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# A Non-Accident-Based Spatial Method to Analyse Pedestrian-Vehicular Conflict

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## ABSTRACT

Due to the tremendous increase in automobile transportation and heavy pedestrian movements in developing countries, roads are becoming deadlier year by year. It is acknowledged that context specific research on pedestrian-vehicular conflict are urgently needed considering the built environment characteristics. Therefore, this paper aims to (1) redefine pedestrian-vehicular conflict that would enable to explain micro- and macro-built environment-related variables in a particular context, and (2) develop a methodology that could be used in a place where comprehensive data are limitedly available for a spatial analysis. This research redefines pedestrian-vehicular conflict as "the pedestrian contact with potentially harmful vehicular traffic", rather than accidents. Based on this definition devise a methodology. The primary data collection method adopted to collect causal factors related to spatial data was, photographs. The spatial data were analysed by using QGIS platform. The pedestrian volume models are constructed by a space syntax framework and correlated with a composite choropleth map to get the potential conflicting points. A perception survey was carried out to confirm the spatial analysis. The research findings indicate that the methodology developed can be used to identify built environment factors related risk areas spatially. Consequently, it is possible to fill the research gap by introducing a low-cost, widely applicable, impartial, spatial and perception-based methodology that assesses the built environmental characteristics in relation to pedestrian-vehicular conflict. This research would support the urban planners and designers, allowing them to comprehend the risk related nature of pedestrian-vehicular conflict in their urban planning schemes before intervening with plans and designs.

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## 1. Introduction

People in developing countries such as India and Sri Lanka are from diverse backgrounds and adhere to different living standards. The traffic characteristics and the road designs are also quite distinctive when compared to some developed countries such as the Netherlands, Portugal and Hong Kong (Kadali, Rathi and Perumal 2014 and Meetiyagoda 2018). Thus, road users, particularly pedestrians, invariably come across difficulties such as pedestrian-vehicular conflicts due to lack of proper planning solutions. Presently, the traffic engineers design the road space, including the pedestrian domain, and urban planners and designers plan for land uses and built form characteristics. Many research studies on spatial planning and design interventions have focused on the pedestrian-vehicular conflicts. Some scholars note the way of separating pedestrians

from automobiles (Hajdu 1988; Robertson 1993; Khder, Mousavi and Khan 2016), and some others discuss the way of sharing the street space by prioritising the pedestrian (Ben-Joseph 1995; Hamilton-Baillie 2008; Khan et al. 2015). Some recent studies suggest augmenting the public transportation facilities (Zaman et al. 2017). However, the prevailing conceptualisations of the pedestrian-vehicular conflict, evaluation methods and solutions are also mostly devised by traffic engineers (Ranasinghe et al. 2015). They mainly consider macro-variables such as capacity, demand, volume, rate of flow, trip origin/destination analysis, congestion patterns, and regional land use patterns, while urban planners and designers need to focus on both macro- and micro-variables, including built environment and local land uses and form (Southworth 2005). Meanwhile, the land use planning efforts need to fulfil the requirements of pedestrians to ensure safe and comfortable pedestrian access (Kadali, Rathi and Perumal 2014). It is a complex task for policy-makers, planners and designers to make a snug, convenient and safe pedestrian domain, which is compatible with existing land uses and contextual characteristics. Therefore, there is a research gap to redefine and analyse pedestrian-vehicular conflict in relation to the built-environmental factors.

Moreover, the cities claiming some heritage values, especially, face constraints in executing the necessary expansions. As different user groups demand different services, urban planners and designers need to put more effort into comprehending the micro situations and proposing solutions. Steinmetz (2004) recommends strong observation-based empirical research when a phenomenon manifests to a particular context.

In this background, it is necessary to review the literature, define the phenomenon, discover the causal factors and test their availability in a case study and to determine the other causes that exist outside the theory. Therefore, this paper considers pedestrian-vehicular conflict in a heritage city by redefining it with non-accident and built environment- based causal factors and by introducing a low-cost, impartial method to spatially analyse the phenomenon.

## 2. Prior Studies

A number of research studies have explored pedestrian-vehicular collision/crashes/conflicts. However, most of the studies either get accident data from police reports and analysis the nature of the crash, but limitedly discuss the causes of conflict risks (Black and Westerman 1989). Meanwhile, few studies incorporated spatial data and perception data (Braddock et al. 1994; Schuurman et al. 2009; Lerman, Rofe and Omer 2014).

In 1980s, Black and Westerman (1989) suggest a framework to collect the data based on the factors influencing road safety. Their intention is to derive a low-cost and practical process, which identifies the significant variables within the context of the road function and the road environment. The data collection methods include video recordings, observations and perception survey. The main analysis methods which they used were correlation analysis and video analysis. However, they mention that the occurrence of accidents is difficult to observe in practice, and historical data reconstruction is only partially possible when information on the accident is incomplete. Moreover, though they suggest a correlation analysis, in general, the number of accidents are often too small to establish statistically significant correlations. Their suggestion is to study of the traffic behaviour as an alternative approach.

In 1990s, Braddock et al. (1994) demonstrate the effectiveness of Geographical Information System (GIS) when examining the child pedestrian conflict by using a 20-year motor vehicle collision records from the Police Department. They used TransCad to code the location of the collision by address matching and develop point maps. This analysis enables them to recognise the distribution pattern of collision within the city, and it proves the ability of using GIS to illustrate the spatial relationship between conflict and other land uses. However, this research focuses more on the characteristics of collision than causes. At the same time, the authors accept the fact that police accident records underestimate the occurrence of non-roadway pedestrian collisions. Nevertheless, this study recommends site-specific interventions to prevent the collisions. The authors' future research intention is investigation of other geographical features.

In 2000s, Schneider, Ryznar and Khattak (2004) conducted the crash analysis by incorporating perceived risk data and the crash records from the police reports. The spatial analysis was also based on GIS. This analysis was combined with regression analysis to understand the factors associated with risk. As a result of spatial analysis, the study identified crash clusters and the density of clusters by using kernel estimation method. Moreover, they produced another map with pedestrian perception. When comparing the two types of data sources, it shows a difference between the locations of police-reported crashes and the places where people perceived as having a potential of a crash. Thus, this research study encourages scholars to research on perceived pedestrian risks over police reported crash. However, they recommend to use their methodology only for moderately perceived crash-risk areas like campuses, neighbourhoods and commercial areas.

Moreover, Parks and Schofer (2006) tested the ability of using secondary data in ArcGIS platform and digital aerial photographs to measure the quality of the pedestrian environment. Then, linear regression was used to estimate and derive several models. The result of the research proves the ability of using laboratory collected variables to assess proposed pedestrian environment design.

Raford and Ragland (2003) explore the possibility of incorporating space syntax volume-modelling approach for estimating pedestrian volume. The urban street network has analysed with space syntax model to generate "movement potentials", and at the same time sample pedestrian counts were collected from key locations. At the end they compare this pedestrian-risk analysis with the crash data. The authors

conclude that spatial syntax model has a detailed level of prediction capacity and it is not a complex model. However, they acknowledged the requirement of integrating automobile volume and land use characteristics.

### *2.1 Gap In The Literature*

According to previous literature, it reveals that many studies (a) depend on police accident reports; (b) aim to find the characteristics of crash/conflict; (c) do not study in detail how built environmental characteristics causal to crash risks and the perception of pedestrians on such characteristic; or (d) use data collected by sophistic methods. Redefining pedestrian-vehicular conflict is again an important consideration in this respect.

Therefore, this study attempts to fill some of these gaps by collecting site specific data on built environmental characteristics with the use of streetscape photographs so as to data would be up-to-date and involve less expensive. It will analyse the potential risks by utilising GIS based spatial analysis. Subsequently, spatial analysis is verified with pedestrian perception. Another importance of this method is that it educates pedestrian and drivers about the areas with perceived risks to get some precautions to prevent injuries and fatalities.

## 3. Redefining Pedestrian-Vehicular Conflict

The broader concept of pedestrian safety can be replaced with the systematised concept of pedestrian-vehicular conflict, as there are ample scholarly works discussing why and how the pedestrian-vehicular conflict affects pedestrian safety (Stoker, Adkins and Ewing 2017; Cloutier et al 2017; Osama and Sayed 2017).

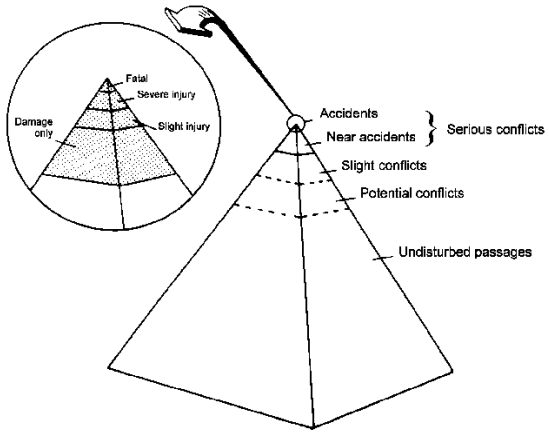


**Figure 1** Safety pyramid (Hydén,1987)

Hydén (1987) illustrates in his seminal research project that accident records are not an ideal representation or evaluation criterion of pedestrian safety. The safety-related interaction between different road users is described using a number of elementary events, and the conceptualisation is presented by the 'safety pyramid' (Figure 1). Hydén's hypothesis postulates that when there is pedestrian and vehicle conflict, the seriousness of conflict indicates the disintegration between two road users. He says pre-crash phases of the safety pyramid can be observed by comparing them to the nature of accidents and allowing for people to study the process causing the accidents.

Raford and Ragland (2003) define pedestrian-vehicular conflict as "pedestrian contact with a potentially harmful vehicular traffic", and "the probability that a pedestrian-vehicle collision will occur" is defined by them as pedestrian-risk. Thus, this research rests on Raford and Ragland's definition as its working definition. By following this concept, 22 causal factors associated with the built environment, vehicular and pedestrians are identified in the light of literature review. See Figure 2 below:

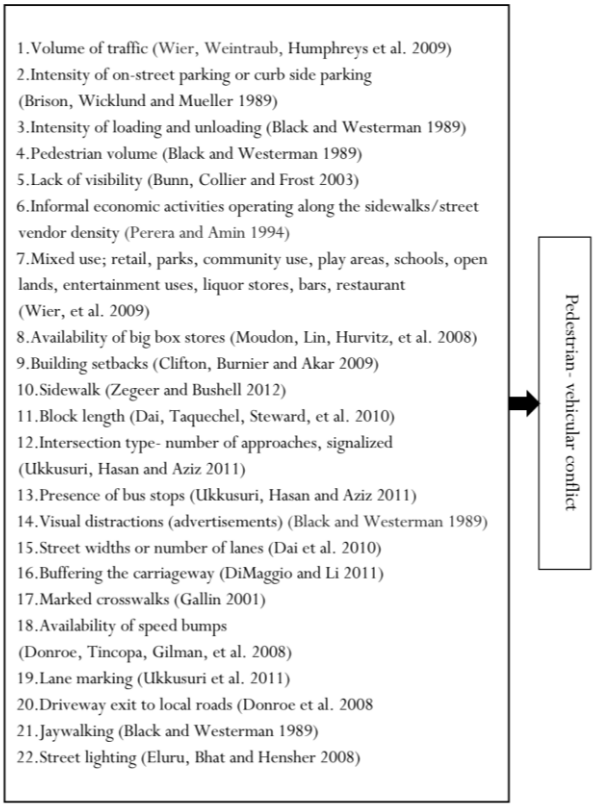


**Figure 2** Causal factors identified in light of the literature (Author)

## 4. Devising a Methodology

This research can be described as an explanatory or causal inference-based research, which expounds its findings by exploring a single empirical case study (i.e., The Kandy Heritage City) (Figure 3) that manifests a single phenomenon, i.e., pedestrian-vehicular conflict (Gerring 2004 and Swanborn 2010).

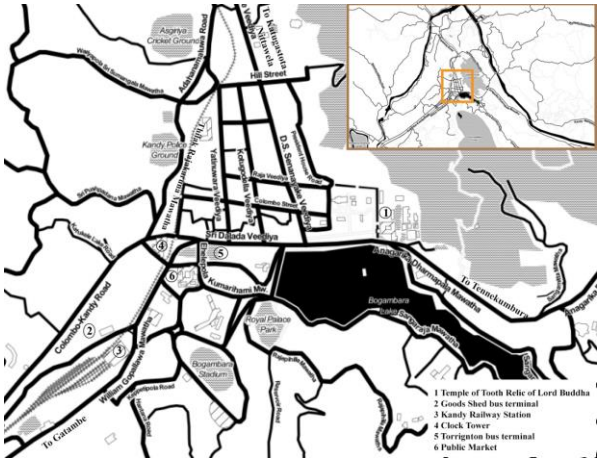


**Figure 3** A base map of Kandy (Author)

### *4.1 Shortlisting of the Causal Factors according to the Context*

A pedestrian's perception survey was conducted in the Kandy Heritage City to shortlist the causal factors. A structured questionnaire was distributed among thirty (30) randomly selected local and foreign pedestrians. First, they were asked to indicate their level of satisfaction with the pedestrian environment in terms of safety. If not satisfied with the present situation, they were asked to prioritise the literarily identified causes to understand the reasons behind their views. Apart from the perception survey, general public discourse and observation assisted the short-listing of the seven casual factors, namely, people on carriageways, land use, undefined pedestrian domain, intersection type, on-street parking, constrained or no sidewalk space and loading and unloading, which cause pedestrian-vehicular conflict to be embedded in the Kandy Heritage City.

Meanwhile, it may be noted that together with factors such the road network layout, connectivity and spatial integration, scholars have already identified the capacity of a space syntax modelling tool for analysing the potential pedestrian volume (Raford and Ragland 2004; Omer and Kaplan 2017). Baran, Rodríguez and Khattak (2008) mention that movement patterns between the different spaces of the built environment are viewed by space syntax as a system and assume better physical connections (the ability to reach from a particular point to every other point), fewer turns and a longer line of sights tend to generate a higher density of movements. Therefore, this research considers spatial integration, which is derived from space syntax analysis, to be a promising predictor of pedestrian movement patterns.

### *4.2 Data Sourcing*

Three main sources of information were used in this research, namely, photographs, GIS data of the road network and pedestrian perception. First, photographs were used to evaluate the spatial variation of seven causal factors. A review of the literature shows that different scholars have included photographic surveys to record the pedestrian and vehicular data at the streetscape level (Sakar and Andreas 2004; Parks and Schofer 2006; Ewing, Handy, Brownson et al. 2006; Sepe 2009). Second, the Kandy Road network shape file of GIS has been used to make the axial map manually and, thereby, to prepare a space syntax map that predicts the pedestrians' movement patterns. Third, a perception survey was used to gather additional information about and interests of the people, which could not have been recorded otherwise with secondary data or photographic survey only. This survey is a common method that cross-checks the computer-based data modelling with people, and it has been used by scholars to identify the conflict behaviour and people's perception (Black and Westerman 1989; Sepe 2009; Dai et al. 2010). Another round of the pedestrian perception survey had to be incorporated after the computer-based analysis to validate the results and particularly to identify the causal factors. It was intended to identify fifty (50) of the highest scored points of the composite choropleth map, and five (5) road users had to be interviewed in respect to each point. Thus, two hundred fifty (250) respondents had to be involved in validating the results.

### *4.3 Content Analysis of Photographs*

Photographs were the main source of information in this research. After the streetscape elevation picture frame was made (Figure 4), it had to be subjected to content analysis based on the factors mentioned in the Table 1. Scholars state that still images or photographs represent one form of qualitative data, and content analysis is a widely used qualitative data analysis technique that summarises the information in texts or photographs in smaller categories by coding (Bernard and Ryan 2009; Meetiyagoda and Munasinghe 2009). In this research, directive content analysis was used, as the codes (or variables) were already derived based on the literature and observations (Hsieh and Shannon 2005). During the content analysis, the authors basically read the information that appears on the photo, coded it and described in detail along with statistics. Accordingly, the evaluation had to be done by using the coding scheme, which was derived based on a 1-5 Likert scale (Table 1). The content analysis had to be done for each picture frame representing the street segment of each 25 m in the Kandy Heritage City (Figure 4), and the codes were fed to the attribute tables of the Quantum Geographical Information System (QGIS) 2.12.1-Lyon and IBM Statistical Package for Social Science (SPSS), version 21 for analysis. This analysis proved the possibility of deriving quantifiable data from it.

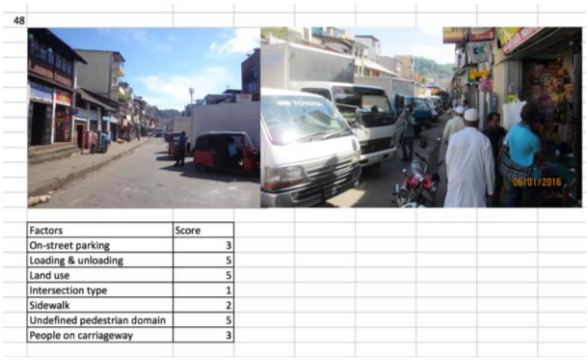


**Figure 4** A sample of content analysis of photographs (Author)

### *4.4 Visualising Geographic distribution of Causal Factors*

The data obtained from content analysis of the photographs had to be converted to spatial data by using QGIS. Pulugurtha, Krishnakumar and Nambisan (2007) mention that features of GIS have the facilitation capability to identify the high pedestrian crash areas with a lower degree of subjectivity. Thus, by means of this spatial analysis, it is expected to identify the spatial distribution of causal factors related to pedestrian-vehicular conflict in the Kandy Heritage City. Hotspot mapping is a widely used simple analytical technique in QGIS, which enables the identification of locations where accidents, diseases or crimes are clustered (Anderson 2007; Chainey, Tompson and Uhlig 2008). Chainey Tompson and Uhlig (2008) mention that point mapping is straightforward, as it represents each event as a point and helps us to visualise geographic distribution by employing the QGIS functions of thematic shading. Rytkonen (2004) also states choropleth maps are used to display some data as spatial units by colouring, shading or hatching. As pointed out by Crampton (2002), the fundamental principle of choropleth mapping is that "the densities of shading on the map are cognitively parallel to the densities of data". The possibility of displaying different data layers with different highlighted data values is an advantage of choropleth maps. When analysing a map to record the places of pedestrian-vehicular conflict and to geocode and produce a point map, the photographs capturing these locations are needed. Each point was attributed a value from its measurement in the attribute table (Table 1). Then, the point information was converted into a choropleth map, which shows the continuous shades of colours to indicate the performances of different causal factors. According to Tobler (1973), the visual intensity of a choropleth map is exactly proportional to the data value

**Table 1** Coding scheme for the content analysis of photographs
*Source: Author*

| **On-site parking** | | **Loading and unloading** | | **Land use** | | **Intersection type** | |
|---|---|---|---|---|---|---|---|
| No parking | 1 | No loading and unloading | 1 | Religious places, housing | 1 | Not an intersection | 1 |
| Approach to a car park | 2 | Approach to the goods loading and unloading area | 2 | Retails and small-scale commercial | 2 | Has marked pedestrian crossings and traffic signals | 2 |
| Permitted on-street parking | 3 | Loading and unloading goods by light vehicles across the pedestrian domain | 3 | Banks, big-box stores and hotels | 3 | Only marked pedestrian crossings | 3 |
| Stopped/parked in the middle of the road | 4 | Loading and unloading people from buses | 4 | Construction or production related commercial, bars | 4 | Approaches to private domain or alleyway across pedestrian domain from the road | 4 |
| Parked on sidewalks | 5 | Loading and unloading goods by heavy vehicles cross pedestrian domain | 5 | Wholesale, markets, schools, government institutions | 5 | Without marked pedestrian crossings or not rectangular intersection | 5 |
| **Sidewalk** | | **Undefined pedestrian domain** | | **People on carriageway** | | | |
| Continuous sidewalks on both sides | 1 | Buffered with permanent structure on both sides | 1 | No people on carriageway or people use only marked road crossings | 1 | | |
| Continues very narrow sidewalks | 2 | Discontinuous buffer one side | 2 | Jaywalking as no road crossings | 2 | | |
| Discontinuing sidewalks at least one side | 3 | Discontinuous buffer on both sides | 3 | Jaywalking as no or narrow sidewalks | 3 | | |

| | | | | | |
|---|---|---|---|---|---|
| Width of the sidewalks not enough for pedestrian as it is used for street vending | 4 | No buffer one side | 4 | Jaywalking as sidewalks are occupied by the vehicles or no sidewalks | 4 |
| No space provided for sidewalk at least one side | 5 | No buffer on both sides | 5 | Informal gathering on street as a result of vehicles parked on sidewalks or no sidewalks | 5 |

### *4.5 Space Syntax Analysis*

The aim of space syntax (that is, the language of space) analysis is to quantify and compare the pattern properties of architectural space or the space between buildings in urban areas and building interiors. According to Bandara, Meetiyagoda and Munasinghe (2010), space syntax is gaining popularity in the area of planning and urban design, mainly due to the urban space modelling possibilities demonstrated by the method associated with it.

The first step in space syntax analysis is transcribing the street network into an axial map. An axial map is "a network of intersecting lines that consists of the longest set of lines of sight that passes through the street space" (Kim and Penn 2004). DepthmapX software has been used to produce the axial map with network analysis once the lines are drawn manually in the QGIS platform. The modelling facilitates assigning a value for each axial line in terms of connectivity, control value, local and global integration. The notion of integration should be defined with the notion of 'depth'. Jiang and Claramunt (2002) define depth as "the number of lines distant from a given number of steps to that axial line". Integration indicates how easily one can reach a specific street or the line of the axial map. When computing access to one line from all the other lines of the axial map, it is called the global integration; if the computed integration value is based on a given number of lines (radii), it is called local integration. The calculation of depth and connectivity is derived from the following equation.

$$\sum_{s=1}^{m} s \times N_s = \begin{Bmatrix} Connectivity\ iff\ m = 1 \\ local\ depth\ iff\ m = k \\ global\ depth\ iff\ m = l \end{Bmatrix}$$

s= shortest distance (or steps) from the node
Ns= number of nodes within the shortest distance
l = maximum shortest distance

For this research, the global integration has been calculated, as it represented most integrated and demanded areas for pedestrian movements in the Kandy Heritage City as a whole. Global integration is the indicator of the attractiveness of different public spaces in the overall spatial configuration of the city (Bandara and Munasinghe 2007). The Space Syntax Toolkit (plug-in) of QGIS was used to handle the geometric and geographic data associated with attribute information, to perform spatial, mathematical and statistical calculations, and to visualise the results (Gil et al. 2014).

### *4.6 Construct Validation with SPSS*

A requisite construct validation was conducted to confirm spatial analysis. First, it confirmed the association between pedestrian volume and causal factors for conflict. For this purpose, correlation analysis was employed in the SPSS platform, and it helped to identify the relationship that exists between each causal factor. At this juncture, global integration values of space syntax analysis were to be benchmarked to enable correlation analysis. For this purpose, a buffer of 25 m had been defined for each conflicting point and had employed the union tool of QGIS to overlap the space syntax layer with buffered conflicting points. Then, the average integration values were assigned under each conflicting point and benchmarked with reference to a 1-5 Likert scale. The two variables subjected to analysis are treated equally but not as predictors or as an outcome.

The second type of construct validation taken up was pedestrian perception, which was used to validate the potential conflict clusters that were derived by spatial analysis. In the process of this pedestrian perception survey, five randomly selected pedestrians from each selected location (250 respondents) were asked, first whether they agree with the view that the location has a potential conflict, and second, they were asked to prioritise the seven causal factors. The responses were subjected to a simple descriptive analysis, which enabled us to identify the most influential casual factors.

## 5. Results of Empirical Study

### *5.1 Results of Spatial Analysis*

A syntactic analysis of spatial integration of the Kandy Heritage City begins by representing the road network with axial lines. The global analysis of space syntax modelling is considered to discuss the results, and according to the level of integration, the colour of axial lines ranges from deep blue to deep red, that is, below the mean integration value to above the mean integration value, respectively. In another words, the axial lines with deep red represent the highest pedestrian volume concentration, which reflects Penn's claim (2003). The highest pedestrian volumes (see Figure 5) are concentrated at the Kandy City Centre, specifically around main transport terminal areas, the public market and the grid city area. However, this finding contradicts what Raford and Ragland's (2003) research (which also used the space syntax analysis to represent pedestrian volume), which reveals that a higher number of pedestrian crashes occurs in the peripheries and not downtown, where the highest number of intersections are concentrated. However, they admit the fact that their findings are contrary to the general research expectations. The average research

findings elaborate the concentration of pedestrian-vehicular conflict in city centres (Steenberghen, Dufays, Thomas et al. 2004) as is the case with the Kandy Heritage City.

Moreover, the aggregate values of seven causal factors represent the points of the composite choropleth map, which denotes the highest potentials of conflicting points from least possible conflicting points by varying the colours from deep red to light green, respectively. The map indicates that the highest potential conflicting locations are mostly concentrated at the grid city (Figure 6), where the pedestrian volume is also substantially high, according to the space syntax analysis.

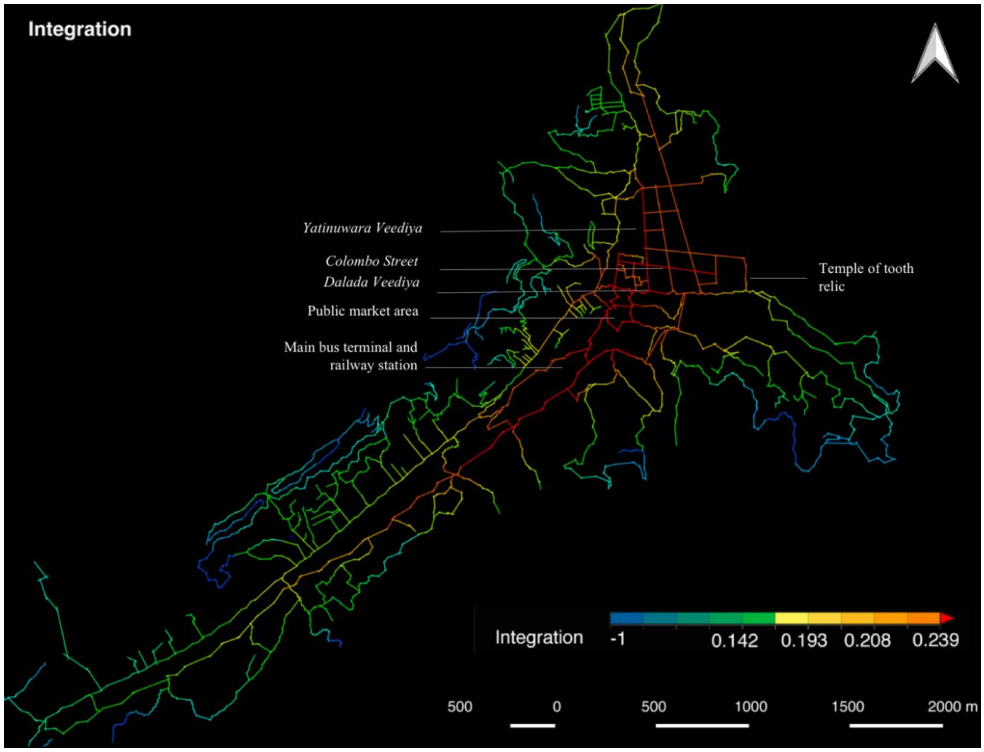


**Figure 5** Global spatial integration (Author)

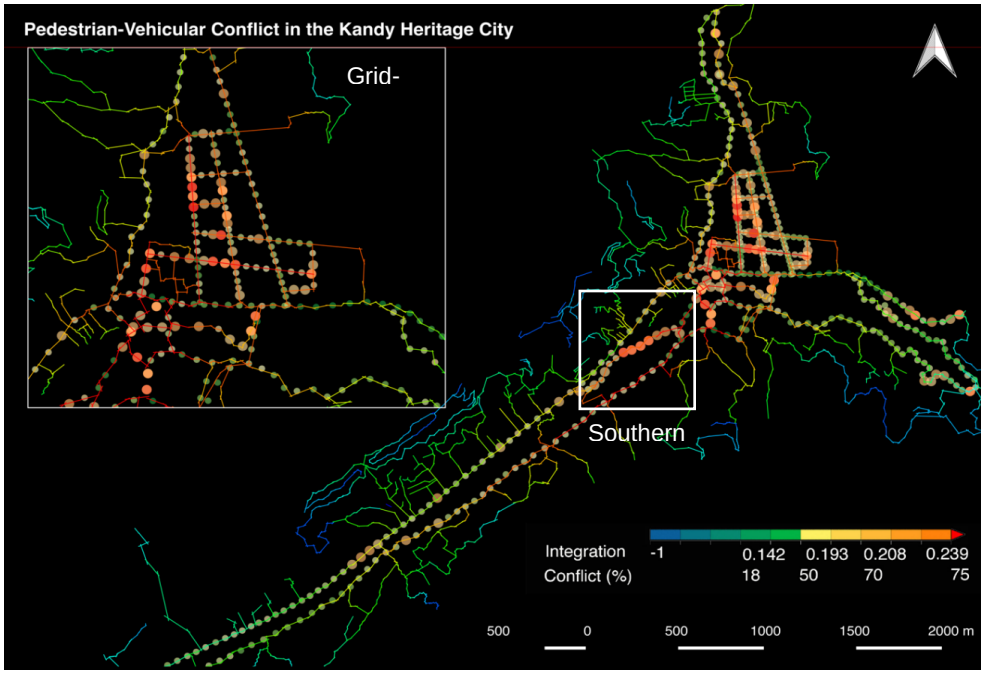


**Figure 6** The overall outcome of the analysis: Pedestrian-vehicular conflict of the Kandy Heritage City (Author

### *5.2 Validation*

According to the correlation analysis, which was undertaken to find the relationship between the seven causal factors and integration level, on-street parking, loading and unloading, land use and people on the carriageway are positively and significantly correlated with integration and thereby with the pedestrian volumes (Table 2). However, on-street parking (r= 0.182, p= 0.000), loading and unloading (r=0.126, p=0.010), land use (r= 0.258, p= 0.000) and people on carriageway as a result of vehicles (r= 0.258, p=0.000) indicate weak correlation (less than 0.3) (Acock 2008). The causal factor, undefined pedestrian domain negatively correlates with weak negative r value (r= -0.201, p= 0.000), perhaps because planning agencies have recently improved two mostly integrated streets (i.e. *Sri Dalada Veediya* and *Willium Gopallawa Mawatha* (Figure 3)) with required pedestrian infrastructure such as fencing. Further, when it was examined the relationship between people on carriage way as a result of vehicles and the other indicators, it was found that it is positive and significant, which indicates that there is a pedestrian-vehicular conflict. People on carriage way as a result of vehicles and on-street parking are the highest correlated items with moderate r value (r= 0.453, p= 0.000), because people might tend to use carriageway to walk when sidewalks are occupied to park vehicles. The reasons of on-street parking can be predicted, considering the correlations of other indicators, namely, loading and unloading (r= 0.311, p= 0.000) land use (r= 0.258, p= 0.000) and undefined pedestrian domain (r= 0.240, p= 0.000).

As per the pedestrians' perspective of this result, 82% of the respondents agreed with the identified pedestrian-vehicular conflicting locations. Additionally, according to their perception, the top five factors causing conflict are as follows: undefined pedestrian domain [44%]; on-street parking [37%]; land use [35%]; loading and unloading [30%] and constrained or no sidewalks [29%]. Various research findings, as well as pedestrians' perception survey of the Kandy Heritage City, emphasise that these five causal factors are influential in terms of pedestrian-vehicular conflict. Rahaman, Ohmori and Harata (2005) identify a buffer (between sidewalks and carriageways) to be a considerable safety issue. Respondents in their research have also stated that the absence of any definition between the sidewalks and carriageways is a main cause of pedestrian-vehicular conflict. Moreover, Brison et al. (1988), Donroe et al. (2008) and Shepherd, Austin and Chambers (2010) found that curb side or on-street parking is a cause of fatal accidents. Loading and unloading is a combined cause, along with land use, and that activity is less common in many heritage cities; thus, it is perceived as a problem by many pedestrians of the Kandy Heritage City. McMahon et al. (2002) found that sidewalks had no effect on pedestrian-vehicular conflict. However, Ossenbruggen, Pendharkar and Ivan (2001) stated the probability of a conflict is about two times more at a site without a sidewalk than a site with a sidewalk.

**Table 2** Correlation analysis

| Causal factors | | On-street parking | Loading and unloading | Land use | Intersection type | Constrained or no sidewalk space | Undefined pedestrian domain | People on carriageway as a results of vehicles | Integration |
|---|---|---|---|---|---|---|---|---|---|
| On-street parking | Pearson Correlation | 1 | | | | | | | |
| | Sig. (2-tailed) | | | | | | | | |
| | N | 419 | | | | | | | |
| Loading and unloading | Pearson Correlation | .311** | 1 | | | | | | |
| | Sig. (2-tailed) | .000 | | | | | | | |
| | N | 419 | 419 | | | | | | |
| Land use | Pearson Correlation | .258** | .410** | 1 | | | | | |
| | Sig. (2-tailed) | .000 | .000 | | | | | | |
| | N | 419 | 419 | 419 | | | | | |
| Intersection type | Pearson Correlation | -.036 | .054 | .064 | 1 | | | | |
| | Sig. (2-tailed) | .465 | .269 | .191 | | | | | |
| | N | 419 | 419 | 419 | 419 | | | | |
| Constrained or no sidewalk | Pearson Correlation | .094 | -.046 | .045 | .014 | 1 | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| space | Sig. (2-tailed) | .053 | .353 | .358 | .772 | | | | |
| | N | 419 | 419 | 419 | 419 | 419 | | | |
| Undefined pedestrian domain | Pearson Correlation | .240** | .058 | .052 | -.021 | .392** | 1 | | |
| | Sig. (2-tailed) | .000 | .234 | .289 | .662 | .000 | | | |
| | N | 419 | 419 | 419 | 419 | 419 | 419 | | |
| People on carriageway | Pearson Correlation | .453** | .317** | .285** | .126** | .367** | .247** | 1 | |
| | Sig. (2-tailed) | .000 | .000 | .000 | .010 | .000 | .000 | | |
| | N | 419 | 419 | 419 | 419 | 419 | 419 | 419 | |
| Integration | Pearson Correlation | .182** | .126** | .258** | .102* | -.072 | -.201** | .258** | 1 |
| | Sig. (2-tailed) | .000 | .010 | .000 | .036 | .139 | .000 | .000 | |
| | N | 419 | 419 | 419 | 419 | 419 | 419 | 419 | 419 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

*Source: Author*

### 5.3 Key Findings

This research complements pedestrian-vehicular conflict as "pedestrian contact with a potentially harmful vehicular traffic", following Hyden (1987) and Raford and Ragland (2003). This research is distinctive from the other research in the pedestrian safety arena taking conflict risks, rather than accident or crash data. This study best demonstrates the utility of this phenomenon, Planners may, thereby, play an important role in designing the locations where accidents will be happening, while precautions to be continued to eliminate the treat locations with accidents.

This study identifies seven built environment related micro-variables and pedestrian volume. This supports the views of some researchers (for examples, Parks and Schofer 2006; Clifton and Kreamer-Fults 2007; Dumbaugh and Li 2010) to examine the relationship between risk of crashes and the social and physical environment where the conflict risks exist.

Moreover, a prototype method developed in this study can be incorporated to study any context, and can be valuable for preventing crashes at individual sites. The previous studies confine to site-specific studies, when only the nature of the conflict can differ according to the specific environmental characteristics.

Finally, this research develops a pre-determined coding scheme, taking photographs at equal distance units and undertaking a pedestrian perception survey to validate the results. The coding scheme, distance intervals and time periods that need to take the photographs and format of perception survey will be decided by any investigator who will use this method based on the research context. Thus, this offers much needed insight for having an objective rating system (Parks and Schofer 2006).

## 6. Conclusion

This research conceptualised the pedestrian-vehicular conflict phenomenon as it facilitates urban planners' and designers' analysis of the spatial circumstance with micro-variables of the built environment and propose planning and design interventions. Most of the research has conceptualised pedestrian-vehicular conflict through the accident records. However, there are causes for road accidents for which the absence of accurate data and lack of a specific method to analyse the causes posed a constraint to conducting research in this field.

Due to this conceptualisation, micro-level and primary data had to be gathered from a case study undertaken in the Kandy Heritage City, where automobiles, roads and car culture have contributed intensely to restructuring the urban built environment. Another reason that prompted the collection of this primary data is the uniqueness of the case study. Almost all the urban areas manifest unique characteristics in some respect, and problems with which planners need to deal are specific. Thus, an inductive research method is vital for framing the problems embedded in those cities. It is necessary to direct attention to historic cities, as the tailor-made solutions are too difficult to enforce due to their conservation and collective values.

A major challenge that we came across in this research field is the limitation of data and information to study the built environmental factors. In this context, a photographic survey was considered an ideal data collection method as it provides impartial, inexpensive, up-to-date information. The method provided in this study to record the empirical data is unique to this research arena, and it is widely applicable. At the same time, though the QGIS platform is not widely used for spatial analysis, this research illustrates that it is a convenient platform for geocoding, preparing maps and, most importantly, conducting space syntax analysis. Analysis with space syntax is new to this research area. Even though accurate pedestrian volume data are compulsory for this nature of research, utilisation of pedestrian counts is costly, and it is hard to find an

up-to-date dataset. The space syntax modelling approach has been utilised to fill this gap with minimal additional input. It is less complicated and provides impartial outcomes. At the same time, this method enables the conversion of the qualitative data into quantitative data and the conduction of further statistical analysis.

The findings of the research are, first, the conceptualisation with definition and a criterion to identify built environmental causal factors that are particular to a case study. Though these findings are contextual, the authors believe that the concept of pedestrian-vehicular conflict and the methodology developed to identify causal factors in this research can be tailored to other towns. Second, the methodology indicates the possibility of doing spatial estimation in relation to pedestrian movement and the causal spots/locations. The construct validation also confirmed that some causal factors (four out of seven in this case) are appropriate for predicting the conflict, while the pedestrians' perception survey confirmed that the derived results are authentic (more than 80%).

Although the results of the study add a strong base for understanding the given phenomenon, there exist some limitations in data recording and interpretations. It is necessary to generate axial lines manually to make the space syntax map and compute spatial integration. Though there is axial generation software, the lines have to be drawn manually, as the software is not compatible with QGIS. Xia (2013) states that manual axial maps may differ from person to person. Thus, there were some technical limitations involved in this research. The limitation of using space syntax is that it may lead us to underestimate the variation of land uses and under-predict the underground and above-ground pedestrian infrastructure networks.

Though photography was considered as the main source of data, it inherits some weaknesses; first, it records only the function of a particular point in time as a static image, and it is difficult to record the functional system of the space of that particular time; second, the capturing of the event as well as interpretation of the photographs can be subjective to some extent. Nonetheless, author tried to overcome these weaknesses by validating the findings with the pedestrian's perception survey and content analysis of the photographs by using a pre-determined coding scheme. Though the pedestrians' perceptions have been taken into consideration to minimise the imprecision by following the other research studies, this study could have benefited from following a time series photographic analysis to figure out outcomes that are more reliable. It is also important to point out that content analysis of photographs is time-consuming, and their application to a city of a larger scale could be a discouraging task. This research could have been impartially and speedily done had there been software to conduct content analysis of photographs. Thus, further research is necessary to explore a software for more convenient computer-based analysis.

If the planners and designers interested in studying pedestrian-vehicular conflict prefer to microscopically experiment the real ground situation in order to explore applicable solutions, it is left to them to adopt this tested methodology.

## Reference

Acock, A. C. (2008). A Gentle Introduction to Stata (2nd ed.). College Station, Texas. Stata Press (USA).

Anderson, T. (2007). Comparison Of Spatial Methods For Measuring Road Accident 'Hotspots': A Case Study of London. *Journal of Maps.* 3(1): 55-63.

Bandara, A., Meetiyagoda, L. and Munasinghe, J. (2009). Spatial Configuration As A Determinant Of The Activity Pattern: The Case Of Two Small Cities In Sri Lanka. Bhumi. *The Planning Research Journal*. 2(2): 25-40

Bandara, A., and Munasinghe, J. (2007). Evolution of a City: A Space Syntax Approach To Explain The Spatial Dynamics of Colombo. In Proceeding (s) of 9th International Congress of Asian Planning Schools Congress.

Ben-Joseph, E. (1995) Changing the Residential Street Scene: Adapting The Shared Street (Woonerf) Concept To The Suburban Environment. *Journal of the American Planning Association.* 61(4): 504-515.

Braddock, M., Lapidus, G., Cromley, E., Cromley, R., Burke, G. and Banco, L. (1994). Using a Geographic Information System To Understand Child Pedestrian Injury. *American Journal of Public Health*. 84(7):1158-1161.

Baran, P.K., Rodríguez, D.A. and Khattak, A.J. (2008). Space Syntax And Walking In A New Urbanist And Suburban Neighbourhoods. *Journal of Urban Design.* 13(1): 5-28.

Bernard, H.R., Wutich, A. and Ryan, G.W. (2016). Analyzing Qualitative Data: Systematic Approaches. SAGE publications.

Black, J. A., and Westerman, H.L. (1989). Pedestrian/Vehicle Conflict in The Main Street Of Country Towns. University of New South Wales Press (Australia).

Brison, R.J., Wicklund, K. and Mueller, B.A. (1988). Fatal Pedestrian Injuries To Young Children: A Different Pattern Of Injury. *American Journal of Public Health.* 78(7): 793-795.

Bunn, F., Collier, T., Frost, C., Ker, K., Steinbach, R., Roberts, I. and Wentz, R. (2003). Area-Wide Traffic Calming For Preventing Traffic Related Injuries. The Cochrane Library.

Chainey, S., Tompson, L. and Uhlig, S. (2008). The Utility Of Hotspot Mapping For Predicting Spatial Patterns Of Crime. *Security Journal.* 21(1-2): 4-28.

Clifton, K.J., Burnier, C.V. and Akar, G. (2009). Severity Of Injury Resulting From Pedestrian–Vehicle Crashes: What Can We Learn From Examining The Built Environment?. Transportation Research Part D: *Transport and Environment* 14(6): 425-436.

Clifton, K.J. and Kreamer-Fults, K. (2007) An Examination Of The Environmental Attributes Associated With Pedestrian–Vehicular Crashes Near Public Schools. *Accident Analysis & Prevention.* 39(4): 708-715.

Cloutier, M., Lachapelle, U., d'Amours-Ouellet, A., Bergeron, J., Lord, S. and Torres, J. (2017). "Outta My Way!" Individual And Environmental Correlates Of Interactions Between Pedestrians And Vehicles During Street Crossings. *Accident Analysis & Prevention*. 104: 36-45.

Crampton, J.W. (2002). Interactivity Types In Geographic Visualization. *Cartography and Geographic Information Science*. 29(2): 85-98.

Dai, D., Taquechel, E., Steward, J. and Strasser, S. (2010). The Impact Of Built Environment On Pedestrian Crashes And The Identification Of Crash Clusters On An Urban University Campus. *Western Journal of Emergency Medicine*. 11 (3): 294.

DiMaggio, C. and Li, G. (2011). Roadway Characteristics And Paediatric Pedestrian Injury. *Epidemiologic Reviews*. 34(1): 46-56.

Donroe, J., Tincopa, M., Gilman, R.H., Brugge, D. and Moore, D.A.J. (2008). Pedestrian Road Traffic Injuries In Urban Peruvian Children And Adolescents: Case Control Analyses Of Personal And Environmental Risk Factors. *PLoS One*. 3(9): 3166.

Dumbaugh, E. and Li, W. (2010), "Designing for the Safety Of Pedestrians, Cyclists, And Motorists In Urban Environments", *Journal of the American Planning Association*. 77(1):69-88

Eluru, N., Bhat, C.R. and Hensher, D.A. (2008). A Mixed Generalized Ordered Response Model For Examining Pedestrian And Bicyclist Injury Severity Level In Traffic Crashes. *Accident Analysis & Prevention*. 40(3): 1033-1054.

Ewing, R., Handy, S., Brownson, R.C., Clemente, O. and Winston, E. (2006). Identifying and Measuring Urban Design Qualities Related To Walkability. *Journal of Physical Activity and Health*. 3(s1): S223-S240.

Gallin, N. (2001). Quantifying Pedestrian Friendliness--Guidelines For Assessing Pedestrian Level Of Service. *Road & Transport Research*. 10(1): 47.

Gerring, J. (2004). What is a case study and what is it good for?. American Political Science Review 98(2): 341-354.

Gil, J., Varoudis, T., Karimi, K. and Penn, A. (2015). The Space Syntax Toolkit: Integrating Depthmapx And Exploratory Spatial Analysis Workflows in QGIS. In SSS 2015-10th International Space Syntax Symposium, 10. Space Syntax Laboratory, The Bartlett School of Architecture, UCL (University College London).

Hajdu, J. C. (1988). Pedestrian malls in West Germany: Perceptions of Their Role And Stages In Their Development. *Journal of the American Planning Association*. 54(3): 325-335.

Hamilton-Baillie, B. (2008). Shared Space: Reconciling People, Places And Traffic. *Built Environment*. 34(2):161-181.

Hsieh, H. and Shannon, S.E. (2005). Three Approaches To Qualitative Content Analysis. *Qualitative Health Research*. 15(9): 1277-1288.

Hydén, C. (1987). The Development Of A Method For Traffic Safety Evaluation: The Swedish Traffic Conflicts Technique. Bulletin Lund Institute of Technology, Department 70.

Jiang, B. and Claramunt, C. (2002). Integration of Space Syntax Into GIS: New Perspectives For Urban Morphology. *Transactions in GIS*. 6(3): 295-309.

Kadali, B.R., Rathi, N. and Perumal, V. (2014). Evaluation of Pedestrian Mid-Block Road Crossing Behaviour Using Artificial Neural Network. *Journal of Traffic and Transportation Engineering (English edition)*. 1(2): 111-119.

Khan, T.H., Isah, A.D., Anjomshoaa, E. and Sabri, S. (2015) Users' Perceptions On Pedestrian Prioritized Neighborhoods: A Study On Terrace Row Housing Estates in Malaysia. *International Journal of Built Environment and Sustainability* 2(1): 29-38

Khder, H.M., Mousavi, S.M. and Khan, T.H. (2016) Impact of Street's Physical Elements On Walkability: A Case Of Mawlawi Street in Sulaymaniyah, Iraq. *International Journal of Built Environment and Sustainability*. 3(1): 18-26

Kim, Y.O. and Penn, A. (2004). Linking the Spatial Syntax Of Cognitive Maps To The Spatial Syntax Of The Environment. *Environment and Behavior*. 36(4): 483-504.

McMahon, P.J. (2002). An Analysis Of Factors Contributing To" Walking Along Roadway" Crashes: Research Study And Guidelines For Sidewalks And Walkways. 1. DIANE Publishing.

Meetiyagoda, L. (2018). Pedestrian safety in Kandy Heritage City, Sri Lanka: Lessons from World Heritage Cities. Sustainable Cities and Society 38: 301-308

Meetiyagoda, L. and Munasinghe, J. (2016). Towards Great Streets: An Empirical Approach To Study A Streetscape. Bhumi. the Planning Research Journal 1(2): 34-49

Moudon, A., Lin, L., Hurvitz, L. and Reeves, P. (2008). Risk of Pedestrian Collision Occurrence: Case Control Study Of Collision Locations On State Routes in King County and Seattle, Washington. Transportation Research Record: *Journal of the Transportation Research Board*. 2073: 25-38.

Lerman, Y., Rofè, Y. and Omer, I. (2014). Using Space Syntax To Model Pedestrian Movement In Urban Transportation Planning. *Geographical Analysis*. 46(4):392-410.

Omer, I. and Kaplan, N. (2017). Using Space Syntax And Agent-Based Approaches For Modeling Pedestrian Volume At The Urban Scale. *Computers, Environment and Urban Systems*. 64:57-67.

Osama, A. and Sayed, T. (2017). Macro-Spatial Approach For Evaluating The Impact Of Socio-Economics, Land Use, Built Environment, And Road Facility On Pedestrian Safety. *Canadian Journal of Civil Engineering*. 44(12): 1036-1044.

Ossenbruggen, P.J., Pendharkar, J. and Ivan, J. (2001). Roadway safety in rural and small urbanized areas. *Accident Analysis & Prevention*. 33(4): 485-498.

Parks, J.R. and Schofer, J.L. (2006). Characterizing Neighbourhood Pedestrian Environments With Secondary Data. *Transportation Research Part D: Transport and Environment*. 11(4): 250-263.

Penn, A. (2003). Space syntax And Spatial Cognition: Or Why The Axial Line?. Environment and Behaviour. 35(1): 30-65.

Perera, L.A.S.R. and Amin, A.T.M.N. (1996). Accommodating the Informal Sector: A Strategy For Urban Environmental Management. *Journal of Environmental Management*. 46(1): 3-15.

Pulugurtha, S.S., Krishnakumar, V.K. and Nambisan, S.S. (2007). New Methods To Identify And Rank High Pedestrian Crash Zones: An Illustration. *Accident Analysis & Prevention*. 39(4): 800-811.

Raford, N. and Ragland, D.R. (2003). Space Syntax: An Innovative Pedestrian Volume Modeling Tool For Pedestrian Safety, Institute Of Transportation Studies. UC Berkeley Traffic Safety Center, UC Berkeley Google Scholar.

Rahaman, K.B., Ohmori, N. and Harata, N. (2005). Evaluation of the Roadside Walkway Environment of Dhaka City. In Proceeding of the Eastern Asia Society for Transportation Studies. 5:1751-1766.

Ranasinghe, G., Amarawickrama, S., Rathnayake, R., Randeniya, T., and Rathnasiri, S. (2015). A Model For Assessing The Level Of Walkability In Urban Neighborhoods in Sri Lanka. *International Journal of Built Environment and Sustainability*. 2(4): 292-300

Robertson, K. A. (1993) Pedestrianization Strategies For Downtown Planners: Skywalks Versus Pedestrian Malls. *Journal of the American Planning Association*. 59(3): 361-370.

Rytkönen, M.J.P. (2004). Not All Maps Are Equal: GIS And Spatial Analysis In Epidemiology. *International Journal of Circumpolar Health*. 63(1): 9-24.

Sarkar, S. and Andreas, M. (2004). Drivers' Perception Of Pedestrians' Rights And Walking Environments. Transportation Research Record: *Journal of the Transportation Research Board*. 1878: 75-82.

Schneider, R.J., Ryznar, R.M. and Khattak, A.J. (2004). An Accident Waiting To Happen: A Spatial Approach To Proactive Pedestrian Planning. *Accident Analysis & Prevention*. 36(2):193-211.

Schuurman, N., Cinnamon, J., Crooks, V.A. and Hameed, S.M. (2009). Pedestrian Injury And The Built Environment: An Environmental Scan Of Hotspots. BMC Public Health. 9(1):233.

Sepe, M. (2009). PlaceMaker Method: Planning 'Walkability' By Mapping Place Identity. *Journal of Urban Design*. 14(4): 463-487.

Shepherd, M., Austin, P. and Chambers, J. (2010). Driveway Runover, The Influence Of The Built Environment: A Case Control Study. *Journal of Paediatrics and Child Health*. 46(12): 760-767.

Southworth, M. (2005). Designing the Walkable City. *Journal of Urban Planning and Development*. 131(4): 246-257.

Steenberghen, T.T., Dufays, I.T., and Flahaut, B. (2004). Intra-Urban Location And Clustering Of Road Accidents Using GIS: A Belgian Example. *International Journal of Geographical Information Science*. 18(2): 169-181.

Steinmetz, G. (2004). Odious Comparisons: Incommensurability, The Case Study, And "Small N's" In Sociology. *Sociological Theory*. 22(3): 371-400.

Stoker, P., Adkins, A. and Ewing, R. (2017). Pedestrian Safety And Public Health. In Walking: *Connecting Sustainable Transport with Health*. 211-229.

Swanborn, P. (2010). Case Study Research: What, Why And How?. Sage Publications

Tobler, W.R. (1973). Choropleth Maps Without Class Intervals?. *Geographical Analysis*. 5(3): 262-265.

Ukkusuri, S., Hasan, S. and Aziz, H. (2011). Random Parameter Model Used To Explain Effects Of Built-Environment Characteristics On Pedestrian Crash Frequency. Transportation Research Record: *Journal of the Transportation Research Board*. 2237: 98-106.

Wier, M., Weintraub, J., Humphreys, E.H., Seto, E. and Bhatia, R. (2009). An Area-Level Model Of Vehicle-Pedestrian Injury Collisions With Implications For Land Use And Transportation Planning. *Accident Analysis & Prevention*. 41(1): 137-145.

Zaman, M., Sultan, Z., Fard, M., Siyaka, A. and Pung, J.C. (2017) An Assessment Of Public Transport Facility In Johor Bahru: A Case Study In Taman Ungku Tun Aminah Area, Majlis Perbandaran Johor Bahru Tengah, Malaysia. International Journal of Built Environment and Sustainability 4(2): 71-80

Zegeer, C.V. and Bushell, M. (2012). Pedestrian Crash Trends And Potential Countermeasures From Around The World. *Accident Analysis & Prevention*. 44(1): 3-11.

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# Interrelationships between Public Open Space, Common Pool Resources, Publicness Levels and Commons Dilemmas: A Different Perspective in Urban Planning

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## ABSTRACT

Public open space (POS) is central to the environment, and oftentimes spatial and architectural designs are emphasised in urban planning as part of creating quality POS. However, such initial design and planning of POS may not adequately encapsulate the sustainability dimensions of the complex social-ecological behavioural patterns of POS consumption and management, hence resulting in space mismanagement, underinvestment, and quality degradation. This phenomenon is particularly true and relevant in the context of government/state-owned POS. Therefore, an objective of this perspective paper, coupled with the concepts of the publicness levels, is to provide a different understanding of exclusivity and subtractibility natures of POS, primarily using the theory of common pool resources (CPRs), which subsequently helps explain and rationalise the perennial, adversarial POS management, quality and sustainability status quo. This paper reveals that, instead of being considered as pure public goods, scarce POS owns two inherent attributes of CPR, namely non-excludable and subtractive (rivalrous) that are ultimately susceptible to social/commons dilemmas, covering the Tragedy of the commons (overexploitation), management shirking, free-riding, underuse, disuse, and moral hazard, which lead to degraded, unsustainable POS. The commons or CPR theory can indeed offer a new paradigm shift, making urban planners and landscape managers to embrace that the unexclusive natures of CPR-based POS are truly finite and depletable and thus vulnerable to POS dilemmas. Hence, to achieve quality, sustainable POS commons, effective governance in terms of consumption and consistent management is vital. For future research, urban design as a necessary societal role is suggested, which has established the need for effective allocation of POS management via an adaptive institutional property rights design.

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## 1. Introduction

Local governments are mandated, through the collection of taxes, to provide and manage various public/civic goods, which are essential to serve as a public purpose, and one of them is public open spaces (POS) (Tiebout, 1956). POS can be defined in wide arrays of definitions, categories, and functions (types of activities and facilities), e.g., recreational park, sidewalk, playground, green space, community garden, semi-active space: basketball court, promenade, revitalised brownfield land, active

and passive spaces (Onwuayi & Ndinwa, 2017; Ling and Pung, 2019). In recent years, research on equitable, sustainable management and provision of POS has grown tremendously as it has evidently rendered various ecosystem services and portrayed significant roles in achieving sustainability and the quality of life, mainly contributing to the 11th and the 12th Sustainable Development Goals and the New Urban Agenda.

There are many studies undertaken on the protection and preservation of POS quality and sustainability, encompassing perception and socioeconomic features: attitudes (preferences) of stakeholders towards POS protection (Broussard et al., 2008; Maruani and Amit-Cohen, 2011), public participation in planning policy (Steelman and Hess, 2009), spatial and architectural POS design and planning models (Maruani and Amit-Cohen, 2007; Colding et al., 2013), and "conventional" state planning policies with edict (Koomen et al., 2008) and critical planning policy implementation and enforcement (Bengston et al., 2004). However, the issues of notably state-owned POS quality with respect to over-exploitation, misuse, underinvestment, and mismanagement, including vandalism (broken POS facilities), graffiti, inaccessible spaces, exclusion, illegal land and space (POS) conversion (e.g., to commercial spaces), insecure and unsafe spaces, cleanliness, congestion, poor landscaping and squatters settlement encroachment issues, are growing and prevalent, especially in developing countries of Southeast Asia including Malaysia, thereby causing POS negative externalities and market failures (World Bank, 2015; Ling et al., 2016, 2018; Foster and Laione, 2016; Ling and Leng, 2018). Thus, a question is posed, i.e., why are POS issues still rampant and occurring, despite the above research undertaken?

The posed problems of such domestic Tieboutian modelled or government-owned POS are closely associated with governance, consumption and management issues (i.e., post-design stage), rather than ab initio design-based issues. Many urban and rural POS in terms of its spatiality (e.g., location, shape, and size) and architecture have been strategically planned at the beginning of the design stage, and the provision of facilities and amenities is sufficient, which overall give quality, inviting spaces. However, such good condition and quality of scarce POS may not sustain due to asymmetric and heterogeneous consumption and management behaviour issues of individuals (Poklembovai et al., 2013; Ling et al., 2016). That is the following questions should be identified and reflected on: What will happen after the spatial and architectural design stage of POS? Is there any efficient enforcement and mechanism used to govern the space, particularly on its consumption and management? Certainly, the design stage (pre-condition) is important as part of provisioning good quality of POS, but what makes POS quality sustained? This post-design and planning issue is more critical and imperative as this involves long-term and complex social-ecological process and interaction, which are often uncertain and conflicting in nature. As Poklembovai et al., (2013) asserted, "Successful physical spaces are dependent on the performance and legitimacy of spatial management processes and practices… Planning and implementation are the initial phases, but public spaces are continually co-created by their users.". As such, to answer the above questions, a transdisciplinary approach is necessary.

Methodologically, the institutional-social-ecological system by Ostrom (2009), the theory of commons or common pool resources (CPRs) (Ostrom, 1990), and the concepts of social dilemmas (Kollock, 1998) and negative externalities were reviewed and adopted in this perspective paper as analytical frameworks to shed light on the current POS governance issues. By looking into the natures of publicness (exclusivity) and rivalrousness (subtractibility/contestability) of POS, the objective of this paper is to establish causal mechanisms, linking types of economic goods (CPR), governance (consumption and management), with resources quality and sustainability outcomes. In other words, this study can be of significance and practical because it essentially showcases how the above CPR theory and its associated concepts (social dilemmas and the social-ecological system) explain and rationalise the status quo of perennial, adversarial POS management and quality issues. More precisely, the main arguments and findings suggested at the end of this study are that via the unexclusive and rivalrous CPR natures discovered in POS with different publicness levels such spaces are argued to be prone to various commons dilemmas and negative externalities. The above theoretical underpinning (via political-microeconomic perspective) by Nobel laureate Elinor Ostrom was chosen because it has proven to be robust and influential in addressing the above POS negative externalities, which are related to consumption and management issues. Based on the literature review, it is, however, found that human-nature (POS) interaction issues to be analysed within the lens of the social-ecological framework have been considerably overlooked in the planning theory (see Elmqvist, 2014; Lai, 2014).

More precisely, the knowledge and application of the commons or CPR in the context POS planning and management (called new commons) are still limited (Colding et al., 2013; Nagendra and Ostrom, 2014; Brown, 2015; Foster and Laione, 2016; Ling et al., 2016; Ling and Leng, 2018). Although the literature on natural resources (old) commons and CPRs (e.g., agriculture and fishery) is copious, it remains a challenge to transpose CPR insights into the urban and neighbourhood-residential resources context in a way that captures the complexity of the urban-neighbourhood, the way that density of an land area, the proximity of its inhabitants, and the diversity of users interact with a host of tangible and intangible resources in neighbourhood-city areas (see Borch and Kornberger, 2015). As such, there is a need to diversify the current mainstream environmental planning system; it is crucial to embrace the idea of 'planning POS with commons in mind'.

The remainder of the paper is structured as follows: (i) Commons/CPR in the POS context, in which, aside from the definitions of POS and conceptualisation of CPR in POS, the typology of economic goods is also employed to explain differences among the goods; (ii) The publicness (sharedness) and exclusivity concepts of POS (i.e., public realm versus public domain versus local public goods); (iii) Implications of CPR-based POS using the social-ecological system and social dilemmas perspectives; and lastly (iv) Conclusion consisting of lessons learnt from the institutional-economic field in POS planning, and of future recommendations.

## 2. Public Open Space (POS) as a Commons/CPR

First, we need to define what 'commons' is. The concept of commons is multidisciplinary as it attracts various scholars from different schools of thought (especially economists, property theorists, and commons theorists), whom have diverse definitions and understanding of commons. The term commons can either be deemed or interpreted as common-property resources (as a property right regime that belongs to one group/community, specifically- known as common property regime) or common resources (as a resource domain/system) (Hess and Ostrom, 2006). However, it seems that the latter is more widely accepted and applied even by institutionalists and property theorists in their scholarly works. As asserted by Bromley (1992), "…there is no such thing as a common property resources…".

Thus, commons are a general term that refer to the resources shared (collectively consumed) by a group of people, in which each of them has equal interest. Campbell and Wiesen (2009, p. 11) stated that commons are "publically accessible, nonexcludable, and managed through shared governance". In a simpler word, commons are a shared resources system (Hess and Ostrom, 2006), or they are a "shared heritage of us all" (Hess, 2008), governed by any form of a property rights regime/system (Ostrom, 2002). Once again Ostrom's argument has drawn a clear, distinctive line between a resource system and a resource (property) regime. This is vital and worth noted because some confusion and misconception occurred over the sharedness (publicness) of commons, which can be discovered in the notable illustration of the seminal theory "Tragedy of the Commons" which erroneously considered commons as total ungoverned, unrestricted, open-access grazing land (as a type of property regime), rather than a resource system (Ciriacy-Wantrup and Bishop, 1975).

Thus, since POS is a collectively consumed resource, it is conceptualised as a commons, more specifically, as an urban commons or neighbourhood (hometown) commons, depending on the settings, which both are part of new commons (Hess, 2008). Such neighbourhood commons or urban commons encompass various civic spaces, including playground, streets, recreation areas, parking space, community parks, gardens, urban public spaces, streets, public roads, recreation areas, football field and basketball court, etc. (Colding et al., 2013), and they can be regarded as POS. Thus, the two terms (POS and commons) are used interchangeably in the paper.

Most of the collectively consumed goods (e.g., forests, roads, pastures, air, river, and sea) are scarce goods, like POS in this context. Based on the typology of goods theory (Ostrom and Ostrom, 1977; see Webster, 2007) (Table 1), the majority of natural resources/commons including POS can be categorised as common-pool resources (CPR), instead of fictitious pure public goods (e.g., non-rivalrous and non-excludable lighthouse and fireworks- see Webster, 2002 on existence value).

**Table 1** Excludability and Rivalry Levels of Four Different Economic Goods

| | | Exclusion | |
|---|---|---|---|
| | | Difficult or costly | easy |
| Consumer rivalry | high | Common-pool resources (e.g., forest, pasture, ground-water aquifers) | Private goods (e.g., timber, Christmas trees) |
| | low | Public goods (e.g., biological diversity, protection against avalanches) | Club or toll goods (e.g., forest road, recreational facility, national park) |

Source: Gluck (2000)

With different types of goods, including pure public goods, club goods, and private goods, and their respective examples, the above table provides clearer understanding on the notions and levels of subtractibility (rivalry) and excludability characteristics of CPRs. As Nobel Laureate Lin Ostrom posited, regardless of the property rights structure, a CPR is frequently denoted as a resource domain, featuring two inherent attributes, namely excludability — the obstacle of restricting (regulating), whether physically or institutionally, individuals from accessing and using resource units from the resource; and subtractibility — once an individual harvested the profit (benefits and enjoyment) of resources, they are not useable anymore by other users (Ostrom, 2005). Although Table 1 shows that a recreational facility and national parks are entrepreneurial club goods (with low-cost exclusion and low rivalry), due to the payment system resulting in exclusion, such POS goods can also transition into CPRs, owing to institutional (property-rights) and spatial factors which are partly discussed in the next section (see Webster, 2002; Webster's 2007 on the transition fluidity of economic goods). Regardless, focusing on the CPRs system and conceptualising the concept of the CPR within a complex social-POS system, it entails that CPR-based POS requires high cost and is difficult to exclude or control users (either residents or non-residents/non-citizens) from accessing and consuming POS and its units, including POS conditions and quality that involve the availability of POS facilities and amenities, functionality, landscape, and cleanliness and safety and security of POS surrounding. Secondly, such scarce POS units in terms of quality and quantity/provision can be fugitive and are diminishable, because once POS conditions are not well-maintained or overused by an individual, and its provision is not replenished, only poor POS quality (e.g., cleanliness and safety issues) and unusable POS facilities (e.g., unavailable basketball court and loss of POS) are available to others (see more in social dilemmas in the later section).

## 3. 'Publicness' of POS: Public Domain, Public Realm and Local Public Goods

Since the non-excludable attribute of CPR- or commons-based POS is synonymous with the general concept of publicness/sharedness, it would be helpful for this paper to deconstruct and theorise about the vague and unspecified concept of unexclusiveness (publicness) of urban and

neighbourhood commons/CPR, using Webster's (2002) theoretical literature of public domain, public realm, and local public goods. By providing the definitions and importance of each publicness concept below, in this paper, we explain how those economic publicness concepts are interrelated, and how they are conceptualised into the urban and neighbourhood commons (POS) planning context. Such publicness analysis is indeed essential because, without the identification of publicness forms and levels, one cannot accurately distinguish to what extent, and what form of, the publicness (unexcludability) of the CPR-based POS is. Different publicness levels and forms may, in essence, and arguably lead to different rivalrousness or congestion levels of POS (Webster, 2002; Webster, 2007), which may consequently contribute to different implications on the behavioural consumption patterns of users, and may therefore account for and result in the aforesaid CPR-POS quality issues (Colding et al., 2013; Ling et al., 2016). Having said this, we, however, have not attempted to causatively and precisely determine which publicness of commons will always have greater contestability and rivalrousness, nor have we identified which publicness level is more prone to, or ensues in, severe overuse and other commons dilemmas. In light of the above, we did, however, provide evidence and arguments to the claims on the interrelationships between CPR publicness levels and vulnerability of commons dilemmas in more indicative and deductive manners. Regardless, what is more important is that the effort of identifying the forms and levels of publicness is consistent with Colding's et al., (2013) position that it is erroneously fallacious and deceptive always to equate commons or CPR with open public space.

Public domain is, as defined by property theorists and economists, "…a sphere of resource consumption within which consumption rights remain unallocated" (Alchian and Demsetz, 1973; Barzel, 1997). See also Allen (2002) that public domain is equivalent to having open access to the resource. Webster (2002), similarly, in his own words, maintains that public domain is "Attributes to which rights are not assigned by formal or informal contract are said to be in the public domain, and are potentially the subject of competition. The public domain is therefore the domain (spatial or otherwise defined) within which competition occurs in the consumption of attributes…Because it is too costly to establish property rights over every attribute of a good, some will inevitably be left in the public domain." Webster continues by implying that public-domain POS means the rights to consume a benefit of the POS are unassigned, whereby a general public (or outsiders/non-contributing users/non-citizen) may have access to it. See Ling et a., 2016 for Sabah's public-domain POS that even Filipinos as a non-citizen can have access to the urban park, as transaction costs for rights assignation and enforcement are high. In the absence of allocated use rights, more resources entailing high transaction costs (e.g., monitoring and physical barricade) are required to protect and manage scarce public-domain POS, and this is assumed to be inefficient because POS is likely to be degraded and its dissipation costs (e.g., queuing, conflict, adopting an inconvenient trip manner, and inaccessible POS) are accruing to no one.

While, public realm is a "spatial domain within which de facto or de jure economic or legal consumption rights over a local public good attribute are shared by all individuals within a city…there exists a group of consumers-noncitizens-to whom property rights over the public good attribute are denied" (Webster, 2002). Similar to public domain, although public-realm POS facilities (e.g., sidewalks, benches, green spaces, and pavements) consumption right is assigned to specific groups of individuals within a city or a neighbourhood, within the very same groups of consumers, they usually cannot prevent the inclusion and seclusion issue; thus, such public commons are also subject to rampant competition. As such, to control public realm and public domain overcrowding issue, they exclude other individuals using a rationing approach, i.e., by costs, the money or time costs of travel, or by congestion (itself a form of cost) (Webster, 2007). Except for few urban/civic POS located in a city centre, which may cater uniform benefits of facilities and services to a large number of urban folks, most spaces give greater levels of enjoyment (use) and access to those living nearer. This type of resources is similar to the case of Tieboutian local public goods, such as urban parks for some city dwellers and neighbourhood community parks in housing estates. The neighbourhood and urban commons are considered as the resources with distance-attenuated attributes and benefits; such POS provides greater levels of enjoyment and consumption to those residents living closer. In respect of a congestion issue, since Tieboutian local neighbourhood POS access and use, espousing local planning standards, are only catered to a community who lives nearby the neighbourhood, the provision (supply of space quantity), in principle, is sufficient, unless the particular local community park is unique compared to other local parks that attract other neighbourhood residents to use and over-occupy it, which then creates a congestion (overuse) issue.

From the publicness definitions, there are interrelationships among the 'publics'. Most of state-owned CPR resources like urban spaces, street walk, and public parks are considered public domain (unassigned consumption right), from the property rights perspective, but due to the cost of spatial extent involving distance, travelling, congestion (a form of exclusion), only certain individuals have greater access to the resources, such public-domain space is a form of local public goods to them. This entails that local public goods can always co-exist and are benefitting certain groups of users with closer proximity. Similarly, due to distance and travelling costs (proximity), the local POS with the distance-attenuated attributes are found in a public realm. The public-domain POS (e.g., community park, neighbourhood playground, and urban park) is de facto fragmented/transitioned into public-realm local goods, when the economic use right is assigned by distance and is reinforced by informal institutions (e.g., practice within a community). Also, it is worth noted that a public realm may de facto become a public domain, once the assigned consumption right of the former is not enforced effectively.

To sum, the publicness concepts of CPR-POS are various and are considered as a continuum (i.e., public domain may transition into public realm and vice versa) (Webster, 2002), due to the spatial concern and institutional factors (rights

assignation and rights enforcement). Also, due to spatial/distance factors and exclusion costs, spaces either within public domain or public realm are considered as local public goods to some users who are closer to them. It appears that a public-domain space may exert a greater congestion level facing severe resource degradation compared to local public goods in public realm as the former is subject to a larger population and therefore greater competition among them for quality POS facilities and amenities (Webster 2002, 2007). However, this assumption is served as instrumental for the quantity aspect of POS provision or level of contestability measurement, instead of POS quality and individuals' consumption behaviour, and the claim by Webster may not always be generalisable and true in reality, if some circumstances are met. In Webster's (2002) study, he argued that public-domain spaces (e.g., on-street parking space as local public goods) can be efficient, so long as it is below the congestion level (i.e., consumption demand for POS is lower than supply).

Moreover, despite consumption right assignation for public-realm space and the distance-attenuated benefits of a local neighbourhood park, since both are having a difficulty in excluding other individuals' use, both spaces are also vulnerable to a certain extent of congestion and degradation (quality) (Webster, 2007; Foster and Laione, 2016; Ling et al., 2016). More interestingly, according to Ling's, (2017) finding, local residential community parks (public realm-local public good) are more prone to congestion and other forms of quality degradation, compared to public-domain civic spaces in the city centre. Irrespective of any levels and forms of publicness of urban and neighbourhood commons (be it public-realm or public-domain local POS), it is discovered that those 'publics', to certain extent, are subject to their respective issues of congestion (undersupply of POS and its units in terms of its quantity) and other negative externalities. The questions of vulnerability/susceptibility and the severity of congestion, competition and other forms of negative externalities among public realm, public goods, and public domain still remain inadequately answered, using only the publicness analysis above.

That is, aside from POS congestion issues that can be well-explained by the publicness levels of CPR (i.e., more of quantity provision rather than quality aspect of POS), to offer more holistic analysis and explain better the above POS quality (post-design) issues (e.g., vandalism, illegal conversion, broken facilities and amenities, and poor cleanliness), one should look into the publicness issues of commons, based on a case-by-case basis. We argue that those issues are fundamentally boiled down to CPR rivalrous/depletable and non-exclusionary (publicness) attributes, which are associated with a selfish and opportunistic behaviour within a social-ecological interaction. Hence, we employ the social dilemmas theory below to explicate the CPR issues.

## 4. Social Dilemmas and Negative Externalities of CPR-POS

Within a complex, large social-POS system, involving multiple interests and stakeholders (e.g., local authority, land officers, and residents/users) and conflicting decision making, it is challenging and difficult to govern and manage the shared commons (i.e., CPR-POS). Rested on the neoclassical economic premises and theories of self-interestedness (rationality maximisation), opportunism (Williamson, 2002) and social dilemmas, we showcase what are possible commons dilemmas involved in the CPR-POS context, and how CPR-POS is vulnerable to numerous social (commons) dilemmas and negative externalities (i.e., how selfish and opportunistic individuals are depicted in a social-POS system). Prior to the detailed discussion of the above questions, the definitions and background of self-interest, opportunism and social dilemmas are provided foremost.

Self-interest (selfishness), a sole intention of human behaviour from an economic lens, refers to individuals who inevitably behave rationally to maximise their advantages (welfare and utility). This concept is relevant to a social-ecological system, where defective self-interested individuals may cause unrestrained pollution and commons degradation (Musole, 2009). Building on the self-interest concept, opportunism provides more accurate understanding with respect to social-ecological behaviour and their decision-making (Williamson, 1975). As Williamson averred, opportunism entails "…self-interest seeking with guile…", in which opportunistic individuals (residents or POS users) tend to pursue their personal interests, whereas breaking their covenant (promises), e.g., neglecting their POS management and maintenance duties and attempting to go against the policies/regulations of POS via vandalism and illegal land use change.

There is a connection between social dilemmas and self-interest based opportunism; the former (self-interestedness and opportunism) are inherent in social dilemmas (latter). A social dilemma is an interdependent decision-making situation where "individually reasonable behaviour leads to a situation in which everyone is worse off than they might have been otherwise" (Kollock, 1998, p. 183). An interaction in social dilemmas is characterised by a conflict between an individual's desire to maximise personal (selfish) interests and his or her motive to maximise collective interests (Rapoport, 1998). Inclination to prioritise and maximise one's interest and advantages is seen as a defective self-interest choice (a dominant strategy), while predisposition to maximise the advantage of the collective interest is considered as a cooperative choice (a less preferred strategy). Individuals always receive a higher return, at least in the short run, when they act opportunistically by making a defecting choice. However, if all individual involved make a defecting decision, all will suffer in the end, and this is called Pareto inefficiency. This phenomenon is illustrated in the game theory/prisoner's dilemma analogy. For the sake of own benefits, a prisoner is likely to act selfishly by defending themselves to get acquitted and start accusing the other prisoner, whether it is done deceptively (opportunistically),

which such choice will compromise the other individuals (collective interest). As such, conceptualising the social dilemma theory and the game theory in the commons or POS context, below are some examples of CPR dilemmas faced with respect to POS management (give-some dilemmas) and overconsumption (take-some dilemmas) issues, whereby the aforesaid prisoners can be analogous to POS users and managers (Ling, 2017).

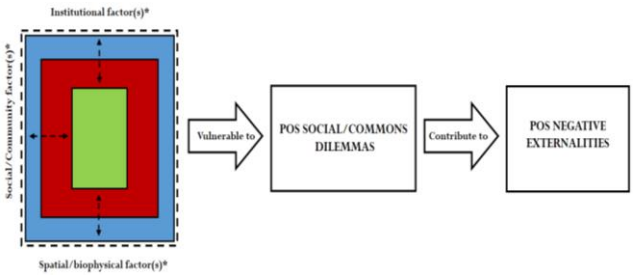
CPR-based POS is vulnerable to overexploitation; open-access/public-domain POS are "classic sites for tragedy" (Ellickson, 1996). Ignoring resources carrying capacity and quality, selfish POS users may maximise their use right for their personal enjoyment and satisfaction or for profit generating. For instance, by occupying POS longer, or via the improper use of POS (misuse) and illegal POS conversion to commercial land use (Ling et al., 2016), all these consumption behaviours ultimately cause the spaces inaccessible and unusable by others, and these negative effects are a form of exclusion — whether temporarily or permanently. Overexploitation can also be exemplified in the Tragedy of the urban and neighbourhood commons metaphor (see Hardin, 1968). Hardin (1968) illustrated the consequences of overuse that can be resulted when rational and self-interest individuals share access and consumption to a common resource (POS). He further analogised and argued that "…freedom in commons brings ruins to all… Therein, lies the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited". In short, it is a circumstance where, due to the incomplete or ill-defined property rights of open-access or public domain POS, individuals are granted with inexhaustible use and access rights (freedom) to POS without any cost-effective mechanism to monitor, manage and regulate others' uses; thus, the rivalrous POS is doomed to overexploitation, ensuing in resource degradation.

Besides, public domain/public realm CPR-POS is also susceptible to a free-riding issue, which is also a form of overexploitation. Paying tax to the local government for POS management is necessary; however, there are individuals, e.g., squatters and outsiders who benefit from POS facilities consumption do not contribute any or equivalent tax and fees. More vitally, they are not prohibited to use POS, subsequently externalising congestion and other social costs that cause other contributors (legal users) to unlikely contribute. The phenomenon is considered as shirking (or a give-some dilemma), where individuals are more often to under-contribute because they fear that others will free-ride on their contributions (McCarter et al., 2014; Ling et al., 2016). At the same time, from the local authority's angle, who has the legal POS management duty, such POS is also vulnerable to shirking and underinvestment (give-some dilemma), due to limited resources (e.g., time and workforce). They (managers) may behave opportunistically or selfishly by neglecting the non-pecuniary POS management maintenance and monitoring duty. Ultimately, such CPR-based POS which normally subjects to overuse may likely to face disuse and underuse issues (Miyanaga and Shimada, 2018). It is not surprising that, compared to income-generating businesses, they may deprioritise environmental goods and provide less maintenance for such non-pecuniary CPRs.

Last but not least, associated with overexploitation and shirking issues, moral hazard is also discovered in state-owned public domain CPR. Since public domain POS ownership and management rights are both held by the local government, self-interest POS users and residents are not incentivised to manage risks or care of their own defective consumption behaviour nor do they help monitor and watch over the improper use of POS by other users. As the above tasks may require some forms of costs (e.g., extra effort, attention and time investment), and most notably, the commons are not belonged to the users, hence they could care less of the POS condition and quality.

The above POS dilemmas will be worsened and more pronounced if more opportunistic behaviours posed and the number of users (competition) escalate; they may lead to other dilemmas, and more negative externalities and social costs will ensue (e.g., vandalism, poor landscaping and cleanliness issues, paper park, misuse or illegal conversion of POS uses, congestion, conflicts among residents, dissatisfaction and discomfort) (McCarter et al., 2014). This situation can be illustrated in Wilson and Kelling's (1982) broken windows theory. Their theory associates the small issues and dilemmas of a neighbourhood community/city with more serious co-occurring dilemmas. For instance, the shirking of POS management and maintenance that cause poor cleanliness, landscaping and total disuse and underuse (space abandonment) issues may lead to severe forms of overexploitation, such as free-riding, which then contributes to safety and security issues (criminal activities, e.g., loitering and panhandling issues) and private physical exclusion that cause de facto inaccessible private spaces (Ling and Leng, 2018; Ling et al., 2016). Whether it is self-interested or opportunism triggered CPR POS dilemmas, this does not entail that CPR (resource) is always a problem per se; instead, it is essential to identify the factors (e.g., institutional design or physical characteristics) that are possible to cause and aggravate the present commons issues (Ostrom, 2005; Webster, 2007).

To recapitulate the above new institutional economics theories and concepts in the POS setting, covering the social ecological system, CPRs, social dilemmas, and negative externalities, and their interconnections (i.e., how and why CPR-based POS are vulnerable to POS commons dilemmas that subsequently lead to degraded and unsustainable POS), a graphical illustration (i.e., a conceptual framework) is presented below (Figure 1).



| Indicators | Descriptions |
|---|---|
| | **CPR-based POS** encompassing three different levels of publicness, which are **vulnerable to** various POS commons dilemmas (e.g., overexploitation, free-riding, moral hazard, shirking, underuse, and exclusion. These CPR-triggered POS dilemmas **contribute to** negative externalities (poor quality, unkempt, inaccessible, degraded, unsustainable POS). |
| * | The natures of CPR and publicness of POS are influenced by institutional (e.g., property rights), social and spatial/biophysical (e.g., location and proximity) factors. |
| | **Public-domain POS** (for anyone, with large and undefined population) covering public realm and local public goods. |
| | **Public-realm POS** (for citizens/residents with smaller and more defined population) covering local public good of POS. |
| | **Local public goods** can co-exist under both public domain and public realm and such POS is for certain citizens/noncitizens who particularly have closer proximity to local urban-neighbourhood POS. |
| ◄- - -► | Transitions of publicness levels between public domain and public realm, due to institutional social-ecological factors. |

**Figure 1** A conceptual framework linking CPR-based POS with commons dilemmas that contribute to POS negative externalities

## 5. Conclusion

To conclude, the objective set in this study has been achieved, arguing that urban and neighbourhood state-owned POS is a type of common resources (commons), more accurately as a common pool resource (CPR) which possesses two inherent natures. POS is being rivalrous (i.e., subtractible and exhaustible in both POS quantity and quality aspects) and non-excludable (i.e., being open-access to the public for access and consumption). The publicness and sharedness of POS can encompass public domain, public realm and local public goods, which all have various implications of the congestion levels. Regardless of any publicness (unexcludability) level of a CPR, as a result of the inherent rivalrousness and non-excludable attributes, as well as self-interest and opportunistic natures in a human behaviour, such POS is found to be subject to numerous commons dilemmas, including commons overexploitation and mismanagement (shirking) issues that result in POS negative externalities. Aside from offering key lessons of CPR conceptualisation and its implications to other commons settings, especially global commons (e.g., climate change and ocean pollution) and bridging the knowledge gap, integrating the social-ecological system and new institutional economics (i.e., commons, publicness analysis, and social dilemma theories) into the fields of urban and landscape planning and resource management, one can eventually understand better and have pragmatic answers why the aforementioned POS negative externalities pertaining to management, consumption, and quality issues are still occurring, despite the fact that POS has been spatially and architecturally well designed in the early planning phase. As such, the narrative synthesis of this concept/perspective paper may suffice to offer policy and management insights to policymakers (urban planners and landscapers), practitioners and consumers to re-think that common resources (POS) are truly finite, depletable and are having difficulties to exclude access and use of the (self-interest and opportunistic) public, and thus highly subject to commons dilemmas. Therefore, to achieve sustainable commons, effective governance/control in terms of POS consumption and consistent management is vital. For future research, a rationale of urban design as a necessary societal role is further proposed, which has established the need for proper and effective allocation and governance of POS via an adaptive institutional design (i.e., distribution of property rights and transaction costs). More accurately, since state-owned CPR-based POS governance is inefficient, this demands re-alignment of the property right regime to the common-property (self-organising) regime which is believed to be more effective in managing scarce resources (Ostrom, 1990; Ling et al., 2014). By doing the latter, it provides community club goods, which have non-rivalrous and exclusionary properties. Club-POS can be more efficient and sustainable; it is less congested and provides an opportunity for better control and commercialisation (membership fees), which incentivise better management.

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## References

Alchian, A.A., and Demsetz. H. (1973). Property Rights Paradigm. *Journal of Economic History*. 33: 16–27.

Allen, D. W. (1991). What Are Transaction Costs? *Research in Law and Economics*. 14: 1–18.

Barzel, Y. (1989/ 1997). Economic Analysis Of Property Rights. Cambridge, MA: Cambridge University Press.

Bengston, D. N., Fletcher, J. O., and Nelson, K. C. (2004). Public Policies For Managing Urban Growth And Protecting Open Space: Policy Instruments And Lessons Learned In The United States. *Landscape and Urban Planning*. 69(2-3): 271–286.

Borch, C., and Kornberger, M (Eds.). (2015). Urban commons. Rethinking the city. Space, Materiality And The Normative. Abingdon, Oxon; New York, NY: Routledge.

Bromley, D. W. (1992). The Commons, Common Property, And Environmental Policy. *Environmental and Resource Economics*. 2(1): 1–17. doi:10.1007/BF00324686.

Broussard, S. R., Washington-ottombre, C., and Miller, B. K. (2008). Attitudes Toward Policies To Protect Open Space: A Comparative Study Of Government Planning Officials And The General Public. *Landscape & Urban Planning*. 86: 14–24.

Brown, A. (2015). Claiming the Streets: Property Rights and Legal Empowerment in the Urban Informal Economy. *World Development*. 76: 238-248.

Campbell, L., and Wiesen, A. (2009). Restorative Commons: Creating Health and Well- being through Urban Landscapes. PA, USA: USDA Forest Service.

Ciriacy-Wantrup, S.V., and R. C. Bishop. (1975). —Common Property As A Concept

Colding, J., and Barthel, S. (2013). The Potential Of "Urban Green Commons" In The Resilience Building Of Cities. *Ecological Economics*, 86: 156–166.

Ellickson, R. C. (1996). Controlling Chronic Misconduct In City Spaces: Of Panhandlers, Skid Rows, And Public-Space Zoning. *Yale Law Journal*. 105: 1165.

Elmqvist, T. (2014). Urban Resilience Thinking. *Solutions*. 5 (5) (Oct 2014): 26–30.

Foster, S. R. (2011). Collective Action and the Urban Commons. *Notre Dame Law Review*. 87: 57–134.

Foster, S., and Laione, C. (2016). The City As A Commons. *Yale Law Policy Review*. 34(2): 1-69.

Glück, P. (2000). Policy Means For Ensuring The Full Value Of Forests To Society. *Land Use Policy*. 17(3): 177-185.

Hardin, G. (1968). The Tragedy Of The Commons. Science. 162: 1243–1248.

Hess, C. (2008). Mapping the New Commons. Paper presented at the 12th Biennial Conference of the International Association for the Study of the Commons, University of Gloucestershire, Cheltenham, 14-18 July. Retrieved from http://dlc.dlib.indiana.edu/dlc/handle/10535/304. [Accessed on October 10, 2014].

Hess, C., and Ostrom, E (Eds.). (2006). Understanding knowledge as a commons: From theory to practice. Cambridge, MA: MIT Press.In Natural Resources Policy. *Natural Resources Journal*. 5(4): 713-727.

Kollock, P. (1998). Social Dilemmas: The Anatomy of Cooperation. Annual Review of Sociology. 22: 183–205.

Koomen, E., Dekkers, J., and van Dijk, T. (2008). Open-Space Preservation In The Netherlands: Planning, Practice And Prospects. *Land Use Policy*. 25(3): 361–377.

Lai, L. W. C. (2014). As Planning Is Everything, It Is Good For Something! A Coasian Economic Taxonomy Of Modes Of Planning. *Planning Theory*. 15(3): 255-273.

Ling, G., & Leng, P. (2018). Ten Steps Qualitative Modelling: Development and Validation of Conceptual Institutional-Social-Ecological Model of Public Open Space (POS) Governance and Quality. *Resources*. 7(4): 62.

Ling, G. H. T., & Pung, J. C. (2019). An Urban Governance Approach In The Development Of Commercial Brownfield: A Case Study Of Iskandar Malaysia. *International Journal of Built Environment and Sustainability*. 6(1): 31-38.

Ling, G. H. T., Ali, N. E. H., Ho, C. S., & Ali, H. M. (2014). Ostrom's Design Principles In Residential Public Open Space Governance: Conceptual Framework And Literature Review. *International Journal of Built Environment and Sustainability*. 1(1): 27-37.

Ling G. H. T., Chau L. W., Ho C. S., Ali H. M. (2018). Low-Carbon Ability of Neighbourhood Public Open Space (POS) Governance: Explanation from Social-Ecological System and New Institutional Economics. *Chemical Engineering Transactions*. 63: 469-474.

Ling, G. (2017). Institutional Property Rights of Residential Public Open Space In Sabah, Malaysia. PhD Thesis. Faculty of Built Environment, Universiti Teknologi Malaysia.

Ling, G. H. T., Ho, C. S., Ali, H. M., and Tu. F. (2016). Do Institutions Matter In Neighbourhood Commons Governance? A Two-Stage Relationship Between Diverse Property-Rights Structure And Residential Public Open Space (POS) Quality: Kota Kinabalu and Penampang, Sabah, Malaysia. *International Journal of the Commons*. 10(1): 294–333.

Maruani, T., and Amit-Cohen, I. (2007). Open Space Planning Models: A Review Of Approaches And Methods. *Landscape and Urban Planning*. 81(1-2): 1–13.

Maruani, T., and Amit-cohen, I. (2011). Land Use Policy Characteristics Of Developers And Their Relations To Open Space Conservation. *Land Use Policy*. 28(4): 887–897.

McCarter, M. W., Samek, A. C., and Sheremeta, R. M. (2014). Divided Loyalists Or Conditional Cooperators? Creating Consensus About Cooperation In Multiple Simultaneous Social Dilemmas. *Group and Organisation Management*. 39(6): 744-771.

Miyanaga, K., & Shimada, D. (2018). 'The Tragedy Of The Commons' By Underuse: Toward A Conceptual Framework Based On Ecosystem Services And Satoyama Perspective. *International Journal of the Commons*. 12(1): 332-351.

Musole, M. (2009). Property Rights, Transaction Costs And Institutional Change: Conceptual Framework And Literature Review. *Progress in Planning*. 71(2): 43–85.

Nagendra, H., and Ostrom, E. (2014). Applying The Social–Ecological System Framework To The Diagnosis Of Urban Lake Commons in Bangalore, India. *Ecology and Society*. 19(2): 67.

Onwuanyi, N., & Ndinwa, C. (2017). Remaking Nigeria's Urbanism: Assessing and Redressing the Dearth of Open Spaces in Benin City. *International Journal of Built Environment and Sustainability*. 4(2): 121-130.

Ostrom, E. (1990). Governing the Commons: The Evolution of Institutions for Collective Action. New York, NY: Cambridge University Press.

Ostrom, E. (2002). Type of Goods And Collective Action. Presented at Public Choice Society Annual Meeting, San Diego, CA (March).

Ostrom, E. (2005). Understanding Institutional Diversity. Princeton, NJ: Princeton University Press.

Ostrom, E. (2009). A General Framework For Analyzing Sustainability Of Social-Ecological Systems. *Science*. 325(5939): 419-422.

Ostrom, V., and Ostrom. E. (1977). Public Goods and Public Choices. In E. S. Savas (Ed.), Alternatives for Delivering Public Services: Toward Improved Performance. 7-49. Boulder, CO: Westview Press.

Poklembovái, V., Kluvánková-Oravskáii, T., and Finkaiii, M. (2012). Challenge of New Commons – Urban Public Spaces. Paper presented at the First Global Thematic IASC Conference on the Knowledge Commons. September. Louvainla-Neuve, Belgium. Retrieved from http://biogov.uclouvain.be/iasc/doc/full%20papers/Poklembova.pdf [Accessed on May 6, 2014].

Rapoport, A. (1998). Decision Theory And Decision Behaviour. UK: Palgrave Macmillan.

Steelman, T., and Hess, G. R. (2009). Effective Protection Of Open Space: Does Planning Matter? *Environmental Management*. 44(1): 93–104.

Tiebout, C. M. (1956). A Pure Theory Of Local Expenditures. *Journal of Political Economy*. 5: 416-424.

Webster, C. (2002). Property Rights And The Public Realm: Gates, Green Belts, And Gemeinschaft. *Environment and Planning B: Planning and Design*. 29(3): 397– 412.

Webster, C. (2007). Property Rights, Public Space And Urban Design. *Town Planning Review*. 78(1): 81–101.

Webster, C. J., and Lai, L. W. C. (2003). Property Rights, Planning And Markets: Managing Spontaneous Cities. Cheltenham, UK; Northampton, MA: Edward Elgar.

Williamson, O. E. (1975). Markets and Hierarchies. New York: Free Press.

Williamson, O. E. (2000). The New Institutional Economics: Taking Stock, Looking Ahead. *Journal of Economic Literature*. 38(3): 595– 613.

Wilson, J. Q., and Kelling, G. L. (1982). Broken Windows: The Police and Neighbourhood Safety. *Atlantic Monthly*. 249(3): 29–38

World Bank. (2015). Public Spaces - Not A "Nice To Have" But A Basic Need For Cities. Retrieved from http://blogs.worldbank.org/endpovertyinsouthasia/publicspaces- not-nice-have-basic-need-cities. [Accessed on June 10, 2015].

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# Climate Change Policy Evaluation and Its Impact on Island Nations: Case Of Singapore And Sri Lanka

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## ABSTRACT

Climate Change (CC) is universally recognized as a major global threat due to its nature of impacts. Island nations are known to be the most vulnerable to CC impacts where many countries have initiated mitigation and adaptation actions through sector-based policy measures. Singapore and Sri Lanka are two Asian island nations with CC induced threats. Two countries are different in terms of economic development, but similar developing countries in the CC agenda. In this context, both the countries have initiated mitigation and adaptation actions through policy measures. This study compares the key climate driven performance indicators with historical data to evaluate the performance of climate change policy of each country. Generally, policy evaluation has been conducted by adopting scientific and non-scientific tools, but it is seldom see that the relation of climate driven indicators along with CC policy. Also the policy research was mostly based on European case studies and Asian island nations were not easy to find in this context. The comparison of two countries in terms of CC policy is to determine the key vulnerable sectors where intervention is necessary for island nations. Mitigation policies are evaluated in Singapore and Sri Lanka using GHG emission pathways under twelve (12) indicators and adaptation policies are measured under the national expenditure of key sectors of the economy under seven (07) indicators. The analysis further elaborated by comparing both countries with key economic sectors that has positive and negative influence on CC impacts. Finally, the analysis outcome is used for lessons to learn from each other in improving the CC policy of Singapore and Sri Lanka. As every country has a unique set of strategies to minimize contributions to CC impacts, unique features that are common to both countries are chosen as variables for the comparison. Policy recommendations are provided to implement solid action plan for post 2020. The study expects to assist island countries to strengthen the CC policy as a national priority to manage unforeseen impacts posed by CC phenomena.

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## 1. Introduction

Climate change (CC) refers to the fluctuations in average global atmospheric conditions such as precipitation pattern, temperature, and extreme weather events. Scientists are aware that anthropogenic causes create most such changes since 20th century. Many researchers found that climate change pose greater threat to island nations, specifically due to sea level rise. Such scenarios make climate change a mainstream issue for many countries. However, there is no specific framework for governments to mandate consistent and coherent policy on climate change. Yet the policy decisions play a key role in formulating climate change resilient countries. CC policy making is a challenging task. Challenges include uncertainty of the impacts, long time frames, clash with long-term socio economic policy objectives, and trans-boundary nature of the

issues. This study attempts to evaluate the performance of CC policy within a stipulated time period from the date of policy implementation.

Globally, CC policies are formulated by countries aiming at reducing the anthropogenic causes of CC through increased greenhouse gas (GHG) emissions to the atmosphere and to reduce vulnerability to CC impacts. Even though countries have crafted well defined CC policies, the threat of CC is significantly increasing everyday. Even though uncertainty and major GHG emitting countries get the blame, the evaluation of level of achievement of CC policies are seldom questioned by the people and research community. Even in most cases, CC policies are evaluated by scientific methods (such as emission levels) and non-scientific methods (stakeholder consultation) which has proven to be not effective in most cases. This research has been identified that mitigation policies must have direct relationship with reducing GHG emissions while adaptation policies must have direct relationship with reducing the vulnerability to CC induced impacts. With this assumption, it is identified that successful mitigation policy means reduction of GHG emissions while successful adaptation policy will reduce the vulnerability of the economy. Governments allocate funds for the sectors that are mostly affected by CC impacts. CC adaptation involves in improving the resilience by strengthening the vulnerable sectors of the country. This study considered on GHG emissions as a proxy to determine the CC mitigation of the country where GDP contribution of key vulnerable sectors of the economy as a proxy to determine the CC adaptation actions. Although the contribution to CC by individual countries may be small but this study tries to develop a framework to assess each country's level of preparedness to CC by evaluating the CC policy outcomes through mitigation and adaptation proxies.

Singapore and Sri Lanka are two islands in Asia with different levels of development, yet facing similar challenges of sea level rise and other impacts of climate change. Both countries have ratified Kyoto protocol and focused on different aspects of response to CC vulnerability. Performance, drawbacks, and limitations of CC policies have been critically evaluated using relevant indicators. Key themes of climate policy evaluation have been identified under economic, social, technological, and environmental aspects and thereby compared Singapore and Sri Lanka with the existing achievements and trends of climate policy responses. GHG emission pathways determine CC mitigation and adaptation actions are determined by the expenditure as a percentage of GDP of key vulnerable economic sectors. The lessons learnt from climate change response perspectives lead countries to move into more focused targets in terms of adaptation and mitigation.

This study focused on climate policy analysis in terms of emission levels, and national expenditure factors of the country along with the scientific and economic indicators relating them into CC policy implementation. The study is based on empirical data available for Singapore and Sri Lanka from international sources such as World Development Indicators (WDI), International Energy Agency (IEA), and United Nations (UN). Study boundary under consideration is within the geographic area of each country, whereas country's impact on nearby regions or the external impacts (emission trading schemes and fuel use for international transportation) on country's CC vulnerability has not been considered. In addition, selection of climate change indicators is based on the selected criterion related to the context of Singapore and Sri Lanka.

CC mitigation and adaptation actions within the country form the basis for evaluation. National level performance indicators support the analysis while the climate change actions are obtained for the period from 1990 to 2020. The level of success or failure is determined by the performance of each country under the given period of time with respect to prevailing climate change response targets.

Methodology adopted for the study is indicated in Figure 1.

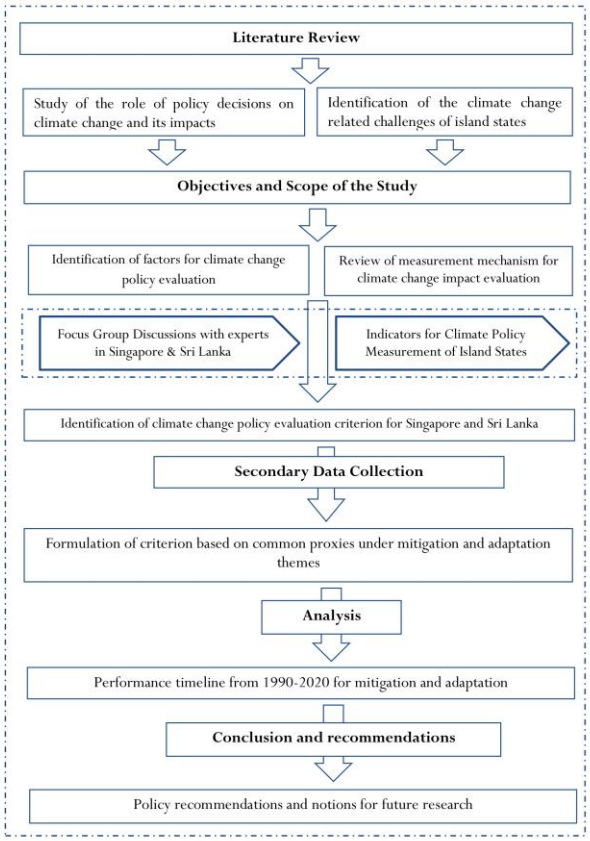


**Figure 1** Methodology of the Study (Compiled by Author)

## 2. Data, Materials and Methods

Accurate risk assessment and estimation of potential losses and their economic impacts to the society are vital information for decision makers to regulate and circulate the limited funds on actions. These funds are misused if decision makers are unaware of real impacts due to complexity of CC challenges. Benchmarking of CC policy actions is difficult as CC challenges have uncertainty in nature. Therefore, performance indicators are used to interpret the behavior of CC impacts, mitigation,

and adaptation actions over the period of time. Periodical assessment helps to evaluate CC policy performance and needed policy reforms for future CC preparedness.

Indicators play a vital role in determining impacts of CC and suitable indicators are necessary to manage policy implementation effectively. UNFCCC encouraged countries to report on CO2 emissions as a key indicator of CC contribution. However, CO2 emissions alone cannot provide the effects of economic policy decisions that reflect on climate policy agenda. Thus, many additional indicators are required to measure the actual performance of the policy in the face of CC. Decision makers have tried forecasting the future costs and benefits of economic activities to compare with the costs of CC mitigation and adaptation. The pricing of non-market effects and calculating costs of socio-economic impacts involve assumptions and series of controversial price effects. The ambiguity of such calculation may overcome by selecting multi scale indicators together with comparing time series data. Use of wide range of indicators benefits the country in different areas.

CC policy measurement indicators are twofold as scientific and economic types. Scientific indicators base on evidences that assess risk and vulnerability of the country under consideration, and these indicators generally measure the probability of experiencing extreme weather events, and natural hazards that are beyond human control. Subsequently, 'tipping points' are identified and benchmarked to understand the growth of such extreme events before determining targets. Economic indicators generally express the pathway movement of economy as a whole for climate resilient development. This involves direct political processes and public interests in general through top-down and/or bottom-up approach. Potential economic losses from anticipated scientific evidences are important facts for decision makers to create CC adaptation and mitigation decisions.

A comprehensive set of indicators would be critical for the decisions with accurate and quantifiable projections. World Bank (2009) identified the mitigation instruments used to measure the response through city level performance indicators. The key sectors of mitigation actions are energy supply, transport, buildings, industry, and waste. Adaptation measures can take different forms such as, vulnerability and risk assessment, anthropogenic causes of CC, and elements at risk. UN-HABITAT (2008) identified a set of criteria for cities to adapt and thereby creating a portfolio for potential projects. Adaptations are expected to establish a framework for policy level measures through appropriate indicators. The key sectors identified are water, infrastructure and settlements, human health, urban transport, and energy.

Various criteria assist climate policy evaluation in different context. It is important to use a rationale criterion for evaluating the climate policy within the scope of island nations. In terms of global CC negotiations, island nations such as Maldives, Pacific Islands, Singapore, and Sri Lanka are categorized under 'developing countries' because of the vulnerability and resource limitations. CC policy is critical to develop nations in order to manage unforeseen effects of CC. Singapore and Sri Lanka has different development status in the economy, but retains similarities in the challenges faced. Finding correct information in expected spatial level is challenging when the geographical scale of a country increases. With reference to various criteria used by different experts in the field and spatial parameters suitable for the selected case studies, following themes are identified as parameters for climate change policy evaluation. Table 1 shows a summary of adaptation and mitigation themes with international sources used to identify universal indicator themes.

**Table 1** Data Sourcing of Evaluation Themes

| | Type of Theme | Source of Indicators |
|---|---|---|
| *Adaptation* | | |
| **1.** | **Consumption Pattern and Food Security** | WDI (World Bank), FAO, UNFCCC, UNEP, ISIC |
| **2.** | **Resource Management and Bio Diversity Conservation** | WDI (World Bank), IUCN, WWF, FAO |
| **3.** | **Human Settlement and Land Use Planning** | UN-HABITAT, WDI (World Bank), UNFCCC, ADB, APEC, ILO |
| **4.** | **Disaster Management** | UN-HABITAT, WDI (World Bank), UNISDR, IMF, ADB |
| *Mitigation* | | |
| **5.** | **Energy Consumption** | IEA, WDI (World Bank), DOS (Singapore), DCS (Sri Lanka), CEIC |
| **6.** | **Infrastructure Development and Transport Management** | IEA, WDI (World Bank), LTI (Singapore), CEIC, APEC |
| **7.** | **Industrial Development** | IEA, WDI (World Bank), CEIC, UNIDO, WTO |
| **8.** | **Research and Development** | WDI (World Bank), ADB |
| **9.** | **Institutional Set-up and Governance** | CPIA (World Bank), APEC, ADB, WGI |

## 3. Case Studies

Categorization of climate change policies of the countries based on the income level is an ineffective method of evaluation. However, development status matters on the sector-based policy reactions. Economic growth strategies of countries provide the key aspects considered by formulating climate policies with respect to development level. Therefore, considering Singapore and Sri Lanka provide the opportunity to evaluate how each country responds to common challenges of CC through mitigation and adaptation policies.

### *3.1 Singapore*

Singapore is one of the smallest countries in the world with an approximate land area of 714 square kilometers. As a low-lying

urbanized island state, Singapore face extreme challenges of CC change, and its impacts.

Singapore is recognized as a developing country since the adoption of Kyoto Protocol (1997) under UNFCCC, and had no specific obligations to reduce GHG emissions. With increasing attention by the public at large and vulnerability of the island nation to adverse impacts of CC, Singapore government initiated key steps on making the climate change policy in 2005. Vulnerability assessments were conducted in 2005 and 2007 through 1st and 2nd 'National Study on Climate Change.' As a result, Singapore government released the 'National Climate Change Strategy' in 2008. Another key milestone of the CC policy of Singapore is the establishment of National Climate Change Secretariat (NCCS) in 2010 under the Prime Minister's office, with the intention of developing policies and strategies to cooperate with CC and related issues. NCCS consist of various governmental organizations, NGOs, business leaders, academic professionals, and the community groups. Objectives of NCCS are:

- Facilitate efforts to mitigate carbon emissions in all sectors
- Help Singapore adapt to the effects of climate change
- Harness economic and green growth opportunities arising from climate change
- Encourage public awareness and action on climate change

The approach of late Prime Minister Lee Kuan Yew of creating "City in a Garden," was extended to the climate resilient livability through National Climate Change Strategy (NCCSt). NCCSt (2012) pledged that Singapore has initiated policies to reduce CO2 emission by 7% - 11% by 2020 business-as-usual (BAU) levels in 2009. This is a significant improvement compared with the strategy paper released in 2008, which did not mention on emission reductions. This is a challenging task by comparing the available resource base and economic base. Singapore has identified key strategy for the mitigation as energy efficiency. The actions on this are already initiated among businesses and households. Government has already identified required fiscal tools, capacity building, and legislative tools to move forward. Sustainable Singapore Blueprint (SSB) (2015) is an important initiative taken by Singapore government to tackle CC impacts through sustainable use of energy, waste, water, public spaces, and commuting modes. Community involvement for achieving targets set by SSB is vital in mitigation and adaptation options.

### *3.2 Sri Lanka*

Sri Lanka is an island state, with an approximate total land area of 65,525 km2 in the Indian Ocean. Although Sri Lanka's contribution to global warming is comparatively low, the country is highly vulnerable to its impacts. A concentration of 70% population and 80% of economic infrastructure are located in coastal cities of Sri Lanka. Further, "the coastal zone accounts for 43% of the nation's GDP, so impacts on coastal settlements translate into substantial impacts on the nation's economy". In this context, National Climate Change Secretariat (CCS) was established in 2010 under the Ministry of Environment (MOE), and key focal point of CC related actions in Sri Lanka under UNFCCC and Kyoto Protocol.

National Advisory Committee on Climate Change (NACCC) is established under CCS for multi stakeholder involvement for integrated decision-making. CCS has formulated National Climate Change Adaptation Strategy of Sri Lanka (NCCASSL) to respond to CC induced challenges in Sri Lanka for 5 years starting from 2011. NCCASSL identified key thrust areas for the CC adaptation and direction of investment to address the challenges posed by it.

- Mainstream the climate change adaptation into national planning and development
- Creation of climate resilient and healthy human settlements
- Minimization of climate change impacts on food security
- Improve climate resilience of key economic drivers
- Safeguard natural resources and bio diversity from climate change impacts

Under the above strategic thrust areas, key thematic areas of action and priority adaptation measures are identified. National Climate Change Policy (NCCP) has conducted disaster management and health impact assessment under vulnerability assessment of the
country. Hence, the national adaptation and mitigation policy statements are identified under the following themes as in Table 2.

**Table 2** Adaptation and mitigation policies under NCCP-Sri Lanka (Source: Climate Change Secretariat – Sri Lanka)

| No. | Adaptation Policy Themes | Mitigation Policy Themes |
|---|---|---|
| 1 | Food Production and Food Security | Energy Sector |
| 2 | Conservation of Water Resources and Bio Diversity | Transportation Sector |
| 3 | Human Settlement and Land Use Planning | Industrial Sector |
| 4 | Infrastructure Design and Development | Waste Management |
| 5 | Coastal Resources Management | Agriculture and Livestock |

To support above mentioned policy themes, supportive policies such as knowledge management, research and development, technology transfer, resource mobilization and other market and non-market mechanisms are identified. In spite of policymaking, it is highly doubtful of the enforcement. As a country with comparatively high level of vulnerability, the NCCP has covered every aspect at large but the complexity remains on the implementation of broad policies. Compromising other national development policies and people at high risk zones are not visibly prioritized in the document.

CC policy and strategy of Singapore and Sri Lanka initiated around 2008 – 2010 period. Singapore established NCCS and Sri Lanka established CCS in 2010. Establishment of CC policy of two countries in the same period is useful to compare the performance in terms of its objectives. Key milestones related to the Climate Change Policy of each country has been compared in Table 3 to understand the actions of each country within the past decade.

**Table 3** Local Level Milestones of Climate Change Policy in Sri Lanka and Singapore

| Sri Lanka | Year | Singapore |
|---|---|---|
| Vulnerability Assessment 1 | 2000/01 | |
| | 2004/05 | Vulnerability Assessment 1 |
| | 2006/07 | Vulnerability Assessment 2 |
| | 2008/09 | National Climate Change Policy |
| Climate Change Secretariat, National Climate Change Policy, NCC Strategy 2011-2016 | 2010/11 | Climate Change Secretariat |
| Vulnerability Assessment 2 | 2012/13 | NCC Strategy 2011-2016 |
| Adaptation based action plan | 2014/15 | Mitigation based action plan |

## 4. Analysis

### *4.1 Selection of Indicators*

IPCC use scientific indicators (GHG Emission, Ocean and Surface Temperature Rise and etc.) for predicting vulnerability and magnitude of CC impacts. However, there are additional socio-economic and political indicators required to measure the overall performance of policies and to guide decision makers on required amendments. It is important to select indicators with appropriate validity and practicality to avoid misleading policy directives (Bartelmus, 2015). Out of the assessed indicators, the critical indicators have been refined based on the following areas of concern:

- Relevance of indicator in terms of objectives of the study
- Possibility of obtaining common base for evaluation through data sources and country specific measures
- Ability of each indicator to provide guidance for policy decisions

Accordingly, the list of indicators selected for the evaluation is elaborated in Table 4.

**Table 4** Selected Indicators for the Evaluation of Climate Change Policy (Source: Compiled by Author)

| Adaptation and Mitigation Theme | Performance Indicator(s) |
|---|---|
| **Consumption Pattern and Food Security** | • Imports of goods and Services (Percentage of GDP)<br>• Agricultural value addition (Percentage of GDP) |
| **Resource Management and Bio Diversity Conservation** | • Forest area (Percentage of total land area)<br>• Total natural resources rents (Percentage of GDP) |
| **Disaster Management** | • Population living in areas where elevation is below 5 meters (Percentage of total population)<br>• Health expenditure, total (Percentage of GDP) |
| **Energy Consumption** | • Fossil fuel energy consumption (Percentage of total)<br>• Energy use (per kg of oil equivalent per capita) |
| **Infrastructure Development and Transport Management** | • No. vehicles per 1km road area<br>• GHG emissions from transport sector (Percentage of total fuel combustion) |
| **Industrial Development** | • Industrial value addition (Percentage of GDP)<br>• $CO_2$ emissions from manufacturing industries and construction (Percentage of total fuel combustion) |
| **Research and Development** | • Research and development expenditure (Percentage of GDP)<br>• Literacy rate, adult (Percentage of people ages 15 and above)<br>• Internet users per 100 population |

Analysis of CC policy of Singapore and Sri Lanka is listed under mitigation and adaptation themes to separately demonstrate the performance of each country. No weightage is assigned for adaptation and mitigation themes because both themes are

considered equally important for the success of CC policy implementation. The physical dimensions of indicators are as follows:

- GHG emission pathways of different sectors (Mitigation of climate change impacts through GHG reduction).
- GDP share of different segments of the economy (Adaptation to climate change impacts through reduction of expenditure on key segments of economy).

Generally, emission pathways help to measure CC response of a country. Additional analysis used here is the GDP share of economic sectors as a proxy for adaptation. Data has been collected from 1990 to 2014 and projected the trend towards 2020. The intention of the analysis up to 2020 is to highlight the required actions for post 2020 climate action agenda of each country. The projections from 2015 to 2020 are useful to determine the policy direction and setting up short-term CC response plans for both the island nations.

## 4.2 Assumptions

As CC policy is evaluated using physical measures, the indicators require guidance to prevent misleading outcomes. Therefore, assumptions are required for the proxies to display CC evaluation objectively. Based on the objective of the study, following assumptions and facts are considered:

- Use of GHG emissions as the determining factor for climate change mitigation
- Use of annual expenditure (GDP Share) of key segments as the determining factor for climate change adaptation
- Projection of emissions and government expenditure based on past results
- Consideration of selected proxies as the key driver of climate change policy failure or success
- Existing barriers for policy implementation and policy driven tools are considered static during the considered time scale
- Political and economic decisions affecting climate change policies are considered stable during the study period

## *4.3 Selective Indicators for Mitigation Actions*

GHG emission pathways are derived ranging from 1990 to 2020, to understand the policy involvement in mitigating climate change impacts. List of indicators selected for the analysis is provided in Table 5.

**Table 5** Selected Indicators to evaluate the Climate Change Mitigation (Source: World Bank – World Development Indicators)

| No. | Mitigation Indicator | Emissions Description (Source) |
|---|---|---|
| 1 | $CO_2$ emissions from gaseous fuel consumption (kt) | From use of natural gas as an energy source (WDI) |
| 2 | $CO_2$ emissions from liquid fuel consumption (kt) | From use of petroleum-derived fuels as an energy source (WDI) |
| 3 | $CO_2$ emissions from solid fuel consumption (kt) | From use of coal as an energy source (WDI) |
| 4 | Other GHG emissions-HFC, PFC and $SF_6$ (kt - $CO_2$ equivalent) | By-product emissions of hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (WDI) |
| 5 | HFC gas emissions (kt - $CO_2$ equivalent) | As a replacement for CFC, used mainly in refrigeration and semiconductor manufacturing |
| 6 | Methane emissions (kt of $CO_2$ equivalent) | From production, handling, transmission, and combustion of fossil fuels and biofuels (WDI) |
| 7 | Nitrous oxide emissions (kt - $CO_2$ equivalent) | From energy processes are emissions produced by the combustion of fossil fuels and biofuels |
| 8 | $CO_2$ emissions from residential buildings and commercial and public services (kt) | From fuel combustion in households (corresponds to IPCC Source/Sink Category 1A 4b) |
| 9 | $CO_2$ emissions from electricity and heat production, total (kt) | From main activity producer electricity generation, combined heat, power generation, and heat plants (IEA) |
| 10 | $CO_2$ emissions from manufacturing industries and construction (kt) | From combustion of fuels in industry (IPCC Source/Sink Category 1 A 2) |
| 11 | $CO_2$ emissions from other sectors, excluding residential buildings, and commercial and public services (kt) | From commercial/institutional activities, residential, agriculture/forestry, fishing and other emissions not specified elsewhere in the IPCC Source/Sink Categories 1 A 4 and 1 A 5 |
| 12 | $CO_2$ emissions from transport (kt) | From the combustion of fuel for all transport activity, regardless of the sector, except for international marine bunkers and international aviation (WDI) |

## *4.4 Selective Indicators for Adaptation Actions*

Key expenditure facts identified under the adaptation themes, which demonstrate the possible vulnerability of country is considered for analysis. Similar to mitigation data analysis, the collected data set ranges from 1990 to 2020 including projections of GDP share of each segment. The adaptation indicators are listed in Table 6.

**Table 6** Selected indicators to evaluate Climate Change Adaptation (Source: World Bank – World Development Indicators

| No. | Adaptation Indicator | GDP Share Description (Source) |
|---|---|---|
| 1 | Imports of Goods and Services (Percentage of GDP) | The value of all goods and other market services received from the rest of the world (WDI) |
| 2 | Total natural resources rents (Percentage of GDP) | The sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents (MDG) |
| 3 | Health expenditure, total (Percentage of GDP) | The sum of public and private health expenditure (WDI) |
| 4 | Research and development expenditure (Percentage of GDP) on CC | Current and capital expenditures (both public and private) on basic research, applied research, and experimental development (WDI) |
| 5 | Industry, value added (Percentage of GDP) | Comprises value added in mining, manufacturing, construction, electricity, water, and gas (WDI) |
| 6 | Agriculture, value added (Percentage of GDP) | Includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production (WDI) |
| 7 | Central government debt, total (Percentage of GDP) | Includes domestic and foreign liabilities such as currency and money deposits, securities other than shares, and loans (WDI) |

The analysis is based on 12 mitigation indicators and 7 adaptation indicators within which climate policy performance is expected to demonstrate via results. The composite graphs for mitigation and adaptation are illustrated separately. It is noted that data is analyzed for both countries based on Business-As-Usual (BAU) scenario. Year 2010 is highlighted in each graph to indicate the CC policy implementation of each country.

## 4.5 Results & Discussion

### *4.5.1 Climate Change Mitigation Analysis*

Singapore depicts undulated emission levels with significant peaks and drops in 1995, 1997, 2003, and 2007. Singapore held the upper hand in Asian Financial Crisis in 1997 where investments flew from region into the country (Lye, 2008). In addition, private consumption expenditure shares of GDP declined drastically by 2006, creating economic growth volatile. Positive trade balance outweighs the negative impacts of capital and financial balances from 2006 onwards. This reveals the synergy between economic profile and GHG emissions of Singapore. However, a steady increase of emissions is visible from 2007 onwards and the projections show rapid growth of total emissions by 2020. This is visible in the GHG emissions graph depicted in Figure 2.

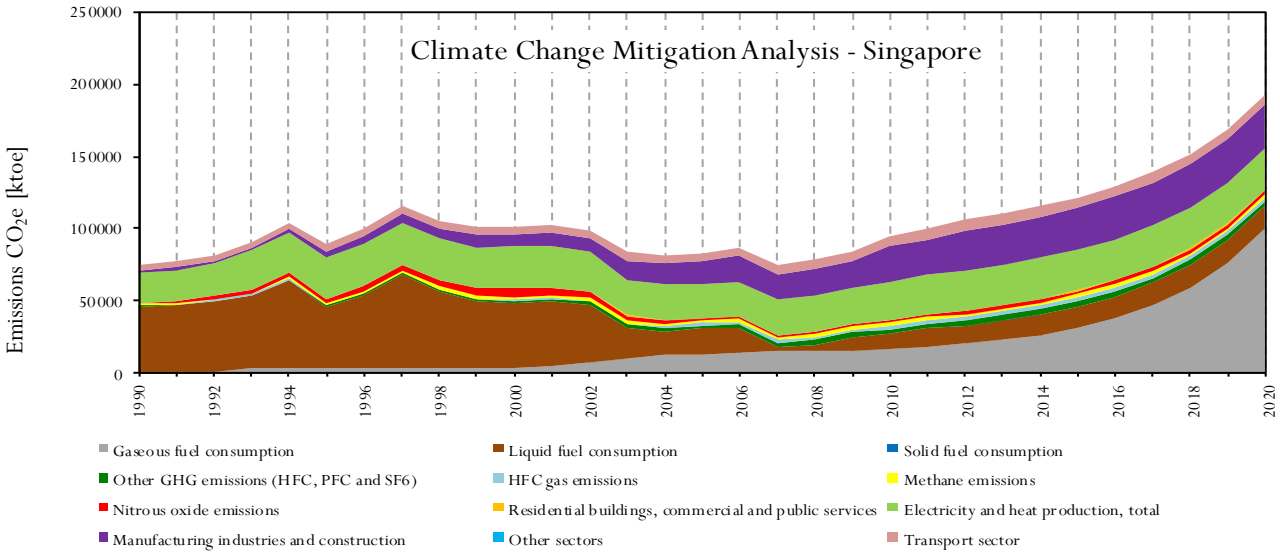


**Figure 2** Climate Change Mitigation Analysis Graph of Singapore

Another significant feature of Singapore is the reduction of oil-based GHG emissions. This reflects the government policy initiation to transfer from fossil oil into natural gas in energy sector from 2006 onwards. Yet, the trend of natural gas-based CO2 emissions is increasing. The next significant emission areas

are the manufacturing industries sector and electricity generation. These segments directly link with economy of Singapore so the climate policy has to be integrated with economic policy to address the issue of GHG emissions. CC policy and strategy focused on energy efficiency and clean tech industries to reduce the emission trends.

Sri Lanka has no significant fluctuation as with Singapore. According to Figure 3, steady fluctuations are evident throughout the timeline. However, the increasing emission trend continues 2011 onwards. With the post-war development in Sri Lanka, government has initiated major infrastructure development projects including airports, harbors, coal power plants, and highways, which contribute to the steady increase of emissions. Emission pathway of Sri Lanka indicates that highest GHG emissions are from methane and fossil oil consumption and it reveals that Sri Lanka economy is heavily dependent on fossil fuel imports in energy and industrial sector.

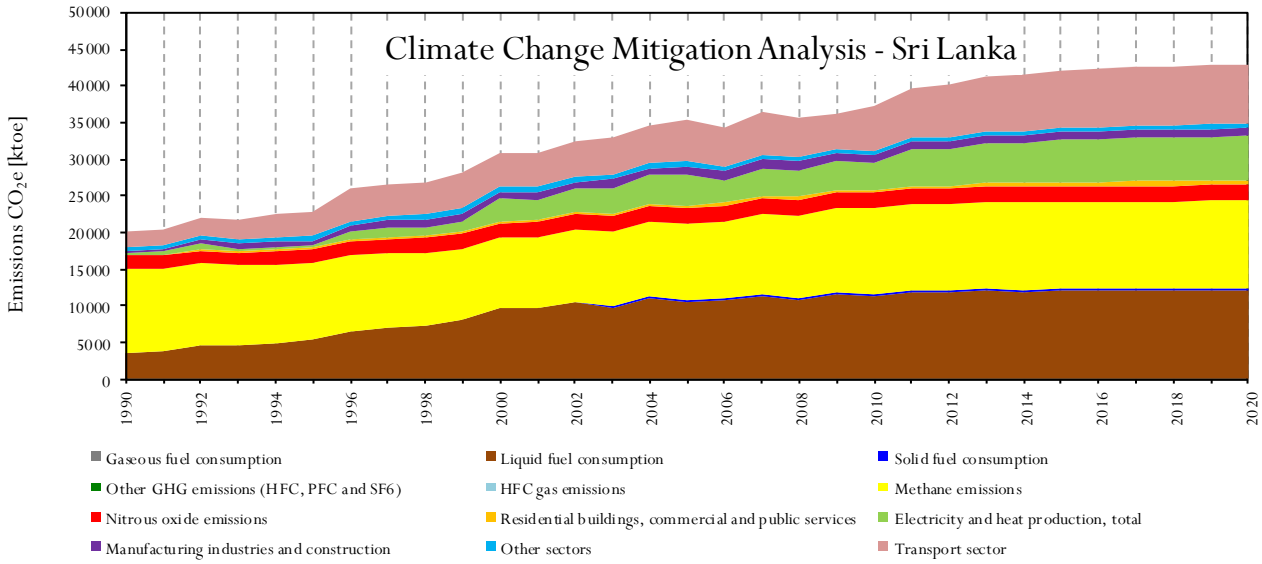


**Figure 3** Climate Change Mitigation Analysis Graph of Sri Lanka

Furthermore, transport sector and electricity generation highly contribute to GHG emissions. The negative impacts of fossil fuel-based power plants and subsidized fossil fuel-based vehicle imports are evident in Figure 3. It is necessary for the government to prioritize mitigation actions of climate change towards key highlighted sectors of energy, industry, and transport sectors.

In comparison, estimations reveal that Singapore may have approximately four times higher emissions than Sri Lanka by 2020 (192,891 kt vs. 42,984 kt) in absolute terms. Consumerism is a reason for Singapore's exponential growth of emissions, which is a result of growth of per capita income (Shove, 2010). Emissions from economic sectors contribute to most of this in Singapore and comparatively, lower emissions from Sri Lanka are due to slow progress development. Hydropower generation, decentralization of industries, and population distribution strategies of Sri Lanka could be the directions Sri Lanka should follow to respond to CC impacts.

With the limited land space, mitigation options are the obvious priority for Singapore. It is about reducing individual emissions, which matters for the both countries in order to avoid any failures in CC policy. It reveals that the trend of total emissions has not affected by CC policy implementation from 2010 onwards, but follows the economic strategies. This shows that CC policy is a dependent variable of economic policy of both countries. Mitigation actions have to be in line with changing socio-economic strategies in Singapore and in Sri Lanka.

### 4.5.2 Climate Change Adaptation Analysis

Adaptation trends of both countries are associated with expenditure on several impactful sectors of the economy. Thus, the analysis demonstrates adaptive capacity of two countries the vulnerability to impacts. Graph reads as the divergent trend of total natural resource rents, R&D expenditure, value added industries, and agricultural share of GDP determines strong CC adaptive capacity of country. Increasing government debt, imports, and health expenditure show the risk and vulnerability of specific sector, and thereby the CC policy. This trend is clearly visible in Figure 4.

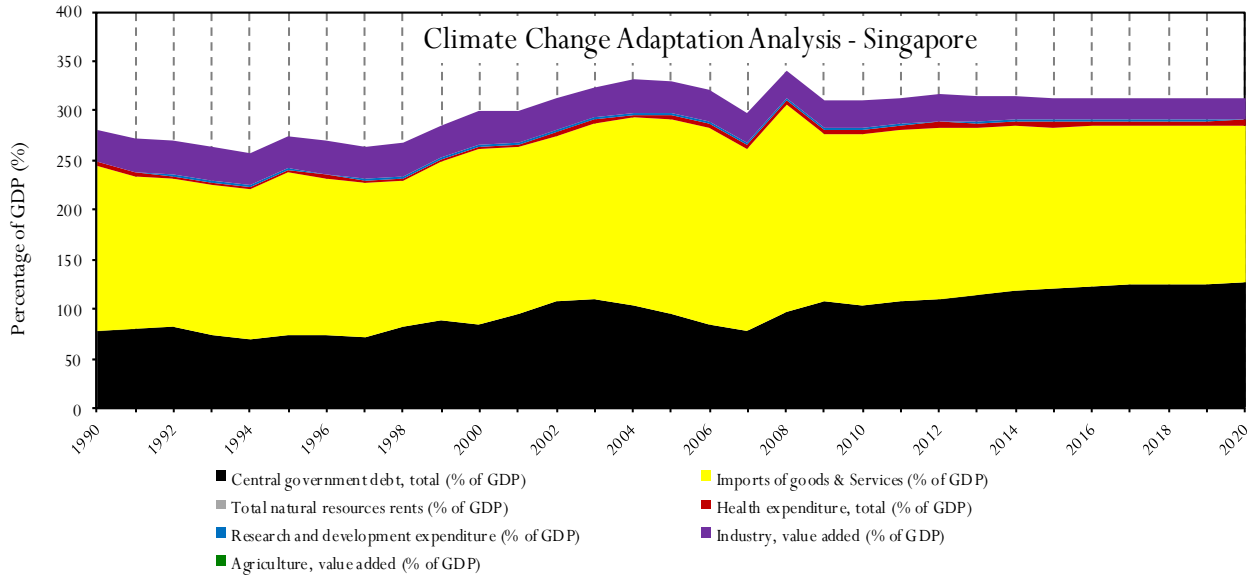


**Figure 4** Climate Change Adaptation Analysis Graph of Singapore

Imports of goods and services also contribute to GHG emissions. Potential of adapting behavioural changes could reverse the risks associated with CC policy, especially in food imports. Food security is one globally accepted area of CC adaptation with the potential to be utilized with latest technology in Singapore. Instant surge of Figure 4 in 2008, which is a result of the Global Financial Crisis, affected import-based trade activities.

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Figure 5 reveals that Sri Lanka has an overall decreasing trend of adaptive indicators. Upon implement of CC policy in 2010, Sri Lanka had a steady contribution to GDP in sectors such as industrial value addition (33% average), central government debts (81% average), and agricultural value addition (11% average). Most significant feature was the reduction of imports by 7% after CC policy implementation. Qualitative analysis indicates that important changes are happening in agricultural and industrial value addition of Sri Lanka and food security through agricultural research and development is addressed by CC policy of Sri Lanka (Climate Change Secretariat, 2010). In addition, mainstreaming of CC actions into local level planning is a positive move by Sri Lanka to improve adaptive capacity to CC impacts.

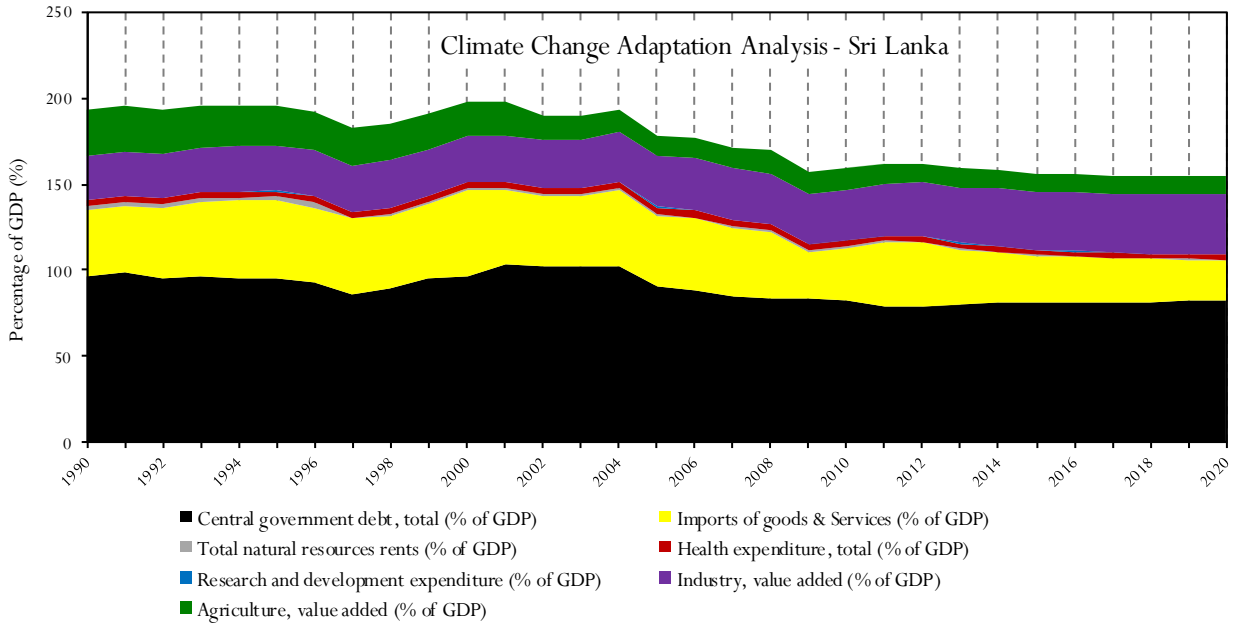


**Figure 5** Climate Change Adaptation Analysis Graph of Sri Lanka

Use of expenditure as GDP contribution has its own merits and demerits. It is difficult to compare indicators – as it is possible for mitigation analysis – because proxies hold different stands in the overall economy. There is no benchmarking for contribution to GDP as it can vary in short terms with government policy changes. Unlike mitigation graph, adaptation graph has to use with individual sectors to review CC policy of each country. Nevertheless, sector-based GDP contribution provides information on short-term strategies, which can be related to CC policy, in order to achieve its success.

Island nations are aware on possible impacts of climate change and the need of strong CC policies and actions. By evaluating the Singapore and Sri Lankan context, CC has been a priority topic in the decision-making process since 2005. Main problem with climate policy analysis is the difficulty in setting benchmarks to the expected goals and objectives of controlling emissions. Each country must use the best possible targets unless otherwise any global convention would not be successful in finding common consensus. Singapore and Sri Lanka must use unique trade-off between development goals and
CC responsibility to reduce the emissions and thereby improve resilience to the CC impacts.

## 5. Conclusion

Traditional scientific indicators cannot necessarily measure the CC policy due to socio-economic and political decision making defining the CC policy of both island nations. Under such situation, it is difficult to perceive an instant change in political and social perceptions towards CC mitigation and adaptation. Public never accepts a change until credible information and reasons are provided for the change. Inherited uncertainty of CC impacts causes complexity during conveying information to public. In such situation, Singapore and Sri Lanka have undertaken actions to face CC impacts. Based on the outcomes, factors that have significant impacts on CC policy objectives are listed as follows.

- Lack of political will and socio-economic dynamics
- Existing barriers for implementation as such the conflicting policies, non-compliance of technical knowledge among decision makers, and lack of long-term planning
- Natural setting of the country (geographic and climate related barriers)
- Non-availability of appropriate tools to implement policy objectives
- Distorted timeline for action plans without considering the socio-political behavior of the economy

Many factors can result in CC policy failure. It is noted, that none of the individual efforts matter unless global emitters agreed upon immediate binding targets. One motive to undertake this study is the uncertain global CC negotiations. Failure of Kyoto protocol is important to view with comparative perspective of other similar treaties involved in global community. Vienna convention of reducing ozone depletion substances and United Nations Convention on the Law of the Sea (UNCLOS) are deemed successful as per the adherence of over 90% of parties. Comparatively, UNFCCC has not succeeded in convincing the economic impacts or significance of

threats. Following list of key conditions have proposed through this study in order to achieve a collective target.

- Integration of Climate Policy with Trade Policy
- Enforcement of Binding Targets and Polluter Pays Principle mandatory for every country
- Independent Climate Policy Planning
- Transition Management through Climate Change Policy

The recommendations are based on identifying possible ways to follow strategies that can be adopted as a learning exercise. In such situation, two countries can exchange the adaptation and mitigation strategies to be climate resilient. Most of the identified issues are due to the conflicts between economic strategies of the country with climate change action plan. As per the identified criterion for CC policy analysis, recommended policy actions are listed in Table 7.

**Table 7** Recommended Actions under Adaptation and Mitigation Criterion (Source: Compiled by Author)

| Adaptation/ Mitigation Theme | Policy Recommendations for Singapore | Policy Recommendations for Sri Lanka |
|---|---|---|
| Consumption Pattern and Food Security | • Development of localized agricultural policy with the use of technology<br>• Responsible consumption practices among citizens through mass media promotions<br>• Reduction of carbon footprint by regulating imports and sustainability accredited products | • Restrictions on import policy in order to promote local agricultural output<br>• Strong waste management strategy in line with CC policy recommendations<br>• Promote responsible consumption |
| Resource Management and Bio Diversity Conservation | • Protection of primary forest cover (nature reserves) from development projects<br>• Introduce natural green belts, and coral growth in order to mitigate extreme CC impacts through independent environmental policy | • Strengthen the legal protection of national parks and rainforests from development projects<br>• Improve linkage with international environmental protection agencies to conserve existing natural resources |
| Human Settlement and Land Use Planning | • Development of land use policy and population distribution policy in line with CC policy recommendations<br>• Long-term population growth policy to achieve minimum conflicts between citizens and environment | • Integrate the land use planning policy with population distribution strategy in line with CC policy recommendations |
| Disaster Management | • Link up the land use policy with mainstreaming CC adaptation actions for the community to move away from vulnerable areas<br>• Integration of disaster impacts of CC with economic policy to evaluate the economic loss | • Land use policy amendment for disaster risk reduction for coastal vulnerable zone and fragile eco systems prone to CC induced disasters<br>• Long-term actions based on development plans to reduce disaster risks |
| Energy Consumption | • Integrate energy policy with CC policy recommendations in order to harness renewable sources of energy production | • Amendment of energy policy to reduce the fossil fuel sources and R&D in renewable energy sector<br>• Implement energy efficiency regulations, building codes, and incentive system for energy savings in the industrial sector |
| Infrastructure Development and Transport Management | • Use of enforcement tools to encourage public transport, bicycling, and walking together with supportive infrastructure<br>• Reduce private vehicle use by tightened road use policies and parking system | • Integrate the road development policy with transportation plan to improve public transportation efficiency<br>• Encourage BRT system, vehicle electrification, and other clean energy sources for vehicle standards |
| Industrial Development | • Industrial value addition and promotion of non-polluting and less energy intensive industries | • Improvement of industrial distribution strategy to minimize pollution and emissions<br>• Target non-polluting industries which can |

| | | |
|---|---|---|
| | | utilize local resources |
| Research and Development (R&D) | • Use of R&D into CC action plans to improve mitigation and adaptation policy recommendations | • Integration of CC policy with R&D institutions to identify mitigation options<br>• Utilize local education system in to CC based R&D |
| Institutional Set-up and Governance | • Link institutions with other stakeholders such as general public and NGOs to avoid policy failure | • Reform institutional set up for CC policy implementation as a collective form<br>• Allow institutions to conduct independent research and decision making so as to guide CC resilience as apex bodies |

Selection of Singapore and Sri Lanka provided the opportunity to explore the preparation for common challenges especially in the context of vulnerability, to unpredictable impacts of CC on island states. The study can extend further by using different proxies that define CC response as follows:

- Use of cost-benefit analysis in terms of damages incur during extreme weather conditions and the actions taken for CC mitigation and adaptation
- Use of socio cultural impacts of CC as a proxy to determine the resilience of population of the country with respect to expected objectives of CC policy
- Evaluation of CC policy by measuring short-term and long-term success of strategies
- Compare and contrast the external linkages (external trade, emissions of neighboring countries or regions, foreign exchange earnings) that effect on CC policy failure

Compare and contrast the external linkages (external trade, emissions of neighboring countries or regions, foreign exchange earnings) that effect on CC policy failure

Different proxies can provide results in terms of sector-based priorities. Uncertainty and unpredictable nature of impacts can create the CC policy vulnerable to failures. Therefore, inclusion of sensitivity analysis and progress monitoring into the assessment can improve evaluation technique.

The priorities of governments are different in each sector of the economy and sector evaluation can use suitable weightage matrix (or similar interpretation) to highlight the comparative magnitude of impacts. Further, the method can apply into individual policy actions to recognize success or failure of individual sector-based policies such as transportation policy, land use policy, or disaster management policy.

Lessons that can be learnt from each other play a vital role in successful implementation of policies to avoid CC policy failure. Adaptation and mitigation policies generally depend on the capacity of the country and political economic objectives for the future. As a result, Singapore focused on mitigation actions and Sri Lanka on adaptation action plans. In order to derive on sustainable global climate change policy, international CC negotiations, avoid free rider roles of developing countries in CC policies, integrate economic impacts of CC impacts, and bottom up approach in CC action plans are vital. Consumerism and dependency on imports has created blowhole in country specific CC response as carbon footprint of individual countries is increasing. This study identified core sector-based improvements for Singapore and Sri Lanka, which then can relate in to island nations.

## References

Abeysinghe, T., & Choy, K. (2007). The Singapore Economy: An Econometric Perspective. 70. Singapore: Routledge.

Bartelmus, P. (2015, January 05). How bad is climate change? Environmental Development. 1-17.

Bradshaw, C., Giam, X., & Sodhi, N. (2010). Evaluating the Relative Environmental Impact of Countries. *Plos One*. 1-16.

Carr, M., & Krukowska, E. (2009, December 21). Carbon Prices Tumble After 'Modest' Climate Deal (Update2). Retrieved January 12, 2015, from Bloomberg: http://www.bloomberg.com/apps/news?pid=newsarchive&sid=a8TD.WeBNprk

Chang, A., & Kleyn, G. (2010). Singapore Secures China as Future Food Source. West Perth: Future Directions International.

Climate Change Secretariat. (2010). National Climate Change Adaptation Strategy for Sri Lanka: 2011 to 2016. Colombo: Ministry of Environment.

Climate Change Secretariat. (2014). Sri Lanka Climate Profile. Retrieved January 10, 2014, from Climate Change Secretariat Sri Lanka: http://www.climatechange.lk/Climate_Profile.html

Climate Change Secretariat Sri Lanka. (2012, December). The National Climate Change Policy Of Sri Lanka. Retrieved December 01, 2014, from Climate Change Secretariat of Sri Lanka: http://www.climatechange.lk/policy.html

Condon, B., & Sinha, T. (2013). The Role of Climate Change in Global Economic Governance. New York: Oxford University Press.

Cust, J. (2011). Using Intermediate Indicators: Lessons For Climate Policy. *Climate Policy*. 450-463.

Davison, G. (2007). Urban Forest Rehabilitation – A Case Study from Singapore . Keep Asia Green.

De Silva, C., Weatherhead, E.K., Knox, J., & Rodriguez-Diaz, J. (2007). Predicting the impacts of climate change—A Case Study Of Paddy Irrigation Water Requirements In Sri Lanka. *Agricultural Water Management*. 93(1): 19-29.

Dessler, A. (2012). Introduction to Modern Climate Change. New Delhi: Cambridge University Press.

DMC. (2010). Vulnerability Profile of Sri Lanka. Colombo: Disaster Management Centre (DMC).

Ecofys & Climate Analytics. (2011, December 21). CLIMATE ACTION TRACKER: Country Assessment Methodology. Retrieved from Climate Action Tracker: http://climateactiontracker.org/methodology
Energy Market Authority. (2013). Singapore Energy Statistics. Singapore: Energy Market Authority of Singapore.

Frankland, R., Hardwick, L., & Watkin, S. (2012). Climate Change Adaptation In A Small Pacific Island Nation. *Proceedings of the Institution of Civil Engineers*. 46-51. ICE Publishing.

Giddens, A. (2008, September). The Politics Of Climate change: National Response To The Challenge Of Global Warming. London, United Kingdom.

Hamilton-Hart, N. (2012). Singapore's Climate Change Policy: The Limits of Learning. *Contemporary Southeast Asia*. 28(3): 363-384.

Harris, P. (2007). Collective Action On Climate Change: The Logic Of Regime Failure. *Natural Resources Journal*. 47(1): 195-224.

Harris, P. (2013). What's Wrong with Climate Politics and How to Fix It. Cambridge: Polity Press.

Heiskanen, E., Kivisaari, S., Lovio, R., & Mickwitz, P. (2009). Designed to Travel? Transition Management Encounters Environmental And Innovation Policy Histories in Finland. *Policy Sci*. 1-19.

Helbron, H., Schmidt, M., Glasson, J., & Downes, N. (2011). Indicators for Strategic Environmental Assessment In Regional Land Use Planning To Assess Conflicts With Adaptation To Global Climate Change. *Ecological Indicators*. 90-95.

Hood, C. (2002). The Risk Game And The Blame Game. *Government And Opposition*. 37(1): 15-37.

Hoods, C., & Margetts, H. (2007). The Tools of Government in the Digital Age. Basingstoke: Palgrave Macmillan.

Howlett, M. (2011). Designing Public Policies: Principles and Instruments. Oxon: Taylor & Francis Group, Routledge.

Howlett, M. (2014). Why are Policy Innovations Rare And So Often Negative? Blame Avoidance And Problem Denial In Climate Change Policy-Making. *Global Environmental Change*. 29: 395-403.

Huhne, C. (2011, December 6). Durban Climate Change Talks: Developing Countries Must Take On More Responsibility, says Chris Huhne. Retrieved from The Telegraph: http://www.telegraph.co.uk/

IPCC. (2013). "Climate change 2013: The physical science basis." Summary for Policy Makers. New York: Cambridge Univ Press.

IPCC. (2014). Climate Change 2014: Synthesis Report. Intergovernmental Panel for Climate Change, United Nations Environmental Programme.

IPS. (2014). Sri Lanka: State of the Economy 2013. Colombo: Institute of Policy Studies of Sri Lanka.

Jayatunge, R. (2014, August 27). Climate Change related Initiatives in Sri Lanka. Retrieved March 2, 2015, from Climate Action Network South Asia: http://www.slideshare.net/CANSA2014/sri-lanka-initiatives-on-climate-change?next_slideshow=1

Kildow, J. (2011). The Utility of Economic Indicators to Promote Policy-Relevant Science for Climate Change Decisions. In Ommer, Perry, Cochrane, & Cury, World Fisheries: A Social-Ecological Analysis. 139-150. Blackwell Publishing Ltd.

Kjosavik, D., & Vedeld, P. (2012). The Political Economy of Environment and Development in aGlobalized World. Colombo 5: Tapir Academic Press.

Klein, N. (2014). This Changes Everything: Capitalism vs. Climate. London: Penguin Books Limited.

Lai, R. (2011, January 22). Lower CO2 emissions anyone? Retrieved January 21, 2015, from ONESHIFT.COM: http://www.oneshift.com/features/826/lower-co2-emissions-anyone

Latin, H. (2012). Climate Change Policy Failures: Why Conventional Mitigation Approaches Cannot Succeed. Hackensack: World Scientific Pub. Co.

LePoer, B. (1991). Singapore: A Country Study. Washington: Library of Congress: Federal Research Division.

Ley, T. (2013, January 5). Climate Change Impacts Pacific Islands. Majuro, Republic of Marshall Islands.

Lim, L. (2008). Singapore's Economic Growth Model – Too Much or Too Little? Singapore Economic Policy Conference, (pp. 1-11). Singapore.

Low, M. (2015). Compliance for Intended Nationally Determined Contributions in the 2015 Climate Change Agreement. Singapore: Energy Studies Institute.

Lye, L. (2008). A Fine City in a Garden: Environmental Law & Governance in Singapore. *Singapore Journal of Legal Studies*. 68-117.

Mahanama, P., Abeynayake, C., Jayasinghe, A., & Bandara, P. (2014). Climate Response of Local Authorities: A Case of Sri Lankan Coastal Urban Areas. *International Journal of Research in Social Sciences*. 59-66.

McCarney, P. (2012). City Indicators on Climate Change: *Implications for Governance. Environment and Urbanization ASIA*. 3(1): 1-39.

MEWR, & MND. (2015). Sustainable Singapore Blueprint. Singapore: Ministry of the Environment and Water Resources and Ministry of National Development.

Ministry of Power & Energy. (2015, April 30). Generation Plants. Retrieved from Ministry of Power & Energy: http://powermin.gov.lk/english/?page_id=1507

NCCS. (2011). About NCCS, Singapore. Retrieved January 10, 2015, from National Climate Change Secretariat: Prime Minister's Office: https://www.nccs.gov.sg/about-nccs

NCCS. (2015). Climate Change and Singapore. Singapore: National Climate Change Secretariat.

Never, B., & Betz, J. (2014). Comparing the Climate Policy Performance of Emerging Economies. *World Development*. 1-15.

Ng, W., & Mendelsohn, R. (2005). The Impact Of Sea Level Rise on Singapore. *Environment and Development Economics*. 10: 201–215.

Nordhaus, W. D. (2013). The Climate Casino: Risk, Uncertainty, And Economics For A Warming World. Yale University Press.

NPTD. (2013). Population White Paper 2013. Singapore: National Population and Talent Division.

OECD. (2009). Governing Regional Development Policy: Use of Performance Indicators. Paris: Organization for Economic Co-operation and Development.

OECD. (2009). Green Growth: Overcoming the Crisis & Beyond. Organisation for Economic Co-operation and Development.

Peake, S., & Smith, J. (2010). Climate Change: From Science to Sustainability. Oxford: Oxford University Press.

Raleigh, C., & Urdal, H. (2007). Climate Change, Demography, Environmental Degradation and Armed Conflict. Political Geography On Climate Change & Conflict. 27-33.

Sanderatne, N. (2012, December 9). Economy Vulnerable To Climate Change. Retrieved from The Sunday Times: http://www.sundaytimes.lk/121209/columns/economy-vulnerable-to-climate-change-23972.html

Scrieciu, S., & Chalabi, Z. (2014). Climate Policy Planning and Development Impact Assessment. *Mitigation & Adaptation Strategies for Global Change*. 255-260.

Scrieciu, S., Belton, V., Chalabi, Z., Mechler, R., & Puig, D. (2014). Advancing Methodological Thinking And Practice For Development-Compatible Climate Policy Planning. *Mitigation & Adaptation Strategies for Global Change*. 261-288.

Senaratne, A. (2014, April 01). Policy Challenges In Climate Adaptation In Sri Lanka: Identifying Major Gaps. Retrieved January 05, 2015, from IPS CLIMATEnet Blog: Climate change policy network of Sri Lanka: http://climatenet.blogspot.sg/2014/04/policy-challenges-in-climate-adaptation.html

Seo, S., Mendelsohn, R., & Munasinghe, M. (2005). Climate Change And Agriculture In Sri Lanka: A Ricardian Valuation. *Environment and Development Economics*. 10(5): 581-596.

Shove, E. (2010). Beyond the ABC: climate Change Policy And Theories Of Social Change. *Environment and Planning A*. 1273-1285.

SIDS. (2014, November 28). Towards Actions for Small Island Developing Nations. Retrieved from United Nations Department of Economic and Social Affairs, Division for Sustainable Development: http://www.sids2014.org

Sinclair, M. (2011). Let them Eat Carbon. London: Biteback Publishers Ltd.

SingStat. (2012). Yearbook of Statistics Singapore 2012. Singapore: Department of Statistics Singapore.

Stern, D., Common, M., & Barbier, E. (1996). Economic Growth And Environmental Degradation: The Environmental Kuznets Curve And Sustainable Development. World Development. 24(7): 1151-1160.

Stern, N. (2007). The Economics Of Climate Change: The Stern Review. Cambridge University Press.

Sundaresan, J., Sreekesh, S., Ramanathan, A., Sonnenschein, L., & Boojh, R. (2013). Climate Change Impacts Pacific Islands and Coastal Vulnerability. New Delhi: Capital Publishing Company, Springer.

Tan, S. (2013). Framework for Formulating Environmental And Climate Change Policies: Perspective From Environmental Macroeconomics. 42nd Australian Conference of Economists. 1-35. Perth.

Tan, S. (2013). Long-Term Land Use Planning in Singapore. Singapore: Lee Kuan Yew School of Public Policy.

Thampapillai, D. (2014). The Need for a Serious Rethink on Economics. Lee Kuan Yew School of Public Policy Research Paper. 14-27.

Tompkins, E. L. (2005). Defining Response Capacity To Enhance Climate Change Policy. *Environmental Science & Policy*. 562-571.

UNFCCC. (1998). Kyoto Protocol to the United Nations Framework Convention on Climate Change. Kyoto: United Nations.

UNFCCC. (2007). Bali Action Plan - CP 13:1. Bali: Climate Change Secretariat (UNFCCC).

UNFCCC. (2007). Investment & Financial Flows to Address Climate Change Impacts. Bonn: Climate Change Secretariat.

UNFCCC. (2014, November 28). Parties & Observers. Retrieved from United Nations Framework Convention on Climate Change: http://unfccc.int/parties_and_observers/items/2704.php

UN-HABITAT. (2008). State of the World Cities. Geneva: United Nations Human Settlement Programme.

UNHabitat. (2011). Climate resilient action plans for Coastal urban areas in Sri Lanka (CCSL). Colombo: United Nations Human Settlements Development Program.

UN-HABITAT. (2012). State of the World's Cities 2012/2013. New York: Routledge Press.

Vasa, A., & Michaelowa, A. (2011). Uncertainty in Climate Policy – Impacts on Market Mechanisms. In G. Gramelsberger, & J. Feichter, Climate Change and Policy: The Calculability of Climate Change and the Challenge of Uncertainty. 127-144. Berlin: Springer.

Voß, J., Smith, A., & Grin, J. (2009). Designing Long-Term Policy: Rethinking Transition Management. *Policy Science*. 42: 275-302.

Wang, Q., & Chen, X. (2013). Rethinking and Reshaping The Climate Policy: Literature Review And Proposed Guidelines. *Renewable and Sustainable Energy Reviews*. 469-477.

Withanachchi, S., Köpke, S., Withanachchi, C., Pathiranage, R., & Ploeger, A. (2014). Water Resource Management in Dry Zonal Paddy Cultivation in Mahaweli River Basin, Sri Lanka: An Analysis of Spatial and Temporal Climate Change Impacts and Traditional Knowledge. *Climate*. 2(4): 329-354.

Withgott, J., & Laposata, M. (2014). Essential Environment: The Science behind Stories. London: Pearson Education Inc.

WMO. (2013, November 13). Provisional Statement on Status of Climate in 2013. Retrieved December 26, 2014, from World Meteorological Organization: http://www.wmo.int/pages/mediacentre/press_releases/pr_981_en.html

World Bank. (2009). Climate Resilient Cities. World Bank.

World Bank. (2011). From Growth to Green Growth: A Framework. Washington DC: Office of the Chief Economist, Sustainable Development Network.

World Bank. (2014). Data by Country and Lending Groups. Retrieved January 29, 2015, from The World Bank: http://data.worldbank.org/about/country-and-lending-groups

WWF. (2014). Living Planet Report 2014. Gland: World Wide Fund for Nature.

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# Political Representation In Urban Public Space In Jakarta Child-Friendly Public Space (Ruang Publik Terpadu Ramah Anak – RPTRA)

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## ABSTRACT

The design of public space often embodies the power and political representation of a specific regime. As urban architecture symbolizes and establishes the identity of a regime, authorities often use a top-down approach to implement urban architectural programs. As a result, the spaces constructed often display power and identity, but lack consideration of public use. Public spaces are often exclusionary for public use. They merely stand for the representation of the authority. Accordingly, many public spaces built by the government are abandoned soon after their launch. Big ceremonies and public space displays only last a few days before these spaces are then closed to the public or appropriated for different uses. Most top-down approaches focus on the physical development, overlooking the users' inclusion in decision making. This research analyses the political representation of public space design in RPTRA Bahari located in the South Jakarta. It analyses the political reason behind the development of RPTRA in Jakarta and the way participative design approach is employed during the design process to get public engagement in public space. Therefore, it investigates how the political representation is perceived in everyday life by analysing how the public space has been used three years since its launch. Through observation and interviews, this paper interrogates the political representation in urban forms and how public spaces become an arena where the government's intentions and everyday uses meet. It concludes that a participative, bottom-up approach leads to more public use and engagement.

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## 1. Introduction

For the past few years, public place making in Jakarta is only targeted to fulfil the lack of green open space in the city. Based on the article about Indonesian city planning No 26, 2007, it is stated that every city should have at least 30% of green open space. Therefore, to achieve this goal, governor tend to use top down approach in making green open spaces. By 2011, the ministry of Women empowerment and Child protection issued an article No 12 about child-friendly city indicators that every city should achieved. Here, the role of public space is not only to provide green open space, but also to enable children to have safe environment. By the end of 2014, the late Jakarta Governor Ahok in collaboration with the Indonesian Women Welfare Organization (PKK) and Community Empowerment, Women and Family Planning Bureau, planned to launch integrated child friendly public space in line with this city planning. The concept of child friendly city has long been abandoned by the former Jakarta governor and Ahok took initiative by making a child friendly community center (Ruang Publik Terpadu Ramah Anak – nicked named as RPTRA). The initial program was to launch 6 pilot projects of RPTRA by early 2015 and build another 200 RPTRAs in Jakarta by 2017 as part of his political representation. This program was his emphasis to win public support for the 2018 election, right before he was sentenced due to blasphemy cases and lost the election.

Funded by PT Pembangunan Jaya, Ahok built the initial RPTRA pilot projects in 6 municipalities to make Jakarta as the child-friendly city. Differentiating himself from the previous governor, Ahok deployed social researchers Imam Prasodjo and Eka Permanasari to be involved in the project to ensure high level of public participation in in the process of making and organizing the community centers (Permanasari, et al., 2018)

However, the process of making RPTRA receives pros and cons both from the users and from the political rivals. The pros are mainly derived from the positive intention of making public space which Jakarta is heavily lacking. Apart from that, by making RPTRA, government land assets are identified and rescued from illegal users and their function is returned for public purposes. On the other hand, the intention of involving community in every step of development to trigger community's sense of belonging towards the public space is questioned as the governor still impose top-down approach in implementing the program and limited public participation. The users are involved but their voice is not fully heard and implemented into the design.

Meanwhile, the political rival sees RPTRAs as vulnerable to be corrupted since they are funded by private company's CSR (Laksana, 2017). The total RPTRA funded by CSR is 67 and by the Regional Government budget is 223 (Mamduh, 2018). In total there are 290 RPTRAs that have been built over period 2015-2018. The political rivals also questioned the term of 'child-friendly' as whether this public space is only for children and disregard other users (Carina, 2017). Therefore, by 2018 soon after Anies Baswedan replaced Ahok, he stopped the uses term of RPTRA. To continue providing green open space, he launched a new term of public space as Taman Maju Bersama (together we moving forward park). By the end of 2018, Anies has launched 10 Taman Maju Bersama parks using the 10 billion of regional government budget (Desrianto, 2018). Here, the political representation manifested in urban forms are imminent. Architectture and urban design have been used as vehicle to symbolize power and identity (Vale, 1992).

However, the previous study in public space mainly focuses on the top-down government's approaches. Kusno (2000) and Permanasari (2010) analyse the political representation symbolized and displayed in public space (Permanasari, n.d.). The analysis is mostly about the top-down approach used by specific regime to symbolize power and identity and often disregard the community's perspective. The study of RPTRA mostly investigates what the government has done by assessing numbers of public facilities being built within the populated area (H. S. Aji, 2016) The analysis is mostly about design criteria instead of looking at the way in which people use the space after their limited inclusion during the design process (Hernowo, 2017).

This paper investigates the political representation in RPTRA Bahari as a public space located in South Jakarta. As one of the 6 RPTRA pilot projects, RPTRA Bahari has shown consistent level of public engagement since its early design concept until now. While other RPTRAs faced certain level of resistance during the design and development process, RPTRA Bahari relatively smooth in gaining public participation (Permanasari, et al., 2018). In terms of the size, RPTRA Bahari has 926 m2 of land and the building is two storeys with total building size 198m2. The main characteristic of this RPTRA is the mini soccer field provided to cater the community needs.

The concept of public space is sometimes ambiguous in terms of political contestation. The term 'public' is questionable as it is often an exclusionary place for a large spectrum of society (Kahraman, Pak, & Scheerlinck, March 2018). Public spaces have long been a mechanism within the capitalist mode of production. In fact, public space is used to symbolize a certain power and identity (Alsayyad, 1992). In creating public spaces, architects and urban designers are thus trapped between the authority's intentions and citizens' rights.

The idea of 'publicness' is a paradox, since the concept does not carry the real meaning of the term. Namely, the term 'public' does not really mean public, as public places are still exclusionary for others. According to Arendt (1998), to be public is a condition wherein people are heard, seen, and included in the political life (Arendt, 1998). However, this condition cannot be materialized because public spaces are always political. The idea of a public space that is open to everyone exists only in principle (Iveson, 2007). In reality, daily uses of public spaces occur within a fragmented society where interest groups compete against each other. Public spaces are the domain for struggles between the dominant, and hence public spaces are by nature counter-public. The idea of public spaces raises the question 'whose public spaces?' Even though public spaces carry the term 'public', political powers will reorganize,

demolish, control, and militarize public spaces if necessary. Authorities tend to limit public access and strive to keep public spaces in line with the original intention behind the spaces' construction.

Public spaces are a social and physical representation of space and community. However, the term 'representation' is also ambiguous, since the word 'representative' means doing something on behalf of someone else. Representation implies both presence and absence of the represented, such that there can be decisions made on behalf of the citizen with clear instructions. However, when representatives make a decision, does it really represent the citizen? Thus, political representation starts to fail when the citizens' explicit objections are voiced.

This condition resonates with Arnstein's (1969) ladder of participation (Arnstein, 1969). Arnstein highlights a ladder of citizen participation on which eight rungs indicate citizen participation levels in public places. The first two rungs show a non-level of participation wherein government policy aims to educate participants. The third and fourth rungs (informing and consultation) show the degrees of tokenism. Citizens are allowed to speak, but they do not have the power to implement opinions. The fifth rung (placation) allows citizens to advise the government. However, citizens do not have the power to decide because the government is the power holder.

The ladder's highest levels represent the degrees of citizen power: the sixth rung (partnership) allows citizens to partner with the government. The seventh rung (delegated power) and eighth rung (citizen control) allow citizens to have majority decision making and full managerial power. Based on these classifications, we can analyse how much citizens can engage in public spaces. It can be concluded that regardless of the level of participation, public space is a tricky concept and does not necessarily include public involvement.

The purpose of urban projects is generally to show the intent of economic growth. In cities, urban spaces are used as leverage to show market-oriented economic growth that is aimed at everyone, even though profits are then exploited by the elite few. Indeed, architecture and urban design are commonly used by political regimes as a way to exercise and express their power. As a result, the development does not involve public engagement and often disregards public needs.

This condition has forced urban designers and architects to analyse public spaces' requirements for everyday uses. Urban planners and architects are challenged: they must accommodate public interests based on the idea of making a public sphere and publicly accessible spaces (Tonnelat, 2010). The public sphere deals with participative democracy while publicly accessible spaces concern the idea of individual liberty, which resonates with Lefebvre's (1996) right to the city (Mitchell, 2003).

In the 1970s, there was a global movement against this condition as to how a public space should be. Jan Gehl (1987) proposed a new approach of designing public space by including the presence of other people, stimulating activities and events. Public spaces are also a common ground for people to do everyday activities, both as routine or periodic activities (Carr, Francis, L.G, & Stone, 1992).

Another movement is called bottom-up urbanism, where the public spaces' design should include the voice of citizens. In bottom-up urbanism, there are three forms of practices: occupy urbanism, tactical urbanism, and hybrid urbanism. Occupy urbanism includes DIY (self-organized) practices where ordinary people gather and reclaim urban spaces through various acts of communing: the collective sharing of space (Pak, 2017). Tactical Urbanism involves ordinary people that take part in shaping their environment during the design process and most importantly through the product itself. This is usually executed for short-term plans or projects. Hybrid Urbanism combines communing practices and planning (Pak, 2017).

Participation is based on the interaction between the designer and the user. It includes various other actors such as governmental institutions, political decision makers, and non-governmental organizations. In a participative design, the public actors have power in the decision-making process in any political context. The local people are the main information source for the designers, as they can provide an understanding of the local knowledge, needs, and values that are important for the design process (Sanders, Elizabeth B-N; SonicRim, 2002). This is especially true in spatial design because users care about their living spaces. In urban design, a good, organized, and efficient public participation will foster a sense of belonging because of its unique locality.

Participation in design has several benefits for both parties and for the whole community (Dede, 2012). For users, it represents an increased sense of influence on the decision-making process and an increased awareness of the consequences. This minimizes activities such as vandalism, since there is a sense of belonging to the space. For the designer, it represents relevant and up-to-date information, which generates many design ideas. Finally, for the whole society, participation benefits the community by meeting their social needs and by increasing the effective use of resources. Participative design's main purposes are to involve and to unite citizens in the decision-making process, to promote a sense of community, and to increase user satisfaction (Dede, 2012).

## 2. Methodology

To analyse the political representation and community sense of belonging in the Child-Friendly Public Space of RPTRA Bahari, three main qualitative research methods were used to gather data: observing physical traces, observing environmental behaviours, and focused interviews. The qualitative research methodology is cross examined through three various research methods to get objective analysis.

Observing physical traces involves carefully examining the physical surroundings to analyse the previous activities that may have occurred within the space (Zeisel, 2006). From these

observations, we were able to determine the users' profiles such as their culture, affiliation, and preferences.

Observing environmental behaviour involves analysing how people use the space and how they interact with others and the environment. At the same time, it also involves examining how a setting interferes with activities. With this method, researchers can generate data about people's activities, the relationship between regulations and people's behaviours, and the uses or misuses of place (Zeisel, 2006).

These observation methods were conducted to analyse the use of RPTRA in everyday life, how people appropriate the space amidst its political insinuation and their inclusion in the public space. Observations were conducted using photography and mapping techniques that captured public activities during weekdays and weekends from the RPTRA Bahari launch until now. Observations were carried out in public spaces without interrupting activities occurring on the site. To maintain the objectivity and privacy, this paper ensures the anonymity of the interviewee and the anonymity the users of RPTRA Bahari while mapping and observing their activities.

## 3. Result and Discussion

Built in Jakarta in 2015, the RPTRA Bahari in South Gandaria district, South Jakarta is one of the city's 6 RPTRA pilot projects. Initially, the project aimed to provide Jakarta with a communal space for children. This aim was in line with the governor's plan to provide a child-friendly city for its citizens (Permanasari, Nurhidayah, & Nugraha, 2018). Unlike the previous urban approach, Ahok wanted RPTRA to be developed by the bottom up model using participative design approach.

The participative design approach in RPTRA Bahari followed the 6 steps of the design process: social mapping, discussions about the initial design, final design, working together in building the RPTRA, and discussion about RPTRA management. The whole process took approximately 6 months during which the society was included in every step of the process.

The social mapping began when the architect, urban designer, and social researcher pictured the existing conditions on the potential site. South Gandaria district area is about 177 ha, with an approximate population of 24,783 people. The heavily populated areas have mixed building density. The district chief is very famous and active in the community engagement. Based on the site visit, there were community-based activities such as handicrafts, a reading club, traditional dancing, a children's learning forum, a creative economy, mini soccer, morning aerobics, and acoustics. The community is also involved in recycling materials and making waste recycling banks.

The next step is forming a design concept to involve the community in the participative design process. The architect and social researcher proposed the idea of a community centre that would cater to the needs of children with positive activities. Since the area is densely populated and has many buildings, the only open space belonged to the government was the proposed area is 926 m2. Achmad Noerzaman, the architect, explained the building's purpose and how it would operate. The community provided feedback on the types of activities they needed so that the design considered the space requirements. During the discussions, the citizens were encouraged to voice their concerns and aspirations. The architect and social researcher became the mediators who linked the citizen and the government.

Gathering people's participation allowed the citizens to speak and propose their ideas. However, the process did not guarantee that these ideas would be implemented (Permanasari, Nurhidayah, & Nugraha, 2018). This finding correlate with Arnstein's (1969) ladder of participation in which informing and consultation become a part of a space's social production. The concept of participation is also questioned, as those who attended the forum were representatives of the citizens. Since the term 'representative' is ambiguous, a process that includes only the citizens' representatives carry multiple dimensions and the ideas of the represented may not actually have been taken into account at all.

Those that attended the meeting were mostly from the family welfare organization; this organization is a top-down organization model which places the wives of the power holder organizing the discussion. Even though public participation was encouraged, it was difficult to identify the public aspirations during the process. The participative design approach's next level was to finalize the design consultation, to build the community centre together, and to plan the activities.

The participatory design approach was a good first bottom-up step that allowed the citizens to speak and channel their aspirations to build and operate in a public space, even if the citizens' participation was somewhat limited and questionable. Regardless, the method allowed the bottom-up process to occur at the beginning of the space's production. However, the initial process should have raised more public awareness and participation; the resulting weaknesses can be examined by the everyday uses of space.

Ahok claimed that the community centres are designed to include citizens; accordingly, the public space should have citizens' activities and engagement. However, the claim on political representation in public space cannot be taken for granted. Therefore, we examined how this place is used in everyday life. The analysis compares the activities that were planned during the participatory design stage with the activities that are occurring now. The time lapse will show the activities' consistency and engagement level.

The activities that were planned before the launch were based on age classification. For instance, activities for children and teenagers included the following: sports (mini soccer, badminton), local music (angklung, traditional hadroh, marawis), drama, and learning (library) and health facilities. Activities for adults and seniors included sports (badminton, aerobics, chest), music and family welfare programmes (gardening, nutrition). The plans show the community centre

space programming [Figure 1] where you can identify a mini soccer field that overlaps with the badminton field, a multi-function room, and a store for selling community products. The multi-function room caters different activities. The garden and fish pond are provided to cater to gardening and fish farming activities. On the second floor, there is a library, training room, youth organization room, and music room. These rooms were planned based on the citizens' requirements, on the budge, and on the space availability. Compromises between the government and the citizen were made.

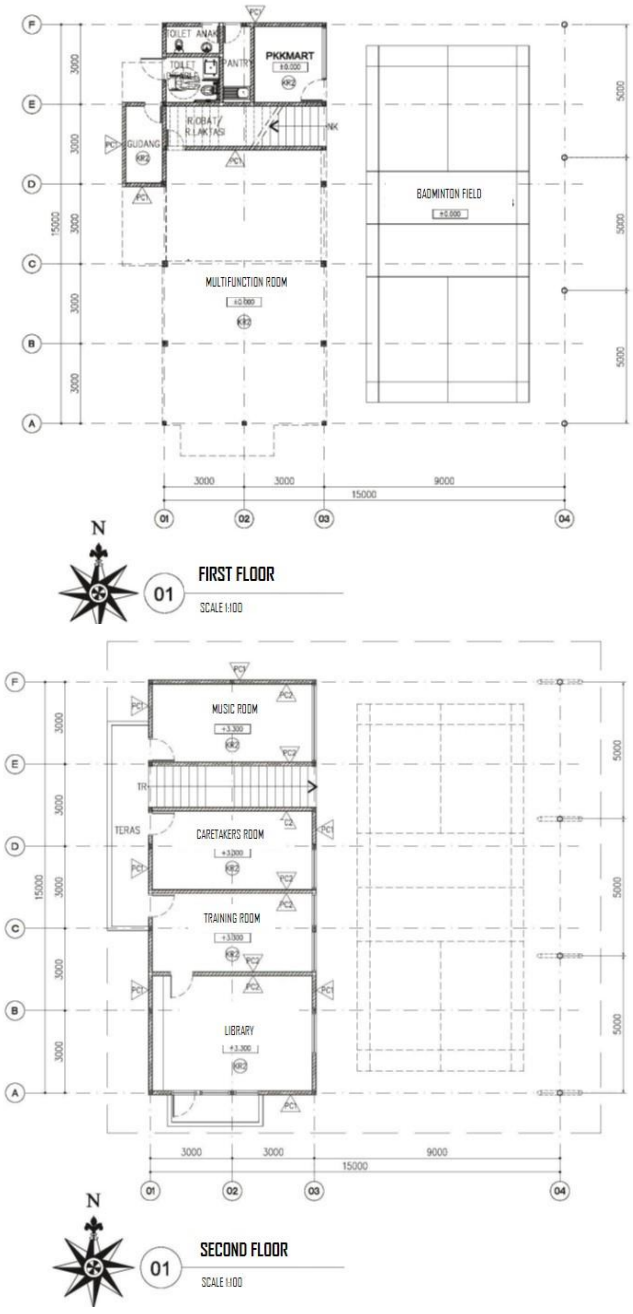


**Figure 1** Floor Plan of RPTRA (Author, 2015)

The proposed activities affect the public space's design, and incorporate the authority's agenda, and citizen's aspirations. Then, to examine whether the bottom up approach has given impact to the idea of publicness, we need to evaluate how this public space is used every day. The observation was done during weekdays and weekends during three time periods (morning, midday, and afternoon) to determine the comprehensive pattern of the activities on the site. Based on the observations, there had

been changes in the uses and space programming. The RPTRA management had replaced the youth organization room. The traditional medicinal plants garden is well looked after, but the hydroponic section is no longer intact and requires heavy maintenance. Some facilities such as the sinks are no longer in use. Other than that, the library, the common rooms, and the multi-function room are used.

To analyse the political representation insinuated in urban forms, we created a special pattern to see how people use the space. The mapping shows how this pace is used over the weekend. Overall, the RPTRA is always busy with children playing mini soccer or parents watching their toddlers. During the school holiday break, RPTRA is more crowded since children use the place as their playground. Weekday observations were taken in July 2018 during the school holiday. In the morning, children played mini soccer while others were in the playground. Parents often accompany their children or have social activities here too.

During school days, it is a different story: the RPTRA is mostly empty and only filled with smaller kids who haven't started school yet. Usually accompanied by their parents, the kids play together downstairs, read books at the library, or are in the music room. The government provided the library to educate children and the general public. Although it is called the music room, its purpose is not only to play with the traditional bamboo music tool (angklung) inside, but also to play with a box full of Lego.

By noon, the activities change into a more regular pattern. Some students from various high schools use the soccer field to practice taekwondo. Students are eager to use the RPTRA for their school activities. Neighbouring schools also use the RPTRA for their routine sports activities. For instance, PAUD Pelangi, Kindergarten Al Huriyah and Madrasah Bahari use the RPTRA on Wednesday and Friday. Students from SMK 28 Jakarta use the RPTRA for traditional dance classes. Based on the FGDs that we conducted to investigate the sense of belonging in RPTRA [Figure 2], these activities are often not found in the organizer's schedule. In fact, there are volunteers in this RPTRA such as Mrs. Maya who is willing to teach English to children pro bono. She was an English instructor at a private English training company but cares about children's education and teaches on Wednesday afternoon. The participation levels show citizen's engagement in this public space.

**Figure 2** FGD about activities in RPTRA (Author, 2018)

RPTRA caters activities not only for those living in the surrounding area but also to surrounding schools. RPTRA has become a public space that is free to use as long as the users respect and follow the rules. However, this publicness is not completely public because there are some accessibility restrictions. For instance, smokers are not allowed to enter the site. The RPTRA closes by 6 pm, which means that the public space only operates within a certain period of time. Figure 3 shows the activities on a Tuesday morning with a few children mostly in the library. Those playing in the mini soccer field are only there for a short time because at this time the sun is already hot. The library and music room are popular spaces because they are air-conditioned.


**Figure 3** Mapping RPTRA weekday morning (Author, 2018)

RPTRA Bahari has more visitors on weekday afternoons. All of RPTRA's facilities are in use such as the badminton and soccer fields. Older children and teenagers play on the soccer field, while the younger children play on the badminton field. Meanwhile, other children are watching from the sides or doing other activities in the playground. Meanwhile, the multifunction room is usually being used by adults while toddlers sit and play. The RPTRA provides a communal space where children, teenagers, and parents interact with each other. The playground is filled with children taking turns using the playing equipment. The children mostly use the music room to play Lego. If we map the activities during the weekday afternoon, most activities are on the ground floor where children play mini soccer and badminton while toddlers play in the playground. Others are on the first floor and in the library [Figure 4].

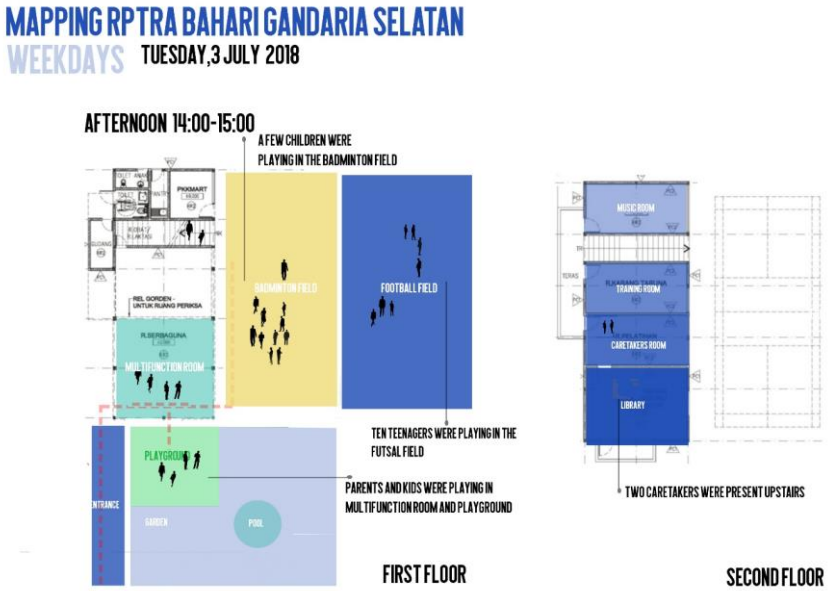


**Figure 4** Mapping RPTRA weekday afternoon (Author, 2018)

During the weekend, many use the RPTRA, like children and mothers during social gatherings (arisan) or governmental bodies implementing their policies, such as marine, agriculture, and food security bureaus that supply highly nutrient food for locals or local NGO named Kelompok Wanita Tani (Female Farmer Group). In collaboration with certain public health organizations (Alfa Omega and Obor Bakat Indonesia), RPTRA Gandaria Selatan also holds events such as free health consultations and free immunization.

Social gatherings and free health consultations only take place once a month. During normal weekends, RPTRA's multi-function room is used in a more open way. It is usually filled with mothers and nannies that are watching children, feeding them, or conversing among each other. This shows that the RPTRA brings people together, provides a safe environment for children, and encourages people to socialize amidst Jakarta's lively bustle.

On weekend mornings, kids usually use the badminton field to play soccer and for other activities such as raising flag ceremony training (Paskibra), Taekwondo, and Pencak Silat. In the image below, girls of SMA Tunas Pembangunan's Paskibra are practicing their march. Once they finished their training session, teenagers have their taekwondo and silat exercises. This place is popular because it has a roof over it, protecting people from the sun's heat.

Meanwhile, the library is in constant use: it is open from 08.00 – 18.00 during weekdays and can stay open late during holidays. Children are welcomed at the library to study or to read books. The library is also used for learning, knowledge sharing, and other educational purposes like English and math lessons. If we map the daily activities during the weekends, we can see that RPTRA is constantly in use. Children prefer to use the soccer field, playground, and library. Adults accompany their children or massage their feet around the reflection pond. Most of the RPTRA's users are children and male teenagers, while teenage girls are only present when there is a specific activity like traditional dancing [Figure 5].

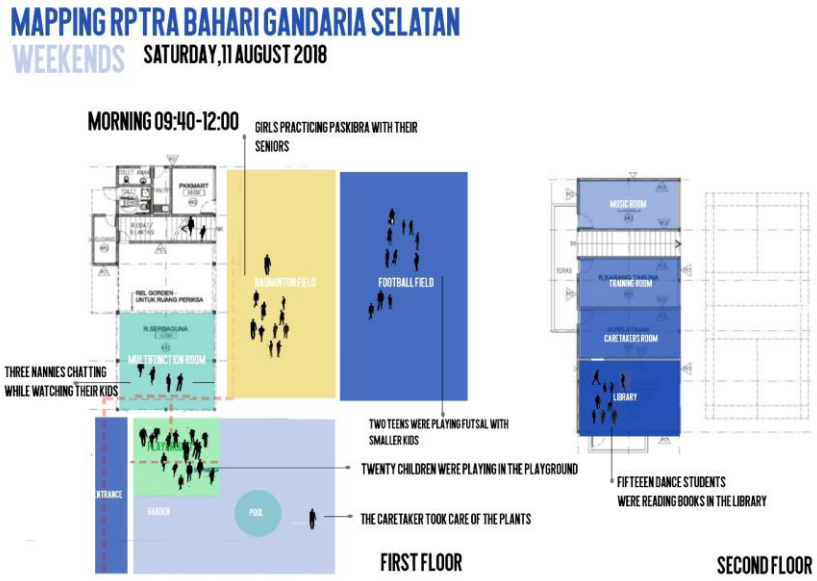


**Figure 5** Mapping RPTRA weekend morning (Author, 2018)

At noon during weekends, there are not many people who visit the RPTRA. Only a few children play on the soccer field while other play in the multifunction room. Most of the rooms upstairs are empty, except for the caretaker's room. According to the caretakers, people start to come to the RPTRA after 2pm, when the weather starts cooling down. During the weekends, some external events are organized like the Arisan Mapan. While social gatherings are in the RPTRA's multifunction room, the rest of the RPTRA is in constant use [Figure 6].

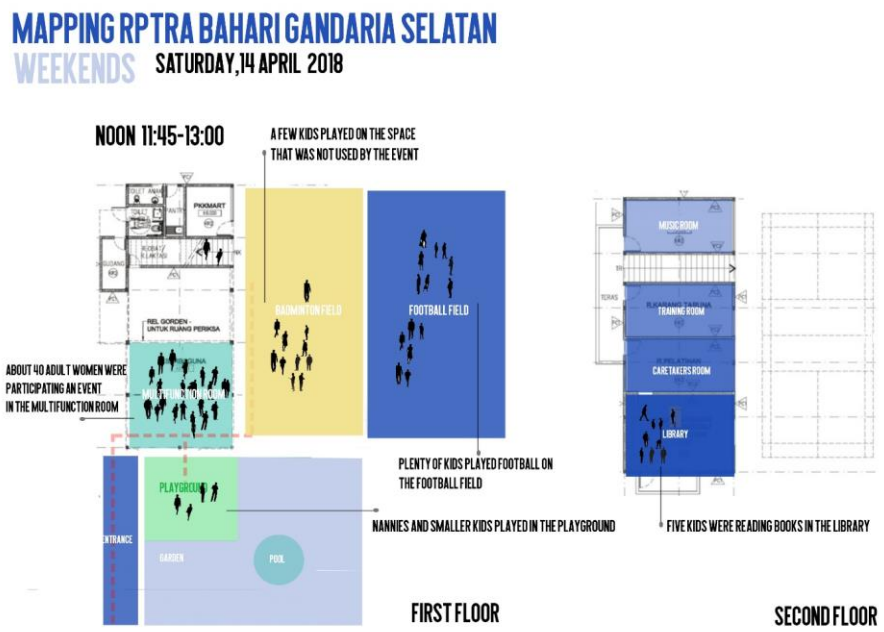


**Figure 6** Mapping RPTRA weekend noon (Author, 2018)

On weekend afternoons, the RPTRA's activities pick up as the weather cools down. The multifunction room is used by girls between 12 and 14 years old use to practice Betawi's traditional dance. The instructor is from Dinas Pariwisata (Government Tourism Office) and is part of the RPTRA programmes in Jakarta. As the girls are dancing, parents and caretakers watch them with joy. During dance classes, other children are in the playground. The mini soccer and badminton fields are the most popular feature where children and teenagers play or watch along the side [Figure 7].

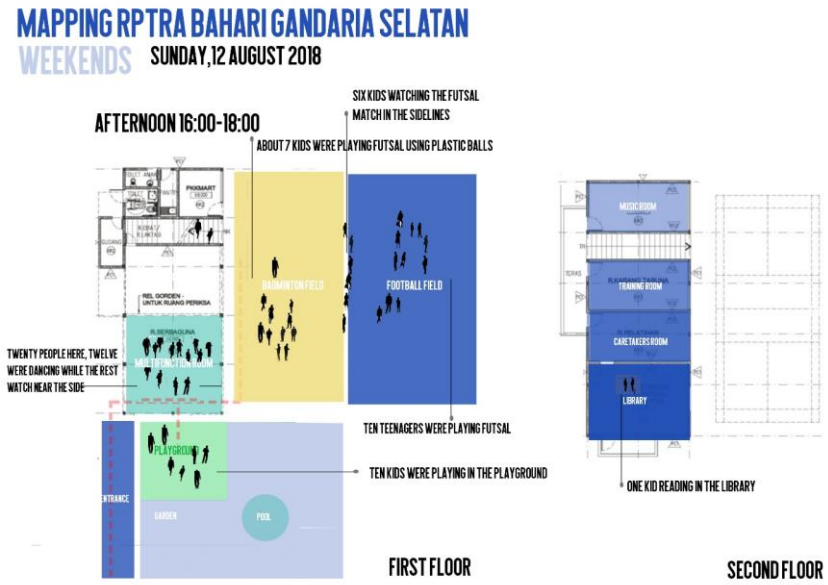


**Figure 7** Mapping RPTRA weekend afternoon (Author, 2018)

As the sun sets, the activities in RPTRA slowly disappear and children go home to study. Apart from observing the everyday uses of RPTRA, we also mapped the visitors to investigate who they are and how frequently they use the RPTRA. The results show that the children who visit the RPTRA are from a 500 m radius, while teenagers are a majority from a 3 km radius. Some of them use the RPTRA to playing mini soccer, taekwondo, and dance while others simply enjoy the public space. Interestingly, the adult visitors are mostly from a 500 m radius, mainly because they accompany their children. Other adults come from the surrounding neighbourhoods for activities such as aerobics or social gatherings. The place's sense of belonging is shown through the constant activities and people coming from the surrounding neighbourhood. Based on this observation, it can be concluded that people are enthused to use this child-friendly community centre for their daily activities (Elyda & Budiari, 2015).

## 4. Conclusion

Jakarta long has been suffering from heavy top down approach in terms of building public places (Kusno, 2000) (Dovey, 2010). Political representation in RPTRA Bahari is portrayed through the inclusion of public participation in the process of designing and building RPTRA. Even though public participation is limited, at the tokenism level, according to Arnstein ladder of participation, this model of making Jakarta public space is claimed to be the first innovation during the Ahok era. The new approach of making public space can be seen as new way of representing the power through urban form. While Ahok is notorius as iron-hand governor in using his authority to evict people from the illegal settlements, RPTRA shows his dichotomy approach toward the city. Allowing people's participation can be seen as a democratic way of making urban space.

Through the analysis of everyday uses, the political representation is unravelled. Even though it is not entirely open for public, the RPTRA Bahari allows citizens to have activities. The participative design approach implemented on the site shows that people are continuously using this space based on their preferences that were indicated during the early development stage. The design process allows input from the community and the facility's development involves public participation. Placing community as the subject made this place a successful urban project. Based on these findings, the participative design approach allowed dialogue between the authorities and the community and is a good model for designing public spaces. The way they use the space allows negotiation between users. Everyone has the same right to the city, even though those rights are limited to a certain period.

## References

Alsayyad, N. (1992). Forms of Dominance: On the Architecture and Urbanism of the Colonial Enterprise. Avebury: Aldershot.

Arendt, H. (1998). The Human Condition. London: The University of Chicago Press.

Arnstein, S. R. (1969). A Ladder of Citizen Participation. *Journal Of The American Planning Association*. 35(4): 216-224.

Carina, J., 2017. DKI Akui RPTRA Hasil CSR Lebih Flexible Dalam Perubahan Desain. Kompas, 28 July.

Carr, S., Francis, M., L.G, R., & Stone, A. (1992). Public Space. New York: Cambridge University Press.

Dede, O. M., 2012. A New Approach For Participative Urban Design: An Urban Design Study Of Cumhuriyet Urban Square in Yozgat Turkey. *Journal of Geography and Regional Planning* .5: 122-131.

Desrianto, M., 2018. Bangun 7 Taman Maju Bersama, Pemrov DKI Ingin Perkuat Interaksi Warga. megapolitan.kompas.com, 11 December.

Dovey, K., 2010. Becoming Places. New York: london.

Elyda, C., & Budiari, I. (2015, September 17). Jakartans Enthused with New RPTRA Community Centers. The Jakarta Post.

Gehl, J. (1987). Life Between Building (Using Public Space). London: Island Press.

Hernowo, E. &. N. A., 2017. Karakteristik Ruang Publik Terpadu Ramah Anak (RPTRA) Bahari di Kecamatan Cilandak Jakarta Selatan. *Jurnal Teknik*. 6(2): 2337-3520.

H. S. Aji, R. B. (2016). The Development Of Child-Friendly Integrated Public Space In Settlement Areas As An Infrastructure of Jakarta. In C. Brebbia, WIT Transaction on Ecology and the Environment (p. 13). USA: WIT Press.

Iveson, K. (2007). Publics and the City. Wiley: Kindle Edition.

Kahraman, M., Pak, B., & Scheerlinck, K. (March 2018). Production of Heterotopias as Public Spaces and Paradox of Political Representation: A Lefebvrian Approach. ITU AZ Journal, 135-145. http://www.azitujournal.com/jvi.aspx?pdir=itujfa&plng=eng&un=ITUJFA-58569

Kusno, A., 2000. Behind the Postcolonial: Architecture, Urban Space and Political Cultures in Indonesia. 1st edition ed. London: Routledge.

Laksana, B. A., 2017. M. Taufik Minta Pembangunan RPTRA yang Pakai Dana CSR diaudit. Detiknews.com, 29 Mei.

Lefebvre, H. (1996). Writing on Cities. Oxford: Blackwell Publisher.

Mamduh, N., 2018. Pemprov DKI akan Hapus Anggaran Pembangunan RPTRA di 2019. Tirto.id, 5 March.

Mitchell, D. (2003). The Right to the City: Social Justice and the Fight for Public Space. New York and London: Guilford Press.

Pak, B. (2017). Strategies and Tools in Bottom-up Practices in Architecture and Urban Design Studios. *Knowledge Cultures*. 12.

Permanasari, E., 2010. Constructing and Deconstructing the Nation: Sukarno's Monuments and Public Places in Jakarta. Germany: LAP Lambert Publishing.

Permanasari, E., in Dovey, K. (2010). New order: Monas and Merdeka Square. In: K. Dovey, ed. Becoming Places": Urbanism / Architecture / Identity / Power. London: Routledge.
Permanasari, E., Nurhidayah, F. & Nugraha, H., 2018. Metode Desain Partisipatif Sebagai Model Pembangunan 6 RPTRA DKI Jakarta. Jakarta: Universitas Pembangunan Jaya.

Sanders, Elizabeth B-N; SonicRim. (2002). From User-Centered to Partisipatory Design Approach. *In J. Frascara, Design and Social Sciences: Making Connections*. London And New York: taylor and Francis.

Tonnelat, S., 2010. The Sociology of urban Public Spaces. In: Territorial Evolution and Planning Solution: Experience from China and France. Paris: Atlantis Press. 1-10.
Vale, L., 1992. Architecture, Power and National Identity. London: Yale University Press.

Zeisel, J. (2006). Inquiry by Design. California: Cambridge University Press.

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# The Role of Environment As Third Teacher Towards The Development Of Educational Space For Dyslexic Children

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## ABSTRACT

Educational space that responds towards disable learning student needs is vital for a conducive learning environment. This paper explores on learning spaces for disable children namely the dyslexic in reference to the role of environment as the third teacher towards designing an appropriate educational space to fulfil their needs. Past literature on dyslexia in Malaysia much focuses on the pedagogy and teaching methods rather than discusses the issue of providing better learning space design that caters to the need of dyslexic children towards their psychological well-being. To conduct this study, the qualitative method involving case study as research strategy is used to establish the appropriate learning space design attributes for the dyslexic children. Data sources for this study are obtained from direct observation on three selected case studies of prominent learning disability school found in the global context. There are two key factors that contributed in the learning process and development of learning disability student namely the dyslexic children. These are the non-physical elements comprises of visual cues, auditory, tactile and kinaesthetic approaches as well as physical elements encompasses of density and size including spatial layout arrangement. Findings of the study are in the form of established referential guideline design to inform future designers, builders, education providers and related authority on how to build a conducive learning space environment for the dyslexic children. This is vital in improving the quality of public education infrastructure for dyslexic students in the Malaysian context towards their betterment in the future.

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## 1. Introduction

Educational space refers to learning environment setting, a place in which teaching and learning occurs (Goouch, 2008). This space therefore, not only limited to indoor physical parameters but also outdoor spaces as well. The existence of this educational space nevertheless, must also be supported with actual or virtual technology application to ensure students obtained better level of education with positive physical, emotional and spiritual enrichment (Brown & Long, 2006). Nonetheless, the existence of conducive educational space in most of Malaysian public schools is still lacking and undermined (Yacob, 2005). This issue however, is much crucial namely in schools that cater for special needs children varying, from 'mild' learning disability cases like dyslexia and ADHD to more severe disabilities like

autism, Down syndrome, mental retardation, physical retardation and many others (Nasir & Efendi, 2017). From observation and scholarly review (2010-2019), Malaysian schools still lacking in providing better education in terms of curriculum as well as building facilities involving conducive learning space to cater for the needs of these special children with learning disability (Ahmad, Shaari, Hashim, & Kariminia, 2015; Ali, Mustapha, & Jelas, 2006; Amar, 2008; Jelas & Mohd Ali, 2014; Muzaliha et al., 2012; Oga & Haron, 2012; Tan, 2015). According to survey, it is estimated that 1 in every 20 children may have learning disability condition due to hereditary, teratogenic issues, medical and environmental factors (Malaysia, 2014).From all type of learning disability mentioned above, dyslexic however, is viewed as the most crucial issue that need to be greatly addressed by all involved parties at the government level, education provider and parents' perspective (Malaysia, 2014). Since there is lack of awareness among society, numbers of dyslexic patient namely among children is stated to rise each year in Malaysia (Malaysia, 2014). Malaysian statistics indicated that from total estimation of 4.5 million children below the age of 18 years old in year 2017, almost 5% have learning incapacity due to reading disability known as dyslexia (Sinnadurai, 2018). Although there are no specific cure or permanent solution to curb dyslexia, guidance and care as well as extra attention like betterment of education facilities and conducive learning environment is important that may provide huge difference for dyslexic patient namely amongst children(Adnan & Hafiz, 2001)

In general, there are five main issues relating to learning disability focusing on dyslexia in the Malaysian context as follows. First, lack of building design approaches comprising of spatial layout and form making as well as facilities readiness to cater for dyslexic patient needs. In this sense, in terms of facilitating, there is no proper physical setting to accommodate those with dyslexia. In brief, there is no well-designed multi-sensory environment yet in Malaysia that can facilitate those with dyslexic (Subramaniam, Mallan, & Mat, 2013). Second, is from the aspect of financial resources constraint that resulted to ineffective human capital development and management to monitor dyslexic individuals (Ta, Wah, & Leng, 2011). Third, lacking in appropriate teaching materials to help and rehabilitate the dyslexic patient namely at the early age (Rahman, Mokhtar, Alias, & Saleh, 2012). Fourth, lack of structured program on early intervention or standardized instrument which includes all categories of impairment condition to identify those with dyslexic consisting of three phases which are at pupils level, teachers role and parents point of view (Osman, Yahaya, & Ahmad, 2015). Fifth, lack of comprehensive guidelines implementation and development for an equitable examination system and procedures for those with reading disabilities or dyslexic (Dzalani & Shamsuddin, 2014).

From all of the above, the most prominent issue that requires attentive attention is in the aspect of infrastructure establishment for the dyslexic children. In this sense, more buildings that function as educational provider must be made accessible and disabled-friendly, especially for children with reading and learning impairment to facilitate their learning processes.

Furthermore, to date, there are only few literature that discusses on the issue of providing better learning space design that caters to the need of dyslexic children in the Malaysian context towards their psychological well being. This is because current studies only focuses on five main areas (Ahmad et al., 2015; Ali et al., 2006; Amar, 2008; Jelas & Mohd Ali, 2014; Muzaliha et al., 2012; Oga & Haron, 2012; Tan, 2015). First, learner's characteristic on dyslexic children. Second relating to instructional approach and method to educate dyslexic children. Third, reviews on learning materials to assist dyslexic children. Fourth, emphasizing on ICT tools for special teaching needs. Fifth, focus on pedagogy or method on teachers' role and perspective to become trainers or caregivers for dyslexic patients. From the findings of literature review above, it can be concluded that special attention need to be emphasis on building design that may solve different obstacles faced by students with learning difficulties like dyslexia. This aspect is important because physical environment of the classroom may influence dyslexic children mind set as well as encourages optimal learning in cultivating constructive knowledge culture among them. This study therefore aims to investigate the condition and problems of existing schools in Malaysia whether or not better learning space for dyslexic children development are provided, focusing only at the primary level. The outcome of the study will be on proposing a design guideline framework on conducive learning space for dyslexic children. The scope of the study involves children at primary level from age 7-12 as they are at the early phase of learning development that are susceptible to behavioural change or adaptation. In this sense, the childhood phase is viewed by many scholars and psychologists as a vulnerable age that can be nurtured in terms of cognitive and psychomotor development (Rao et al., 2017). This is vital namely for ensuring positive growth and wellbeing of disable children to be well knowledgably equipped in terms of literacy, numeracy and skills development.

For the benefit of the study and to fulfil the objectives, section two is divided into three parts. Firstly, will define the type, characteristic and behavioural pattern of dyslexic patient. Second, reviewing on learning approaches and strategies for dyslexic children. The third part will elucidate on the issues, definition as well as characteristics of learning space of current special schools in Malaysia, followed by the importance of learning space design in shaping dyslexia children behaviour and psychology.

## 2. Literature Review

### *2.1 Definition And Types Of Dyslexia*

Dyslexia in general terms is defined as disorders that involve difficulty in learning to read or interpret words, letters, and other symbols, but that do not affect general intelligence(Lyon, Shaywitz, & Shaywitz, 2003).In other words, dyslexia is stated as a spectrum learning disability involving reading fluency, writing and phonological difficulties (Lyon et al., 2003).There are no specific cure for dyslexic patient but they can improve their development in literacy and numeracy skill with more intensive instruction and motivational learning surroundings equipped with appropriate facilities. Dyslexia is also referred to as a learning disability, which does not have physically visible signs that can be detected during infants (Lyon et al., 2003). Dyslexia symptoms only can be detected when a child begins his or her education years when it involves process of reading, writing and conducting numerical skills. If untreated, it may disrupt and lessened their academic achievement of vocabulary and numeracy abilities due to poor phonological memory of visual object recognition and speech vocabulary which later resulted to poor social skills and interactions, frustration as well as low self -esteem. In long term this will affect their life time opportunities.

Scholars identifies that there are three types of dyslexia which are visual dyslexia (early stage), auditory dyslexia (medium stage) and deep dyslexia (severe stage)(Frith, 2017). The early stage is defined as phases that applies only to reading task. They only make errors when reading aloud and speaking while not making errors in silent reading. At this early stage, they manage to identify letters and their relative position but still have errors of letter migrations between words. Secondly, is the medium stage. This medium stage in general involve reading and speaking. At this stage, patient commonly make regularization errors in reading aloud. In this sense they typically have problem with accuracy and in comprehension which resulted to slower reading. Finally, is

severe stage. At this phase, they could not understand the words they read although they can read aloud correctly. All three stages above nonetheless require attention from parents and teacher to help those with dyslexic to deal with their difficulties in a much proper approach. Although it is viewed that dyslexia much relates to individual achievement in terms of reading skills, many scholars also do agree that proper learning space and appropriate facilities supported by structured pedagogy may also influence dyslexic patient to develop, stimulate and improve their learning abilities (Frith, 2017). To understand this in depth, the next section will explain on learning strategies and approaches to improve the condition of dyslexic patient.

### *2.2 Learning Approaches For Dyslexic – Environment As Third Teacher*

Dyslexic patient in general may share the same profile and weaknesses in terms of learning disability but in specific they require a variety of approaches and learning strategies to overcome the learning issues. This not only focuses on the implementation of proper pedagogy but also in terms of providing sound environment and surrounding to help their process of learning (Démonet, Taylor, & Chaix, 2004). For instance, based on scholarly research, dyslexic patients whom are struggling with numeracy, usually have problems with directional confusion, sequencing problems, poor short-term a working memory, speed of working, cognitive style, anxiety, stress and self-image. Thus, they require the help of multisensory environment as pedagogical approaches to aid this type of dyslexia. This however, may be different with dyslexic patient whom has spelling difficulties because they have stronger visual senses and semantic ability. In other words, these category of individuals have higher learning abilities to understand new words by the visual strength combined with either kinesthetic and/or auditory channel. In this case, they require strong visual image such as big and colourful elements as well repeating patterns visibly shown within their learning sorroundings to help them remember and memorize. From this it is shown that physical learning setting may influenced the experience of an individual towards a form of exploration and collaborations. According to scholars, designing proper learning space and environment will attribute to almost 25% of a student's achievement over their progress in their whole academic year (Nasir & Efendi, 2017). This however, is much crucial namely for children with learning disability (Nasir & Efendi, 2017).

In this case, the environment becomes the third teacher to facilitate disable learning children to discover variety materials while actively exploring, investigating and solving problems as one way in accomplishing active learning through play experiences (Strong-Wilson & Ellis, 2007). As an example, by providing better environment for the children to thrive in indoor and outdoor learning space will trigger their senses to imagine, think, investigate, create and solving problem based on their experience. This in return will help them be more calm, have high esteem and engaged with society. From conducted literature studies it is found that there are two basic aspects of architectural aspects that needed consideration in establishing a better environment as third teacher to accommodate learning disable children with special needs in their learning process (Strong-Wilson & Ellis, 2007). This involves the physical- setting, scale and proportion, materials and finishes adaptation and the non- physical aspects which are environmental considerations as follows (refer Table 1).

**Table 1** Important aspects in designing learning spaces for learning disable children obtained from literature review (Strong-Wilson & Ellis, 2007)

| **Physical aspects** | **Features** | **Approaches** |
|---|---|---|
| Setting | Comfortable classroom setting and furniture layout | Combinations of group and individual setting for flexibility and privacy. |
| Scale and Proportion | Appropriate class size and density | Appropriate size to ease movements, comfort and wayfinding will creates independency for the children in their learning spaces. |
| Materials and finishes adaptation | Suitable Multisensory aspects – visual, touch, smell, auditory | Displaying tactile decorated walls, bright warm or cool colors soft stimuli with appropriate materials and finishes implementation will spark the children's interests towards learning and enhance the sense of arrival. Transparency throughout the space using mirrors, windows, internal glass wall, glass objects, transparent film, large plastic sheets will promote creativity and exploration. |
| **Non Physical aspects** | **Features** | **Approaches** |
| Environmental Integration | Accommodating users' health and wellbeing - Natural daylighting and shading, air quality control, comfort room temperature and suitable acoustic level | Indoor and outdoor relation, learning spaces near to the courtyard will have clear visibility, usage of appropriate materials, natural lighting at core area with different height of space openings create conducive learning ambience |

In sum, the above had briefly outlined that thoughtful learning experience for disable children is linked with the stimulating learning environment that affects physical, emotional and cognitive readiness of the individual on a new learning task. This is vital to prepare the disable learning children for a much promising adulthood. However, the current special schools namely in the Malaysia context still lacking and undermined in providing better learning environment specifically for the learning disable children. Therefore, the design of current learning setting in Malaysia should be shifted from traditional type for a more holistic approach emphasizes on the physical environment as third teacher to help child's development

especially for children with dyslexia. During live case observation and conducted interviews, there is no specific school built by private or the public government to cater for learning disable children. From Ministry of Education statistics it is estimated that a total of 314,000 students diagnosed to have dyslexia in Malaysia (Nasir & Efendi, 2017). Many of these students are placed in remedial classes with other learning difficulties students since there are limited number of rehabilitation services for children with dyslexia in the country (Nasir & Efendi, 2017). In other words, as a common practice, this learning disable children will enter the public government schools and placed in kelas khas or remedial class but separated from normal children or they enrolled in privately funded individual learning centres operated in rented shop houses or office buildings. Due to this matter it resulted to many disadvantages for the learning disable children to obtain better facilities and sound environment for them to improve their condition. To elaborate on this matter, next section will highlight the existing condition of learning spaces and form making in current Malaysia's schools for learning disable children that needed consideration and change in the future.

### *2.3 Problem of Learning Spaces and form making in Malaysian Schools*

In general, there are three aspects that may influence learning process. First is the student-teacher relationship, second is in terms of management aspect and thirdly, is the classroom condition or learning environment. Nonetheless, learning spaces are the most important space that forms the backbone of school design planning. This is because learning is defined as an identification process that can give an understanding of knowledge and experience whether formally or informally. Studies shown that in Malaysian school, students from the age of 7 to 12 years old will spent an average of 25 hours per week in learning environment like school. This learning environment is defined as classroom where the learning process takes place involving physical and non physical elements in order to produce a balance context in terms of psychological and pedagogical aspects which give impacts on the student's behavior and achievements. In reference to this, the physical and non physical aspects are vital to ensure conducive learning environment. However, the existing layout of the typical classroom in most of Malaysian public schools are not suitable to cater the needs of these learning disable children. In detail, there are two main issues that can be identified on how current Malaysian schools are designed (Ismail & Abdullah, 2018).

a) Deficiency from non-physical aspects comprising of air quality control, room temperature, lighting and acoustic level.(Ismail & Abdullah, 2018)

Most of Malaysian classrooms are designed in a typical rectangular style and even with a side opening on both opposing sides of the wall, there is hardly enough air circulation to cool the entire internal section of the classroom especially the central portion. The air circulation conditions in a classroom becomes more critical whenever it rains, as the windows are closed to avoid rain splashes from getting into the classroom. This will result in a closed, noisy, crowded learning space that increase sound decibel in the classroom, combined with the students' and instructors' body heat, leading to a raucous classroom conditions that are also humid and hot. Even though a ceiling fan is available, the air circulation is poor, and indirectly increases the temperature inside the learning space to an uncomfortable level and unconducive for learning. Poor natural lighting also presents in the current classroom design. This is crucial if the classroom block is hidden or blocked by another block that has to utilized artificial lighting. Studies indicate that, students within classroom conditions which are equipped with artificial lighting at a duration exceeding 4 hours and above will easily experience emotional stress, depression as well as the lack of visual stimulation and concentration. Hence, if the classroom view is dark and enclosed student will not be exposed with a significant quantity of natural lighting, therefore they will feel anxiety, disinterest, and hard to focus on the learning task at hand as compared to students situated in a relatively natural lit bright classroom, with extensive light illuminated by natural lighting.

b) Large capacity, size and dense classroom in terms of physical aspect(Ismail & Abdullah, 2018)
Classroom size and density also influences the behaviour of students. Currently many schools are quite dense and possesses limited space due to the increase in student enrolment every year caused by the rising economy and drastic social development. Hence, the capacity of each study classroom has to support a large amount of students and this causes each space in the classroom to be filled with tables and chairs for the students' use. The result is that there is no space left that can be used for various other activities whether it is for individual or group work as a result of the static and rigid furniture arrangement which is more akin to a traditional/standard classroom characteristic with a row-by-column seating. Other than that, the large number of students in a packed classroom can also affect the students' psychology in that they will exhibit a laziness to mix around, be individualistic, and affect the desire to have an associative attitude, and this will reduce the degree of motivation and creativeness of the students. Furthermore, students will be in a noisy and agitated environment due to the issue of overcrowding.

From the highlighted issues above clearly indicates that from the perspective of encouragement, to date, there is no special design that promotes the development of dyslexia children cognitive and psychomotor development in a comprehensive manner to allow them to stimulate and interact with the existing environment. Since there is no proper design of dyslexic school in Malaysia, the next section will explain on the study methodology and analysis technique using comparative analysis from selected case study at global context to derive the appropriate indicators to produce guidelines in designing better dyslexic school in the Malaysian context in the future.

## 3. Methodology

This study utilises case studies as the research strategy under the framework of qualitative methods and approaches. For data

collection method, direct observation is used to observed the selected case studies. This is important to answer the study objectives to develop design strategies or guidelines that is suited for the development of conducive learning space for dyslexic children in which focusing on the environment as third teacher concept. The obtained data from observation then is built upon the theories and concepts outlined by Saussure on sign relations, Barthes on levels of signification and Gottdiener on reading the built environment as reliable ways for analysing and understanding the design of classrooms in selected dyslexic schools at the global context. To analyse data from the case study, triangulation technique is used and the data are comparatively analysed and tabulated in table format. All collected data then are finalised to propose the best possible design guideline and strategies for learning space to accommodate the needs of dyslexic children. This is important to achieve the objective of the study. Justification selection on the case study are based upon two main criteria. The first criteria are based on the school category which caters for specific learning disabilities type in terms of curriculum and pedagogy implementation. The second criteria are according to the school approach that portray much emphasis on the implementation of learning environment as third teacher to aid learning disable children namely on the dyslexic patient.This involve the physical and non- physical elements that include multi sensory element involving visual, auditory, kinesthetic and tactile aspects. The finding of the case study will be discussed in Section 4.0. The conducted research framework as in Figure 1.

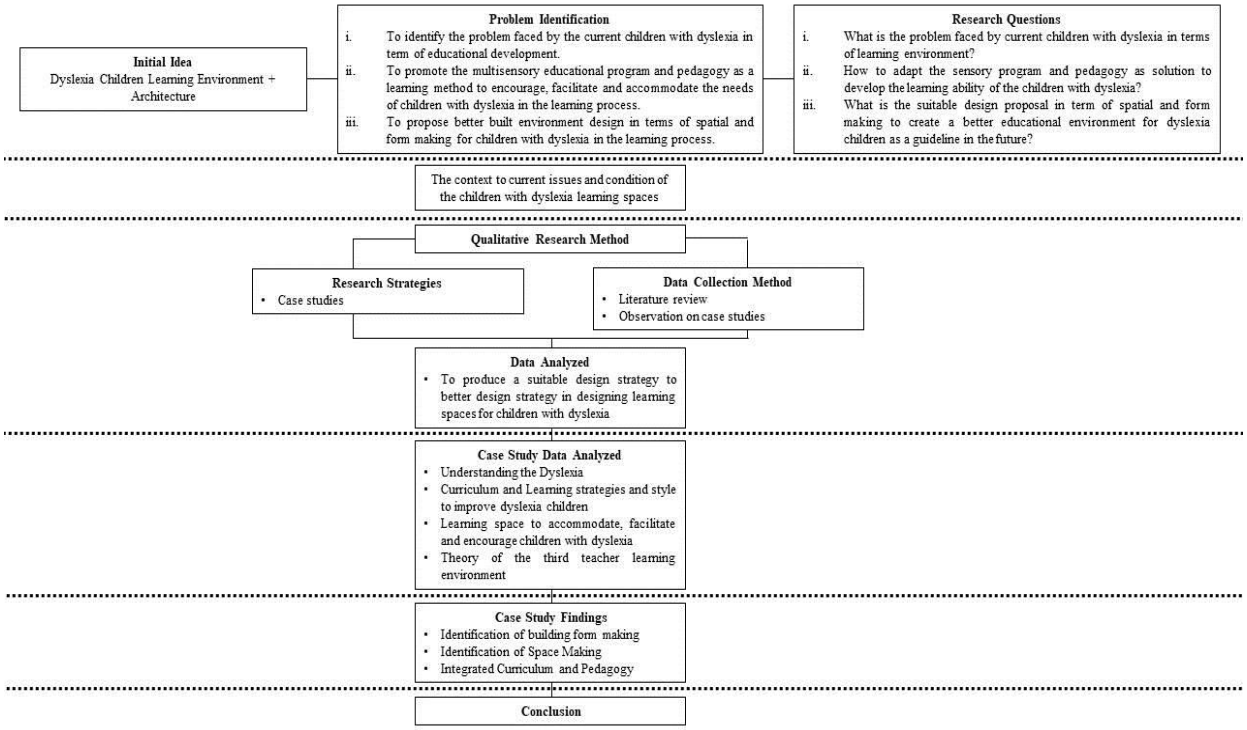



**Figure 1** Research framework to conduct the study

## 4. Findings

This section discusses on the findings gathered from observation and literature review on the three selected case study of prominent learning disable school found in global context which are CS1) Pond Meadow School, Guilford CS2) Daaf Geluk School, Netherlands CS3) Stephen Gaynor School, Amsterdam. These three schools are chosen as case study based on the justification of the effectiveness of their applied curriculum and pedagogy as well as the school successfulness in term of addressing the needs of the learning disable children through its unique architectural design in terms of form and space making. The observation on the school learning environment therefore is conducted referring to two main indicators; physical and non physical elements.A1) Non physical elements comprise of A1i) visual A1ii) auditory A1iii) tactile and A1iv)kinaesthetic approaches. A2) Physical elements encompasses of A2i) density and size A2ii) spatial layout. In overall, all three case study did show similarities in their design approach which adopt environment as the third teacher strategy in determining their design scheme. Although these three case studies did not specifically focus on dyslexia students per say but addressing the learning disable children in general. Hence, it can be summarized that learning spaces are important. Therefore, the two aspects of physical and non -physical elements need to be taken into consideration when designing learning space relating to the role of environment as third teacher to promote better social interaction and learning functions. To understand this

matter in depth, the next section will elaborate further how both of the physical and non physical elements can be adopted and implement in reference to propose design at complex, block and units level in terms of form and space making. (refer Table 2).

**Table 2** Findings from case study at global context to derive related indicators in determining design strategies

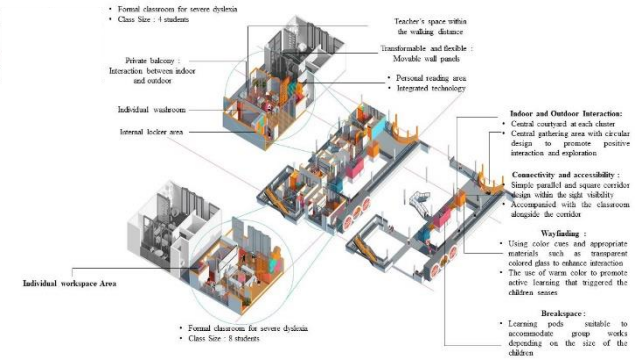
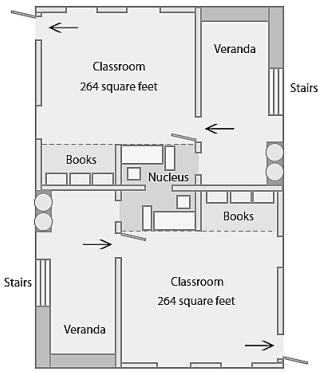
| **Case study** | **A1) Non Physical elements (learning space)** | | | | **A2) Physical elements (learning space)** | |
|---|---|---|---|---|---|---|
| | **A1i) Visual cues in learning space** | **A1ii) auditory** | **A1 iii) tactile** | **A1 iv) kinaesthetic** | **A2i) density and size** | **A2ii)spatial layout** |
| **CS1- Pond Meadow School**<br><br>**CS2-Daaf Geluk School**<br><br>**CS3-Stephen Graynor School** | Provide natural daylight for bright visual effect throughout the day<br><br>Use different lighting strategies as colour pattern for shadow play | Appropriate acoustics for low sound transmission in class (LSTC)<br><br>Adopt appropriate floor–ceiling systems, and carpet on lower and upper floors, to improve the impact insulation class (IIC) rating between levels. | Sensorial experience awareness of hand touch and visual problem solving activities<br><br>Sensorial experience and exploration of learning through touch of equipment and texture on wall and floors. | Flexible and non fix learning space.<br><br>Individually decorated with movable partition wall to create individual and group space<br><br>Openness in learning space to promote interaction between indoor and outdoor environment | Smaller class size<br>Less than 15 students per class<br><br>Class must have suitable proportion height and floor plan size for comfort, easy monitoring and movement | Centralized planning concept<br><br>Open courtyard and shared facilities as focal point<br><br>Low rise storey for easy access to individual space<br><br>Nodes and gathering area are connected to each other for easy wayfinding<br><br>Provide wide corridors and easy access for all pupils |

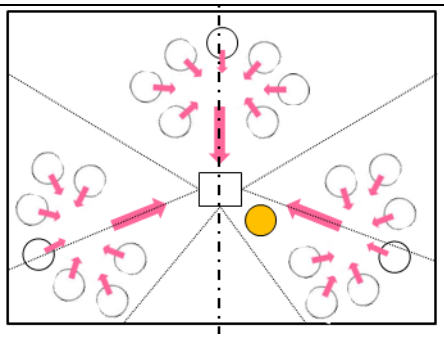
## 5. Discussion – Design Strategies And Approaches

In designing learning spaces for children with dyslexia, it is important to shift away from traditional norm to a more holistic approach that emphasis on the physical and non physical element that shaped the environment for the disable learning children development at the complex, block and unit level. (refer Table 3).

In brief, the implementation of appropriate building components in terms of form and space making is important in designing a learning space for children with learning disability, with consideration to the environment as third teacher to meet the needs of different types of dyslexia for their education betterment. To sum, the guideline in designing an institution for dyslexia children is as in Table 4.

**Table 3** Proposed Design Strategies For Dyslexic Children Learning Spaces At Complex, Block And Unit Level

| **Institutional design for dyslexia children**<br>**Physical element** | **Complex level** | **Block level** | **Unit level** |
|---|---|---|---|
| **Spatial layout, density and size**<br>  <br>Figure 5.1.a: Centralized planning with open courtyard in the middle (5) connected by nodes and landmarks (1,2,3,4 and 5) in the overall complex planning to promote accessibility that enhance wayfinding abilities of the children (source : Author)<br>  <br>Figure 5.1.b: Design of different classroom units according to indoor and outdoor interaction, connectivity and accessibility, wayfinding and break space (source : Author)<br>  <br>Figure 5.1.c: Design of learning space units with nucleus for teacher's space for easy monitoring (Unicef, 2009) | Should adopt centralized design planning act as a focal point surrounded with classrooms or special areas minimizing travel distance between the learning space with provided facilities (refer Figure 5.1.a) | Should have clear and transparent connectivity between indoor and outdoor nodes that are well linked to the size and shape of the educational blocks. This will optimize the access to all spaces (refer Figure 5.1.a) | Should have appropriate class size. Eg max 8 students in one class for the mild dyslexia, while max 4 students in one class for severe dyslexia.<br><br>Should locate classrooms alongside the corridor of the educational building to ease sight visibility of the students. (refer Figure 5.1.b)<br><br>Should provide the essentials facilities like own washroom area, nucleus for the homeroom teacher to be in the class to monitor the children and personal storage in each classroom. (refer Figure 5.1.c)<br><br>Should provide furniture setting and layout that are in open arrangement such as clusters and u-shaped to enhance social interactions and contact among children. (refer Figure 5.1.d) |

| | | | |
|---|---|---|---|
|  <br>Figure 5.1.d: Furniture setting in class according to multiple projection with students in clusters for flexible learning style (Smith, 2017) | | | |
| **Non Physical element** | **Complex level** | **Block level** | **Unit level** |
| **Visual cues in learning space, auditory, tactile, kinaesthetic.**<br>  <br>Figure 5.1.e: Visual cues in form of contrasting wall design used for wayfinding (SEGD, 2019)<br>  <br>Figure 5.1.f Visual cues in form of contrasting elements like staircase for functional purposes (Studio, 2019)<br>  <br>Figure 5.1.g Visual cues in form of lighting strategies to provide visual clarity (DSDHA, 2019) | Should have visible and easily recognize visual cues to identify areas and assisting with wayfinding like contrast between objects and their background (refer figure 5.1.e) | Should minimize the use of pattern and colour unless it serves a function rather than an aesthetic purpose.<br><br>Should have Contrast between vertical and horizontal elements, especially on stairs and walkway (refer figure 5.1.f) | Should have visual cues such as photographs, drawings, graphics or computer generated icons in learning spaces as signage to grasp children attention, reduce anxiety in academic learning situations as well help to express their thoughts.<br><br>Should have play of light to crate visual cues. using natural and electric lighting to illuminate objects in a space while minimizing negative effects such as glare and low contrast. The use of luminance, color and value contrast to improve visual clarity of the environment is especially helpful to persons with learning disability (refer figure 5.1.g) |

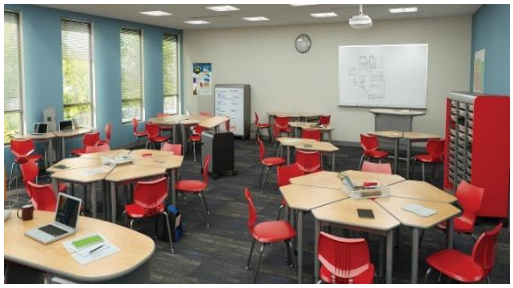
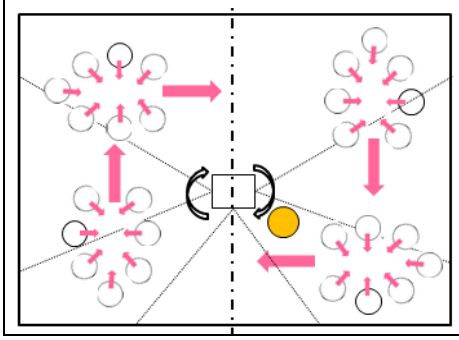
<table>
<tr>
<td>Auditory<br><br>  <br>Figure 5.1.h Auditory solution in terms of using sound absorbing wall material as well act as visual cues (Brite, 2011)<br><br>  <br>Figure 5.1.i Auditory solution in terms of using sound absorbing flooring material(smithsystem, 2019)</td>
<td>Should create buffer zone by making playground, outdoor recreation area and playing field as buffer to separate the main learning building from noisy zone like access roads and parking areas,</td>
<td>Should provide acoustical tiling and flooring (sound field system) along all corridorway to learning spaces and other facilities to avoid loud noise</td>
<td>Should use acoustic absorption materials in walls and ceiling for minimization of noise to reduce sound pollution for learning concentration (refer figure 5.1.h)<br><br>Carpet material and laminated flooring to absorb the echo sounds in the learning space(refer figure 5.1.i)</td>
</tr>
<tr>
<td>Tactile (materials and texture)<br><br>  <br>Figure 5.1.j: Usage of different tactile creates visual cues and creativity (Archdaily, 2008)</td>
<td colspan="3">Should use proper material to represent opaque, solid. transparent or hollow outlook to enhance connectivity and provide active social interaction. Example hollow and solid walls at the learning pods provides the sense of curiosity, creativity and connectivity to the surrounding. (refer Figure 5.1.j)</td>
</tr>
<tr>
<td>Kinasthetic (variations and movement)<br>Figure 5.1.k: Flexible partition walls that can divide the learning space in multiple layouts (Smith, 2017)<br>  </td>
<td colspan="3">Should have flexibility and transformability is where the classroom has installed a movable wall in order for the children to separate the activities according to space and time. (refer Figure 5.1.k)</td>
</tr>
</table>

**Table 4** Design guideline for dyslexic children learning spaces encompassing physical and non physical elements

| Design Elements of Learning Space (physical and non physical elements) | Description | Explanation |
|---|---|---|
| Color | Decorated walls, bright warm or cool colors | • Displaying soft stimuli<br>• Spark the children's interests towards learning<br>• Enhance the sense of arrival |
| Indoor outdoor relationship | Interior courtyard and sensory garden as flexible spaces | • Learning spaces are located near to the courtyard<br>• Act as buffer zone to separate different function when is necessary |
| Lighting | Natural daylighting, natural shaded, wide window and door sizes | • Clear visual from the interior and exterior of the learning spaces using appropriate materials<br>• Punching light to the core of poorly lit spaces and ensure that there will always have lights at the end of the corridor |
| Spatial Layout | Central courtyard | Surrounded by classroom and served as an internal link to shared spaces |
| | Informal auditorium, gathering area | Broad wooden staircase function as the school center and a seating stage act as informal auditorium for the students to gather around. |
| | Location of the public and private space zoning | • Located at the end of the building to ensure that it was provided with its own entrance makes it easier for the students to access after the school hour. |
| Cluster planning | Separate by using two zones one belong to the upper class and lower class connected by the building shared facilities. | Separate by shared facilities which located at the center |
| | Basic square and parallel routing system | • Runs in parallel routing system and sight visibility.<br>• Straight and square shapes help the viewer to connect from the corridor to the existing space. |
| Class Size | Small number of students in one class:<br>a) 8 students for mild dyslexia<br>b) 4 students for severe dyslexia | Small distance between speaker and listener to avoid obstruction along the direct sound path |
| Safety and Surveillance | Teacher spaces | Located inside the classroom and any provided learning spaces to ensure that teacher is always monitoring the children and in walkable distance ease to reach whenever in need |
| Acoustical | Acoustical tiling (sound field system) | • Carpet material, flooring to absorb the echo sounds in the classroom<br>• Acoustical flooring installation along the corridor<br>• Laminated flooring in the art, dance, drama and music studio gives impact to sound insulations. |
| Vertical Zoning | According to the curriculum and school program | • The noisiest area was located at the ground floor as it was really close to pedestrian street<br>• Administration and management located below the academic floor that as a security value in the circulation building. |

| | | |
|---|---|---|
| Materials | Use a proper material to enhance connectivity and provide active social interaction | • Transparence colored glass at the learning pods provides the sense of curiosity, creativity and connectivity to the surrounding visually |
| Texture | Ceramic tile walls | Arranged in an asymmetrical fashion to create texture |
| Space Flexibility | Furniture layout | According to the different function of the classroom and can rearrange depends of the suitability of the curriculum and time. |
| | Programs and curriculum | Combinations of formal lectures, group work and individual work, flexibility and privacy |
| | Learning Breakspace | • Multiple sizes of the learning pods is placed alongside the corridor which is 1.5 to 2meters width.<br>• The learning pods are used for the individual or group works according with the group size and comfort and privacy level of the students. |

## 6. Conclusion

From the above, it is shown that in designing schools for learning disable children namely the dyslexic, there are two main aspects that contributed to the level of wellbeing of the students. These are the physical elements like density, size and spatial layout. Second, is the non -physical aspect of learning space comprises of visual cues, auditory, tactile and texture as well as kinaesthetic approaches. These aspects are crucial as it could lead to conducive learning and teaching environment. The government and involved authorities should work together with education providers in providing a better learning environment to elevate the education quality for this learning disable students namely the dyslexic children as well as to improve their physical and educational development. This is vital in discovering their full potential to enhance their hidden abilities for better living in the future.

## Reference

Adnan, A. H., & Hafiz, I. A. (2001). A Disabling Education: The Case Of Disabled Learners in Malaysia. *Disability & Society*. 16(5): 655-669.

Ahmad, S. S., Shaari, M. F., Hashim, R., & Kariminia, S. (2015). Conducive Attributes Of Physical Learning Environment At Preschool Level For Slow Learners. *Procedia-Social and Behavioral Sciences*. 201: 110-120.

Ali, M. M., Mustapha, R., & Jelas, Z. M. (2006). An Empirical Study on Teachers' Perceptions towards Inclusive Education in Malaysia. *International Journal Of Special Education*. 21(3): 36-44.

Amar, H. (2008). Meeting the Needs Of Children With Disability In Malaysia. *Med J Malaysia*. 63(1); 1.

Archdaily. (2008). Classroom Design. Retrieved from http://www.archdaily.com/6267/kindergartens-70%C2%BAn-arkitektur/ Date access: 20 January 2019

Brite, J. (2011). Seeyond Architectural Solutions. Retrieved from https://www.architectmagazine.com/technology/products/seeyond-architectural-solutions / Date access: 19 January 2019

Brown, M., & Long, P. (2006). Trends In Learning Space Design. *Learning Spaces*. 9: 1-9.11.

Démonet, J.-F., Taylor, M. J., & Chaix, Y. (2004). Developmental Dyslexia. *The Lancet*. 363(9419): 1451-1460.

DSDHA. (2019). Education. Education. 1st. Retrieved from http://www.dsdha.co.uk/projects / Date access: 17 January 2019

Dzalani, H., & Shamsuddin, K. (2014). A Review of Definitions and Identifications of Specific Learning Disabilities in Malaysia and Challenges in Provision of Services. *Pertanika Journal of Social Sciences & Humanities*. 22(1): 1-18

Frith, U. (2017). Beneath the Surface Of Developmental Dyslexia. In *Surface dyslexia*. 301-330: Routledge.

Goouch, K. (2008). Understanding Playful Pedagogies, Play Narratives And Play Spaces. *Early Years*. 28(1): 93-102.

Heschong, L., Wright, R. L., & Okura, S. (2002). Daylighting Impacts On Human Performance In School. *Journal of the Illuminating Engineering Society*. 31(2): 101-114.

Ismail, A. S., & Abdullah, S. (2018). Learning Space in Public Secondary Schools for Students Psychological Development and Well Being. *International Journal of Engineering & Technology*. 7(3.25): 365-374.

Jelas, Z. M., & Mohd Ali, M. (2014). Inclusive Education In Malaysia: Policy And Practice. *International Journal of Inclusive Education*. 18(10): 991-1003.

Lyon, G. R., Shaywitz, S. E., & Shaywitz, B. A. (2003). A Definition Of Dyslexia. Annals Of Dyslexia. 53(1): 1-14.

Malaysia, U. (2014). Children with Disabilities In Malaysia: Mapping The Policies, Programmes, Interventions And Stakeholders. Kuala Lumpur: UNICEF Malaysia.

Muzaliha, M.-N., Nurhamiza, B., Hussein, A., Norabibas, A.-R., Mohd-Hisham-Basrun, J., Sarimah, A., Shatriah, I. (2012). Visual Acuity And Visual Skills In Malaysian Children With Learning Disabilities. Clinical Ophthalmology (Auckland, NZ). 6: 1527.

Nasir, M. N. A., & Efendi, A. N. A. E. (2017). Special education For Children With Disabilities In Malaysia: Progress And Obstacles Muhamad Nadhir Abdul Nasir. *Geografia-Malaysian Journal of Society and Space*. 12(10): 78-87

Oga, C., & Haron, F. (2012). Life Experiences Of Individuals Living With Dyslexia In Malaysia: A Phenomenological Study. *Procedia-Social and Behavioral Sciences*. 46: 1129-1133.

Osman, A., Yahaya, W. A. J. W., & Ahmad, A. C. (2015). Educational Multimedia App For Dyslexia Literacy Intervention: A Preliminary Evaluation. *Procedia-Social and Behavioral Sciences*. 176: 405-411.

Rahman, F. A., Mokhtar, F., Alias, N. A., & Saleh, R. (2012). Multimedia Elements As Instructions For Dyslexic Children. *International Journal of Education and Information Technologies*. 6(2): 193-200.

Rao, S., Raj, A., Ramanathan, V., Sharma, A., Dhar, M., Thatkar, P. V., & Pal, R. (2017). Prevalence Of Dyslexia Among School Children In Mysore. *International Journal of Medical Science and Public Health*. 6(1): 159-164.

SEGD. (2019). A Multidisciplinary Community Creating Experiences That Connect People To Place. What is Wayfinding? 1st. Retrieved from https://segd.org/what-wayfinding/ Date access: 18 January 2019

Sinnadurai, S. L. (2018). Phonological Awareness in Young Bilingual Dyslexics in Malaysia. NTNU,

Smith, C. (2017). The Influence of Hierarchy and Layout Geometry in the Design of Learning Spaces. *Journal of Learning Spaces*. 6(3): 59-67.

Smithsystem. (2019). Designing the Classroom around the Curiculum. Retrieved from https://smithsystem.com/school-setting/classrooms/ Strong-Wilson, T., & Ellis, J. (2007). Children And Place: Reggio Emilia's Environment As Third Teacher. *Theory Into Practice*. 46(1): 40-47.

Studio, T. (2019). The Perception Of Color In Architecture. Architecture. 1st. Retrieved from https://medium.com/studiotmd/the-perception-of-color-in-architecture-cf360676776c/ Date access: 17 January 2019

Subramaniam, V., Mallan, V. K., & Mat, N. H. C. (2013). Multi-Senses Explication Activities Module For Dyslexic Children In Malaysia. *Asian Social Science*. 9(7): 241.

Ta, T. L., Wah, L. L., & Leng, K. S. (2011). Employability of People With Disabilities In The Northern States Of Peninsular Malaysia: Employers' Perspective. Disability, CBR & Inclusive Development. 22(2): 79-94.

Tan, S. H. (2015). Development and Psychometric Properties Of A Scale Assessing The Needs Of Caregivers Of Children With Disabilities. Disability And Health Journal. 8(3): 414-423.

Unicef. (2009). Manual: Child Friendly Schools. New York: UNICEF.

Yacob, S. (2005). Maintenance Management System Through Strategic Planning For Public School In Malaysia. Universiti Teknologi Malaysia,

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# BIM Backed Decision Support System in the Management of Heritage Building

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## ABSTRACT

Historical buildings are always at risk to great danger strike by fire, flood and other potential disasters affecting the building conditions. Thus positive and continuous actions need to be taken to preserve the heritage buildings or else a country might lose its cultural heritage value. In managing historic buildings, managers are often faced with complex decision-making process due to limited or unavailability of reliable information. The absence of such information influenced the way decision making and problem-solving made by the managers. This paper aims to highlight the potentials of Building Information Modelling (BIM) as a decision support system for cultural heritage management. An embedded case study was conducted on Istana Balai Besar Kota Bharu, focusing on the changes of the historical building's layout to demonstrate the ontology. A measured drawing dated back in 1976 was used together with the terrestrial laser scanning activity performed presently on the physical building in creating a model in BIM environment. The result gives an overview about tracking information on changes within a historical building as part of cultural heritage management. This paper finds that by modelling the data captured by the 3D laser scanner and utilizing the existing data, BIM is capable of helping managers to retrieve, analyze and store important information in a more efficient and productive process. This exploration is substantial as a precursor to a much broader study on BIM for cultural heritage in the Malaysian context. As BIM is set to drive the construction industry, the finding made would be a catalyst for creating awareness to support the development of BIM for cultural heritage management in Malaysia.

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## 1. Introduction

Technological advancement has enabled benefits in the area of decision support system for cultural heritage. Managers will be able to have faster and efficient process when it comes to making crucial decisions in managing problems. BIM approach, which emphasizes on the digitization of information, is believed to have many unexplored potentials in the area of heritage building

management. Allen, Cruz and Warburton (2017) believed that highly capable Decision Support System (DSS) which is now mostly computer, internet and cloud-based is underutilized. In Malaysia, the level of maturity of DSS such as BIM is considered low and slow (CIDB Report, 2016 and Zahrizan et al. 2013). Thus, investigating the potential of BIM is a continuous effort in Malaysian construction industry as an initiative to improvise the industry's practice. Although there have been a few number of publications on BIM for heritage buildings worldwide, not many have touched on the Malaysian heritage context. Therefore, this paper which employs exploratory embedded case study methodology aims to highlight the potentials of BIM as decision support system for cultural heritage management by providing an overview on how to utilize BIM in tracking the changes of a historical building's layout.

### *Decision Support System*

In any process, information plays a major role. Information value depends on how it is applied and used. Tripathi (2011) suggested that an organization's success depends heavily on the organization's Decision Support System (DSS) adoption. The information generated from DSS will affect the decision-making process and the quality of decisions.There are many definitions for DSSs and their functions in decision-making process, such as data modeling, remote access to databases, data conversion, data verification and validation, textual data translation into a multilingual system, standardization of data formats and access methods, and integration of database management systems as further suggested by Tripathi (2011). The potential of each functions can be utilized for many purposes.

DSS can be defined as an application that processes and analyzes data and presents it so that users can make decisions more conveniently. According to Tripathi (2011), among the characteristics of a good DSS is that it can perform 'what if' and goal-seeking analysis.

Since construction industry is a data-dependent industry, therefore data must be managed efficiently with the right tool to ensure a project's success (Ismail, Bandi and Maaz, 2018).

BIM presently revolutionizing the construction industry and becoming the standard in several countries around the world because of its various advantages (Seghier et al.,2017). Due to the awareness and readiness for Industrial Revolution 4.0, there is an increasing need in adoption of innovative technological processes and development in Malaysia. Although the construction industry in Malaysia plays a crucial role in stimulating the economy, it lags behind other economic sectors. This is probably because of its unique features such as fragmentation and slow adoption of technology (Bean, Mustapa, and Mustapa, 2018). There have been many studies from many previous researchers highlighting the importance of using technological approach in day - to - day business activities, thus implying the importance to consider a DSS technology to ensure better productivity and efficiency for our construction and specifically, for heritage sector. The emergence of more advanced technologies nowadays have necessitate a much stronger emphasis on job competencies than ever before (Oladotun and Edosa, 2017).

### *BIM as a Decision Support System (DSS) in Cultural Heritage Management*

Traditionally, historical buildings have subscribed to the belief that it reflects the identity of a nation and culture. Its existence is a proof for future generations of origins, civilization, and level of technology of the ancestors (Sodangi et al., 2014). The buildings such as the Taj Mahal and Hawa Mahal in India, the Colosseum in Italy, The Parthenon in Greece, Sultanahmet Mosque and Hagia Sofia in Turkey, St Basil's Cathedral in Russia, and The Forbidden Palace in China have proven to convey this message successfully. Throughout the buildings' lifespan, conservation by repairing the physical of the buildings was rampant (Rashid & Ahmad, 2011). However, the rampant changes are giving serious effect on the historic buildings' documentation process. There is an increasing concern that some of the buildings are being disadvantaged by the unavailability of documents, which may also be exposed to risks such as inadequate and outdated information (Blinn & Issa, 2017). Historical information and documents are important because it is the primary means (Arayici, 2013) to eventually guide a decision making process by property owners, site managers, public officials and conservators. In this regard, it is important for owners, managers and custodians, to know how to systematically and effectively evaluate, plan and implement the management program for their historical buildings. A well - preserved historical building improves the quality of life for all in the community, helps attract investment to the community (tourism product), contributes to regeneration and provides a source of local pride and sense of place.

Previous studies have reported that the practice of cultural heritage management should maintain as much as possible the original building structure and fabric. Base to this principle and aims to maintain the national heritage in "true nature", major challenges and issues, especially in judgment and decision-making, there is imperative need for decision-making activities to be carefully well-thought-out (Harun, 2011). Thus, the unavailability of historical data will pose more issues and causing more problems which may lead to project failure.

According to Allen, Cruz and Warburton (2017), "in recent times, DSS has been redefined as broader initiatives of knowledge transfer that comprise: i) a development process with active stakeholder involvement; and ii) an interactive (often internet/computer based) tool that is easy to use, has minimal data requirements, can be readily updated, and provides information access, model analysis and decision guidance. Decision support system aims to provide multiple benefits including improved communication, collaboration and learning amongst stakeholders and with the development team ".

The BIM technology can be considered as a powerful DSS that acts as a database tool which comprises of information-enriched 3D model. It is a technology that has improved the way buildings are analysed and managed (Calin et al., 2015; Baik et al., 2014). Similarly, to automotive and robotic industries which develop

digital prototypes of vehicles and robots, Architectural, Engineering and Construction (AEC) industry are now able to provide an informative digital representation of a building before the first shovels hit the ground by using BIM. One of the most important feature of BIM is it can store information about the process involving the assembly of building components and spaces into a virtual representation of the building or facility (Lopez et al., 2018; Arayici, 2013) in the form of geometry (tangible data) and associated information (intangible data). In short, BIM can be used to document and store information efficiently and effectively, including data about culture, historical material and operational information (Carbonari et al., 2015; Nunez et al., 2015). By having this feature, the classic problem of having inadequate and outdated documentation for technical references (Ali et al., 2018; Blinn & Issa, 2017; Volk et al., 2014) can be mitigated. BIM is anticipated to be an essential tool as a central database to support comprehensive data input for activity such as cultural heritage lifecycle management (Ali et al., 2018; Volk et al., 2014). Thus, it is also anticipated that BIM would be beneficial for various efforts such as preservation, adaptive re-use, and reconstruction.

BIM is not just a software, as Hardin (2009) put it, but a process that integrates all the building works and information to create a new way of thinking in the essence of not doing the same old things. The concept of BIM consists of integrating information and all previously dispersed data into the BIM model, which consists of structures and architecture design and other associated information regarding the buildings. BIM's primary objective is to eliminate the future work of recollection or reformatting of information about facilities; which is wasteful (Eastman et al, 2008). Hardin (2009) as cited in Mohamed Salleh et al. (2018) suggests that BIM is a virtual building model that contains smart technology that collects all information on building elements in the same server file that can be shared to increase communication and collaboration among the project team members.

As BIM's potential to model existing buildings that have heritage or cultural values to local people are increasingly being recognised (Calin et. Al., 2015; Volk et al., 2014; Baik et. al.,2013), building owners and facility managers have also seen tremendous benefits in handling their building using the approach (Carbonari et al., 2015; Volk et al., 2014; Baik et al., 2014). What is not yet clear is on the process of how BIM can be utilized as DSS in cultural heritage management. Thus, next section will demonstrate the process of data extracting, which the data will be used as information to support historical building managers in their decision-making process.

## 2. Methodology

In this paper, a descriptive embedded case study approach is adopted by comparing the techniques of getting building measurement and utilizing BIM approach in tracking the changes of a historical building's layout. Descriptive embedded case study is a method of analysing sub-units of the phenomenon to make the descriptions available to others (Bengtsson, 1999). According to Baxter & Jack (2008), a case study method will be helpful when to study science, develop theories and involvements and when to evaluate programs, when the method is applied correctly. In order to study the potential of BIM as DSS for cultural heritage management, this paper chose to analyse the changes of layout for Balai Besar Kota Bharu (Kelantan) as the sub-units of analysis.

### *2.1 Istana Balai Besar (the Grand Palace)*

Istana Balai Besar (the Grand Palace) is selected as the case study based on its cultural heritage significance. The palace was built by Sultan Muhammad II in 1844 and situated near to the Kelantan River. The Istana Balai Besar symbolized sovereignty and was used for official ceremonies such as inauguration and state official awards. The palace is a single-story structure made of Chengal wood and surrounded by palisades within an area of a 175,000-foot square (Mohd Nor et al., 2017). Istana Balai Besar was previously known as the Istana Kota Lama and used to be the center for the government of Kelantan in the 18th century. The building is now much valued for its elegant architectural features as shown in Figure 1.

**Figure 1** Balai Besar Kota Bharu (https://sejarahkelantan.wordpress.com/tag/istana-balai-besar, 2018)

### *2.2 Descriptive Embedded case study*

In the early days, documentation for cultural heritage buildings is driven by the information and sources used to build them and the real value proposition of it to analyse data (Baik et al., 2014). These conventional methods of architectural documentation on existing building are done manually by measured drawing (Gaidyte, 2010). Measured drawings are carried out to retrieve information such as dimension and the form of a building in the architectural study (Harun, 2011). This technique used measuring tools; a measuring tape, adjustable set square rulers, ladder, graph papers, and pens conducted in a large group of 10-20 people. The measurement recorded will be drawn on butter paper and re-drawn for documentation. Nowadays, the conventional method of collecting data has inspired advancement in other technological tool known as Terrestrial Laser Scanner (TLS). TLS is an automatic tool that able to measure the 3D coordinates based on the object in X, Y, and Z-axes. These coordinates are based on the scanned surface that will reflect an encoded angular orientation in the form of point clouds, thus making the object collected into 3D data (Calin et al., 2015; Nunez et al., 2012).

Two primary sources of building's data were gathered by comparing the old layout of the building taken in the year 1976 by a group of researcher from Universiti Teknologi Malaysia (UTM) and the latest layout of the building captured using TLS in the year of 2017 by researchers from International Islamic University Malaysia (IIUM). TLS was also used in this research as comparative tool because it allows accurate and faster capture of measurement to be modelled in the 3D environment (Shukor et al., 2015; Alkan & Karsidag, 2012). This process is then followed by facilitating an iterative process of discussion and mapping of activities. The old layout of Istana Balai Besar was extracted from a measured drawings report dated May 1976 as shown in Figure 2, while Figure 3 shows the plan view of the extracted layout after being modelled using BIM platform by tracing method. The BIM platform used for this activity is Autodesk Revit.

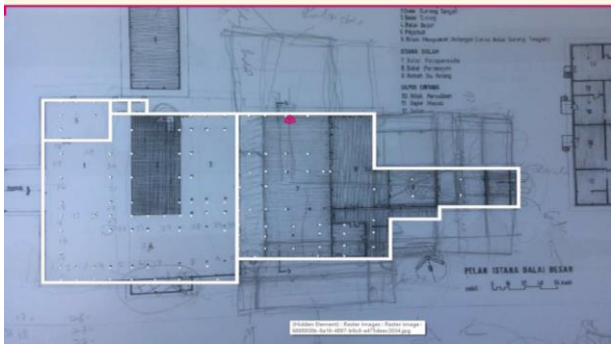

**Figure 2** Istana Balai Besar layout (not to scale) in 1976 as per measured drawing report
(Drawing report from UTM)

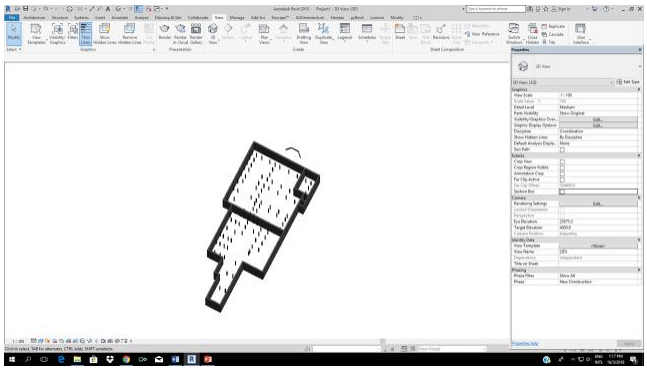

**Figure 3** Istana Balai Besar layout (1976) as per BIM model
(Authors' work)

### *2.3 Process Carried Out For The Case Study*

This is the first study on Istana Balai Besar Kota Bharu using laser scanning activity. In conducting laser scanning activity, a technique known as 'tie points' was employed. 'Tie points' are represented by targets in which the laser scanner identified to minimize the 'noise' while capturing point clouds. Point cloud is described as the minimal level of detail based on its abstractions that produce a higher level of details (Alkan & Karsidag, 2012).

The site was explored and the locations for the 'target' locations for the scanning process to take place was identified. Targets' used for laser scanning is a paper with portions of black and white on it as in Figure 4 to enable the laser scanner to detect the surface of the building effectively. The data collection is conducted outside the building using a Leica scan station P16 (Figure 5) to acquire the point clouds. Figure 6 shows the positioning of TLS around the building during the scanning process. The external building was scanned with a total of 26 total stations in a clockwise direction. After the scanning process was carried out, the data was then transferred into the data processor, and the point cloud cleaning and registration took place using Leica Cyclone 9.1.6 and Autodesk Recap.

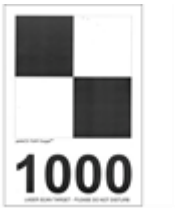


**Figure 4** Example of black and white (B&W) target used with TLS
(https://www.point3d.us.com/product-page/tuff-targets-100-pack)

**Figure 5** Leica Terrestrial Laser Scanner P16
(http://surveyequipment.com/leicascanstation-p16-3d-laser-scanner/)

Point cloud data must be collected from several scans locations using a laser scanner to ensure full coverage of the studied object as shown in Figure 6. Laser scanners needed millions of accurate 3-D points which later underwent cleaning and registration process. Scans are often clouded with measurement noise due to reflection from building surface. Therefore to get a proper mesh, cleaning is necessary (Alkan & Karsidag, 2012). Cleaning of data was carried out to eliminate irrelevant cloud points taken during the scanning process. Mesh is a raw format and is a collection of vertices, edges, and faces that describe the shape of the 3D object (Baik et al., 2014). Hence, registration process is carried out where the cleaned captured point clouds are converted into usable 3D information and formats such as .las, .pts or .rcp. This process is dependent on the type of TLS tool used during the scanning process since every TLS tool has specialized software to process their data accordingly. Providers such as Leica and Faro has dedicated software that helps to process, manipulate and analyze the enormous amount of point clouds captured. For this activity,

researchers used P16 Leica scanner and the specialized software is known as Cyclone 9.1.6.

**Figure 6** Positioning of Leica Terrestrial Laser Scanner P16 during scanning (Authors' work)

The study on the process continues as researchers superimposed the laser scanning data and measured drawings into BIM environment. This was done after the processing of point clouds by cropping some parts of the building such as the roof and wall from plan view so that a clear layout can be seen. The extracted layout is then modelled in a BIM platform for further analysis. Figure 7 shows the building's point clouds after it was cropped using Autodesk Reality Capture, and after the model's layout have been modelled into BIM environment using Revit (Figure 8 and 9). The layouts from both sources were then compared. Changes were observed on the buildings on its transition from the 1976 measured drawing up to the TLC output. It is anticipated that by knowing the changes of layout and area, managers can interpret the data and information into relevant contexts related to decision-making. The process to support the study of DSS for cultural heritage management is discussed in the next section.

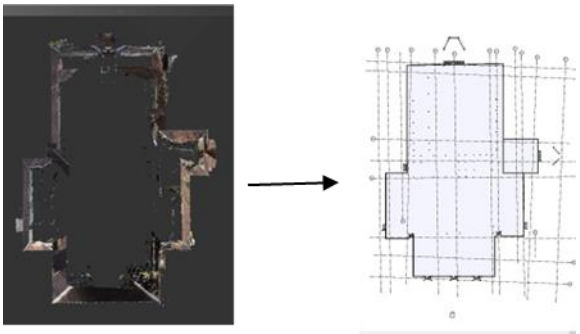

**Figure 7** Building layout converted from point clouds to BIM using Revit (Authors' work)

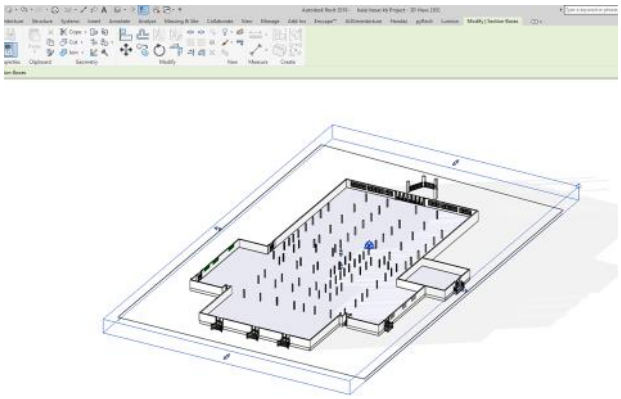

**Figure 8** Building layout converted from point clouds to BIM using Revit in 3D view (Authors' work)

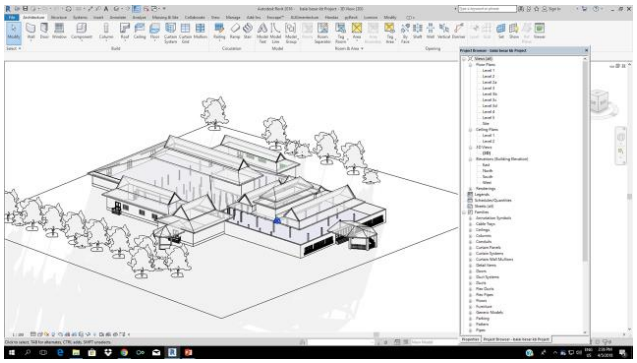

**Figure 9** BIM model of Istana Balai Besar (2017) (Authors' work)

### *2.4 Analysis and Discussions*

Prior to commencing the analysis of study, the building layouts are extracted and modelled into BIM environment. Following this, the comparison is made through observation and area calculation between them. Figure 10 shows the differences in the building layout, by comparison for the year 1976 (above) and 2017 (below). It is found that the layout is different from each other, deducing that the building had undergone a renovation in between 1976 to 2017. The front of the building at the entrance porch is maintained, but the size of the main hall has been made wider. The comparison also shows that there is an increase in space for storage at the rear of the building. This changes in the layout should be acknowledged by preservationist as it is an essential event in the building lifecycle.

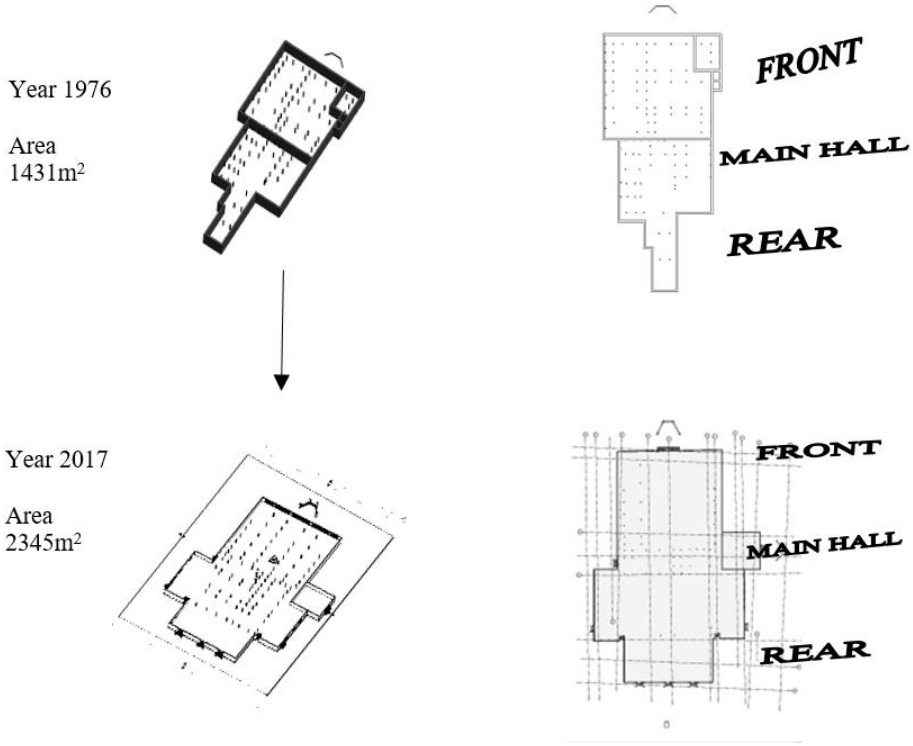


**Figure 10** Building's layout and its transitional changes from 1976 to 2017
(Authors' work)

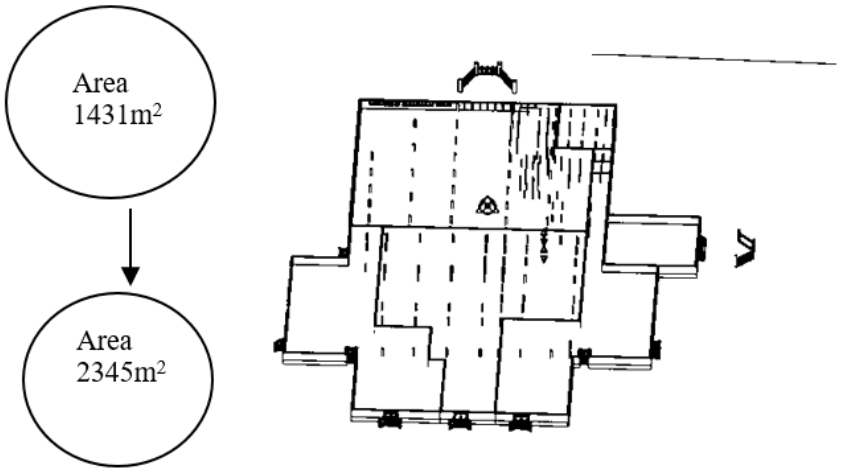


**Figure 11** Superimposed layout of Balai Besar
(Authors' work)

Figure 11 shows the comparison of the layouts of Balai Besar in 1976 that have been superimposed onto the Balai Besar in 2017. The inner layout of the year was extracted from measured drawing, while the outer layout modelled using the data collected using TLS in 2017 were used to calculate the difference between the areas of the layout using BIM platform. It showed that an additional 914m$^2$ in size. This result suggests the changes is due to a renovation that was carried out in between 1976 to 2017. Interestingly, the discovery of Istana Balai Besar has underwent a renovation is fascinating as researchers have managed to prove it scientifically. This information is significant, and this activity shows that such an event can be recorded with the utilization of

DSS such as BIM. The process as described can complement the use of a wider range of more specific strategic planning and methodologies using information stored in the file, for future references (Ali et al. 2018; Carbonari et al., 2015; Volk et al., 2014).

DSS focuses on outcomes that require an understanding of how, and under what conditions. The information produced is interpreted and can be conveniently used by stakeholders (Matthews et al. 2011). The development and implementation of decision support systems (DSS) require knowledge and understanding of managerial decision making, levels of reasoning and problem solving and roles of managers. DSS as a tool can support project teams in the assessment of the facility by making it possible for them to choose the best working approach based on their data (Seghier et al., 2017). The desired long-term outcomes include priorities by providing technical and historical knowledge, demonstrating impacts on social, economic and environmental assets. These priorities are indicators and targets that need to be developed in advance in each outcome to assess the intensity of impacts to refine future planning.

The studies presented thus far provide evidence that primary benefit of the activity is that it helps to give output in a shorter time. The activity only took eight (8) hours to capture the raw data for measurement. The scanner also provides reliable measurement output as TLS provides a high level of measurement accuracy (Baik et al., 2014). Moreover, the conventional methods of data collection for buildings are complicated as it needs a lot of workforces, tedious to process and time-consuming. However, with the development of technology such as Building Information Modelling (BIM) and Terrestrial Laser Scanning (TLS), the process of measuring the existing building becomes easier, faster and safer (Ali et al.,2018; Alkan & Karsidag, 2012; Gaidyte, 2010). With the help of this technological and intelligent modelling approach, it allows easy interpretation of the building and provides up to date information for documentation. In other words, the main strength of this activity is, it can provide recent and reliable information for documentation in a very short time and conveniently compared to the conventional method.

Besides, the activity carried out for this study promotes an innovative and advancement of methods in DSS for cultural heritage management by complementing the conventional method and technological advancement. This gives an opportunity for the earlier documentation of the building to be updated easily because the method was convenient as the scanning activity can be conducted from time-to-time. Thus, data and information of the building can be revised and administered easily to ensure its relevancy throughout its lifespan (Lopez et al., 2018; Ali et al., 2018; and Baik et al., 2014). The problem such as data void can be minimized as BIM has a user-friendly interface to allow practitioners to identify missing information and give a solution for it. This also opens up another opportunity for new job scope within the industry (Ali et al., 2018; Maina, 2018; Volk et al., 2014).

This finding has important implications for developing a systematic process in utilizing DSS such as BIM for cultural heritage management. The historical buildings in Malaysia are unique and not similar to other countries, thus requiring special attention and in-depth study. A clearer understanding is needed so the heritage of a culture can be appreciated by the people of the nation. The development of ground-breaking technology such as TLS and the introduction of technological approach work-processing such as BIM must be fully-utilized by industry players, hence to produce more efficient results and highly reliable historical information.

## 3. Conclusion and Recommendations

This case study provided an important opportunity to advance the understanding of underutilized technology such as BIM in the context of cultural heritage of a nation. In this investigation, the aim was to assess the potential of DSS such as BIM for cultural heritage management. The results of this investigation show that effective management of complex problems needs to be recognized and implemented based on a systematic approach. The documentation process demonstrated is beneficial for preserving roots and identity purpose. Despite its exploratory nature, this study offers some insight on the importance of tracking historical data and information in accordance to scientific approach. It also shows how BIM can lead to better stewardship of the future in term of historic buildings. Although this explorative embedded case study only focuses and describes on the changes of layout in a historic building, other area remains crucial to ensuring stakeholders work in a coordinated manner across many management activities to achieve their desired vision for effective historical building management. Finally, researchers highly recommend that further study in the area of cultural heritage management for Malaysia's historical buildings to be conducted extensively in the future as there is abundant room for further progress in determining other potentials of BIM in this field. The following are some recommendations in order to excel the practicing of BIM for heritage works within the industry:

i. Organizing appropriate and adequate service training, workshops and seminars by relevant professional bodies and academia to enhance the acquisition of more BIM and technological skills and experience to enhance the ability to perform duties related to the use of BIM for historical buildings.

ii. BIM for historical buildings practitioners in Malaysia should not just settle with the roles and functions of the profession but should also be familiar with the roles and functions of other professionals in the conservation and preservation field.

iii. BIM for historical buildings practitioners should ensure that they possess competencies that include personal qualities, core competencies, and process competencies. The qualities should include independence, adaptability, willingness to learn, and ability to reflect on what has been achieved and what has not been achieved. A professional's core skills should include the ability to present clear and validated information, critical analysis,

computer literacy, business awareness, prioritization, negotiation, and managing ambiguities and complexity.

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## References

Abdul Rashid, R., & Ahmad, A. G. (2011). Overview Of Maintenance Approaches Of Historical Buildings In Kuala Lumpur - A Current Practice. *Procedia Engineering*. *20*: 425–434. https://doi.org/10.1016/j.proeng.2011.11.185

Abdul Shukor, S. A., Wong, R., Rushforth, E., Basah, S. N., & Zakaria, A. (2015). 3D Terrestrial Laser Scanner For Managing Existing Building. *Jurnal Teknologi*. *76*(12): 133–139.https://doi.org/10.11113/jt.v76.5895

Allen W, Cruz J, Warburton B (2017) How Decision Support Systems can Benefit From A Theory Of Change Approach. Environmental Management, https://dx.doi.org/10.1007/s00267-017-0839-y

Ali, M., Ismail, K., Suhaimi, M.S, Hashim, K.S.H.Y, and Mustafa, M.H., (2018), Heritage Building Preservation through Building Information Modelling: Reviving Cultural Values through Level Of Development Exploration. *Journal of the Malaysian Institute of Planners, Volume.* 16(2): 62 -72. http://dx.doi.org/10.21837/pmjournal.v16.i6.461

Ali, M., Ismail, K., Hashim, K.S.H.Y, Suhaimi, M.S, and Mustafa, M.H., (2018), Historic Building Information Modelling (HBIM) For Malaysian Construction Industry. *Journal of the Malaysian Institute of Planners*. 16(3): 332 -343. http://dx.doi.org/10.21837/pmjournal.v16.i7.522

Alkan, R. M., & Karsidag, G. (2012). Analysis of The Accuracy of Terrestrial Laser Scanning Measurements. *FIG Working Week 2012 - Knowing to Manage the Territory, Protect the Environment, Evaluate the Cultural Heritage*, (May 2012), 16.

Baik, A., Alitany, A., Boehm, J., & Robson, S. (2014). Jeddah Historical Building Information Modelling "JHBIM"; Object Library. *ISPRS Annals of Photogrammetry, Remote Sensing, and Spatial Information Sciences*, *II-5*(May), 41–47. https://doi.org/10.5194/isprsannals-II-5-41-2014

Baxter, P., & Jack, S. (2008). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers . *The Qualitative Report*. 13(4): 544-559. Retrieved from https://nsuworks.nova.edu/tqr/vol13/iss4/2

Bengtsson P. (1999), Multiple Case Studies- Not Just More Data Points?!. Term Paper In Graduate Course in Research Methodology, University of Karlskrona Ronneby. Spring 1999. doi=10.1.1.30.9769

Blinn, N., & Issa, R. R. A. (2017). Utilisation of Drawing Management Software To Enhance BIM Educational Experiences. *BIM Academic Symposium*. *0*: 1–8.

Calin, M., Damian, G., Popescu, T., Manea, R., Erghelegiu, B., & Salagean, T. (2015). 3D Modeling for Digital Preservation of Romanian Heritage Monuments. *Agriculture and Agricultural Science Procedia*. *6*: 421–428. https://doi.org/10.1016/j.aaspro.2015.08.111

Carbonari, G., Stravoravdis, S., & Gausden, C. (2015). Building Information Model Implementation For Existing Buildings For Facilities Management: A Framework And Two Case Studies. *149*: 395–406. https://doi.org/10.2495/BIM150331

Cheong, Y. Y., & Nur Emma Mustaffa. (2017). Critical Success Factors for Malaysian Construction Projects: An Investigative Review. *International Journal of Built Environment and Sustainability*. 4(2): 93–104. https://doi.org/10.11113/ijbes.v4.n2.180

Eastman, C. Teicholz, P. Sacks, R., & Liston, K. (2008). BIM Handbook A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors. John Wiley & Sons, Inc.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory Building From Cases: Opportunities and challenges. *The Academy of Management Journal*. 50(1): 25-32. https://doi.org/10.5465/amj.2007.24160888

Gaidytė, R. (2010). 2D and 3D Modeling Comparison, 1–38. Retrieved from http://brage.bibsys.no/hig/bitstream/URN:NBN:no-bibsys_brage_12669/1/Gaidyte,R..pdf

Hardin, B. (2009), BIM and Construction Management: Proven Tools, Methods and Workflows, Canada:Wiley Publishing Incorporated.

Harun, S. N. (2011). Heritage Building Conservation In Malaysia: Experience And Challenges. *Procedia Engineering*. *20*: 41–53. https://doi.org/10.1016/j.proeng.2011.11.137

Ismail, S. A., Bandi, S., & Maaz, Z. N. (2018). An Appraisal into the Potential Application of Big Data in the Construction Industry. *International Journal of Built Environment and Sustainability*. 5(2): 145–154. https://doi.org/10.11113/ijbes.v5.n2.274

Jones C, Cowan P, Allen W (2012) Setting Outcomes, And Measuring And Reporting Performance Of Regional Council Pest And Weed Management Programmes. Landcare Research, Lincoln, New Zealand

Kidder, T. (1982). Soul of a New Machine. New York: Avon.

López, F., Lerones, P., Llamas, J., Gómez-García-Bermejo, J., & Zalama, E. (2018). A Review of Heritage Building Information Modeling (H-BIM). *Multimodal Technologies and Interaction*. *2*(2): 21. https://doi.org/10.3390/mti2020021

K.B. Matthews, M. Rivington, K. Blackstock, G. McCrum, K. Buchan, and D.G. Miller. 2011. Raising the bar? - The Challenges Of Evaluating The Outcomes Of Environmental Modelling And Software. *Environ. Model. Softw.* 26(3) (March 2011): 247-257. DOI=http://dx.doi.org/10.1016/j.envsoft.2010.03.031

Maina, J. J. (2018). Barriers to effective use of CAD and BIM in Architecture Education in Nigeria. *International Journal of Built Environment and Sustainability*. 5(3): 175–186. https://doi.org/10.11113/ijbes.v5.n3.275

Mazzanti, Massimiliano, 2002. "Cultural Heritage As Multi-Dimensional, Multi-Value And Multi-Attribute Economic Good: Toward A New Framework For Economic Analysis And Valuation," *Journal of Behavioral and Experimental Economics (formerly The Journal of Socio-Economics)*, Elsevier. 31(5): 529-558.

Mohamed Salleh, R., Mustaffa, N., Abdul Rahiman, N., Tajul Ariffin, H., & Othman, N. (2019). The Propensity of Building Information Modelling and Integrated Project Delivery in Building Construction Project. *International Journal of Built Environment and Sustainability*. 6(1-2): 83-90. https://doi.org/10.11113/ijbes.v6.n1-2.386

Mohd-Isa, A. F., Zainal-Abidin, Z., & Hashim, A. E. (2011). Built heritage maintenance: A Malaysian perspectives. *Procedia Engineering*. *20*: 213–221. https://doi.org/10.1016/j.proeng.2011.11.158

Mohd Noor, N., Kamaruddin, Z., Abdullah, A., Abdullah, A.A., Eusoff, S.S. and Mustafa, M.H. (2018), "Using Terrestrial Laser Scanner For Malay Heritage Documentation: Preliminary Approach to Istana Balai Besar, Kelantan", *International Journal of Development and Sustainability*. 7(6): 1886-1897.

Núñez Andrés, A., Buill Pozuelo, F., Regot Marimón, J., & de Mesa Gisbert, A. (2012). Generation of Virtual Models Of Cultural Heritage. *Journal of Cultural Heritage*. 13(1): 103–106. https://doi.org/10.1016/j.culher.2011.06.004

Oladotun, A. J., & Edosa, O. M. (2017). The Need for Professionalism and Competencies in the Construction Industry. *International Journal of Built Environment and Sustainability*. 4(1): 10–16. https://doi.org/10.11113/ijbes.v4.n1.154

Seghier, T. E., Lim, Y. W., Ahmad, M. H., & Samuel, W. O. (2017). Building Envelope Thermal Performance Assessment Using Visual Programming and BIM, based on ETTV requirement of Green Mark and GreenRE. *International Journal of Built Environment and Sustainability*. 4(3): 227–235. https://doi.org/10.11113/ijbes.v4.n3.216

Sodangi, M., Khamdi, M. F., Idrus, A., Hammad, D. B., & Ahmedumar, A. (2014). Best Practice Criteria For Sustainable Maintenance Management Of Heritage Buildings in Malaysia. *Procedia Engineering*. 77: 11–19. https://doi.org/10.1016/j.proeng.2014.07.017

Tripathi, K. P. (2011). Decision Support System Is a Tool for Making Better Decisions in the Organization. *Indian Journal of Computer Science and Engineering*. 2(1): 112–117.

Volk, R., Stengel, J., & Schultmann, F. (2014). Building Information Modeling (BIM) For Existing Buildings - Literature Review And Future Needs. Automation In Construction. 38(October 2017): 109–127. https://doi.org/10.1016/j.autcon.2013.10.023

Yusuf Arayici, (2008) "Towards Building Information Modelling For Existing Structures". *Structural Survey*. 26(3): 210-222, https://doi.org/10.1108/02630800810887108