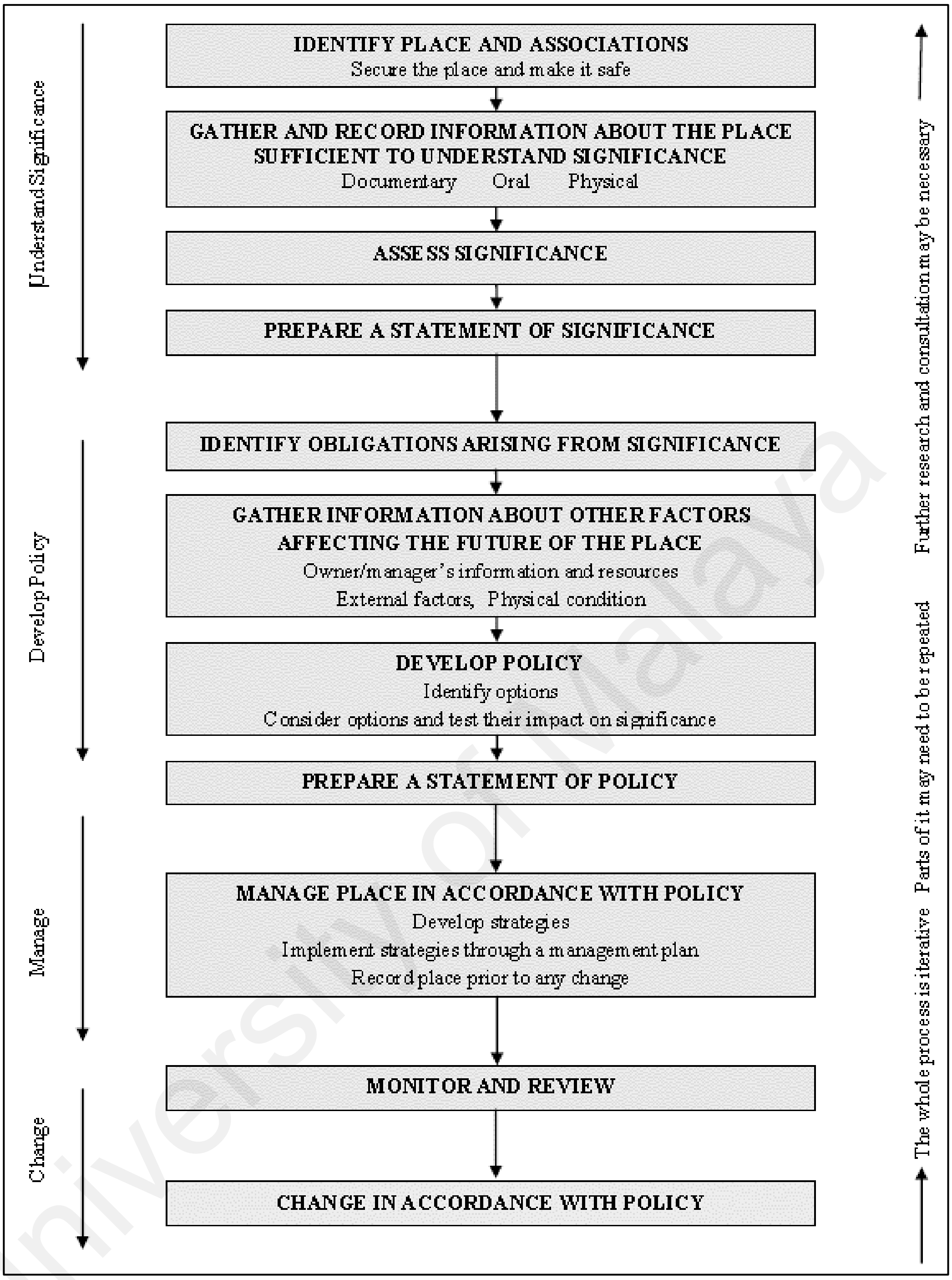


Figure 2.14: Conservation process (ICOMOS, 1999)

2.7 Contextualising PCE with Museum Trifold Aspects

The topic herein presents the essence of conceptual PCE of the current research by contextualising the three facets of building performance (physical, functional and financial) with IEQ contexts in relation to the museum trifold aspects (building, collections, and users) as well as museum financial aspect:

2.7.1 Physical Performance

Physical performance relates to the behaviour of building fabric and embraces physical properties such as structural integrity, heating, lighting, energy efficiency, maintainability, durability etc. (Sapri & Pitt, 2005). The drive to maintain a building is typically influenced by the necessity to protect its building performance as well as to increase its productivity and users' satisfaction. This rationalises why maintenance management would be peculiar for different types of buildings owing to their respective unique nature of users and functional requirements (Olanrewaju & Abdul-Aziz, 2015).

Meant for the public use, museum architecture revolves around spaces that can be used to house specific museum functions such as exhibition and display, preventive and remedial active conservation, study, management, and receiving visitors (Desvallées & Mairesse, 2010). As museums are intended for preserving, displaying and educating, Cassar (1994) regarded them as the most difficult type of building to be designed and constructed for having to reconcile functions which often conflict each other. They are reportedly among the most heavily occupied buildings which operation basis normally extend to seven days per week (Othuman Mydin, Ismail, & Md Ulang, 2012).

Museums typically can be either in the forms of new (designed or purpose-built) or old (preserved or converted) buildings. The notion that museum contents carry the highest significance (SIEMENS, 2015) is void for museums which buildings are of historical fabric. In fact, the historic building itself should be considered as the largest museum artefact for embedding historical, cultural, architectural and aesthetical values (Cassar, 1994). It is imperative to note that historic buildings which function as museums face a relatively higher level of stress and different threats to its historic integrity compared to historic buildings used as private residences (Babor & Plian, 2008).

As museum buildings serves as the first layer of protection for the collections against external environment (Ladkin, 2004) and composes of the facilities required by the museum users, optimal IEQ performance is therefore vital. Sulaiman, Schellen and Hensen's (2010) study reported that the envelope, components and interior of historic buildings may not withstand the changes of IEQ. They exemplified that inappropriate IEQ has caused severe deterioration to the physical fabric of a Dutch historic monumental museum building, the Amerongen Castle.

Jaggs and Palmer (2000) added that poor IEQ conditions would cause failure and defects to the building components and subsequently increase in maintenance and repair costs. Hence, museum building needs a strict building control system (ASHRAE, 2005). Cassar (1994) recommended that maintenance for historic buildings used as museums should be in the context of preventive building conservation. Based on financial budget, he suggested three strategies for building envelope to provide better environmental protection for museum collections as presented in Figure 2.15:

If enough money is available

- Improve building's capability to buffer environmental conditions

If there is some money

- Concentrate on providing localised microclimates for museum collections

If there is little money

- Focus on reviewing operational procedures to assess changes for improving environmental control

Figure 2.15: Strategies for building envelope to provide better environmental protection for museum collections (Cassar, 1994)

2.7.2 Functional Performance

Functional performance relates to the relationship of the building with its occupiers and embraces issues such as space, layout, ergonomics, image, ambience, communications, health, safety, flexibility etc. (Sapri & Pitt, 2005). It is being considered important in the field of museology which stresses on the methods and techniques related to museum functional practicality such as organisation of displays, use of lighting, circulation flows and accessibility (Günçe & Misirliso, 2014). Museums have been categorised functionally as recreational buildings along with depositories, theatres, auditoriums, athletic facilities, and libraries (Jokilehto, Cameron, Parent , & Petze, 2008).

Pavlogeorgatos (2003) observed that the study on environmental conditions of historic buildings especially relating to museum and archival buildings is growing in demand since the last decade. Indoor Environmental Quality (IEQ) has been associated with the service of museum management, which led to the requirement in maintaining and achieving the IEQ performance (Boyd, 2002). The building internal environment is influential to the preservation of museum collections as well as the comfort and enjoyment of museum visitors (Museums and Galleries Foundation of NSW, 2004). IEQ performance is thus critical for the functionality of museum ‘occupants’ which refer to museum collections and museum users (Jaggs & Palmer, 2000).

a) Museum Collections

Museum collections have been pervasively discussed in the field of museology and curatorship. Along with archives and libraries, museums are responsible for the preservation and conservation of important cultural collections (Pavlogeorgatos, 2003).

b) Museum Users

Museum users basically comprise of the visitors and staff (Shuang, Kamaruzzaman, & Zulkifli, 2014; SIEMENS, 2015). Convenience of visitors and staff for institutions such as libraries, archives, museums and galleries were central prior to the growth in concern on the effects of environmental condition towards objects or collections (Pavlogeorgatos, 2003). Through physical context with the museum exhibitions and displays, people can directly learn from their real-time experience (Jacobsen, 2010). Interestingly, Jeong and Lee (2006) cited that the true content of a museum is its visitors whereas the building envelopes and collections are merely the containers.

Reportedly, poor building performance poses a risk towards the safety and health of the building users (Khalil, Kamaruzzaman, & Baharum, 2016). In connecting to this sense, poor IEQ is contributory to Sick Building Syndrome on museum users which includes tired eyes, tiredness, dry skin, runny nose, dizzy, headache, blurred vision, sore throat, cough, glare, itchy nose, itchy skin, wheezing, breathing difficulty, itchy eye, rash, stress, anxiety, chest tightness, and tension or nervousness. Besides health issue, poor IEQ has been linked with staff's efficiency and productivity, and to the extent of tarnishing a country's (Shuang, Kamaruzzaman, & Zulkifli, 2014). Kwon, Chun and Kwak (2011) also associated IEQ with satisfaction and temporal behaviour of people occupying or visiting a building.

c) Achieving Collections Preservation and Users' Comfort Through IEQ Performance

IEQ performance would leave either a positive or negative impact to the museum trifold aspects of building, collections and users (Kamaruzzaman & Sulaiman, 2011). Therefore, optimum IEQ performance would be significant for sustaining museums in a holistic manner. Various scholars such as Cassar (1994), Pavlogeorgatos (2003), Michalski (2004), Finney (2006), Sulaiman, Kamaruzzaman, Salleh and Mahbob (2011), and Abdul Karim, Talib and Sujak (2012) have stressed on several important IEQ parameters for museums which are influential in preventing decay and slowing down deterioration of museum collections.

The study by Sulaiman, Kamaruzzaman, Salleh and Mahbob (2011) is deemed significant to the Malaysian museums context for providing a theoretical framework on achieving a balanced environment of historic buildings used as museums in the local climate. As shown in Figure 2.16, Sulaiman, Kamaruzzaman, Salleh and Mahbob's (2011) framework stresses on the IEQ parameters comprising thermal environment, lighting, indoor air quality and noise. The subsequent discussion explains each of the aforesaid parameters and their respective threshold values in brief.

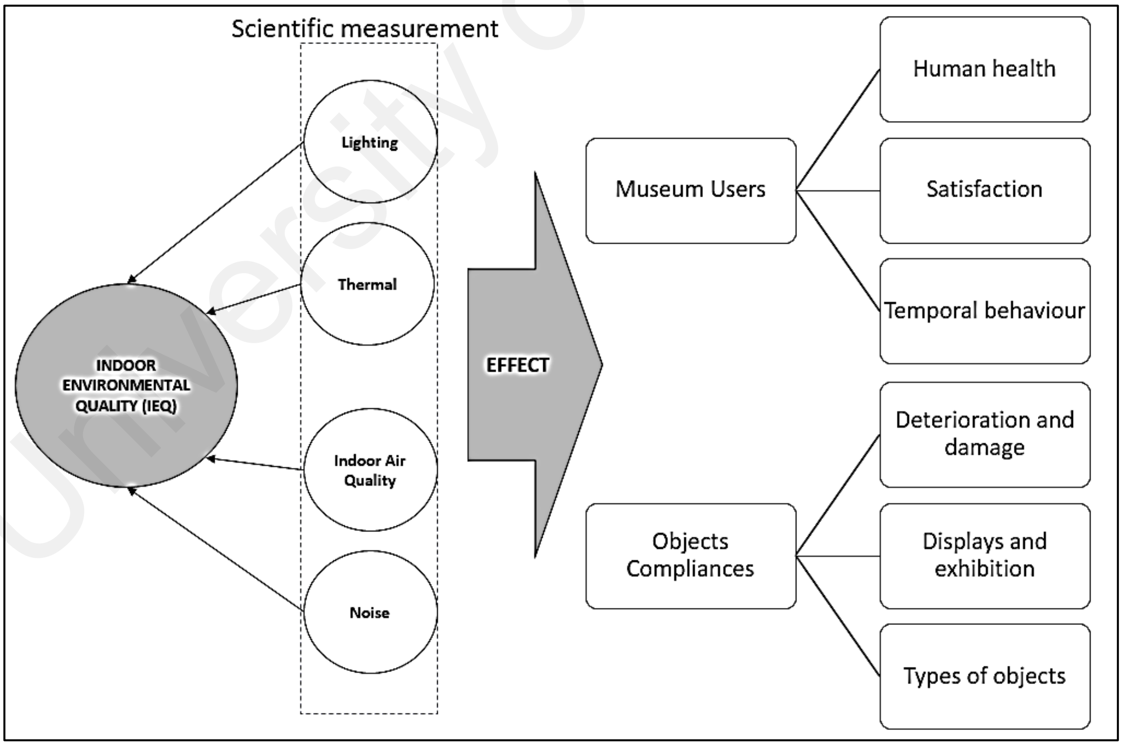


Figure 2.16: Theoretical framework for a balanced environment in Malaysian museum buildings (Sulaiman R. , Kamaruzzaman, Salleh, & Mahbob, 2011)

i. Thermal Environment

Thermal environment determines thermal comfort through a specific range of relative humidity and temperature conditions (ASHRAE, 2005). The thermal environment parameters that people generally relied on for thermal comfort are air temperature, mean radiant temperature, air velocity and relative humidity (Sulaiman & Kamaruzzaman, 2012). The two parameters of thermal environment concerning museums commonly discussed by scholars such as Cassar (1994), Pavlogeorgatos (2003), Michalski (2004), and Finney (2006) are relative humidity and indoor temperature:

Relative humidity is the ratio between the actual amount of water vapour in the air and the maximum amount of water vapour that the air can hold at certain temperature, expressed in percentage (Abdul Karim, Talib, & Sujak, 2012; Othuman Mydin, 2016). Humidity of the air basically depends on the temperature of the air, if the temperature fluctuates between the day and night, the relative humidity will also fluctuate.

Table 2.8: Compilation of recommended standards for relative humidity

Standard Recommendations	Description	Source
50-55 %	For museums holding a variety of materials	Padfield (1994)
50-60 %	Recommended for valuable objects such as paintings and antique furniture	Brown and Rose (1996)
55-70 %	For museum collections	Heritage Collection Council (2002)
50%	For general museums and art galleries with chemically stable collections	ASHRAE (2004)
40-60 %	For people’s comfort	ASHRAE (2004)
<65 %	Exceeding this level would cause the presence of mold, mildew and pests	Finney (2006)
60-70 %	For people’s comfort	Department of Standard Malaysia (2007)

Indoor climate is regarded as one of the most crucial aspects regarding climate-induced damage to building materials and cultural collections (Sulaiman, Schellen, & Hensen, 2010). Temperature, measured in the degree of Celsius (°C), influences relative humidity as with higher temperature, the ability of air to withhold water increases and vice versa (Abdul Karim, Talib, & Sujak, 2012). Paine (2006) informed that the rate of biological or chemical deterioration can be speed up due to changing temperature.

Table 2.9: Compilation of recommended standards for indoor temperature

Standard Recommendations	Description	Source
23-26 °C	For people's comfort (non-residential buildings)	Department of Standard Malaysia (2007)
22-28 °C	For museum collections	Heritage Collection Council (2002)
15-25 °C	For general museums and art galleries with chemically stable collections	ASHRAE (2004)
23-24 °C	For people's comfort	ASHRAE (2004)
12-15 °C	For slowing down object degradation	Finney (2006)
17-21 °C	Human comfort levels	
16-20 °C	For the display of mixed collections	Paine (2006)

ii. Lighting

Lighting is considered as a very important design and functional element for operating environments (Kamaruzzaman & Zulkifli, 2014). Quality of light is considered very decisive in museums as they exhibit objects for display and study (Neufert & Neufert, 1970). As cited by Sulaiman R. , Kamaruzzaman, Salleh and Mahbob (2011) interaction between human and the artefacts within a defined space is developed through light. The intensity of light is measured in lux and foot candle units, with the relationship of 1-foot candle equals to 10.76 lux (McCormick, 1990).

In general, energy is required for materials' deterioration process. Light is a critical environmental factor, which consists of bundles of energy travelling in wave motion called photons, known as electromagnetic radiation (Daniel, 2001). Light is in fact being considered as the most powerful form of energy in museums (Pavlogeorgatos, 2003). Yet, it can cause serious damage to museum collections, posing a great threat to their long-term care (Abdul Karim, Talib, & Sujak, 2012). Thompson (1986) even commented that light is more damaging to museums' collections than temperature.

Reportedly, natural and artificial lightings can cause an increase in temperature thus causing the drying of objects, depending on the colour of the object and its distance from light source (Thomson, 1986; Pavlogeorgatos, 2003). Since both natural and artificial lights can cause deterioration, they therefore need to be controlled accordingly. Natural light consists of visible light over the frequency range of 380-760 nm, plus Ultraviolet (UV) and infrared radiations (IR) at shorter and longer wavelengths respectively (Daniel, 2001). It is noteworthy that natural light has the highest UV radiation rate (Pavlogeorgatos, 2003). IR meanwhile produces heat that can be devastating to museum collections.

Comparatively, full sunlight can illuminate up to 100, 000 lux, indirectly sunlight 10, 000 lux, bright spot light 2000 lux, typical office light 750 lux and a candle held an arm's length away 1 lux (Michalski, 2004). If sunlight falls on museum collections, UV radiation and IR heat will cause a lowering of relative humidity of the surrounding. Temperature will drop whereas relative humidity will eventually increase with the removal of sunlight. Hence, Daniel (2001) opined that this cyclical scenario will against the conservation of objects, especially to organic materials. He informed that when the vibrating photons of light collide with a substance, they react with the surface layers causing photochemical damages such as fading of dyes, yellowing of paper, darkening of vanishes, make brittle of textile fibres and so on.

Artificial lighting is considered less damaging compared to natural lighting. Incandescent lamps such as spotlight generate heat (Daniel, 2001). Yet, it is virtually free of UV radiation (McCormick, 1990). In contrast, fluorescent lamps are cool in temperature yet produce high UV output. Hence, the uses of incandescent lighting over daylight and fluorescent lightings is recommended for gallery spaces. Alternatively, UV filters can be used on windows or lighting fixtures where daylight and fluorescent lights are presence in museums. However, in the context of historic building, application of such filters can affect both individual windows and overall building's the original character (Sheetz & Fisher, 1990).

Museums have been perceived as dark and gloomy space by the public (Sulaiman R. , Kamaruzzaman, Salleh, & Mahbob, 2011). Hence, lighting within museums should be improved especially when it is considered as one of the failure factors in attracting visitors (Taha, 2009). Low artificial and natural light levels are resulted by poor lighting controls besides not making necessary replacement, insufficient installation or use of wrong type of light fittings (Kong, 2014). Realising the availability on these two light forms, compilation on recommended standards for ambience and display lightings was made in Table 2.10:

Table 2.10: Compilation of recommended standards for light intensity

Standard Recommendations	Description	Source
50-200 lux	50 lux for light fugitive materials and 200 lux for less fugitive light materials	Thomson (1986)
50-100 lux	For very sensitive materials such as prints, drawings, water colours, dyed fabrics and botanical specimens	McCormick (1990)
≤150 lux	For oil paintings, photographs, ivory, wood and lacquer objects	
<200 lux	For oil/ tempera paintings, undyed leather, lacquer, wood, horn, bone and ivory, stone	Paine (2006)
<50 lux	For costume, textiles, water colour painting, tapestries, furniture, prints and drawings, stamps, manuscripts, ephemera, miniatures, wallpaper, dyed leather and most natural history and ethnographic items	
100-200 lux	For ambience light intensity	Michalski (2004)
50-150 lux	Common practice by museum management	
150-300 lux	For human's visual comfort	
<50 lux	For light sensitive objects: watercolours, textiles, papers, photographs and plastics	Finney (2006)
≤250 lux	For less sensitive objects: oil paintings, wood, ceramics, metal glass etc.	

iii. Indoor Air Quality

Indoor air quality is one of the major environmental concerns within built environment domain. This is evident as it is an important parameter in green building assessments worldwide such as Leadership in Energy and Environmental Design (LEED), GBTool, Green Building Index (GBI) Malaysia, Building Research Establishment Environmental Assessment Method (BREEAM), Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) and the Green Mark Singapore tools (Prihatmanti & Bahauddin, 2014). Indoor air quality refers to the quality of physical, chemical and biological traits of indoor environment air (Shafiepour, Ashrafi, & Tavakoli, 2010).

Indoor air quality is significant to building functioning as museum for carrying potential risks on the collections and users (Pavlogeorgatos, 2003; Shafiepour, Ashrafi, & Tavakoli, 2010; Sulaiman R. , Kamaruzzaman, Salleh, & Mahbob, 2011; Prihatmanti & Bahauddin, 2014; National Park Service, 2016). It can be costly to building owners for demanding expensive repair on building and mechanical systems, legal costs and to the extent of tarnishing a building reputation and loss of use (Kong, 2014). Dean (1994) asserted that among the main environmental factors to be considered in providing adequate care for museum collections are particulate matter and pollutant. Godoi et al., (2013) denoted that assessment of damage to indoor cultural heritage due to pollutants is gaining a major concern by both curators and conservators (Godoi , et al., 2013). Figure 2.17 shows the two types of air pollutants.

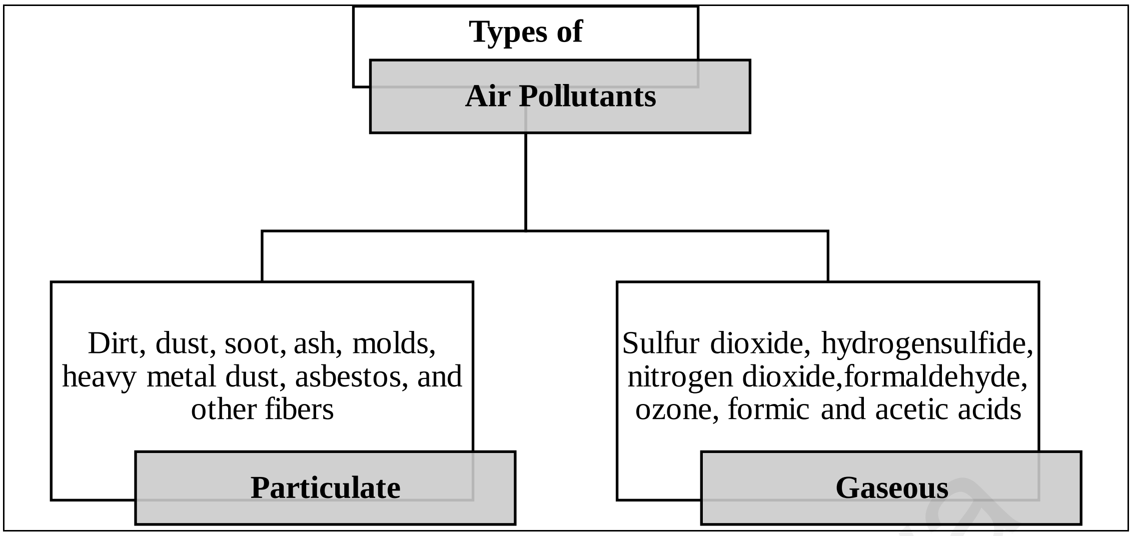


Figure 2.17: Types of air pollutants (National Park Service, 2016)

According to National Park Service (2016), air pollution is sourced by contaminants produced from both outside and inside of museum environment, whether airborne, transferred by contact, or inherent within objects themselves. Outdoor atmospheric pollutants are channelled to the indoor space through HVAC systems or building openings. The main outdoor pollutants are sulphur dioxide, hydrogen sulphide, nitrogen oxide, nitrogen dioxide and ozone. Pavlogeorgatos (2003) considered these as the most significant threat for museum collections, specifically highlighting particulates, sulphur, nitrogen oxides and ozone as the air pollutants that can accelerate and exacerbate the deterioration of museum exhibits. Kong (2014) described factors that will increase exposure to indoor air pollutants are reduced ventilation rates due to energy conservation, use of synthetic building materials and furnishings, as well as appliance of chemically formulated products such as pesticides, household detergents and printing inks. The sources of indoor air pollution are presented in Figure 2.18:

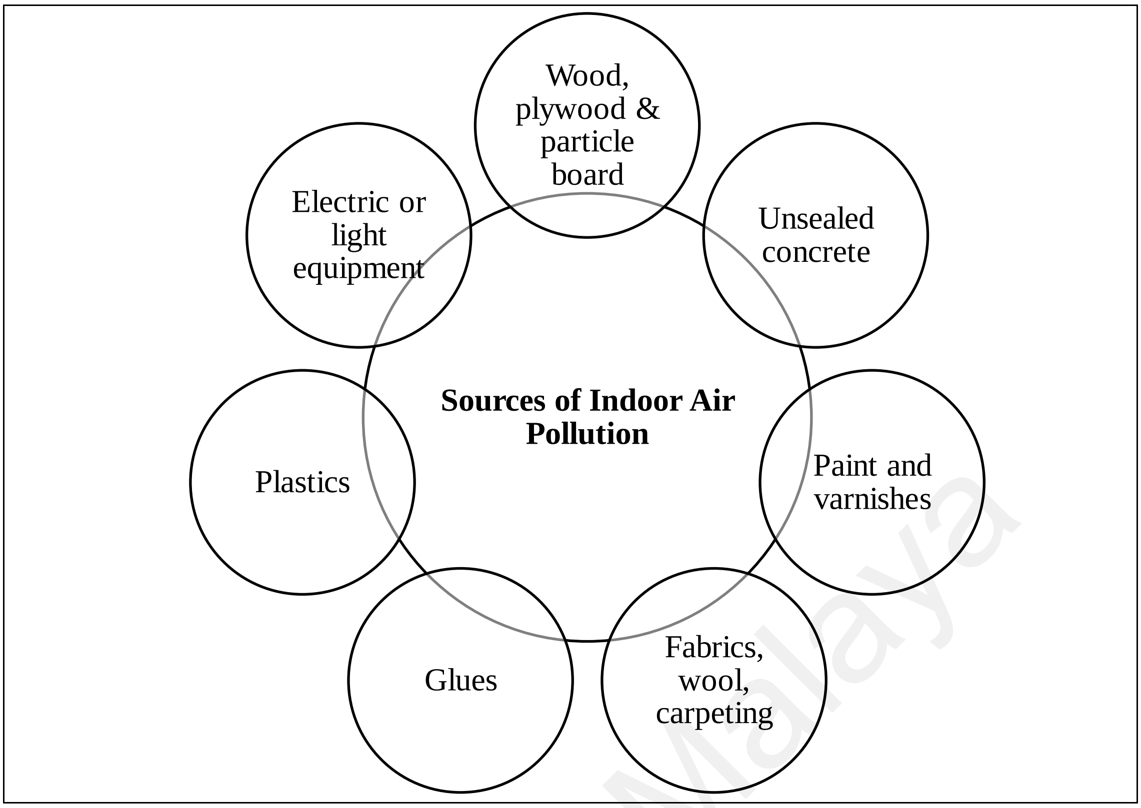


Figure 2.18: Sources of indoor air pollution (National Park Service, 2016)

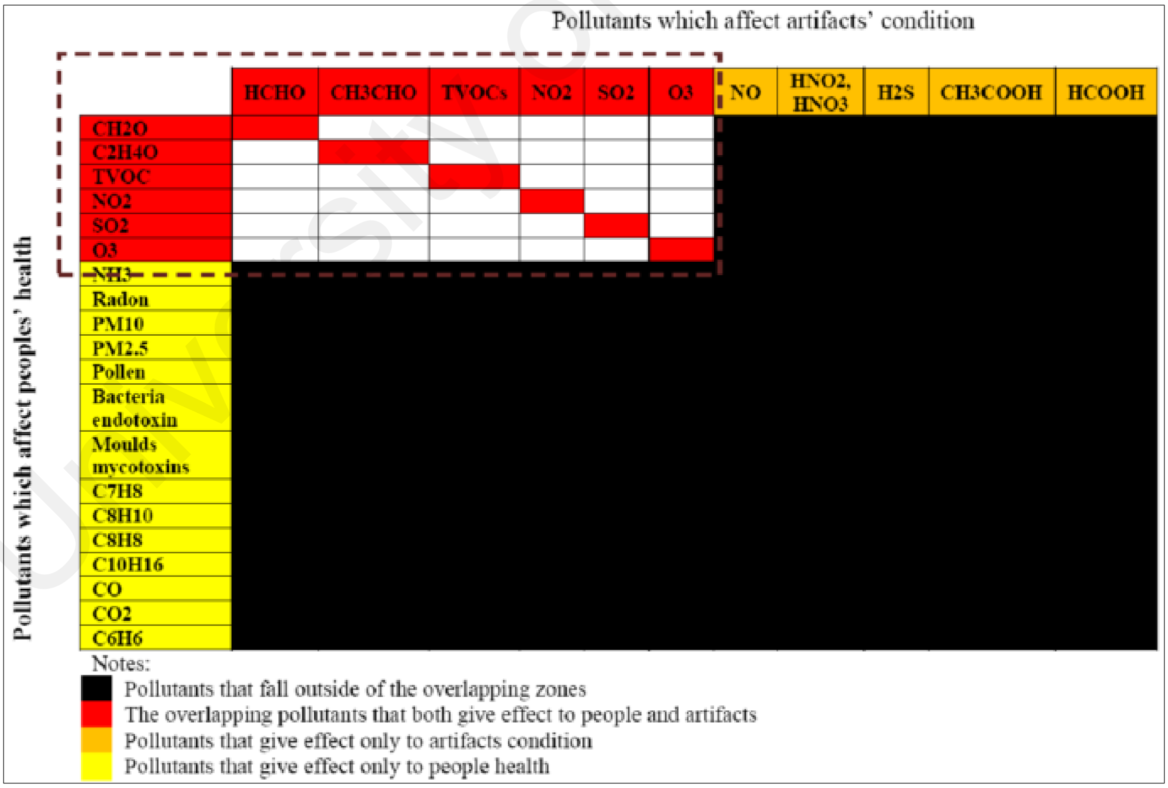


Figure 2.19: The overlapping zones of gaseous pollutants between people's health and artefacts' deterioration (Sulaiman R. , Kamaruzzaman, Salleh, & Mahbob, 2011)

In Figure 2.19, Sulaiman R., Kamaruzzaman, Salleh and Mahbob (2011) integrated the 11 pollutants that are harmful to museum collections and 20 pollutants that are harmful to people. They overlapped the pollutants that affect both people's health and artefacts' condition. It is noteworthy that clean air, as a basic life requirement, is crucial for people's health and well-being. It affects personal, psychological and occupational aspects of human being. A good indoor air quality has been linked to a happier mood and work productivity for building occupants.

Among the pollutants affecting people's health in museums mentioned by Sulaiman R., Kamaruzzaman, Salleh and Mahbob's (2011), carbon dioxide (CO_2) is factually a by-product of human respiration (Sulaiman & Mohamed, 2011). Production of CO_2 is proportional to human metabolic rate and long as the most important biologically active agent (Bencko, 1994). It is deemed as a significant parameter for indoor air quality assessment and has been strongly linked with ventilation inadequacy (Prihatmanti & Bahauddin, 2014). Sulaiman and Mohamed (2011) informed that areas lacking in fresh outdoor air due to stagnant ventilation (above 1000 ppm) may cause a feeling of stuffiness due to CO_2 built up. Decreased productivity, drowsiness, headache, and fatigue have also been associated to the elevated levels of CO_2 concentration. Carbon dioxide (CO_2) concentration has been reportedly high within old buildings (Shuang, Kamaruzzaman, & Zulkifli, 2014).

In contrast, total volatile organic compound (TVOC), the pollutant which affects both people's health and artefacts' condition mentioned by Sulaiman R., Kamaruzzaman, Salleh and Mahbob's (2011), is found significantly high in concentration level within new buildings. The presence of indoor air pollutants emitted through furniture, paint and finishes, mould and other sources can be indicated through TVOC. TVOC along with relative humidity, indoor temperature and the presence of bacteria are reported as influential factors to the prevalence of SBS (Sulaiman & Mohamed, 2011).

Humans can sense TVOC through olfactory sensor, through smelling (1993). In fact, CO_2 and VOC are the two predominant parameters in relation to odour constituent (Jokl, 2000). Realising that both CO_2 and TVOC are influential to museum collections and users, compilation on recommended standards for both parameters is made as provided in Table 2.11:

Table 2.11: Compilation of recommended standards for indoor air quality

Standard Recommendations	Description	Source
3 ppm	VOC that exceeds this limit will cause eyes and nose irritation, dizziness and headaches	Code of Practice on Indoor Air Quality (DOSH, 2010)
0-14 ppm	Low pollution of TVOC	Meter Industrial Company (MIC)
15-34 ppm	Moderate pollution of TVOC	
35-50 ppm	High pollution of TVOC	
<1000 ppm	Considered toxic if CO_2 exceed this threshold value	Ramalho et al., (2015)

iv. Noise (Acoustic)

The vibration transmitted as a wave through object or air refers to sound, which is measured in sound pressure level, with Decibel (dB) as its unit of measurement. OSHA (2015) informed that the normal sound level for human is 90dB. Meanwhile, unwanted or undesired sound is known as noise (Hin, Wong, & Yong, 2008), which is one of the ergonomic issues within the scope of IEQ (Shuang, Kamaruzzaman, & Zulkifli, 2014). Noise can influence human moods (Frijda, 1993).

Reportedly, noise along with thermal comfort and density of visitors is part of ambient environment in museums which can indirectly affect visitors' satisfaction (Jeong & Lee, 2006). Apart from layout congestion and the deluge of media and printed materials in museums, noise can also distract visitors' attention in understanding and appreciating museum collections (Kotler & Kotler, 2000). In the aspect of auditory hazards for museum safety, high level of noise can mask sound which is purportedly used to warn visitors of incoming dangers (Johnston, 1987). There are four types of noise as explained in the Malaysian Factories and Machinery (Noise Exposure) Regulations 1989 (Legal Research Board, 1989) as shown in Figure 2.20:

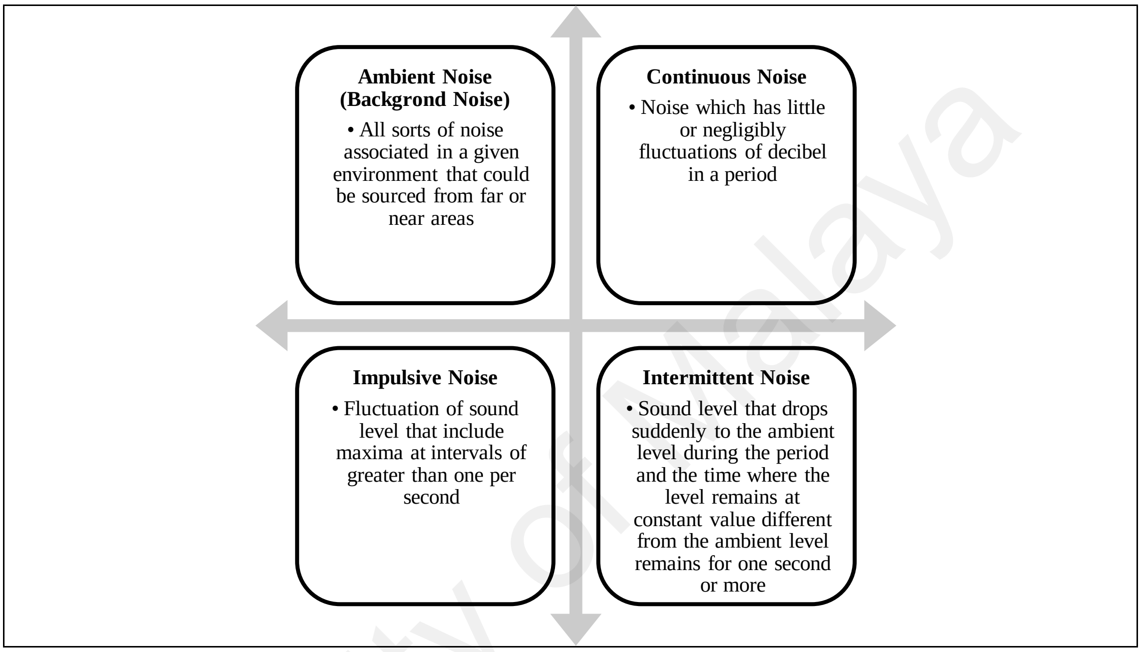


Figure 2.20: Types of noise (Legal Research Board, 1989)

Sources of noise in museums can come from motorised vehicles, noisy locations such as airports, railways, highways, clubs etc., construction works, HVAC and cleaning systems, as well as visitors (Pavlogeorgatos, 2003). Besides affecting visitors' convenience, noise and vibrations can also cause problems to museum collections. Pavlogeorgatos (2003) detailed it as such:

i. Causing damage or even destruction to crystal and glass exhibits which are in unstable condition

ii. Causing the detachment of parts of unstable exhibits

Table 2.12: Compilation of recommended standards for noise (acoustic)

Standard Recommendations	Description	Source
35NR	Noise pollution will damage glass and crystal collections, result in detachment on parts of unstable exhibits, as well as cause inconvenience to museum users	(Thomson, 1986)
<65dB	for non- residential buildings	(Department of Standard Malaysia, 2001)
<45 dB	Ideal values for museum's exhibition rooms and for several acoustical parameters	(Carvalho , Gonçalves, & Garcia, 2013)
90dB	Normal sound level for human	(OSHA, 2015)

2.7.3 Financial Performance

Apart from meeting occupant's requirements (how users perceived the building in meeting their needs and community development) and environmental requirements (such as energy and water efficiency), building performance may be evaluated for how the building performs financially through its economic sense (value for money or return of investment) (Leaman, Stevenson, & Bordass, 2010). Financial performance arises from the physical and functional performances of the building and comprises capital and recurrent (life-cycle) expenditures, depreciation, and efficiency of use etc. (Sapri & Pitt, 2005). It is imperative for historic buildings especially those conserved through the means of adaptive reuse which main aim is to revitalise and sustain old buildings through giving them a new life through their operational and economical facets (Langston, Wong, Hui, & Shen, 2008; Bullen & Love, 2011; Kamal & Ab Wahab, 2014).

Willingness-to-pay (WTP), an aspect of Contingency Valuation Method (CVM) used to reflect people evaluation of cultural heritage based on their consumerism preference should be considered to promote the sustainability of heritage sites (Kim, Kevin , & Cho, 2008; Choi , Ritchie , Papandrea, & Bennett, 2010; Dong, Zhang , Zhi, Zong, & Li, 2011; Noor Fazamimah , Anuar , & Yahaya, 2015). This is because, WTP can be meaningful in informing the return of investment for cultural heritage goods, typically valued through their consumption via entrance fees gained and conservation funds received (Beltran & Rojas, 1996). For historic buildings in Malaysia, return of investment is an important indicator of conservation success as the local conservation philosophy encompasses the twofold criteria of (Keromo, 2000):

i. To safeguard; to retain the authenticity of materials (type, colour and texture), architecture (construction technique and workmanship) and original use (function or type)

ii. To develop heritage; to utilise and leverage heritage for economic gains without forsaking its preservation and conservation

As the aspects of building performance that needs to be assessed depends on evaluation purposes (Khalil, Kamaruzzaman, & Baharum, 2016), the following aspects are reviewed for understanding the economic sense of museum organisations occupying historic building premises:

a) Operating Expense Ratio (OER)

There are few standard financial ratios used in business practice which can be leveraged as management tools to ascertain financial performance trends over time such as the Profitability Sustainability Ratio, Operating Expense Ratio (OER), Liquidity Ratio, Leverage Ratio etc. OER which is commonly used for financial analysis in the domain of property investment would be useful for museum organisations as it allows the comparison of total operating expenses with gross revenue annually. The calculation of OER assists investor to notice the property trends in terms of their operating expenses. A decreasing OER is desirable as it informs the property has been managed efficiently and is profitable due to lesser coverage of the property income onto the operational and maintenance costs. In contrast, annual increment of the OER signals that an investor may lose more money if he or she holds the property longer (Investopedia, LLC., 2014; DV, 2016).

b) Life-Cycle Costs (LCC)

For buildings, consideration on economic performance through its life-cycle costs (LCC) is required to determine cost-effectiveness and later influence strategic, tactical and operational decisions (Dorasol, Mohammad, Mohammed, Hamadan, & Nik Lah, 2012). Blanchard , Verma and Peterson (1995) reported that 50% to 80% of the total LCC is spent during in-service life. In this sense, building operation and maintenance phase of LCC is crucial and has major impact on building performance. NIBS (2009) described cost-effective building is the one that renders the lowest operating and maintenance costs, has the longest lifespan, encourage productivity among users and offer the greatest return on investment. Dorasol, Mohammad, Mohammed, Hamadan and Nik Lah (2012) added specifically that an efficient building is one that uses energy and water efficiently.

2.8 Summary

The available building evaluation tools such as BPE and POE for instances are apparently manoeuvred to the contexts of contemporary and occupied buildings, which performance typically judged through the end-users and environmental data. There is a knowledge gap in evaluating historic buildings which are culturally precious yet physically sensitive, especially to those which have been adapted to suit new functions. Adaptive reuse interventions necessitated certain alterations and adjustments to be made to the cultural fabric of historic building which can affect the much-required authenticity and integrity conditions. This chapter hence introduced PCE to address the gap raised, with special considerations on the contexts of adaptive reuse museums in the UNESCO Word Heritage sites of Malaysia.

This chapter reviewed literature on UNESCO World Heritage, adaptive reuse of historic buildings and IEQ performance related to museum trifold aspects to conceptually form the PCE criteria thus answering RQ 1: What are the criteria for evaluating the post-conservation impacts of adaptive reuse museums within the UNESCO World Heritage of Malaysia context? The literature findings on the relevant criteria for the conceptual PCE are summarised below:

i. UNESCO governs cultural places that have international significance which include heritage cities that dwell valuable historic buildings (Sodangi, Khamidi, & Idrus, 2013; Bernat, Janowski, Rzepa, Sobieraj, & Szulwic, 2014). Imperatively, the two conditions required by UNESCO for both qualification and retention of the World Heritage status are authenticity and integrity (UNESCO, 2005; Pendlebury, Short, & While, 2009; Nezhad, Eshrati, & Eshrati, 2016). Known to be equally important with the OUV, these two conditions however are reportedly difficult to be identified and maintained (Alberts & Hazen, 2010). Physical appropriateness can be evaluated by assessing authenticity and integrity conditions of adaptive reuse museums through physical interventions made at the building and the current building conditions respectively. Appropriateness refers to the extent of an activity/ programme is sanctioned by policies or requirements associated with an organisation or government (CeDRE International, 2014). Investigation on physical interventions can be done by adopting Ab Wahab's (2013) assessment on 16 building elements and the impact grading used by ICOMOS (2011), with reference to the NARA Documents on Authenticity, ICCROM's four criteria of authenticity and local guidelines. Inspection of building conditions meanwhile can be done by adopting the BCA system used by JKR with the consideration on the 10 most defective historic building elements in Malaysia as reported by Kamal and Ab Wahab (2014).

ii. The museum institution was made central in the current research following its significance in terms of social and educational importance, economic gains via tourism industry as well as its likewise role with the UNESCO World Heritage concept in preserving natural and cultural heritage (Museums and Galleries Foundation of NSW, 2004; Davies, Paton, & O'Sullivan, 2013; ICOM, 2013; Nazrin, 2014). Owing to the importance of the trifold aspects of building, collections and users for museums, the functionality concerning adaptive reuse museums thus lies in the ability of the building envelope to accommodate its collections and achieve users' (visitors and staff) comfort (Jaggs & Palmer, 2000; Museums and Galleries Foundation of NSW, 2004; Sapri & Pitt, 2005). In this regard, adaptive reuse museums need to comply with IEQ parameters that correspond with the protection of collections against external environment (Jaggs & Palmer, 2000; Ladkin, 2004) and the welfare of users against Sick Building Syndrome (Shuang, Kamaruzzaman, & Zulkifli, 2014; Khalil, Kamaruzzaman, & Baharum, 2016). Functional effectiveness can be evaluated by monitoring the building performance of adaptive reuse museums in providing the suitable IEQ for collections preservation and users' comfort. Effectiveness refers to the extent of the results of a programme can be contributed appropriately in meeting needs and solving problems (CeDRE International, 2014). In tune with that definition, converted buildings therefore should be functionally transformed to meet the specific museum functions and requirements (Desvallées & Mairesse, 2010). This can be done by monitoring significant IEQ parameters for museums as reported by various scholars such as Cassar (1994), Pavlogeorgatos (2003), Michalski (2004), Finney (2006), Sulaiman, Kamaruzzaman, Salleh and Mahbob (2011), and Abdul Karim, Talib and Sujak (2012) comprising thermal environment, lighting, indoor air quality and noise (acoustic). Imperatively, IEQ performance is central to the sustenance of the museum trifold aspects of building, collections and users.

iii. Conservation of built heritage has long been associated with the agenda of sustainability, in meeting the trifold environmental, social and economic dimensions (Feilden, 2000; Bullen P. , 2007; Godwin, 2011). In relation to that, the concept of adaptive reuse is essentially manoeuvred to foster in the financial resilience of historic buildings, through rejuvenation and prolongation of their physical and functional aspects respectively (Langston, Wong, Hui, & Shen, 2008; Bullen & Love, 2011; Kamal & Ab Wahab, 2014). Thus, the economic sense of adaptive reuse museums should be evaluated through their return of investment by reviewing their annual OER trends. This can shed the light on financial efficiency by reviewing the Operating Expense Ratio (OER) of adaptive reuse museums. OER basically indicates the annual patterns of expenditure (focusing on their life-cycle costs of operational use and building maintenance) over income and revenue. Efficiency refers to the extent of which activities or the desired effects are achieved with the lowest possible use of resources or inputs (National Centre of Sustainability, 2011). Imperatively, economic factor is one of the sustainability components.

For evaluating the post-conservation impacts of adaptive reuse museums, these evaluation criteria will be tested using case studies and then validated by conservation experts and stakeholders prior to its establishment and proposal for utilisation. Formation of the conceptual PCE framework based on these criteria are shown in Figure 2.21. The subsequent chapter expounds on methodological approaches to complement the evaluation criteria abovementioned.

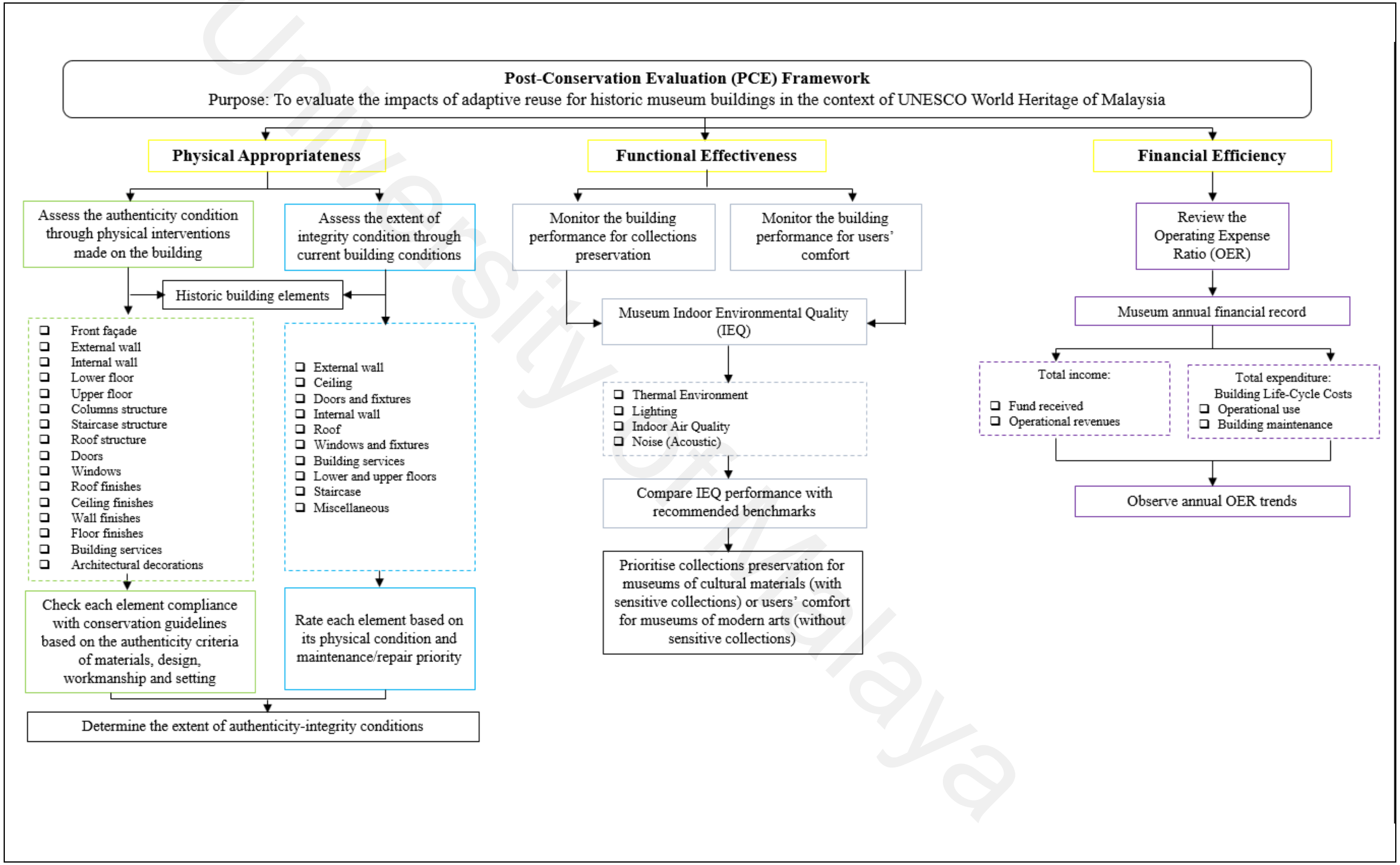


Figure 2.21: The conceptual PCE framework

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter enlightens on methodological aspects of the current research as illustrated in Figure 3.1. Case studies and validation were the two methodological aspects applied to accomplish the research aim in proposing the Post-Conservation Evaluation (PCE) framework specifically for adaptive reuse museums (in the UNESCO World Heritage of Malaysia context). The following sub-headings explains on the procedures and tools used to conduct:

i. Case studies comprising multi-method field works comprising field observation (investigation on physical interventions and inspection on building conditions), field measurement (monitoring of building performance on several IEQ parameters) and key informants survey (acquiring financial data from museum income and expenditure).
ii. Validation on the conceptual PCE framework (based on content and face validity tests) using Delphi survey involving experts and stakeholders

This chapter also touches on the ethical considerations of the current research.

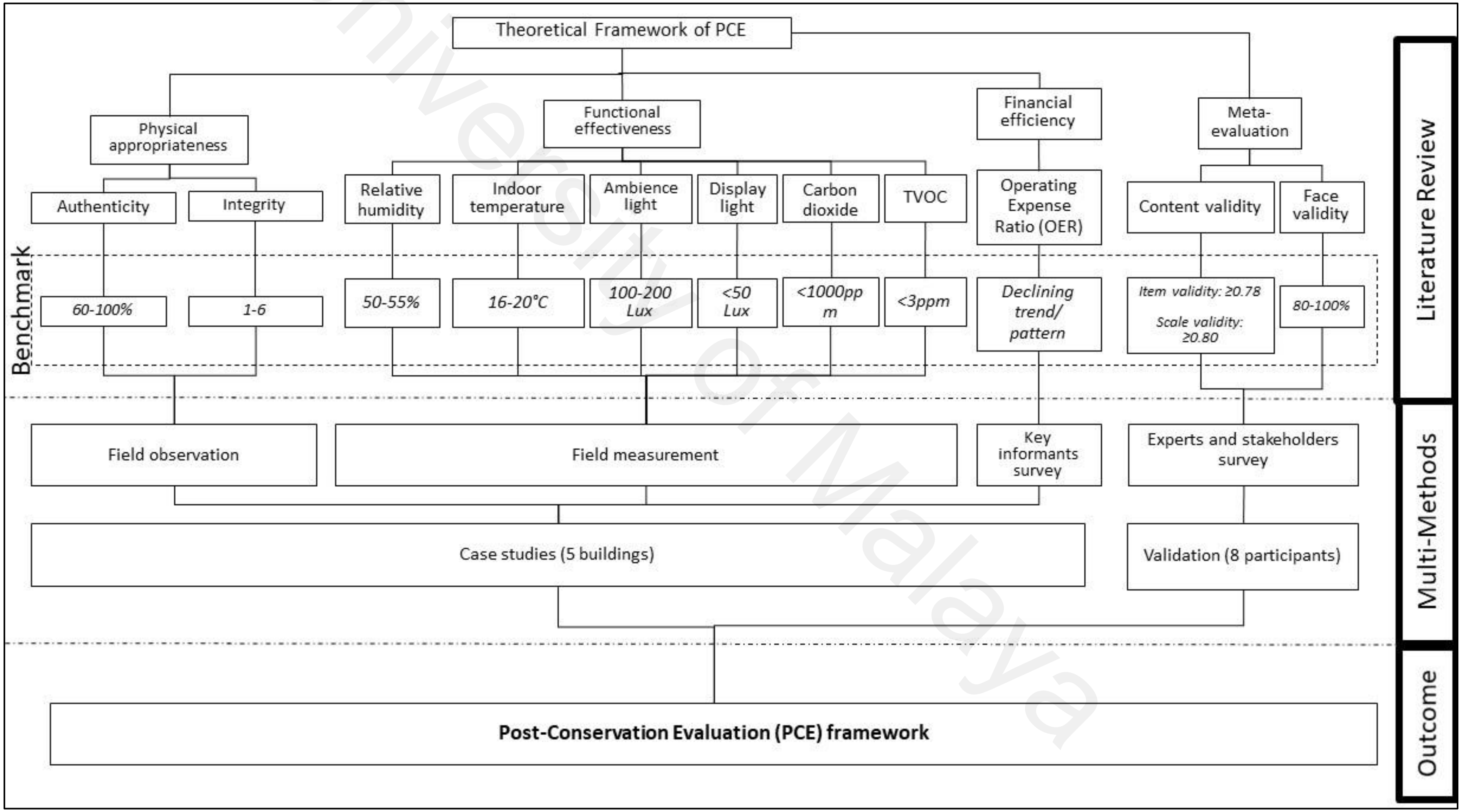


Figure 3.1: The research design

3.2 Case Studies

Case study approach was found advantageous for the current research which has varying evaluation needs and goals with reference to Eisenhardt (1989), Hamel (1993) and Maxwell (2005). Hence, case studies were used to test the workability of the theoretically derived PCE criteria through multi-method field works of field observation, field measurement and key informants survey. These field works would allow in the testing of the conceptual PCE framework operationally and empirically, by evaluating the post-conservation impacts of the adaptive reuse museums in terms of their physical appropriateness, functional effectiveness and financial efficiency.

Results yielded through the case studies would assist in understanding the ‘how and why’ of the phenomenon of interest as raised in RQ 2: How appropriate, effective and efficient are the post-conservation impacts of adaptive reuse museums in the UNESCO World Heritage of Malaysia? In this sense, the needs of the current research would be addressed through case study approach. Its methodological strength as mentioned in Yin (1989), Flyvbjerg (2004), Zainal (2007) and Løkke and Dissing Sørensen (2014) includes:

i. Valuable tool for testing theories
ii. Useful to accentuate reality through direct examination on real-life situation or phenomenon
iii. Triggers in-depth investigation on specific instances within the research subject
iv. Enables data examination to be performed within a specific, micro-level context
v. Allows multi-methods data collection

3.2.1 Procedures

Selection of buildings was done prior to conducting the field works. Field observation, field measurement and key informants survey then follow suit. The following sub-topics explain each procedure involved while conducting case studies.

a) Selection of Buildings

Firstly, an inventory of museums in Melaka and Penang was carried prior to select buildings for the case studies. Consequently, 61 museums were found available and operational in both states. The prevalent trend of adapting historic buildings to museums is testified as 27 out of the total 61 museum buildings were found to be adaptive reuse museums (equalling to 44% converted museums, amounting nearly half of the total percentage). The research locale was then narrowed down to George Town following to these rationales:

i. George Town is significant as the capital city to the state of Penang which has the highest number of historic buildings in Malaysia, followed by Perak, Johor and Melaka (Kamaruzzaman & Zulkifli, 2014).

ii. On the face value, very few studies have been done on private museums compared to public museums. Since there are many private museums in George Town, involvement of private museums in heritage and conservation research would be increased by focusing on the context of George Town.

Purposive sampling was then adopted to select museum buildings (for the case studies) that correspond with the research aim using these two criteria:

i. Location- Buildings within the demarcated Conservation Zone (Core Zone and Buffer Zone) of George Town)

ii. Conservation- Buildings of cultural, historical or architectural importance which have gone through adaptive reuse implementation

As a result, 14 out of the 29 museum buildings met the dual criteria. They were then approached individually using a formal protocol letter (Appendix A). Table 3.1 presents the building selection matrix comprising the dual selection criteria combined with the accessibility factor (consent granted by respective museum owners or managers as attached in Appendix B). The shortlisted museum buildings were also categorised into shophouse and non-shophouse following the emphasis made in the OUV criterion IV on this significant architectural type towards Melaka and George Town.

Table 3.1: Building selection matrix

Museums in Penang	Purposive Sampling Criteria: Location (within Core or Buffer Zone of George Town)	Purposive Sampling Criteria: Conservation (Status as Adaptive Reuse Historic Building)	Accessibility Factor (Consent Granted)	Building Category
1. The Camera Museum	Yes	Yes	No	Shophouse
2. Colonial Penang Museum	No	Yes	-	-
3. Sun Yat Sen Museum	Yes	Yes	Yes	Shophouse
4. PG Gold Museum	Yes	Yes	No	Non-shophouse
5. Teochew Puppet and Opera Museum	Yes	Yes	No	Shophouse
6. Batik Painting Museum	Yes	Yes	Yes	Shophouse
7. Penang 3D Trick Art Museum	Yes	Yes	No	Shophouse
8. Straits Chinese Jewelry Museum (Pinang Peranakan Mansion)	Yes	Yes	No	Non-shophouse
9. Penang State Museum	Yes	Yes	Yes	Non-shophouse
10. Penang State Museum 2	No	Yes	-	-
11. Penang War Museum	No	No	-	-
12. Tuanku Fauziah Museum and Art Gallery	No	No	-	-
13. Upside Down Museum	Yes	Yes	No	Shophouse
14. Wax Museum + Toy Museum + Museum of Bags and Collectibles + Heritage Garden	No	No	-	-
15. Penang Ghost Museum	Yes	Yes	No	Shophouse
16. History Museum (Pinaon Time Tunnel)	Yes	Yes	No	Non-shophouse
17. I-Box Museum Glass	Yes	No	-	-
18. Wonderfood Museum	Yes	Yes	No	Non-shophouse
19. Made in Penang Interactive Museum	Yes	Yes	Yes	Non-shophouse
20. Asia Camera Museum	Yes	No	-	-
21. The Owl Museum	No	No	-	-
22. Dark Mansion - 3D Glow in The Dark Museum	Yes	Yes	Yes	Shophouse
23. Asia Comic Cultural Museum	No	No	-	-
24. One East Museum	No	No	-	-
25. Teddy Ville Museum	No	No	-	-
26. Penang Forestry Museum	No	No	-	-
27. My Cristal Museum	No	No	-	-
28. Chocolate and Coffee Museum	Yes	No	-	-
29. Malaysia Civil Defense Force Museum	No	No	-	-

Accordingly, five buildings were selected as case studies, they are the Penang State Museum (PSM), Made in Penang Interactive Museum (MIPIM), Sun Yat Sen Museum (SYSM), Batik Painting Museum (BPM) and Dark Mansion-3D Glow in the Dark Museum (DM). Each of their detailed background is presented in Chapter Four. The field works at the case studies were carried out from November 2016 until January 2017. The period was significant since there were active number of visitors visiting the museums compared to other months following the year-end school holidays. This period typically marks the peak season for local tourism activities in the Malaysian calendar (Tourism Malaysia, 2016). Table 3.2 presents the data collection period for the field works conducted for the case studies:

Table 3.2: Data collection period for field works

Case Studies	Date of Data Collection
1. PSM	03rd November 2016 – 09th November 2016
2. SYSM	06th December 2016 – 12th December 2016
3. BPM	14th December – 23rd December 2016 (extended period due to BPM closure on 19th, 20th and 21st December 2016)
4. MIPIM	24th December – 30th December 2016
5. DM	31st December 2016 – 06th January 2017

b) Field Observation

Field observation was conducted through investigating physical interventions (to evaluate building authenticity) and inspecting current building conditions (to evaluate building integrity). In the case where building plans and drawings were unavailable, measurement work using measuring tape and sketches were done on-site and later transformed to digital files using Google Sketchup software.

i. Investigation on Physical Interventions

Walkthrough observation was conducted to investigate the physical interventions which were done on individual building elements that can collectively reflect the whole building authenticity. The 16 building elements considered by Ab Wahab (2013) were used as parameters. Those elements were investigated individually, based on their sequence from parameters A to P as listed in Table 3.8. During this stage, visual and textual data were recorded in the observation form as shown in Figure 3.11. Inputs from respective museum owners and staff who were knowledgeable and familiar with their respective museum building were recorded and acknowledged. Information leaflets on historic buildings in Penang were also referred for further guidance.

Upon completion of data collection, the sets of data obtained from the investigation of physical interventions were brought to a mini-focus group discussion (FGD) session for analysis purposes. The current researcher acted as the moderator in the mini-FGD conducted. Three out of seven invited participants (Penang-based experts in the field of built heritage conservation) showed up and took part in the session. Mini-FGD is best conducted within a small group of participants with homogeneous expertise and background (Krueger, 1994). In this case, the expert participants selected were familiar and some used to be involved directly with the case studies.

The mini-FGD session was started with describing the objectives to evaluate authenticity and integrity of the case studies. To support the objectives, a short briefing was presented to the participants on the NARA Document of Authenticity, ICCROM's criteria of authenticity and the MBPP's Guidelines for the Conservation Areas and Heritage Building. This is important to reinforce their familiarity on those doctrines, which also served as the basis of their judgements.

Two scoring methods were introduced to the participants as following:

- The dichotomy of Yes (for authentic elements/ appropriate interventions) and No (for inauthentic elements/ inappropriate interventions) for evaluating individual building elements. This required the participants to provide their judgement on the authenticity of each building element recorded in the observation form as exemplified in Figure 3.2. Data obtained from observation on the 16 building elements were then computed to derive the authenticity percentage, based on consensus in the sense of importance for structural elements and intrusiveness of interventions.


Building Services (O)

Observation Photo	Description
	The air conditioner compressors have been placed at PSM front façade with few other units located around the building perimeter. This scenario violated the aspect of the guideline which prohibited installation of air conditioners to be visible from the external view.
	A cylinder-shaped ventilation duct spans across PSM wedding chamber room. This installation is intrusive to the historic building fabric.
Authenticity Remark	
No	

Figure 3.2: Screenshot on the data entry made on observation form for physical interventions

- The five-point scale of impact grading on built heritage derived from ICOMOS (2011) as presented in Table 3.3. Authenticity percentage derived earlier was used as a guidance to conclude the overall extent of authenticity condition for the building assessed. However, in this stage, the focus was more on the impact of changes of the buildings rather than the number of changes. Consensus from the participants in judging the overall building authenticity (with rationale) was imperative at this point. Their theoretical knowledge and practical expertise as well as awareness on the conservation doctrines were leveraged at this stage.

Table 3.3: Scale on impact grading used to indicate authenticity condition (ICOMOS, 2011)

Impact Grading	**Built Heritage Attributes**
Major	Change to key historic building elements that contribute to OUV such that the resource is totally altered. Comprehensive changes to the setting.
Moderate	Changes to many key historic building elements, such that the resource is significantly modified. Changes to the setting of an historic building, such that it is significantly modified.
Minor	Change to key historic building elements, such that the asset is slightly different. Change to setting of an historic building, such that it is noticeably changed.
Negligible	Slight changes to historic building elements or setting that hardly affect it.
No change	No change to fabric or setting.

ii. Inspection on Building Conditions

Walkthrough observation was carried out to inspect each the current conditions of building elements that can collectively reflect the whole building integrity. The 10 building elements considered by Kamal and Ab Wahab (2014) were used as parameters. Those elements were inspected individually, based on their sequence from parameters A to J as listed in Table 3.8. During this stage, visual and textual data were recorded in the observation form as shown in Figure 3.12. Data entry into computer was made instantly on-site to avoid missing and confusing information, upon completing inspection on each building parameter.

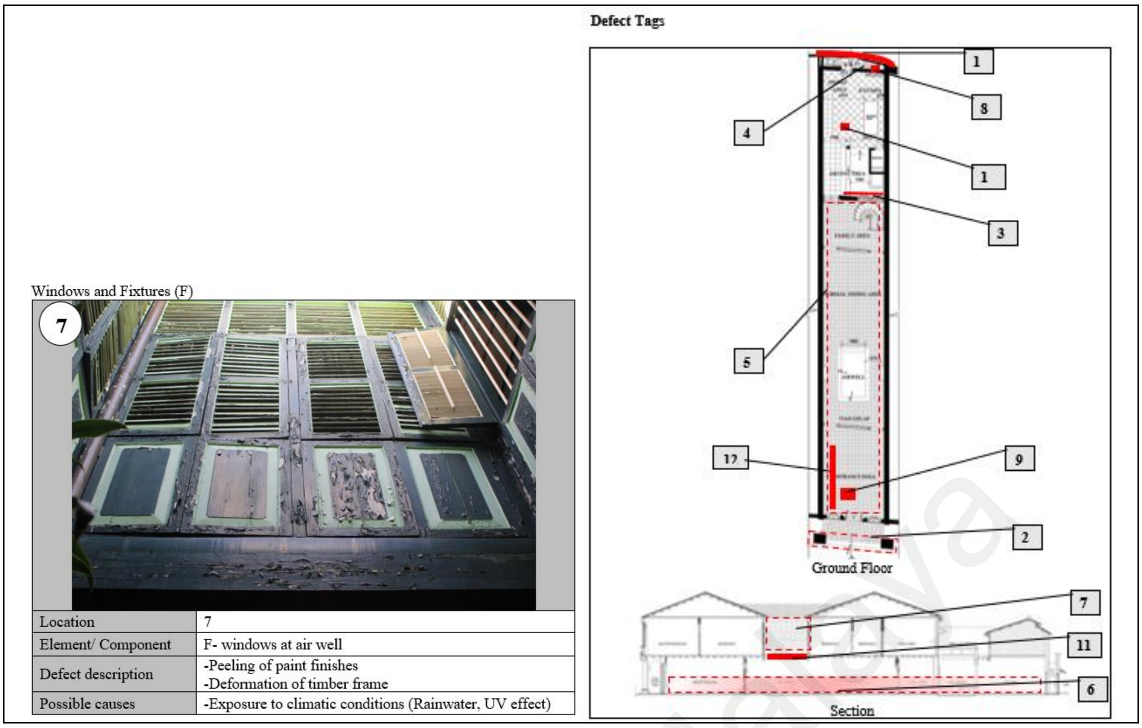


Figure 3.3: Screenshot on the data entry and defect tags made on observation form for building conditions

Data analysis on the building conditions were made subsequently after the analysis on building authenticity performed during the same mini-FGD session. Inputs gained from the expert participants were recorded and analysed based on the BCA system which consists of:

(a) Condition Assessment= based on physical conditions of building elements

(b) Priority Assessment= based on priority of maintenance or remedial works required

(c) Matrix Analysis = (a) X (b)

(d) Total Marks = ∑ of (c)

(e) ∑ No. of Defects (affected building elements)

Total Score = (d)/ (e)

Based on the BCA system, ratings on each building element were made on twofold aspects namely (a) condition assessment and (b) priority assessment. The FGD participants were required to describe the types of defects and their possible causes shown in the observation form used. They were then required to rate the cases based on consensus, with awareness on the totality of each building element and their relationships with immediate surroundings. Table 3.4 shows the two five-point numerical scales used for condition assessment and priority assessment, with their respective linguistic values:

Table 3.4: The matrix of BCA System and its linguistic values (PWD, 2013)

Matrix Scale		**Priority Assessment (b)**				
		5- Replacement	4- Rehabilitation	3- Repairs	2- Routine	1- Normal
Condition Assessment (a)	5- Very Poor	25	20	15	10	5
	4- Poor	20	16	12	8	4
	3- Fair	15	12	9	6	3
	2- Good	10	8	6	4	2
	1-Very Good	5	4	3	2	1

Linguistic Value		
Condition Assessment (a)	Very Good	As new, no defect, performing as intended
	Good	Minor defect, good condition, performing as intended
	Fair	Major defect, moderate condition, still can functioning with supervision
	Poor	Major or minor defect, not functioning as agreed service level
	Very Poor	Major or minor defect, critical, not functioning as agreed service level Very critical, not functioning, risky to safety and health
Priority Assessment (b)	Normal	No defect or damages, element/ component well maintained
	Routine	Minor defects/ damages, needs for monitoring, repairs, replaced to prevent serious defect/damages
	Repairs	Major defects/ damages, needs for major repairs and replacement
	Rehabilitation	Critical/ serious defects/ damages, needs for urgent and immediate repairs
	Replacement	Critical/ serious defects/ damages, needs for urgent replacement, refer to expert detail inspection/ expert judgement

After the ratings of (a) and (b) completed by the participants, the matrix analysis score (c) which values range from one to 25 as assigned with the five different colours presented in Table 3.4 was then determined. Then, summation of (c) for all the 10 parameters was made to derive total marks (d). The number of affected parameters meanwhile was summed and labelled as (e). Then, (d) was divided with (e) to gain the Total Score which indicates the overall integrity condition of the building as presented in Table 3.5 (the lower the Total Score basically indicates a better integrity condition of the building):

Table 3.5: Scales on building conditions used to indicate integrity condition (PWD, 2013)

Rating	Physical Condition	Action Matrix	Total Score
A	Very Good	Preventive Maintenance	1 to 5
B	Good	Condition-Based Maintenance	6 to 10
C	Fair	Repairs	11 to 15
D	Poor	Rehabilitation	16 to 20
E	Very Poor	Replacement	21 to 25

Both results obtained from the investigation of physical interventions (authenticity condition) and inspection of building conditions (integrity condition) were then colligated quantitatively, using representative score as shown in Table 3.6. To conclude on the extent of authenticity-integrity conditions, the representative scores for the two aspects (authenticity and integrity) were then summed up.

Table 3.6: Authenticity-integrity scales and their representative numerical scores

	Authenticity	Integrity	Representative Score
Scale	Major	Very poor	-2
	Moderate	Poor	-1
	Minor	Fair	0
	Negligible	Good	1
	No change	Very good	2

Table 3.7: The comparative scale indicating the extent of physical appropriateness

INAPROPPRIATE					APPROPRIATE			
-4	-3	-2	-1	0	1	2	3	4

Based on the summative value yielded, comparative scale in Table 3.7 was then used to indicate the extent of physical appropriateness. For instance, if a building obtained Major for its authenticity condition and Good for its integrity condition, the calculation would be: (-2) + (1) = -1, thus indicating that the building is inappropriate in terms of its physical post-conservation impact. In the case where the summative value yielded is zero (0), it means neutrality of the building in terms of its physical post-conservation impact.

Table 3.8: Field observation methodological summary

<table>
<tr><th>Evaluation Criteria</th><td colspan="2">Appropriateness of the physical impact on historic building after adaptation to museum</td></tr>
<tr><th>Scope</th><td>Building authenticity condition</td><td>Building integrity condition</td></tr>
<tr><th>Indicators</th><td>Physical interventions made at 16 elements of historic buildings (Ab Wahab, 2013)</td><td>Current building conditions based on 10 most defective elements of Malaysian historic buildings (Kamal & Ab Wahab, 2014)</td></tr>
<tr><th>Parameters</th><td>A. Front façade
B. External wall
C. Internal wall
D. Lower floor
E. Upper floor
F. Columns structure
G. Staircase structure
H. Roof structure
I. Doors
J. Windows
K. Roof finishes
L. Ceiling finishes
M. Wall finishes
N. Floor finishes
O. Building services
P. Architectural decorations</td><td>A. External wall
B. Ceiling
C. Doors and fixtures
D. Internal wall
E. Roof
F. Windows and fixtures
G. Building services
H. Lower and upper floors
I. Staircase
J. Miscellaneous</td></tr>
<tr><th>Tools and Judgement Basis</th><td>Observation form to assess each building element compliance with the NARA Document of Authenticity 1994, ICCROM 1982 and relevant local acts and guidelines</td><td>Observation form to assess each building element current conditions based on the BCA system (PWD, 2013)</td></tr>
<tr><th>Measurement Scales/ Ratings</th><td>Major
Moderate
Minor
Negligible
No change</td><td>Very Good
Good
Fair
Poor
Very Poor</td></tr>
<tr><th>Evaluation Basis on Physical Appropriateness</th><td colspan="2">Colligation on the results of physical interventions and building conditions quantitatively via summation of representative score and reference to comparative scale to determine the extent of authenticity-integrity conditions</td></tr>
</table>

c) Field Measurement

Field measurement was conducted by assessing building performance of the adaptive reuse museums, specifically by monitoring on the IEQ parameters of:

i. Thermal environment (relative humidity and indoor temperature levels)
ii. Lighting (ambience and display light intensities)
iii. Indoor air quality (CO_2 and TVOC concentrations)

Firstly, identification and selection of the compatible monitoring tools were made. Official application for lending the required tools was done at the Environmental Lab, Faculty of Built Environment, University of Malaya. Monitoring tools acquired then were checked to ensure their functionality, accuracy and software compatibility (synchronisation with computer for data uploading purposes).

i. Monitoring Thermal Environment Levels (Relative Humidity and Indoor Temperature) and Ambience Light Intensity

Three units of HOBO U12 Temp/RH/ Light External Data Logger were used for assessing relative humidity, indoor temperature and ambience light. Configuration was made on the tools to log data every five-minutes' intervals, continuously for one-week period. The tools were placed at three different sampling spots in the museums with each marked with X, Y and Z label. They were located within areas or spaces containing museum collections, covering both lower and upper floors where applicable. As shown in Figure 3.4, placement of the tools was made at least at 1.5m height above floor level to obtain proper reading based on human anthropometric, similar to Chung and Ossen's (2012) and Kamaruzzaman and Zulkifli's (2014) approach. After one-week period, the tools were recollected for data transfers into computer. Figure 3.5 shows the typical results generated from the HOBO U12 Temp/RH/ Light External Data Logger.

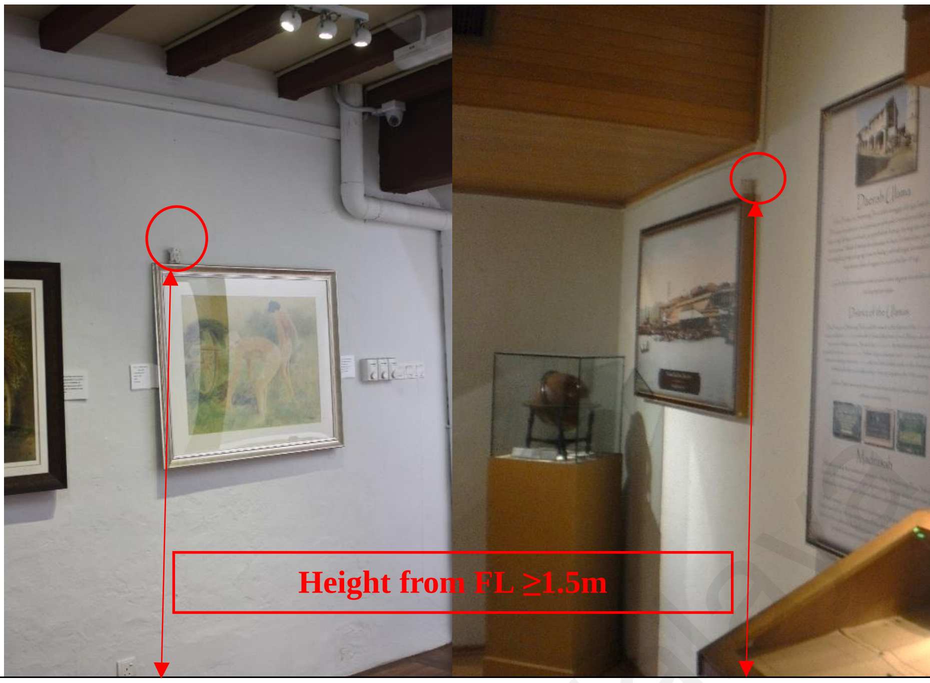


Figure 3.4: Placement of HOBO U12 External Data Logger at BPM (left) and PSM (right)

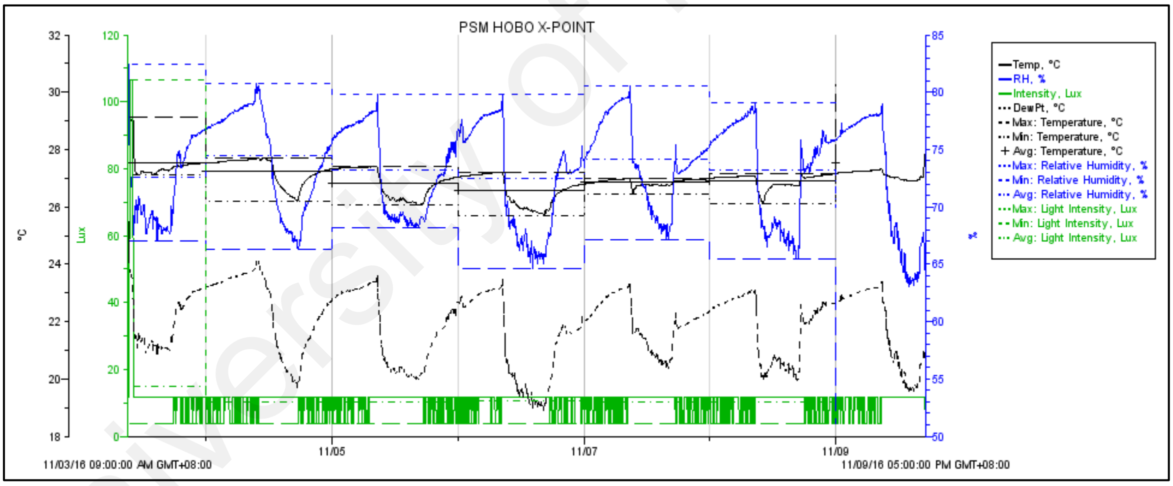


Figure 3.5: A typical results generated from the HOBO U12 Temp/RH/ Light External Data Logger

ii. Monitoring Display Light Intensity

Two units of the TENMARS Data Logger Light Meter TM-203, with each marked with X and Y label, were used for assessing display light. The tools were configured to log data for every five-minutes' intervals, beginning at the museums' opening hours until their closing time (typically around 9 am to 5 pm) for one-week duration. As shown in

Figure 3.6, the tools were then placed at sensitive collections, facing directly towards light source for the museums of cultural materials namely PSM, SYSM and BPM which housed sensitive collections. Meanwhile for museums of modern arts namely MIPIM and DM that did not possess any sensitive collections, the tools were placed at exhibition areas containing less or medium sensitive collections. Figure 3.7 exemplifies the typical results generated from the TENMARS Data Logger Light Meter TM-203:

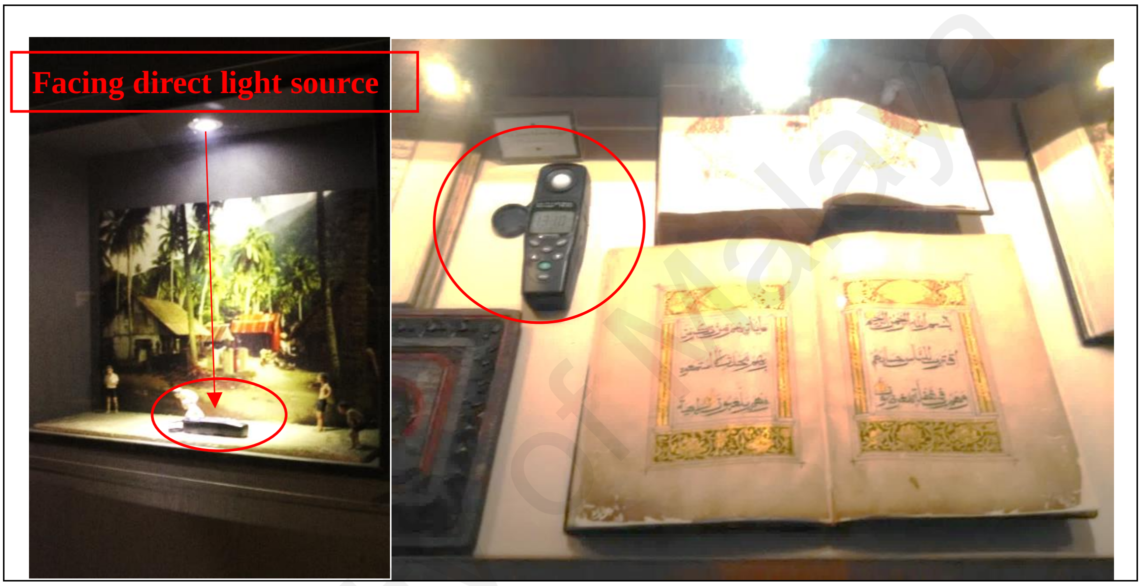
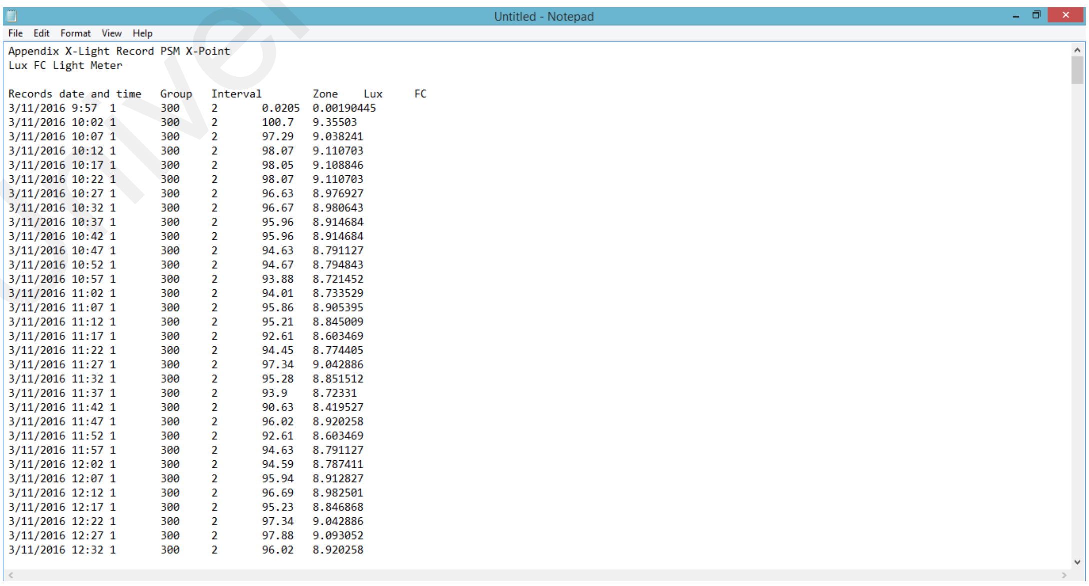


Figure 3.6: Placement of TENMARS Light Meter inside the display's showcase cabinet at MIPIM (left) and PSM (right)


Untitled - Notepad
File Edit Format View Help

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Appendix X-Light Record PSM X-Point
Lux FC Light Meter

Records date and time   Group   Interval        Zone    Lux     FC
3/11/2016 9:57  1       300     2       0.0205  0.00190445
3/11/2016 10:02 1       300     2       100.7   9.35503
3/11/2016 10:07 1       300     2       97.29   9.038241
3/11/2016 10:12 1       300     2       98.07   9.110703
3/11/2016 10:17 1       300     2       98.05   9.108846
3/11/2016 10:22 1       300     2       98.07   9.110703
3/11/2016 10:27 1       300     2       96.63   8.976927
3/11/2016 10:32 1       300     2       96.67   8.980643
3/11/2016 10:37 1       300     2       95.96   8.914684
3/11/2016 10:42 1       300     2       95.96   8.914684
3/11/2016 10:47 1       300     2       94.63   8.791127
3/11/2016 10:52 1       300     2       94.67   8.794843
3/11/2016 10:57 1       300     2       93.88   8.721452
3/11/2016 11:02 1       300     2       94.01   8.733529
3/11/2016 11:07 1       300     2       95.86   8.905395
3/11/2016 11:12 1       300     2       95.21   8.845009
3/11/2016 11:17 1       300     2       92.61   8.603469
3/11/2016 11:22 1       300     2       94.45   8.774405
3/11/2016 11:27 1       300     2       97.34   9.042886
3/11/2016 11:32 1       300     2       95.28   8.851512
3/11/2016 11:37 1       300     2       93.9    8.72331
3/11/2016 11:42 1       300     2       90.63   8.419527
3/11/2016 11:47 1       300     2       96.02   8.920258
3/11/2016 11:52 1       300     2       92.61   8.603469
3/11/2016 11:57 1       300     2       94.63   8.791127
3/11/2016 12:02 1       300     2       94.59   8.787411
3/11/2016 12:07 1       300     2       95.94   8.912827
3/11/2016 12:12 1       300     2       96.69   8.982501
3/11/2016 12:17 1       300     2       95.23   8.846868
3/11/2016 12:22 1       300     2       97.34   9.042886
3/11/2016 12:27 1       300     2       97.88   9.093052
3/11/2016 12:32 1       300     2       96.02   8.920258
```

Figure 3.7: Screenshot on the typical results generated from the TENMARS Data Logger Light Meter TM-203

iii. Monitoring Indoor Air Quality Concentrations (CO2 and TVOC)

One unit of Portable CO_2. TVOC Pressure Meter 98132J was used for assessing indoor air quality. The tool was set-up on top of a mini tripod and placed near to electrical point available in the museums, following the manufacturer's suggestion to use direct power source instead of relying on batteries usage. Configuration to log data for every five-minutes' intervals, starting from the museums' opening hour until their closing time (typically around 9 am to 5 pm) for one-week duration was made to the tool. As shown in Figure 3.8, the tool was positioned to face museum visitors, at the height of breathing zone approximately 110 cm similar to approach used by Prihatmanti and Bahauddin (2014), following humans are the prime source of CO_2 within an indoor environment (Kong, 2014). Figure 3.9 shows the typical results generated from the Portable CO_2. TVOC Pressure Meter 98132J.

Figure 3.8: Placement of Portable CO^2. TVOC Pressure Meter 98132J at BPM (left) and MIPIM (right)

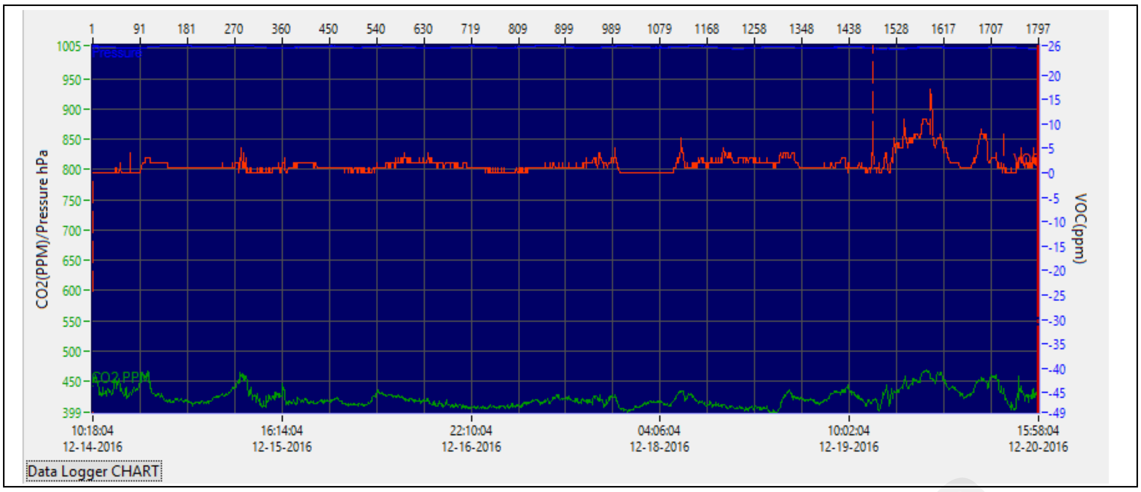


Figure 3.9: A typical results generated from the Portable CO_2. TVOC Pressure Meter

Upon completion of one-week data logging period at each museum involved, data recorded on all the tools used were then uploaded into computer for analysis purposes. The data files were transformed to Microsoft Excel spreadsheet and computed based on descriptive statistics to ascertain their average readings (mean relative humidity, mean temperature, mean intensity and mean concentration). These values were then compared with respective performance benchmarks as tabulated in Table 3.9:

Table 3.9: The performance benchmarks selected for museum IEQ parameters

IEQ Parameters		Standard Recommendations/ Threshold Limit Values	
		Collections Preservation	**Users' Comfort**
Thermal Environment	Relative humidity (%)	50-55% (Padfield, 1994)	60-70 % (Department of Standard Malaysia, 2007)
	Indoor temperature (°C)	16-20 °C (Ambrose & Paine, 2006)	23-26 °C (Department of Standard Malaysia, 2007)
Lighting	Ambience lighting (lux)	-	100-200 lux (Michalski, 2004)
	Display lighting (lux)	<50 lux (Finney, 2006)	-
Indoor Air Quality	CO_2 concentration (ppm)	-	<1000 ppm (Ramalho, et al., 2015)
	TVOC concentration (ppm)	-	3 ppm (DOSH, 2010)

The basis of evaluation to conclude functional effectiveness was based upon the compliance of IEQ performance to its respective performance benchmark. Prioritisation towards meeting either the demands of collection preservation or users' comfort was set to be dependent upon the museum category (museum of cultural materials or museum of modern arts). In this manner, museums of cultural materials (with sensitive collections) must prioritise the demand for collection preservation whereas museums of modern arts (without sensitive collections) must prioritise the demand of users' comfort.

Table 3.10: Field measurement methodological summary

Evaluation Criteria	Effectiveness of the functional impact on historic building after adaptation to museum				
Scope	Building Performance				
Indicator	Indoor Environmental Quality (IEQ)				
Parameters	Thermal Environment		Lighting		Indoor air quality
	Relative humidity level	Indoor temperature level	Ambience light level	Display light level	CO_2 and TVOC concentration
Measurement Units	Percentage (%)	Celsius (°C)	Intensity (lux)	Intensity (lux)	Parts Per Million (ppm)
Tools	HOBO U12 Temp/RH/ Light External Data Logger			TENMARS Data Logger Light Meter TM-203	MIC Portable CO^2. TVOC Pressure Meter 98132J
Quantity of Tools Used	3			2	1
Data Monitoring and Recording (Duration and Frequency)	A continuous period of one-week starting from museums' operational hour on day one to museums' closing hour on day seven			During museums' daily operational hours for a period of one-week	During museums' daily operational hours for a period of one-week
Evaluation Basis on Functional Effectiveness	Prioritisation of IEQ compliance to the performance benchmark based on the museum respective category (museum of cultural materials or museum of modern arts) and its collection types (with sensitive collections or without sensitive collections)				

d) Key Informants Survey

Survey of museum key informants was done to gain feedback on financial performance. In acquiring the financial performance data regarding the museum income and expenditure, the form shown in Figure 3.13 was personally explained then submitted to the respective museum key informants during the first day of research trip. Further instructions and follow-ups on the required information was occasionally made to them via phone calls, text messages and emails. This was deemed important in ensuring their understanding on the purpose of the survey, carrying the specific objective of yielding the OER pattern. The survey form submitted was then recollected upon feedback completion by the museum key informants for analysis purpose. To yield the OER, the sum of museum expenditure was divided with the sum of museum income for each operational year. The annual OER pattern then was observed to understand financial efficiency. Declining annual OER trend indicates the property (or building) attained higher income over expenditure (financially efficient) and vice versa.

3.2.2 Tools

Several research tools as shown in Figure 3.10 to Figure 3.13 were utilised to conduct field works through case studies:

(A) (B)

(C) (D)

Figure 3.10: Tools used. (A) Canon EOS 60D. (B) HOBO U12 Temp/RH/ Light External Data Logger. (C) TENMARS Data Logger Light Meter TM-203. (D) Portable CO². TVOC Pressure Meter 98132J.

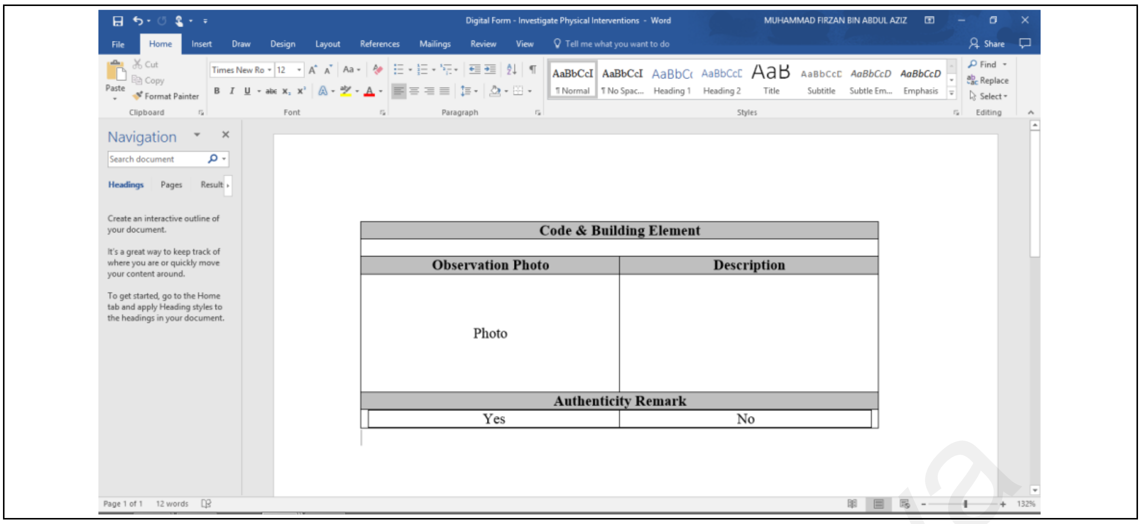


Figure 3.11: Screenshot of the observation form used to investigate physical interventions

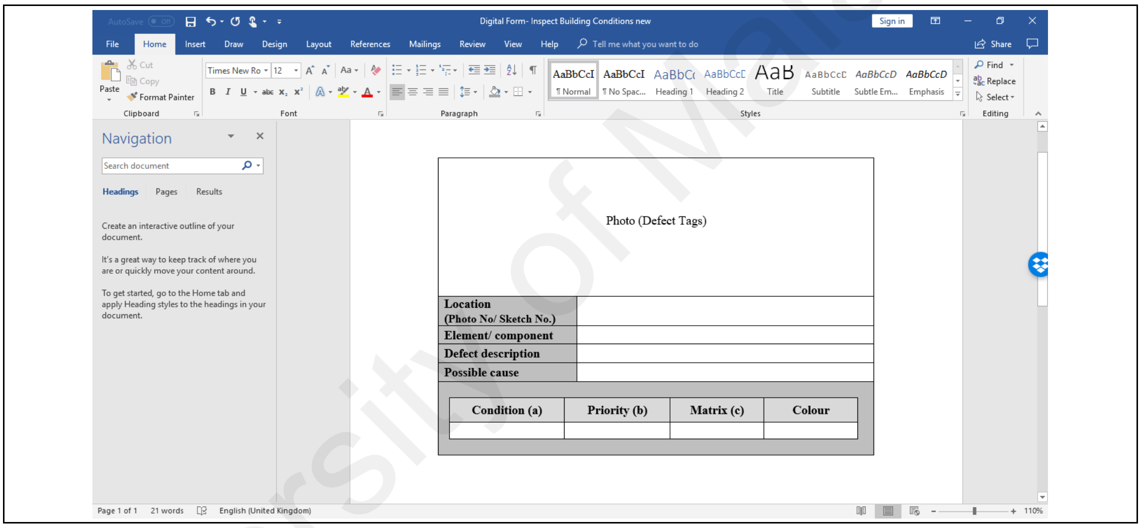


Figure 3.12: Screenshot of the observation form used to inspect building conditions

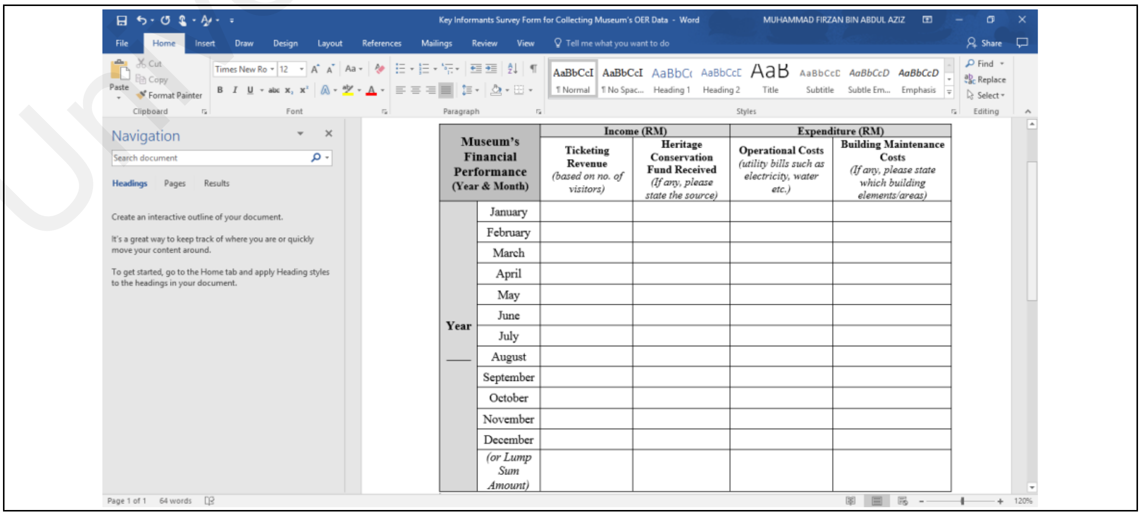


Figure 3.13: Screenshot of the key informants survey form to collect data on financial performance

For field observation, a digital single-lens reflex (DSLR) camera (Canon EOS 60D) as shown in Figure 3.10(A) was used to capture visual data with the aim to attain high resolution and quality photos. Besides that, two observation forms as shown in Figure 3.11 and Figure 3.12 (each for investigating physical interventions and inspecting building conditions respectively) were used to record field observation data systematically, on-site. Both forms basically contain the sections for inserting textual and visual information.

For field measurement, three units of HOBO U12 Temp/RH/ Light External Data Logger as shown in Figure 3.10(B) were used to monitor and assess the thermal environment and ambience lighting within the case studies. Manufactured by Onset Computer Corporation, these loggers are small plastic boxes (58 X 74 X 22 mm) weighted at 46 g each containing sensors and memory chip with necessary electronics and power source (that can be connected to computer for measurement setting and data downloading purposes). By specification, the tool can log relative humidity data from the range of 5% to 95%, temperature data from the range of -20°C to 70°C and light intensity from the range of 10.76 lux to 32280 lux. The tools were last calibrated in April 2012 (prior to purchase made) yet they still work within the acceptable accuracy of ±2.5% (from 10% to 90%) for relative humidity and ±0.35°C (from 0°C to 50°C) for temperature.

Also, two units of TENMARS Data Logger Light Meter TM-203 as shown in Figure 3.10(C) were used to monitor and assess display lighting. The tool's sensor is made of Silicon Photodiode and capable to measure all visible light sources. Readings were shown through its LCD display using Lux and foot candle units. Each unit of the tool dimensions are 38 X 55 X 172 mm and weighted at 250 g (including a 9V battery). By specification, the tool can measure up to 2000 Lux light intensity. The light meters can be self-calibrated to reached 0.00 Lux with the sensor lid closed, with the accuracy of

±3% to standard incandescent lamp and 6% to other visible light sources based on the manufacturer's instruction.

Apart from that, a Portable CO_2. TVOC Pressure Meter 98132J as shown in Figure 3.10(D) was used to log data on the level of CO_2 and TVOC concentrations. This 160 X 60 X 40 mm pressure meter tool can detect TVOC gasses such as Ammonia, Toluene, Ethanol, and Air Hydrogen Sulphide and has a screen with triple display and a sensor on top it. The tool's power requirements include either electrical energy (through its AC/DC adaptor) or six pieces of AAA-sized batteries. As written in the manufacturer's manual by Meter Industrial Company (MIC), this pressure meter measuring range for CO_2 is from 0 to 9,999 ppm whereas for TVOC is from 0 to 50 ppm. This tool has long-life sensors calibrated by the manufacturer prior to each purchase shipment (the tool used was purchased by the Faculty of Built Environment, University of Malaya around February 2016). Figure 3.14 to Figure 3.18 meanwhile indicate the placements of all the research tools used during field measurement within all the museums involved.

Figure 3.14: Placement of the research tools at ground floor (top) and first floor (bottom) of PSM

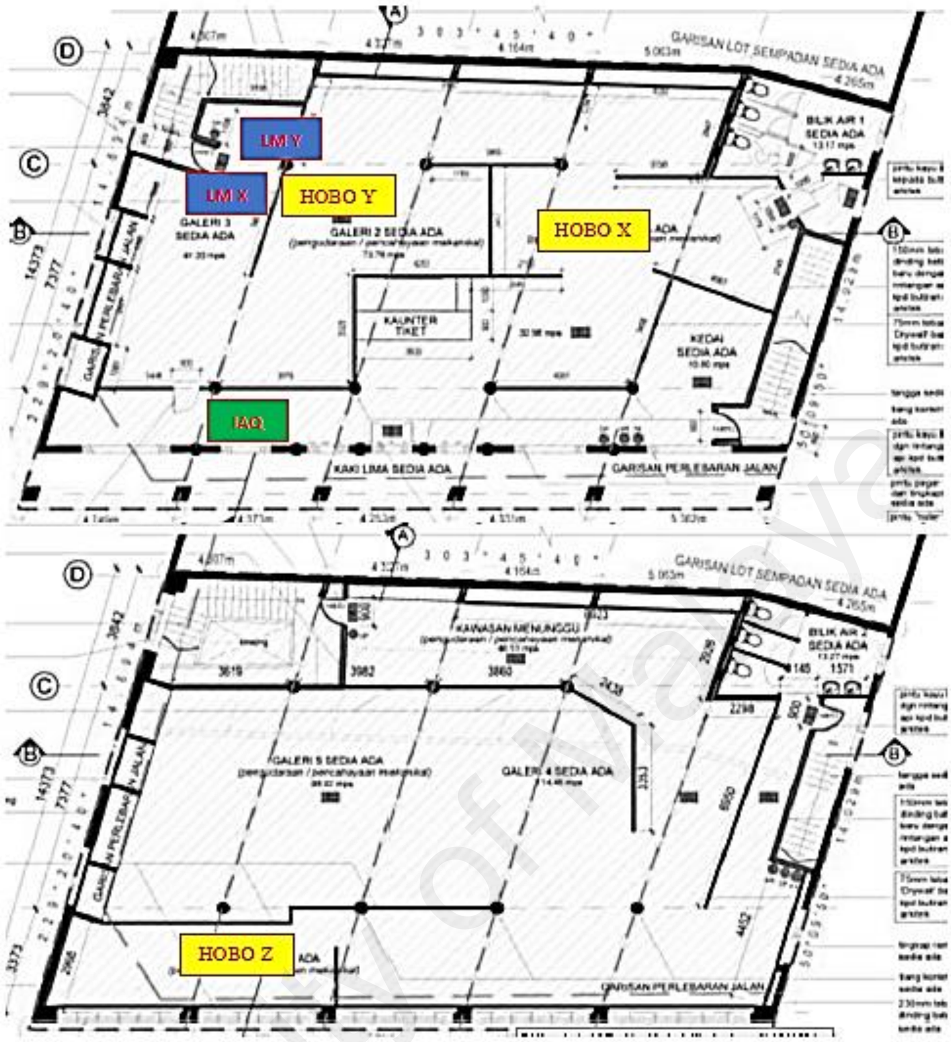


Figure 3.15: Placement of the research tools at ground floor (top left), mezzanine floor (top right) and first floor (bottom) of MIPIM

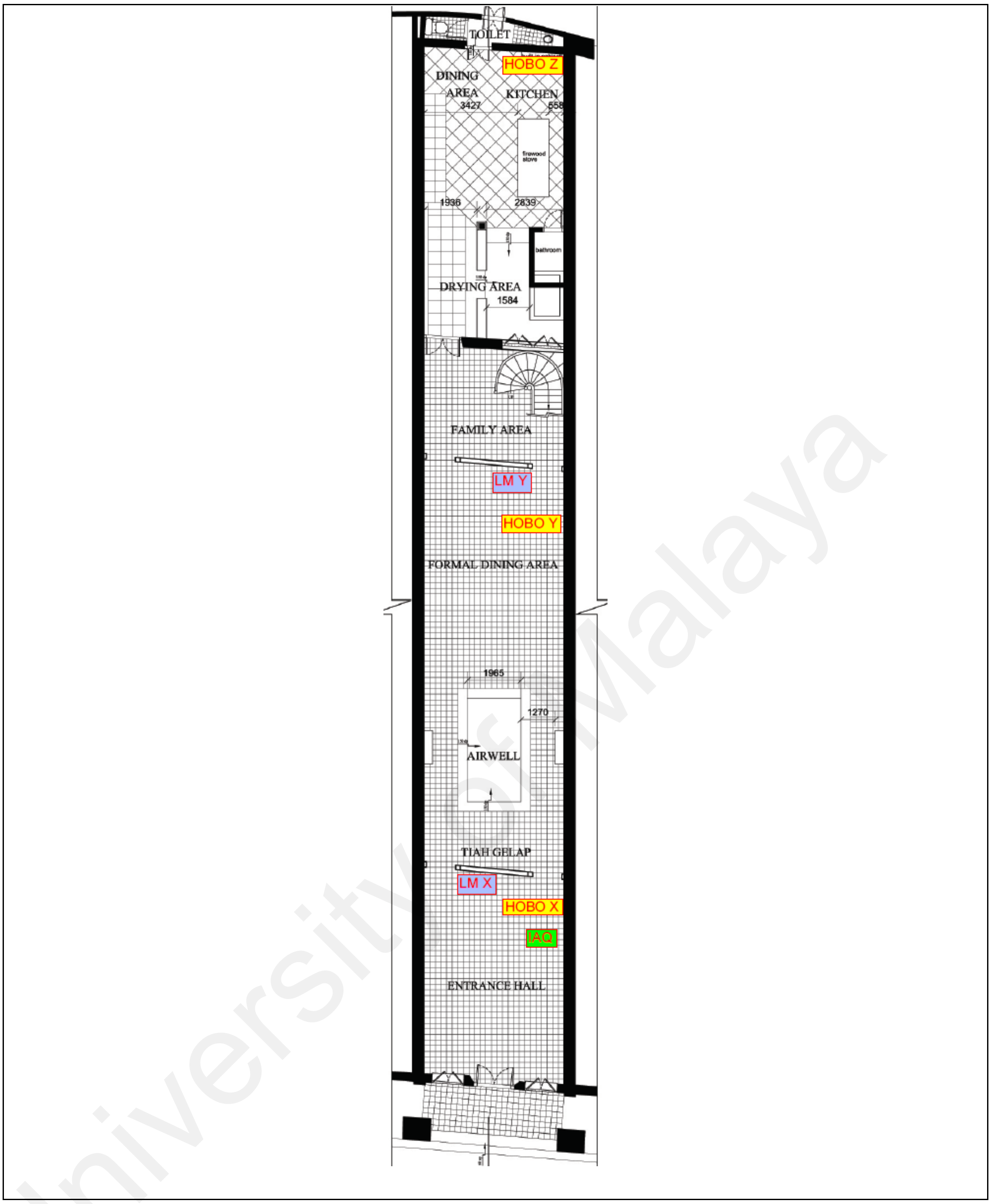


Figure 3.16: Placement of the research tools at ground floor of SYSM

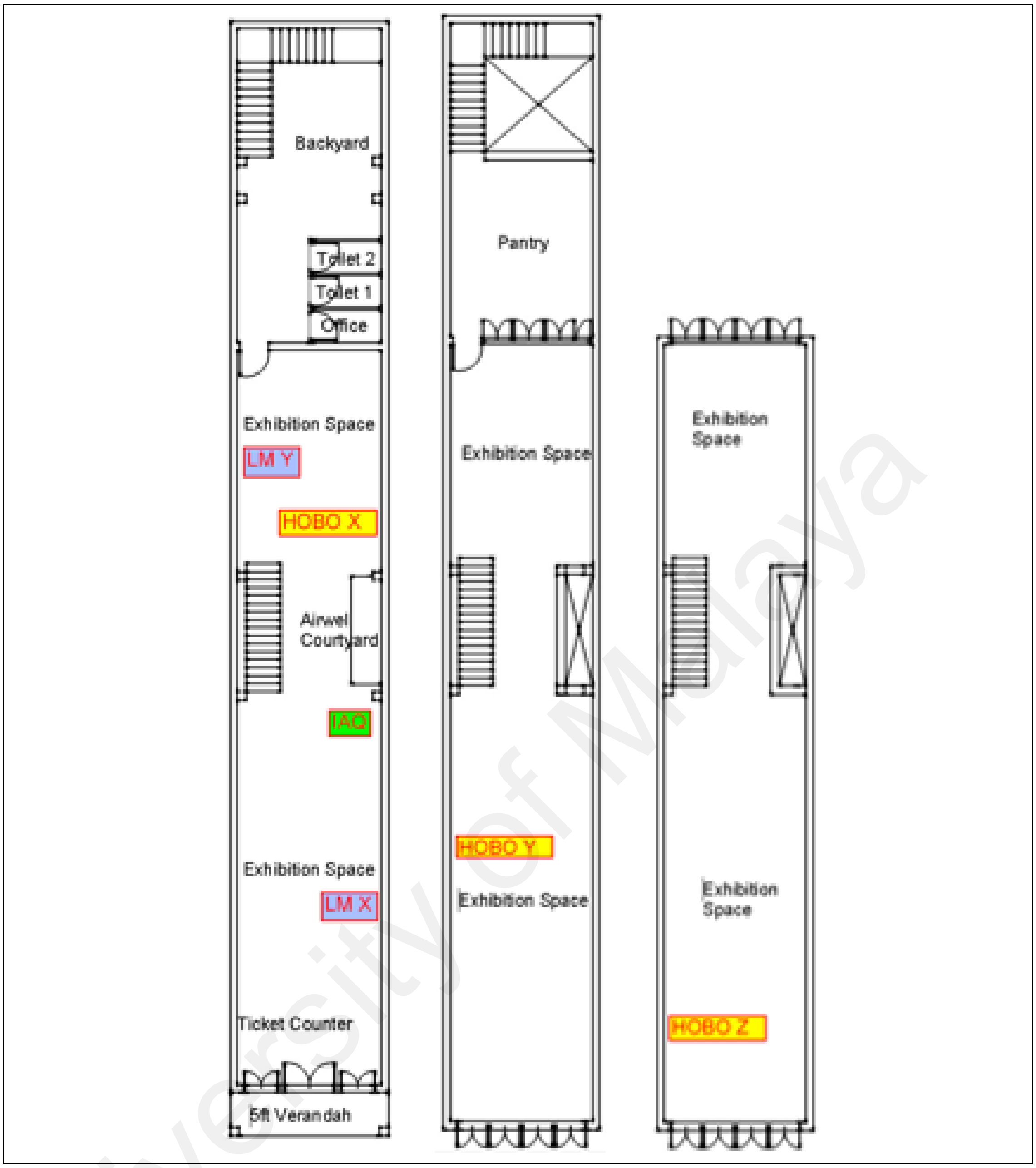


Figure 3.17: Placement of the research tools at ground floor (left), first floor (middle) and second floor (right) of BPM

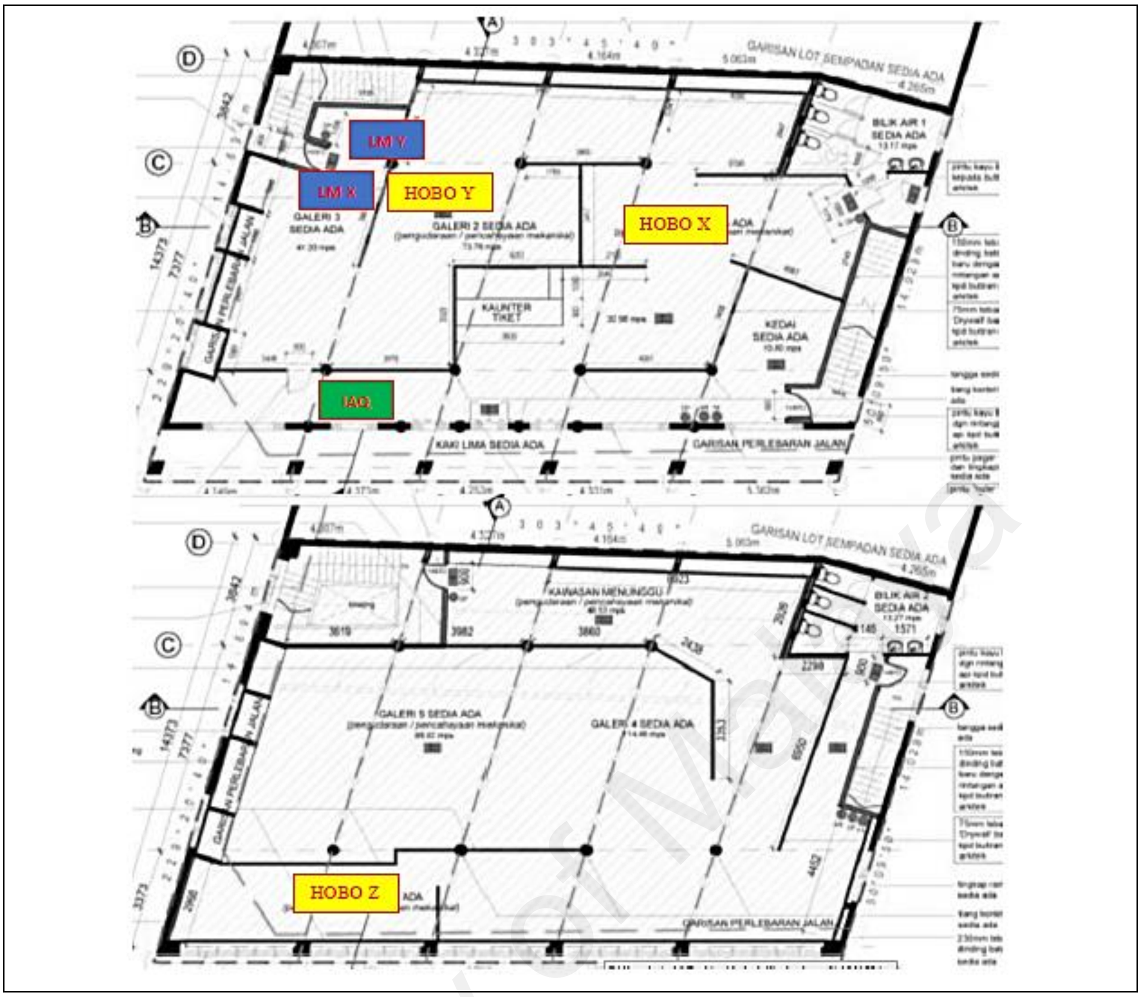


Figure 3.18: Placement of the research tools at ground floor (top) and first floor (bottom) of DM

For surveying museum key informants, the form shown in Figure 3.13 was used to gain their feedback on financial performance data of their respective museums. It entails the columns on year and months, as well as on income and expenditure. Within the income column, the survey form was sub-divided into two sections of: i. Ticketing revenue (based on visitations) and ii. Heritage conservation fund received (based on financial grants or other monetary assistance received in relation to building conservation, if any). The expenditure column of the survey form meanwhile was also sub-divided into two sections consisting: i. Operational costs (based on utility bills such as electricity, water and other expenses required for building operation) and ii. Building maintenance costs (based on maintenance or remedial works required on the building elements or areas).

3.3 Validation

Validation stage in the current research serves as the meta-evaluation (a systematic and formal evaluation of specific evaluation tools to guide evaluation planning or management) for the conceptual PCE framework based on Scriven M. (2009). This stage emphasised on methodological soundness and appropriateness of the conceptual PCE framework as suggested by Kitchenham, Pfleeger and Fenton (1995). The objective was to verify on the aspects of coverage and correctness of the conceptual PCE framework in evaluating its evaluands (subjects of evaluation).

The validation was done based on translational validity, a constituent of construct validity known to be the most important form of validation strategy which assesses whether the items of the conceptual PCE framework does really measure what it is supposed to measure and has clear construct definitions (Creswell, 1994; Okoli & Pawlowski, 2004; Neill, 2004). Criterion-related validity which simply validates a measure based on its relationship to another measure was excluded for having no relevance in this research context (Hashim, Murphy, & O'Connor, 2007). Translational validity was important to assess whether the conceptual PCE framework has a good reflection of the construct, consisting of content validity and face validity as summarised in Table 3.11 (Trochim, 2006; Seshadhri & Topka, 2016):

Table 3.11: Types of translational validity

Types	Explanation
Content Validity	Deals with the representativeness of the instrument content (Kerlinger, 1986), adequacy of a specified domain of the instrument content that is sampled (Nunnally, 1978), degree of the instrument coverage on the content it is supposed to measure (Bush, 1985) and adequacy of the sampling of the instrument content that should be measured (Polit & Hungler, 1991), as cited in Yaghmaie (2003). Inclusion of content validity is highly recommended in any research study (Hashim, Murphy, & O'Connor, 2007). Polit and Beck (2006) informed that content validity is largely about judgement based on two distinct phases: i. Priori efforts; content validity performed by scale developer through careful conceptualisation and domain analysis prior to item generation ii. Posteriori efforts; content validity performed to evaluate the relevance on the content of scale developed using experts' assessment
Face Validity	Measures what they are supposed to measures as explained by Bornstein (2004). Commonly, it shows the degree to which a research instrument looks like it is measuring a specific attribute and relies on subjective evaluation through opinion, experience and judgement (Jones, 1999; Leedy & Ormrod, 2004). Although face validity is considered the easiest and weakest form of validity, it nevertheless can be a precursor or supplementary to other forms of validity test (Neill, 2004; Hashim, Murphy, & O'Connor, 2007). It can be used to show the usability of the instrument tested (Parsian & AM, 2009).

Content validation was performed based on posteriori efforts, by leveraging inputs from conservation experts and stakeholders to evaluate the relevance of the conceptual PCE. This would strengthen the priori efforts made earlier through deliberate literature review to conceptualise the PCE framework, and the field works done throughout the case studies to test its operational and empirical capability.

Face validation meanwhile was employed to test the face value of the overall constructs of the conceptual PCE framework whether it is evaluating its evaluands. Sensitising the notion that face validity is the easiest yet weakest form of validation, it is necessary to declare that it was merely used to supplement the content validation in the current research. Inclusion of the face validation was intentional to conclude the usability of the conceptual PCE framework.

A versatile research tool employable at various stages of a research that involves the pooling opinions of experts or stakeholders known as Delphi method was employed. Accordingly, validation of the conceptual PCE framework was based on an iterative process, of collecting and distilling experts' judgements through a series of questionnaires interspersed with their inputs (Skulmoski, Hartman , & Krahn, 2007; Hsu & Sandford, 2007; Geist, 2010).

3.3.1 Procedures

The first step taken was to develop the validation questionnaire, pre-tested for ambiguities and vagueness through consultation with research advisors and academic colleagues. Three relevant participants were initially selected based on their willingness to respond on the pilot validation questionnaire. Consequently, the modified aspects from the pilot validation questionnaire were:

i. Inclusion of code labelling (A1-C4) to the conceptual PCE framework and its respective questions (closed-ended items of Q1-Q12) to ease participants in making quick referencing
ii. Replacement of five-point rating system (for the satisfaction scale) with four-point rating system to avoid having a neutral and ambivalent midpoint for analysis purposes
iii. Simplification of the questions probed by using succinct and standard wordings to foster participants' clarity and understanding e.g. "According to the framework above, is…relevant to the PCE framework?" and "If you have given a score of 1 and 2, what improvements do you suggest?"

Then, identification of the participants was done via desktop search by browsing the websites of local conservation authorities (such as GTWHI, MBPP, MWHSB, MBMB etc.) as well as academic institution with the awareness that merely choosing individuals who are knowledgeable concerning the subject matter is not recommended by scholars (Helmer & Rescher, 1959; Klee, 1972). Selection of relevant and appropriate participants was deliberately made to make the validation process judicious. It involved individuals from top management, comprising decision makers and professional staff members. Their knowledge and expertise in the fields of built heritage conservation, building performance and historic museums were highly considered during this process as suggested by Delbecq, Van de Ven and Gustafson (1975, p. 85) and Adler and Ziglio (1996).

Upon identification of suitable participants, an introductory email was sent to each of the targeted individual. Follow-up emails and text messages were also sent occasionally to solicit their participation. Following time constraint, a maximum period of one month was set to complete each round of validation stage since further iteration of the survey will be necessary given the initial pool of items demand substantial improvements (Polit & Beck, 2006).

Hsu and Sandford (2007) informed that literature never arrives at a consensus on what constitute the optimal number of subjects for Delphi method. Seshadhri and Topka (2016) mentioned that typically seven or more experts are required for validation. The current researcher initially managed to involve eight participants in the first-round validation. However, merely seven participants responded in the second-round validation. The number of participants for these two rounds however was sufficient from the context of content validity because:

i. Having a minimum of three experts would be fine (Lynn, 1986)

ii. Small sample would suffice to yield the results if the participants involved were homogeneous (Skulmoski, Hartman , & Krahn, 2007)

iii. Literature never arrives at a consensus on what constitute the optimal number of subjects for Delphi method (Skulmoski, Hartman , & Krahn, 2007)

Data analysis based on content validity index (CVI) was then performed after receiving the survey response. The CVI was computed by dichotomising participants' feedback for each item into 'relevant' (for item rated with the scale of 3 or 4) or 'not relevant' (for item rated with the scale of 1 or 2) (Polit & Beck, 2006). Based on Lynn's (1986) suggestion, there were two types of CVI computed comprising:

i. Content validity of individual items (I-CVI); used for the 'purpose of clarity' of the conceptual PCE framework to revise, delete and substitute items (Polit & Beck, 2006). The I-CVI for each individual item was computed by dividing the number of participants rated 'relevant' with the total number of participants involved in the validation process.

ii. Content validity of the overall scale (S-CVI); used for the 'sake of clarity' (Polit & Beck, 2006). The two types of S-CVI considered were the proportion of items on a scale that achieved 'relevant' with the total items (S-CVI/ UA) and the average of the I-CVI for all items of the scale (S-CVI/ Ave). Both values of the S-CVI types were reported in the current thesis to present more informative results as suggested by Polit and Beck (2006).

The I-CVI, SCVI/ Ave and SCVI/ UA results obtained were then compared with the benchmarks by Lynn (1986), Polit and Beck (2006) and Davis (1992). Accordingly, the I-CVI for each item of the conceptual PCE should be not less than 0.78 with the S-CVI/ Ave of 0.90 or higher for it to be considered as having excellent content validity, subjected to the total number of eight participants involved. The S-CVI meanwhile should not be less than 0.80. Face validity meanwhile was analysed based on the percentage obtained from the rating on the four-point scale provided by the eight participants.

After collecting the initial response, adjustments were made to the conceptual PCE framework based on feedbacks received. Iteration of the process was made by transmitting the adjusted conceptual PCE framework and questionnaire to the participants. In line with the typical Delphi method undertakings, the validation process was then ended when sufficient information and consensus were reached. Upon completion of the validation phase, the final validated framework was then shared with participants involved for their reference.

3.3.2 Tools

Validation process of the conceptual PCE framework was carried using the means of questionnaire survey forms (Appendix F1 and F2). Google Forms, an online survey platform was used to create the survey forms. The preliminary section of the forms consists of the main title with a brief description on the purpose of the survey. The first two questionnaire items probe on the background of the participants comprising their name and areas of expertise. Then the forms present the conceptual PCE framework, with unique labelling of letters and numbers (A1 to A9, B1 to B6 and C1 to C4) on their respective individual components. These labels were only placed at relevant components that require validation (components of 'museum annual financial record' and 'observe OER annual trends' were not labelled for validation due to their obviousness nature).

Subsequent items consisted of 12 close-ended questionnaires, with each accompanied by an open-ended item. The close-ended items from Q1 to Q11 probe on content validity whereas the closed-ended item of Q12 conclusively probes on face validity of the conceptual PCE framework. Four-point rating was used for the close-ended items from Q1 to Q12 to avoid having a neutral and ambivalent midpoint as advocated by Waltz and Bausell (1981) and Lynn (1986). The scale adopted was based on the most frequently used ones as informed by Davis (1992) in particular: 1-not relevant, 2-somewhat relevant, 3-quite relevant and 4-highly relevant.

The accompanying open-ended items were meant for acquiring further feedback, suggestions or comments from the participants in the case they have rated 1-not relevant or 2-somewhat relevant, at any of the 12 close-ended items. This was imperative to expand the validation on the relevance of the conceptual PCE framework to other content validity criteria such as clarity, ambiguity and simplicity as stated by Yaghmaie (2003) The final item required participants to insert the completion date of their validation session.

3.4 Ethical Considerations

Permission to conduct research was initially requested from the museum organisations and participants prior to commencing data collection. Following to this, several ethical considerations were taken as such:

i. Contact information of the current researcher such as name, contact number, email address, faculty address and supervisors' details were fully provided.

ii. Intention and purpose of the research were informed both by written and direct conversation to ensure good understanding from the parties involved.

iii. An official postgraduate confirmation letter issued by University Malaya and an informed consent letter (Appendix A) was submitted to the parties involved either by hand or via e-mail. Copies of returned and signed informed consent letters from all the museums approached were attached (Appendix B).

iv. Confidentiality of discreet information and voluntary of participation were the matters taken seriously by the current researcher. The raw data on financial performance was not provided in the appendices section of the current thesis in respecting to confidential policy.

v. Upon research completion, a copy of evaluation findings will be handed over to the parties involved (based on request made).

3.5 Summary

Both secondary and primary data were utilised towards achieving the research aim and objectives. After having the relevant evaluation criteria identified through literature review, the conceptual PCE was then tested in terms of its operational and empirical capabilities through field works. The field works comprised of field observation, field measurement and key informants survey conducted at the case studies comprising two non-shophouse (PSM and MIPIM) and three shophouse buildings (SYSM, BPM and DM).

Field observation was conducted to evaluate physical appropriateness of the historic buildings following their adaptation to museums. Through field observation, physical appropriateness was evaluated based on the extent of authenticity and integrity conditions of the case studies, acknowledging that these pivotal requirements are sanctioned by UNESCO for World Heritage properties. Investigation on physical interventions and inspection on current building conditions made were done to evaluate the authenticity and integrity conditions respectively.

Field measurement meanwhile was conducted to evaluate functional effectiveness of the historic buildings as adaptive reuse museums, in the sense of their building performance in preserving museum collections and achieving users' comfort. Through field measurement, functional effectiveness was evaluated by assessing the case studies' IEQ against the performance benchmarks identified from literature review. The IEQ parameters monitored and assessed were based on those highly significant to museums which include:

i. Thermal environment; represented by the levels of relative humidity and indoor temperature. Reasonably, having a stable thermal environment for the welfare of both museum collections and users is important. Fluctuating, too high or too low of relative humidity and indoor temperature are the primary causes of objects deterioration as well as visitors discomfort and dissatisfaction.
ii. Lighting; comprising the intensity of ambience light and display light. Ambience light is vital for people's comfort particularly the museum users whereas the display light is important for the preservation of museum collections, especially to those made of sensitive materials.
iii. Indoor air quality; represented by the concentration of carbon dioxide (CO_2) and total volatile organic compound (TVOC). Concentration of these two gaseous pollutants are reportedly high in old buildings and new buildings respectively. Besides, CO_2 and TVOC affect people's health and artefacts' deterioration respectively.

Key informants survey was done to evaluate financial efficiency of the historic buildings following their adaptation to museums. The survey probed financial performance of the respective museums, in terms of their income and expenditure for further OER analysis. Finally, meta-evaluation on the conceptual PCE framework was performed via content and face validity tests using questionnaire survey, engaging eight participants of experts and stakeholders in the built heritage conservation field. The following chapter presents detailed background information of the case studies.

CHAPTER 4: CASE STUDIES

4.1 Introduction

This chapter presents the background overview of the five case studies namely the Penang State Museum (PSM), Made in Penang Interactive Museum (MIPIM), Sun Yat Sen Museum (SYSM), Batik Painting Museum (BPM) and Dark Mansion-3D Glow in the Dark Museum (DM). By building typology, PSM and MIPIM belong to the non-shophouse category while SYSM, BPM and DM belong to the shophouse category. Figure 4.1 indicates their respective location within the Conservation Zone of historic city of George Town, UNESCO World Heritage of Malaysia.

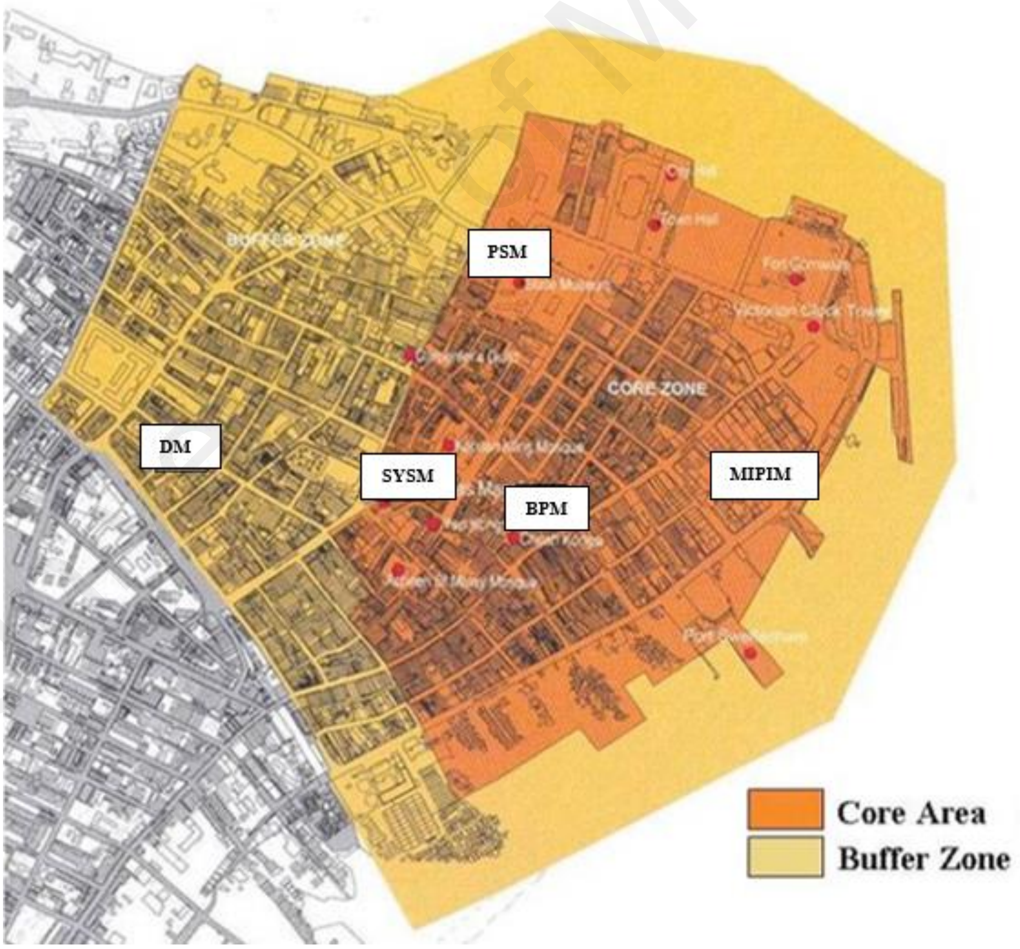


Figure 4.1: Location of the case studies within the Conservation Zone of Historic City of George Town

4.2 Non-Shophouse Buildings

The following sub-headings present the two adaptive reuse museums of conserved non-shophouse category which are the Penang State Museum (PSM) and Made in Penang Interactive Museum (MIPIM). This building category commonly belongs to government agencies or private companies. Some buildings of this category in Penang are significant as they have been classified as heritage Category 1 by the State Government for carrying national importance.

4.2.1 Penang State Museum (PSM)

PSM is a public museum managed by the Penang State Museum Board (LMNPP). PSM building is located within the Core Zone of George Town, coordinated at °25'13.6"N 100°20'18.7"E. The building is situated in between of St. George's Church and the Cathedral of the Assumption. PSM is opposite to the Penang Supreme Court Building with the Hutchings National Secondary School on its rear side. Originally, PSM building housed Penang Free School from 1907 until 1927 and Hutchings School from 1928 to 1960 prior its adaptation to museum.

Figure 4.2: Penang State Museum, Lebuh Farquhar, 10200 George Town, Penang

Figure 4.3: Site plan of PSM (Source: Google Earth)

PSM building features British Neoclassical style. Its architectural qualities can be seen through its outstanding building elements such as the cupola at the top juncture of the building, the central portico, the façade division into bays by classical pilasters, the arch with panelled window at each of the bays, the use of Tuscan capital on the ground level, the use of Corinthian capital at the upper level, and the pinnacles accentuating the solid parapet wall of the top pilasters at the roof level (Hassan & Che Yahaya, 2012). As informed by MBPP's Department of Heritage Conservation, the gross floor area of this two-storeys building is approximately 750 m^2 (Ahmad M., personal communication, 09^{th} December 2016).

PSM building was erected in two stages (M. Amil, personal communication, 28^{th} September 2015) in which half of the building (near to the St. George's Church) was built in 1896 while the other half of the building was built in 1906. PSM building however suffered twice tragic incidences during the second World War. Its east wing was bombed by the Japanese between the year 1941 and 1945. PSM building was saved from being demolished and started its operation as a museum and art gallery in 1964 prior to the suggestion by the late Tunku Abdul Rahman Putra Al-Hajj, the first prime minister of Malaysia.

Figure 4.4: An old photo of PSM building prior to the bombing tragedy
(Source: LMNPP)

LMNPP was then entrusted to operationalise the building as museum after the Federal Government acquainted the building in 1965 (Hassan & Che Yahaya, 2012). PSM building has been classified as Category 1 by the Penang State Government. This category applies to heritage properties that are of exceptional interests, declared as ancient and gazetted by the former Antiquities Act 1976, registered under the National Heritage Act 2005 (Act 645), or located in the Core Zone of George Town (Shamsuddin, Sulaiman, & Che Amat, 2012).

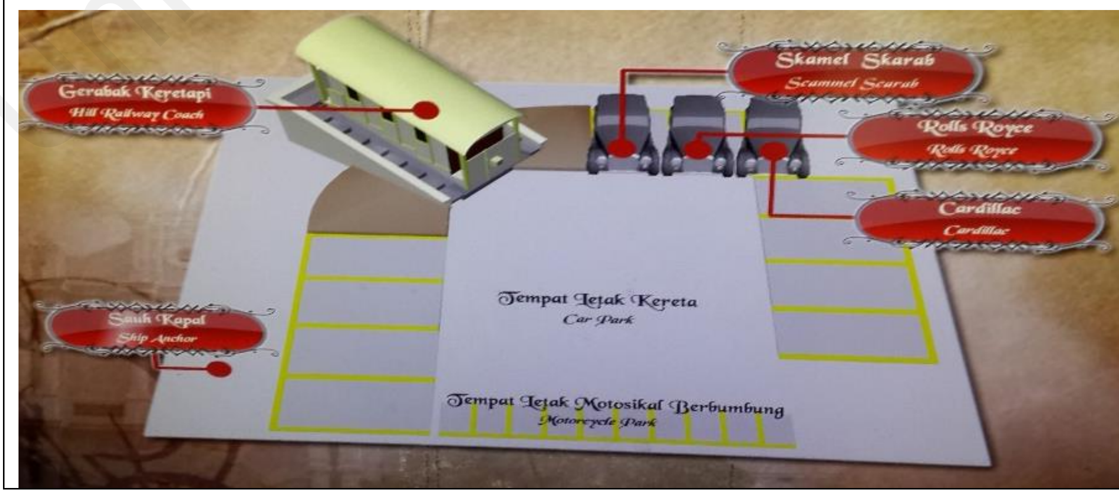


Figure 4.5: PSM external compound layout (Source: LMNPP)

The east wing building area that was ruined due to Japanese bombing was cleared and now forms as PSM external compound. The area now serves as a parking space comprising parking lots for museum visitors and staff. Besides, the external compound area also displays outdoor exhibitions consisting of the old Penang Hill's tramp as well as three antique cars. A mini security hut for the uses of night-shift guard stands next to these outdoor exhibitions.

Figure 4.6: PSM external compound and its outdoor exhibition

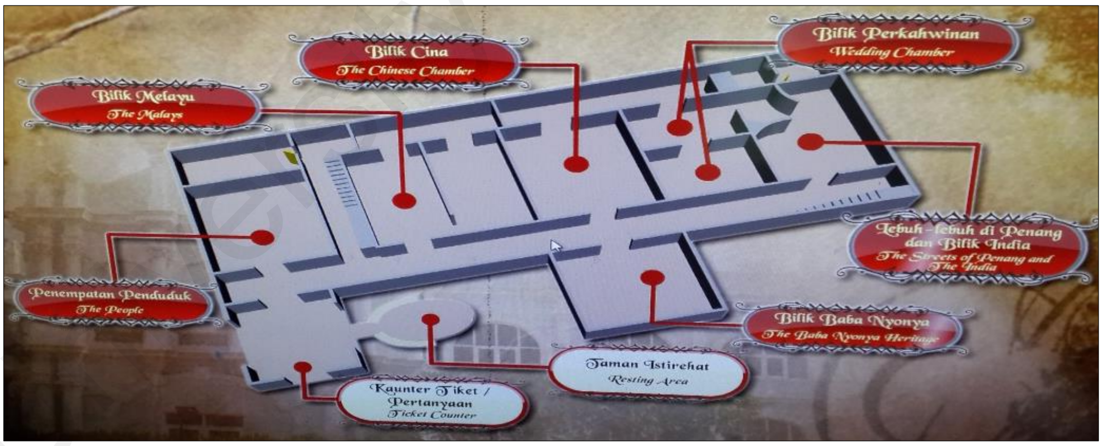


Figure 4.7: PSM ground floor layout (Source: LMNPP)

PSM ground floor meanwhile consists of a reception area where ticketing and merchandising sales are done. Right opposite to the reception counter is the People Room, which is basically the first exhibition area that will be encountered by visitors. Next to it by sequence are the Malays Room, Chinese Chamber, Wedding Chamber, and at the very end, the Sikh and Indian Room. Baba and Nyonya Heritage Room meanwhile is in parallel to the reception area, separated with a mini outdoor courtyard in between. Two lavatories are available at PSM ground floor, each for gents and ladies. The museum administration office is housed in a container structure outside of the main building, accessible through a door at the very end of PSM front corridor.

Figure 4.8: PSM first floor layout (Source: LMNPP)

PSM first floor mainly comprises of a large exhibition space, displaying exhibition themes relating to Penang cultural scenes. Other than the large exhibition space, there were galleries displaying various artworks and paintings. To be interactive, the museum management also prepared a mini-game zone for visitors to play *congkak* (a Malay traditional game). The balcony area at PSM first floor however is not accessible to the public. There are two private spaces inaccessible to the public particularly the balcony area and the CCTV room within PSM first floor.

Figure 4.9: The various collections and displays within PSM

PSM reflects the old scenery of George Town city and its transformation into an international port, exhibiting various collections (of both sensitive and non-sensitive) comprising old scriptures, traditional clothes, antique furniture, street scenes, old transportations, multiracial photos, as well as the high in value 19th-century historical paintings of Penang by Captain Robert Smith. Summarily, the museum has been mainly curated to express local uniqueness of Penang through its collective identities of multi-racial heritage of the Malays, Chinese, Indians as well as other minorities.

PSM charge flat rate of RM 1.00 for its entrance fee which is relatively cheap. The museum operates from 9 am to 5 pm daily and only closes on Fridays as well as during public holidays. Seven staff were seen in charge at PSM comprising three ticketing staff, a security guard, two management personnel and a janitor. PSM maintains its official website at www.penangmuseum.gov.my/museum.

4.2.2 Made in Penang Interactive Museum (MIPIM)

MIPIM is privately owned by a Singaporean named Loke Gim Tay. MIPIM building is located within the Core Zone of George Town, coordinated at 5°24'59.0"N 100°20'37.7"E. MIPIM is a sea-fronting building built on a reclamation land area of the old port along Pengkalan Weld. It is located opposite of the Penang Jetty and within proximity to other old administrative and godown buildings as well as the traditional water-villages of the clan jetties.

Figure 4.10: Made in Penang Interactive Museum, 3, Pengkalan Weld, 10300 George Town, Penang

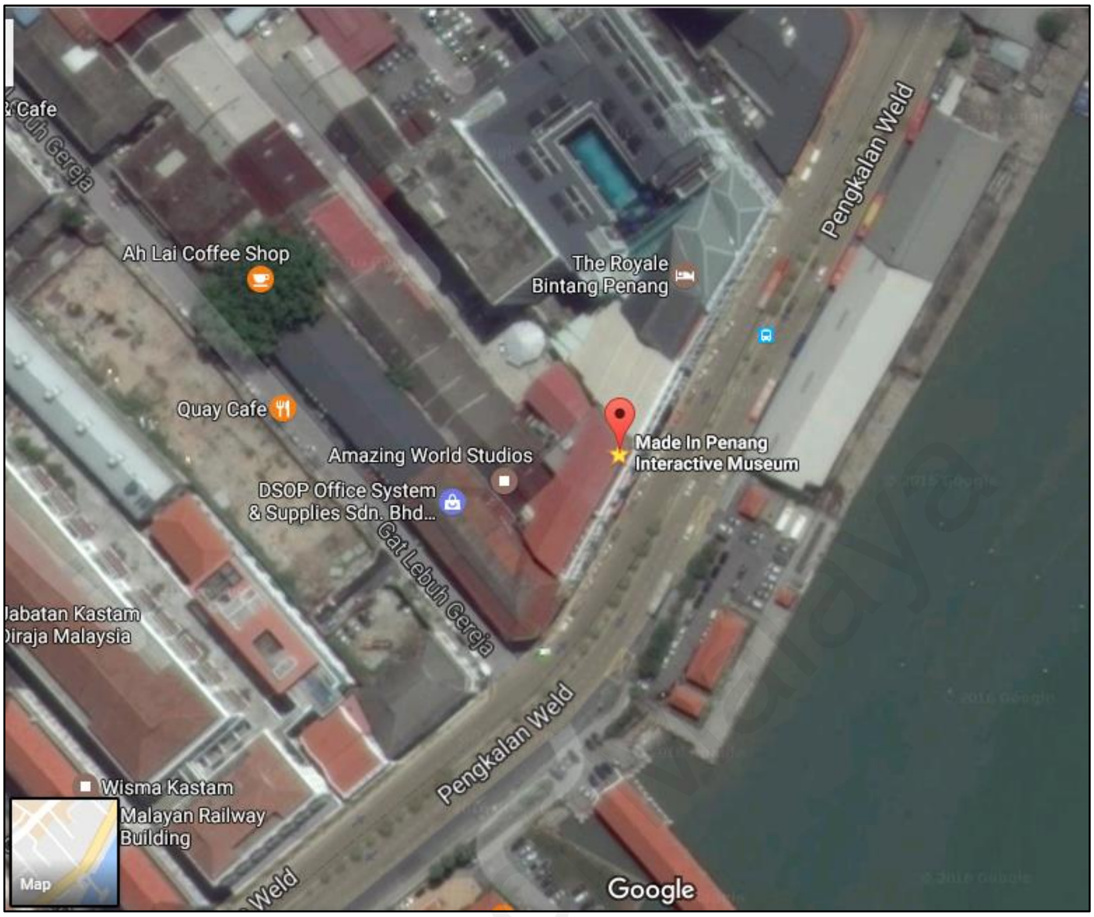


Figure 4.11: Site plan of MIPIM (Source: Google Earth)

Originally, MIPIM building was used as an industrial godown. It previously housed a European trading company known as Behn Meyer, founded in 1840 in Singapore by two Germans. In this regard, the building has been included in the German heritage trail of Penang due to its significance. MIPIM building was also occupied by the British Council prior to its conversion to a museum. Only in 17th September 2013, the building started to house MIPIM. MIPIM had a soft launch on the 1st November 2013 and officially launched during the first quarter of 2014 in tandem with the Visit Malaysia Year 2014.

Figure 4.12: The former looks of MIPIM building before converted to museum
(Source: Timothy Tye)

As reported in BERNAMA (2014), the two and a half building (with a mezzanine floor) covers a gross floor area approximately 1393.55 m² (based on conversion from 15,000 square feet). The architecture of MIPIM building features Neoclassical style, based on the last phase of European Classicism which characterised by monumentality. The building is typified by high ceilings, masonry structure with pitched roof.

MIPIM ground floor consists of a long and tapering main entrance corridor on the left side of the building. This corridor leads visitors to the rear lobby of the building, in which the museum entrance is located. Kiosks selling merchandises lined along the corridor hallway, which also accommodates an information counter and ticketing counter. A photo booth, two toilets and a staff pantry were spotted available at the rear lobby. MIPIM ground floor are separated into three main internal spaces: the exhibition on diorama of the old scenery of Weld Quay and MIPIM administration office on the right side of the building layout, miniature displays within showcase compartments with staircases to upper floors on the middle of the building layout, and thematic exhibition area at the entire left side of the building layout.

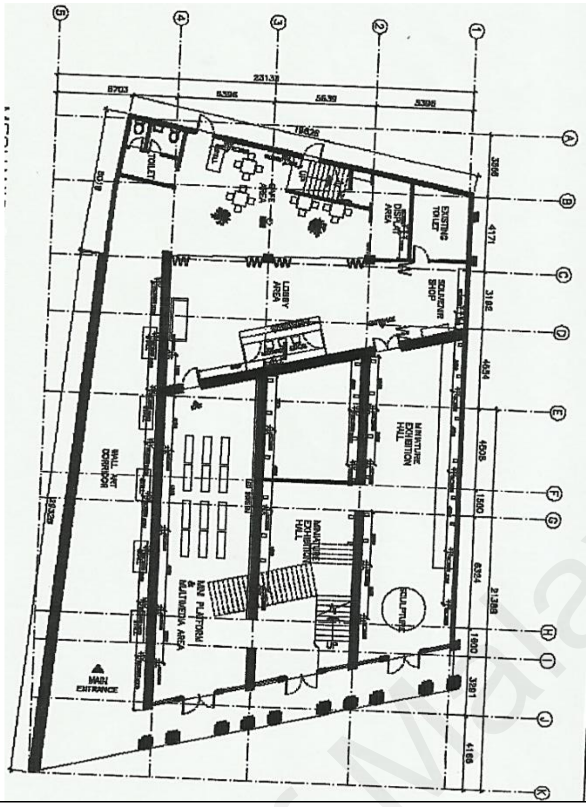


Figure 4.13: MIPIM ground floor plan (Source: MIPIM)

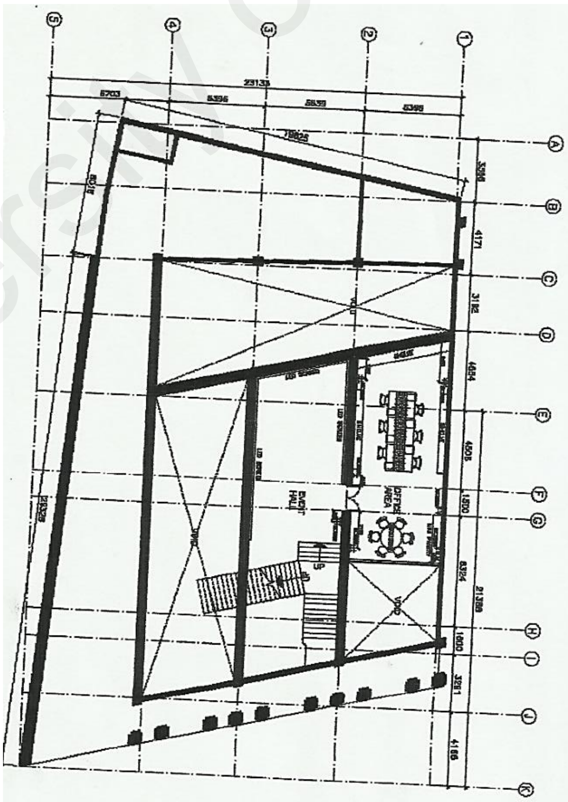


Figure 4.14: MIPIM mezzanine floor plan (Source: MIPIM)

There were interactive multimedia kiosks with more 3D thematic exhibition areas for photography purposes located on the MIPIM mezzanine floor. The director’s office was also located herein. The first floor of MIPIM meanwhile accommodates halls with varieties of 3D thematic exhibitions. Besides, this floor also has toilets for each gender and an emergency escape route.

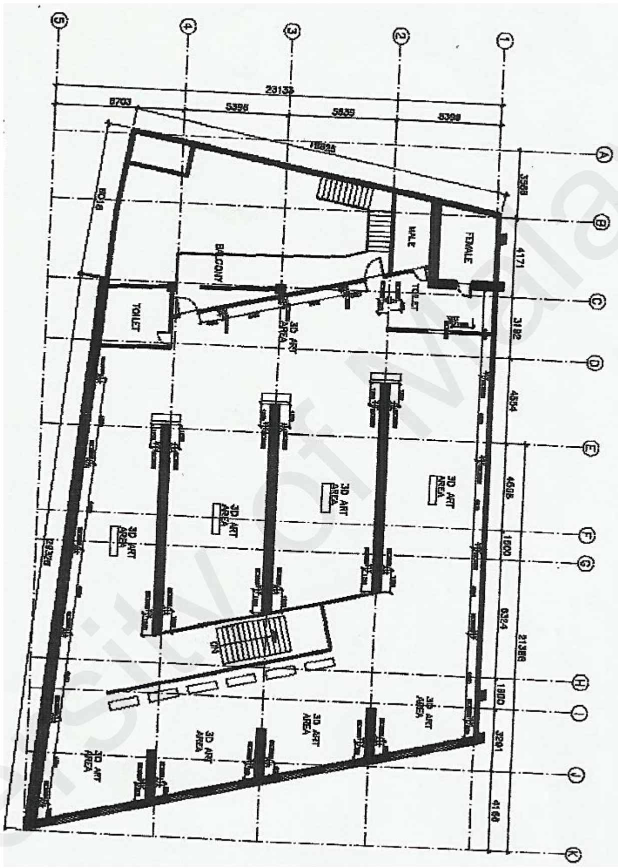


Figure 4.15: MIPIM first floor plan (Source: MIPIM)

MIPIM claimed to be the first 3D museum in Penang. It showcases modern arts and funky Penang-based exhibitions such as a fleet of wall paintings depicting the early 19th Century Penang port, a 20-foot long handmade miniature of jetty waterfront by a Penangite artist, Mr. Khoo Chooi Hooi, interactive cultural arts on old memories associable to Penang’s culture, and tricky multimedia kiosks. MIPIM charges RM 15 for adult visitors and RM 10 for students, elder citizen and kids. It opens from 9 am to 6 pm daily and closes during eve and Chinese New Year celebration. According to the museum administration executive, there are 15 staff in charge at MIPIM inclusive of full and part timers (Khan, Q., personal communication, 25th December 2016). MIPIM maintains its official website at www.madeinpenang.my.

Figure 4.16: Among the various interactive themes and multimedia kiosks within MIPIM

4.3 Shophouse Buildings

The following sub-headings present the three selected adaptive reuse museums of conserved shophouse category, they are the Sun Yat Sen Museum (SYSM), Batik Painting Museum (BPM) and Dark Mansion-3D Glow in the Dark Museum (DM). Most of the buildings of this category have been classified as heritage Category II for making up the urban character. Significantly, shop houses and town houses have been explicitly mentioned in OUV Criterion IV of Melaka and George Town. This type of building is commonly owned by private owners.

4.3.1 Sun Yat Sen Museum (SYSM)

SYSM is a private museum under the custodianship of Khoo Salma Nasution, a Penang-born historian and heritage advocator. Her grandfather, a Hokkien merchant named Ch'ng Teong Swee owned the building since 1926 (Yvonner, 2013) and now inherited to Khoo's mother. SYSM building is located within the Core Zone of George Town, coordinated at 5°24'56.9"N 100°20'10.3"E. The shophouse building stands along Lebuh Armenian's heritage row, which also accommodates two other museums namely the Teochew Puppet and Opera Museum and the Penang Islamic Museum (also known as Syed Al-Attas Mansion which is currently closed for conservation works).

Figure 4.17: Sun Yat Sen Museum, 120, Lebuh Armenian, 10300 George Town, Penang

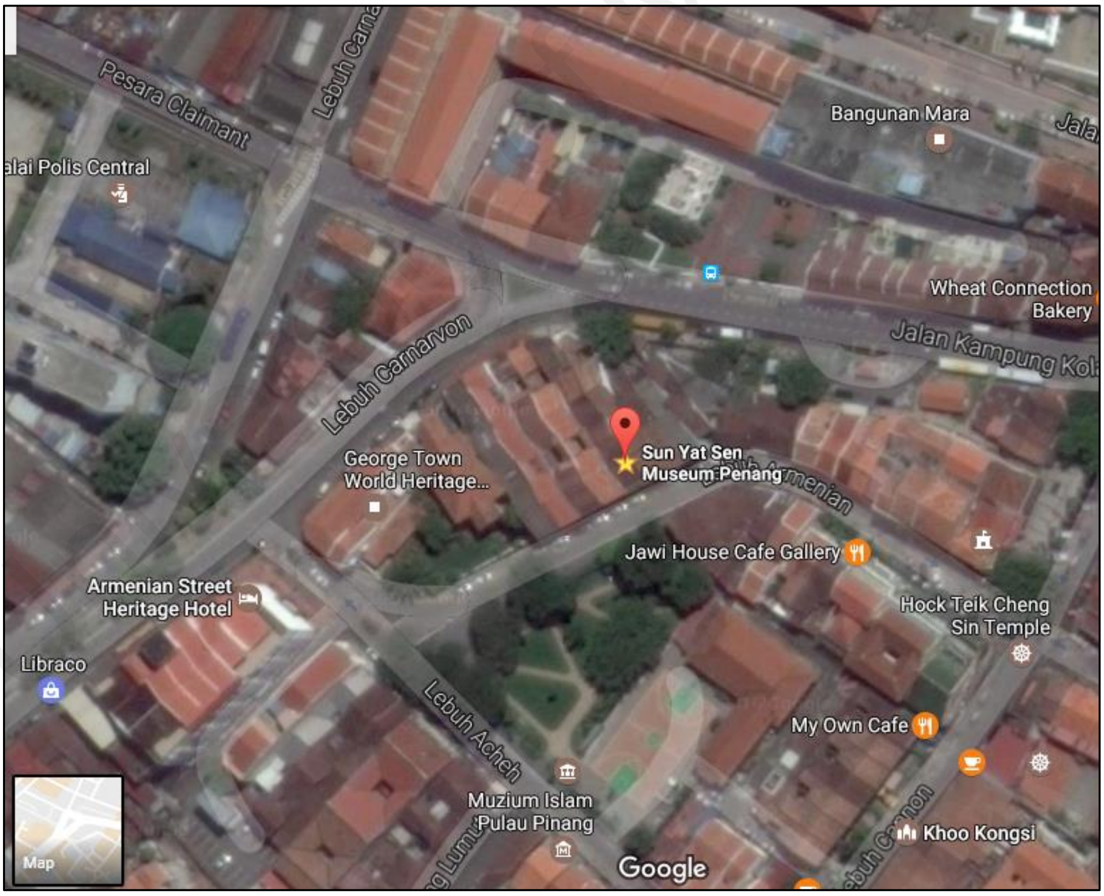


Figure 4.18: Site plan of SYSM (Source: Google Earth)

SYSM building was mainly used for civic purposes where Dr. Sun Yat Sen based his Penang Philomatic Union therein from 23rd May 1909 until 28th January 1912. It was then known as the Sun Yat Sen Penang Base, being added to the State Government's Penang Heritage Trail in 1999. Three years later, it was established as SYSM. The former prime minister of Malaysia, Tun Dato' Seri Dr. Mahathir Mohamad launched the exhibition of 'Dr. Sun Yat Sen in Penang' on 04th February 2001.

SYSM building was built circa 1880, featuring an exemplar of Southern Chinese Eclectic style that was dominant during the year 1840s to 1900s. The building displays Chinese and European influences such as carved timber door, indoor air well, and louvered shutters. The building is culturally significant due to its association with a prominent historical figure from China, the late Dr. Sun Yat Sen. During his stay in Penang from the end of July until early December 1910, Dr. Sun Yat Sen called for a secret strategy meeting, the Penang Conference in November 1910 to plan the Huanghuagang Uprising in Guangzhou, China.

Dr. Sun Yat Sen appealed for donations through a fundraising meeting which was held in the SYSM building in 14 November 1910. Historically, SYSM building used to house the Penang Philomatic Union due to its strategic location that was near to other Tongmenghui leaders. Besides, the revolutionaries and respectable members of the society alike could access the building unrecognised or unseen and exit the building safely using the back door which provided escape routes to many narrow lanes and secret passageways.

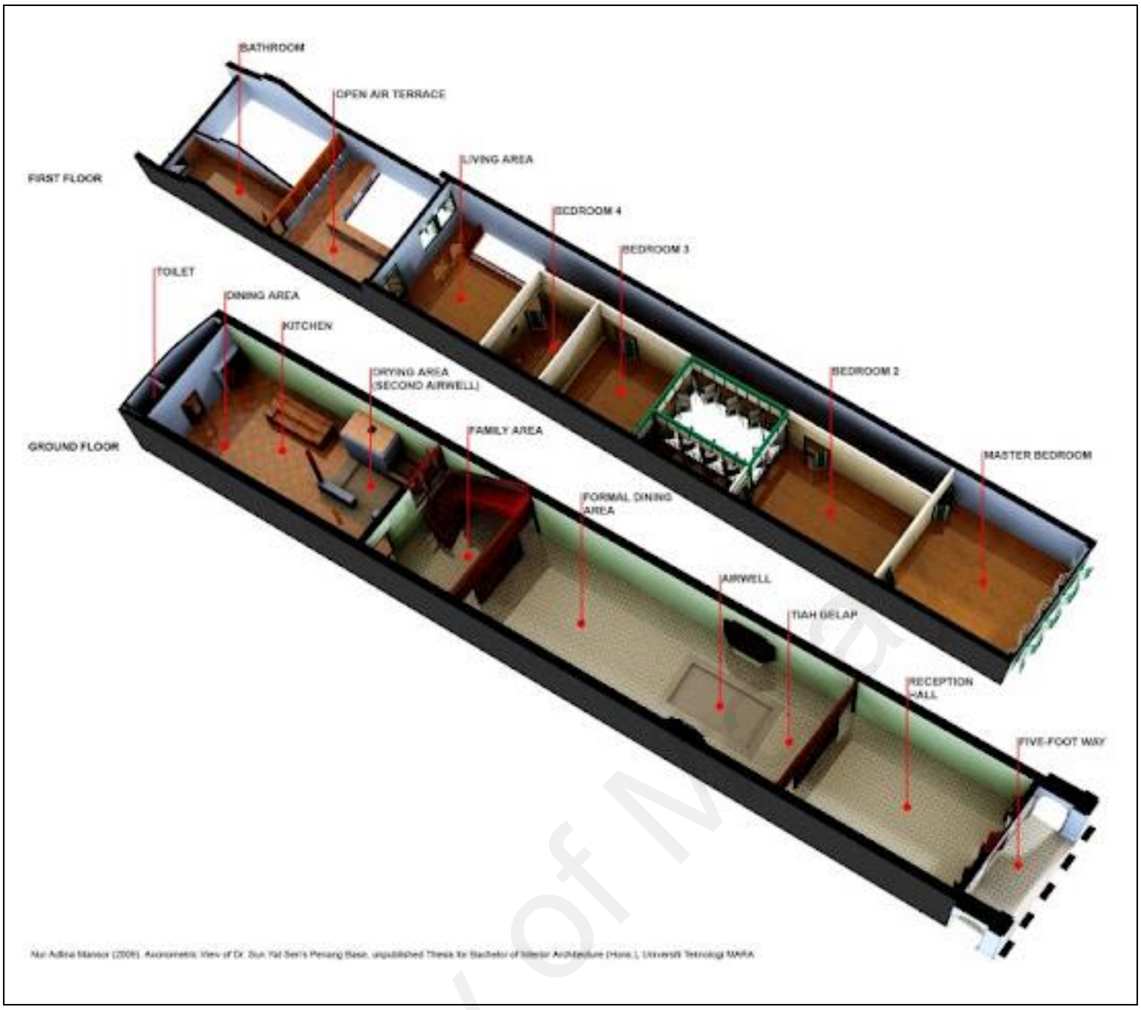


Figure 4.19: SYSM building layout (Nur Adlina, 2009)

According to MBPP's Department of Heritage Conservation, the gross floor area of this two-storeys building is approximately 170 m² (Ahmad M., personal communication, 09th December 2016). SYSM exhibition areas are only located on the ground floor area, spanning from the main entrance to the kitchen area. Access to the building first floor is restricted to public as it is used for accommodation purpose for renting guests.

Figure 4.20: The various collections and displays within SYSM

SYSM mainly boasts a historical gallery presenting the amazing story of Dr. Sun Yat Sen's revolutionary years. Various antique furniture, information boards, old letters and documents associated with the late Dr. Sun Yat Sen are well preserved and exhibited in this museum. SYSM charges RM 5.00 for normal visitors and RM 3.00 for students. It opens from 9 am to 5 pm daily, seven days a week. Two main staff were seen in-charge during the weekdays with an occasional substitute staff for the weekends. SYSM maintains its official website at www.sunyatsenpenang.com.

4.3.2 Batik Painting Museum (BPM)

BPM is privately owned by a medical practitioner, Dr. Tan Chong Guan who is also the current museum director. BPM building is located within the Core Zone of George Town, coordinated at 5°24'54.0"N 100°20'15.4"E. It strategically stands at the cultural heritage enclave of Lebuh Armenian, a famous tourism spot of George Town for having varieties of local street food and street arts. BPM building is surrounded with other historic buildings such as the Khoo Kongsi Temple and Yap Kongsi Temple.

Figure 4.21: Batik Painting Museum, 19, Lebuh Armenian, 10200 George Town, Penang

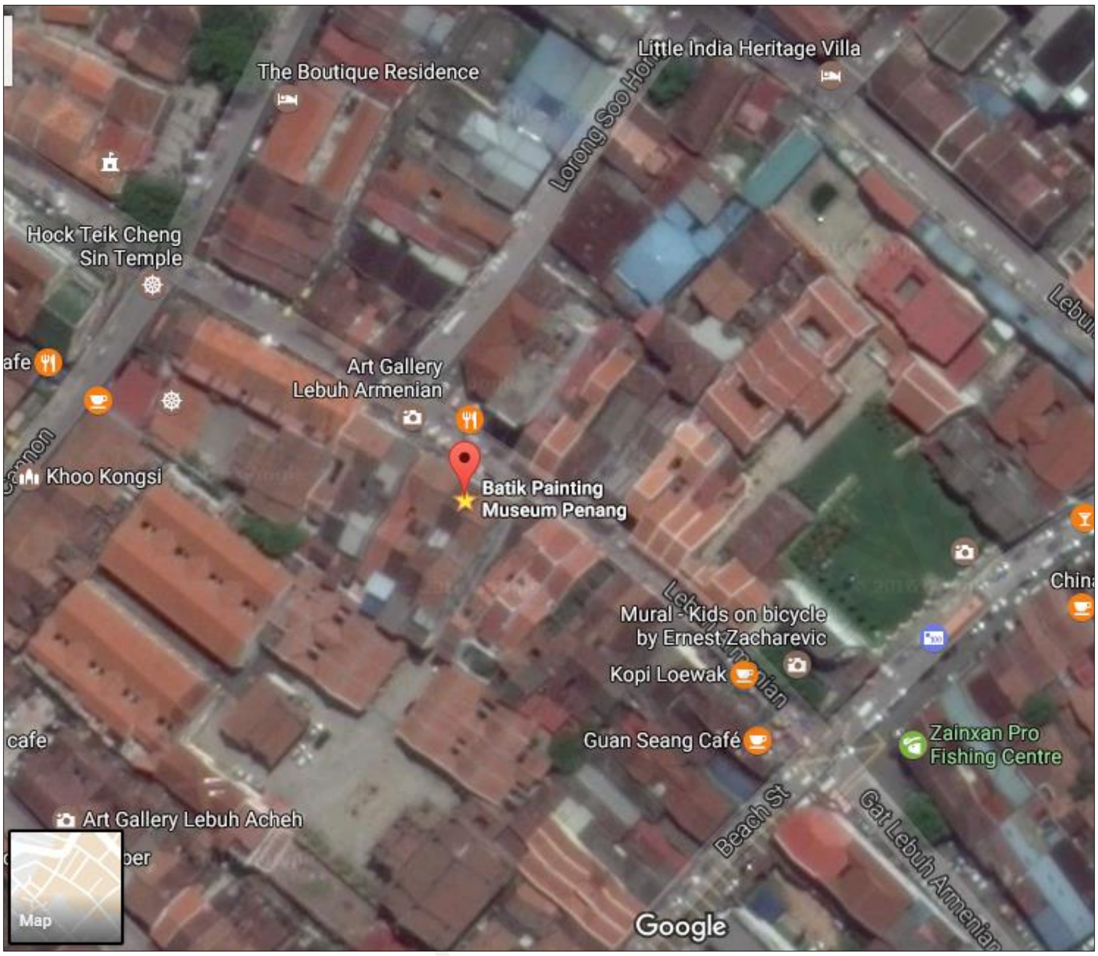


Figure 4.22: Site plan of BPM (Source: Google Earth)

BPM building was previously used for residential purpose. Among the prominent architectural characteristics of this Southern Chinese Eclectic Style building observed were its five-foot veranda, internal air well courtyard, simple ornamental element using green glazed ceramic vents, the uses of Tuscan order on its plain pilasters as well as horizontal mouldings along its beams. The building is built of masonry walls with terracotta flooring on the ground floor and timber flooring on the upper floors. As typical for shophouses, BPM building is supported by load bearing walls and timber beams and topped with pitch roof finished by roof tiles.

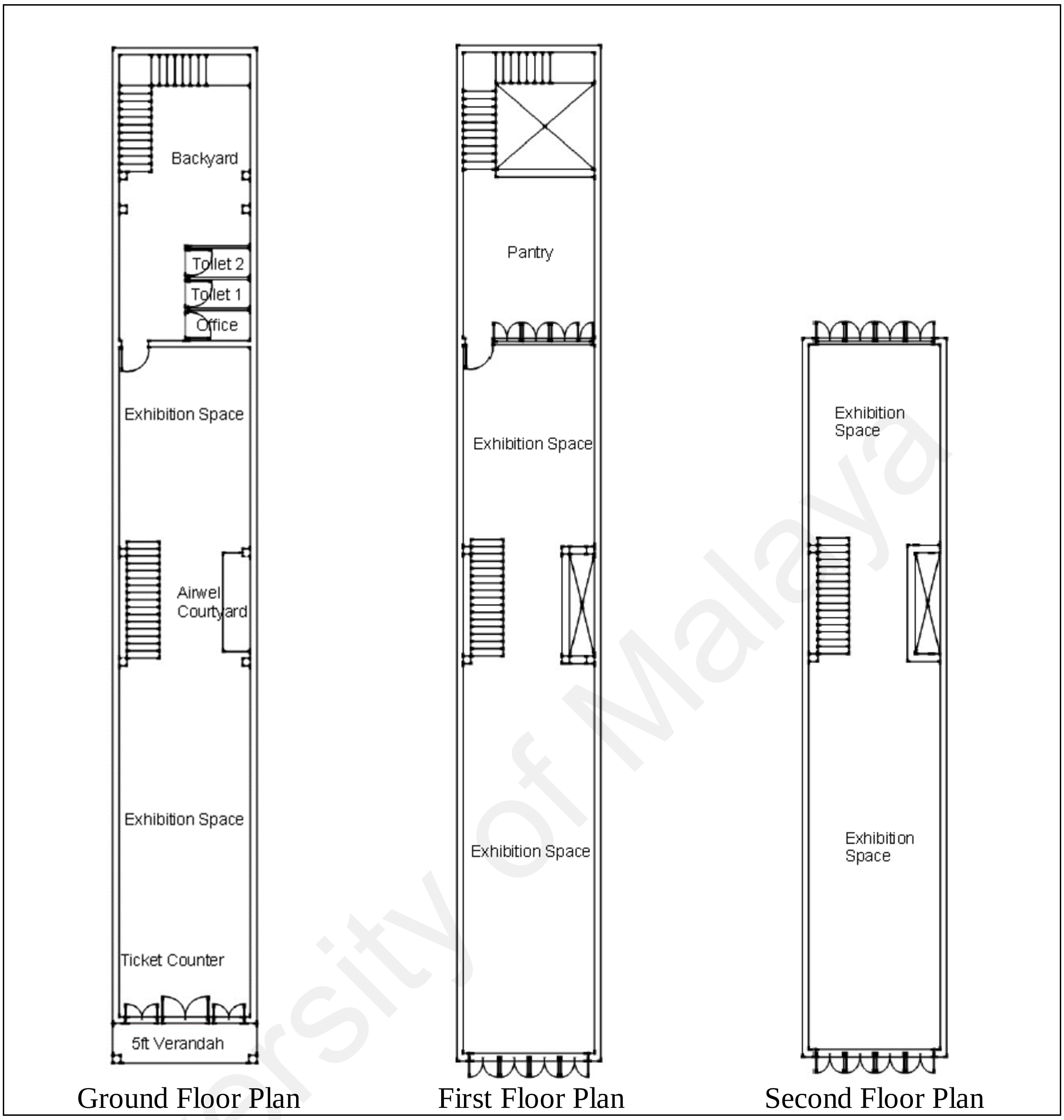


Figure 4.23: BPM floor plans

Entering BPM building, a simple setup of the reception area and souvenirs section awaits museum visitors at the main entrance on the ground floor. The long and narrow halls within BPM serve as the museum exhibition area which are repetitive for the entire three floors. Along the exhibition area, batik artworks are wall-hung on the building's internal walls. The main building staircase stands opposite of the indoor air well courtyard. The backyard area of the ground floor also accommodates two toilets and an office room. The first floor meanwhile extends over the ground floor's veranda walkway.

Additional staircase at the backyard area of the ground floor is linked to the first floor's pantry. BPM top floor meanwhile is relatively smaller in area compared to the two lower floors as it merely covers the exhibition space without the backyard area.

According to MBPP Department of Heritage Conservation, the building was built circa 1840 to 1900 and the gross floor area of this three floors building is approximately 137m² (Ahmad M., personal communication, 09^{th} December 2016). However, not much historical account of BPM building was attainable from both building owner and local authority. BPM was established in 2013 as a museum. Ever since, it displays over 80 original batik artworks (paintings) by 30 local and abroad artists from Malaysia, Singapore, Indonesia, Thailand and China. The museum aims to introduce the historical background of Batik arts dated back in the 1950s plus their subsequent developments.

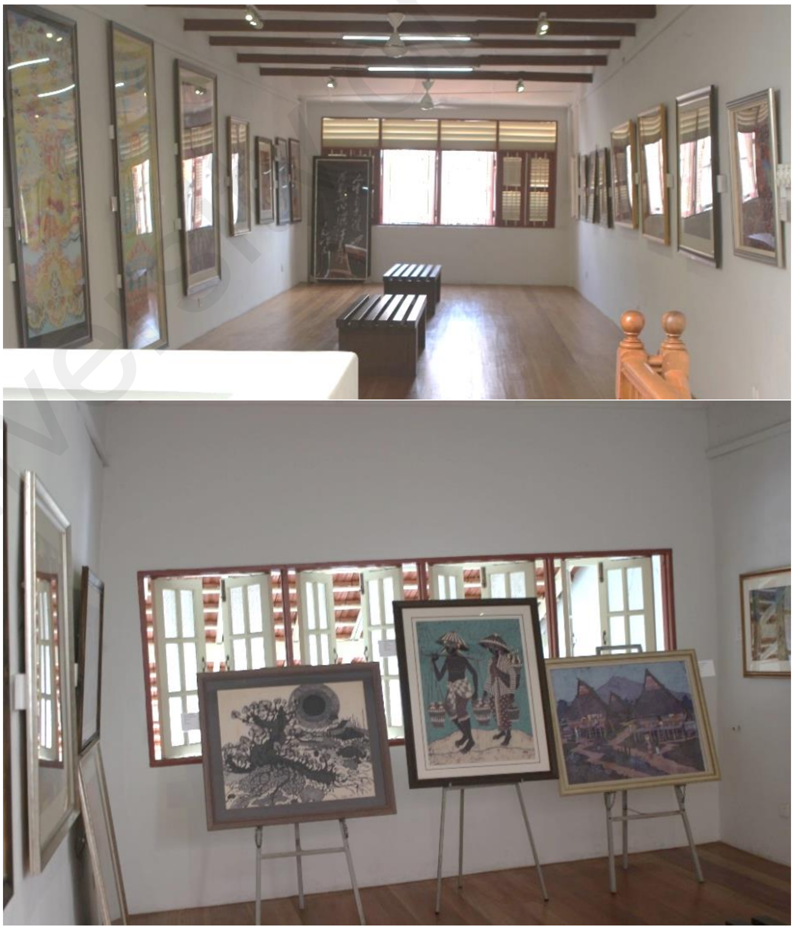


Figure 4.24: Among the Various Batik Painting Collections Displayed in BPM

BPM charges RM 10.00 for adult visitors and RM 5.00 for students. It opens at 10 am and closes at 6 pm daily, seven days a week. According to a staff in-charge, two staff including himself are usually in charge at BPM every weekdays and weekends alternately (Khon, K.A., personal communication, 16th December 2016). BPM maintains its official website at www.batikpg.com.

4.3.3 Dark Mansion- 3D Glow in the Dark Museum (DM)

DM is a private museum owned by Mencity Galleries Sendirian Berhad. DM building is located within the Buffer Zone of George Town, coordinated at 5°24'59.4"N 100°19'57.0"E. It is in between of Jalan Sg Ujong on the east and Jalan Kuala Kangsar on the west, along shophouses area where most buildings primarily function as retail premises. Prior to its museum use, DM building was used as a clothes wholesale retailer shop. Based on DM Heritage Impact Assessment (HIA) report, the building is deemed to be closest to the Southern Chinese Eclectic Style based on remaining features available and immediate surrounding architecture (Multi Spex Architects , 2016)

Figure 4.25: Dark Mansion- 3D Glow in the Dark Museum, 145,147,149,151,153, Lebuh Kimberly, 10100 George Town, Penang

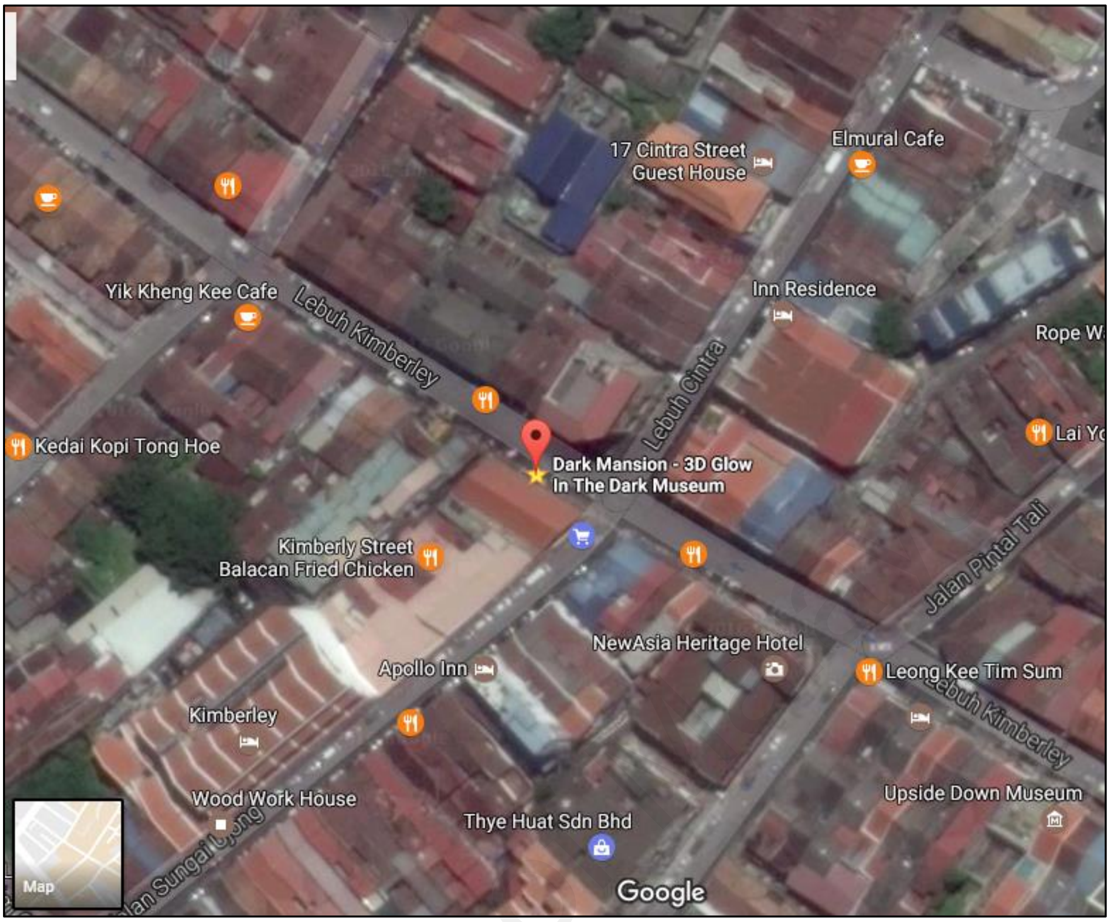


Figure 4.26: Site plan of DM (Source: Google Earth)

Although the exact year built of DM building is unknown it is believed to be built circa 1840s to 1900s according to a staff from the MBPP Department of Heritage Conservation (Ahmad M., personal communication, 09th December 2016). The site of DM building is historically significant as Lebuh Kimberley is one of the oldest streets in George Town, named after the first Earl of Kimberley, John Wodehouse who was a British colonial secretary during the 1870s. Based on Kelly's Map 1891-1893, DM building was built connected to other buildings on its rear side without any back lane.

The originally five separated unit of buildings were then renovated and merged into a single DM building. Based on HIA report, DM building has lost its significant historical features due to previous interventions. As a result, its status was changed from

‘Category II’ building to ‘Replacement’ in the Draft of Special Area Plan 2011 (Multi Spex Architects , 2016). To revitalise the building and its surrounding site, the building was then put back into operation through adaptive reuse of the building, as a museum. DM started its business operation recently, since May 2016. The gross floor area of the two-storeys is 588.61 m².

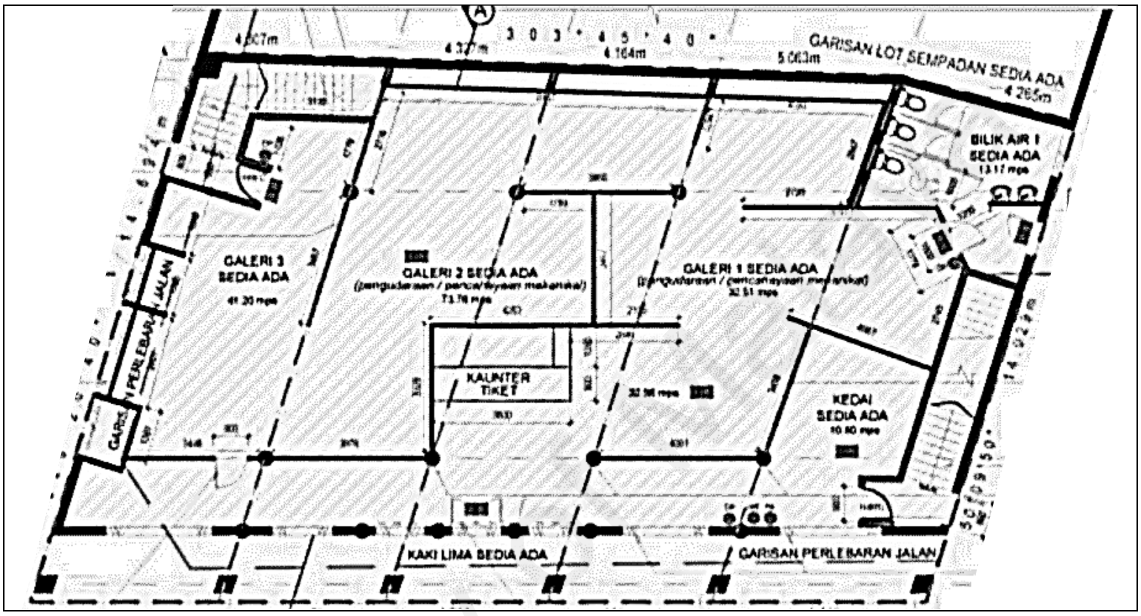


Figure 4.27: DM ground floor plan

DM ground floor consists of a reception lobby at the main entrance with photography booth and merchandise shop at the lobby corridor. The entry to exhibition spaces, next to the ticketing counter, is concealed with a black curtain veil. Inside it, there are exhibition spaces with different thematic concepts await visitors which are divided with internal walls. At the right end corner of the building is a unisex toilet. DM ground floor and first floor are linked by two staircases at both sides of the building.

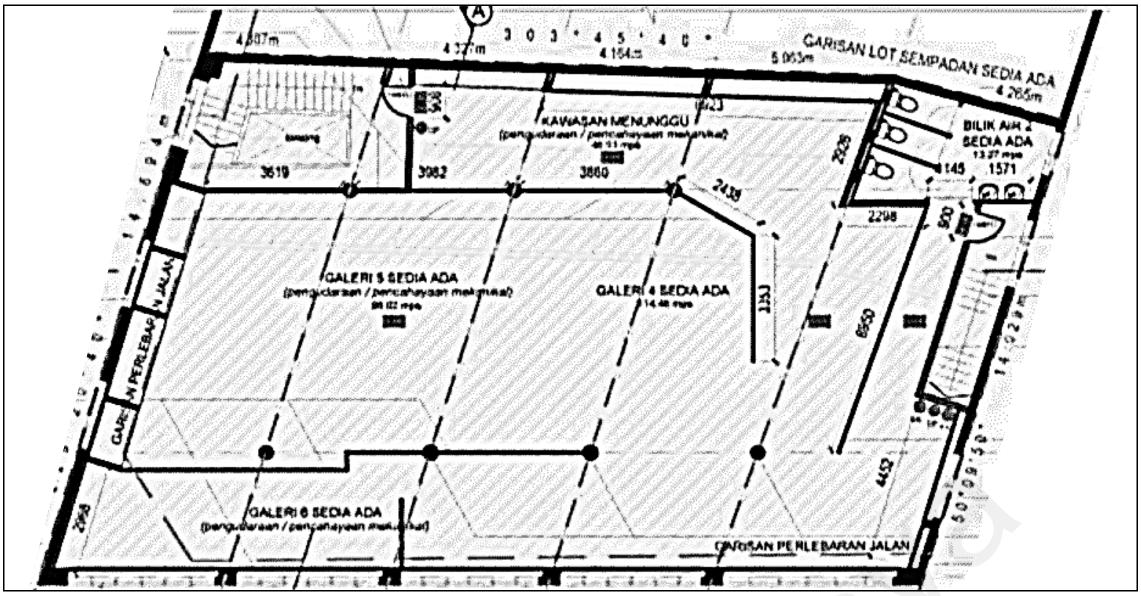


Figure 4.28: DM first floor plan

DM first floor meanwhile comprises of exhibition spaces painted with 3D glow in the dark paint materials combined with special UV lighting. Flora and fauna motives are dominantly used as the theme as apparent in the exhibition called “Tropical Pandora: The Forbidden Land”. The main attraction of DM located at the core of the exhibition space is called “Fire and Water: Tribute to Darwin”, a masterpiece of a renowned street painter from Germany named Edgar Mueller. The other unique attraction available at the left end of front corridor at DM first floor is the “Infinity Room: Origins of Eywa” which exhibition was inspired from the Hollywood movie, the Avatar. There is also a unisex toilet available on DM first floor at the right end corner of the building.

For local visitors, DM charges RM 20 for adults and RM 12 for child and senior citizens. Meanwhile for foreign visitors, DM charges RM 27 for adults and RM 17 for child and senior citizen. DM opens daily starting from 10.30 am until 6.30 pm. According to a DM staff, normally there are six staff will be on duty during weekdays whereas 10 staff during the weekends (Fazil, N., personal communication, 20th January 2017). DM maintains its official website at www.darkmansionpenang.com.

Figure 4.29: Among the thematic exhibition spaces within DM

4.4 Summary

The five adaptive reuse museums can be assorted to case studies of non-shophouse (PSM and MIPIM) and shophouses (SYSM, BPM and DM). They can be classified as historic buildings of masonry-based, constructed prior to the second World War. Their locations include both Core Zone (PSM, SYSM, BPM and MIPIM) and Buffer Zone (DM), within historic city of George Town, the UNESCO World Heritage of Malaysia. Moreover, the case studies also involved museums of cultural materials with sensitive collections (PSM, SYSM and BPM) as well as museums of modern arts with non-sensitive collections (MIPIM and DM). Table 4.1 presents the comparative matrices of the case studies. The subsequent chapter presents the results yielded from field works conducted at the case studies as well as the validation results on the conceptual PCE framework.

Table 4.1: Comparative matrices of the case studies

Museum Name	PSM	MIPIM	SYSM	BPM	DM
Museum Type	Public- State Museum	Private Museum	Private Museum	Private Museum	Private Museum
Owner/ Management	Penang State Museum Board (LMNPP)	Loke Gim Tay	Khoo Salma Nasution	Dr. Tan Chong Guan	Mencity Galleries Sdn. Bhd
Architectural Style	British Neoclassical	British Neoclassical	Southern Chinese Eclectic	Southern Chinese Eclectic	Southern Chinese Eclectic
Building Materials	Masonry-built	Masonry-built	Masonry-built	Masonry-built	Masonry-built
Original Use	Educational	Industrial	Civic	Residential	Retail
Museum and Collection Type	Museums of cultural materials (with sensitive collections)	Museums of modern arts (without sensitive collections)	Museums of cultural materials (with sensitive collections)	Museums of cultural materials (with sensitive collections)	Museums of modern arts (without sensitive collections)
Ventilation system	Air-conditioned (wall-hung and cassette units)	Air-conditioned (wall-hung units)	Natural and mechanical ventilations (ceiling and standing fans)	Natural and mechanical ventilations (ceiling fans)	Air-conditioned (wall-hung units)
Lighting system	Artificial lighting with minimal UV-filtered day lighting	Artificial lighting	Natural and artificial lighting	Natural and artificial lighting	Artificial lighting
Security measure	Gated and guarded, CCTV units	CCTV units	Access card entrance	CCTV units	CCTV units
Fire safety measure	Fire sprinklers and fire extinguishers	Fire sprinklers and fire extinguishers	Fire extinguishers	Fire extinguishers	Fire extinguishers
Parking space availability	Yes (provision by the museum for cars and motorcycles, for both staff and visitors)	None provided by the management, yet paid parking lots provided by the local council are available	None provided by the management, yet paid parking lots provided by the local council are available	None provided by the management, yet paid parking lots provided by the local council are available	None provided by the management, yet paid parking lots provided by the local council are available
Landscaping	Potted plants and planted trees at the building compound	None	Potted plants within the indoor air well courtyard	Potted plants within the indoor air well courtyard	None
Accessibility by public transportation	Near to a bus stop and facing main road	Near bus stop and facing main road	Walking distance to bus stop and main road	Walking distance to bus stop and main road	Walking distance to bus stop and main road

CHAPTER 5: RESULTS

5.1 Introduction

This chapter encapsulates the case studies' results on field observation, field measurement and key informants survey conducted in the quest to evaluate the post-conservation impacts of adaptive reuse museums in the UNESCO World Heritage of Malaysia (RO 2). Results on the authenticity-integrity conditions were yielded to inform on physical appropriateness, building performance to inform on functional effectiveness and the Operating Expense Ratio (OER) to inform on financial efficiency. This chapter finally includes the validation results of the conceptual PCE framework to establish its relevance to the actual conservation practise for adaptive reuse museums (RO 3).

5.2 Authenticity Condition

As explained in Chapter Three, the authenticity condition was determined by investigating physical interventions applied at the case studies. Table 5.1 presents the summarised results on authenticity condition obtained at the case studies. The label 'Yes' refers to building element that was appropriately retained whereas the label 'No' refers to otherwise. These remarks collectively lead to the summative score and percentage of the overall building authenticity. Consensus from the FGD conducted was then used to verify on the impact of changes, indicating the extent of the building authenticity condition. Detailed observation data on the investigation of building physical interventions are compiled in Appendix D (D1 to D5).

Table 5.1: Individual results on authenticity condition

Code & Building Element	Case Studies				
	PSM	MIPIM	SYSM	BPM	DM
A. Front façade	No	Yes	No	Yes	No
B. External wall	No	No	Yes	Inaccessible	No
C. Internal wall	No	No	Yes	Yes	No
D. Lower floor	No	Yes	Yes	No	No
E. Upper floor	No	No	Inaccessible	No	No
F. Columns structure	Yes	Yes	Yes	Yes	No
G. Staircase structure	No	No	No	Yes	No
H. Roof structure	Yes	Yes	No	No	Yes
I. Doors	No	Yes	Yes	Yes	No
J. Windows	No	No	Yes	No	No
K. Roof finishes	Inaccessible	Inaccessible	Yes	Yes	Inaccessible
L. Ceiling finishes	No	Yes	Yes	Yes	No
M. Wall finishes	No	No	Yes	Yes	No
N. Floor finishes	No	Yes	Yes	Yes	No
O. Building services	No	No	No	No	No
P. Architectural decorations	Yes	Yes	Yes	Yes	Yes
Authenticity Percentage	(3/15) 20%	(8/15) 53%	(11/15) 73%	(10/15) 67%	(2/15) 13%
Impact of Changes	Moderate	Minor	Negligible	Negligible	Major

The following section presents analysis made on the authenticity condition results in a comparative manner. Table 5.2 is used to guide the comparisons made on the authenticity condition based on intra- and inter-case studies:

Table 5.2: Comparative results on authenticity condition

Case Studies	Authenticity Results				
Individual	**PSM**	**MIPIM**	**SYSM**	**BPM**	**DM**
	20% (Moderate)	53% (Minor)	73% (Negligible)	67% (Negligible)	13% (Major)
Categorical	**Non-shophouse**		**Shophouse**		
	37% (Moderate)		51% (Minor)		
Overall	45% (Minor)				

Comparatively, SYSM of the shophouse building category recorded the highest authenticity condition with negligible impact (73% elements retained). Meanwhile, DM also from the non-shophouse building category recorded the lowest authenticity condition with major impact (13% elements retained). Comparing the average results of the two building categories, the shophouse category shown a better authenticity condition (minor impact-51% elements retained) in relative to the non-shophouse category (moderate impact-37% elements retained).

By overall average, the five buildings recorded authenticity condition with minor impact (45% elements retained). On a positive note, all the five buildings were found to well-retained a building element in common namely architectural decorations (parameter: P). On the flipside, inappropriate intervention regarding the building services (parameter: O) was found at all the five buildings. Figure 5.1 and Figure 5.2 highlight on the elements aforementioned:

Figure 5.1: Well-retained architectural decorations at the case studies

Figure 5.2: Inappropriate interventions made in regard to building services at the case studies

5.3 Integrity Condition

The integrity condition was determined from the inspection of current building conditions made at the case studies, by assessing the 10 most defective historic building elements, using the JKR's Building Condition Assessment (BCA) system as explained earlier in Chapter Three. Table 5.3 to Table 5.7 present the integrity condition results obtained for each building of the case studies. Ratings on the physical condition (Condition Assessment) and repair or maintenance priority (Priority Assessment), based on visual condition survey, were made to ascertain the Matrix Analysis. Calculation on the overall integrity condition is yielded by dividing the Total Marks (summation of the Matrix Analysis) with the Total Number of Defects (presence and spotted during the data collection period). Detailed observation data for each building are compiled in Appendix E (E1 to E5).

Table 5.3: Integrity condition of PSM

Building Element	Defect Description	Defect Tags	BCA Matrix		
			Condition Assessment [a]	Priority Assessment [b]	Matrix Analysis [c] (a X b)
A. External wall	-Detached plaster renderings	1,2,3,4,5	4	4	16
	-Peeling of paint finishes	6,7,8,9			
	-Salt attack	10			
	-Harmful growth	19			
B. Ceiling	-Falling damp (causing watermark)	11,12,13	4	3	12
C. Doors and fixtures	None	-	1	1	1
D. Internal wall	-Rising damp -Salt attack -Detached plaster renderings	14,15	4	4	16
	-Vertical wall crack	16			
E. Roof	-Leakage	17,18	4	5	20
F. Windows and fixtures	-Decayed window panels	20	4	4	16
G. Building services	-Defective rainwater good (rusty material)	21	4	4	16
	-Fungal growth	Through out perimeter drain			
H. Lower and upper floors	None	-	1	1	1
I. Staircase	None	-	1	1	1
J. Miscellaneous	-Broken/ detached/disintegrate architectural element	22	4	3	12
Total No. of Defects [e]= 7					**Total Marks [d]= 111**
Total Score (d/e) = 15.8					
Overall Integrity Condition = Poor					

Table 5.4: Integrity condition of MIPIM

Building Element	Defect Description	Defect Tags	BCA Matrix: Condition Assessment [a]	BCA Matrix: Priority Assessment [b]	BCA Matrix: Matrix Analysis [c] (a X b)
A. External wall	-Harmful growth	1,2	3	3	9
	-Fungal growth	3			
B. Ceiling	-Decayed (shrinkage of) timber strip	4	4	3	12
C. Doors and fixtures	None	-	1	1	1
D. Internal wall	None	-	1	1	1
E. Roof	Inaccessible	-	-	-	-
F. Windows and fixtures	None	-	1	1	1
G. Building services	None	-	1	1	1
H. Lower and upper floors	None	-	1	1	1
I. Staircase	None	-	1	1	1
J. Miscellaneous	-Broken/ detached/disintegrate architectural element (cornice)	5	4	3	12
Total No. of Defects [e]= 3					**Total Marks [d]= 39**
Total Score (d/e) = 13					
Overall Integrity Condition = Fair					

Table 5.5: Integrity condition of SYSM

Building Element	Defect Description	Defect Tags	BCA Matrix		
			Condition Assessment [a]	Priority Assessment [b]	Matrix Analysis [c] (a X b)
A. External wall	-Discoloration of limewash -Fungal growth	1,2,3,4	4	3	12
B. Ceiling	-Peeling of paint finishes	5	4	3	12
C. Doors and fixtures	None	-	1	1	1
D. Internal wall	-Discoloration of limewash	6	4	4	16
E. Roof	Inaccessible	-	-	-	-
F. Windows and fixtures	-Peeling of paint finishes -Deformation of timber frame	7	4	4	16
G. Building services	-Broken/ detached/disintegrate services element (rainwater downpipe)	8	4	5	20
H. Lower and upper floors	-Broken/ detached/disintegrate architectural element (floor tiles)	9.10	4	5	20
I. Staircase	None	-	1	1	1
J. Miscellaneous	-Decayed timber beam	11	5	5	23
	-Broken/ detached/disintegrate services element (timber drain cover)	12			
Total No. of Defects [e]= 7					**Total Marks [d]= 121**
Total Score (d/e) = 17.2					
Overall Integrity Condition = Poor					

Table 5.6: Integrity condition of BPM

<table>
<tr><th rowspan="2">Building Element</th><th rowspan="2">Defect Description</th><th rowspan="2">Defect Tags</th><th colspan="3">BCA Matrix</th></tr>
<tr><th>Condition Assessment [a]</th><th>Priority Assessment [b]</th><th>Matrix Analysis [c] (a X b)</th></tr>
<tr><td>A. External wall</td><td>-Fungal stain/ growth</td><td>1</td><td>3</td><td>2</td><td>6</td></tr>
<tr><td>B. Ceiling</td><td>None</td><td>-</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>C. Doors and fixtures</td><td>None</td><td>-</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td rowspan="3">D. Internal wall</td><td>-Plaster crack</td><td>2</td><td rowspan="3">3</td><td rowspan="3">2</td><td rowspan="3">6</td></tr>
<tr><td>-Peeling of paint finishes
-Rising damp</td><td>3</td></tr>
<tr><td>-Falling damp</td><td>4,5,6</td></tr>
<tr><td>E. Roof</td><td>Inaccessible</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>F. Windows and fixtures</td><td>None</td><td>-</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>G. Building services</td><td>None</td><td>-</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>H. Lower and upper floors</td><td>None</td><td>-</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>I. Staircase</td><td>None</td><td>-</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>J. Miscellaneous</td><td>None</td><td>-</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>Total No. of Defects [e]= 2</td><td colspan="4"></td><td>Total Marks [d]= 19</td></tr>
<tr><td colspan="6">Total Score (d/e) = 9.5</td></tr>
<tr><td colspan="6">Overall Integrity Condition = Good</td></tr>
</table>

Table 5.7: Integrity condition of DM

Building Element	Defect Description	Location (Photo Tag)	BCA Matrix: Condition Assessment [a]	BCA Matrix: Priority Assessment [b]	BCA Matrix: Matrix Analysis [c] (a X b)
A. External wall	-Detached plaster renderings	1	4	3	12
	-Peeling of paint finishes	1,3			
	-Stained surface	4			
B. Ceiling	None	-	1	1	1
C. Doors and fixtures	None	-	1	1	1
D. Internal wall	None	-	1	1	1
E. Roof	Inaccessible	-	-	-	-
F. Windows and fixtures	None	-	1	1	1
G. Building services	None	-	1	1	1
H. Lower and upper floors	None	-	1	1	1
I. Staircase	None	-	1	1	1
J. Miscellaneous	-Decayed timber beam	2	4	4	16
Total No. of Defects [e]= 2					**Total Marks [d]= 35**
Total Score (d/e) = 17.5					
Overall Integrity Condition = Poor					

The following write-up presents analysis made on the integrity condition results in a comparative manner. Table 5.8 is used to guide the comparisons made on the integrity condition based on intra- and inter-case studies:

Table 5.8: Comparative results on integrity condition

Case Studies	Integrity Results				
Individual	**PSM**	**MIPIM**	**SYSM**	**BPM**	**DM**
	15.8 (Poor)	13 (Fair)	17.2 (Poor)	9.5 (Good)	17.5 (Poor)
Categorical	**Non-shophouse**		**Shophouse**		
	14.4 (Poor)		14.7 (Poor)		
Overall	14.6 (Poor)				

Comparatively, BPM of the shophouse building category recorded the highest integrity condition with good physical state (BCA score 9.5). Meanwhile, DM also from the shophouse building category recorded the lowest integrity condition with poor physical state (BCA score 17.5), followed with SYSM (BCA score 17.2) of the similar building category, and PSM (BCA score 15.8) of the non-shophouse building category. Both building categories however recorded poor physical state based on their average results, with the non-shophouse building category (BCA score 14.4) recorded a slight better integrity condition compared to the shophouse building category (BCA score 14.7). By overall average, the five buildings recorded poor physical state (BCA score 14.6). Figure 5.3 highlights on the common building element inflicted with integrity issues at the five adaptive reuse museums:

Figure 5.3: Peeling of paint finishes, unwanted biological growth, faded and mouldy surfaces and crumbling plastering work at the case studies

5.4 Thermal Environment Performance

The thermal environment performance was measured through monitoring the IEQ parameters of relative humidity and indoor temperature levels within the case studies. Table 5.9 shows the performance benchmarks used for analysis purpose:

Table 5.9: Performance benchmarks for thermal environment

IEQ Parameter		Collections Preservation	Users' Comfort
Thermal Environment	Relative humidity (%)	50-55% (Padfield, 1994)	60-70 % (Department of Standard Malaysia, 2007)
	Indoor temperature (°C)	16-20 °C (Ambrose & Paine, 2006)	23-26 °C (Department of Standard Malaysia, 2007)

Figure 5.4 to Figure 5.8 present the thermal environment performance graphs of the five buildings individually, with the readings based on hourly average during their operational hours (from 9 am to 5 pm) on 03rd November 2016 until 09th November 2016 (for PSM), on 24th December 2016 until 30th December 2016 (for MIPIM), on 06th December 2016 until 12th December 2016 (for SYSM), on 14th December 2016 until 23rd December 2016 (for BPM), and, on 31st December 2016 until 06th January 2017 (for DM).

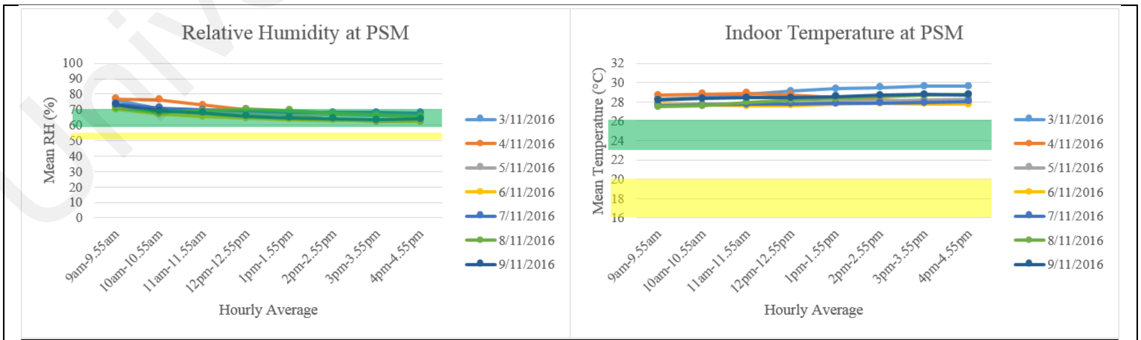


Figure 5.4: Relative humidity (left) and indoor temperature (right) levels at PSM

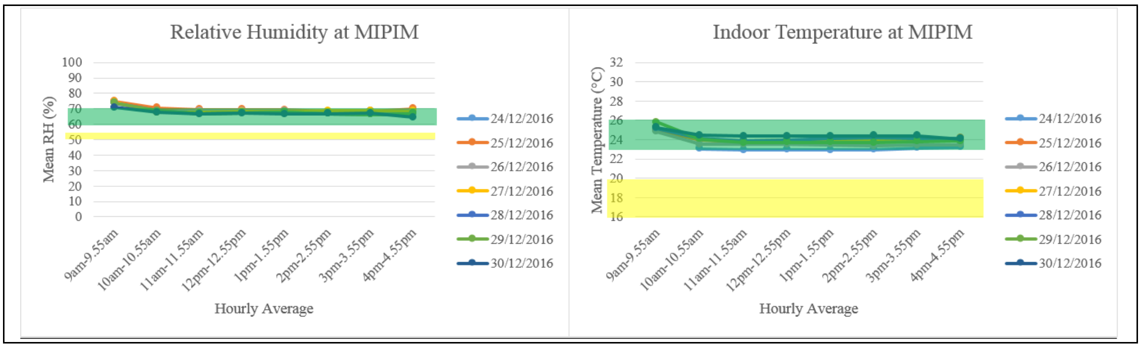


Figure 5.5: Relative humidity (left) and indoor temperature (right) levels at MIPIM

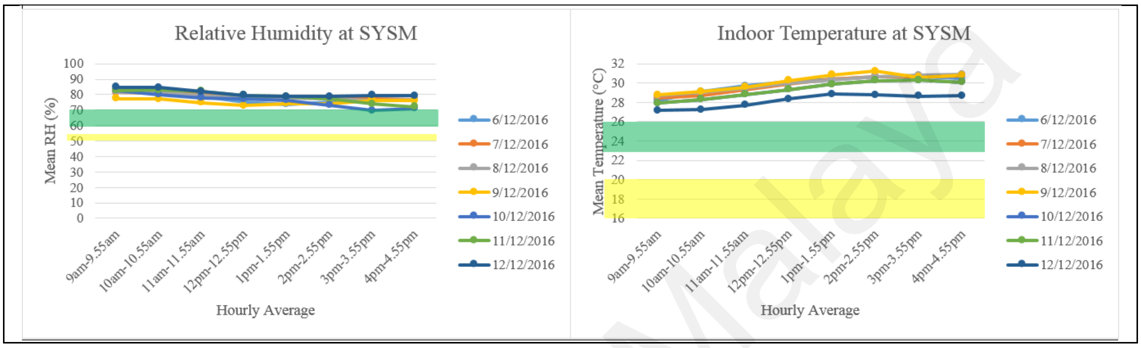


Figure 5.6: Relative humidity (left) and indoor temperature (right) levels at SYSM

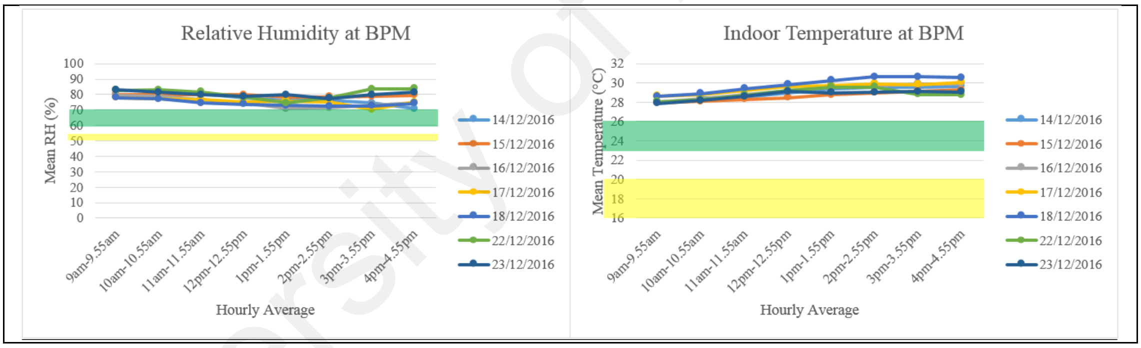


Figure 5.7: Relative humidity (left) and indoor temperature (right) levels at BPM

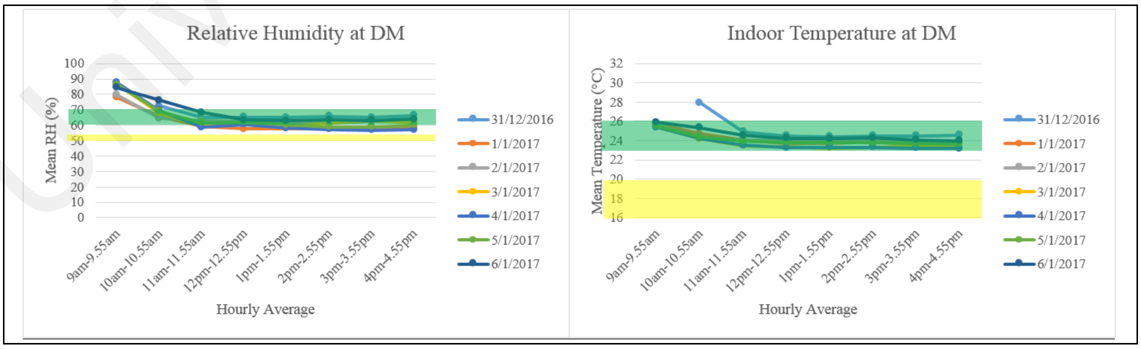


Figure 5.8: Relative humidity (left) and indoor temperature (right) levels at DM

Referring to the graphs on thermal environment performance for the non-shophouse and shophouse building categories based on daily average from 9 am to 5 pm for one-week period shown in Figure 5.9, none of the adaptive reuse museums from the two building categories did comply with the performance benchmark ranges of relative humidity and indoor temperature for collections preservation. Meanwhile in terms of compliance with the performance benchmark ranges of relative humidity and indoor temperature for users’ comfort, only one museum, each from the two building categories, did comply namely MIPIM of non-shophouse building and DM of shophouse building. Within the shophouse building category, SYSM and BPM did not comply with the performance benchmark ranges of relative humidity and indoor temperature for both collections preservation and users’ comfort.

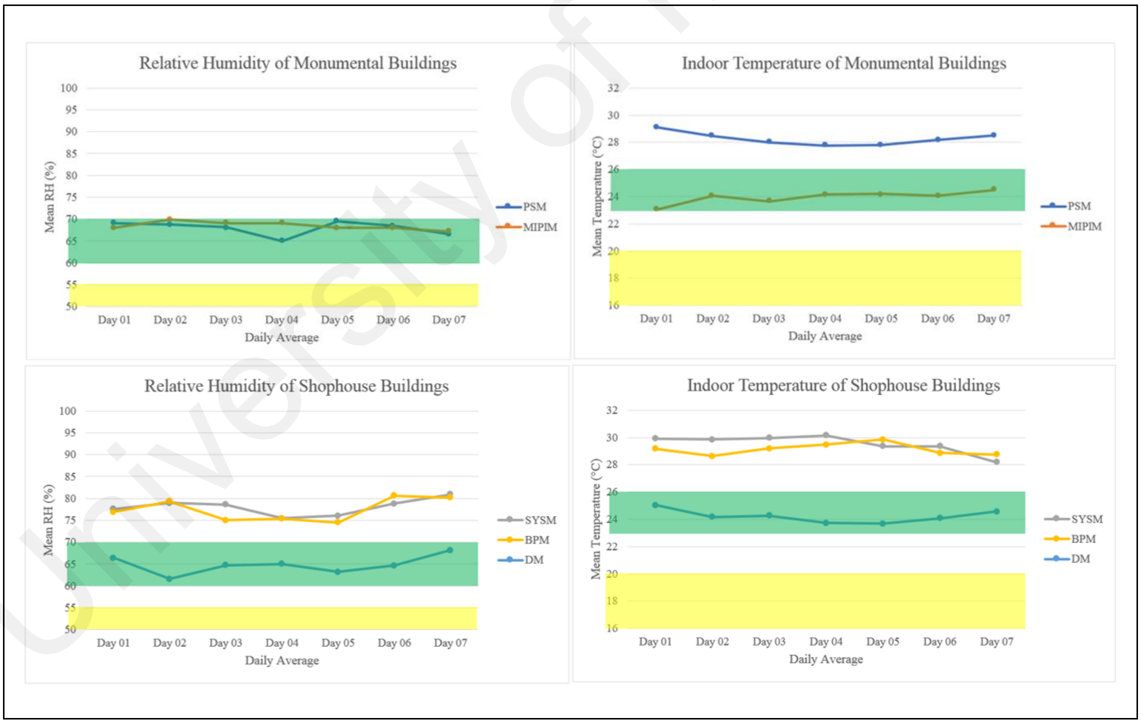


Figure 5.9: Thermal environment performance of the non-shophouse (top) and shophouse buildings (bottom)

It can be inferred that following the non-use of air-conditioners to control indoor climate and non-concealed building openings, the shophouse buildings ought to have lower relative humidity level and higher indoor temperature level compared to non-shophouse buildings. Except for DM, both SYSM and BPM of shophouse building category use their internal courtyard feature, window openings as well as mechanical fans for their ventilation purposes.

Figure 5.10: The uses of internal courtyard, ceiling fans and window openings for ventilation purposes at SYSM (left) and BPM (right)

Figure 5.11: Air-conditioned room at PSM (left) and glass-concealed window at MIPIM (right)

Referring to the thermal environment performance of the overall case studies based on one-week average from 9 am to 5 pm for one-week period shown in Figure 5.12, merely two out of the five of the adaptive reuse museums namely MIPIM and DM did comply with the performance benchmarks of relative humidity and indoor temperature for users' comfort. Surprisingly, none of the five adaptive reuse museums did comply with the performance benchmarks of relative humidity and indoor temperature for collections preservation.

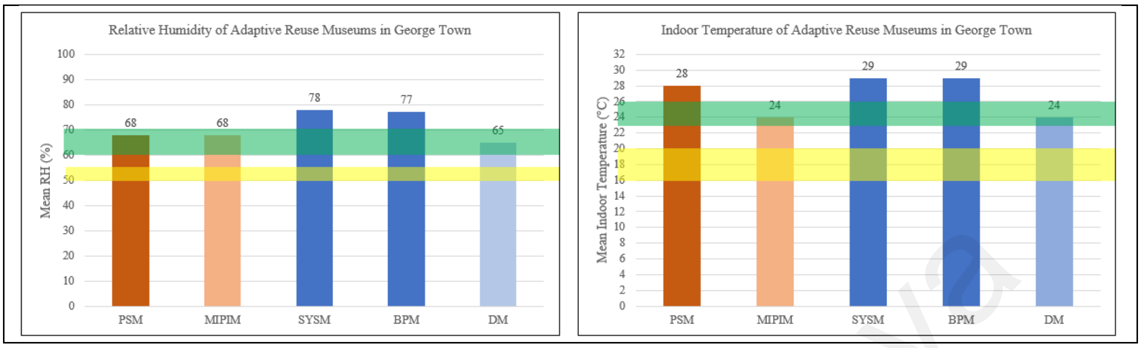


Figure 5.12: Thermal environment performance of the case studies

Comparatively throughout the week, SYSM recorded the highest relative humidity level (78%) whereas DM recorded the lowest (65%). On the other aspect, both SYSM and BPM recorded the highest level of indoor temperature (both 29°C) whereas MIPIM and DM recorded the lowest level of indoor temperature (both 24°C). It can be inferred that all the five adaptive reuse museums did not accomplish the required thermal environment performance for collections preservation due to having high relative humidity and indoor temperature levels.

From the results, it can be implied that the types of ventilation systems used at SYSM and BPM was the underlying cause for these two museums having high relative humidity and indoor temperature levels. As with higher temperature, the ability of air to withhold water increases (Abdul Karim, Talib, & Sujak, 2012). Both SYSM and BPM use mechanical ventilation (ceiling fans and standing fans) to complement their natural ventilation gained through window openings and internal air-wells. With the absence of air-conditioning, the two museums hence have a relatively higher indoor climate compared to air-conditioned museums of PSM, MIPIM and DM.

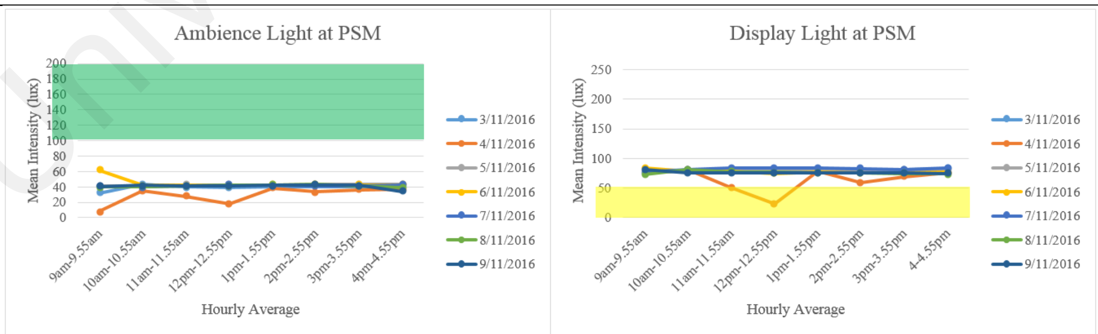
5.5 Lighting Performance

The lighting performance was measured through monitoring the IEQ parameters of ambience light and display light intensities within the case studies. Table 5.10 shows the performance benchmarks used for analysis purpose:

Table 5.10: Performance benchmarks for lighting performance

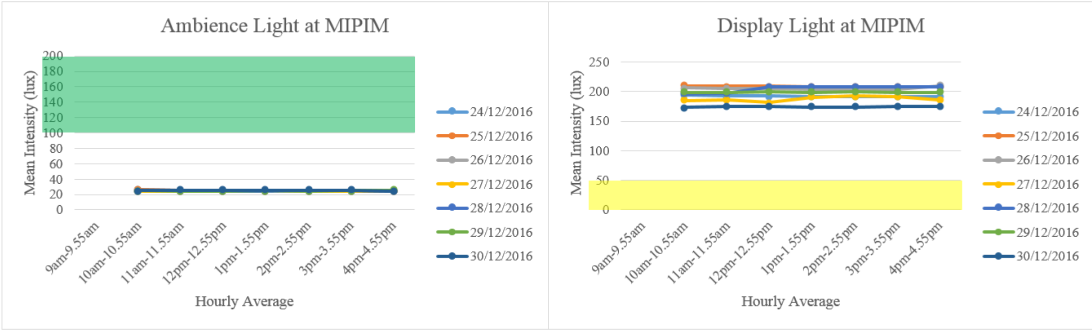
IEQ Parameter		Collections Preservation	Users' Comfort
Lighting	Ambience lighting (lux)	-	100-200 lux (Michalski, 2004)
	Display lighting (lux)	<50 lux (Finney, 2006)	-

Figure 5.13 to Figure 5.17 meanwhile present the lighting performance graphs of the five buildings individually, with the readings based on hourly average during their operational hours (from 9 am to 5 pm) on 03rd November 2016 until 09th November 2016 (for PSM), on 24th December 2016 until 30th December 2016 (for MIPIM), on 06th December 2016 until 12th December 2016 (for SYSM), on 14th December 2016 until 23rd December 2016 (for BPM), and, on 31st December 2016 until 06th January 2017 (for DM). The outdoor weather conditions obtained from the Malaysian Meteorological Department were also included therein (MMD, 2018).



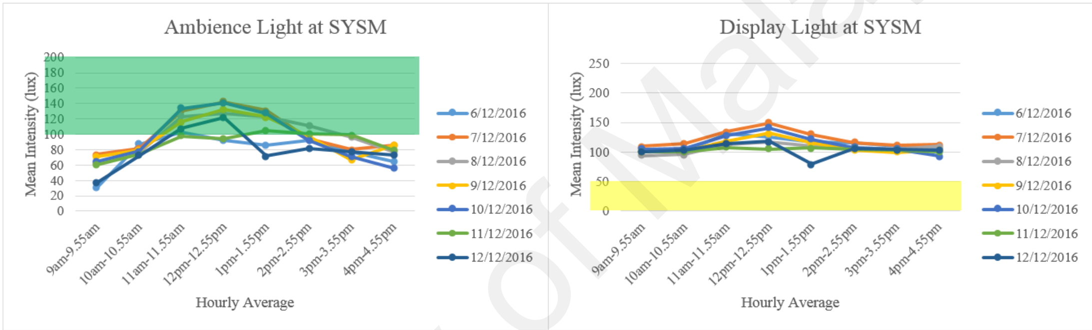
Outdoor Weather Condition (MMD, 2018)		Day						
		01	02	03	04	05	06	07
Period	9am-12pm	Cloudy	Sunny	Rainy	Cloudy	Rainy	Sunny	Cloudy
	12pm-5pm	Cloudy	Rainy	Cloudy	Cloudy	Sunny	Cloudy	Cloudy

Figure 5.13: Ambience light (left) and display light (right) intensities at PSM



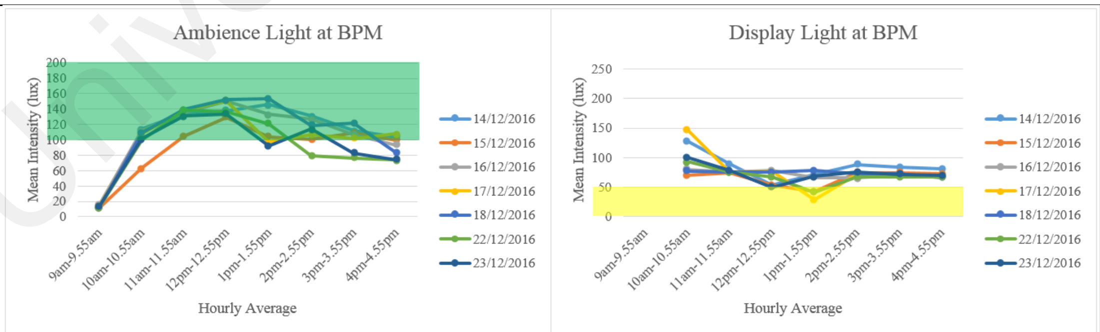
Outdoor Weather Condition (MMD, 2018)		Day						
		01	02	03	04	05	06	07
Period	9am-12pm	Cloudy	Cloudy	Sunny	Sunny	Cloudy	Cloudy	Cloudy
	12pm-5pm	Sunny	Cloudy	Cloudy	Sunny	Cloudy	Cloudy	Cloudy

Figure 5.14: Ambience light (left) and display light (right) intensities at MIPIM



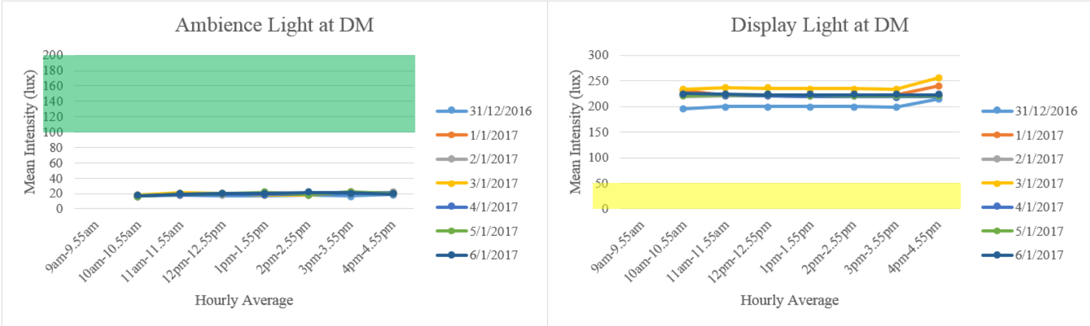
Outdoor Weather Condition (MMD, 2018)		Day						
		01	02	03	04	05	06	07
Period	9am-12pm	Cloudy	Cloudy	Cloudy	Sunny	Cloudy	Rainy	Cloudy
	12pm-5pm	Sunny	Sunny	Sunny	Sunny	Cloudy	Cloudy	Sunny

Figure 5.15: Ambience light (left) and display light (right) intensities at SYSM



Outdoor Weather Condition (MMD, 2018)		Day						
		01	02	03	04	05	06	07
Period	9am-12pm	Cloudy	Cloudy	Cloudy	Sunny	Sunny	Sunny	Cloudy
	12pm-5pm	Sunny	Cloudy	Cloudy	Sunny	Cloudy	Cloudy	Cloudy

Figure 5.16: Ambience light (left) and display light (right) intensities at BPM



Outdoor Weather Condition (MMD, 2018)		**Day**						
		01	02	03	04	05	06	07
Period	9am-12pm	Cloudy	Cloudy	Sunny	Sunny	Sunny	Sunny	Sunny
	12pm-5pm	Sunny	Sunny	Cloudy	Cloudy	Cloudy	Sunny	Sunny

Figure 5.17: Ambience light (left) and display light (right) intensities at DM

Referring to the graphs on lighting performance for the non-shophouse and shophouse building categories based on daily average from 9 am to 5 pm for one-week period shown in Figure 5.18, only SYSM and BPM from the shophouse building category did partially comply with the performance benchmark range of ambience light for users' comfort. However, none of the adaptive reuse museums from both building categories did comply with the performance benchmark range of display light for collections preservation.

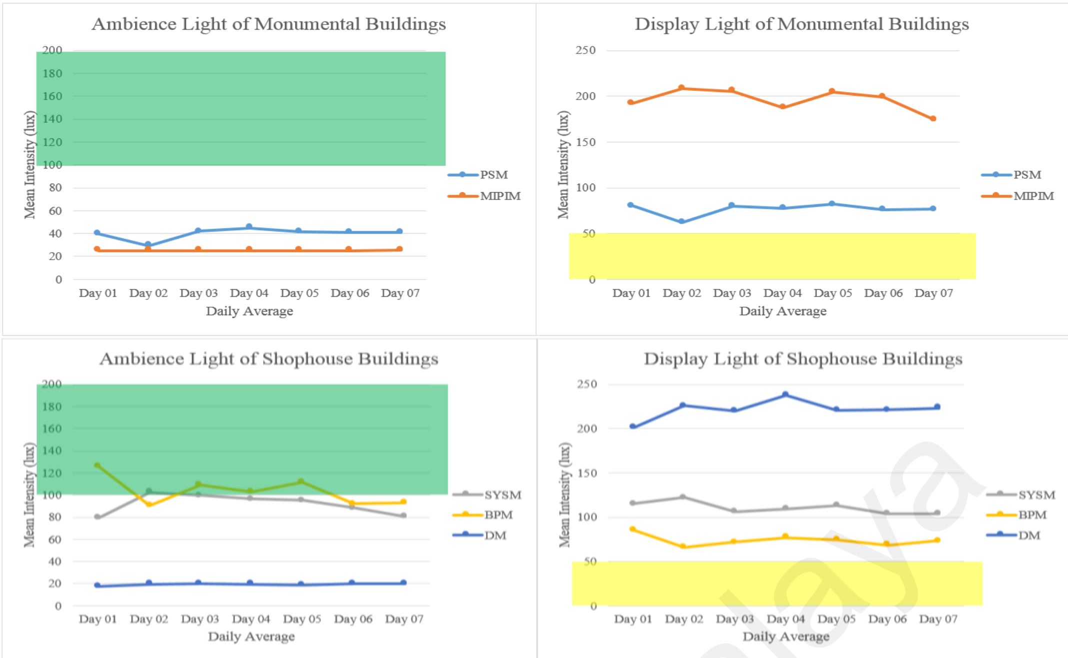


Figure 5.18: Lighting performance of the non-shophouse (top) and shophouse buildings (bottom)

It can be inferred that the adaptive reuse museums of shophouse building category ought to have better ambience lighting for users' comfort compared to the adaptive reuse museums of non-shophouse building category following the penetration of natural daylighting through internal courtyard feature and window openings as available at SYSM and BPM. The lighting performance results also shows that the adaptive reuse museums from the two building categories have high level of display lighting which can trigger in the deterioration of sensitive collections.

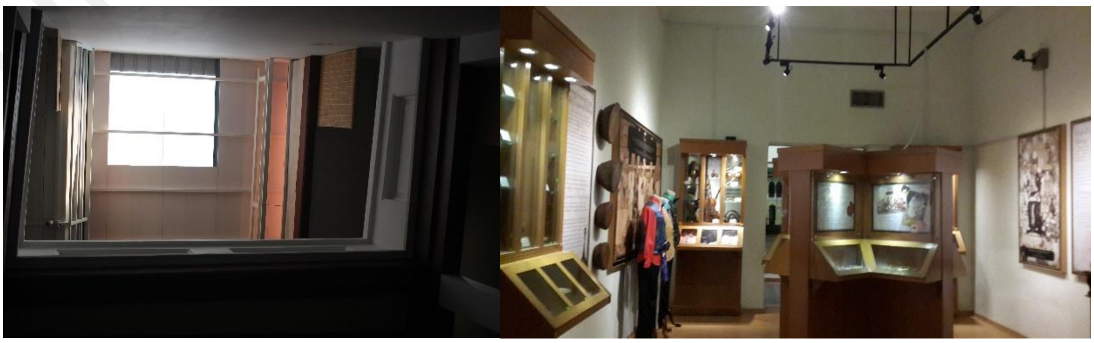


Figure 5.19: Natural daylight penetration through internal courtyard for ambience lighting at BPM (left) and artificial light settings for display lighting at PSM (right)

Referring to the lighting performance of the overall case studies based on one-week average from 9 am to 5 pm for one-week period shown in Figure 5.20, only one of the adaptive reuse museums namely BPM did comply to the performance benchmark range of ambience light for users' comfort while none of the five adaptive reuse museums did comply to the performance benchmark range of display light for collections preservation.

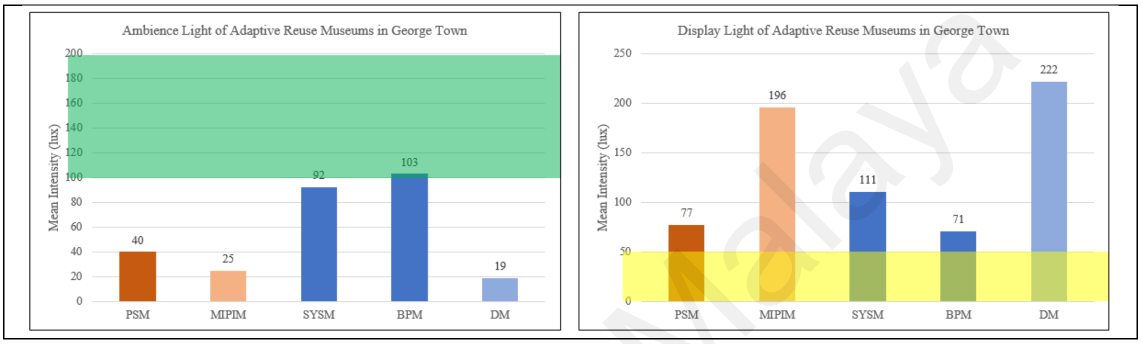


Figure 5.20: Lighting performance of the case studies

Comparatively throughout the week, BPM recorded the highest ambience light intensity (103 lux) whereas DM has the lowest (19 lux). Conversely, DM recorded the highest display light intensity (222 lux) while BPM has the lowest (71 lux). It can be inferred that majority of the adaptive reuse museums (all except BPM) did not accomplish the required lighting performance for users' comfort for having low ambience light intensity. Besides, they all did not accomplish the required lighting performance for collections preservation due to having high display light intensity.

Implying from the results, the high intensity of ambience light for BPM can be associated with the case where along the museum operational hours, the museum staff opened most of the building windows, at both front and rear sides of the building to allow natural daylight penetration. DM which recorded the lowest ambience light intensity reading meanwhile can be attributed to the nature of the museum which projects special effects via glow in the dark features, requiring all openings at the first floor of the building to fully enclosed.

5.6 Indoor Air Quality Performance

The indoor air quality performance was measured through monitoring the IEQ parameters on the concentration levels of carbon dioxide (CO_2) and total volatile organic compound (TVOC) within the case studies. Table 5.11 shows the performance benchmarks used for analysis purpose:

Table 5.11: Performance benchmarks for indoor air quality performance

IEQ Parameter		Users' Comfort
Indoor Air Quality	CO_2 concentration (ppm)	<1000 ppm (Ramalho, et al., 2015)
	TVOC concentration (ppm)	<3 ppm (DOSH, 2010)

Figure 5.21 to Figure 5.25 present the indoor air quality performance graphs of the five buildings individually, with the readings based on hourly average during their operational hours (from 9 am to 5 pm) on 03rd November 2016 until 09th November 2016 (for PSM), on 24th December 2016 until 30th December 2016 (for MIPIM), on 06th December 2016 until 12th December 2016 (for SYSM), on 14th December 2016 until 23rd December 2016 (for BPM), and, on 31st December 2016 until 06th January 2017 (for DM).

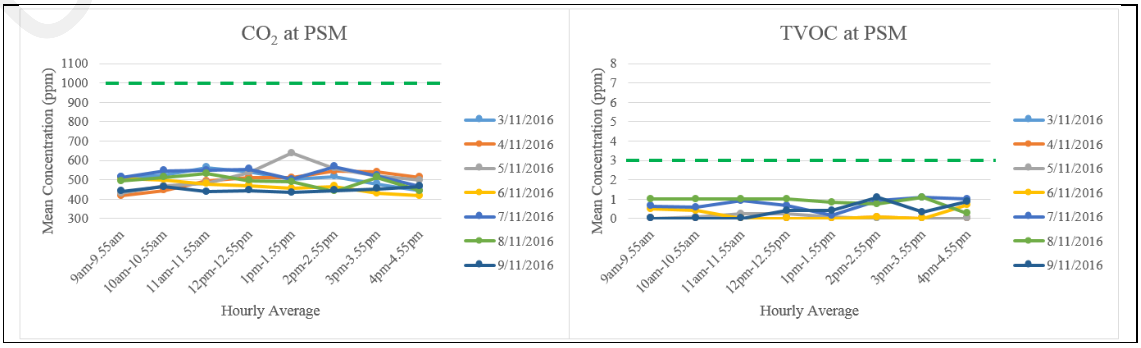


Figure 5.21: CO_2 concentration (left) and TVOC concentration (right) levels at PSM

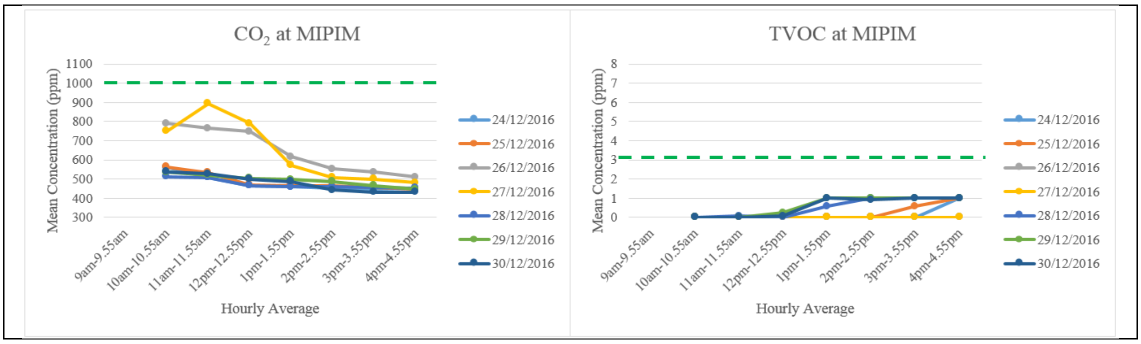


Figure 5.22: CO_2 concentration (left) and TVOC concentration (right) levels at MIPIM

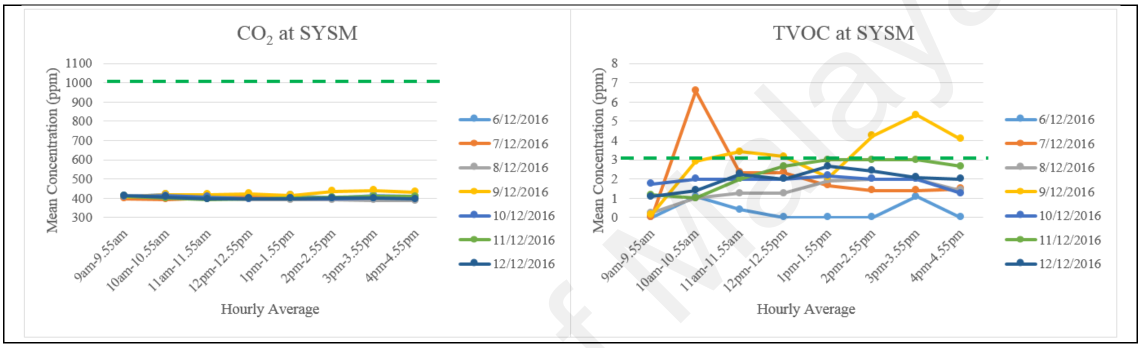


Figure 5.23: CO_2 concentration (left) and TVOC concentration (right) levels at SYSM

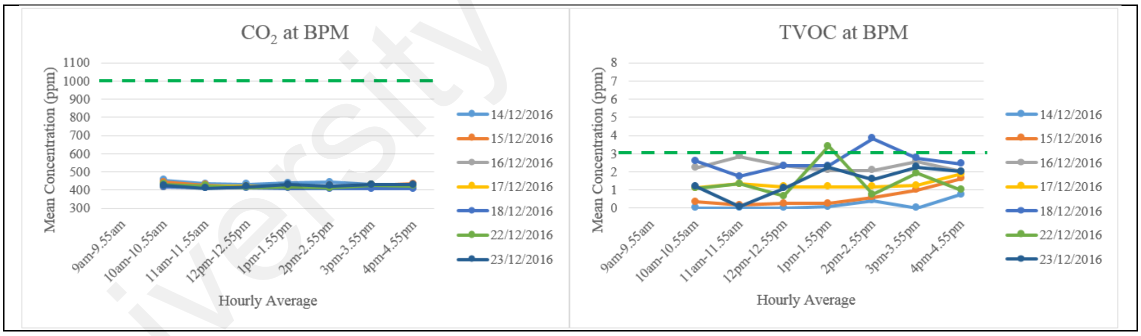


Figure 5.24: CO_2 concentration (left) and TVOC concentration (right) levels at BPM

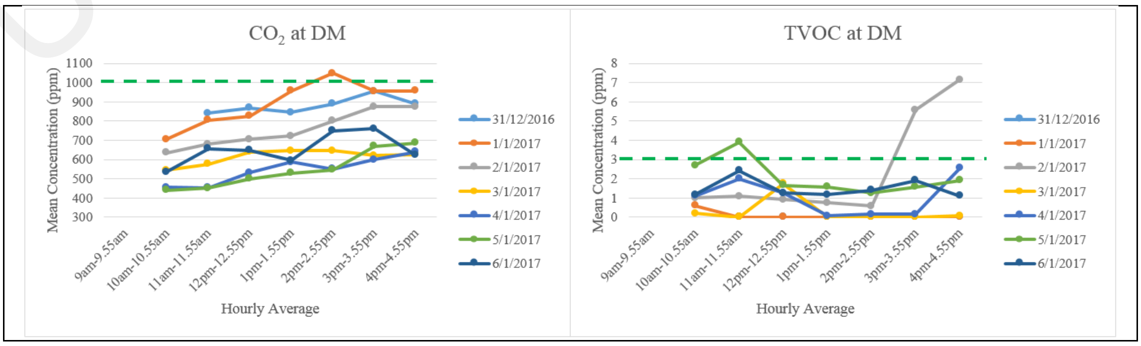


Figure 5.25: CO_2 concentration (left) and TVOC concentration (right) levels at DM

Referring to the graphs on indoor air quality performance for the non-shophouse and shophouse building categories based on daily average from 9 am to 5 pm for one-week period shown in Figure 5.26, all the adaptive reuse museums from the two building categories did not exceed the threshold limit values of CO_2 and TVOC. Only SYSM particularly on Day 04 has slightly reached the threshold limit value of TVOC following the uses of joss stick for religious rituals and the periodical termite prevention routine using pesticide on that very day. The results indicate that the adaptive reuse museums from the two building categories did comply with the indoor air quality requirement for users' comfort.

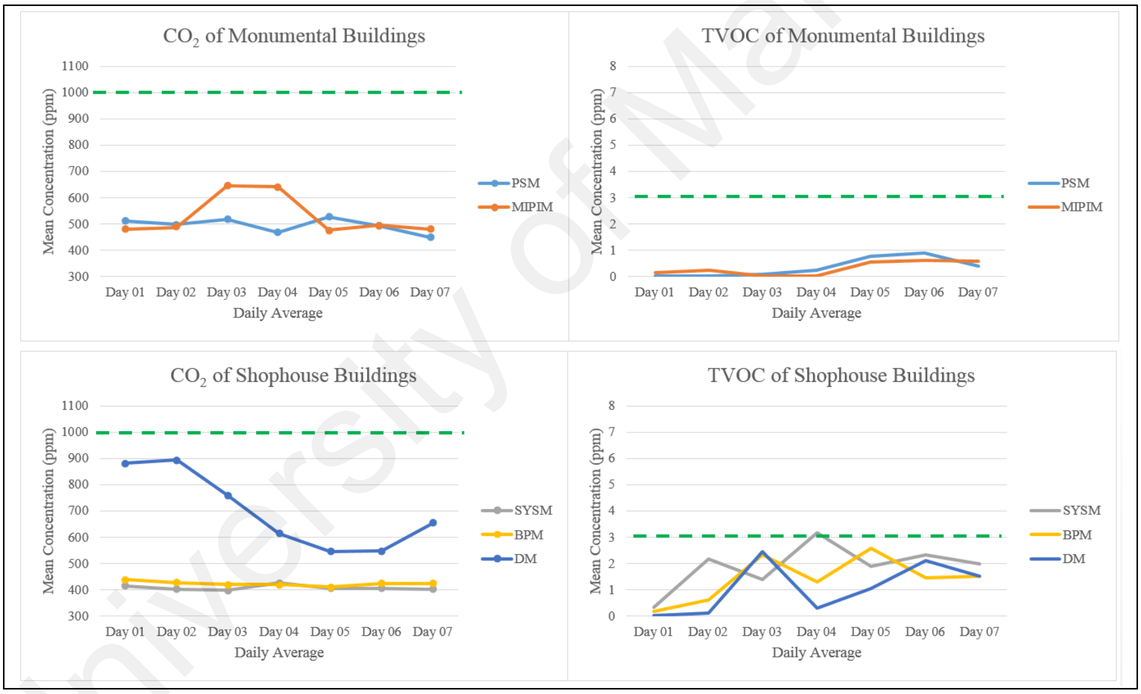


Figure 5.26: Indoor air quality performance of the non-shophouse (top) and shophouse buildings (bottom)

Referring to the indoor air quality performance of the overall case studies based on one-week average from 9 am to 5 pm for one-week period shown in Figure 5.27, all the five adaptive reuse museums did not exceed the threshold limits of both CO_2 and TVOC concentration levels for users' comfort. Comparatively throughout the week, DM recorded the highest CO_2 concentration level (692 ppm) whereas SYSM recorded the lowest (406 ppm). On the other aspect, SYSM recorded the highest TVOC concentration level (2 ppm) whereas PSM and MIPIM both recorded the lowest (both 0 ppm). It can be inferred that all the five adaptive reuse museums accomplished the required indoor air quality performance for users' comfort for having low CO2 and TVOC concentration levels.

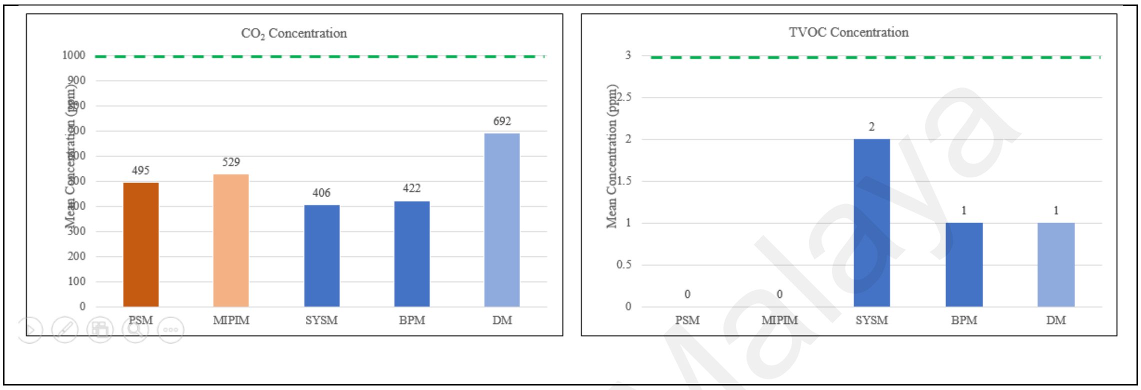


Figure 5.27: Indoor air quality performance of the case studies

From the results, it can be implied that SYSM and BPM have lesser CO_2 concentration in relative to the other museums due to having internal air-well features which promote natural air circulation and ventilation. Besides, SYSM and BPM whom had the least visitors in relative to the other museums (based on observed estimation throughout the week of data collection), can be associated with their less production of CO_2 concentration. This is because humans are known to be the prime source of CO_2 within an indoor environment (Kong, 2014). DM meanwhile had the highest CO_2 concentration possibly due to lacking in fresh outdoor air following the visitors over space size ratio. This thus causing CO_2 to build up when the building gets overcrowded with visitors (Sulaiman & Mohamed, 2011). The high reading of TVOC concentration at SYSM can be associated with the uses of joss sticks in the museum for religious rituals and practice. Apart from that, pesticide was also sprayed within the building to eliminate termite infestation, confirming Kong's (2014) claim that chemically formulated products will increase in the exposure to indoor air pollutants.

5.7 Operating Expense Ratio (OER)

For evaluating the post-conservation impacts of adaptive reuse museums in terms of financial efficiency, the two aspects sought from the case studies through the survey were on the museums income (based on ticketing revenue and heritage conservation fund received) and expenditure (based on operational and maintenance costs). The museums involved as case studies basically consisted of a public museum (government-owned) namely PSM. The other four meanwhile were private museums, based on individual ownership namely SYSM and BPM, as well as, company-based ownership namely MIPIM and DM. Financial data from PSM was retrievable through the LMNPP's annual reports for the years 2010 until 2014. Yet so, LMNPP's financial performance for the years 2015 and 2016 were unavailable since their annual report (issuance based on biennial frequency) was yet to be published.

Financial data from the private museums however were relatively difficult to be obtained, especially from those based on individual ownership. SYSM specifically did not provide the financial data due to confidentiality whereas financial records of BPM for the year 2013 and 2014 have been missing. DM meanwhile merely provided one-year financial data for the year 2016 following the recent establishment of the museum. In these regard, annual OER patterns for SYSM and DM cannot be projected. The OER from the case studies was yielded through surveying key informants as listed in Table 5.12:

Table 5.12: Museum key informants involved in the financial performance survey

Museums	Key Informants' Position
PSM	Museum assistant
MIPIM	Museum co-owner and accounting staff
SYSM	-
BPM	Museum staff
DM	Museum director

Table 5.13 meanwhile summarises the individual results on OER of the case studies, in accordance to the approach explained earlier in Chapter Three:

Table 5.13: Individual OER results of the case studies

Case Studies		OER								
		2008	2009	2010	2011	2012	2013	2014	2015	2016
Non-Shophouses	PSM	-	-	0.14	0.10	0.11	0.13	0.12	-	-
	MIPIM	-	-	-	-	-	0.13	0.02	0.11	0.11
Shophouses	SYSM	-	-	-	-	-	-	-	-	-
	BPM	-	-	-	-	-	-	-	0.29	0.46
	DM	-	-	-	-	-	-	-	-	0.16

Based on the results shown in Table 5.13, none of the adaptive reuse museums shows a steadily declining OER trend throughout the years. Implying from the results, the historic buildings of the case studies have yet to gain a stable return of investment from their conversion to museums following their lukewarm income received compared to operational and maintenance costs required.

5.8 Framework Validation

This sub-heading presents the meta-evaluation results of the conceptual PCE framework prior to its establishment, based on validation made by conservation experts and stakeholders. Table 5.14 and the following sections describe the participants involved to validate the conceptual PCE framework.

The first participant (P1) was from Universiti Sains Malaysia (USM). He is currently the director of Creative Design House in USM and an expert in the field of design and culture and has published articles in historic museum and interior preservation. The second participant (P2) was from Universiti Malaysia Kelantan (UMK). He is an expert in the field of facility management, known to contribute in the development of a theoretical framework which linked cultural heritage building values with the roles of facility management from his doctoral thesis.

Table 5.14: Participants involved in the validation process

Participant	Areas of Expertise	Affiliation
P1	Design and culture, museum and interior preservation	Universiti Sains Malaysia (USM)
P2	Facility management for historic building	Universiti Malaysia Kelantan (UMK)
P3	Building conservation and heritage management	Current: Universiti Teknologi MARA (UiTM)/ Past: Department of National Heritage (JWN)
P4	Building physics, conservation of historic buildings and objects	Eindhoven University of Technology (EUT)
P5	Built environment and monitoring of UNESCO World Heritage Site (George Town)	George Town World Heritage Inc. (GTWHI)
P6	Building conservation procedures and techniques	Current: Universiti Sains Malaysia (USM)/ Past: Department of National Heritage (JWN)
P7	Fire prevention for historic building functioning as museum	International Islamic University Malaysia (IIUM)
P8	Conservation and maintenance of historic building	Department of National Heritage (JWN)

The third participant (P3) was from Universiti Teknologi MARA (UiTM). She is an expert in the field of building conservation and heritage management and used to serve the Department of National Heritage (JWN) of Malaysia as a deputy commissioner. The fourth participant (P4) was from Eindhoven University of Technology (EUT). He is an expert in the areas of building physics, conservation of historic buildings and objects. P4 has authored several academic articles on building performance of historic buildings and museums.

The fifth participant (P5) was from George Town World Heritage Inc. (GTWHI). He is the built environment monitoring officer for historic city of George Town, the UNESCO World Heritage of Malaysia. The sixth participant (P6) was from USM. He is an expert in the conservation of historic building in Malaysia and used to serve JWN as a deputy commissioner. He used to represent Malaysia as a delegate and panel to attend UNESCO World Heritage meeting.

The seventh participant (P7) was from International Islamic University Malaysia (IIUM). He is an expert in the field of fire prevention for historic museums and has visited numerous museums in Malaysia following his research niche. The eighth and final participant (P8) was from JWN. She is currently the conservation director in JWN and renowned for her expertise in the conservation and maintenance of historic building in Malaysia.

5.8.1 Content Validity

a) Delphi First-Iteration

Figure 5.28 presents the code-labelled conceptual PCE framework developed based on criteria reviewed in Chapter Two, which then tested for its operational and empirical capabilities using the case studies. The labelling (from A1 to C4) on the framework represents the respective questionnaire items (from Q1 to Q12) as used in the validation form (Appendix F1). Table 5.15 presents the results on Content Validity Index (CVI) comprising the Content Validity of Individual Items (I-CVI) and the Content Validity of Overall Scale (S-CVI).

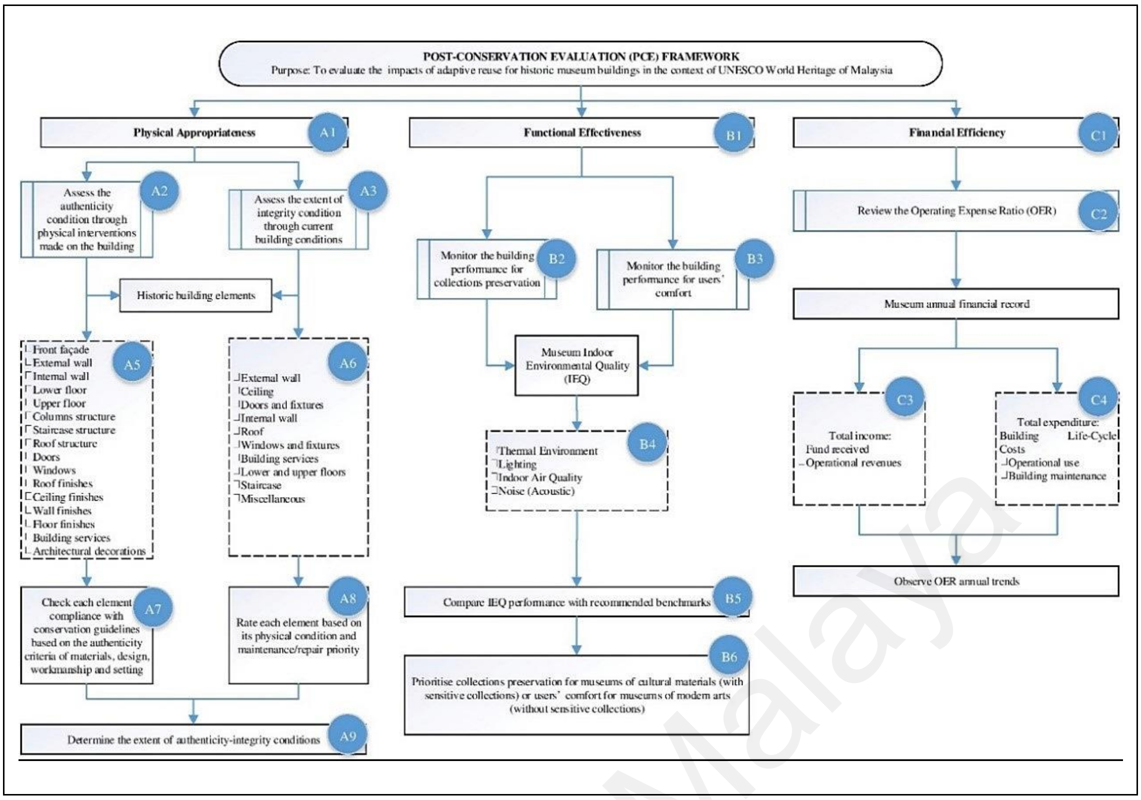


Figure 5.28: The conceptual PCE framework for first-round validation

Table 5.15: Results on CVI for first-round validation

		Participants (Experts/ Stakeholders)									
		P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**No. in Agreement**	**I-CVI**
PCE Contents	**Q1**	X	X	X	X	X	X	X	X	8	1.00
	Q2	X	X	X	X	X	X	X	X	8	1.00
	Q3	X	X	X	X	X	X	X	X	8	1.00
	Q4	X	X	X	X	X	X	X	X	8	1.00
	Q5	X	X	X	X	X	X	X	X	8	1.00
	Q6	X	X	X	X	X	X	X	X	8	1.00
	Q7	X	X	X	X	X	X	X	X	8	1.00
	Q8	X	X	X	X	X	X	X	X	8	1.00
	Q9	X	X	X	X	X	X	X	X	8	1.00
	Q10	X	X	-	X	X	X	X	X	7	0.88
	Q11	X	X	-	X	X	X	X	X	7	0.88
Remark: i. 'X' indicates item rated 'relevant' by the participants. It refers to item rated 3-quite relevant or 4-highly relevant. ii. '-' indicated item rated 'not relevant' by the participants. It refers to item rated 1-not relevant or 2-somewhat relevant.										**S-CVI Ave (Mean I-CVI)**	0.97
										S-CVI/ UA	0.82

i. Content Validity of Individual Items (I-CVI)

Referring to Figure 5.28 and Table 5.15, the I-CVI result of 1.00 has been achieved for the PCE components (A1 to A9 labels) to evaluate physical appropriateness criterion (as probed from Q1 to Q5 in the survey). Similarly, the I-CVI result of 1.00 has been achieved for the PCE components (B1 to B6 labels) to evaluate functional effectiveness criterion (as probed from Q6 to Q9 in the survey). The physical appropriateness and functional effectiveness criteria of the PCE framework hence have been proven to be relevance.

Meanwhile, the I-CVI result of 0.88 has been achieved for the PCE components (C1 to C4 labels) to evaluate financial efficiency criterion (as probed from Q10 to Q11 in the survey). The slightly lower value was due to the rating of 'not relevant' by P3, whom suggested that Contingency Valuation Method (CVM) in terms of willingness-to-pay (WTP) should be included for evaluating financial efficiency of adaptive reuse museums. This result however exceeds the minimum benchmark of 0.78 as stated in Chapter Three.

ii. Content Validity of Overall Scale (S-CVI)

The S-CVI/ Ave is computed based on the mean of I-CVI results from Q1 to Q11. Meanwhile, S-CVI/ UA is based on dividing the sum of questions that were rated 'relevant' (as indicated by 'X') by all the eight participants (n=9), with the total questions (N=11). With none of the I-CVI achieved less than 0.78, content validity of the PCE framework achieved 0.97 for S-CVI/ Ave and 0.82 for S-CVI/ UA. Both S-CVI of the PCE framework exceed the minimum 0.80 as benchmarked by Davis (1992). Conclusively from the results, the conceptual PCE framework has excellent content validity (Lynn, 1986; Polit & Beck, 2006).

b) Delphi Second-Iteration

Figure 5.29 presents the conceptual PCE framework refined based on the first-round validation performed. The labelling (from A1 to C4) on the framework represents the respective questionnaire items (from Q1 to Q12) as used in the validation form (Appendix F2). Table 5.16 presents the results on Content Validity Index (CVI) comprising the Content Validity of Individual Items (I-CVI) and the Content Validity of Overall Scale (S-CVI).

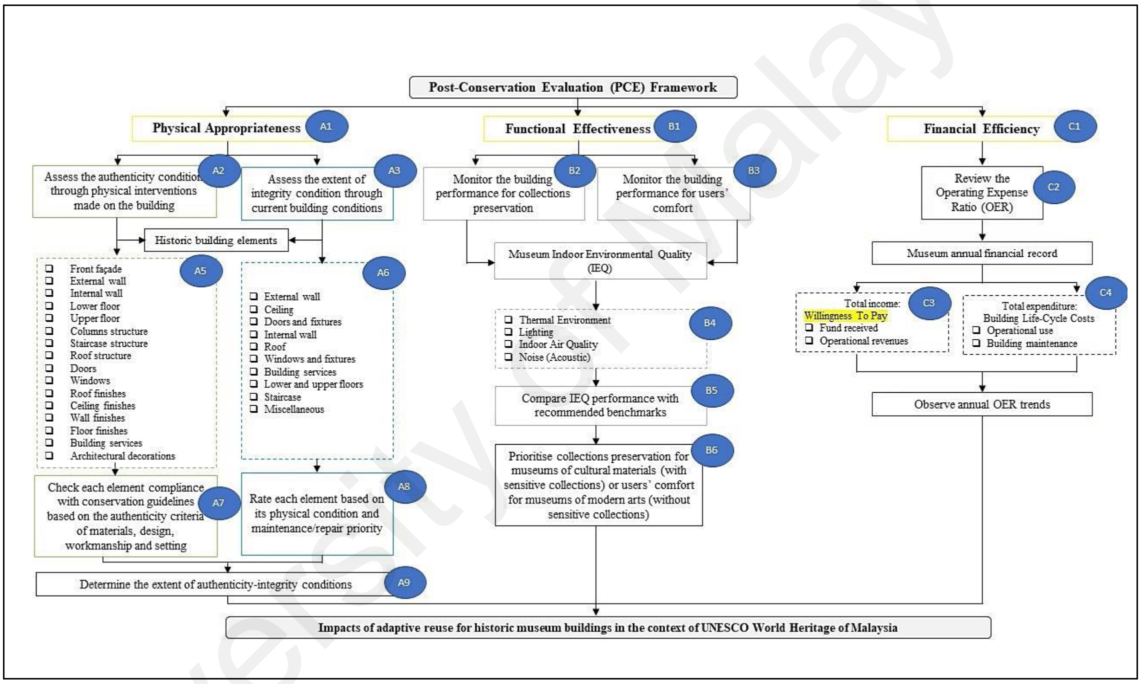


Figure 5.29: The conceptual PCE framework for second-round validation

Table 5.16: Results on CVI for second-round validation

		Participants (Experts/ Stakeholders)									
		P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**No. in Agreement**	**I-CVI**
PCE Contents	**Q1**	X	X	X	-	X	X	X	X	7	1.00
	Q2	X	X	X	-	X	X	X	X	7	1.00
	Q3	X	X	X	-	X	X	X	X	7	1.00
	Q4	X	X	X	-	X	X	X	X	7	1.00
	Q5	X	X	X	-	X	X	X	X	7	1.00
	Q6	X	X	X	-	X	X	X	X	7	1.00
	Q7	X	X	X	-	X	X	X	X	7	1.00
	Q8	X	X	X	-	X	X	X	X	7	1.00
	Q9	X	X	X	-	X	X	X	X	7	1.00
	Q10	X	X	X	-	X	X	X	X	7	1.00
	Q11	X	X	X	-	X	X	X	X	7	1.00
Remark: i. 'X' indicates item rated 'relevant' by the participants. It refers to item rated 3-quite relevant or 4-highly relevant. ii. '-' indicated item rated 'not relevant' by the participants. It refers to item rated 1-not relevant or 2-somewhat relevant.										**S-CVI Ave (Mean I-CVI)**	1.00
										S-CVI/ UA	1.00

i. Content Validity of Individual Items (I-CVI)

Referring to Figure 5.29 and Table 5.16, the I-CVI results of 1.00 have been achieved for the PCE components (A1 to C4 labels) to evaluate physical appropriateness, functional effectiveness and financial efficiency criteria (as probed from Q1 to Q11 in the survey). These results (after the inclusion of WTP to the conceptual evaluation framework as suggested by P3 in the earlier round of validation) have proven the absolute relevance of the three criteria to the PCE framework.

ii. Content Validity of Overall Scale (S-CVI)

The overall scale of the refined conceptual evaluation framework yielded full score for its content validity. Both S-CVI/ Ave and S-CVI/ UA results of the PCE have achieved 1.00. In this regard, the conceptual PCE framework has excellent content validity (Lynn, 1986; Polit & Beck, 2006).

5.8.2 Face Validity

a) Delphi First-Iteration

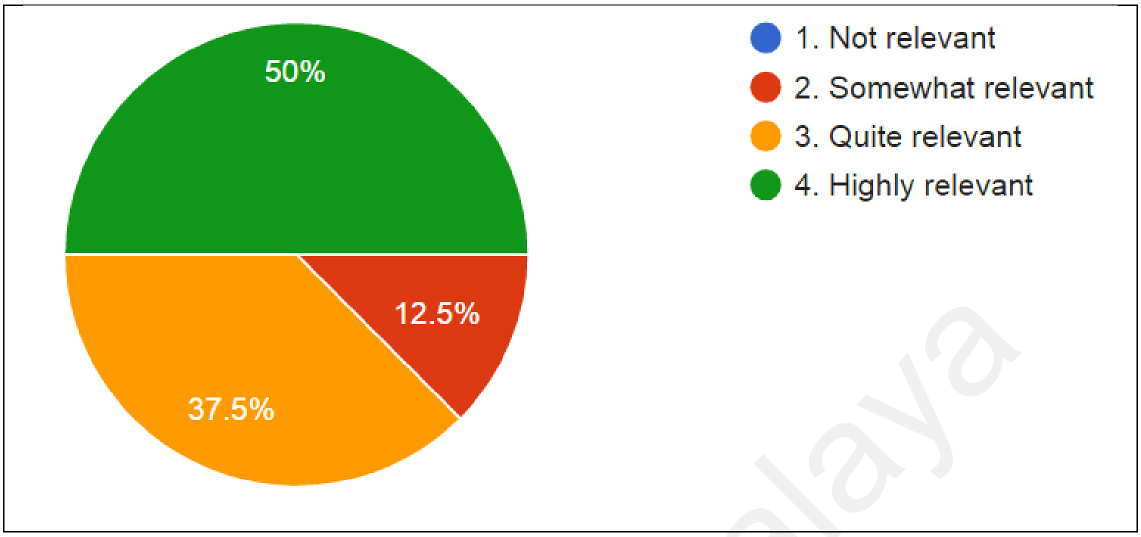


Figure 5.30: Result on face validity for first-round validation

The face validity question was posed in Q12. As shown in Figure 5.31, the overall face value of the conceptual PCE framework in evaluating its evaluands (subjects of evaluation) was rated 87.5% for its relevance (50% for 4- highly relevant and 37.5% for 3- quite relevant). Merely 12.5% from the overall face value of conceptual evaluation framework was rated 2-somewhat relevant, suggesting that WTP should be stated to evaluate the financial efficiency criterion.

b) Delphi Second-Iteration

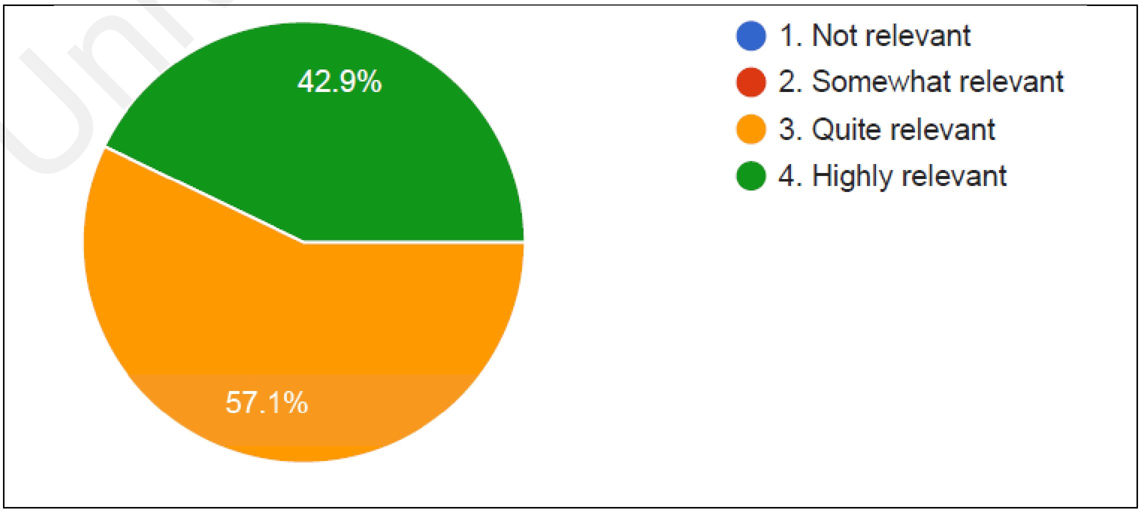


Figure 5.31: Result on face validity for second-round validation

The face validity question was posed in Q12. As shown in Figure 5.31, the overall face value of the conceptual PCE framework in evaluating its evaluands was rated 100% for its relevance (42.9% for 4- highly relevant and 57.1% for 3- quite relevant) after the inclusion of WTP to overarch the total income aspects of fund received and operational revenues (in the financial efficiency criterion).

5.9 Summary

Summarily, the results obtained from field observation, field measurement, key informants survey and validation conducted are:

- For authenticity condition, SYSM and BPM recorded slight changes to its elements or setting that hardly affect them (negligible impact). MIPIM recorded changes to its elements and setting which still noticeable (minor impact). PSM meanwhile recorded changes to its elements and setting that it has been significantly modified (moderate impact). DM recorded comprehensive change to its elements and setting that contribute to its total alteration (major impact).
- For integrity condition, BPM recorded good physical state which can be complemented with condition-based maintenance (BCA score 9.5). MIPIM meanwhile recorded fair physical state which necessitated repairs (BCA score 13). DM, SYSM and PSM meanwhile recorded poor physical state which necessitated rehabilitation (BCA scores of 17.5, 17.2 and 15.8 respectively).
- All the five adaptive reuse museums did not achieve the performance requirement of thermal environment for collections preservation due to having high relative humidity and indoor temperature levels. Merely MIPIM and DM did achieve the performance requirement for users' comfort due to having optimal relative humidity and indoor temperature levels.

- All the five adaptive reuse museums did not achieve the performance requirement of lighting for collections preservation due to having high display light intensity. Meanwhile, only BPM did achieve the performance requirement for users' comfort due to having optimal ambience light intensity.
- All the five adaptive reuse museums did achieve the performance requirement for indoor air quality in meeting users' comfort due to having optimal CO_2 and TVOC concentration levels.
- In terms of the OER, none of the adaptive reuse museums indicates a steadily declining trend over the years. However, a more comprehensive financial data is required in the future to make a better conclusion on the financial performance of the five adaptive reuse museums.
- After two rounds of validation performed, the conceptual PCE framework achieved full score of 1.00 for its content validity and 100% relevance for its face validity due to inclusion of WTP to overarch the total income aspects of fund received and operational revenues (in the financial efficiency criterion). These resulted in the establishment on the relevance of the conceptual PCE framework to the actual practise of adaptive reuse museums within the UNESCO World Heritage of Malaysia context.

CHAPTER 6: DISCUSSION AND CONCLUSION

6.1 Introduction

This chapter interprets and consolidates the results presented in the previous chapter. In responding to the research questions raised, discussion is made to implicate the findings on post-conservation impacts based on the case studies' physical appropriateness, functional effectiveness and financial efficiency. This chapter also discusses on the validation findings prior to propose the PCE framework. This chapter finally concludes the current research by reiterating the accomplishment of the three research objectives, highlighting the main contribution of the thesis, addressing the research limitations and providing some recommendations for future researchers.

6.2 Post-Conservation Impacts of Adaptive Reuse Museums

Post-conservation impacts of adaptive reuse museums are important to gauge the way forward of this trending conservation approach in achieving long-term heritage sustainability. Understanding the trifold aspects of physical appropriateness, functional effectiveness and financial efficiency are deemed imperative especially for Melaka and George Town that possess various historic buildings which form an integral part of their OUVs as the UNESCO World Heritage of Malaysia.

6.2.1 Physical Appropriateness

Historic buildings adapted to museums carry the cultural importance as much as the significant collections housed within them. Apart from the OUVs, authenticity and integrity are the two conditions emphasised by UNESCO for heritage properties within UNESCO World Heritage localities.

Table 6.1: Summary on physical appropriateness

	Results				
	PSM	**MIPIM**	**SYSM**	**BPM**	**DM**
Authenticity	Moderate (-1)	Minor (0)	Negligible (1)	Negligible (1)	Major (-2)
Integrity	Poor (-1)	Fair (0)	Poor (-1)	Good (1)	Poor (-1)
Summative Value	-2	0	0	2	-3
Physical Appropriateness	**No**	**Neutral**	**Neutral**	**Yes**	**No**

As shown in Table 6.1, the results on authenticity and integrity conditions were colligated quantitatively to conclude the post-conservation impact of the adaptive reuse museums in George Town in terms of their physical appropriateness. Accordingly, merely BPM has been found to be physically appropriate based on its authenticity-integrity condition. PSM and DM meanwhile have been found physically inappropriate. MIPIM and SYSM on the other hand achieved neutrality for their physical post-conservation impact, indicating fair state on their authenticity-integrity condition. Implying from this, post-conservation impacts of adaptive reuse museums in George Town have been not convincing in terms of their physical appropriateness.

6.2.2 Functional Effectiveness

Museums have varying environmental condition needs to cater sensitive collections and users' comfort. Preservation of important cultural collections is important as much as the efficiency, productivity, safety and health of building users. Owing to that, prioritisation towards meeting the demands of collection preservation was set for museum of cultural materials (with sensitive collections) while prioritisation towards meeting the demands of users' comfort meanwhile was set for museum of modern arts (without sensitive collections).

Table 6.2: Summary on functional effectiveness

			Performance Benchmark Compliance				
			Museums of cultural materials			Museums of modern arts	
			PSM	SYSM	BPM	MIPIM	DM
IEQ Parameters	Thermal Environment	Relative Humidity	X	X	X	√	√
		Indoor Temperature	X	X	X	√	√
	Lighting	Ambience	-	-	-	X	X
		Display	X	X	X	-	-
	Indoor Air	CO_2	-	-	-	√	√
		TVOC	-	-	-	√	√
Prioritisation			Collections Preservation			Users' Comfort	
Functional Effectiveness			No	No	No	Yes	Yes

As shown in Table 6.2, PSM, SYSM and BPM of the museums of cultural materials have been found functionally inappropriate for not having the required IEQ to preserve their sensitive collections. Meanwhile, MIPIM and DM of the museums of modern arts have been found to be functionally appropriate for having the required IEQ to cater their users' comfort. Implying from this, post-conservation impacts of adaptive reuse museums in George Town have been merely functionally effective in housing non-sensitive museum collections and providing comfort to the museum visitors and staff. On the flipside, they have been functionally ineffective in preserving and conserving sensitive museum collections due to having unsuitable IEQ conditions.

6.2.3 Financial Efficiency

Declining OER trend by principal is desired for indicating efficient and profitable building due to lesser coverage of its revenue onto the operational and maintenance costs. Inclining OER meanwhile signals that an investor may face financial loss if he or she holds the property longer. Contextually, adaptive reuse museums with declining OER means they are operating optimally based on their relatively higher income (through ticketing sales or conservation funding) over expenditure (operational costs and building maintenance). Figure 6.1 projects the annual OER trends of the adaptive reuse museums, showing a fluctuating OER trends for PSM and MIPIM, with an inclining OER trend for BPM:

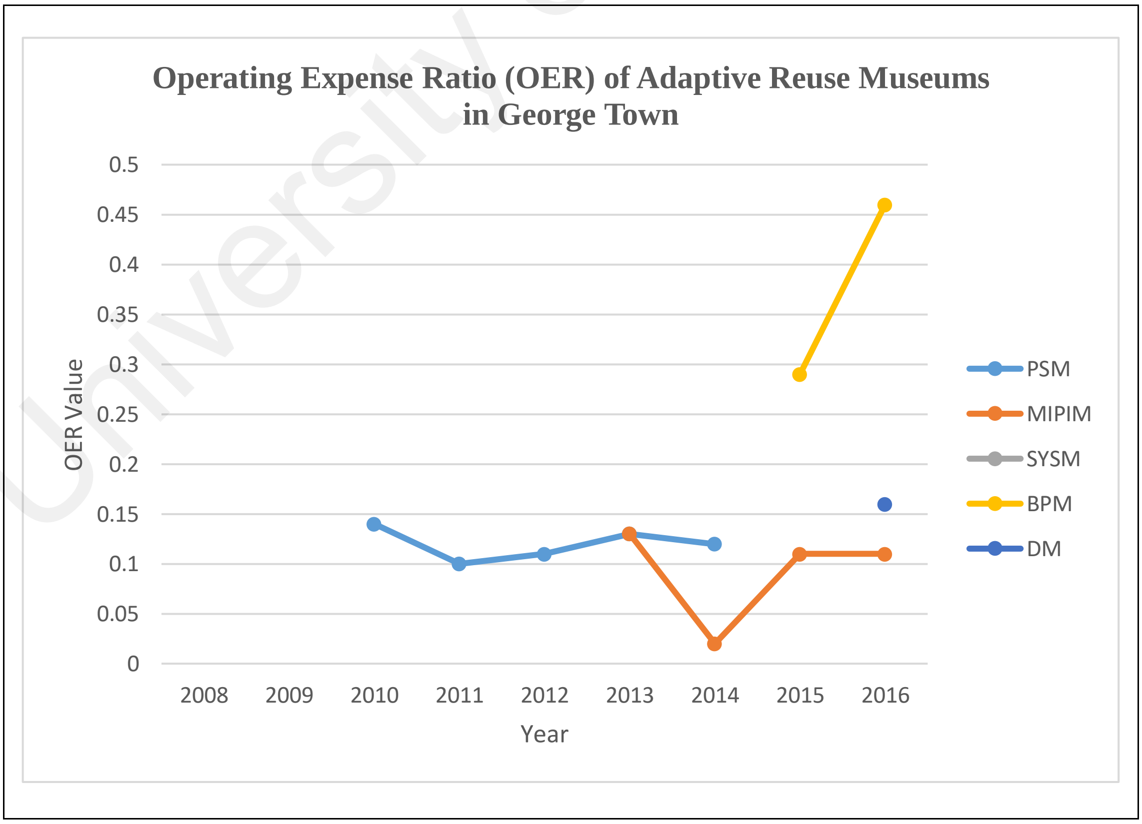


Figure 6.1: Annual OER trends of the case studies

The results yielded shown that none of the adaptive reuse museums have a steadily declining OER over the years. However, the trends generated are deemed inadequate to conclude on the post-conservation impact of the adaptive reuse museums in George Town. A more comprehensive data on the museums' financial performance that span further throughout the upcoming years would be essential in yielding better OER trends.

6.3 Establishment of the PCE Framework

The main contribution of the current thesis lies in the development and establishment of the PCE framework focusing specifically on the context of adaptive reuse museums in the UNESCO World Heritage of Malaysia. Formulation of the conceptual PCE framework was theoretical-based, made upon review on the aspects of building performance (physical, functional and financial), considerations on the museum trifold aspects (building, collections and users), as well as the general evaluation criteria (appropriateness, effectiveness and efficiency). Contextualisation of those criteria with complementing indicators, benchmarks and operational methods (which can yield tangible results through numerical-based assessments) were based on these considerations:

i. UNESCO World Heritage requisitions, conservation principles from both local and international doctrines and significant historic building elements for evaluating physical appropriateness.

ii. Optimum IEQ performance ranges and threshold limits specifically for museum requirements based on the needs of collections preservation and users' comfort for evaluating functional effectiveness.

iii. Willingness-to-pay (WTP) for, and life-cycle-costs (LCC) of museums, through their Operating Expense Ratio (OER) for evaluating financial efficiency.

Meta-evaluation process involving two rounds of validation (content and face validity tests) via Delphi survey meanwhile has verified the relevance of the conceptual PCE framework in evaluating its evaluands (the trifold criteria on post-conservation impacts of adaptive reuse museums in the context of UNESCO World Heritage of Malaysia). The validation results yielded based on inputs from experts and stakeholders in the domain of built heritage conservation are as follows:

i. The criterion on physical appropriateness evaluated by assessing authenticity and integrity conditions through investigation on physical interventions (made on the 16 building elements) and inspection on building conditions (on the 10 most defective building elements commonly found in Malaysia) is relevant to the PCE framework. The two results were then colligated quantitatively to arrive at the conclusion.

ii. The criterion on functional effectiveness evaluated by monitoring the building performance is relevant to the PCE framework. This includes assessing their IEQ parameters comprising thermal environment, lighting, indoor air quality and noise (acoustic). The conservation experts and stakeholders have fully agreed that compliance of adaptive reuse museums IEQ with the performance benchmarks for preserving collections or achieving users' comfort should be based on prioritisation, depending upon the categories of the museums. In this sense, museums of cultural materials (with sensitive collections) would prioritise collections preservation whereas museums of modern arts (without sensitive collections) would prioritise users' comfort.

iii. The criterion on financial efficiency evaluated by reviewing the annual OER trend is found relevant to the PCE framework. This includes finding the ratio between the museum expenditure (based on building Life-Cycle Costs of operational use and building maintenance) and museum income (based on fund received and operational revenues). However, to increase the content and face validity of the PCE framework, willingness-to-pay (WTP) which is an aspect of Contingency Valuation Method (CVM) used to reflect people evaluation of cultural heritage based on their consumerism preference has been added to overarch the income aspect. This refinement of the framework was based on P3's feedback whose expertise and experience are much related to urban conservation. Inclusion of WTP is deemed imperative to attain the overall sustainability of UNESCO World Heritage sites. Despite the difficulty in obtaining the discreet and sensitive financial performance data, the financial efficiency criterion is remained in the proposed PCE framework. This is following the consideration that museum organisations (building managers and owners specifically) can independently review the annual OER trend using their very own internal capacity without the needs of having external evaluators.

Conclusively, the meta-evaluation done on the initial framework using validation tests and reliable participants has epistemologically strengthened the PCE framework for practical adoption and utilisation. The proposed PCE framework has been verified for its theoretical soundness and measures completeness by experts and stakeholders in the field of built heritage conservation. The conceptual PCE framework is hence established and proposed as finalised in Figure 6.2:

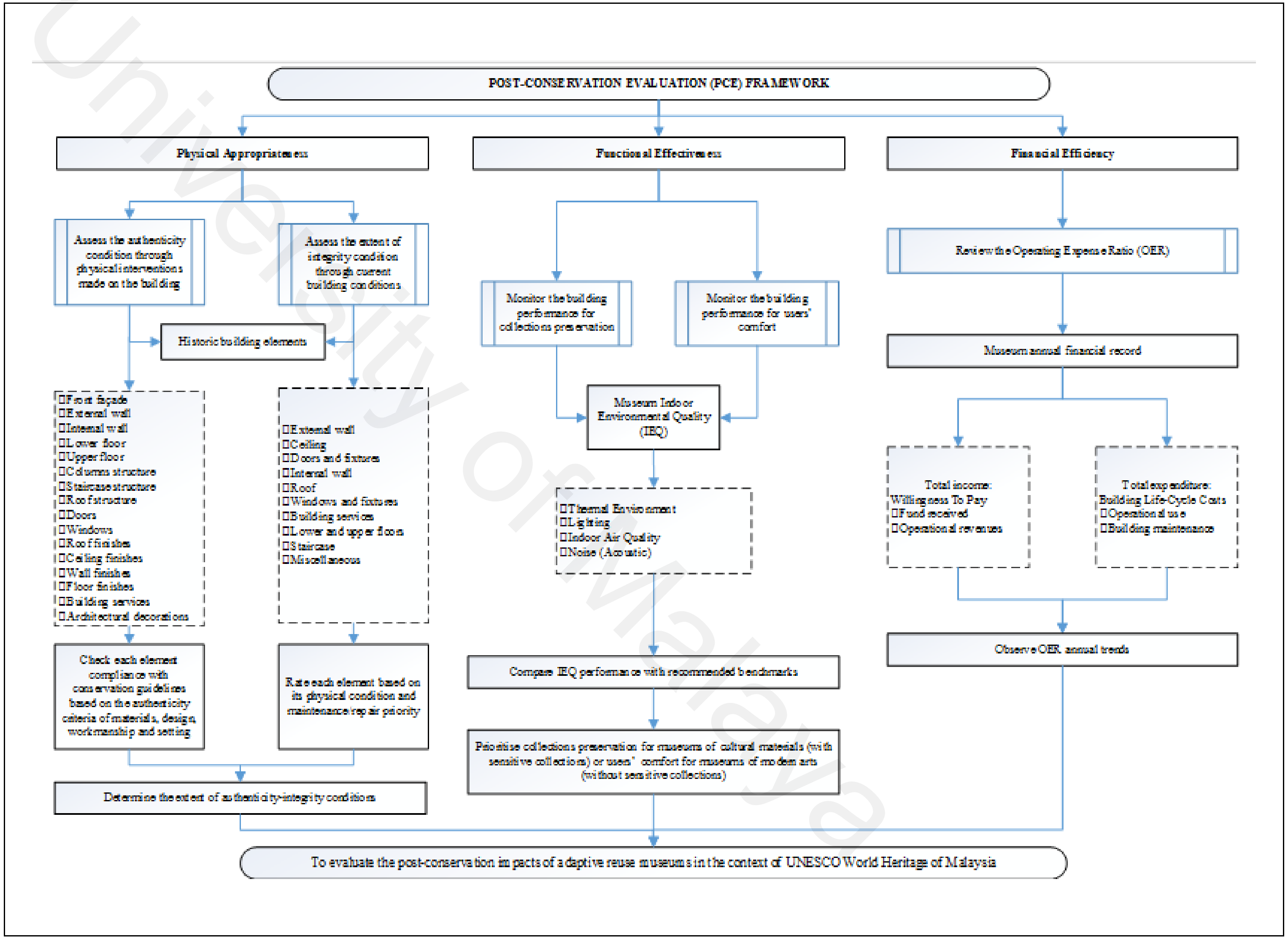


Figure 6.2: The proposed PCE framework

6.4 Concluding Remarks

The current research has pointed out the need of incorporating evaluation paradigm into the current Malaysian built heritage conservation framework which arguably is still in an incipient stage following its linear and non-cyclical process. Advocation on the integration of PCE as an evaluation paradigm to complement the Malaysian built heritage conservation framework has been emphasised to achieve a more comprehensive (cyclical and dynamic) conservation process. Following to that, the main question raised in the current research is: How to evaluate the post-conservation impacts of historic buildings converted to museums (adaptive reuse museums) within the UNESCO World Heritage of Malaysia context?

With the concern that adaptive reuse of historic buildings may jeopardise the OUVs for UNESCO World Heritage localities since its implementations have not always led to positive impacts after conservation phase, the current research sought to propose an evaluation framework focusing on the post-conservation impacts of historic buildings converted to museums (adaptive reuse museums). With special emphasis on the UNESCO World Heritage of Malaysia context, the current research focused on the following:

i. The first objective is to review the relevant criteria for evaluating the post-conservation impacts of adaptive reuse museums (RO 1).

ii. The second objective is to evaluate the post-conservation impacts of adaptive reuse museums using the identified criteria (RO 2).

iii. The third objective is to establish the relevance of the conceptual evaluation framework to the actual conservation practise for adaptive reuse museums (RO 3).

Correspondingly, the three research objectives were accomplished as revisited below:

i. Secondary data were leveraged to identify the criteria of physical appropriateness, functional effectiveness and financial efficiency to conceptually form the PCE framework. Relevant past literature and seminal works were also scrutinised to select the pertinent operational methods to complement the trifold evaluation criteria, leading to RO 1 accomplishment.

ii. The theoretically derived conceptual PCE framework was then tested for its operational and empirical capabilities through case studies. Five adaptive reuse museums in historic city of George Town were involved, classifiable into two non-shophouse and three shophouse buildings. Through them, multi-method field works were taken comprising field observation by investigating physical interventions and inspecting building conditions, field measurement by monitoring building performance (IEQ) and key informants survey by acquiring feedback on income and expenditure of the respective museums. Findings generated through the case studies contributed in understanding the post-conservation impacts of adaptive reuse museums in the UNESCO World Heritage of Malaysia and indirectly proved the practicality of the conceptual PCE framework, leading to RO 2 accomplishment. Respective management bodies of the adaptive reuse museums evaluated can practically use the evaluation findings to fine-tune and rectify their building conservation and maintenance, as well as, to reconfigure their building performance towards reaching optimal IEQ and economic sense.

iii. The conceptual PCE framework was then placed for a meta-evaluation process. It included two rounds of validation, performed based on content validity and face validity tests. Conservation experts and stakeholders from the field of built heritage conservation were involved to rate the PCE relevance in evaluating its evaluands (the trifold criteria on post-conservation impacts of adaptive reuse museums in the context of UNESCO World Heritage of Malaysia). A slight fine-tuning was then made to the initial framework in accordance to a minor suggestion induced from the validation results, leading to RO 3 accomplishment. The proposed PCE framework would be beneficial for adoption and further scrutiny by heritage and conservation stakeholders.

6.5 Research Limitations

There were some limitations faced in the current research as following:

i. Restricted areas (such as roof and certain museum areas due to safety and privacy concerns).
ii. Absence of information (historical documents such as old building plans and photos were either no longer available or not retrievable).
iii. Unavailability of suitable data logging tools (to cover several IEQ parameters such as noise level besides other indoor air variations).
iv. Confidentiality and inadequacy (due to recent operational years) of financial data.

6.6 Recommendations for Future Research

Expansion and improvement of the current research can be made in these following ways:

i. To evaluate other types of adaptive reuse historic buildings using the proposed PCE framework.
ii. To conduct the PCE at Melaka and other UNESCO World Heritage localities.
iii. To cover other IEQ parameters that have been left-out in the current study.
iv. To obtain a more comprehensive data on financial performance.

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