PLANNING AND DESIGNING PUBLIC OPEN SPACES (POS) AS A STRATEGY TO ENHANCE COASTAL CITIES' RESILIENCE TO TSUNAMIS IN SRI LANKA

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ABSTRACT

Public open spaces (POS) in cities are considered as an asset in enhancing cities' sustainability contributing to its' three pillars; economic, social and environmental. Nevertheless, the importance of POS for disaster resilience is less recognised and remains under-rehearsed in the urban planning context. Therefore, there is significant importance of investigating potentials of POS for disaster resilience. Further, addressing this research need in the context of coastal cities is even more critical due to the increasing vulnerabilities of coastal cities as a result of rapid urbanisation and growing population in coastal cities. However, the potentials of POS to improve the disaster resilience in coastal cities may differ from one disaster to another. Tsunami is one of the coastal hazards that can be considered as infrequent, nonetheless extremely destructive. Further, the literature suggests that the physical intervention in cities with the sole purpose of Tsunami disaster resilience, often fail to sustain in the long run due to the infrequency nature of this hazard. Therefore, there is an imperative need to increase the inherent capacity of the city to resist, absorb, accommodate and recover from the effects of a Tsunami through multipurpose planning interventions. Accordingly, 'exploring the potentials of POS to increase the Tsunami disaster resilience through multipurpose planning interventions' can be identified as a seldom addressed research need. Addressing this research gap, this research study attempts to answer the research question 'How to plan and design POS as a strategy to enhance the coastal cities' resilience to Tsunamis?'. Further, the answer to this research problem is focused down to the Sri Lankan context, as Sri Lanka is one of the Tsunami prone countries fronting many challenges such as rapid urbanisation in coastal cities, and degradation of the natural and built environment due to the unplanned development activities.

The research study adopted the Grounded theory method as the research strategy. Unstructured interviews were used as the primary data collection technique covering a wide range of interview groups in Sri Lanka including Tsunami affected communities, disaster resilience experts, urban planners, sociologists, civil engineers, and coastal planners. Further, these interviews were supplemented by document review and visual images. Accordingly, grounded theory inductive coding procedure was used to analyse the transcripts, notes, maps and documents related to the interviews conducted.

The findings reveal that there is a significant potential to use POS to enhance the coastal cities' resilience to Tsunamis as an emergency evacuation directing point, as a primary place for emergency rescue, as an agent for temporary sheltering, as a facilitator for Tsunami disaster mitigation and as a mediator to provide Tsunami awareness. Further, to harness these identified potentials, research findings suggest a framework with five core principles, three types of POS, thirteen specific strategies and ten generic strategies to plan and design POS as an approach to enhance coastal cities' resilience to Tsunamis in Sri Lanka. This framework is developed closely related to the data in the Sri Lankan context. Therefore, urban planners and urban designers in Sri Lanka can use and practice this framework when planning and designing POS to enhance coastal cities' resilience to Tsunamis. The proposed framework will benefit the policymakers in Sri Lanka when preparing policies related to POS. Further, the findings can be adopted by other countries after the context-specific alterations are identified in the framework.

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LIST OF ABBREVIATIONS

POS: Public Open Spaces

DRR: Disaster Risk Reduction

DMC: Disaster Management Center

UDA: Urban Development Authority

NBRO: National Building Research Organisation

DM: Disaster Management

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Special thanks to my son Arya for bringing so much joy, love, and happiness into my life. Last but not least, I would like to thank my loving husband Nuwan who has always stood by me at all the time. Your patience, commitment, encouragement, and love added enormous strength to my life and without you, this achievement would have just been a dream!

DEDICATION

I dedicate this piece of work to all who were affected by the 2004 Indian Ocean Tsunami

CHAPTER 1: INTRODUCTION

1.1 Background to the research

Global urbanisation trend patterns demonstrate that continuous growth of world population and human migration towards the coastal cities, cause the rapid population growth in coastal cities. Hence, the coastal urban centres will contain a progressively large percentage of the world's human population with a high population density in coastal areas than in non-coastal areas (Neumann, Vafeidis, Zimmermann, & Nicholls, 2015). Population distribution studies further confirm this by revealing that half of the world's population lives within 60 km of the sea, and three-quarters of large cities located along the coast (UNEP, 2015).

Further, this growing population towards coastal cities together with rapid urbanization, generate significant challenges to both natural and built environments which include high demand on land and services, insufficient resource management, settling in unauthorised areas which are prone to hazards, inadequate capacities, uncertain directive for Disaster Risk Reduction (DRR) at local level and over-exploitation of ecosystems and so on (UNISDR, 2012). Apart from that, the implications of climate change set all coastal locations at risk with the impacts, such as accelerated global sea-level rise, changing storm frequency and other related coastal hazards (Neumann et al., 2015). The combined implication of the population growth, rapid urbanisation, and the climate change increase the exposure of coastal urban dwellers to natural coastal hazards such as coastal Floods, Storms, Sea erosion, Saltwater intrusion, and Tsunamis.

Out of these coastal hazards, Tsunami is a rapid-onset coastal hazard that can be considered as an ever-present threat to lives, infrastructure, and properties along the coasts (Taubenböck et al., 2009). Historical records indicate that Tsunamis worldwide have killed hundreds of thousands of people (National Tsunami Hazard Mitigation Program, 2001). For instance, the Tsunami 2004 reminded the world to be more proactive by claiming nearly 275 000 lives and destroying billions of dollars' worth properties (Barber, 2005). Recently, Indonesia was struck by Tsunamis two times within the year 2018. In September 2018, a magnitude 7.5 Earthquake and Tsunami killed more than 2,000 people in Palu, the capital (WorldVision, 2019). Then, in December 2018, another Tsunami struck Java and Sumatra resulting in more than 300 deaths (WorldVision, 2019). Accordingly, these unpredictable and infrequent Tsunami events time to time remind the world, the importance of the continuous focus on making coastal areas resilience to Tsunamis.

However, despite these threats, coastal urbanisation gathers more people towards coastal cities which further increase the vulnerability of coastal urban dwellers. The estimations confirm this by revealing that 489 cities within the Pacific states are vulnerable to Tsunamis including Alaska, California, Hawaii, Oregon, and Washington and 900,000 people in these cities are at risk of being inundated by a 50-foot Tsunami (National Tsunami Hazard Mitigation Program, 2001).

Therefore, the task of enhancing coastal cities' resilience to Tsunamis has become an increasingly important task. Further, achieving this increasingly important task in cities context is even more critical given the rapid urbanisation challenges to both natural and built environment in cities. Within this context, there is a growing understanding of the importance of urban planning and designing when making cities resilience to disasters. According to León and March (2014), urban designing and planning interventions in cities integrate multi-dimensional aspects affecting DRR. UNISDR (2012) confirms this by stating that when the spatial elements are strategically planned and designed, it positively influences on the natural and built environment and enhance the city's capacity to absorb and recover from disasters. Out of these spatial elements, Public Open Space is one of the vital spatial elements which can play a critical role in cities.

Public Open Spaces (POS) can act proactive manner with its' contribution to the entire city in multi-scale and have the capacity to resolve both current and future problems (Vargas-Moreno, Meece, & Emperador, 2014). However, the potential contribution of this key spatial element to enhance the cities' resilience to disasters remains largely uncovered. Hossain (2014) confirms this by stating that the role of POS to enhance the city's resilience, especially to encourage the adaptive response following a disaster, has not been fully discovered yet. Therefore, finding out the role of POS in enhancing cities' resilience can be identified as a critical research need which needs to be answered. At the same time, as it was discussed, addressing this research need in a Tsunami prone coastal cities context is even more significant, given the existing and emerging challenges such as population growth and rapid urbanisation. Accordingly, considering this research gap together with emerging critical need of the world, this particular research study explores the potentials of POS to enhance coastal cities' resilience to Tsunamis and methods to harness the potentials.

1.2 Justification of the Research

Contemporary planning and designing approaches of POS mostly focuses on achieving sustainable cities through its contribution to the three main pillars of sustainability; economic, social and environmental. Accordingly, contemporary urban planners and urban designers often use POS to increase the quality of living, improve visual beauty, improve the ecological health, growth of the economic growth, and increase the walkability, liveability, and vitality of the city. However, sustainable development should encompass strategies for creating disaster-resilient communities (Paton & Johnston, 2006). Nevertheless, the potential use of POS to enhance cities' resilience to disasters has not been fully uncovered within the current research field.

Further, the synthesis of literature confirms that POS have a substantial potential to contribute at three main stages of the disaster cycle: emergency management, recovery, and mitigation (Section 2.6.3). The literature which focuses on emergency management and recovery, suggest that POS have the potential to be used as safe areas for emergency evacuation and to provide facilities and services within the recovery period (Jayakody, Amarathunga, & Haigh, 2018). However, most of these discussions emphasise the potential uses, yet less consideration has been given to find out how to harness these potentials and the practical implementation of these potentials to a city context. Generally, urban planners look at the POS as a part of the built environment, and recovery planners identify open spaces as a part of the environment plan without looking at an integrated approach (Allan & Bryant, 2010). Conversely, it is evident that effectiveness increases when the emergency management plans and recovery plans are aligned with the day-to-day life of the city (Allan, Bryant, Wirsching, Garcia, & Teresa Rodriguez, 2013). Nevertheless, how to integrate the emergency management plans and recovery plans with the everyday life of the city is a question to be answered.

Apart from that, the literature which shows the potential use of POS for mitigation mostly looks at 'open spaces' with preservation and conservation perspective, instead of using the space as a public space which can contribute both urban development and disaster mitigation. Furthermore, keeping open spaces in cities merely for disaster mitigation challenges the sustainable development concept with the issues such as in the long run abundant land can promote social issues, inability to get the economical use of the land and so on. In supporting this view, Kubal, Haase, Meyer, and Scheuer (2009) have identified that most of these open spaces can convert as POS encouraging wildlife habitat and leisure activities which can provide

many economic and social benefits to the city. Further, considering all these aspects, POS manifest an important potential to contribute to disaster resilience from many perspectives. However, lack of attempts has been made to identify 'how to harness these potentials practically in a city context' and 'how to incorporate the disaster resilience-oriented potentials with the day-to-day use of POS in cities'.

While the potentials of POS for disaster resilience and the methods to incorporate these potentials to the everyday life of the city remain uncovered, filling this research gap in the context of Tsunami-prone cities is even more important due to two reasons. The first reason is the increasing vulnerability of coastal cities due to the urbanisation and population growth which was already discussed in section 1.1. The second reason is due to the nature of the Tsunami Hazard. Tsunami is infrequent and unpredictable; it may occur after 100years or 1000years. Therefore, allocating resources with a sole purpose of preventing a disaster which may or may not happen for the next 100 or 1000 years, cannot be considered as a sustainable solution. For instance, in some cities, large numbers of unstructured open spaces allocated for emergency evacuation, have created issues to achieve liveable, diverse and sustainable urban environments (Allan & Bryant, 2010).

Furthermore, it will be difficult to negotiate the need for these preventing measures when prioritising the resource allocation in cities. Hence, Tsunami disaster resilience measures need to be multipurpose. Therefore, addressing the research need of 'finding out the uses of POS for disaster resilience incorporating the day-to-day uses of the cities' to Tsunami prone coastal cities context can be considered as a significant and critical research need. With the identification of this research need, this study focuses on finding out the potential uses of POS for Tsunami disaster resilience and methods to incorporate these potentials into the everyday life of the city.

The research gap mentioned above lead to the two research problems 'what are the potentials of POS to enhance the coastal cities' resilience to Tsunamis?' and 'How to plan and design POS in cities to enhance the Tsunami disaster resilience while obtaining the everyday uses of the city?'. Further, the answers to these research problems need to be more specific rather than generic and may differ from one context to another due to geographical, political, environmental and socio-cultural differences. Therefore, the study was focused down to Sri Lankan context and the selection was done due to three main reasons. The first reason is Sri Lanka is one of the Tsunami prone countries located in the Indian ocean, and the 2004 Tsunami

was one of the worst disasters ever recorded in Sri Lankan history. Secondly, as pointed out by UN-Habitat (2016), approximately 80% of national economic infrastructure and 70% of the urban population is concentrated in coastal cities and cities in disaster-prone areas in Sri Lanka. Hence, any adverse effect on the coastal urban centres will affect significantly to the country's national economy and the social setting. Thirdly, despite these vulnerabilities, the built-up area is increasingly expanding in coastal cities mostly through unplanned development activities which further increases the disaster risk in coastal cities, Sri Lanka. Therefore, it is inevitably essential to find out the strategies to improve the resilience of coastal cities in Sri Lanka to Tsunamis. With the consideration of all these factors, this study focuses on finding out the methods and approaches to plan and design POS as a strategy to enhance coastal cities' resilience to Tsunamis in Sri Lanka. With this justification, the aim and objectives of the study are set out as follows (Section 1.3).

1.3 Research Aim and Objectives

1.3.1 Aim

This research aims to develop a framework to plan and design public open spaces (POS) as a strategy to enhance coastal cities' resilience to Tsunamis in Sri Lanka.

1.3.2 Objectives

1. Identify the current relationship between the POS and Tsunami disaster resilience
2. Explore the potentials and challenges of using POS as a strategy for Tsunami disaster resilience
3. Explore the planning and designing methods and approaches of using POS as a strategy for Tsunami disaster resilience
4. Study the relationship between the identified potentials and challenges (Objective 2) with methods and approaches (Objective 3) of using POS as a strategy for Tsunami disaster resilience
5. Develop a framework to plan and design POS as a strategy for Tsunami disaster resilience

1.4 Scope of the research

Approaches to make cities resilience to disasters may vary from urban governance approaches, institutional approaches, infrastructure resilience, community approaches to environmental approaches. Out of these approaches, this particular study is focused on urban planning and

designing methods to make cities resilience to disasters. Further, these planning and designing strategies can be focused on various spatial elements of an urban built environment ranging from buildings, parks, playgrounds, streets to infrastructure.

Out of these spatial elements, this research study focuses on POS in cities. The main reason for this selection is the role of POS to enhance the cities' disaster resilience has not been fully discovered yet. However, as it will be discussed in section 2.6.3, there are many literature evidence which presents the potential uses of the POS to enhance the disaster resilience in cities. Further, the way POS can act to improve the disaster resilience may vary from one disaster to another. For instance, the role of POS in an Earthquake is entirely different from a Flooding event (Fuentes & Tastes, 2015). Accordingly, it was necessary to narrow down the research to a specific type of disaster. Therefore, with the identification of research need at the 2.2.6, this research is scoped down to Tsunami hazard.

Furthermore, this research study primarily focuses on the urban context in Sri Lanka, not in the rural setting. As described in section 1.2, human migrations, growing population and unplanned urban development in Sri Lankan coastal cities have created significant development challenges to both natural and built environments in coastal urban centres in Sri Lanka. Therefore, find out the planning, designing solutions to the city context is imperative within the current setting of Sri Lanka.

In summary, the scope of this research study is narrowed down from four main borderlines; 1. Planning and designing strategies 2. public open spaces 3. Tsunami disaster and 4. City context in Sri Lanka.

1.5 Research Methodology

The methodology of this research is presented in detail in chapter 3. In summary, the first part of the methodology chapter establishes the research aim, objectives and research questions (Section 3.2). The second part offers the methodological design of the research (Section 3.3). Accordingly, as it is summarised in section 3.2, the analysis of the literature informs that, there is a critical need of enhancing coastal cities' resilience to Tsunamis and POS have a substantial potential to contribute for Tsunami disaster resilience. However, 'what are the potentials?' and 'how to harness these potentials within the city context?' are questions to be answered within the current research field. Based on this literature confirmed the research gap, the central research question was formed; 'How to plan and design POS as a strategy to enhance coastal cities' resilience to Tsunamis?'.

Following the establishment of the research problem, the research aim, objectives and research questions were identified. Subsequently, the methodological design is established to address the identified research questions. The methodology of the research is designed based on 'the research onion' model of Saunders et al. (2016). Accordingly, based on the following philosophical assumptions, the researcher has established the ontological, epistemological and axiological philosophical position of the research towards the subjectivism, interpretivism, and value bound respectively (Section 3.3).

1. Ontological view - The researcher views that if POS are planned by the planners, urban designers and used by the public, finding a new way to plan it (focusing on disaster resilience), cannot be achieved without considering these social actors attached to it.

2. Epistemological view - to answer the research question, the researcher seeks to find the answer through the knowledge of local planners, coastal planning experts, disaster resilience experts and the local knowledge of the community, rather than using objects, facts, numbers.

3. Axiological view - since the researcher believes that the social entities and social actors do not exist independent of each other, this research cannot be detached from the researcher's values and beliefs. Therefore, this research follows a value-bound process.

Research Approach is inductive as literature search confirmed that there is no pre-developed theory to be tested. Therefore, the theory needs to be discovered through the process of data collection and analysis (Section 3.4), Further, the methodological choice of the study is multi-method qualitative study (Section 3.5), as the answer to the research question is found through the qualitative data using more than one data collection technique: interviews, documents, and visual images.

As it is demonstrated in section 3.6, after the comparison of potential research strategies, grounded theory was selected as the most suitable research strategy for the study. The selection was made based on the following four factors.

- The role of POS as a strategy for Tsunami disaster resilience cities has not been fully discovered and poorly understood within the existing literature.
- Grounded theory suits with inductive researches which seek to build a theory based on data

- Grounded theory is an ideal research strategy when the researcher needs to build up theories from 'ground', data from the field, especially in the actions, interactions and the social processes of people.
- The grounded theory allows a systematic analysis, yet provide a flexible base to collect and analyse qualitative data which produce a 'Well constructed theory.'

After the selection of Grounded theory as the research strategy, the next task was to select the most appropriate version of grounded theory as there are several versions emerged since the origin of the original version introduced by Glaser and Strauss (1967). As section 3.6.4 describes, this particular study adopts the principles from the second version of the grounded theory, with the use of literature at two stages of the theory development process. Firstly, the review of literature is used to establish the research gap and secondly, to support the emerging theory. The use of POS for Tsunami disaster resilience is studied at a particular time. Hence the study is cross-sectional (Section 3.7).

The study mainly uses the unstructured interviews for data collection with the community in Tsunami hazard-prone areas and both practitioners and academics in the fields of urban planning, coastal planning, disaster resilience, sociology, and civil engineering. Apart from the interviews, document review and visual images related to the interview discussions were reviewed as the secondary method (Section 3.8.5). The data were analysed concurrently to the data collection, through the adoption of grounded theory data analysis procedure (Section 3.9). The data analysis was supported by Nvivo Pro (Version 11) which is a qualitative data analysis software. Concurrently, the 'framework to plan and design POS as a strategy to enhance coastal cities' resilience to Tsunamis in Sri Lanka' was developed using the grounded theory coding procedure; open coding, axial coding, and selective coding.

Further, this research used three types of triangulation methods throughout the process of building up the theory to ensure the reliability and validity of the findings; methodological triangulation, data triangulation, space triangulation. Once the final framework (the theory) is built up, it is validated through respondent validation and external validation which further confirmed the credibility of the research (Section 4.6). The analysis and research findings are detailed in chapter 4, and the achievement of research objectives through the research development process is presented in section 5.3.

1.6 Structure of the thesis

This thesis is structured into five chapters. Chapter 1 provides the introduction to the research through the demonstration of background to the study, research justification, research aim, objectives, the scope of the study and a summary of the research methodology.

Chapter 2 synthesises the literature related to the field of study by reviewing the literature on four leading platforms. The first section provides the background literature to the study through the discussions on what is a disaster-resilient city, focus on coastal cities and focus on Tsunami disaster resilience. Secondly, the literature is gathered to clarify the current role of the built environment in Tsunami disaster resilience. Thirdly, the literature discussion is scoped down to Sri Lankan context with a focus on existing early warning and evacuation system in Sri Lanka, built environment-related current approaches for Tsunami disaster prevention and their challenges. The fourth section, defines the term POS, the current focus of POS, potentials of POS for Tsunami disaster resilience. Finally, the analysis of literature emphasises the need for new Tsunami disaster resilience focus on POS where the literature demonstrates the gap of the research.

Chapter 3 describes the methodological design of the research starting from the establishment of the research aim, objectives and questions. Subsequently, methodological framework justifies the research philosophy, research approach, methodological choice, comparison of potential research strategies, selection of Grounded theory method, time horizons, data collection, data analysis and the credibility of the research.

Chapter 4 presents the analysis and findings of the research under six main topics; core principles, three types of POS to enhance coastal cities' resilience to Tsunamis, specific strategies, general strategies, sub findings and validation of the findings. Subsequently, the summary of the findings proposes the 'framework to plan and design POS as a strategy to enhance coastal cities' resilience to Tsunamis in Sri Lanka'.

Chapter 5 provides the conclusion of the study by presenting the summary of the research problem, a summary of key findings, the achievement of objectives, contribution to the theory and practice, limitation of the study and further research ideas.

1.7 Summary and the link

This chapter provided an overview of the study introducing the research background, aim, objectives, justification, and scope of the research. Further, the summary of the methodology explained the appropriateness of the adopted methodology. The next chapter (Chapter 2) review and synthesise the literature related to the field of study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Chapter 1 presented the research background, justification, aim, objectives and structure of the thesis. The emphasis of this chapter is to synthesise the literature related to the field of study. Accordingly, the chapter is organised as follows.

- Firstly, the chapter explores the key terms related to the research; disasters in context, the concept of disaster resilience, the importance of the concept at the city level, disaster resilience cities and role of urban planning and designing. Subsequently, it discusses the need for focusing on coastal cities, coastal cities' resilience to Tsunamis and defines the term 'Tsunami disaster resilience'.
- Secondly, it explores the role of urban planning and designing in Tsunami disaster resilience and attempts to position the research focus within the global policy context.
- Thirdly, the literature focus is scoped down to Sri Lankan context exploring the changes affected due to Tsunami disaster 2004, existing Tsunami early warning and evacuation planning system in Sri Lanka, current urban planning and designing related approaches for Tsunami disaster resilience and their challenges. This discussion demonstrates the need for enhancing coastal cities' resilience to Tsunamis in the context of Sri Lanka.
- Fourthly, the literature synthesis discloses the specific research focus which is the potential use of POS for Tsunami disaster resilience. Accordingly, this section first defines the meaning of POS in this study as there can be different interpretations of the term. It is followed by the literature synthesis on the current planning and designing focus on POS and the potential use of POS for disaster resilience. Then the chapter streams through the potential use of POS to enhance the coastal cities' resilience to Tsunamis showing how this research interrelates with (complements/supports) similar work in the field of study.
- Finally, the chapter is concluded with establishing the gaps in knowledge which need to be filled by this research.

2.2 Disaster Resilience, Tsunami and Resilient Coastal Cities

2.2.1 Disasters in Context

The term 'Disaster' is defined as 'a severe disruption to the functioning of a community or a society concerning widespread human, material, economic or environmental losses and

impacts, which surpasses the ability of the affected community or society to deal with using its resources' (UNISDR, 2017). In general, disasters can be categorised into two main types as natural disasters and human-made disasters. However, Haigh and Amaratunga (2010) highlight that the origins and the causes of these disasters may differ, but the consequences are more or less same which include loss of lives, economic losses, destructions to the built and natural environment, and disruption to the local institutions and livelihood.

Further, if the consideration is given on natural disasters, it can be noted that the frequency and severity of natural disasters have been increased in recent history. The increase in the frequency of natural disasters can be graphically presented as follows (Figure 2.1).

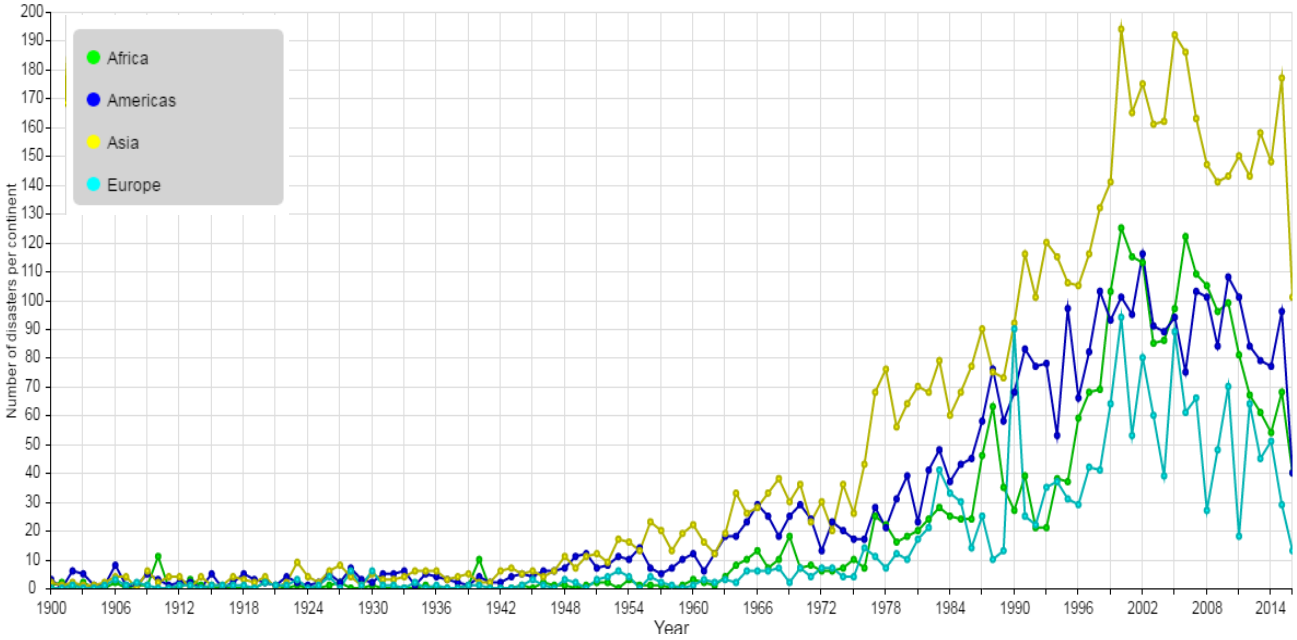


Figure 2.1- Total number of reported natural disasters between 1900 - 2016. Source- (EMDAT, 2016)

Furthermore, the increase of the severity of natural disasters within recent history can be identified from the figure 2.2. Accordingly, it can be noted that more than 45% of the total disaster mortality since 1990 is concentrated only on four events; Cyclone Gorky in Bangladesh in 1991, the Indian Ocean Tsunami in 2004, Cyclone Nargis in Myanmar in 2008 and the Haiti Earthquake in 2010.

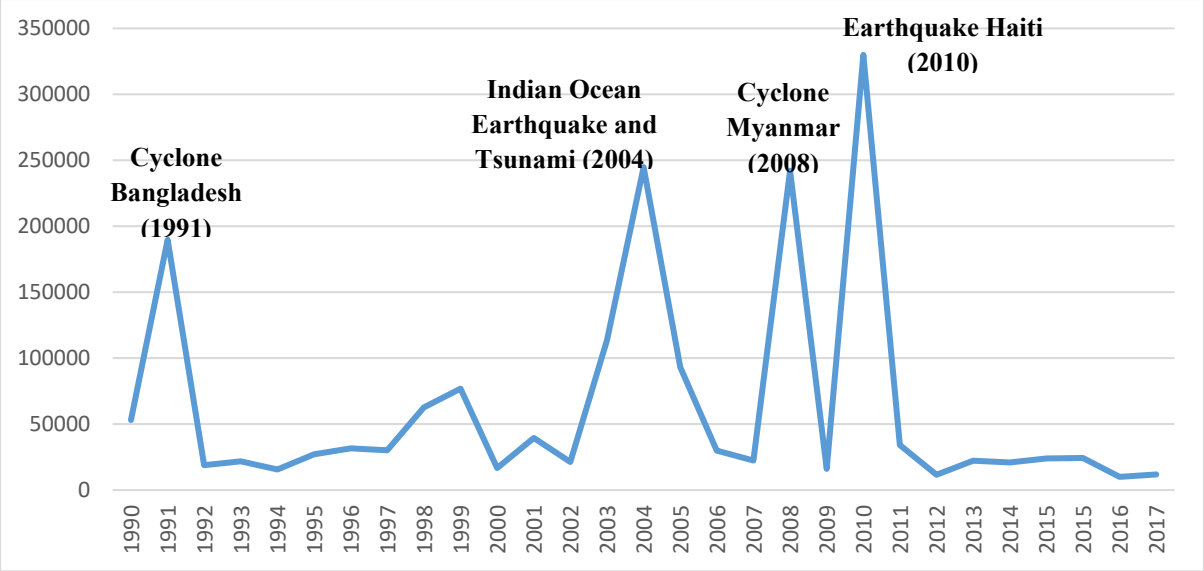


Figure 2.2- Mortality from natural disasters from 1990-2017, Source- (EMDAT, 2018)

In addition to the losses of lives, disasters damage the financial stabilities of countries. Figure 2.3 shows the economic value of the impaired assets from various disasters around the world within the period of the year 1990 to 2017. This analysis indicates that only in the year of 2011, 371 billion (USD) worth asserts were damaged due to natural disasters which is the highest worth of assets that have been injured in history.

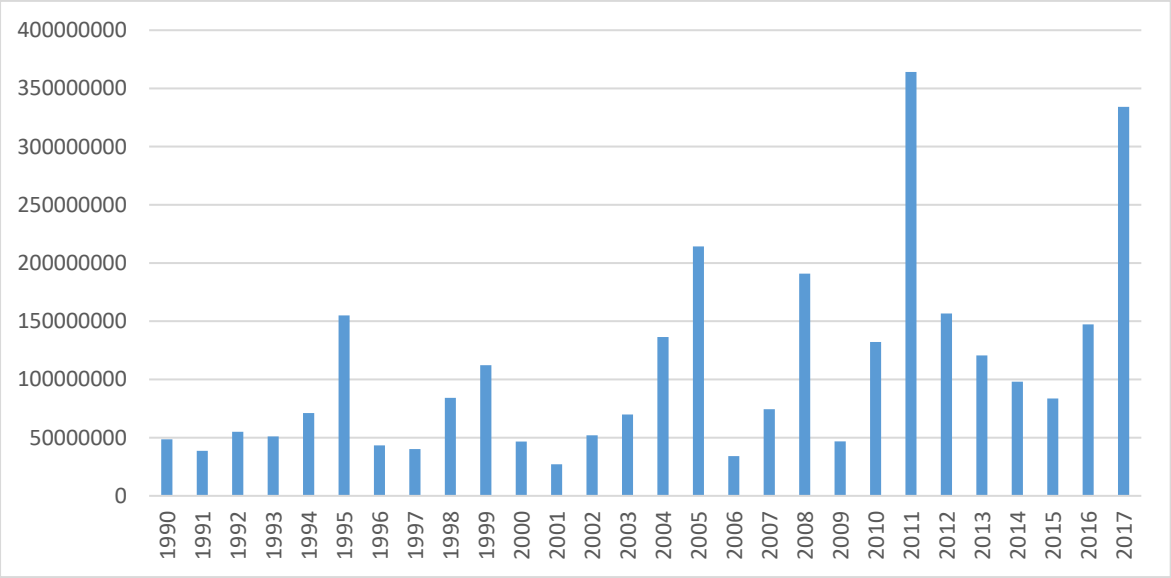


Figure 2.3- Damages for Assets (USD Billion) from 1990-2017, Source- (EMDAT, 2018)

Accordingly, it can be noted that the effects of disasters are extensive and it has severely affected the social lives and economic capacities of people during recent history. This emphasis informs the importance of finding out the ways and means, how to be more resilience to disasters in the future. With the emergence of this need, the concept of disaster resilience

became widely popular in the research field. Accordingly, section 2.2.2 further investigates the concept of disaster resilience.

2.2.2 Concept of Disaster Resilience

The term 'resilience' is originated from the Latin word 'resilio' which means 'jump back' or 'bounce back' (Paton & Johnston, 2006). As a concept, this was first introduced by a theoretical ecologist C.S Holling in 1973 (Kärrholm, Nylund, & Prieto de la Fuente, 2014). He introduced 'resilience' as the ability of an ecosystem to absorb a shock without a meaningful change to its' structure or function (Wallace & Wallace, 2008). Since then this term has been explored by many subject areas such as psychology, sociology, engineering, business management, and disaster management. Given these influences, the core meaning of the term 'resilience' can still be framed as the ability of a system, enterprise, or a person to maintain its core purpose and integrity in the face of dramatically changed circumstances.

The concept of resilience is used in the field of disaster management (DM) since the 1980s (Dufty, 2012). However, this concept became prevalent and significant in the field of DM with the increase of the frequency and severity of disasters in recent history. UNISDR (2009) defines the term Disaster resilience as 'the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions'.

Sendai Framework (2015-2030) operates as the major international document for DRR (DRR) which was adopted by united nation member states in 2015. This framework Emphasises the prevention, preparedness and mitigation side of the concept of disaster resilience. In achieving this, the framework views the DRR and the building resilience to disasters as an urgent need within the context of sustainable development (UNISDR, 2015b). Furthermore, Twigg (2009) highlights the community aspect of this concept which is the most critical concern in a disaster event. Twigg (2009) emphasizes that a disaster resilience community can be categorised into three main elements (a) the ability to absorb the trauma through resistance or adaptation; (b) the capacity to maintain essential functions and structures during disasters; and (c) the capacity to recover or 'bounce back' after a disaster.

The fundamental notion of disaster resilience promoted the idea of bouncing back to the original state after a disaster. However, notwithstanding with this original notion of 'bounce back', researchers such as Manyena, O'Brien, O'Keefe, and Rose (2011) and Paton and

Johnston (2006) argued that this notion could not capture the changed reality after a disaster and the new possibilities that can be opened up after a disaster. Accordingly, the 'bounce forward' notion is emerged promoting the idea that disaster resilience is not only resistance and recovery from a disaster but also it increases the ability of the community to learn from the disaster and to improve the networks, systems and capabilities to a higher level for more resilience future. However, these notions opened up the use of the concept of disaster resilience to a broader context.

Further, the concept of disaster resilience can be studied and explored from different standpoints and in different scales. For instance, disaster resilience can be reviewed for infrastructure resilience, community resilience, economic resilience, institutional resilience or it can be considered at the national level, regional level, city level, local level or neighbourhood level. The exploration of this concept in the city scale resulted in the emergence of the notion 'disaster-resilient city'. Accordingly, the importance of studying this concept at the city level and the concept of 'disaster-resilient city' will be further discussed in the next section; 2.2.3.

2.2.3 Importance of Disaster Resilience at the City Level

A city is a spatial entity which contains a considerable amount of people, infrastructure, amenities, modern facilities. According to the dictionary terms, the city is a centre of population, commerce, and culture; with significant size and importance (The American Heritage, 2015). Apart from the tangibles in a city, there are intangibles in a city which wove people together; traditions, values, cultures, subcultures. Further, Pelling (2012) describes, cities are the engines of economic growth; an integrated system linked with consumption and production, a source of livelihood, a stock of accumulated assets, and, a political and cultural arena. Thus, any adverse effect to the city means, it is a detrimental effect on the engines of the economy, centres of population, commerce, and culture of a country.

While cities have become an essential element of a country, an increase in urban population and rapid urbanisation create many challenges to the natural and built environment of cities. As UNISDR (2012) states, rapid urbanisation brings more pressure on land and services due to the increased population density, lack of capacities and unclear mandates for DRR at local levels, insufficient resource management, settlements in hazard-prone areas, uncoordinated emergency services and decline of ecosystems. Adding to this, Malalgoda, Amaratunga, and Haigh (2013) disclose that unplanned cities and urbanisation is one of the significant challenges to create a disaster resilient built environment in cities. While the rapid urbanisation has

become a major challenge for the disaster resilient built environment in cities, as UNISDR (2015b) states, the increase of frequency and intensity of natural disasters is another major challenge ahead in making cities resilience to disasters. Accordingly, it can be noted that cities are becoming more vulnerable to disasters due to combined implications of the increase of frequency and intensity disasters and the threats positioned by the rapid urbanisation. Hence, the consideration of the concept of 'disaster resilience' has become even more important in the context of the city.

2.2.4 Disaster Resilient Cities and Urban Planning/Designing

The concept of 'disaster-resilient city' emerged with the identification of the importance of the 'disaster resilience' concept at the city level (Section 2.2.3), and now this term is widely used by many works of literature on DM and institutional policy documents. Accordingly, a resilient city can be identified as a city that has developed capacities to absorb future shocks and stresses to its social, economic, and technical systems and infrastructures so as still be able to maintain substantially the same functions, structures and systems (Recilientcity, 2015).

With a holistic perspective on the city, Jabareen (2013) has conducted a critical review on understanding a disaster-resilient city and has come out with four primary concepts which underline a disaster-resilient city. Accordingly, he has stated a city should address four interrelated concepts and its components to make the city resilience to disasters as shown in figure 2.4.

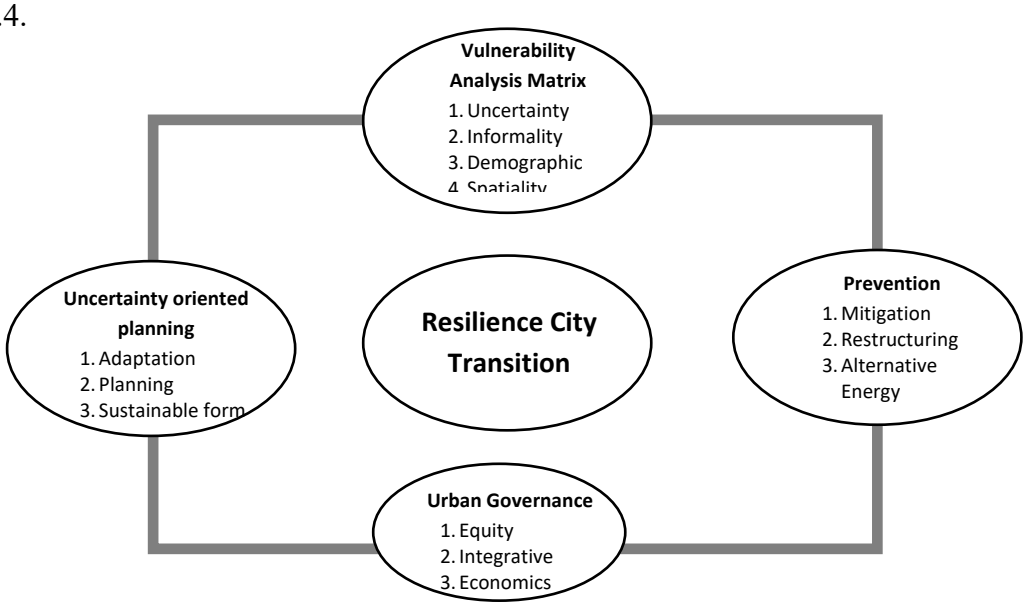


Figure 2.4- Framework for a disaster resilience city- (Adopted from Jabareen, 2013)

According to Jabareen (2013), 'disaster-resilient city' is created through four interrelated approaches; urban governance, prevention, vulnerability analysis matrix and uncertainty oriented planning.

Furthermore, Godschalk (2003) emphasises a set of principles for a disaster-resilient city. He has stated a comprehensive set of hazard mitigation practices along with better social and institutional resilience combined with the community mitigation capacity is required to make a city resilience for disasters. The findings of Godschalk (2003) reveals that a resilient city should be technically equipped with the modern and traditional disaster resilience strategies, there should be a functional link between the society and the institutions responsible for disaster resilience, and finally, people should have proper awareness about disaster risk and mitigation.

Likewise, the strategies and approaches to make cities resilience to disasters can be identified from various sources of literature and institutional documents. The work of the United Nations International Strategy for Disaster Reduction (UNISDR) can be recognised as one of the significant inputs for the development of the notion 'making cities resilience to disasters'. Accordingly, UNISDR introduced a toolkit with ten essentials which were developed under the Campaign of '*Making Cities Resilient – My City is Getting Ready',* to accelerate the implementation of the Sendai Framework for DRR (2015-2030) at the local level (UNISDR, 2015a). The primary aim of this toolkit is to address the issues of local governance and urban risks in making cities resilient (Panda & Amaratunga, 2016). Those '10 Essentials' are as follows (UNISDR, 2015a).

Essential 1: Organise for Disaster Resilience
Essential 2: Identify, Understand and Use Current and Future Risk Scenarios
Essential 3: Strengthen Financial Capacity for Resilience
Essential 4: Pursue Resilient Urban Development and Design
Essential 5: Safeguard Natural Buffers to Enhance Ecosystems' Protective Functions
Essential 6: Strengthen Institutional Capacity for Resilience
Essential 7: Understand and Strengthen Societal Capacity for Resilience
Essential 8: Increase Infrastructure Resilience
Essential 9: Ensure Effective Disaster Response
Essential 10: Expedite Recovery and Build Back Better

Accordingly, these ten essentials cover a broad variety of aspects of the city. Further, it can be noted that the strategies to enhance cities' resilience to disasters may widely vary from institutional approaches, community resilience, urban development and design approaches, Infrastructure resilience and ecosystem resilience approaches. Out of these approaches, urban planning and designing can play a dynamic role within a city integrating many aspects related to disaster resilience. Confirming this, León and March (2014) state urban planning and designing interventions in cities can fit in multi-dimensional aspects affecting DRR. Recognising this importance, this particular study focuses on urban planning and designing approaches to making cities resilience to disasters.

Revisiting Jabareen's framework (Figure 2.4), the uncertainty oriented planning platform covers the adaptation, planning and sustainable form. This concept suggests that urban planning should be uncertainty-oriented rather than adapting the conventional planning approaches (Jabareen, 2013). It indicates that climate change, disasters and their resulting uncertainties challenge the concepts, procedures, and scope of conventional approaches to planning, also creating a need to rethink and revise current planning methods.

With this emphasis, if the consideration is given on the ten essentials, UNISDR (2015a) endorses that the actions identified under each essential need to be implemented as part of the overall DRR planning process and also should influence the urban planning and design strategies. Further, the fourth essential proposes the action of maximising the use of urban design solutions to make cities resilience. Consequently, this fourth essential suggests three elements to follow under the resilient urban development and design; 1) Place urban planning and land-use management at the core of urban resilience, 2) Conduct systemic and specific vulnerabilities mapping, 3) Mainstream resilience into ongoing urban master plan updates and sectoral strategies. Accordingly, it can be understood that these approaches have identified that urban planning and designing can play a vital role in making cities resilience to disasters.

Furthermore, Johnson and Blackburn (2014), categorise all these strategies of enhancing cities' disaster resilience into two broad strands. The first strand directly increases the resilience of the city to known hazards and these strategies come under the DRR umbrella, including vulnerability assessment, risk assessment, hazard mapping, risk awareness, hazard mitigation infrastructures, preparedness, emergency response and these strategies can be reflected through urban planning and designing. The second strand indirectly increases the resilience of the city to all types of disturbances through the inbuilt capacity of a city which can be gained through

the overall improvement of infrastructure development, socio-economic development, institutional strengthening, financial capacity. Johnson and Blackburn (2014) identify this indirect development of resilience as 'accumulated resilience'. Out of these two strands, this research study will take the first strand of enhancing cities' resilience which is finding strategies to directly increase the resilience of the city to a known hazard. Accordingly, in this study, the focus will be given to enhance coastal cities' resilience to Tsunamis, and the reasons for the selection will be discussed in the next two sections; 2.2.5 and 2.2.6.

2.2.5 Focus on Coastal Cities

According to Zhang (2015), firstly in 2007, it was noted that more than half of the world's population lives in urban areas. Confirming this, key facts of world urbanisation prospects: 2018 revision proclaims that the percentage of the global population lives in urban areas is 55% (UN-DESA, 2018). Further, projections show that this will increase up to 68% by 2050. Adding to this, Baird (2009), revealed that the world's urban population would increase from another 2.1 billion within less than two decades with the majority located in coastal cities. Population distribution studies confirm this by revealing that half of the world's population lives within 60 km of the sea, and three-quarters of large cities are located on the coast (UNEP, 2015). These global urbanisation trends, together with the growing tendency of migration towards the coastal cities, validate that the coastal cities will contain an increasingly large proportion of the world's human population.

Further, this urbanisation trend pattern and the growing population towards coastal cities generate significant challenges to both natural and built environments in coastal towns including

- the concentration of waste,
- more pressure on land,
- sprawling across the coastal environment and
- destroying ecosystems and coastal resources (UNISDR, 2012).

Accordingly, these challenges work together as disaster risk drivers which increase the exposure and vulnerability of coastal dwellers to disasters. Apart from that, all coastal locations are at risk due to the implications of climate change such as the accelerated global sea-level rise and related coastal hazards, changing storm frequency. (Neumann et al., 2015).

Apart from these inherent vulnerabilities, some coastal cities have got specific vulnerabilities such as being located in low lying coastal plains, in close proximity to the shoreline, a high rate of poverty, a weak ability to build and maintain infrastructural defences, susceptibility to cyclone activity, and soft erodible coasts (Celliers & Ntombela, 2015). Due to these inherent and specific vulnerabilities, a large number of coastal population around the world are to more or less, vulnerable to coastal hazards such as coastal Flooding, Tsunamis, Hurricanes, Storm and Wind Damage, and Transmission of marine-related infectious diseases. (Adger, Hughes, Folke, Carpenter, & Rockström, 2005). Therefore, it is an increasingly essential but critical task, to make coastal cities resilience to disasters especially in the context of rapid urbanisation. Accordingly, this study mainly focuses on making coastal cities resilience to disasters. Further, as it was mentioned in section 2.2.4, this study focuses on directly increasing the resilience of the city to a known hazard rather than on accumulated resilience. Hence, the specific coastal hazard is Tsunami which will be focused in this study. This emphasis and the reasons for this focus on Tsunami will be discussed in the next section; 2.2.6.

2.2.6 Focus on Tsunamis

Tsunami is a series of long waves made by a sudden displacement of a large volume of water (National Tsunami Hazard Mitigation Program, 2001). Tsunamis are activated by submarine Earthquakes, submarine volcanic eruptions, underwater Landslides or slumps of large volumes of earth, meteor impacts, and even coastal slope failures that fall into the ocean or a bay. Out of these causes, submarine Earthquakes are the most common cause of Tsunamis (IOC, 2015). Further, Tsunamis can be categorised into two groups; local (near-source) and distant (far-source) Tsunamis (Ardekani & Hosseini, 2012). The first type Tsunamis do not take a long time to reach to the coast generally less than an hour, whereas distant Tsunamis may take longer to reach the coastline.

Tsunami is a hazard, and this hazard turns in to a disaster when it harms people and damages property beyond the ability of the community to cope with it. Tsunami disasters are considered as the ever-present threat to lives, infrastructure, and properties along the coasts. Confirming this, the effect of Tsunami events occurred in various countries from 1980 to 2018 can be presented as follows (Table 2.1).

Year	Country	Total Deaths (No. of People)	Economic Damage (US$X1000)
2004	Indonesia	165,708	4,451,600
2004	Sri Lanka	35,399	1,316,500
2011	Japan	19,846	210,000,000
2004	India	16,389	1,022,800
2004	Thailand	8,345	No Data
2018	Indonesia	3,400	1,000,000
1998	Papua New Guinea	2,182	No Data
2006	Indonesia	802	55,000
2010	Indonesia	530	No Data
2010	Chile	562	30,000,000
2004	Somalia	298	100,000
2004	Maldives	102	470,100
2004	Malaysia	80	500,000

Table 2.1- Overview of Tsunami Disasters from 1980-2018, Source- (EMDAT, 2019)

Accordingly, considering the number of deaths, Tsunami 2004 is recorded as the most devastating Tsunami event during the period of 1980 to 2018, which has taken the lives of more than 275,000 people. Comparably, Tsunami of the north Pacific coast, Japan 2011 took a lesser number of human beings around 19,000 (Asian Disaster Reduction Center, 2011). As per table 2.1, the economic damage was higher as the cost was more than 200 billion US$. Accordingly, it can be noted that the destruction caused by two major Tsunamis in the history; Indian Ocean 2004 and Japan 2011 have exposed the weaknesses of capability and understanding to cope with these catastrophic events.

Disasters such as Tsunamis are unavoidable. Nevertheless, the impact and the risk can be reduced. For instance, the Indian Ocean Tsunami, 2004 with a magnitude of 9.0 Earthquake became one of the deadliest disasters in recent history, which was caused not only because of the extreme Tsunami heights but also due to the insufficient warning, awareness, and early evacuation responses (Mas et al., 2015). Comparably, the Japan Tsunami 2011 with a magnitude of 9.0–9.1 Earthquake had fewer casualties, not only because of structural countermeasures, but also due to the rapid dissemination of warning information, disaster education, Tsunami awareness, and, in particular, speedy evacuation responses (Mas et al., 2015). Accordingly, the comparison of these two events can be used as a learning tool to understand the importance of social component especially for saving lives during Tsunami evacuation.

Further, the recent Tsunami events in Indonesia 2018, reminded the world, the importance of the continuous focus on resilience approaches to Tsunamis. For instance, Indonesia was struck by Tsunamis two times within the year 2018. On 28th September 2018, a magnitude 7.5 Earthquake and Tsunami killed more than 2,000 people in Palu, the capital, and nearby areas on Sulawesi island (WorldVision, 2019). Then, on the 22nd of December 2018, another Tsunami struck Java and Sumatra resulting in more than 300 deaths (WorldVision, 2019). Accordingly, it can be understood that though Tsunami was known as a disaster which in unpredictable and infrequent, the frequency has increased affecting different parts of the world. Therefore, there is a growing need for making coastal cities around the world resilience to Tsunamis. Recognising this importance, this study focuses on making coastal cities resilience to Tsunamis.

Further, there are various approaches to make coastal cities resilience to Tsunamis. Considering the social aspect, the methods of public awareness through education regarding Tsunami risks, community preparedness and early warning have become more prevalent in DRR approaches of Tsunamis. Apart from that, the strategies to reduce the vulnerabilities should also include hazard, vulnerability and risk assessment, making specialists in national and early warning, promote engineers, designers and official administers to plan and design efficiently against Tsunamis, develop and update more effective warning systems and offer new technologies (Altan, 2008). Adding to this, Taubenböck et al. (2009) emphasise the need of interdisciplinary approach integrating engineering, technology and social science disciplines to provide comprehensive information for disaster risk assessment, risk reduction and DM. Out of these various approaches, as it was mentioned in section 2.2.4, this study focuses on urban planning and design strategies. However, section 2.2.4 broadly discussed the role of urban planning for disaster resilience, not for Tsunami disaster resilience. Therefore, with a specific focus on Tsunamis, the importance of urban planning and design approaches for Tsunami disaster resilience will be discussed in section 2.3.

However, before moving to the discussion on the role of the urban planning and designing for Tsunami disaster resilience, it is important to define the term ‘Tsunami disaster resilience’ in this study, as there can be different interpretations to this term. Accordingly, the following section; 2.2.7 defines the term Tsunami disaster resilience.

2.2.7 Definition of 'Tsunami Disaster Resilience'

As it was discussed in section 2.2.2, the term 'Disaster resilience' is defined as 'the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner'(UNISDR, 2009). Further, as mentioned in section 2.2.3, this study focuses on the city context. Therefore, this research focuses on 'the ability of a city to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner'. Furthermore, as it has been discussed in section 2.2.6, the particular focus of this study has been given on the Tsunami Hazard. Therefore, the meaning of the 'Tsunami Disaster Resilience' in this study, can be framed as 'the ability of a city exposed to Tsunamis to resist, absorb, accommodate to and recover from the effects of a Tsunami in a timely and efficient manner'. With this meaning framed, following section (section 2.3) explores the role of urban planning and designing in Tsunami disaster resilience.

2.3 The Role of urban planning/designing in Tsunami Disaster resilience

Approaches related to the built environment contribute inter-disciplinary strategies to reduce the disaster risk through building, spaces and places (Haigh & Amaratunga, 2010). These built environment-related approaches may widely vary according to the disciplines varying from urban planning, construction management, landscape architecture, to engineering and so on. As it was mentioned in section 2.2.4, out of these various approaches, this study focuses on urban planning and design approaches. Accordingly, this particular section investigates the current role of urban planning and designing when enhancing cities' resilience to Tsunamis. Accordingly, literature related to urban planning and design approaches to Tsunami disaster resilience can be categorised based on a wide variety of themes,

- Based on the stages of the disaster cycle; preparedness, response, recovery and mitigation
- Based on the main components of the development planning; land-use zoning plan, infrastructure plan, transport plan, environment conservation plan and urban design guide and so on.

Accordingly, with a focus on covering all the possible contributions and overlaps, the role of urban planning and designing in Tsunami disaster resilience can be divided into five themes as follows.

1. Role of land-use planning
2. Role of Infrastructure planning

3. Role of site planning
4. Role of design and construction
5. Role of Transport planning
6. Role in risk communication through the built environment

2.3.1 Role of Land-use Planning

Land-use planning directs the location, type of land uses and the intensity of development. Therefore, land-use planning is recognised as a useful tool to reduce the exposure of people and properties to Tsunami Hazards. National Tsunami Hazard Mitigation Program (2001) state that the most effective method of mitigating the Tsunami risk is to avoid or minimise the exposure of people and property through land-use planning. In supporting this view, Ardekani and Hosseini (2012) state that land-use planning should guide the development leaving Tsunami high hazard areas from the development. Here the land-use planning refers to large-scale decisions and plans which determine location types and future development considerations to mitigate community exposure and vulnerability to Tsunami hazards.

Further, the study of the National Tsunami Hazard Mitigation Program (2001) informs that land-use planning strategies are helpful to mitigate the risk in three ways. The first option is to prevent development in high hazard areas. Secondly, when the development cannot be avoided, land-use intensity, building value, and occupancy need to be minimised. Thirdly, when the above two strategies cannot be implemented, when the development takes place in possible inundation areas, planners and designers need to mitigate the risk through site planning and designing techniques. The study further proposes specific land-use planning strategies to reduce Tsunami risk as follows.

1. Designate Tsunami hazard areas for open-space uses and use them for such open-space uses as agriculture, parks and recreation,
2. Acquire Tsunami hazard areas for open-space uses
3. Restrict development through land-use regulations
4. Support land-use planning through capital improvement planning and budgeting

However, this works as a trade-off between the current and future development needs. Land uses change continuously with the development and these changes create more opportunities to integrate Tsunami-disaster prevention measures.

So far, these literature discussions were focused on the mitigation aspect of land-use planning. Apart from that, the synthesis of literature informs that there is a need for more research focus on the relationship between land-use planning and emergency management planning. In supporting this view, Britton and Lindsay (1995) propose urban planners should reflect the aspects of emergency management in development plans instead of emergency planners dealing with risk later the development plan has taken place. Spatial planning defines the orientation of spatial patterns of the built environment with the development of various urban activities and infrastructures. Spatial distribution of urban activities and infrastructures determine the spatial distribution of people.

Further, the spatial distribution of people determines the methods of early warning and evacuation. In that sense, spatial planning is strongly linked with early warning methods and evacuation planning. For instance, if the urban activities are planned with more population concentration towards the Tsunami hazard areas, the early warning methods and mass evacuation plans need to be re-arranged accordingly. Therefore, rather than making emergency evacuation plans after the urban activities are in place, land-use planning need to be well-linked with emergency evacuation planning at the early stages of planning.

Furthermore, the spatial, physical organisation of urban areas regulates the built areas reflecting the needs of conservation areas, buffer zones, open areas for evacuation, etc. which determines the disaster risk (Setiadi, 2014). If the land-use plans and development plans are prepared without considering these linkages, it is challenging to incorporate the emergency evacuation planning and vulnerability reduction measures later. Therefore, instead of simply recompensing the developed risks, emergency planners should be consulted in the overall planning process.

For instance, a study in Padang, Indonesia (Taubenböck et al., 2009) develops inundation scenarios considering the irregular urban pattern characterised by the fundamental physical elements of buildings, streets and open spaces in the entire urban area of Padang. This study shows that the combination of hazard assessment, disaster mitigation, strategic planning and the formulation of policies on land-use planning can reduce the potential impact of a Tsunami in the city of Padang. The level of risk should be determined before planning activities could take place. The approach of disaster managers capacitates the local planners and stakeholders to decide where safe areas could be located, e.g. for evacuation procedure. In this study, information about maximum inundated regions are classified in four distinct probabilistic

impact zones, and they recommend that the houses, buildings and shelters need to be located according to zoning from high, medium to low risk. Likewise, spatial planning can play a significant role in modifying (prohibiting or specialising) land-use in hazardous areas to minimise the impact of hazard events as well as determine the intensity of emergency evacuation responses. Further, this type of risk-based land-use planning is beneficial to identify the safest areas to prioritise direct investments in urban improvements and infrastructure projects and to influence the location, type, design, quality, and timing of development (Setiadi, 2014).

Above discussion identified the connection between land-use planning and urban spatial planning in shaping the growth of built environment and population distribution, thereby reducing the human exposure in Tsunami hazard area. Further, early consideration of risk reduction through spatial planning will make emergency evacuation planning frameworks straightforward. Apart from reducing the risk exposure, spatial planning can facilitate emergency evacuation by integrating emergency response related interests and infrastructure to the urban planning

2.3.2 Role of Infrastructure Planning

Though infrastructure planning is inter-related with the land-use planning and can be covered under the land-use planning section, the special consideration allows discussing unique features which need to be considered in infrastructure planning. The fundamental relationship between the infrastructure planning and the disaster resilience is to minimise the damage to a variety of infrastructures including social infrastructure such as schools and hospitals, transport infrastructures such as railroads, highways, airports, marine facilities, and facilities for electric power, natural gas, petroleum products, water supply, and wastewater.

Out of these infrastructures, critical infrastructure which need to be protected from possible harm (e.g. power substations, hospitals, sewage treatment facilities) should be located out of the Tsunami hazard zone as an integral part of the Tsunami mitigation plan. However, the essential services such as fire stations or permanent lifeguard stations should be located within the hazard zone. Therefore, these structures need to designed to survive Tsunami damage (National Tsunami Hazard Mitigation Program, 2001). Accordingly, the synthesis of literature informs that critical facility or related facilities such as electrical generation, transmission, substations, and distribution systems need to be located out of the hazard zone considering the intended purpose. At the same time, the essential service which does not have alternative

locations such as harbours, railroad, bridges, switching yards for freight and passengers and which serve the day-to-day needs of the cities need to be located within the Tsunami hazard zone with proper safety measures.

Another dimension of infrastructure planning is the industrial facilities which can damage the environment in a Tsunami event. The best example for this is the impact of the 11 March 2011, the Japan Earthquake and Tsunami on the chemical industry (Krausmann & Cruz, 2013). This type of consideration may include dry docks, refineries, power plants, and other shoreline industrial facilities which can cause disasters with burning oil, toxic chemicals, and other hazardous materials.

Apart from the mitigation aspect, Greiving and Fleischhauer (2006) suggest that urban planning plays a significant role in incorporating emergency response related interests. This may also include allocation of additional infrastructure and facilities such as access to healthcare providers (first aid facilities), helicopter landing and access to military care which facilitate the emergency management plan. Likewise, urban spatial planning can support and facilitate the disaster preparedness and response, by providing adequate infrastructure and safeguarding the integration of emergency response related interests in settlement. However, as Setiadi (2014) points out, these needs and concerns should be addressed at the initial stage of the planning and decision process. In this sense, there should be more collaboration and interaction between both domains; urban planning and disaster management.

2.3.3 Role of Transport Planning

The role of transport planning in Tsunami disaster resilience has got two platforms. One platform is the mitigation side of it which was already discussed under section 2.3.2; infrastructure planning related to harbours, railroad, bridges. Therefore, this section is more focused on identifying the relationship between transport planning and emergency evacuation planning.

The basis for the planning evacuation routes is linked with the number of evacuees who need to be moved out of the Tsunami inundation zone and the amount of time available for evacuation (Taubenböck et al., 2009). Generally, there are two methods of evacuation; horizontal evacuation which means moving people to more distance location or higher ground and vertical evacuation which means moving people to top floors in buildings. Out of these two options, if the area is not densely populated, higher grounds are available within reachable distance and if the time permits, horizontal evacuation can be considered as the most

appropriate option. Planning evacuation routes for horizontal evacuation entails two options evacuation by foot and evacuation by vehicle. When evacuating by foot, pedestrian road network, road connectivity with higher grounds and road capacity dynamics are directly linked with urban planning. When evacuating people using vehicles, modes of transportation and traffic management issues need to be considered. In this instance, road connectivity and road capacity are directly linked with urban planning.

However, in some cases, evacuating a large number of people in the hazard area to safer locations may not be possible due to the inexistence of sufficient and reachable higher grounds, limitation of time, infrastructure and mode of transportation. In such cases, especially in a coastal urban area where population and building densities are high, vertical evacuation can be considered as the most appropriate option. When planning evacuation routes for vertical evacuation especially in a densely populated area, evacuation by foot needs to be promoted considering the possible traffic situations. At this point, road connectivity and road capacity dynamics are directly linked with urban planning.

Accordingly, it can be understood that all these possible evacuation scenarios are linked with road connectivity and road capacity. Therefore, the local transport plans under local development planning should address these types of evacuation needs proactively. For instance, the last mile preparation study in Padang, Indonesia (Taubenböck et al., 2009), demonstrates the inundation scenarios using a multi-scenario approach. This study identifies potential bottlenecks in evacuation and gives scenario-specific evacuation recommendations including evacuation by foot due to the traffic situation, vertical evacuation and locating Tsunami proof shelters and so on. Apart from that, related with the urban planning, the study recommends changes to the built environment of the city including the building of new bridges in order avoid possible bottlenecks in evacuation and widening of narrow streets to improve the coping capacity in the evacuation. In supporting this view, I. O. C. o. UNESCO (2017) highlights that even the public is informed to evacuate by foot or bicycle, they will instinctively drive vehicles during evacuations. Therefore, planners should consider these dynamics when identifying optimum evacuation routes. Further, narrow and heavily used roads in densely populated areas should be planned accordingly to prevent the bottlenecks in traffic. Consequently, it can be understood that the transport planning can play a significant role when planning emergency evacuation routes, through its ability to influence them.

Apart from the above-discussed factors, Evacuation behaviour is another expanse which needs

to be considered when planning evacuation routes. It is not directly related to urban planning. However, urban planning and designing determine how people take quick actions accordingly. Further, the evacuation behaviour of all the social groups and most vulnerable people of society is an important factor to consider when designing evacuation routes. As an example, a study of Padang, Indonesia (Taubenböck et al., 2009) shows that because of not considering the age and gender structure in the evacuation estimations, the evacuation time in the context of Padang would be caused such heavy traffic that individual evacuation velocity would not be significant anymore. In this regard, differences in the proportion of women, children, and aged people is an essential factor when planning and designing the evacuation routes.

In summary, considering the fact that most of the coastal cities are densely populated, possible traffic management solutions need to be considered when planning evacuation routes. In this regards, urban planning solutions need to be introduced considering the connectivity and road capacity, e.g. widening the roads, bridges, straight roads towards the hinterland. Apart from that, evacuation behaviour of all members of the society (women, children, disabled people and aged people) need to be considered when planning and designing streets as evacuation routes.

2.3.4 Role of Site Planning

Once the development plans determine that such development will take place on a particular location with transport connectivity, site plan determines the arrangement of the structures within site and shaping the space between, which include access to the site, circulation, location of structures and landscaping. Further, when the development site is located within Tsunami hazard area, site planning can play a role to minimise the risk through its ability to intervene through the strategic location of structures and open space areas within site, erection of barriers through the design of landscaping, the density of development, and so on. National Tsunami Hazard Mitigation Program (2001) state that when minimising the Tsunami risk through site planning, local site conditions need to be adequately analysed with an understanding on understanding how Tsunamis impact different types of site geography, land uses and building types, and development patterns. Further, they state that the depth of Tsunami inundation, speed of currents, presence of breaking wave or bore conditions, debris load, and warning time can vary significantly from one site to another. Accordingly, they propose four basic site planning techniques which can be used to reduce the Tsunami disaster risk, as follows.

1) Avoid inundation areas – e.g. raising structures above Tsunami inundation levels on piers or hardened podiums.
2) Slow water currents – Specially designed forests, ditches, slopes, and berms can slow and strain debris from waves.
3) Steer water forces - using angled walls and ditches, and using paved surfaces that create a low-friction path for water to follow.
4) Block water forces - Hardened structures such as walls, compacted terraces and berms, parking structures, and other rigid construction can block the power of waves.

In supporting this view, Eisner (2005) emphasises that site planning can be used to slow and channel inundation away from structures and Federal Emergency Management Agency's (FEMA) Coastal Construction Manual 2002 introduces numerous structural techniques that apply to both storm surge and Tsunami inundation. However, these methods and procedures may vary according to the type of development. For instance, if tourist resort is to be sited with a broad range of facilities, the resort planning can incorporate various mitigation methods such as open space and Tsunami forests, elevating or locating structures above estimated inundation levels, and buffering smaller buildings with larger hotels and waterfront structures (National Tsunami Hazard Mitigation Program, 2001). Neighbourhood planning can also reduce the risk through the arrangement of housing and subdivision and by providing access roads perpendicular to shore which can be used for emergency evacuation and so on. Accordingly, it can be understood that site planning can also play a significant role when mitigation the Tsunami risk and even when planning for emergency response.

2.3.5 Role of Design and Construction

As it was discussed in section 2.3.1, the most straightforward mitigation practice is to locate the new development out of the hazard zone. However, with the pressure of the urbanisation, with the intended purpose of the building use, if the development needs to be located within the hazard zone, as discussed in section 2.3.3, site planning can also play a particular role in mitigation and emergency evacuation. Apart from the macro-scale development, when it comes to the micro-scale, the building design and the construction need to play a critical role regarding the structural stability in a Tsunami event.

Ardekani and Hosseini (2012) state that building design considerations can effectively mitigate the disaster risk with the use of construction methods, architectural and structural strategies. This is where the architecture, construction management and civil engineering disciplines can

act an effective manner in Tsunami DRR. For example, one of the most effective strategies to reduce the wave loads on the structure and walls of the building through a Tsunami attack is to design the building in a way to let the water pass through the ground floor of the building. Adding to this, National Tsunami Hazard Mitigation Program (2001) emphasise that location of the building and its configuration (size, shape, elevations, and orientation) can address the forces associated with water pressure, buoyancy, currents and waves, debris impact, scour, and fire. However, these requirements need to be regularised through the building codes by the municipalities rather than keeping them as proposals.

2.3.6 Role in Risk Communication through Built Environment

UNISDR Framework for effective Early Warning Systems includes four elements (Hettiarachchi, 2014) as follows.

1. Risk Knowledge, Detection,
2. Monitoring and Warning Service,
3. Dissemination and Communication,
4. Response Capability.

Out of these four elements, risk knowledge element represents the effective communication and response capacity of the community to the local Tsunami early warning system and the evacuation process. The effectiveness of the early warning system and the evacuation process is determined by how well communicated the risk information to the local level and the ability of the community to act accordingly to evacuate on time. When communicating the disaster risk to the community level, more focus is given on awareness programs for individuals and groups, and institutional arrangement. The part of urban planning and designing in communicating the disaster risk is less focused. Emphasising this need, the study of Setiadi (2014) highlights that urban planning and designing can play a mediator role in risk communication through signboards and urban design elements.

Out of these various interventions, signage is the most common method of risk communication through the built environment. Further, Signage is an integral part of practical Tsunami risk management. As IOC (2015) manual informs, to increase the efficiency and effectiveness of Tsunami evacuation, public awareness needs to be raised through the signage showing evacuation zones and routes. Placing this evacuation signage in a well-linked manner in strategic places determines the critical link between the evacuation plan and an actual event. Adding to this, Taubenböck et al. (2009) state, the strategic signposting can be used to release

congestion areas in case of evacuation. Accordingly, it can be understood that strategic signposting can significantly affect the overall effectiveness of the Tsunami evacuation process, therefore need to be placed well-aligned with the built environment and the activity pattern of people.

In summary, this section categorised the role of urban planning and designing in Tsunami disaster resilience into six main parts; land-use planning, infrastructure planning, transport planning, site planning, design and construction, and risk communication through the built environment. Accordingly, it was identified that the ability of land-use planning in reducing the human exposure in Tsunami hazard area is a well-recognised area, yet its ability to facilitate the emergency evacuation through integrating emergency response related interests to the urban planning remains under-covered. Reflecting the same scenario, infrastructure planning section emphasised that apart from the mitigation, urban planning facilitates the disaster preparedness and response, yet, such needs and concerns should be considered at the early stages of planning and decision-making process. Widening the area of discussion, transport planning section highlighted that mainly evacuation planning is linked with road connectivity, road capacity and traffic management aspects of transport planning. Therefore, the local transport plans under the local development planning should address the local evacuation needs proactive manner. Furthermore, evacuation behaviour of all members of the society (women, children, disabled people and aged people) need to be considered when planning and designing streets as evacuation routes.

Narrowing down the discussion to a small scale within the city context, site planning section emphasised that site-specific conditions can significantly contribute to mitigation strategies and also when planning an emergency response, yet these strategies may vary according to the type of the development. In the microscale design, building design considerations can effectively mitigate the disaster risk with the use of construction methods, architectural and structural strategies. However, these requirements need to be regularised through the building codes by the municipalities rather than keeping them as proposals. Finally, it was identified that urban planning and designing could effectively communicate the risk to the communities through the strategic signposting and placing them well-aligned with the built environment and the activity pattern of people. Accordingly, it can be understood that urban planning and designing can play a significant role when making cities resilience to Tsunamis through its ability to intervene different scale (macro and micro) within the city, to different types of development, contributing different stages of the disaster cycle.

Recognising this importance, out of the various approaches to make cities resilience to Tsunamis, this particular study will focus on urban planning and design strategies. However, as it was identified in this section, these approaches may broadly vary according to the type of development. Therefore, this study will focus on Public Open Spaces (POS) as the type of the development and reason for this selection will be discussed in section 2.6, following the discussion on focus on Sri Lankan context in section 2.5. Before moving into the specific focus on POS and context of Sri Lanka, next section (section 2.4) attempts to position the research focus, and the factors discussed so far, within the global policy context.

2.4 Global Policy Context

Up to now, the literature chapter outlined the significance of central focus of this research on disaster resilience, Coastal cities and Tsunamis, and the need of focusing on urban planning and designing related approaches of making cities resilience to Tsunamis. Accordingly, this section attempts to position this research focus on the global policy context. There are two leading global policies which emphasise the need of this research focus; the Sendai Framework for DRR 2015-30 (SFDRR) and the Sustainable Development Goals (SDGs). These two policy documents will be discussed in the next two sub-sections 2.4.1 and 2.4.2. Apart from that, other related policies and manuals in the global context will be identified in the sub-section 2.4.3.

2.4.1 Sendai Framework for DRR 2015-2030 (SFDRR)

The SFDRR is a 15-year, voluntary agreement which was adopted at the 3rd UN World Conference in Sendai, Japan, in 2015. This international document is considered as the global framework for DRR effecting 187 UN member states (UNISDR, 2015b). The SFDRR outlines seven targets and four priorities for action to reduce existing and prevent new disaster risks. The four priorities are as follows.

Priority 1: Understanding disaster risk
Priority 2: Strengthening disaster risk governance to manage disaster risk
Priority 3: Investing in DRR for resilience
Priority 4: Enhancing disaster preparedness for effective response and to 'Build Back Better' in recovery, rehabilitation and reconstruction

To achieve 'priority 1; understanding disaster risk', Sendai framework suggest that cross-sectoral approach tailored to localities need to be followed in DRR, which means rather than

just limiting to a specific sector, plans and programmes need to be cross-sectoral affecting policies, strategies and procedures.

Further, these DRR plans should use the traditional, indigenous and local knowledge and practices together with the scientific knowledge in DRR. This emphasis provides a solid base for this study, as this particular research study is not limited to DM strategies, but the study searches the methods and approaches across the disciplines such as urban planning, urban designing, landscape architecture and disaster management. As mentioned above without limiting to the scientific knowledge, the study will ensure the use of traditional, indigenous and local knowledge tailored to localities.

Further, this priority emphasises the importance of developing effective global and regional campaigns as instruments for public awareness and education, where they highlight the importance of the 'Making Cities Resilient: My city is getting ready' campaign. This emphasis encourages the DRR initiatives in all levels local, national, regional and global levels, at the same time highlights the importance of considering the city context. Recognising this importance, this study focuses on urban and city context. Furthermore, the relationship of this study with the 'Making Cities Resilient' campaign was already discussed in section 2.2.4.

Recognising the importance of urban planning and designing related approaches, priority 2 points out the need to mainstream and integrate DRR within and across all sectors including urban planning and designing, where this study precisely focuses. Further, priority 2 encourages the establishment of necessary mechanisms to enhance the existing safety-enhancing provisions including strategies related to land-use and urban planning, building codes. Similarly, priority 3 promotes the idea of building better from the start to resist hazards through appropriate design and construction, including the use of the principles of universal design and the standardisation of building materials; retrofitting and rebuilding. This also promotes the mainstreaming of disaster risk assessments into land-use policy development and implementation, including urban planning, land degradation assessments and so on.

Apart from the existing and future development plans, priority 4 highlights the need for guiding disaster reconstruction through land-use planning interventions and structural standards improvement. Further, the fourth priority indicates the need to further strengthen disaster preparedness for response through the development of effective early warning systems. Similarly, as it will be discussed in section 2.6, in this study the role of POS in land-use

planning interventions and when developing effective early warning and evacuation system are focused as an essential factor within the scope of Tsunami disaster resilience.

In summary, the SFDRR which is the current international framework for DRR confirms the importance and the critical need of the focus of this research study which is the urban planning and designing approaches to enhance the disaster resilience in the city context.

2.4.2 Sustainable Development Goals (SDGs)

Sustainable Development Goals (SDGs) are the global goals set by the United Nations as part of the 2030 agenda for "Transforming our World: the 2030 Agenda for Sustainable Development." (UNDP, 2016). Accordingly, there are 17 global goals covering social and economic development issues as follows.

1. End poverty
2. End hunger
3. Ensure healthy lives
4. Ensure inclusive and equitable quality education
5. Achieve gender equality
6. Ensure sustainable management of water and sanitation
7. Ensure access to energy
8. Promote sustainable economic growth
9. Build resilient infrastructure
10. Reduce inequality within and among countries
11. Inclusive, safe, resilient and sustainable cities and human settlements
12. Ensure sustainable consumption and production patterns
13. Combat climate change and its impacts
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
15. Protect, restore and promote sustainable use of terrestrial ecosystems
16. Promote peaceful and inclusive societies for sustainable development
17. Strengthen the means of implementation and revitalise the global partnership for sustainable development.

Out of these 17 goals, the 11th goal is 'Sustainable cities and communities' which emphasise the need to focus on urban space. Cities are the engines of economic growth, yet it is also identified that most of the social issues such as poverty, affordable housing, sanitation issues are often concentrated in cities, basically in urban spaces. Therefore, making cities safe and sustainable means ensuring access to safe, affordable housing, upgrading slum settlements, upgrading public transport, creating green public spaces, and improving urban planning and management in a way that is both participatory and inclusive (UNDP, 2016). Further, UNDP (2016) confirms the importance of this goal through the emphasis on following facts and figures.

- 3.5 billion people, half of the world's population, live in cities.
- Cities inhabit just 3% of the Earth's land but account for 60 to 80 % of energy consumption and 75% of carbon emissions.
- Currently, 828 million people live in slums, and the amount is increasing.
- In 1990, there were ten cities with 10 million inhabitants or more; by 2014, the number of 'mega-cities' had reached 28.
- In the near future, 95% of urban expansion will take place in the developing world.

Accordingly, this global goal of 'Sustainable cities and communities' confirms the critical need of focusing on cities context which is the focus of this particular research. Together with the emphasis on cities, this goal informs that '95 percent of urban expansion will take place in the developing world' which means the focus is more needed on developing countries context.

Relating this fact with Sendai framework, priority 3 promotes the collaboration between academic, scientific and research bodies and networks and the private sector to develop new products and services to help to reduce disaster risk, specifically, those that would assist developing countries and their specific challenges (UNISDR, 2015b). Particularly, Disaster-prone developing countries should give special attention to their risk levels, and higher vulnerabilities which surpass their capacity to respond to and recover from disasters. Recognising this importance, this particular research study will focus on Tsunami prone developing country which is Sri Lanka, and further justification for this selection will be discussed in section 2.5.

2.4.3 Other related Global policies and Manuals

Under this section, two main international documents will be addressed; the Paris agreement 2015 and Intergovernmental Oceanographic Commission (IOC): Manuals and Guides 52.

Paris agreement which operates under the United Nations Framework Convention on Climate Change (UNFCCC) is prepared to combat the climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future (UNFCCC, 2015). Though climate change is not directly related to this study as this study focuses on Tsunami, this agreement contains collective, long-term adaptation goals on adaptation towards enhancing adaptive capacity, strengthening resilience and reducing vulnerability. Accordingly, Article 7 identifies the importance of knowledge of traditional knowledge, knowledge of indigenous peoples and local knowledge systems and special attention on developing countries which is the focus of this research study.

The second document is the Intergovernmental Oceanographic Commission (IOC): Manuals and Guides 52 which guides the Tsunami risk assessment and mitigation for the Indian ocean. As this study focuses on Tsunami and the Sri Lankan context, this document informs the existing strategies to enhance resilience to Tsunamis. In a broader context, IOC (2015) suggests four main strategies to improve resilience to Tsunamis through the analysis on lessons learned from three major Tsunamis; Indian Ocean 2004, Chile 2010 and Japan 2011. Those four main areas are as follows,

- Importance of a global Tsunami warning system, with procedures for Tsunami hazard and risk assessment, warning guidance and preparedness.
- Adequacies procedures and seismic networks to characterise Earthquakes and the magnitudes of potential consequent Tsunamis
- 'The need for awareness'. Public awareness of actions need to be taken during Tsunami emergency and also their vulnerability
- Reduced Physical Vulnerability through land-use planning. For example, the location of critical infrastructure, including shelters, hospitals, schools, power plants, emergency operation centres and airports.

Accordingly, IOC (2015) has identified first and third strategies to reduce social vulnerability, the first and second strategies focusing technological and procedural side and fourth strategy focusing both physical and social resilience. Further, the fourth strategy identifies the

importance of land-use planning as the primary tool to reduce physical vulnerability. Cross-referencing this with the Sendai framework, UNISDR (2015b) emphasise that poor land management, unplanned and rapid urbanisation is a disaster risk driver together with other factors such as the consequences of poverty, inequality, weak institutional arrangements and so on.

In summary, the discussion on the global policy context confirmed the significance of the focus of this research on disaster resilience in the context of the city, developing countries and planning and designing approaches. Further, the planning and design strategies may vary due to the context-specific factors such as geography, planning laws and regulation, socio-cultural factors. Therefore, it is important to focus on a particular context if the research finding needs to be more robust and specific rather than abstract and impractical. When focusing down to a specific condition, the above discussion identified the importance of focusing on developing countries context. Within the Tsunami prone developing countries context, this study will mainly focus on the Sri Lankan context due to three main reasons. The first reason is, Sri Lanka is one of the Tsunami prone countries located in the Indian ocean, and the 2004 Tsunami was one of the worst disasters ever recorded in Sri Lankan history. Secondly, Sri Lanka is a rapidly urbanising country with a majority of the population lives in coastal cities with major income sources are concentrated. Hence, any adverse effect on the coastal cities will affect the country's national economy and the social setting. Thirdly, despite these vulnerabilities, the built-up area is increasingly expanding within the coastal cities through unplanned development activities which significantly increases the disaster risk of coastal cities in Sri Lanka. These reasons will be further discussed in section 2.5.

2.5 Tsunami Disaster Resilience in Sri Lanka

2.5.1 Disasters and the planning system in Sri Lanka

According to the world risk report 2018, Sri Lanka has been ranked at 61 on the world natural disaster risk index as the result of disaster exposure and vulnerability (ReliefWeb, 2018). Within Sri Lanka, Flooding and Landslides are recorded as the most frequent disasters. Apart from that, the Disaster risk index 2017 has identified that the Tsunami is the highest risk for Sri Lanka with the risk index of 8.2 (OCHA, 2017). These discussions would unquestionably place Sri Lanka as one of the disaster-prone countries compared to the world context. Accordingly, the next question is, in responding to these vulnerabilities whether the planning system in Sri Lanka facilitates the risk-sensitive development or not, and integrate the disaster

risk reduction initiatives to the development plans. The search of literature answering the above-mentioned question informs that, initiatives have been taken place, yet improvements need to be taken place to lift up the country from the current place of disaster exposure and vulnerability.

As in most of the other countries of the globe, the planning system in Sri Lanka is guided by three levels; national planning, regional planning and local planning. The National Physical Planning Policy and national physical plan provide a broad framework at the national level (NPPD, 2010). Within this broad framework, Land-use planning operates in four levels; National land-use Policy 2007, District land-use plans, Divisional secretary-level land-use plans and local level land-use plans (Jayasundara, 2017). In relation to urban planning, Urban development authority under the Ministry of urban development plans and implements the economic, social and physical development of the areas declared as urban development areas. In terms of local planning, local authorities develop the local plans within the national physical planning guidelines. UN-Habitat (2015) in their country report highlights that planning system in Sri Lanka is relatively strong at the national level and weak at the local level in terms of technical capabilities in implementation, therefore implementation strategies need to be reviewed. Further, these development plans largely change due to political influences. Within this context, if the consideration is given on the disaster risk-sensitive planning and disaster preparedness in Sri Lanka, the attention on disaster management and prevention was gained mainly after the 2004 Indian Ocean Tsunami (DMC, 2014). Concisely, most of the legislative and policy decisions were came into operation after the 2004 Tsunami. However, most of the recent disaster events display that still the Sri Lanka's disaster management system focuses more on disaster response and recovery rather than on disaster prevention and preparedness (IPS, 2007; OCHA, 2016). Reflecting this issue on urban planning system in Sri Lanka, disaster management and resilience is well-addressed at the vision-mission statements of the development plans and seldom-addressed in strategies. Even with the identified strategies, as emphasized by UN-Habitat (2015) the effectiveness of implementation of these strategies depends on the technical capabilities of the local authorities and the political influence. As it was mentioned above, if the disaster management strategies were implemented by the national-level organisations, then the effectiveness is relatively high than the local level.

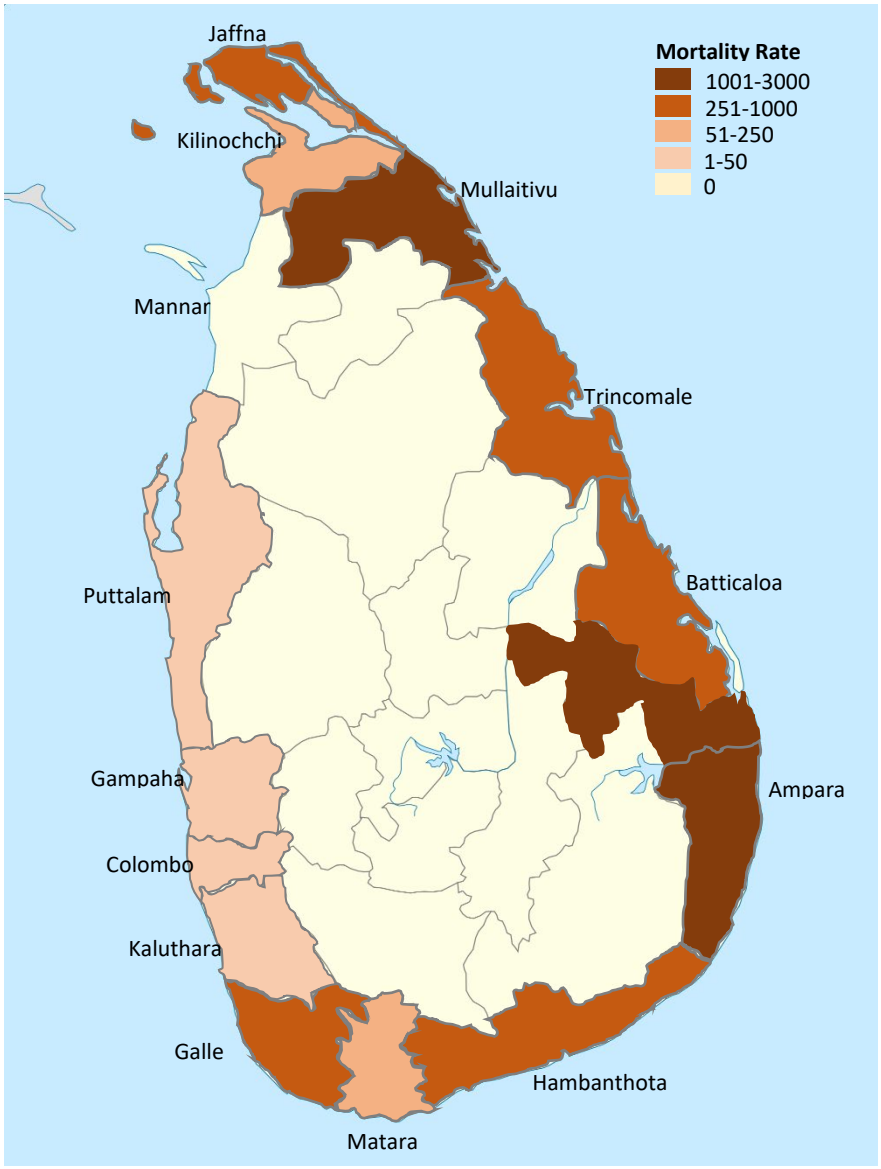
2.5.2 Tsunami Disasters in Sri Lanka

Sri Lanka is a rapidly urbanising island country with a trend pattern of the rapid transformation of rural areas to urban. UN-Habitat (2016) points out that the estimated population living in urban local authority areas will reach up to 22 million by 2020 turning the urban population percentage to 50%. Further, UN-Habitat (2016) highlights that with the urbanisation trend pattern, 70% of the urban population and 80% of national economic infrastructure is concentrated majority in coastal cities and other cities in disaster-prone areas. Moreover, the average contribution of Sri Lanka's coastal zone to the national Gross Domestic Production (GDP) is 40% with a significant contribution from Marine fisheries and tourism-related industries and services (Samaranayake, 2006). Accordingly, it can be noted that any adverse effect on the coastal zone of Sri Lanka will affect the significant proportion of the country's population and 40% of the GDP of the country.

Apart from that, the development pattern and the unplanned coastal urbanisation have brought many issues and problems to the coastal zone such as overexploitation of coastal resources, water quality deterioration, degradation of coastal habitats, sand mining, coal mining, coastal erosion and so on. Even though these issues exist before the Tsunami 2004, making this situation even worst and disrupting the economy primarily, marine fisheries and tourism-related industries, the Tsunami December 2004 caused extensive damage to the coastal zone of Sri Lanka (Map 2.1). It disrupted lives, livelihood, infrastructure, private and public properties, effects to the society and economy of the whole country (Table 2.2).

Overview of the Impact of 2004 Tsunami Disaster, Sri Lanka	
No. of Deaths:	35 322
No. of People Injured:	21 441
No. of People Missing:	Over 5000
No. of People-Internally displaced:	516 150
Value of lost assets	US$900 million

Table 2.2 Overview of the Impact of 2004 Tsunami Disaster, Sri Lanka, Source-(Samaranayake, 2006)



Map 2.1 2004 Tsunami Disaster-Number of deaths by District, Sri Lanka, Source-(Grossman, 2005)

Due to this massive devastation and fatalities occurred, Tsunami 2004 is considered as one of the worst disasters ever recorded in Sri Lankan history. However, it is known that the Tsunami warning call was sent to the central authorities of Sri Lanka, India, Maldives and other affected countries. Nevertheless, this warning was not delivered to the people at the coastline due to the absence of any experience with Tsunami and as there was no established communication network or organizational infrastructure to deliver the warning call to the local level (Samaranayake, 2006). Accordingly, these facts alarmed the country and the region about the importance of having a Tsunami early warning system and evacuation process, including other factors such as Tsunami hazard and risk assessment, warning guidance, public awareness, and measures to reduce the vulnerability (physical and social).

Apart from the lessons learned from the Tsunami 2004, the Disaster risk index 2017 (OCHA, 2017) has identified that the Tsunami is the highest risk for Sri Lanka with the risk index of 8.2. Accordingly, these records highlight the importance of the continuous focus on Tsunami threat within the context of Sri Lanka on which this study is focused.

2.5.3 Issues related to Early warning and Evacuation planning

Recognising the prominence of an effective early warning system, in the aftermath of the Indian Ocean Tsunami, the Indian Ocean States decided to establish an Indian Ocean Tsunami Warning System (IOTWS) under UNESCO/ Intergovernmental Oceanographic Commission (IOC), Paris in March 2005 (Hettiarachchi, 2014). The IOTWS is developed to be an End-to-End Tsunami Warning System which includes two parts; upstream and downstream. The upstream includes detection, verification, threat evaluation, Tsunami forecast, warning dissemination and the downstream includes, the commencement of national counter-measures, delivery of public safety message, preparation and implementation of standardised response.

Subsequently, Sri Lanka developed an early warning system to disseminate the Tsunami warning to the ground level under the Ministry of Disaster Management, Sri Lanka. Once the Tsunami threat is detected, the regional Tsunami service provider (TSP) communicates the warning to the national Tsunami warning centre (NTWC) in each country. According to the current institutional arrangement in Sri Lanka, Department of Meteorology (DoM) acts as the NTWC who receives the warning information from the Indian ocean TSPs. Once the alert is received by the DoM, they determine the possibility of a Tsunami and its local impact.

Once the threat is confirmed, the warning is sent to the Disaster Management Centre (DMC) who acts as the national disaster management organisation in Sri Lanka, to take the necessary actions of warning the public and evacuation, while informing all the relevant institutions at national and local level (Haigh et al., 2019). Then the alert will be disseminated to the local level through district disaster management centres, divisional secretariat offices to the GN level (WorldBank, 2014). Further, Police, forces, Grama Niladaries (Heads of GN division), community committees operate in the ground level to disseminate the early warning and directing people to the high grounds and previously identified evacuation shelters. Apart from that, District Emergency Operation Centre informs the other relevant authorities such as Tri-forces (Navy, Army, Air Force), Ceylon Transport Board (CTB), Ceylon Electricity Board (CEB), Hospitals to facilitate the evacuation response.

Further, in case of a Tsunami, public schools and religious places are commonly used in Sri Lanka to provide shelters to those who are evacuated from the affected area (Haigh et al., 2019). The current evacuation process is equipped with communication methods like telephone, Fax, cell broadcast, V-Sat communication, and early warning towers (WorldBank, 2014). Apart from this formal mechanism, many alternative channels have been developed through media including TV, radio and local fishers who are directly connected with the regional centre mobile alert. WorldBank (2014) states that there has been a series of community-based activities promoting awareness, identification of evacuation centres through community-based mapping, and mock drills,., to improve the community awareness and preparedness. Apart from that, DMC has conducted school safety programmes, hospital safety programmes to strengthen institutional awareness and preparedness.

Though there is a system developed to disseminate the Tsunami early warning and for emergency evacuation, the literature findings reveal that the current early warning and evacuation system entails numerous issues as follows.

- Lack of understanding about each other's roles in decision making among the national actors (Haigh et al., 2019).
- Disaster preparedness is centralised, and the decision making power is not transferred among national, regional, local and to village level (Thomalla & Larsen, 2010).
- The SOPs followed by different institutions do not follow a standard guideline, creating misunderstandings and miscommunication among the actors (Haigh et al., 2019).
- Lack of coordination within different stakeholders resulting in the absence of a proper warning system and evacuation plan (Shaw, 2015)
- Local government institutions in both rural and urban areas are not assigned clear roles within the system (Haigh et al., 2019).
- The tourist sector agencies are not appropriately integrated into the system, which could potentially put a large number of local and international tourists at risk (Haigh et al., 2019).
- Measures need to be developed to safeguard the interests of tourists (Shaw, Kurita, Nakamura, Kodama, & Colombage, 2006)
- Inadequate technical capacity among the district and local level actors to deal with emergencies (Haigh et al., 2019).

- Issue of lack of training among the different actors within the downstream as they are endowed with other roles and responsibilities in addition to Tsunami preparedness (Haigh et al., 2019).
- Seminars and drills on disaster have not thus far been conducted among general officials other than the military and police (Shaw et al., 2006)
- Less capacity of the community to take action in response to a received warning (Thomalla & Larsen, 2010)
- Lack of consultation with communities when identifying shelters and evacuation routes (Thomalla & Larsen, 2010)
- Some of the signs and direction boards installed have been either vandalised or not maintained by the relevant institution and these need to be restored without delay (Haigh et al., 2019).
- Some places, sign pointing to a safe site had been erected, but the shelter was never constructed due to a lack of funds (Thomalla & Larsen, 2010).
- There are also specific vulnerable segments of the population that fall outside the usual network of communities and need special attention within the early warning and evacuation system (Haigh et al., 2019).

Apart from the above, DMC has also identified a set of challenges through the self-evaluation their system as follows (ICG/IOTWMS, 2018).

- Frequency of Tsunami event is low, therefore challenging to sustain village level committees
- Issues related to receiving early warning messages from TSPs (Tsunami Service Providers)
- Not prepared for near Tsunami event
- Never tested the early warning at night

Accordingly, it can be understood that Sri Lanka's Tsunami early warning and evacuation system faces may challenge, compared to the global context. For instance, Indonesia which is a Tsunami prone country in Southeast Asia demonstrates good practices on Signage warning about danger zones, beach observation posts, evacuation routes and assembly points are also placed in affected areas and locations with a high frequency of visitors and passers-by (UNESCO, 2019). In terms of disaster risk awareness and education, Japan proves the good practices on risk awareness, as it starts at the school's level. Drawing from past disaster experiences, risk awareness is enhanced through the development of practical skills and routine

disaster education at school in order to take actions when a disaster strikes (OECD, 2019). Likewise, compared to the global context, Sri Lanka's early warning and evacuation system together with the public awareness need to be improved on a wide scale.

Out of the issues discussed in the current Tsunami early warning system and the evacuation planning system in Sri Lanka, some of these issues are directly related to developing an effective communication system, decision-making system, capacity development, institutional and procedural matters which are not directly related with the urban planning and designing focus of this research. However, apart from that, there are issues which are directly and indirectly related to urban planning and design solutions as follows.

- Delays in early warning system and evacuation planning due to various issues which need to be rectified from the institutional level. However, apart from that, by planning the cities' buildings and spaces facilitating the easy evacuation can speed up the process in evacuation which can further strengthen the process.
- Participatory mapping when identifying shelters and evacuation routes
- Evacuation planning system which can be easily understood by local and international tourists.
- Without relying solely on signboard system arrange the buildings and spaces directing people towards the right direction.
- Plan and design evacuation routes and the shelters with special attention on all the vulnerable groups of the society including disabled people, aged people, women and children.

In supporting this view, the study of Haigh et al. (2019) recommends strengthening the evacuation procedure by improving on evacuation infrastructure such as direction boards, evacuation paths, shelters, logistical facilities, adequate space. Here, evacuation paths and adequate space are directly linked with the POS where this study will be focused on (Section 2.6). Further, in addressing these identified issues, especially the city context (which attract a large portion of the population including commuters and tourists), should have a proper mechanism to arrange these evacuation infrastructures such as direction boards, evacuation paths, shelters, logistical facilities, adequate space. This emphasis further highlights the importance of urban planning and designing interventions for an effective early warning and evacuation system. With this emphasis, section 2.6 will explore the potentials of POS in addressing these urban planning and designing interventions.

2.5.4 Issues related to Mitigation Planning

The issues and challenges discussed in the above section; 2.5.3, are associated with the existing Tsunami early warning system and the evacuation process. Apart from that, if the consideration is given to the Tsunami disaster mitigation measures in Sri Lanka, 'Tsunami 100m buffer zone' was the major input which was enforced after 2004 Tsunami to mitigate the future risk.

Prior to Tsunami 2004, most of the state land especially in urban areas were encroached by the coastal communities. After the Tsunami, considering the vulnerability factors such as exposure to extreme natural events, current development densities geomorphological characteristics, and availability of free space, the government decided to apply set-back zones of 100 and 200 metres in the west and south coasts and then north and east coasts respectively (Samaranayake, 2006). However, due to the limited available land to relocate displaced families, the Secretary of the Ministry of Urban Development and Water Supply and the district secretaries requested the Coast Conservation Advisory Council (CCAC) to reduce the size of the setback zone. As stated by Samaranayake (2006), the CCAC considered the request and approval were granted for construction following the setback standards stipulated in the National Coastal Zone Management Plan 1997. Subsequently, despite the risk of the next Tsunami, people and organisations have gradually initiated rebuilding, especially the fisheries and tourism sectors (Samaranayake, 2006). Currently, the coastal zone setback lines are demarcated primarily focusing on coastal erosion and not considering the Tsunami threat. Accordingly, it can be understood that Sri Lanka is still facing many challenges in mitigation methods.

As it was discussed in section 2.5.3, rapid urbanisation brings more pressure on coastal cities in Sri Lanka, along with these challenges in the early warning system, evacuation planning and mitigation. Therefore, it is increasingly important to enhance the resilience of coastal cities in Sri Lanka to Tsunamis. Further, as it was discussed in section 2.3, particularly planning and designing strategies can play a vital role when enhancing the cities' resilience to Tsunamis. Accordingly, the research focus is further narrowed down to the context of Sri Lanka when finding out the planning and designing approaches to enhance the cities' resilience to Tsunamis. Further, as it was discussed in section 2.3, these planning and designing strategies may vary according to the type of development. Therefore, this research is focused on POS development and the reasons for the selection of POS will be discussed in section 2.6.

2.6 Public Open Spaces (POS) for Tsunami Disaster Resilience

The importance of integrating urban planning and designing strategies with disaster management strategies when enhancing cities' resilience to Tsunamis was discussed in section 2.3. Furthermore, these planning and designing strategies for Tsunami disaster resilience can be focused on different spatial elements such as building structures, evacuation road networks, open spaces, forests and natural reserves. Out of these spatial elements, this particular research focuses on the use of POS when enhancing cities resilience to Tsunamis using effective evacuation planning, mitigation and public awareness.

Accordingly, first, it is essential to identify what does it mean by 'POS'. Secondly, whether the POS has already been used to enhance the disaster resilience to Tsunamis and whether the use of POS for Tsunami disaster resilience is fully discovered within the context of the city. Therefore, this section first explores the meaning of POS as there can be different interpretations of this term. Then the above-discussed factors will be explored through reviewing the literature on the current focus on POS as a tool for disaster resilience in general. Then the specific attention will be given to identify the need to focus on POS as a tool for Tsunami disaster resilience and the current research gaps associated with it.

2.6.1 What is a Public Open Space?

The term 'Public open space' was first used in the 19th century in the United Kingdom and the United States with a view of assigning spaces to enhance the quality of life and health of the working-class people who lived in squalid and congested living environments (Giles-Corti et al., 2005; Jayakody, Amarathunga, et al., 2018). Mitchell (1995) states that these public parks were not just 'parks' for the homeless; it was a 'home' for them. Since then the development of POS especially in urban context took place due to various reasons including preserving ecologically sensitive areas; maintaining property values by establishing an undevelopable greenbelt; providing places for recreation and so on. However, POS still play an important role within the urban environment, with a range of meanings from 'green space' (e.g.: parks, greenways) to all public spaces including streets, squares and private open spaces such as gardens, courtyards (Allan & Brytan, 2010; Swanwick, Dunnett, & Woolley, 2003).

POS can be defined from different perspectives. Woolley (2006) describes two types of definitions. The first definition is based on the primary purpose of allocation derived from Policy guidance and the second one from the user's point of view derived from the academic approach.

According to the first definition which derived from policy stance, Public open space stands between green and civic spaces including places such as,

- Parks and gardens
- Natural and semi-natural greenspace, including urban woodland
- Green corridors
- Outdoor sports facilities
- Amenity green space
- Provision for children and young people
- Allotments, community gardens and urban farms
- Cemeteries, disused churchyards and other burial grounds.

The second definition is from the user's point of view, as a place that allows different types of activities encompassing necessary, optional and social events. This includes places such as,

- Parks
- Playgrounds
- Playing fields and sports grounds
- School playgrounds
- Streets
- City farms
- Incidental or 'natural' green spaces

Two main important points that can be raised from these two definitions are

1. POS can be any space between green space and civic space but has to be used by the public and

2. It needs to be an outdoor space which is not covered by buildings.

Carmona (2010) opens up another dimension to this understanding, by categorising the Public space into three categories based on the accessibility, ownership and used by the public.

1. External Public Space – all spaces between the private landholdings including Public squares, streets, highways, parks, parking lots, stretches of coastline, forests, lakes and rivers.
2. Internal Public Space – various public institutions (e.g. Libraries, museums, town hall) and Public transport facilities (e.g. Bus stations, Train stations)

3. External and internal Quasi-Public Space – this means privately owned public spaces such as sports grounds, restaurants, cinemas and shopping malls. Places where legally private and nominally public.

However, Carmona's definition is for Public Space, not for Public Open Space. His description on the first category; external public space, highlights some characteristics of POS such as any outdoor space and publicly own space. Adding to this, Thompson (2002), states that mostly POS are the green spaces, protecting or enhancing natural resources and systems while linking the urban area for recreational uses. This links the idea of publicly accessible outdoors space with the benefits such space can bring; protect natural resources and recreational use. Furthermore, it can be noted that there are various interpretations of the term 'public open space'. Therefore, it is an important task to outline the term 'public open space' in this particular study or other words to define 'what does it mean by POS in this particular study?'

The important point of the Woolley's definition is, 1) it can be any space between green and civic spaces but should be used by the public and 2) The spaces need to be an outdoor space not covered by buildings. Then as Carmona (2010) highlighted, accessibility and use, are two main important points for this study; the open space should be accessible to the public and need to be used by the public. Accordingly, there can be 'open spaces' within a city, but if it is not accessible to the public, that cannot be considered as 'Public' Open Space. Therefore, the 'Public open spaces' should be accessible to the public and also should be allocated for public use which was also identified by Woolley's definition.

Accordingly, it can be summarised that the working definition of 'Public Open Space' in this study, is 'an outdoor space which is accessible to the public and allocated for the public activities'(Jayakody, Amarathunga, et al., 2018), e.g. Parks and gardens, amenity green spaces, public squares, and coastlines. With this understanding, the next section discusses the current use of POS for disaster resilience.

2.6.2 Current Focus on POS

In this section, the researcher will identify the current urban planning and designing focus on POS. In other words, what factors do planners and urban designers consider when creating POS in contemporary cities.

According to Thompson (2002), the most popular use of POS is to obtain recreational uses and to protect the natural resources and green areas. Adding to this, Carmona (2010) states that the

outdoor POS provide life breath to the cities by adding recreational prospects, venues for special events, wildlife habitats and chances for walkability. Further, he states that an open spaces networks connected with green corridors integrate the natural and the built environment which is a key objective of a sustainable city (Jayakody, Amaratunga, & Haigh, 2018).

Adding the socio-cultural aspect to this, Thompson (2002) points out that POS in cities act as a place to party the cultural diversity, to engage with the natural environment, a place to meet the strangers and one can transcend, and the other can be anonymous. Similarly, POS can encourage outdoor activities and results to increase social integration and interaction among people (Chiesura, 2004). Woolley (2006) confirms this by stating that social benefits are the most apparent benefit of urban open spaces. He further discusses that the evidence reveals POS bring social cohesion by promoting passive recreation, active recreation, education opportunities for the children, cultural and community focus. Passive activities mostly linked to the watching children, vegetation, water, other activities and reading, chatting. Active recreation refers to skateboarding, cycling, children games and outdoor games. All these things act together to increase the social interaction of urban life and bring benefits such as safety and social security to the city.

Further, the study of Giles-Corti et al. (2005), confirms that by improving the access to eye-catching large urban open spaces, POS can promote physical activities of the people and the walkability which can possibly subsidise to the health of residents. Adding to this, Thompson (2002) states Public open space should not be an isolated place, and network of open spaces can act as a social space by offering the places to relax, to enjoy the urban experience, for a range of different activities. He further emphasises that especially in the western world there is an ageing demographic trend, therefore providing better access to POS and design for mobility problems will integrate all the members of the society to space. Apart from the benefits for physical health, urban green parks can benefit mental health by reducing the stress of city dwellers and by providing a sense of peacefulness and calmness (Chiesura, 2004). Furthermore, Rishbeth (2001) emphasise that contemporary planners and designers need to focus more on aspects such as ‘inclusive design’ which means design for all including children, aged people, disable people, ethnic minority groups considering their cultural experiences. Accordingly, it can be noted that POS have been used to bring many socio-cultural benefits to the society especially in the urban context.

Apart from the socio-cultural, Physical and mental health, aesthetic beauty and environmental benefits, POS can bring many economic benefits for the cities. For instance, promoting aesthetic, historical and recreational values through the POS, benefit the tourism industry which brings more visitors to the city and thereby creating more employment opportunities and income to the municipalities (Jayakody, Amarathunga, et al., 2018). Further, natural and recreational elements increase the property value and therefore the tax revenues (Chiesura, 2004). Likewise, POS contributes to the overall economic growth of the area.

In summary, the literature synthesis reveals four main areas that most planners and designers focus on; liveability of the city, socio-cultural benefits, environmental benefits and economic benefits. Accordingly, it can be noted, that POS contribute to creating sustainable cities from all its three counts; social, economic, and environmental (Chiesura, 2004). The factors such as increasing the social interaction, urban quality of life, improve aesthetic attractiveness, increase the walkability, liveability and vitality of a city contribute to the social pillar of sustainability. Air and water purification, wind and noise filtering, or microclimate stabilisation and improve environmental health add to the environmental pillar of sustainability. Increase of property value, tourism attraction, employment opportunities provide the economic component of sustainable cities. Consequently, POS can play a significant role when creating sustainable cities.

2.6.3 Potentials of POS for Tsunami Disaster Resilience

While POS play a vital role in making cities sustainable contributing to three main pillars; social, economic and environmental, as Vargas-Moreno et al. (2014) states POS can act proactive manner with its' contribution to the entire city in multi-scale and have the capacity to resolve both current and future problems. At the same time, as it was discussed in section 2.2 and 2.5, the need to enhance the cities' resilience to Tsunamis, is an increasingly important but critical task especially in the context of Sri Lanka. On the other hand, if the current focus is towards sustainable cities, sustainable development should incorporate the improvements of disaster resilience (Paton & Johnston, 2006). However, Hossain (2014) states that the role of POS in increasing cities' resilience to disasters, has not been fully uncovered yet. Within this context, the following literature synthesis examines the potentials of POS when enhancing cities' resilience to Tsunamis. Accordingly, the literature analysis discloses that the POS in cities has the potential to contribute three main stages in the disaster cycle; emergency response, recovery and mitigation.

2.6.3.1 Emergency Response and Recovery

The potential use of POS for emergency response and recovery is mostly discussed in the literature related to Earthquakes and Tsunami events. In an Earthquake or Tsunami event, people may have a few minutes or hours to gather to a safe place and for shelter. Accordingly, León and March (2014) state, the community's ability to make appropriate decision and response rapidly and effectively for an emergency, decides the resilience of that community. When improving the community resilience, Allan and Bryant (2010), analyse the critical role of POS in an Earthquake event: a case study in San Francisco, Northern California. This study reveals that, after a major Earthquake, a network of open spaces acts as a 'second city' providing simple to complex services such as gathering, shelter, distribution of goods and service, temporary inhabitation, commemoration. Further, they highlight that different typologies of open spaces contribute different functions, varying from small parks to playgrounds.

In addition, Dionísio, Ota, and De Souza (2011) state that in case of fire resulting from Earthquake, small and medium POS helps to local disaster prevention by providing water access points and prevent spreading the fire through the built fabric. However, their study highlights that not all open space have the same role as some open spaces can also be used as an answer to problematic accessibilities to designated evacuation areas. This discussion further confirms the Allan and Bryant's idea of different open spaces for various uses in emergency response. Further, Taubenböck et al. (2009) emphasize the need of identification of natural safe areas for emergency evacuation by overlapping the land-use maps with Tsunami hazard maps using remotely sensed data and these natural safe areas are defined as open spaces accessible by the street network and larger enough to accommodate the people in a rescue situation (Jayakody, Amarathunga, et al., 2018). Accordingly, open spaces which are accessible by the street network and have the capacity to assist people, are an asset for emergency evacuation in the event of a Tsunami.

However, most of this literature which discuss the use of open spaces for emergency gathering do not discuss the public use of it which can be obtained by converting them as POS. Further, the literature which discusses public uses does not confer the real-world application of this potential to an urban context and thereby balancing both disaster resilience and urban resilience. In supporting this view, C. W. Fuentes and M. T. R. Tastes (2015) emphasise the need of considering following factors when planning and designing open spaces based on the

studies on 2010 Earthquake and Tsunami in Chile; Case study on San Pedro de La Paz (Jayakody, Amaratunga, et al., 2018),

- The understanding of the connection between resilience, open space, and urban design as an integral way to plan and design resilient cities.
- Open space as a public good when planning and designing plans for reconstruction
- Design of the open space network contributing to urban resilience
- Include open spaces as an urban asset for seismic events under the resilience framework.

With this study, Fuentes and Tastes (2015) emphasise the significance of connectivity between the POS in a city, through the consideration on the linkage between open space, resilience and urban design as an integral way to plan and design resilient cities. Adding to this argument, León and March (2014) demonstrate that, along with the connectivity, the consideration also needs to be given on three other factors, when using POS as a tool for 'rapid resilience'. This study was undertaken with a particular focus on Tsunami-prone coastal urban communities, and the findings reveal that open spaces and streets need to be planned and designed with a focus on Tsunami evacuation providing safe assembly spaces, essential emergency services and utilities, such as first aids, freshwater, electricity, and communication (Jayakody, Amarathunga, et al., 2018). Further, they emphasise that, along with the accessibility and connectivity, these open spaces need to be planned and designed with adequate location, capacity and terrain qualities for Tsunami prone coastal urban communities. However, the study focus is mostly given on open space but not POS.

Further, it can be understood that attempts have been made to identify the potentials of POS for disaster resilience but lack of contribution on how to harness these potentials. Furthermore, the factors such as capacity, accessibility, connectivity and terrain qualities, may differ as per the type of the disaster and the context, hitherto there is an important potential of using POS for emergency evacuation and recovery in the event of Tsunami. Furthermore, it is imperative to harness this potential when increasing cities' resilience to Tsunamis in an urban context which has not been adequately answered by the current literature.

2.6.3.2 Mitigation

In addition to the use of POS for emergency response and recovery, current literature points out the potential use of POS for mitigation.

White and Richards (2007) and Burby and French (1981) have stated, that the most common way to protect the Flood-prone areas from land encroachment and to control the future development is keeping Flood-prone areas for open space purposes. Adding to this, Kubal et al. (2009) have identified that these open spaces have the potential to be converted as POS promoting wildlife habitat and recreational activities.

To mitigate the risk of Tsunami, IOC (2015) propose that Tsunami mitigation strategies need to be formed using land-use planning and regulation strategies. Further, they introduce a guideline presenting the necessity of setting up a development setback line through the integration of Tsunami inundation modelling into land-use planning (Jayakody, Amarathunga, et al., 2018). Further, the National Tsunami Hazard Mitigation Program (2001) emphasises the use of open spaces as an element to mitigate the Tsunami Risk. They introduce seven basic principles of planning and designing for Tsunami events. Out of these seven principles, the second principle describes, that Tsunami hazard areas need to be allocated for open-space uses (National Tsunami Hazard Mitigation Program, 2001). Conversely, most of these discussions, emphasise the need for acquiring Tsunami hazard areas for open-space uses and confine the uses in conservation and preservation perspective.

Further, some of these arguments even suggest to use these open spaces for agriculture or scenic easement, but less consideration has been given on the use of POS which is an integral part of the vitality of the city. Notably, in a coastal urban city where the land is a scarce resource, allocating open spaces only for mitigation cannot be considered as the best practice. In this context, using preserved hazard areas for public open space uses of a city can be regarded as a sustainable and practical solution.

2.6.4 Establishment of the Research Gap

Sections 2.6.3.1 and 2.6.3.2 pointed out the potential applications of POS to enhance the cities' resilience to Tsunamis. In summary, POS in cities have a significant potential to provide safe areas for emergency evacuation, to provide essential facilities and services in the recovery period and for mitigation. These identified potentials are related to various types of disasters

which can be possibly used for Tsunami disaster resilience. However, all the possible uses of POS for Tsunami disaster resilience in cities have not been fully discovered yet.

Further, literature suggested that a network of open spaces could be used as a strategy to provide simple to intricate services in emergency response and recovery. Furthermore, different typologies of spaces can contribute to different functions in emergency response and recovery (Jayakody, Amaratunga, et al., 2018). Adding to this, the literature informed that depending on the type of uses, open places could be planned considering various Tsunamis disaster-related factors such as connectivity, adequate location, capacity and terrain qualities. However, most of these discussions emphasised the potential uses, yet less consideration has been given to find out the practical implementation side to an urban context. More specifically, 'how to harness these potentials in a city context' is a question to be answered.

Apart from that, Allan and Bryant (2010) discuss that urban planners look at the POS as a part of the built environment and recovery planners identify open spaces as a part of the environment plan without looking at an integrated approach. Further, when these emergency management plans and recovery plans are integrated into day-to-day life, people become more resilience to disasters. Furthermore, 'how to incorporate the emergency and recovery plans with the everyday life of the city, is a question to be answered.

Consequently, merely keeping open spaces for emergency evacuation, recovery or mitigation challenges the sustainable development of cities. As described by Allan and Bryant (2010) concerning some Earthquake planning strategies, large quantities of unstructured open spaces left for emergency evacuation in cities, have created issues to achieve liveable, diverse and sustainable urban environments. This applies to the discussion of making Tsunami resilience city as well because Tsunami is a rare event and the provision of large quantities of open space for the sole purpose of emergency management planning is not practical. It is even more difficult to apply in an urban context. Further, those places will not function well in an emergency if it is not well connected with the street network and in the long run, those places will become neither physically prepared nor identified by the public in an emergency event. Therefore, León and March (2014), highlight the necessity to plan and design POS to function well during both emergency and non-emergency times. Most of these discussions end up with recommendations on 'what to do' but not on 'how to do it' through planning and designing strategies. Further, it can be understood that fewer attempts have been made to identify the use of POS as an interconnected system of a city, rather than keeping them as a separate set of

spaces for mitigation and a separate set of spaces for emergency evacuation which are not aligned with the everyday life of a city.

Apart from that, it can be noted that most of these studies on the role of open spaces in Tsunami resilience are focused on urban morphological studies. Mostly, open spaces for Tsunami mitigation are identified by Tsunami inundation modelling with land-use maps and safe open areas are defined by overlapping the hazard maps with land-use maps. Popularly, GIS approaches are used for these studies, especially in identification evacuation places and routes. However, Castle and Crooks (2006) inform that these GIS approaches are considered as top-down methods, where the evacuation routes and places are identified from the geographical information system without considering the complexity and diversity of human behaviour which is interrelated and produce dynamic changes that GIS models are not well suited to tracking. Therefore, the consideration needs to be given on the social component of human behaviour in Tsunami evacuation and Tsunami mitigation. This informs that, it is critically important to understand the human behaviour pattern during an adverse event when planning for disaster preparation, warning, response, and recovery.

In summary, the above-discussed problems and potentials of using POS for Tsunami disaster resilience in cities can be presented as follows (Table 2.3).

Potentials	Challenges
• The use of Emergency response and recovery – Gathering, Shelter, Distribution of goods and services • The use of different typologies of POS for different functions of Tsunami disaster resilience • The utilisation of Tsunami Hazard Prone areas for public use rather than just keeping them for preservation and conservation purpose in mitigation	• Identification of open spaces without connecting everyday life of the cities resulting in large quantities of unstructured open spaces contradicting to the sustainable city concept • Designation for the only purpose of conservation and preservation • Constraints in practical implementation to the urban context • Identify the uses discretely but not as an interconnected network which can significantly enhance the cities resilience to Tsunamis • The critical importance of understanding the human behaviour pattern during an adverse event when planning for disaster

	preparation, warning, response, and recovery

Table 2.3- Summary of discussion on potentials and challenges of using POS

In summary, the synthesis of literature informs the research gap as follows highlighting three key points.

- The possible uses of POS for Tsunami disaster resilience in cities have not been fully discovered yet
- Methods and approaches to harness the identified potentials within the city context incorporating the day-to-day uses of POS in cities have not been fully explored
- Methods and strategies to overcome the identified challenges of using POS for Tsunami disaster resilience in cities have not been fully explored

Further, identification of this research gap as above leads identifying the research problem in two parts.

1. 'What are the potentials of POS to enhance the coastal cities' resilience to Tsunamis?'
2. 'How to plan and design POS in cities to enhance the Tsunami disaster resilience while obtaining the everyday uses of the city?'.

Accordingly, the first point of the research is covered by the first part of the research problem and the second and third points of the research gap are covered by the second part of the research problem. Further, the answer to the research problem needs to be more specific rather than generic and may differ from one context to another due to geographical, political, environmental and socio-cultural differences. Therefore, as per the reasons mentioned in section 2.5, the study is focused down to the Sri Lankan context. Accordingly, with the establishment of the research gap and research problem, this study focuses on finding out the strategies to plan and design POS to enhance coastal cities' resilience to Tsunamis in Sri Lanka. Further, as suggested by the literature findings, special consideration will be given to understand the human behaviour pattern during an event Tsunami when planning for disaster preparation, warning, emergency response, and recovery.

2.7 Summary and the Link

This chapter first synthesised the literature emphasising the significant need for enhancing coastal cities' resilience to Tsunamis and the importance of urban planning and designing strategies when enhancing the cities' resilience to Tsunami. Further, the analysis of literature positioned the study within the global policy context, followed by the discussion on the need of focusing on the context of Sri Lanka. Subsequently, the literature confirmed that out of POS have the potential to enhance the cities inherent capacity to resist, absorb and recover from the effect of Tsunamis. However, yet, lack of consideration has been given to find out the strategies to harness this potential in the city context. Accordingly, the literature analysis confirmed the need of the research 'The use of POS as a strategy to enhance coastal cities' resilience to Tsunamis' through the exploration of potentials and existing challenges of using POS for Tsunami disaster resilience. Accordingly, with the confirmation of the research gap through the literature synthesis, the next chapter explains the methodological framework of the research.

CHAPTER 3: METHODOLOGY

3.1 Introduction

Previous chapter (Chapter 2) synthesised the literature related to the study, demonstrating how this research interrelates with similar work in the field of study and confirmed the gap of the research which needs to be filled by this research. This chapter first explains the process of establishing the research aim, objectives and research questions. Subsequently, the chapter justifies the methodology of this research by detailing methodological design, philosophical stance, research approach, methodological choice, research strategies, time horizon, research techniques and procedure, and credibility of the research.

3.2 Establishment of Research Aim, Objectives and Questions

Section 2.6.4 established the research gap and the research problem which need to be answered by this research. Setting the research problem helps the researcher to demarcate the boundaries and gives a focus to the study (O'leary, 2004). Accordingly, with the identified research problem in section 2.6.4, the next step is to identify how the researcher answers the research problem and fills the research gap. This can be achieved through the exploration of research aim, objectives and research questions. Accordingly, the process of establishing the research aim, objectives and research questions were outlined by researcher's area of interest (Section 3.2.1), review of the literature (Section 3.2.2), and the research need within the Global Context (Section 3.2.3).

3.2.1 Researcher's Area of Interest

The first step of commencing a research study is to decide the researcher's area of interest which the researcher would like to conduct his or her research (Marczyk, DeMatteo, & Festinger, 2005). Accordingly, this research was commenced with the researcher's interest in identifying innovative approaches to plan POS in cities. As the researcher is from urban planning and urban design background, the researcher knows how useful POS are in cities for the cities' functionality and vitality. POS such as public squares, parks and playgrounds offer a range of benefits to the city, plus due to the land scarcity in most cities, those are the only available lands for new interventions.

At the same time, through the global reports and the news feeds, it is well known to the world that natural disasters are increased in terms of frequency and magnitude all around the world. The degree of disaster risk is even higher in cities due to the high population density and

development concentration. Therefore, every spatial element of a city should be planned and designed focusing cities' disaster resilience. However, the researcher through reading and with her experience noted that POS in cities are rarely used to enhance cities' resilience to disasters. With this view, the researcher had a question that 'Can we use POS in cities for disaster resilience?'. This was the initial incitation to this research. Starting with this question in mind and having discussed this with the supervisors, the researcher started reviewing the literature to narrow down the research focus. Accordingly, the outcomes of the literature review are explained in the next section; 3.2.2.

3.2.2 Review of Literature

The analysis of literature can be used for many different purposes within a research study. The literature review is primarily used to get familiar with the related work in the selected field of study (Marczyk et al., 2005). Further, literature review helps to develop the research problem (O'leary, 2004) and to select a unique research focus which has not been discovered yet by others (Wisker, 2007). Similarly, in this study, the literature review is used to familiar with the related work, select a unique research focus which has not been discovered by others and to develop the research problem. This process was detailed throughout the literature review chapter (chapter 2) and summarised in section 2.6.4.

Accordingly, within the researcher's area of interest in finding out the possibilities of using POS for disaster resilience, the researcher conducted the specific literature review on following areas.

- Disaster resilience at the city level
- Coastal Cities and Tsunamis
- Urban planning and urban designing
- Sri Lanka
- POS for Tsunami Disaster Resilience

In summary, as it was detailed in section 2.6.4, the synthesis of literature informed the research gap as follows highlighting three key points.

- The potential uses of POS for Tsunami disaster resilience in cities have not been fully discovered yet
- Methods and approaches to harness the identified potentials within the city context incorporating the day-to-day uses of POS in cities have not been fully discovered

- Methods and approaches to overcome the identified challenges of using POS for Tsunami disaster resilience in cities have not been fully discovered

Further, the identification of this research gap leads to identifying the research problem in two parts.

1. 'What are the potentials of POS to enhance the coastal cities' resilience to Tsunamis?'
2. 'How to plan and design POS in cities to enhance the Tsunami disaster resilience while obtaining the everyday uses of the city?'.

Further, the literature analysis informed that the answer to the research problem needs to be specific to a context due to the geographical, political, environmental and socio-cultural differences. Accordingly, as it was justified in section 2.5, the study is focused down to the Sri Lankan context. Accordingly, with the establishment of the research gap and research problem through the literature synthesis, this study is focused on 'finding out the strategies to plan and design POS to enhance coastal cities' resilience to Tsunamis in Sri Lanka'.

3.2.3 Research need within the Global Context

The importance of the above (Section 3.2.2) identified research need which is to 'find out the strategies to plan and design POS to enhance coastal cities' resilience to Tsunamis in Sri Lanka' can be further explained through positioning the research within the global needs.

Global urbanisation trend patterns demonstrate that the population growth in coastal cities is increasingly high due to the continuous growth of the world's population and human migration towards the coastal cities. Hence, Neumann et al. (2015) state that the coastal urban centres will contain an increasingly large proportion of the world's human population with a high population density in coastal areas than in non-coastal areas. Accordingly, it can be noted that any adverse effect on the coastal cities in the world means it affects a large proportion of the world's human population.

At the same time starting from 2004 Tsunami event to most recent Tsunami events in Indonesia in 2018 warned the world that Tsunami is infrequent but extremely destructive, it can happen at any time at any Tsunami prone area, because it is unpredictable. Therefore, all the coastal cities around the world which are within the Tsunami-prone zone should get ready to face Tsunami hazard. Nonetheless, the ways and means to increase the inherent capacity of a city to face for this type of disaster are still in the investigation which has not been adequately answered.

Within this context, this research attempts to find out an innovative approach to use POS in coastal cities to enhance the cities' resilience to Tsunamis. Most importantly, in cities land is a scared resource. Therefore, the highest and best use needs to be acquired from the available land. However, 'how to use these available POS to enhance cities' resilience Tsunamis' is a question which has not been answered yet. Accordingly, this research attempts to answer the global need of making coastal cities resilience to Tsunamis through the use of POS as an asset in cities. Through addressing this global need, this research contributes to the 11th goal of Sustainable Development Goals (SDGs) which is the 'Sustainable cities and communities' by contributing to make cities and human settlements inclusive, safe, resilient and sustainable.

Further, when addressing this research need particular focus is given to planning and designing strategies because urban planning and designing can play a vital role in making cities resilience to disasters. UNISDR (2012) states strategic planning and design of spatial elements and their influence on the natural and built environment are the directives of the city's capacity to absorb and recover from disasters. Adding to this, Sendai framework (UNISDR, 2015b) which is the global framework for DRR, suggests that a cross-sectoral approach tailored to localities need to be followed in DRR. This emphasis provides a solid base for this study, as this particular research study is not limited to disaster management strategies, but the study searches the methods and approaches across the disciplines of urban planning, urban designing, landscape architecture and disaster management. To find the cross-sectoral approach which is tailored to localities, the particular focus is given to the context of Sri Lanka which is a Tsunami prone developing country fronting many development challenges in coastal cities.

Accordingly, this discussion emphasis that 'finding out the strategies to plan and design POS to enhance coastal cities' resilience to Tsunamis in Sri Lanka' is a research need which addresses the needs in a global context.

3.2.4 Research Aim and Objectives

Following the identification of the central research gap which is to 'find out the strategies to plan and design public open spaces to enhance coastal cities' resilience to Tsunamis in Sri Lanka', the next question is how to fill this gap.

Accordingly, in order to fill this gap, this research aims to 'develop a framework to plan and design POS as a strategy to enhance coastal cities' resilience to Tsunamis in Sri Lanka'. Further, to achieve the above-mentioned research aim, the SMART (Specific, Measurable, Attainable, Realistic and Time-bound) objectives were formulated as follows.

Objectives

1. Identify the current relationship between the POSs and Tsunami disaster resilience
2. Explore the potentials and challenges of using POS as a strategy for Tsunami disaster resilience
3. Explore the planning and designing methods and approaches of using POS as a strategy for Tsunami disaster resilience
4. Study the relationship between the identified potentials and challenges (Objective 2) with methods and approaches (Objective 3) of using POS as a strategy for Tsunami disaster resilience
5. Develop a framework to plan and design POSs as a strategy for Tsunami disaster resilience

3.2.5 Research Questions

As mentioned in section 3.2.2, this study identified the research problem into two parts which need to be solved by this research. However, Corbin and Strauss (2008) state that the research problem can give the focus to the study, but cannot cover all the aspects of the problem. Therefore, they widely acknowledge the need for identifying specific questions which need to be resolved by the research. Accordingly, in relation to the research objectives, the specific research questions were identified as follows.

1. What is the current relationship between the POSs and Tsunami disaster resilience?
2. What are the potentials and challenges of using POS as a strategy for Tsunami disaster resilience?
3. What are the planning and designing methods and approaches of using POS as a strategy for Tsunami disaster resilience?
4. What is the relationship between the potentials and challenges with methods and approaches of using POS as a strategy for Tsunami disaster resilience?
5. What are the strategies to plan and design POS to enhance coastal cities' resilience to Tsunamis in Sri Lanka?

In summary, the relationship between the research gap, problem, aim, objectives and research questions can be illustrated as follows (Figure 3.1).

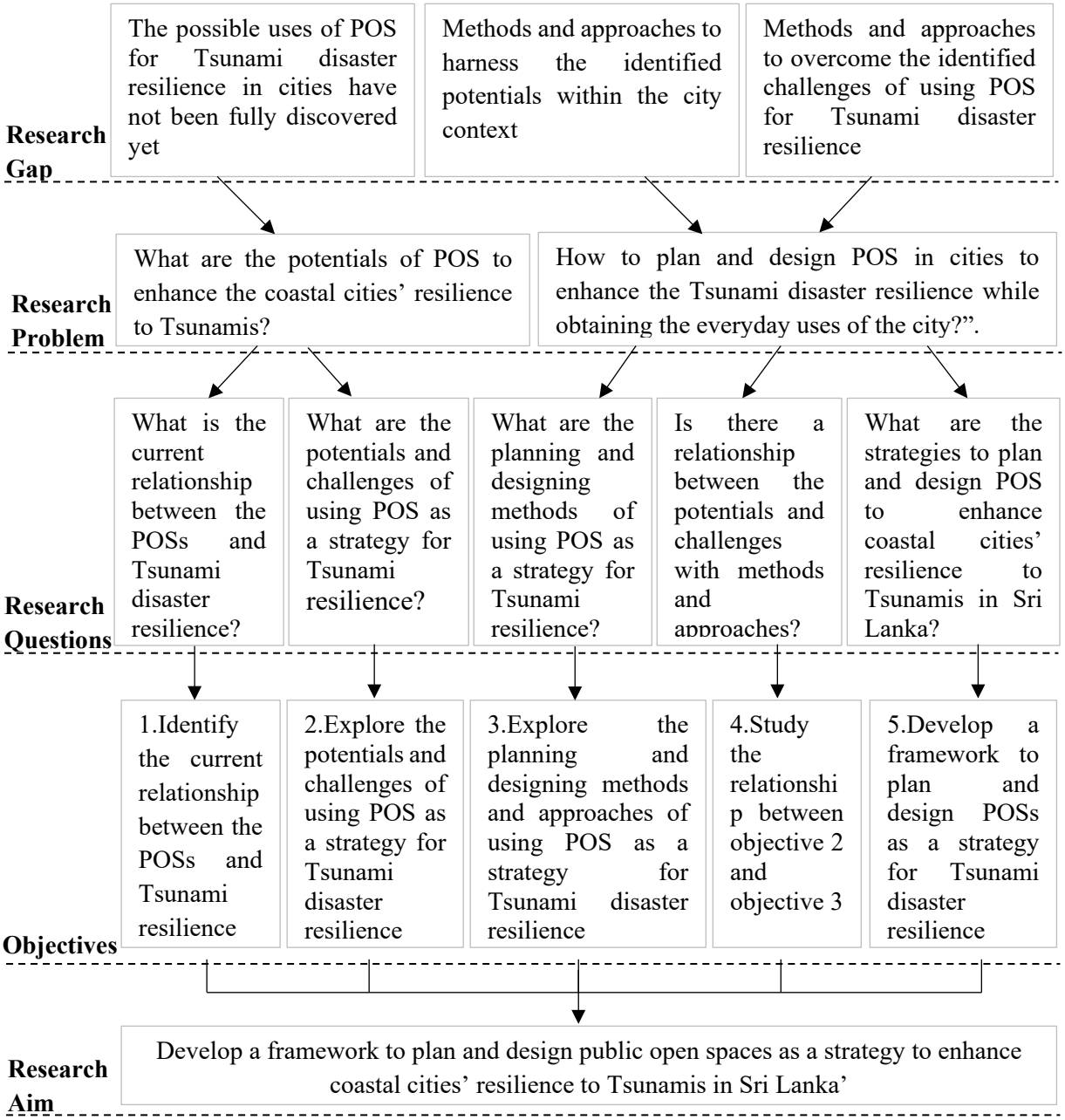


Figure 3.1- Relationship between the research gap, problem, aim, objectives and research questions

3.3 Methodological Design

Research methodology is a systematic approach which can be adapted to achieve the research aim (Creswell, 2009). Accordingly, the systematic approach to achieve the aim of this study; 'Develop a framework to plan and design POS as a strategy to enhance coastal cities' resilience to Tsunamis in Sri Lanka', will be explained within this chapter. Further, Dainty (2008) indicates, research methodology is not just the methods adopted, but it refers to the philosophical assumptions and the logic that underlies a particular study. Adding to this, Collis and Hussey (2013), refers to the methodology as an overall approach to the research process.

The overall methodological approach of a study can be explained using various research models. There are two main research models which are popular among researchers; the 'Onion model' (Saunders et al., 2016) and the 'Nested model' (Kagioglou, 1998). The Nested model (Figure 3.2) comprises three parts framing research philosophy, research approach and the research techniques (Kagioglou, 1998).

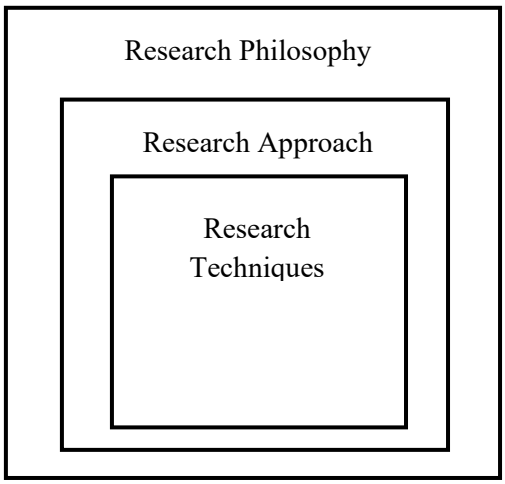


Figure 3.2- Nested Model (Kagioglou, 1998)

Onion model (Figure 3.3) covers six aspects of research methodologies which are research philosophy, research approaches, methodological choices, research strategies, time horizons, data collection and analysis techniques and procedures (Saunders et al., 2016).

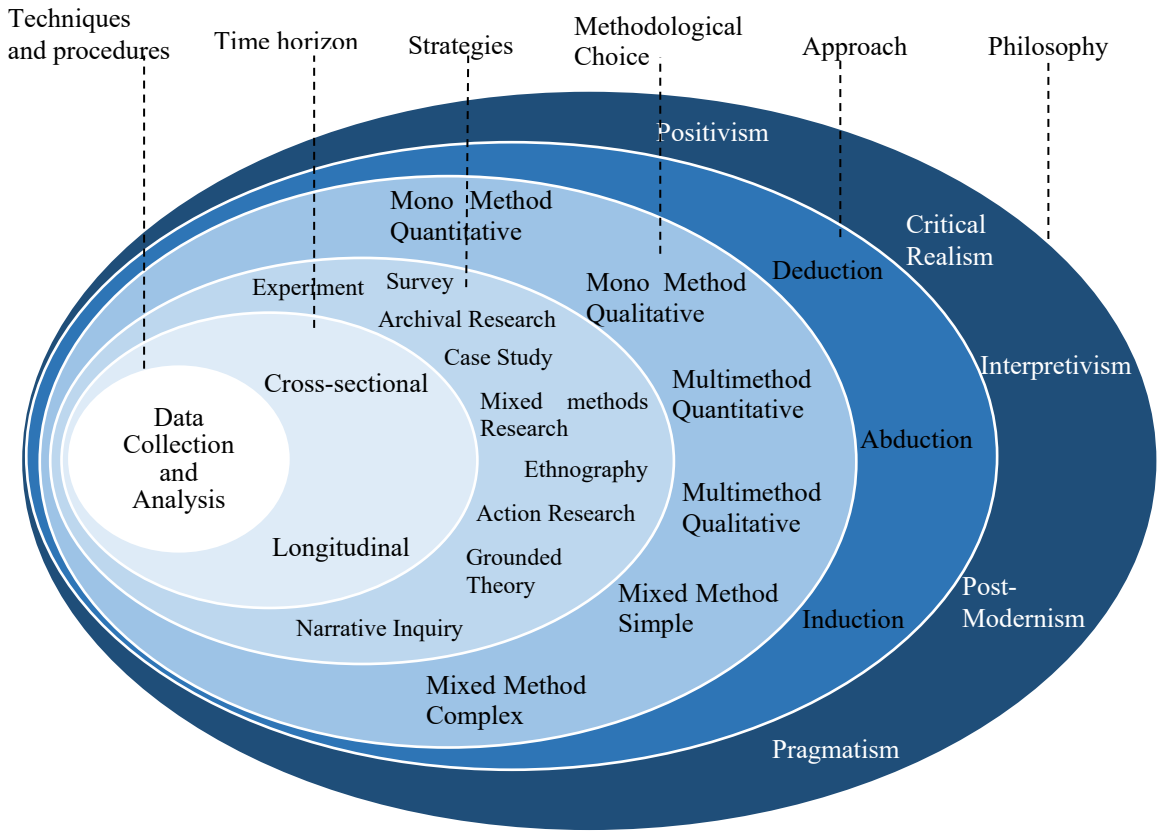


Figure 3.3- Onion Model (Saunders, Lewis, & Thornhill, 2016)

Both research frameworks inform the philosophical stance as the first step towards establishing a research methodology. Then both nested model (Kagioglou, 1998) and the onion model (Saunders et al., 2016) present the research approach as the second stage within the research models. According to Saunders et al. (2016), the research approach is mainly for the theory development and either by employing induction, deduction or abduction processes, whereas Kagioglou (1998) uses the induction and abduction as the research approaches. At the third step, Kagioglou (1998) discusses research techniques, which include; interview, questionnaire, secondary data. However, Saunders et al. (2016) discuss further three steps prior to research techniques, which comprise methodological choices, research strategies, and time horizons. Therefore, in this study, the researcher adopted the onion model as the additional three steps help the researcher to frame the methodological design comprehensively and as it indicates all the key aspects that need to be investigated in the research.

3.3 Research Philosophy

The philosophical position of research is determined by the researcher's assumptions about how the researcher views the world (Saunders, Lewis, & Thornhill, 2012). These assumptions affect to shape up researcher's understanding of the research question, methods used and the interpretation of findings (Crotty, 1998). According to Saunders et al. (2016), there are three types of research assumptions to differentiate research philosophies; ontology, epistemology and axiology.

Ontology can be identified as the researcher's view of the nature of reality (Saunders et al., 2012). In other words, the researcher's assumptions about the way the world operates. There are two aspects of ontology; subjectivism and objectivism. Subjectivists accept the concept of social constructionism, which understands the reality as being socially constructed, whereas Objectivism argues that reality is external to social actors (Saunders et al., 2016). In this study researcher attempts to answer the question of 'How to use POS as a strategy to enhance coastal cities' resilience to Tsunamis?'. The researcher's view is that the POS is planned by the planners, urban designers and used by the public. Therefore, finding a new way to plan it, focusing on disaster resilience cannot be achieved without considering these social actors attached to it.

Further, the new methods and approaches mean a new way in which planners and designers view the POS. For instance, finding the use of Public open space for emergency evacuation should be guided by how people use the space in the event of an emergency. It cannot be

understood just by looking at the physical entities of the world excluding the social actors attached to it. Accordingly, the researcher's view of this research study, which directs to answer the research question can be placed at the subjectivism aspect of ontology.

Epistemology is another branch of research philosophy which concerns how the knowledge should be acquired and what is adequate knowledge in the field of study. Under the epistemology, the objectivism considers that the knowledge can be acquired by the objects, facts, numbers (Saunders et al., 2016). In contrast, this research focuses on social actors and conducts research among people rather than objects. Therefore, the researcher believes that if the reality is socially constructed, the truth about the socially constructed reality needs to be discovered through the opinions, narratives, individuals and contexts rather than through the facts and numbers. Therefore, to answer the research question, the researcher seeks to find the answer through the knowledge of local planners, coastal planning experts, disaster resilience experts and the local knowledge of the community, rather than using urban morphological studies or GIS methods.

Axiology describes the values of the researcher which can play a role in all stages of the research process (Saunders et al., 2012). Axiologically, the researcher, believe that the social entities and social actors do not exist independent of each other. If the answer to the research question needs to be found through the opinions, narratives, individuals and contexts, the outcome of this research is affected by the way the researcher interprets the responses. Therefore, this research cannot be detached from the researcher's values and beliefs. Accordingly, this research follows a value-bound process. In summary, the philosophical assumptions of the study within the two extremes of subjectivism and objectivism can be positioned as follows (Table 3.1).

Assumption Type	Objectivism	Subjectivism
Ontology	Real External One true reality Granular Order	Nominal Socially Constructed Multiple Realities Flowing Chaos
Epistemology	Adopt assumptions of the natural scientists Facts Numbers Observable phenomenon	Adopt assumptions of the arts and humanities Opinion Narratives Attributed meanings
Axiology	Value-Free Detachment	Value-bound Integral and reflective

Table 3.1- Philosophical Assumptions of the research, adopted from (Saunders et al., 2016)

Apart from the two extremes of subjectivism and objectivism, research philosophy can be represented using another continuum; positivism and interpretivism. Positivism views the 'natural scientists' approach which is that the reality is observable or measurable (Saunders et al., 2016). Interpretivism highlights that human is different from physical phenomena because they create meanings and interpretivists study these meanings (Saunders et al., 2016). The researcher views that the answer to the research question 'how can POS be used to increase the cities' resilience to Tsunamis?', can be found through the responses of the participants. Within this view, the researcher excludes the positivism philosophy because the researcher argues that reality is not objective or exterior which can be observed. Accordingly, the researcher's view within this positivist and interpretivists paradigm lay towards the interpretivism.

Further, the philosophy of critical realism is an extreme form of realism where the reality is viewed as something beyond what we see or what we experience. Critical realists believe that the reality is external and independent which is not directly accessible through our observation and knowledge (Saunders et al., 2016). Though the researcher agrees that the answer could be found through the participant's response, the research is not towards something beyond what we see or what we experience. Further, the researcher does not wish to consider the role of language and power relations as in postmodernism philosophy. However, the researcher is interested in finding practical solutions to a problem as in pragmatism. The answer to the research question 'how to use the POS as a strategy for Tsunami disaster resilience city' need to be found through the participants' view. Once the concept is developed, then that can be supported by the actions or by practical solutions as in pragmatism. (Saunders et al., 2016).

Accordingly, it can be summarised that the researcher's philosophical position is more towards the interpretivism and not placing towards the other four main philosophies; positivism, critical realism, postmodernism and pragmatism. After establishing the philosophical position of the research, the next section (section 3.4) discusses the second layer of the onion model; research approach of the study.

3.4 Research Approach

According to Saunders et al. (2016), there are three main research approaches; deduction, induction and abduction. Deductive reasoning involves when the research begins with a theory and designs the research strategy to test that theory. However, in this research, there is no pre-developed theory to test. The review of literature informed that POS contribute to enhance the disaster resilience but did not inform how to plan and design POS to enhance cities' resilience to Tsunamis. Therefore, there is no pre-developed theory to test or to evaluate a phenomenon.

Instead, the theory needs to be discovered through a series of data collection and analysis. The data collection will focus to achieve the research objective; to explore the methods and approaches to plan and design POS as a strategy for Tsunami disaster-resilient coastal cities. As Easterby-Smith, Graça, Antonacopoulou, and Ferdinand (2008) state, researchers in inductive tradition, work with qualitative data and use various data collection methods to establish different views of phenomena. Conversely, this study will collect data to 'explore a phenomenon' using an inductive approach instead of 'evaluating a phenomenon' as in a deductive approach. Accordingly, it can be concluded that this research is inductive research. Further, abduction approach cannot be applied to this research as the researcher does not wish to combine deduction and induction approaches (the pathway for back and forth strides between theory and data) within the time limit of this research.

3.5 Methodological Choice

Research choice is the ways and means of selecting the techniques and procedures which can be used to collect and analyse data applicable to the topic of the research. There are two main methodological choices; quantitative and qualitative (Saunders et al., 2012). Further, Saunders et al. (2012) explain that the term"quantitative" refers to any data collection technique, or data analysis technique, which produces numerical data. Further, they state that data collection (e.g. interviews) and data analysis (e.g. content analysis) techniques, which generate non-numerical data, can be considered under the term "qualitative".

Further, Saunders et al. (2016) inform that the primary categorization of research choice gives two options; mono methods and multiple methods. If the researcher employs a single data collection and a single analysis procedure, such research is a mono-method study. If the researcher employs a more than one data collection technique and one analysis procedure, such research is called a multiple method research. Under this categorisation, there can be multi-method qualitative and multi-method quantitative. At the same time, there are mixed-method researches when the researcher employs both quantitative and qualitative techniques and procedures.

In this study, based on the researcher's philosophical position and research approach, the researcher seeks to employ qualitative data collection and analysis techniques which will be further discussed in sections 3.8 and 3.9. Accordingly, the interview method will be used as the primary data collection method. In addition to that, the researcher will review maps, images, development plans and documents related to the interview discussions. Accordingly, the data evolving from the study will be non-numerical data where the researcher can categorise the study as a qualitative study. However, as stated, in order to find the answer to the research question, the researcher will use more than one data collection techniques and analysis procedures within the qualitative platform. Therefore, the methodological choice of this study is a multi-method qualitative study.

3.6 Research Strategy

The strategy is a plan of action to achieve a goal. Thus, Saunders et al. (2016) define the research strategy as the plan of how the researcher will go about answering the research question. Accordingly, this section explains the plan of action to answer the research question. Further, this discussion will link the research philosophies with the subsequent selection of data collection methods and analysis techniques.

3.6.1 Comparison of Potential Strategies

In this section, the researcher compares eight research strategies which researchers commonly use; experiment, survey, archival research, case study, ethnography, action research, grounded theory, and narrative inquiry (Saunders et al., 2016).

The research strategy is principally linked with the qualitative, quantitative and mixed methods research choices (Saunders et al., 2016). In relation with the research choice, this research study is mainly a qualitative research study as it is focused on finding out the use of POS for Tsunami

disaster resilience through the opinions of experts, practitioners and the community who relate to the field of study. Accordingly, the experiment method does not match with the investigation, as this study does not test an experimental variable against controlled variables (adopted from Saunders et al. (2012)). Further, the survey strategy is not suitable for this study, as the survey strategy is generally used in deductive researches. Further, archival and documentary research strategy does not match with this research as the answer to the research question cannot be found only through the study on archival resources and documents. Apart from these three research strategies which were discussed so far, Saunders et al. (2016) present another five strategies; case study, ethnography, action research, grounded theory and narrative inquiry.

Out of these strategies, Creswell (1998) states, ethnography is most suitable when there is a need to comprehend the local cultural or ethnic setting for a longer period. In ethnography research, the researcher becomes a part of the natural setting. However, this research study does not focus on acquiring a deep understanding of local cultures or ethnic context or behaviour patterns. In action research, researcher becomes part of the setting and work closely with the people of the setting to improve the situation in that particular setting (Dawson, 2009), whereas in this research the researcher needs the genuine and natural perspectives of people about the potentials of POS and does not intend to change their status quo. Therefore, an action research strategy cannot be considered as a suitable strategy for this study. Further, narrative inquiry is inquiring a story of a personal account (Saunders et al., 2016), and in this research, participants are not involved in storytelling.

Accordingly, the researcher had to choose between the case study method and the grounded theory method. Yin (2013) introduces the twofold definition of the case study. The first part focuses on the scope of a case study and the second part focuses on features of a case study.

First Part – *'A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-world context……'*

Second Part – *'A case study inquiry copes with the technically distinctive situation……. Relies on multiple sources of evidence…., benefits from the prior development of theoretical propositions to guide data collection and analysis'.*

According to the first part of this definition, the case study method would suit to the study as it can be used to investigate the contemporary phenomenon in depth which is the 'methods and approaches that can be used to plan and design POS in the real world'. However, the second

part of the definition elevates the consideration of the researcher to another stage where it says the study needs to be benefited by the prior development of theoretical proposition to guide data collection and analysis. Yin (2013) highlights that the case study method is mostly guided by a framework, if the existing literature base does not provide a theoretical statement, the study needs to be guided by an exploratory case study. Furthermore, he says exploratory research also need to be guided by a pre-developed criterion explaining what needs to be explored. Therefore, the researcher has particular concerns to use the case study as the research strategy as current literature does not provide a theoretical statement to answer the research question. As it was discussed in chapter 2, contemporary literature emphasises that there is a significant potential to use the POS for disaster resilience, yet fewer attempts have been made to identify the methods and approaches explaining how to plan and design these POS as a strategy to make cities resilient to Tsunamis. Therefore, the study cannot be conducted using a pre-developed criterion explaining what needs to be explored.

In summary, it was demonstrated, that the research strategies alike ethnography, action research, narrative inquiry are not best suited for this particular research. However, case study research has shown some potentials to be used as a research strategy in this study, but as justified above the existing literature does not provide a comprehensive theoretical statement to answer the research question. Therefore, the researcher explored the possibilities of grounded theory as the research strategy in this study as follows.

3.6.2 Selection of Grounded Theory

Denscombe (2007) describes that grounded theory is more appropriate when the phenomenon is poorly understood, and further exploration is needed to increase the existing understating. Adding to the discussion of Denscombe (2007), Charmaz (2014) states, grounded theory method is a systematic approach, yet provides a flexible base to collect and analyse qualitative data and to construct theories which emerge from the data. Similarly, Creswell (2007) has stated, grounded theory is an ideal research strategy when the researcher needs to build up theories from the 'ground', data from the field, especially in the actions, interactions and the social processes of people.

Further, as mentioned in section 2.6.4, it is little known in the field how to use POS to enhance cities' resilience to Tsunamis. Most of the related studies are focused towards emergency evacuation and mitigation stages of disaster cycle but not on preparedness and recovery stages of the disaster cycle. Even the current studies towards evacuation and mitigation, do not

provide a comprehensive answer to the study. Apart from that, current strategies identify the use of open spaces discretely, but not as an interconnected system which can significantly increase cities' resilience to Tsunamis. This means, yet the role of POS as a strategy for Tsunami disaster resilience cities has not been fully discovered and poorly understood in the current context. Accordingly, the setting explained by Denscombe (2007) matches with the setting of this research study. As he explained, grounded theory is more suitable when the phenomenon is poorly understood, and further exploration is needed to increase the existing understating. Similarly, as described above the role of POS in the context of Tsunami disaster resilience is poorly understood, and further exploration is needed to identify the methods and approaches to plan and design POS with this new focus.

In addition to that, the explanations of Creswell (2007) and Charmaz (2014) further justifies the use of grounded theory in this study. For the reason that they state grounded theory is identically useful when there is a need to obtain data from the ground and when there is a need to explore a social process. Accordingly, this research seeks to build up resilient coastal cities using the data from the field (experts, practitioners and community) and the study is associated with a social process which investigates the actions and interactions of people with the built environment. The use and functionality of POS are related to social interactions and engagements. Therefore, the use of grounded theory in this study is further justified.

Further, Saunders et al. (2016) inform that the grounded theory usually takes the inductive approach and it may be appropriate for the abductive approach as well. As explored in section 3.4, this research is inductive research which seeks to build a theory to enhance coastal cities' resilience to Tsunamis using POS grounded to the data. Therefore, the recommendations of Saunders et al. (2016) further justifies the use of grounded theory in this research.

Furthermore, Aldiabat and Navenec (2011) emphasise that grounded theory generates explanatory theories reflecting the complexity and the variability of the phenomenon. Planning and designing POS with a focus on social process attached to the built environment is complex and dynamic as it involves many stakeholders and many aspects need to be considered. Achieving this task with a new focus on disaster resilience is even more complex and multifaceted. Accordingly, this study includes many perspectives with human aspects such as planning and designing of POS considering the way people behave in a Tsunami emergency, the possibility of accommodating displaced people in the recovery period and increase the public awareness through the planning and design features and so on. Also, this study includes

a technical aspect of DM as well such as consideration on disaster-specific factors when planning for Tsunami disaster resilience including location, terrain qualities and capacity.

Moreover, this study includes coastal environment-specific factors and urban planning trends and patterns as well. Thus, it can be understood that finding planning and designing framework to use the POS as a strategy for Tsunami disaster resilience, requires tackling many interlinked and overlapping themes, considerations and issues. Within this situation, the grounded theory method allows the researcher to go to the field with an open mind and excavate these many interlinked and overlapping themes, considerations and issues related to the phenomenon.

After the consideration of all the above-discussed reasons, it can be established that the most appropriate research strategy for this research is the grounded theory. In summary, the selection of the grounded theory method as the research strategy was made based on the following key factors.

- Grounded theory is more appropriate when the phenomenon is poorly understood, and further exploration is needed to increase the existing understating. Similarly, in this study, the role of POS as a strategy for Tsunami disaster resilience has not been fully discovered and poorly understood within the existing literature.
- Grounded theory is an ideal research strategy when the researcher needs to build up theories from 'ground', data from the field, especially in the actions, interactions and the social processes of people which this study focuses.
- Grounded theory suits with inductive researches which seek to build a theory based on data and this study take an inductive approach.
- Ability to generate an explanatory theory reflecting the complexity and the variability of the study
- The grounded theory allows a systematic analysis yet provide a flexible base to collect and analyse qualitative data which produce a 'Well constructed theory'.

After the selection of Grounded theory as the research strategy, the next task is to select the most appropriate version of grounded theory. Accordingly, the choice of the most appropriate version of grounded theory will be discussed in section 3.6.3 and 3.6.4.

3.6.3 Versions of Grounded Theory

The Grounded Theory method emerged at a time when there was a tension between the qualitative and quantitative studies in the early 1960s in the United States. At that time most of

the qualitative researchers did the fieldwork, gathered a considerable amount of data and presented showing relationships, but not reasonably with an analytical approach using analytical strategies. Within this context, Anselm Strauss and Barney Glaser discovered the grounded theory as a response for the 'extreme positivism' by publishing the book; 'The discovery of Grounded theory' in 1967. This discovery refocused the flow of qualitative studies towards more empirical findings through systematic analysis and with systematic methodological strategies. In this first version of grounded theory the research problem areas from the first level of data collection, then the theory emerges grounded in the data (Glaser & Strauss, 1967).

De-orientation of the original idea of grounded theory

Glaser and Strauss subsequently disagreed over the application of grounded theory, which led to two different approaches of grounded theory. Glaser (as cited in Easterby-Smith et al. (2008)) founds that there should not be a conceived theory in mind, whereas Strauss and Corbin (as cited in Easterby-Smith et al. (2008)) highlight the requirement for a theoretical statement to enable an explanation or prediction of the theory. Glaser and Strauss both acknowledge that the researcher will not enter the field free from ideas, but differ considerably in the role they see for the literature. The differences between the two versions can be summarised as follows.

• The theory is derived from a structured set of data with or without a preliminary research question • There should not be a preconceived theory in mind • Inductive • No use of literature prior to theory development • Coding: Open and selective	• The theory is driven by a preliminary research question • There can be a theoretical statement to enable an explanation or prediction of the theory • Inductive/ Deductive • Review of literature prior to study will identify any gaps in knowledge • Coding: Open, Axial and selective

Table 3.2- Differences between the two versions of grounded theory

Adding to the second version of grounded theory, Charmaz (2006) introduced the version of the constructive grounded theory which further allows the researcher to have a preconception theory and literature prior to the data collection. However, constructivists such as Charmaz, view that people gather knowledge through experiencing it and through the interaction of experience and their ideas. With this view, Charmaz (2014) states that the categories of the

theory and the theory itself are co-constructed by the researcher and respondent. This approach attends more to the language and action. However, much common in all these versions are all approaches direct the inductive process starting from rich data collection, comparative analysis and inductive theory building from data. Further, it can be noted that in the current context, the grounded theory works as a more flexible and positive research strategy to conduct qualitative research while allowing the researchers to use it in a more diverse and complex social research environment.

3.6.4 Principles of the Selected Version

The theory in this research is driven by the preliminary research question; How to plan and design POS as a strategy to make coastal cities resilience to Tsunamis? Whereas, in the first version of the grounded theory, the research problem emerges from the first level of primary data analysis. Therefore, considering the appropriateness to the study, this study adopts the principles from the second version of the grounded theory.

Secondly, if the consideration is given on the usage of literature within the grounded theory context, Glaser's approach promotes that literature should not be reviewed prior to the study as it may lead to building a biased theory (Knight & Ruddock, 2008). However, Heath and Cowley (2004) argue that no one can be detached entirely from their own experiences and readings in this process. They suggest that the literature can be used to support the developed theory. Further, Goulding (2002) suggests that literature can be used as part of the data collection. Apart from that, Strauss and Corbin (1998) and Cutcliffe (2000) indicate that a review of literature prior to the study will help to establish the knowledge gap. Accordingly, it can be understood that different authors suggest different approaches to review the literature within the theory-building process. Some authors suggest prior to the study and some authors suggest parallel to the data collection or after the development of the theory.

In this research, literature is used at two stages of the theory development process. Firstly, as it was explained in chapter 2, the literature was used to establish the research gap. This approach enables to identify the gaps in knowledge which need to be filled by the research findings. The identified research gap explained the emerging theory which is planning POS for Tsunami disaster resilience need to be aligned with the everyday life of the city. Further, the use of literature provided a direction for the data collection and to select initial participants. This will be further discussed in section 3.8.1. Secondly, literature will be used to support the emerging theory which means whenever the emerging theory seeks further support the

literature will be used to support the emerging theory. Accordingly, the principles of the selected version of grounded theory can be summarised as follows.

- The theory in this research is driven by the preliminary research question; How to plan and design POS as a strategy to make coastal cities resilience to Tsunamis?
- The literature was reviewed prior to the data collection to identify the research gap
- The identified research gap explained the emerging theory which is planning POS for Tsunami disaster resilience need to be aligned with the everyday life of the city.
- This research will take the inductive approach as it was discussed in section 3.4
- Follow the coding procedure of the second version: Open, Axial and Selective; the coding procedure will be further discussed at section 3.8.2

3.7 Time Horizons

As described by Bryman (2012), there are two types of researches; cross-sectional and longitudinal which focus on the timeline of the study. The cross-sectional study entails a study of a phenomenon at a particular time, whereas longitudinal studies involve a study of the phenomenon over time. According to Bryman and Bell (2011), most of the research studies which are time-constrained lead to cross-sectional studies. Similarly, as this is a doctoral study, the research needs to be completed within the limited period of time. Together with this time constrain the exploration on 'the uses of POS and the methods and approaches to plan and design POS for Tsunami disaster resilience' need not to be carried out over a period of time. Therefore, this study is a cross-sectional study where the phenomenon is studied at a particular time.

Up to now, five layers of research onion were discussed; research philosophy, research approaches, methodological choices, research strategies and time horizons. Accordingly, the next task is to disclose the core of the research onion; research techniques and procedures and this will be revealed in two sections; 3.8 on data collection and 3.9 on data analysis.

3.8 Research Techniques and Procedures: Data Collection

The grounded theory provides a systematic approach to collect and analyse data (Saunders et al., 2016). Therefore, the data collection process of this research was mainly guided by the grounded theory data collection approach. Accordingly, based on the selected version of the grounded theory (Section 3.6.4), the unique features of the data collection process of this study

are data collection with an open mind, select the participants according to the need of the theory and concurrent data collection and analysis. This process will be explained step-by-step from section 3.8.1 to 3.8.6.

3.8.1 Data collection with Open mind

Open mind approach means the data collection will not be guided by a framework or preconceived set of ideas. According to Denscombe (2007), this feature of open mind approach or the avoidance of preconception lead to discovering new data relevant to the field of study. However, as this research follows the second version of grounded theory, the main criticism which may arise is 'the review of the literature before data collection might lead to a biased data collection'. Because, the classical grounded theorists argue that having a preconception or preconceived theory in mind before data collection, increases the possibility of having a biased theory and therefore, there is lack of space for the openness and the emergence of unbiased novel theory. Answering this argument, Corbin and Strauss (2008) state that researcher reviews the literature before data collection, to develop the research problem and to identify the research questions, However, the researcher will not collect data with a preconceived theory in mind. Therefore, as per grounded theory second version, the researcher used the literature review to establish the research gap and to set the central research question 'How to use POS as a strategy to make coastal cities resilience to Tsunamis'. Nevertheless, the review of the literature was not used to guide the data collection or to develop a draft framework before the data collection. Accordingly, the baseline for the data collection was 'collect data with an open mind staying within the central research question'.

3.8.2 Selection of Initial Participants

After the identification of the specific area of study and the establishment of the research gap through the literature, the next task was to start the data collection through the selection of initial participants. Therefore, the challenge was how to select the participants with no guided outline for the data collection. Especially, as this research combines two fields; urban planning and disaster resilience, the study field is exceptionally vast, and selection of participants may vary across disciplines; disaster experts, planners, architects, ecologists, geologists, sociologists, community, administrative bodies and so on. To overcome this challenge, Glaser and Strauss (1967) suggest that the selection of the groups for the data collection in grounded theory, need to be for a theoretically relevant data collection. Adding to this, Dey (1999) informs that the selection and comparison of data collection sites and groups may vary

depending on the factors such as location and function. Out of these factors, the location of this study is within the context of Sri Lanka which has already been justified in section 2.5.

Within Sri Lanka, the 'site' need not be specific, as this is an issue specific study rather than a context-specific study. The specific issue is 'How to use POS as a strategy to make coastal cities resilience to Tsunamis in the context of Sri Lanka'. Therefore, the researchers who follow the grounded theory method do not need to locate their fieldwork in a particular setting as in case study approach (Denscombe, 2007). Therefore, rather than conducting the fieldwork in a site, the researcher decided to select the participants relevant to the central research question within the context of Sri Lanka.

With this view, in order to conduct a theoretically relevant data collection, four groups were identified as initial participants within the context of Sri Lanka; urban planners, disaster resilience experts, coastal planners and Tsunami affected communities (Figure 3.4).

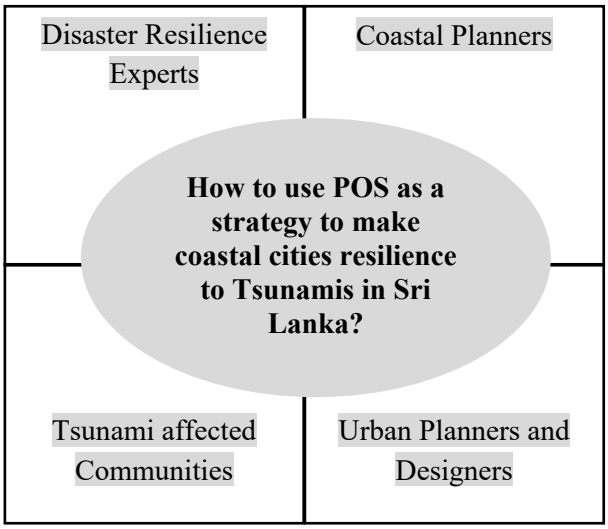


Figure 3.4- The selection of initial groups for the data collection

These four initial groups were identified through the literature and the researcher's professional experience. One of the main intentions for this selection is to combine the local knowledge with practical knowledge and scientific knowledge. Confirming the value of this combination, Sendai framework priority 1: Understanding disaster risk, recommend the use of traditional and local knowledge and practices, to complement the scientific knowledge when developing and implementing the DRR policies, strategies, plans and programmes (UNISDR, 2015b). Further, particular reasons for the selection of these four primary groups can be listed down as follows.

1. Urban planners and designers- this study is to plan and design POS in a new direction. Therefore, urban planners and designers both in academia and practice were chosen as they can provide the views on current planning practices, planning laws and regulations, challenges within the existing development pattern, potentials and future recommendations to plan and design POS with a new direction towards Tsunami disaster resilience.
2. Disaster resilience experts – Both practitioners and professionals in disaster resilience in Sri Lanka, were selected as they can provide the DM specific needs and practices in the context of Sri Lanka.
3. Coastal Planners – Coastal planning practitioners in Sri Lanka were selected as they can provide the coastal context-specific factors, environmental needs and current coast conservation laws and regulations as the study is focused on coastal cities.
4. Tsunami affected Communities - Community who were affected by 2004 Tsunami is taken for the study as they can provide the views on how they used the space in the event of 2004 Tsunami, what type of spaces did they use, did they use any open spaces, how did they use the spaces immediately after the Tsunami, within the recovery period and afterwards. By taking the community, the researcher intends to look at the POS for Tsunami disaster resilience from the user's point of view.

Here the above discussed first three categories; planners and designers, disaster resilience experts and coastal planner were selected within Sri Lanka without limiting to a specific area or site. However, when selecting Tsunami affected communities, the researcher had to select three coastal districts; Batticaloa, Galle and Hambantota, due to two main reasons. The first reason is communities always refer their views to a particular setting. Therefore, concentration on one district may have led to giving district-specific data, and there was a need to differ the districts. Secondly, out of 15 coastal districts in Sri Lanka, seven districts in the northeast coast and southwest coast were severely affected by the 2004 Tsunami (Map 2.1). Out of these seven districts, three severely affected districts were selected due to the practicality of data collection within the limited time.

However, this selection of three districts was made representing both the northeast coast and southwest coast. Further, as this study is focused on urban context (More information on section 2.2.4), within the selected 3 districts, Tsunami affected 'municipal council areas' were taken into consideration, because according to Ministry of Local Government & Provincial Councils Sri Lanka (2016), municipal council areas preside the largest cities in terms of the

population in the country. Furthermore, when selecting the participants within the municipal areas, consideration was also given on inclusiveness with the community representation on cultural and linguistic diversity, people with disabilities, seniors, gender and interest groups.

Although the data collection process was initiated with these four groups, the participant groups were not limited to these four groups. Accordingly, the researcher selected further participants to the study using a sampling procedure (Section 3.8.4). Bryant and Charmaz (2007) emphasise that to reach excellence in grounded theory, both data collection and analysis techniques need to be rigorous. To make the process rigorous, firstly the data need to be obtained through careful sampling, and the sampling procedure used in this research to select the further participants will be discussed in section 3.8.4. Secondly, according to Bryant and Charmaz (2007), the data collection and analysis should not be two processes, data should be collected and analysed concurrently, which will be further discussed in the next section; 3.8.3.

3.8.3 Concurrent Data Collection and Analysis

One of the unique features of the grounded theory is the concurrent data collection and analysis process. This means, generating theory whereby researcher jointly collects data, code them and analyse (Glaser & Strauss, 1967). Thus, data collection and analysis are done concurrently in an iterative process (Charmaz & Bryant, 2011). This simultaneous process of data collection and analysis allow the researcher to start the analysis as soon as the very first piece of data is available.

Accordingly, in this study, the process of analysis was started with the very first set of data collected from the initial participants. Then, the concurrent data collection and analysis process leads to the selection of further questions and further participants (Figure 3.5). This type of alternating data collection with the data analysis enriches the findings significantly (Strauss & Corbin, 1990).

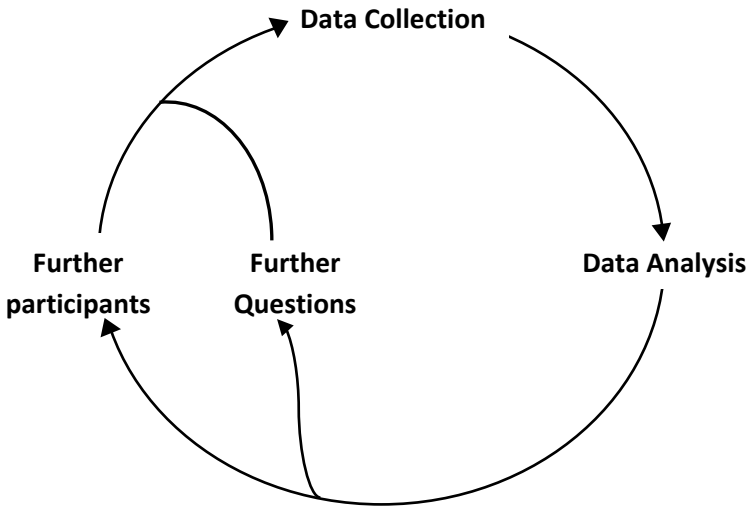


Figure 3.5- Illustration of concurrent data collection and analysis process of study

Within the concurrent data collection and analysis process, the sampling procedure used to select the further participants in this study will be discussed in section 3.8.4.

3.8.4 Sampling Procedure

According to Bryant and Charmaz (2007), there are four main types of sampling methods as follows.

1. Convenience Sampling – Participants are selected based on accessibility, at the initial stage of the project to identify the scope of the project.
2. Purposeful Sampling – Participants are selected based on the initial analysis of the interviews
3. Theoretical Sampling – Participants are selected according to the need of the emerging theory
4. Theoretical Group Interviews – To verify the emerging model, participants are recalled into small groups

Out of these four sampling methods, convenience sampling is used to identify the scope of the project, and the theoretical group interview is used at the end of the project to verify the model. Therefore, these two methods were not taken as the scope of the study was identified through the literature review and as there is no developed model to verify at the data collection stage. Further, purposeful sampling is most appropriate when participants are going through stages of the project and researcher would compare the experience of the first set of participants with the experience of the second set of participants (Bryant & Charmaz, 2007) which is more suitable for healthcare researches and this research does not involve with stages of a process.

Consequently, comparing with other sampling methods theoretical sampling was selected as the most suitable sampling method, because as per Bryant and Charmaz (2007), the selection of further participants according to the need of the emerging theory will increase the researcher's understanding of the developing theory. Confirming this, Creswell (2007) states in theoretical sampling, after collecting data from initial participants, subsequent participants are theoretically chosen to help the researcher to best form the theory. This means, according to the emerging theory the researcher decide what data to collect next (Glaser & Strauss, 1967). Accordingly, after selecting initial participants, the researcher used theoretical sampling method to select the further participants according to the need of the emerging theory and full list of groups of participants and reasons for selecting those participants are presented in Table 3.4. Next section (section 3.8.5) details the data collection techniques used to obtain data from these participants.

3.8.5 Data Collection Techniques

Qualitative researches use different types of data collection techniques such as questionnaire, interviews, focused group discussion, document review, observations and so on. Out of these qualitative data collection techniques, grounded theorists commonly gather data through interviews, documents, observation and combinations (Strauss & Corbin, 1990), (Dey, 1999). Glaser and Strauss (1967) state that to generate a theory various qualitative sources can be used alone or in combination. Adding to this, Denscombe (2007) highlights the combination of different methods increases the understanding of the phenomenon as the research topic will be looked from a variety of perspectives. With this view, the researcher used the combination of three data collection techniques; interviews, documents review and visual images.

3.8.5.1 Interviews

The interview is the most common data collection method in grounded theory, and it permits the use of other data collection methods (Charmaz & Bryant, 2011) including documents review and images. There are three main types of interviews; structured, semi-structured and unstructured (Bryman, 2012).

1. Structured interviews – Interview is guided by a pre-arranged list of questions and these questions are asked often in sequence. This method is cost-effective when the sample size is large.
2. Semi-structured interviews – Interviewer has a clear list of questions or issues to be covered, but the interviewer is prepared to be flexible within the question in a

discussion. So, participants can express their views more freely, unlike in structured interviews.

3. Unstructured interviews – also known as non-directive interviews. Interviews are not guided by pre-arranged questions.

As it was discussed in section 3.8.1, in this study, the research gap was established through the literature review. However, the literature was not used to identify a theoretical framework. Accordingly, there is no guided framework for data collection. Therefore, there is no pre-arranged list of questions which can be used for structured interviews. In line with open mind approach (section 3.8.1) of this research, the researcher did not attempt to develop underlying issues, questions or areas to be explored which can be used for semi-structured interviews.

In contrast to structured and semi-structured interviews, unstructured interviews allow more flexibility to both interviewer and interviewee. In unstructured interviews, the researcher can ask relatively open-ended questions to discover the participant's views on the topic of interest (SAGE Research Methods, 2008). Accordingly, in line with the grounded theory open mind approach, the researcher found that the unstructured interview is the most suitable interview type. Further, Questions types can be open-ended questions or close-ended questions. Out of these, unstructured interviews often use open-ended questions. Interviews with open-ended questions tend to provide a deeper reflection of an issue (Charmaz, 2006). Therefore, the researcher used unstructured interviews with an open-ended question to gain an in-depth understanding of the phenomenon and to avoid the biasness in data collection.

When conducting the interviews, the researcher (interviewer) used two approaches vary according to the two types of participants; Type 1- experts and practitioners and Type 2- Tsunami affected Community.

Type 1- Experts and practitioners

With experts and practitioners, the discussion was started with the question of 'What do you think of the idea of using Public Open Spaces (POS) for Tsunami disaster resilience?'. This question was asked based on central research question 'How to use POS as a strategy to make coastal cities resilience to Tsunamis in Sri Lanka?'. Further, by asking this question in this way, the researcher shows that 'this is just an idea' 'so what is your view on this'. Therefore, interviewees were open to answer either 'I do not think the idea would work because ……...' or 'Yes that is a good idea because…….'. Then according to the answer of the interviewee, further questions were asked with the use of appropriate probes. These further questions were

asked either to get more information on the topic of interest or to keep the interviewee within the boundary of the central research question; 'How to use POS as a strategy to make coastal cities resilience to Tsunamis'. Sample transcript is annexed to the report (Appendix 1) as an example interview with the experts and practitioners.

Type 2- Community

From the community, the researcher did not directly ask the question 'What do you think of the idea of using Public Open Spaces (POS) for Tsunami disaster resilience?' as it can confuse the participant and general public may not have an answer for that. Therefore, the researcher began the discussion with background questions such as 'What did you do when you got to know about Tsunami waves in 2004?' or 'How did you hear about the Tsunami wave first?'. Then further questions were asked relating to the central research area. These further questions were varied according to the answer such as 'Where did you go?', 'How did you find the way?', 'Where did you stay?' and 'What type of spaces did they use during an emergency evacuation, recovery period?'. In this way, the researcher explored the use of open spaces and the possibility of using POS for Tsunami disaster resilience according to natural human behaviour of the community. Sample transcript is annexed to the report (Appendix 2) as an example interview with the Tsunami affected the community.

There are different modes of interviews; group interviews, one to one, face to face and over the phone. Out of these modes, the researcher used one to one, face to face interviews. In contrast to group interviews, one to one interviews are easy to handle. According to Goulding (2002), one to one interviews are flexible, allow in-depth conversation and potential to generate rich ideas. In contrast to interviews over the phone, face to face interviews is convenient to the interviewee to express ideas and less technical interruptions. Especially, telephone interviews well come more formal discussions (Creswell, 2007). Accordingly, considering the appropriateness to the study, the researcher conducted the one to one and face to face interviews.

When recording the interviews, Bryman and Bell (2011) inform that digital voice recording increases the accuracy of the transcription. Therefore, the researcher recorded all the interviews using a digital voice recorder. Further, the researcher conducted the interviews whichever the language convenient to the interviewee. Thus, the interviews were conducted in three languages including English language and two local languages; Sinhala and Tamil. As the researcher is proficient in both English and Sinhala languages, all the English and Sinhala

interviews were conducted by the researcher. However, as the researcher is not skilled in the Tamil language, an interpreter who is proficient in both Tamil and Sinhala was used to interpret the Tamil interviews to the Sinhala language. Then, all the interviews in the Sinhala language were translated into English by the researcher. As the researcher is a Sri Lankan, she was able to understand the words and idioms which come from the social and cultural background of Sri Lanka. In this way, the researcher was able to maintain the quality of English translations. Then all the interviews were transcribed and saved as Microsoft Word files for the analysis.

At the end of the concurrent data collection and analysis process which was discussed in section 3.8.3, there were 72 no. of interviews in total. Out of these interviews, 45 interviews were the interviews conducted with the community who were affected by the 2004 Tsunami in three selected districts (Section 3.8.2). Further, the following table (Table 3.3) presents the no. of interviews in each district.

Type of Interviewee	**No. of Interviews**
Community- Batticaloa	15
Community- Galle	15
Community- Hambanthota	15
Total	**45**

Table 3.3- No. of interviews conducted with the community

Out of 72 interviews, 27 interviews were conducted with experts and practitioners. Accordingly, the list of interviews and the purpose of selecting the interviewee can be presented as follows (Table 3.4).

No.	**Respondents ID**	**Type of Interviewee**	**Organisation**	**Purpose**
1.	B16	Urban Planner	Urban Development Authority (UDA), District Office	To provide planning and designing perspective in Local Level, Challenges and potentials
2.	B14	DM Practitioner	DMC District Office	Tsunami DM practices and needs at the local level and the potential for a new direction
3.	B11	Coastal Planner	CCD District Office	Coastal planning needs and practices
4.	B13	Development Officer	CCD District Office	Coastal planning needs and practices

5.	B15	Administrative Head	Municipal Council	Tsunami DM in local government level the potential for a new direction
6.	C9	Urban Planner, Project planning division	Non-governmental organisation	Current urban planning project focuses on DM
7.	C5	Civil Engineer, Project planning division	Non-governmental organisation	Engineering perspective of using POS for Tsunami disaster resilience
8.	C4	Sociologist/ Researcher in disaster resilience	Colombo University	Social perspective of using POS for Tsunami disaster resilience
9.	C1	Urban Planner	National building research organisation (NBRO)	Existing and future evidence-based research and project directions
10.	C6	Architect/ Urban Planner	NBRO	Existing and future evidence-based research and project directions
11.	C13	Urban Planner	NBRO	Existing and future evidence-based research and project directions
12.	C8	Sociologist/ Researcher in disaster resilience	Colombo University	Social perspective of using POS for Tsunami disaster resilience
13.	C2	DM Practitioner	DMC Head Office	Tsunami DM strategies in national and regional level and future directions
14.	G1	DM Practitioner	DMC District Office	Tsunami DM practices and needs at the local level and the potential for a new direction
15.	G15	Urban Planner	UDA, District Office	To provide planning and designing perspective in Local Level, Challenges and potentials
16.	G16	Urban Planner, Strategic Planning Division	Ministry of Megapolis and Western Development	To provide planning and designing perspective in national and regional Level, Challenges and potentials
17.	G17	Coastal planning Engineer	CCD District Office	Coastal planning needs and practices

18.	G18	Coastal Planning Development Officer	CCD District Office	Coastal planning needs and practices
19.	C7	Professor in Structural Engineer	University of Peradeniya	Engineering perspective of using POS for Tsunami disaster resilience
20.	C10	Practitioner in Community-based DM	Non-governmental organisation	From the perspective of Community-based disaster management (CBDM)
21.	H3	Urban Planner	UDA, District Office	To provide planning and designing perspective in the national and regional level, Challenges and potentials
22.	H4	Urban Planner	UDA, District Office	To provide planning and designing perspective in national and regional Level, Challenges and potentials
23.	H1	Coastal Planner	CCD District Office	Coastal planning needs and practices
24.	C3	DM Practitioner	UNDP	About the DRR strategies in national and sub-national level
25.	H2	DM Practitioner	DMC District Office	Tsunami DM practices and needs at the local level and the potential for a new direction
26.	C11	DM Practitioner-Preparedness	DMC Head Office	Tsunami disaster preparedness practices and needs in national and sub-national level
27.	C14	DM Practitioner-Early warning	DMC Head Office	Tsunami early warning practices and needs in national and sub-national level

Table 3.4- List of interviews with experts and practitioners

3.8.5.2 Documents Review

Documents can take any form varying from newspapers, trade journals, business journals, government publications, advisor reviews, annual company documents to press releases (Bowen, 2009). The grounded theory allows the use of any document as the source of data, but these data should have a relevance to the research interest and useful for interpretation (Glaser

& Strauss, 1967). Further, document review can be done in separate to the other methods or in parallel to the other methods including interviews. In this study document review was used in parallel to interviews to get additional data related to the interview discussion or to clarify the interview data. In supporting this view, Mason (2002) recommend the use of documents to verify or clarify the data derived from the interviews.

Accordingly, Table 3.5 presents the documents which were reviewed in this study to get additional data related to the interview discussion or to clarify the interview data. Furthermore, these documents were carefully chosen through the evaluation for their authenticity, credibility and ability to represent.

Document No	Document Name
1	Development Plan- Batticaloa Development Area
2	Batticaloa DMC Approach for Recovery
3	Galle Development Plan
4	Green Belt project, Batticaloa
5	Batticaloa DRR Preparedness Plan
6	Hambanthota MC Development Plan
7	Strategic Cities Development Project: Galle City upgrading-Inception Report
8	Strategic Cities Development Project: Galle Ocean Pathway Project
9	Batticaloa Disaster Reduction Plan
10	Galle city map with Ocean Pathway
11	Map locating the activity squares within the Ocean pathway, Galle

Table 3.5- Documents reviewed to verify and clarify the interview data

3.8.5.3 Visual Images

In grounded theory, everything you learn in the research setting is considered as data (Dey, 1999). Here 'everything' means field notes, observation, interaction, interviews, documents maps and visual images, Out of these various sources of data, with the 'digital turn', there is the growing popularity of using materials related to visual communication which includes photographs, video recordings, paintings, graffiti, photo blogs, video blogs, (Konecki, 2011). Under these visual communication methods, Denscombe (2007) highlights that visual images are a valuable source of data and can be used as a means of recording events, places.

Considering the advantages of visual images and as this research is focused on the built environment aspect and space, the researcher identified the visual images as a valuable source of data. Accordingly, this study collected data through photographs as a supplementary source

of data alongside the interviews. As an example, when an interviewee mentioned a particular POS related to the discussion, the researcher went to that site and photographed the evidence. Following the same procedure, several photos were taken. However, out of these photos only selected photos were taken after the careful consideration on research ethics, authenticity, credibility and ability to represent.

Accordingly, Table 3.6 presents the visual images used in this study to get additional data related to the interview discussion or to clarify the interview data.

Visual Image No	Visual Image Name
1	Photo of Batticaloa green belt project
2	Photo of Kallady Beach Park
3	Photo of the Tsunami sculpture in Kallady Beach Park
4	Photos of Tsunami signboards in Sri Lanka
5	Photo of Galle Cricket Stadium
6	Photo of Dumping Hill in Galle

Table 3.6- Documents reviewed to verify and clarify the interview data

In summary, this section discussed the data collection techniques used in this study; interviews, document review and visual images. Accordingly, the next section; 3.8.6 describes how the researcher decided on the number of interviews, documents and images.

3.8.6 Theoretical Saturation

In the grounded theory method, how many interviews need to be conducted or how many documents need to be reviewed to generate a theory is not important and always vary from one research to another. According to Knight and Ruddock (2008), from a range of two to a significant number of interviews can confirm a theory. The main reason for this variation is in grounded theory the data collection and analysis are done as a simultaneous process and the decision to stop this iterative process broadly vary according to the need of the final theory. However, the continuous development of theory through the data collection and analysis will be stopped at one point when the meaning of data is little to add to the core of the theory (Glaser & Strauss, 1967). This point where the data collection ceases to reveal any new meaning to the theory is called ‘theoretical saturation’ (Charmaz & Bryant, 2011).

Accordingly, in this research, the researcher started the data collection with the initial participants (Section 3.8.2). Then the analysis process was started concurrently to the data

collection (Section 3.8.3). This continuous theory development process directs the researcher to select further participants according to the need of the emerging theory (Section 3.8.4). Finally, when the researcher identified that further data collection does not add any new meaning to the core of the theory, the researcher decided to stop the data collection which is called theoretical saturation.

Although the data analysis was conducted in conjunction with the data collection, this iterative process is presented in two separate sections; Data collection (3.8) and Data analysis (3.9), to make the process clear to the reader. Accordingly, this section detailed the data collection techniques and procedures and the next section; 3.9 is focused on explaining data analysis techniques and procedures.

3.9 Research Techniques and Procedures: Data Analysis

Data analysis together with data collection locates at the core of the research onion (Saunders et al., 2016), which means data analysis techniques and procedures need to be principally linked with the researcher's philosophical and methodological assumptions which were made at the research design of the study. Accordingly, based on the research philosophy (Section 3.3) and the research approach (Section 3.4), the researcher made the methodological choice of the study as a multi-method qualitative study (Section 3.5). Further, following the path through the research strategy as the grounded theory (Section 3.6) and the time horizon (Section 3.7), qualitative data were collected through the grounded theory data collection process (Section 3.8).

When analysing these qualitative data, Saunders, Lewis, and Thornhill (2009) identify two types of qualitative data analysis procedures; deductively-based procedures and inductively-based procedures. In deductively based procedures, data can be analysed based on a structure predetermined by the researcher which was reflected through the interview questions. Then, these predetermined categories or themes can be revised or altered through the analysis. In contrast, inductively based analysis procedures identify the categories freshly from the analysis without trying to relate the data to predetermined categories. Consequently, aligning with the inductive research approach (Section 3.4) and the open mind approach of data collection (Section 3.8.1), this study follows the inductively based analysis procedures to analyse the data.

Further, there are different types of inductively based analysis procedures such as template analysis, narrative analysis, discourse analysis and grounded theory analysis. Out of these

analysis procedures, as this research study used the grounded theory research strategy and the grounded theory data collection procedure, the researcher selects the grounded theory analysis procedure as the most appropriate analysis procedure to the study.

Following the grounded theory analysis procedure, Glaser and Strauss (1967), disclose that there are three main approaches to analyse qualitative data as follows.

1. Qualitative data can be converted to quantifiable form through coding the data first and then analysing it based on the factors such as frequency or significance.
2. Qualitative data will be used to form theoretical ideas where the researcher would not do explicit coding, instead merely inspect data for new properties for the theoretical categories.
3. The third approach is the constant comparative analysis which combines the explicit coding procedure from the first approach and theory development procedure from the second style.

Out of these three methods, as in the first method, the researcher does not want to measure the frequency and significance of the data, neither to form some abstract theoretical ideas as in the second method. Furthermore, Glaser and Strauss (1967) emphasise that relatively constant comparative analysis method joint the coding and analysis together with theoretical sampling and generate the theory more systematically. Adding to this, Dey (1999) states this integrative process reveal the similarities and differences, identify a pattern within the data and clarify the logic of the theory. Therefore, the researcher selects the third approach; constant comparative analysis to analyse the qualitative data collected in the study. Accordingly, the next section; 3.9.1 explains the constant comparative analysis of this study.

3.9.1 Constant Comparative Analysis

Glaser and Strauss (1967) describe the comparative analysis as 'a strategic method of generating theory'. It commences with first sorting the data into properties and categories, conducting line-by-line analysis and identify common themes from that (Goulding, 2005; Knight & Ruddock, 2008). This type of analysis procedure starts coding an incident into categories on analysis. Then when coding the next incident, it will be compared with the previous incidents to identify whether there are any similarities or differences (Glaser & Strauss, 1967). In this way, constant comparison analysis compares 'incident to incident', 'group to group' and brings out a different aspect of the same phenomenon. Accordingly, in this study, the researcher used the constant comparison method to compare all units of data to all other units of data. As an example, when the researcher starts coding one interview, it will be compared with previously coded interviews, documents, and visual images. If the information is similar to previous data, it will be coded to the same category or property; if it is different, it will be coded as a newly emerged category or property.

Comparative analysis process produces two elements which are called categories and properties. Glaser and Strauss (1967) define the categories as 'conceptual elements of a theory' and properties are the conceptual elements under each category. According to Dey (1999), Categories play a dual role by providing stability required to generate the theory and by providing rich interpretation to social theory. Based on the three key sources, Dey (1999), Glaser and Strauss (1967), and Glaser (1992), the researcher identify the key differences between the categories and properties as follows (Table 3.7).

Categories	Properties
• Categories are elements of a theory and can stand by themselves	• Properties cannot stand by themselves, as they are elements of categories
• Type of a concept	• It is a concept of a concept
• A higher level of abstraction	• A lesser level of abstraction
• The distinction will lead to categories	• Property is a conceptual characteristic of a category
• Categories can be assigned through comparison and classification	• Properties can be attributed through analysing the interaction

Table 3.7- Differences between categories and properties

Furthermore, the step-by-step process of using constant comparative analysis in the study can be explained through the coding procedure which will be detailed in section 3.9.3.

3.9.2 Theoretical Sensitivity

However, as it was discussed above (section 3.9.1), when identifying the units of data and when differentiating them as categories and properties, the researcher's theoretical sensitivity plays a significant role. Theoretical sensitivity refers to the researcher's personal qualities which determine the researcher's ability to give meaning to data, capacity to understand the meaning of data and separate data (Dey, 1999). Theoretical sensitivity may derive from different sources such as through reading the literature or researcher's professional and personal experience. Accordingly, in this study, researcher's theoretical sensitivity through reviewing the literature related to the field of study, work experience in social research, urban planning and designing experience determined the researcher's ability to give the meaning of data.

3.9.3 Coding process and Memo Writing

Strauss and Corbin (1990), introduced the coding process as 'the process of analysis'. There are mainly two types of coding procedures; inductive coding and deductive coding (Dey, 1999). In inductive coding, codes are identified directly from data. In deductive coding, data are coded to pre-identified themes. As this research follows inductively based analysis procedures (Section 3.9), the coding procedure will be inductive coding. If the data are first coded and then analysed as in this research, Dey (1999) refers to the coding procedure as a translation of data from its raw state to a new state. Adding to this, Charmaz (2006) identifies coding means classifying segments of data and label them, or in other words, each segment is about what. By categorising and comparing initial codes, the gaps in data can be identified which need to be filled through theoretical sampling and concurrent data collection. Then the newly collected data need to be coded comparing with the previous data. In this iterative data analysis process, memo writing operates as an integral part. Memos are written records of analysis or the running logs of the analytical process (Corbin & Strauss, 2008). When you code one interview and move to another if you feel that you forget the previous idea of coding, Glaser and Strauss (1967) state 'stop coding and record a memo on your ideas'. Similarly, in this study, memos were used to record how and why decisions were taken in the analysis process (Figure 3.7).

Furthermore, the coding procedure can be explained connecting with the constant comparative analysis process. Glaser and Strauss (1967), identify three main stages in constant comparative analysis;

1. Start coding each incident into categories on analysis,
2. Integrating categories and their properties and

3. Delimiting the theory where the theory is modified by clarifying the logic, taking out non-relevant properties, integrating elaborating details of properties into the primary outline of interrelated categories.

Reflecting these three stages, there are three main types of coding; open coding, axial coding, and selective coding. Accordingly, the comparative analysis process of the study will be discussed step-by-step, using these three types of codes; open coding (Section 3.9.4), axial coding (Section 3.9.5), and selective coding (Section 3.9.6).

3.9.4 Open Coding

Open coding is defined as 'the process of breaking down, examining, comparing, conceptualising and categorising data' (Strauss & Corbin, 1990). This is the initial stage of the constant comparative analysis which breaks the data into distinctive units (Goulding, 2002). In open coding, researcher reads and analyses the data either word by word, line by line, paragraph by paragraph, or incident by incident, or might use more than one of these methods (Bryant & Charmaz, 2007). As this study does not attend more to the language and action, the researcher did not use the word by word coding for the analysis. Further, as the researcher does not want to miss the data within the paragraph or incident, did not use the paragraph by paragraph or incident by incident coding in this study. Accordingly, considering the appropriateness to the study, the researcher chose the line by line coding as the most appropriate strategy for open coding.

When starting the process of analysis with line by line coding, the consideration needs to be given on how to manage the amount of data in this study, which includes 72 lengthy interviews plus documents and images. Knight and Ruddock (2008) state that Computer-aided data analysis can be used to overcome the complication, messiness, time-consuming and tiresome in manual analysis processes. Nvivo is one of the useful computer-aided analysis software which facilitates the qualitative analysis processes (Bryman, 2012). Accordingly, considering the factors such as easiness to handle massive amount of qualitative data, allowing the storage of different types of data (e.g. interview transcripts, documents, videos and images), ability of writing memos and user-friendliness, the researcher chose Nvivo Pro (Version 11) software for the analysis process in this study.

3.9.4.1 Data analysis in Nvivo Pro (Version 11)

Firstly, the interview transcripts, documents and images were uploaded to the project created in the Nvivo Pro (Version 11). Then started the line by line open coding comparing data with previously coded data following the comparative analysis method. When open coding, the researcher used the following rules which were suggested by Glaser for open coding (Dey, 1999).

- Ask yourself a set of questions when coding, such as what is this data a study of, what category does this indicate?
- Analyse the data line by line
- Always interrupt coding to a memo
- Stay within the confines of the substantive area and field of study

Following this method, all the data were broken into discrete parts. Figure 3.6 presents one example of the line-by-line coding an interview transcript in Nvivo Pro (Version 11) software. Documents were coded the same way as transcripts.

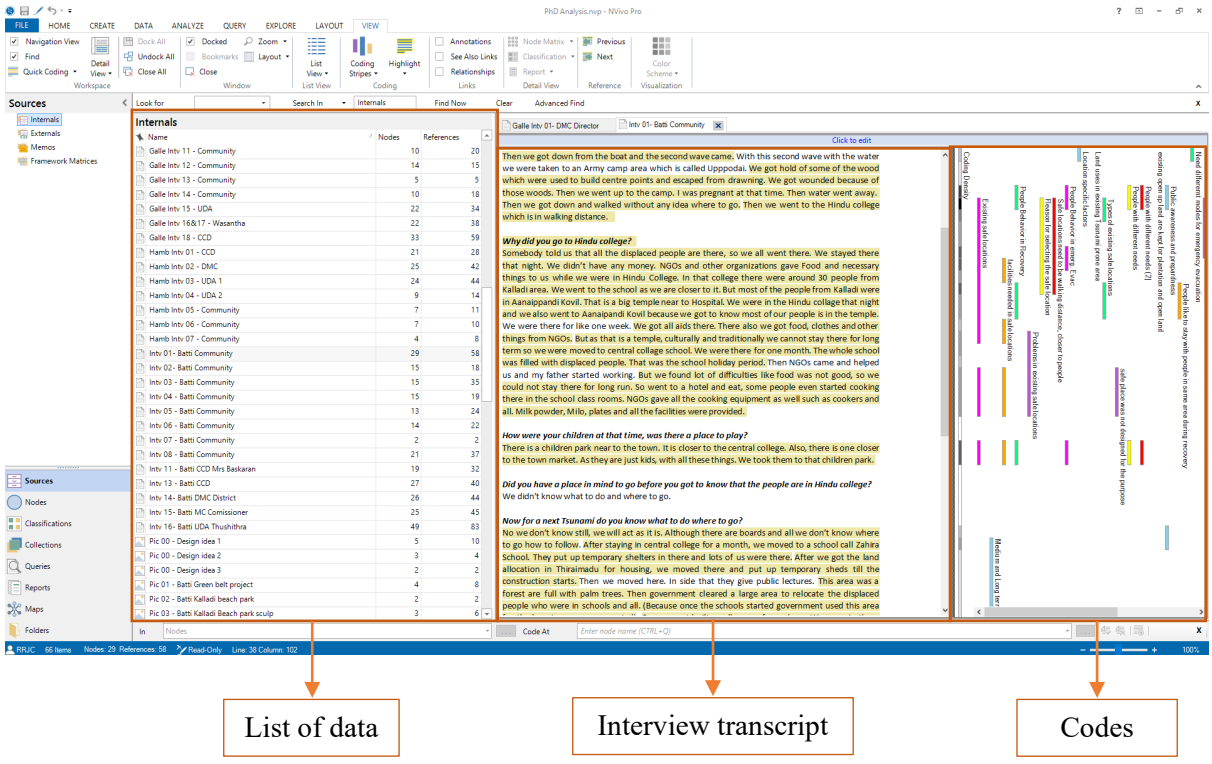


Figure 3.6- Open Coding Interview Transcript in Nvivo Pro (Version 11)

When coding visual images, first the meaning of the visual image was transcribed and then coded as shown in figure 3.7.

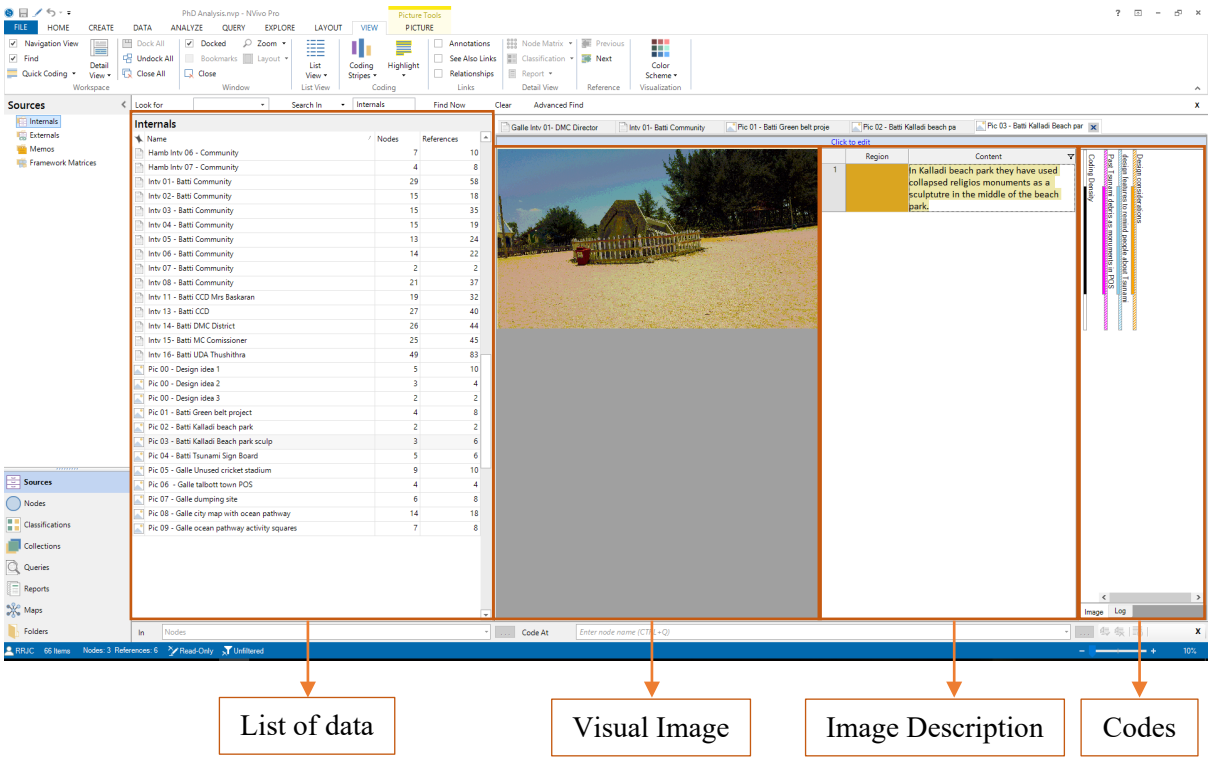


Figure 3.7- Open Coding Visual Image in Nvivo Pro (Version 11)

As it was discussed in section 3.9.3, while coding the interviews, documents and images, the researcher used memos to record the meaning of the codes, reasons why particular lines are categorised into one node, further explanations and so on. Figure 3.8 illustrates the memos created in Nvivo Pro (Version 11).

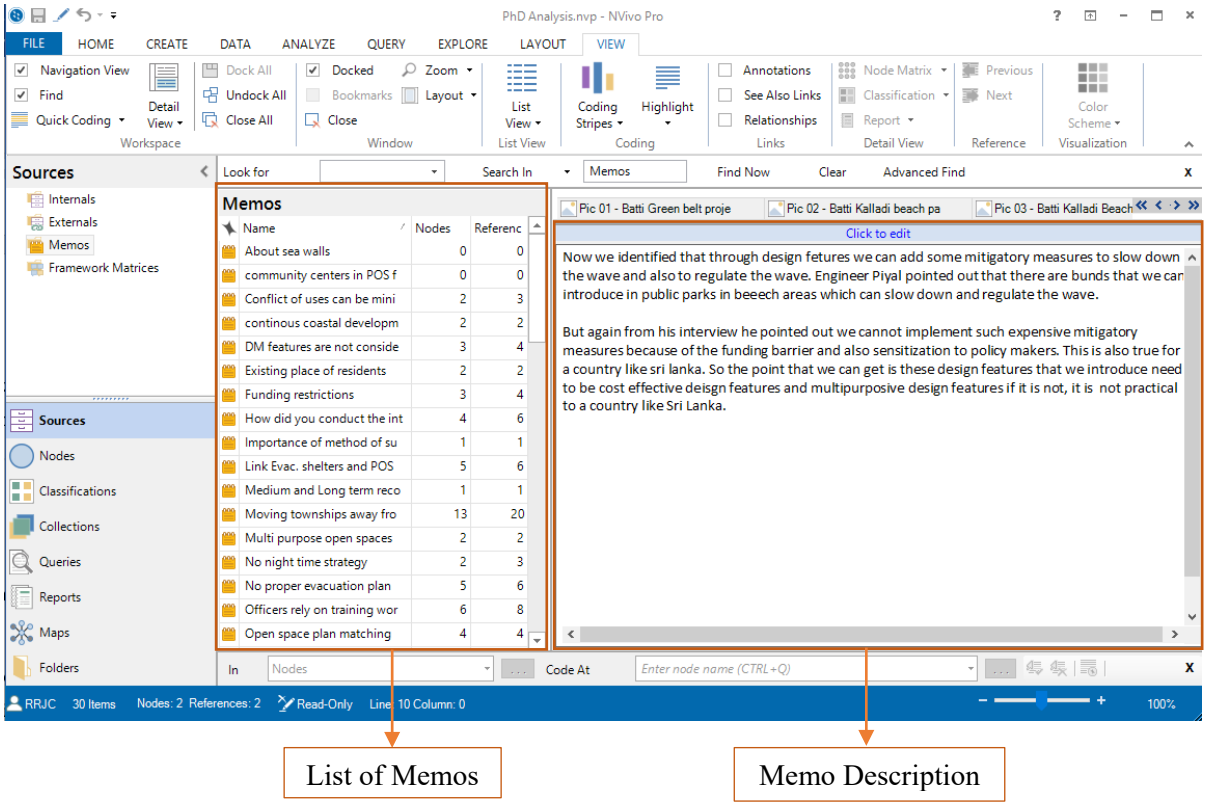


Figure 3.8- Memos created in Nvivo Pro (Version 11)

Using the theoretical sampling procedure (Section 3.8.4), the coding the first set of data suggested the further sources or participants for the data collection. Subsequently, the newly collected data were coded using the same procedure as discussed above. Similarly, all the collected data which includes 72 interviews, 11 Documents and 6 Visual Images, were open coded and in parallel, memos were recorded as per the need of the researcher. At the end of the open coding, list of parent nodes and list of child nodes under each parent node were identified (Figure 3.9). At this stage, it was difficult to recognise the parental nodes as 'categories' and child nodes as 'properties'. These parental nodes and child nodes gave suggestions for categories and properties but without any link to each other.

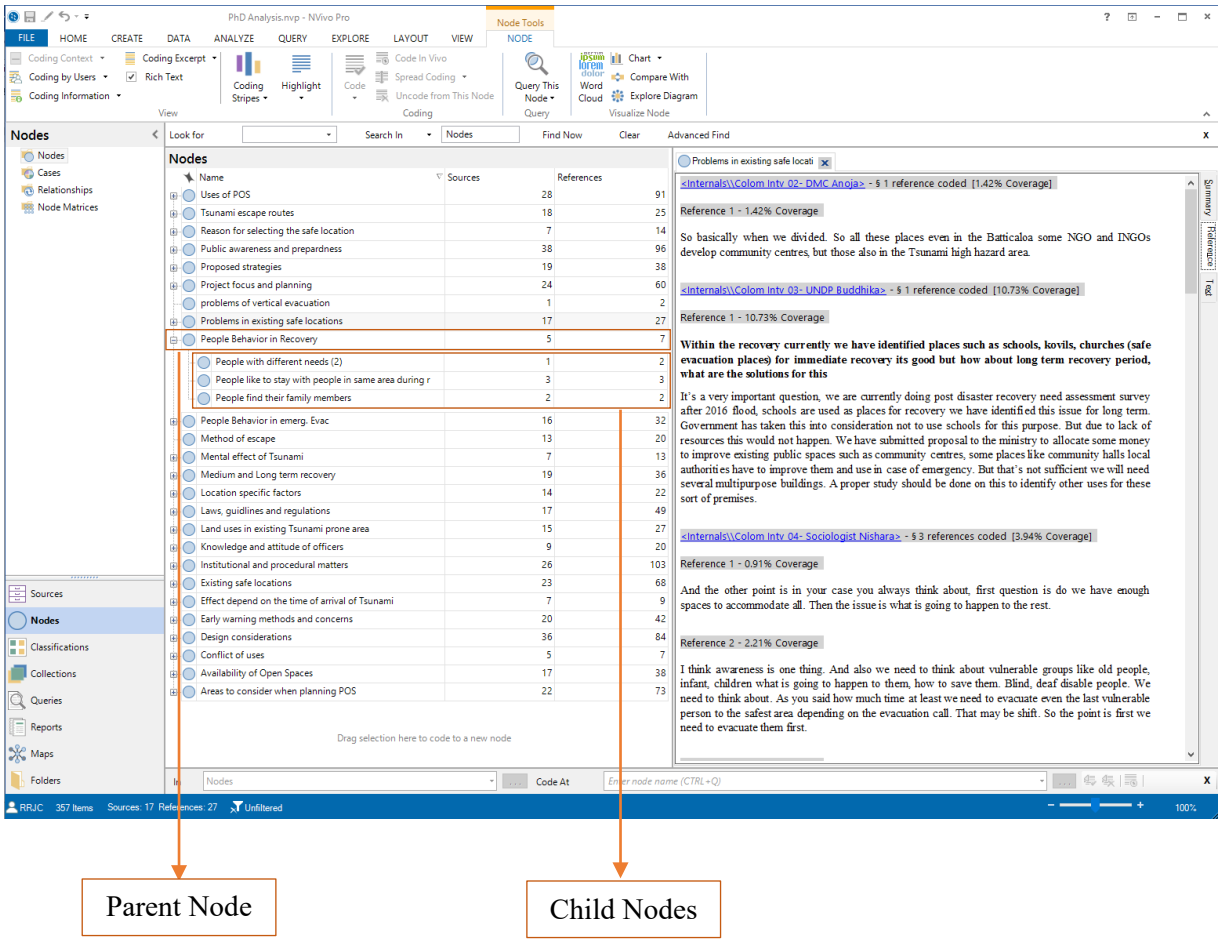


Figure 3.9- Parent and child Nodes in Nvivo Pro (Version 11)

Altogether there were 25 parent nodes and 318 child nodes. Accordingly, the identified parent nodes and the number of child nodes under each parent node can be listed as follows.

1. Areas to consider when planning POS -31 Child Nodes
2. Availability of Open Spaces - 7 Child Nodes
3. Conflict of uses - 2 Child Nodes
4. Design considerations - 33 Child Nodes
5. Early warning methods and concerns - 13 Child Nodes

6. Effect depend on the time of arrival of Tsunami - 1 Child Node
7. Existing safe locations - 15 Child Nodes
8. Institutional and procedural matters - 26 Child Nodes
9. Knowledge and attitude of officers - 7 Child Nodes
10. Land uses in existing Tsunami prone area - 12 Child Nodes
11. Laws, guidelines and regulations - 20 Child Nodes
12. Location specific factors - 9 Child Nodes
13. Medium- and Long-term recovery - 5 Child Nodes
14. Mental effect of Tsunami - 6 Child Nodes
15. Method of escape - 1 Child Node
16. People Behaviour in emergency evacuation - 10 Child Nodes
17. People Behaviour in Recovery - 3 Child Nodes
18. Problems in existing safe locations - 14 Child Nodes
19. Problems of vertical evacuation - 1 Child Node
20. Project focus and planning - 16 Child Nodes
21. Proposed strategies - 15 Child Nodes
22. Public awareness and preparedness - 28 Child Nodes
23. Reason for selecting the safe location - 5 Child Nodes
24. Tsunami escape routes - 10 Child Nodes
25. Uses of POS - 28 Child Nodes

In this way, open coding was used to separate the data into discrete parts without any theoretical connection to each other. Accordingly, the next step is the axial coding where these distinct parts will be stitched together in a theoretical connection (Section 3.9.5).

3.9.5 Axial Coding

Axial coding is defined as ‘a set of the procedure whereby data are put back together in new ways after open coding by making connections between categories’ (Strauss & Corbin, 1990). Adding to this, Dey (1999) states axial coding put together the data fragmented by open coding. In this way, axial coding is used to specify the relationship of categories and properties (Goulding, 2002) and to clarify the emerging theory (Charmaz, 2014).

Following the same procedure, the researcher used the axial coding to stitch the data together with a theoretical connection. Accordingly, the researcher first tried to do the axial coding using the Nvivo software. However, it was difficult to see the relationship between codes through the Nvivo software, due to the huge amount of data which includes 25 parent nodes and 318 child nodes. Therefore, the researcher decided to connect data manually instead of using software to connect data. Because computers do not do the thinking process, therefore researchers must interpret data (Bryman & Bell, 2011).

Further, software should be used just as a tool and not as a method in researching (Flick, 2006). Accordingly, following the manual method, the researcher printed all the parent and child nodes identified in the open coding into hard copies. Then using these printed hard copies, the researcher tried to identify the relationship between the codes through stitching them together (Figure 3.10).

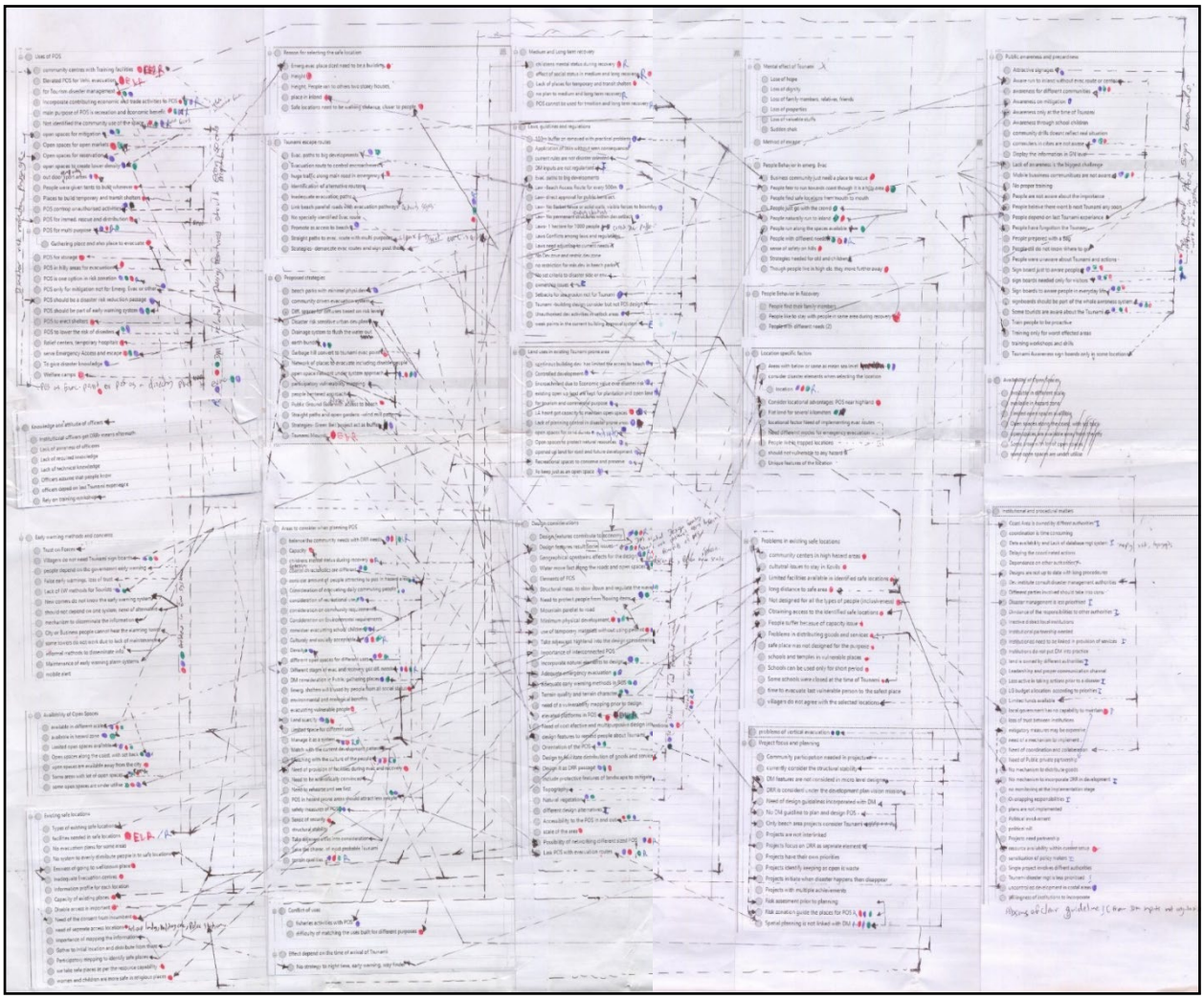


Figure 3.10- Axial coding by connecting parent nodes and child nodes

Through the axial coding procedure, set of interrelated categories, properties, sub-properties were identified as follows (Figure 3.11).

Categories	Properties	Sub-Properties
Strategies to use POS for DRR	- Networking POS - Multipurpose POS - Terrain quality and the Topographic characters guided POS - Risk Zonation guided POS - Use of POS depending on the location and size	- Development of evacuation route network linking Beach Access roads and local road network with POS - Use the lighting and signage of POS network to facilitate the night time evacuation way finding strategy - Link the POS network with vertical evacuation shelters - Need of Tsunami sign board system linked with POS
Potentials of POS	- To Mitigate the Tsunami Disaster Risk - To Direct the Emergency Evacuation - Use for Emergency Evacuation Distribution - Provide Public Awareness - Use as an Emergency Evacuation gathering place - To Provide basic, services and facilities in emerg. response - To distribute goods and services	- Minimum Physical development and use of natural features protecting mitigatory measures - Use design features and orientation of the POS to slow down and regulate the wave - Plan for safe evacuation by linking POS with evacuation road network and linking neighbouring highlands - Use design features to remind Tsunami and importance of being pro-active - Display mitigation related features - Use design features and orientation of POS to slow down and regulate the wave - Plan for safe evacuation by linking POS with evac. road network and linking neighbouring highlands in to the design - Use POS as a distribution place with improved access to use vehicles in evac. - Plan for safe evacuation by linking POS with evacuation road network and linking neighbouring highlands in to the design - Direct people through a landmark system and use design features as landmarks - Minimum physical development and designed as a loose space - Space for Temporary sheltering for immediate recovery - designed within walking distance - Inclusive design with sense of security - Linked with community centres - Provision of basic facilities or facilitate the provision of basic services and facilities - Linkage with the access locations and other service providers
Challenges to use POS for DRR	Challenges through the development pattern Design challenges Environmental challenges Funding challenges Locational challenges Institutional challenges Procedural challenges	- Limited availability of land, therefore, multipurpose use of space - Consider natural human behaviour pattern when allocating evacuation routes and POS for safe evac. - Tsunami DM-related features need to be economically and socially acceptable - Allocation of POS need to be matched with the current development pattern of the city - Map evacuation routes and POS for safe evacuation in-cooperating the local knowledge through participatory mapping - Use POS to aware people on local evacuation plan by displaying signage and evacuation maps

Figure 3.11- Categories, properties, sub-properties identified in Axial coding

Further, by linking the codes with each other and specifying the relationship of categories and properties, the researcher identified a story behind every property and sub-property which were presented in figure 3.10. For example, if the very first property in figure 3.10 is taken into consideration, the following figure (Figure 3.12) illustrates the story behind this property. This will be further explained throughout the findings chapter (Chapter 4).

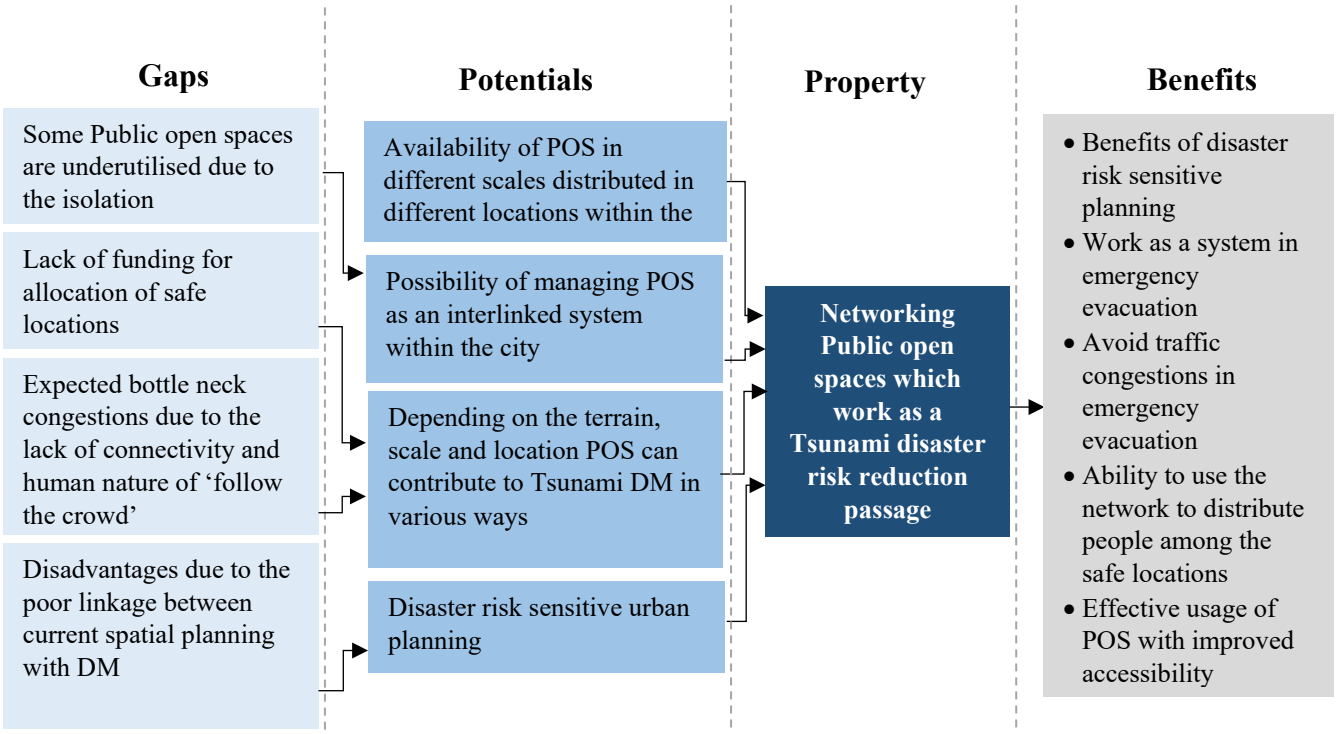


Figure 3.12- Example story behind properties and sub-properties

Though the axial coding was used to identify categories, properties, sub-properties and the relationships, the refinements need to be made to find a complete answer to the research question 'How to plan and design POS as a strategy to make coastal cities resilience to Tsunamis in Sri Lanka?'. By following the next coding step which is called selective coding describes the process of refining the theory and finalising the theory. Accordingly, the next section on selective coding (Section 3.9.6) describes how the final theory emerged through the refinements.

3.9.6 Selective Coding

Selective coding is defined as the process of selecting the core category and systematically relating it to another category, validating those relationships, and filling in categories that need in further refinement and development' categories'(Strauss & Corbin, 1990). This step attends in both delimiting and integrating theory in constant comparison (Dey, 1999).

Accordingly, the next step of the analysis was to select the most significant or frequent category and then systematically relate the other categories and properties to it, together with taking off the non-relevant properties. However, according to Dey (1999), there may be more than one category around the central phenomenon and selecting one as the core category may mislead the whole theory. With this view, the researcher carefully identified the most significant categories related to the central phenomenon and then compared the other categories and properties to the core categories. Accordingly, five core categories were identified. Those five core categories and the process of identifying the core categories and the related categories will be explained in detail within section 4.2. After the identification of these core categories, the relationship of the core categories with other categories and properties was established by delimiting and integrating. Accordingly, the final theory (Figure 4.32) which emerged through the selective coding, will be detailed in the analysis and findings chapter (Chapter 4).

3.10 Sequence and Phases of Data collection and Analysis

Sequence and phases of data collection and analysis were detailed throughout sections 3.8 and 3.9. Accordingly, this section attempts to summarise the sequence and explains how the data collection and analysis was operationalised in the field. In summary, the research was operationalised in the field as follows.

Step 1 – Data collection with an open mind

The data collection process was started with an open mind following the second version of the grounded theory (Section 3.8.1). Accordingly, the data collection was not guided by a framework or preconceived set of ideas and the review of the literature was used only to confirm the research gap and to select the initial participants.

Step 2 – Selection of Initial Participants

Literature confirmed research gap suggested four main groups of participants to start the data collection process (Section 3.8.2). The four types of participants are urban planners, disaster resilience experts, coastal planners and Tsunami affected communities in Sri Lanka. Out of these four types, urban planners, disaster resilience experts, coastal planners were chosen within Sri Lanka without limiting to any district or site. Representatives from both academia, practice and key authorities/organizations related to the field of study were taken to the study.

When selecting communities who were affected by the 2004 Tsunami, the researcher selected three coastal districts; Batticaloa, Galle and Hambantota, due to two main reasons. The first

reason is communities always refer their views to a particular setting. Therefore, concentration on one district may have led to giving district-specific data. Secondly, out of 15 coastal districts in Sri Lanka, seven districts in the northeast coast and southwest coast were severely affected by the 2004 Tsunami (Map 2.1). Out of these seven districts, three severely affected districts were selected due to the practicality of data collection within the limited time. However, this selection of three districts was made representing mix of ethnic groups and all the types of geographical conditions in Sri Lanka as follows.

- Batticaloa – Dry weather Condition, Marshy, Flat terrain, Lagoon diversity, Calm and quiet Shallow, Low population density, Multi-ethnic groups
- Galle – Contrast to Batticaloa, highly urbanised with high population density, High elevation and terrain characters, Wet weather condition, highly eroded coast, Less geographical features such as lagoons and sand dunes.
- Hambanthota – Mix of Galle and Batticaloa conditions, Moderate terrain, moderate tidal characteristics, No thick vegetation as in Galle, Dry weather Condition.

Step 3 – Conduct the Interviews

The researcher used unstructured interviews with an open-ended question to gain an in-depth understanding of the phenomenon and to avoid the biasness in data collection. As it was discussed in section 3.8.5.1, two different approaches were followed according to the two types of participants; Type 1- experts and practitioners and Type 2- Tsunami affected Community. The detailed interview schedule can be found in Appendix 8. However, the interview questions in this appendix 8 were used only to start the discussion and further questions were varied as per the interview flow. However, these further questions were asked either to get more information on the topic of interest or to keep the interviewee within the boundary of the central research question.

When conducting the interviews with Tsunami affected communities within the municipal areas, consideration was also given on inclusiveness with the community representation on cultural and linguistic diversity, people with disabilities, seniors, gender and interest groups. Especially, the researcher with her knowledge of Sri Lankan culture had to follow some strategies to get access to certain groups of society. To get the access seniors or the aged people of the society, researcher went to the village boutiques in Tsunami affected areas or Tsunami relocated areas during the day time because that is where the aged people get together and chat during the day time. In order to interview the women, researcher went to houses during the

daytime. However, in order to access working men in the household, the researcher had to visit evening times when it is out of the working hours. Then the disabled people were accessed through the community groups and organisations. Likewise, researcher had to visit multiple locations multiple times in order to get the representation of all the groups of the society.

Step 4 – Review of Documents and Visual Images

In parallel to interviews, the researcher reviewed documents either to get additional data related to the interview discussion or to clarify the interview data. Table 3.5 presents the documents which were reviewed in this study. Apart from the documents, considering the advantages of visual images and as this research is focused on the built environment aspect and space, the researcher identified the visual images as a valuable source of data. Accordingly, this study collected data through photographs as a supplementary source of data alongside the interviews. Accordingly, Table 3.6 presents the visual images used in this study to get additional data related to the interview discussion or to clarify the interview data.

Step 5 – Selection of further Participants

Without limiting to the initial four groups of participants, the researcher selected further participants according to the need of the emerging theory will increase the researcher's understanding of the developing theory (Section 3.8.4). Accordingly, after selecting initial participants, the researcher used theoretical sampling method to select the further participants according to the need of the emerging theory and full list of groups of participants and reasons for selecting those participants are presented in Table 3.4.

Step 6 – Concurrent Data collection and Analysis

In this study, the process of analysis was started with the very first set of data collected from the initial participants. Then, the concurrent data collection and analysis process leads to the selection of further questions and further participants (Figure 3.5). This continuous theory development process directs the researcher to select further participants according to the need of the emerging theory (Section 3.8.4). When the researcher identified that further data collection does not add any new meaning to the core of the theory, the researcher decided to stop the data collection which is called theoretical saturation. In this way, the researcher jointly collected the data, code them (Open coding, axial coding and selective coding) as explained in section 3.9 and regenerated the theory.

Step 7 – Validation and Theory Building

The accuracy and suitability of the data of this study can be confirmed based on triangulation and grounded data (section 3.11.1). Apart from that, the researcher used respondent validation and external validation to validate the final framework which will be further discussed in the next section; 3.11.

3.11 The credibility of the research

Positivists who rely on quantitative techniques, often challenge the credibility of the qualitative researches. The main reason behind this is, quantitative research provides hard facts and figures whereas qualitative researches may get affected by the subjective nature of human thought, beliefs and values of the individuals (Thomson, 2011). However, qualitative researches are needed as those uncover the subjective viewpoint at the very heart of these hard facts and figures which are provided by quantitative techniques (Thomson, 2011). Further, both quantitative and qualitative studies should demonstrate the credibility of the research, as it reflects the way how researcher minimises the possibility of getting wrong answers to the study (Saunders et al., 2009). Accordingly, in this section researcher attempts to determine the credibility of the study.

Traditionally, the credibility of the study can be demonstrated, establishing the validity and reliability of the study (Murphy & Yielder, 2010). Accordingly, following two sections 3.11.1 and 3.11.2 explain the validity and reliability of the study.

3.11.1 Validity

In qualitative researches, validity means to which extent qualitative researchers can demonstrate the accuracy and the appropriateness of their data (Denscombe, 2007). Accordingly, accuracy and suitability of the data of this study can be confirmed based on four factors; triangulation, grounded data, respondent validation and external validation.

3.11.1.1 Triangulation

The method ‘triangulation’ originated in the field of navigation where the location is determined by using the angles from two known points (Heale & Forbes, 2013). With this view, the triangulation method became popular in the research field to view things from more than one perspective.

Consequently, triangulation can be applied in various ways; using different research methods, a different source of data or different researchers within one study (Collis & Hussey, 2013). Accordingly, there are different types of triangulation such as methodological triangulation, data triangulation, investigator triangulation, theory triangulation, space triangulation and so on. Out of these various types of triangulation, based on the time restriction, practicality in a doctoral study and appropriateness to the study, the researcher selected following two types of triangulation to demonstrate the validity of this study.

1. Methodological triangulation

   Methodological triangulation means the use of more than one method to investigate the same phenomenon (Grix, 2010). As it was discussed in section 3.5, the methodological choice of the study is multi-method qualitative study. Accordingly, the researcher used more than one data collection techniques to investigate the same phenomenon. As it has been described in section 3.8.5, three types of data collection techniques were used; interviews (Section 3.8.5.1), document review (Section 3.8.5.2) and visual images (Section 3.8.5.3). In this way, the researcher used the methodological triangulation to investigate the same phenomenon using three different techniques.

2. Data triangulation

   Data triangulation means the validity of the findings can be determined by the use of contrasting sources of information (Flick, 2006). Within data triangulation, data can be triangulated using different Respondents (Respondent triangulation), using data collection times (time triangulation) or use of more than one cultural, social or geographical context (space triangulation). As it was discussed in section 3.8.5.1, the interview data of this study was collected from various sources including practitioners, policymakers, academics and community within the field of study. Thus, this study has employed respondent triangulation. Further, the researcher used space triangulation by collecting data from more than one cultural, social or geographical context. As it was described in section 3.8.2, the data was collected from three different settings; Galle, Hambantota and Batticaloa. In this way, the researcher has used the space triangulation which further establishes the validity of the research.

3.11.1.2 Grounded in the empirical data

According to Denscombe (2007), when the findings are grounded in the empirical data, it increases the credibility of the research. Therefore, the use of empirical data as the foundation

to build the theory is one of the ways to prove the credibility and validity of the research findings. In supporting this view, Georgieva and Allan (2008), emphasise that when the theory comes directly from the real-world data itself, such theory is reliable. Adding to this, some researchers argue that theory which emerged from grounded theory method, do not need to go through a validation phase, because the theory itself emerged from the data, therefore, the validation is a continuous part of the comparative analysis (McCreaddie & Payne, 2010).

Similarly, the findings of this research emerged directly from the real-world data through the process of constant comparative analysis in grounded theory (Section 3.9.1). Accordingly, the use of empirical data and grounded theory analysis procedure itself is proof to confirm the credibility and the validity of the research findings.

3.11.1.3 Respondent validation

Apart from the above two methods; triangulation and grounded data, Murphy and Yielder (2010) demonstrate the respondent validation as a means to verify the emerging theory by comparing and checking it with the data or the respondents. This is also known as the 'member checking' which means the researcher goes back to the participants or the Respondents to double-check the information given and to show how the findings were derived. Respondent validation can be used as a method of checking the accuracy of data and the validity of the results (Denscombe, 2007). Similarly, the researcher used respondent validation to verify the accuracy of data and the validity of the findings.

When validating through respondents, it is more accurate if the findings can be verified by all the respondents. However, Walliman (2011) points out that it is not practical to let all the participants edit the research findings which could cause a long delay to the process. Therefore, considering the time limitation and the practicality, the researcher presented the analysis and findings to respondents C1 and C4 to validate the results. Outcomes of the respondent validation are presented in section 4.6.1. Apart from going back to the participants, there is a different approach to validate the findings by inviting new participants to discuss the findings with (Gunne-Jones, 2009). Introduction of this approach which is called 'external validation' opens up the discussion to the next section; 3.11.1.4.

3.11.1.4 External Validation

External validation is defined as the 'transferability of the concept to the wider environment' (Murphy & Yielder, 2010) which means prove the validity of the research by linking the idea

with the external world. This can be achieved by inviting new participants to discuss the findings with (Gunne-Jones, 2009). Accordingly, the transferability of the research findings to a wider environment within the Sri Lankan context was checked by inviting the new reviewers to discuss the findings with. Accordingly, a list of experts (Table 4.3) related to the field of study was interviewed to validate the findings externally. Outcomes of the external validation will be discussed in section 4.6.2.

3.11.2 Reliability

Reliability denotes the replicability of the data collection techniques or analysis procedures to produce the same result (Murphy & Yielder, 2010). This checks the stability of measurement and whether the results of the study are replicable (Bush, 2007). When demonstrating the reliability of this study, as it was discussed in section 3.6.2, the researcher compared all the possible research strategies and selected grounded theory approach as the most suitable method to collect data and to analyse with the inductive coding procedure. However, without limiting to that, as it was revealed in sections 3.6.3 and 3.6.4, the researcher compared different versions of grounded theory and chose the most suitable version for the study. Accordingly, the data collection with open mind and the grounded theory coding procedure allowed the researcher to go through a logical process when answering to the central research problem 'How to plan and design POS as a strategy to make coastal cities resilience to Tsunamis?'. Therefore, as the data was collected minimising the biasness of the researcher and as these collected data went through the rigorous coding procedure towards the final results, the study can be repeated with the same results which prove the reliability of the research.

3.12 Summary and the Link

This chapter established the research aim, objectives and questions and justified the methodology of the study by detailing methodological design, philosophical stance, research approach, methodological choice, research strategies, time horizon, data collection techniques and procedures, data analysis techniques and procedures. Each of these elements of the research methodology was elaborated, and the rationale for the selection of each component was justified. Finally, the credibility of the research was demonstrated by verifying the validity and reliability of the study. The next chapter presents the analysis and findings of the research study.

CHAPTER 4: ANALYSIS AND FINDINGS

4.1 Introduction

Previous chapter (Chapter 3) justified the methodology of this research and detailed how the data collection and the data analysis was carried out in this research study. However, one of the primary criticisms of the grounded theory research studies is that the work fails to report the stages involved (Knight & Ruddock, 2008). The main reason for this criticism is that the data collection, coding and analysis are conducted as a parallel process and findings emerge as a result of this concurrent process. Therefore, in some research work, findings may appear to emerge abruptly from the process. Answering this, Knight and Ruddock (2008), emphasise enough evidence should support the developed theory and the logic in building the theory, and the process should be adequately explained. Accordingly, to avoid this identified criticism and also to make the process clearer to the reader, in this study the researcher decided to present the data analysis in two parts; first part the step-by-step process of the analysis and second part the emergence of findings through the analysis.

Section 3.9 detailed the first part which is the step-by-step process. Accordingly, the process first started breaking down the data into discrete elements (Open coding- Section 3.9.4). Then, these distinct elements were integrated identifying the patterns and relationships (Axial coding- Section 3.9.5). The next step is to identify the core categories and the relationships with the sub-categories and properties. Accordingly, this chapter presents the second part of the analysis which is the emergence of the findings through the analysis. Accordingly, starting from the five core categories, this chapter first explains the integration of properties and categories around the identified five core categories within the analysis process. In this way, the researcher attempts to avoid the criticism mentioned above by explaining the analytical procedure and the evidence underpinning the theory altogether in this chapter. Accordingly, the chapter is structured as follows.

- Firstly, section 4.2 presents the core categories identified in section 3.9.6 in detail and the process of identifying them as the core principles for 'planning and designing POS as a strategy for Tsunami disaster resilience.'
- Secondly, section 4.3 introduces the three types of POS which are categorised based on the above-introduced core categories. Further, this section details the related categories and properties which are identified under each type of POS.

- Thirdly, Section 4.4 presents the general strategies linked with the five core categories/ principles.
- Then section 4.5 introduces the sub findings of the research which were eliminated from the core findings when delimiting the final theory in selective coding.
- Finally, section 4.6 of the chapter introduces the final theory which is called the final framework of the research, integrating above-discussed core categories, related categories, properties and the sub-properties.

4.2 Core Principles

The main purpose of the thirst stage of coding which is the selective coding is to identify the most significant or frequent category and then systematically relate the other categories and properties to it, together with taking off the non-relevant properties. Following this process, the researcher identified five core categories as the most significant categories related to the central phenomenon. These five core categories which can also be identified as the core principles of the final framework are as follows;

1. Risk zonation guides for the locations of POS and the benefits involved,
2. Terrain quality and the Topographic characters that guide the Tsunami DRR use of POS,
3. Different POS have different uses depending on the location and size,
4. Multipurpose POS, and
5.
6. Networking POS works as a DRR passage.

Accordingly, this section details the logical reasons for identifying them as five core categories or core principles of the theory.

4.2.1 Risk Zonation guides for the locations of POS

The interviews conducted with DM practitioners in Sri Lanka highlighted that spatial planning in Sri Lanka is not well linked with the DRR (DRR) strategies. Instead, DRR is considered mostly at the vision-mission statements of the urban development plans and lacking at the strategy level and action project level.

For instance, respondent C2 points out,

"From the DM perspective the first thing is for any development planning, we encourage planners to do a risk assessment. It shouldn't necessarily be a very scientific one; it can be a simple participatory risk assessment would be sufficient." (respondent C2 – DM Practitioner)

Adding to this, Respondent C3 suggests,

"And also need to do a risk zonation (identify the level of risk not only the risk). Some spaces are not good even not for POS. It will find out no development zone, forest area zone, low lying one to maintain the biodiversity. Using for the public is one option here. .... Based on the risk level, a Tsunami risk assessment should be conducted, identify the elements of risk and then based on that we can do that. We can decide how we can use different spaces. Based on the risk level what is the use of the space can be identified, including the spaces for POS" (Respondent C3 – DM Practitioner)

Likewise, in Sri Lanka, there is a need for disaster risk-sensitive planning including the risk sensitivity of a Tsunami disaster. Therefore, following the path of risk-sensitive planning, the allocation of POS for Tsunami disaster resilience also need to be guided by the Tsunami risk zonation. However, instead of taking these types of proactive measures for Tsunami DRR, mostly the focus is given both from the funding perspective, and the project perspective disaster aftermath and lack of prevention.

For instance, Respondent C2 points out,

"So, in a different way, they can plan. Even the local government they have priorities with mostly budget allocation for recreation. Then risk-sensitive planning and all are less prioritised. So, it is not happening." (Respondent C2 – DM Practitioner)

Adding to this, Respondent C1 suggests,

"It is all about informing the local authority about the risk. It works if something happens only. As an example, in 2011 the building permit system was begun. At the same time Landslides increased due to the haphazard development in the hilly areas. Therefore, we introduced the building permit system. Hazard areas were divided into 4 zones, safe, modest, risk and high-risk. Except for safe areas, for the constructions of the other three areas, the permit should be obtained. Likewise, it works if something happens only." (Respondent C1 – Urban planning Practitioner)

Likewise, most of the DM practitioners and urban planners pointed out the importance of risk-sensitive planning as a proactive measure for Tsunami disaster prevention. This identification generally framed the importance of this category; 'Tsunami risk zonation guides for the

allocation of POS for Tsunami disaster resilience'. Apart from that, there are a set of specific reasons to position this category at the core of the central theory as follows.

The analysis of the data revealed that POS could mainly contribute to emergency evacuation plans in three ways (Section 4.3 for more information). Firstly, as an emergency evacuation directing place to direct evacuees towards the right direction through a landmark system and using design features in POS as landmarks. Secondly, as a place to distribute people to safe places through the use of vehicles in the evacuation. Thirdly, as a safe place for emergency gathering through the design with more space. However, these three types of applications of POS will be determined by the location where the POS are located within the Tsunami risk zonation.

Respondent C3 explains,

> *"We can use them for emergency evacuation but based on the risk level. Tsunami risk assessment should be conducted, identify the elements of risk and then based on that we can do that. We can decide how we can use different spaces. Based on the risk level what is the use of the space can be identified." (Respondent C3 – DM Practitioner)*

For instance, to use large scale POS as an emergency gathering points, such POS needs to be located out of the Tsunami risk zone. Further, to use POS as a distribution place, such POS need to be found at least within Tsunami moderate-risk or low-risk area, because allocating distribution place within a Tsunami high-risk zone can be risky considering the permitted time for evacuation and the distance to the safe zone.

In contrast, if the time permits and if there is a short distance from Tsunami high-risk zone to a safe zone, such POS have the potential to be used as a distribution place with improved access. Further, all the types of POS within the Tsunami risk zone can be used to direct people towards the safe area through a landmark system and using design features as landmarks. Accordingly, it can be understood that Tsunami risk zonation can guide for the locations of POS and the benefits involved in emergency evacuation planning.

Apart from that, findings informed that POS could contribute to mitigating the Tsunami risk in two ways (Section 4.3 for more information). One method is by lowering the population density through allocating new POS within the hazard-prone areas. The second method is the use of design features and the orientation of the POS to slow down and regulate the wave. However, these two types of mitigation applications need to be guided by the risk maps. As an example,

Respondent C1 states,

> *"We started last year, a programme to map the risk areas, that's how we can integrate planning concept into high-risk areas. We integrate this with the hazard map. In that, we consider building density, land-use time, open space. we categorised this into three categories, there were around 19 sub-categories. We have identified high-risk areas, low-risk. As an example, in settlement areas the risk is high, and in open spaces the risk is low. Promoting open spaces in hazard areas can lower the risk" (Respondent C1 – Urban planning Practitioner)*

Likewise, these two types of mitigation-related uses of POS and the three types of emergency management-related applications of POS need to be guided by the Tsunami risk zonation. Furthermore, this type of risk-sensitive allocation of POS will bring many benefits of disaster risk-sensitive urban planning which was pointed out at the very beginning of this section.

Accordingly, this discussion confirms the importance of Tsunami risk zonation guided allocation of POS for Tsunami disaster resilience and the need for positioning this factor at the core of the theory. In summary, the above-discussed elements which confirm the necessity of this core principle/ category are illustrated as follows (Figure 4.1)

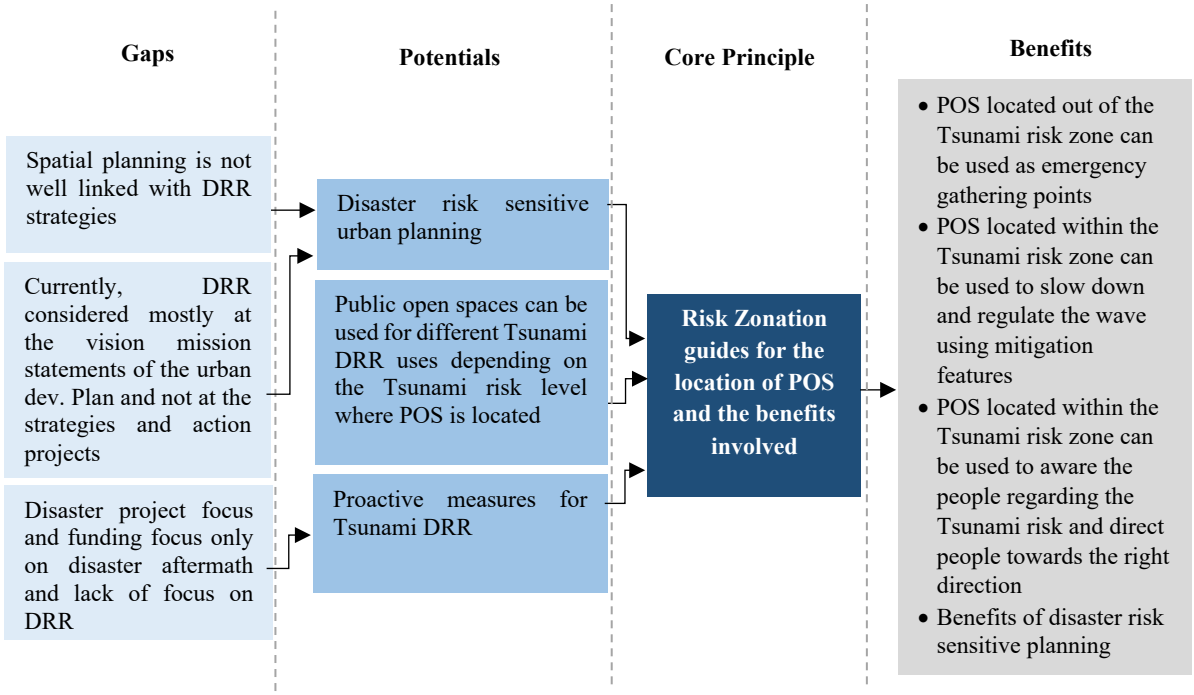


Figure 4.1- Risk Zonation guides for the location of POS and the benefits involved

4.2.2 Terrain characters that guide the Tsunami DRR use of POS

Section 4.2.1 discussed the factors related to Tsunami risk zonation. The point to be noted here is, risk zonation is different from hazard zonation. Hazard is characterised by its location, intensity or magnitude, frequency and probability (UNISDR, 2017). Risk is calculated through the multiplication of Hazard with the Vulnerability (R=H x V). Therefore, Risk calculation requires knowledge of the Tsunami source, the wave propagation and subsequent inundation, geographical conditions of the affected area, and social and economic aspects (Jelínek, Eckert, Zeug, & Krausmann, 2009).

Accordingly, underlying terrain and topographic characters are already considered at the hazard zonation and therefore already included in the risk zonation. Further, risk zonation and its relationship with POS was previously discussed in section 4.2.1. However, findings rationalised that terrain, and topographic characters need to be considered as a separate factor when allocating POS for Tsunami disaster resilience at three instances.

The first instance is if the area is below mean sea level or if the flat terrain continuous for several kilometres and if there is a long distance to mountainous terrain, instead of allocation of vertical evacuation shelters to shorten the evacuation time, there is a possibility of allocating POS on an artificially elevated platform. This elevated platform can even be a Tsunami mound which absorbs the devastating energy from the Tsunami wave; however, necessarily there should be POS on top facilitating as a safe evacuation area.

In supporting this view, Respondent C8 states,

> *"You can build Tsunami mounds which raise the elevation of certain places along the coast. It can then be nicely landscaped and used as a park. I called it Elevated Park. ……. Even in an emergency, people can go up and escape. For instance, in many places. Tsunami mounds and you know the point is, it is not necessary for some places where the higher grounds are available nearby. But for some areas where the land is flat for several Kilometres, what do you do.*
>
> *That will be a useful resource to Sri Lanka for several reasons. One is we have several kilometres of low flat land all around the country. So, it is ideal to have these types of mounds. Number two is it will be a response to population pressure. Because SL is very dense. Number three it will be a resource for recreation and so and so. It will be aesthetically very nice, and it will enhance the value of the land." (Respondent C8 – Sociologist and Disaster Resilience Expert)*

In this way, POS on artificially elevated platforms can contribute both Tsunami disaster mitigation and emergency evacuation in the event of a Tsunami. At the same time, in everyday life of the city, it can be used as a POS with increased visibility of the sea.

The second instance is when the areas below mean sea level, and the terrain is sloping inward the inland, it increases the speed of the Tsunami wave. In such instance, either POS in elevated platforms can be used for, or the landscape treatments such as earth bunds can be incorporated to the POS design to break the speed of the wave as a mitigation feature.

Respondent C5 conveys some examples to confirm this factor, as follows.

> *"Ok. For example, if you take Polwattha or Hikkaduwa area, one example is that disaster took place in a train killing many people. The main reason is the terrain which is sloping inward. Then the wave came, and because of the slope gradually it became faster. So, it depends on the terrain quality and terrain characters. So, you can compromise that. If the terrain is sloping inwards, then again you cannot use POS in that area. You should have elevated platforms, buildings for that. Then you always have to have the open spaces in elevated areas or hilly areas." (Respondent C5 – Civil Engineer)*

The third instance is if there is mountainous terrain located near to POS these highlands need to be connected with the design of POS which increases the attractiveness of the POS and also can be used for safe evacuation in Tsunami event especially for the people who gathered in POS. Pointing out this need, Respondent H4 explains an example as follows.

> *"……. We divided the area into two parts. One part is for recreation, and the other part is for tourism. Open space development considered on this side with the main road and the highland. (Showing a map) Here is the town centre; there are paths for people to use in case of emergency. With the main road, this is the zone plan, and this is the beachside, in case of a disaster they can evacuate from this side as this is the highland area as it's for recreation and open for public." (Respondent H4 – Urban Planner)*

In this way, adjacent mountainous terrain needs to be taken into consideration when designing POS for Tsunami resilience as it will make sure the provision of adequate emergency evacuation place to the public in POS.

Accordingly, considering the above-discussed three instances, terrain quality and the topographic characters of the area need to be regarded as a separate core principle when planning and designing POS for Tsunami disaster resilience. Further, the above-discussed factors can be summarised as follows (Figure 4.2).

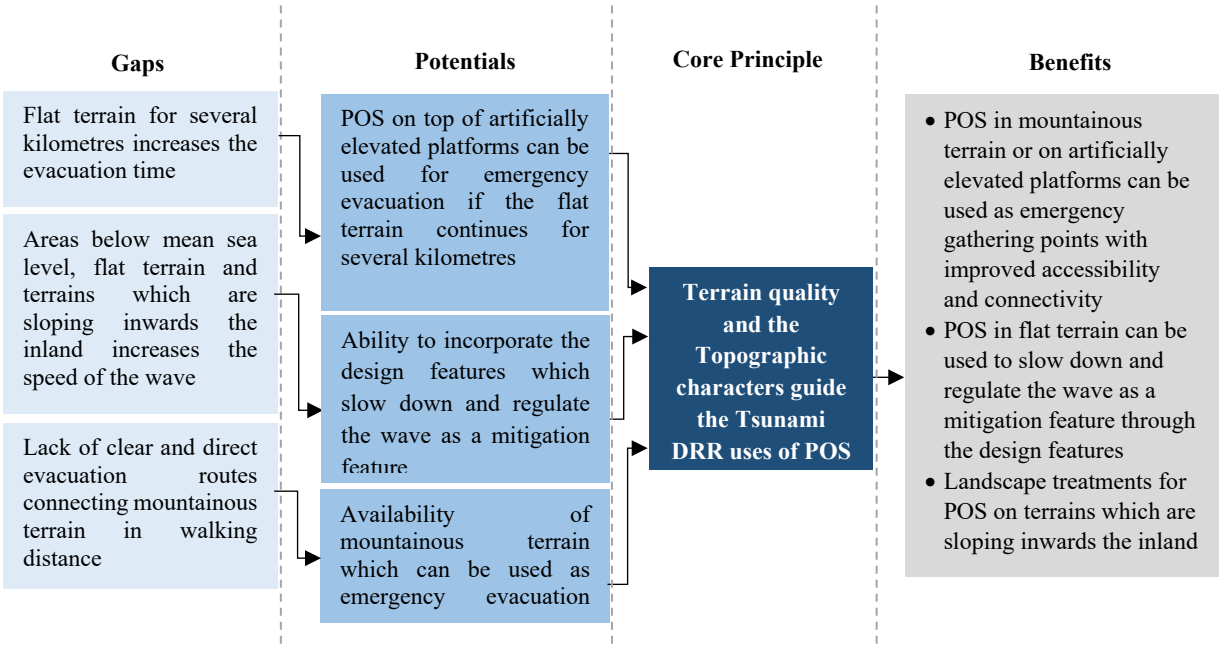


Figure 4.2- Terrain and Topographic characters guide the Tsunami DRR uses of POS

4.2.3 Tsunami DRR Uses depending on the location and size

Third core category is the location and size of POS which determine the DRR uses of POS. In this core category, especially the location factor overlaps with the other two core principles which were introduced in sections 4.2.1 and 4.2.2. Section 4.2.1 discussed that the uses of POS might differ depending on the location of POS within the Tsunami risk zonation. Further, section 4.2.2 emphasised the importance of the terrain level and its relationship with POS. These discussions confirmed the importance of considering the location factor. However, apart from the above discussed two factors, the analysis identified that the location factor needs to be especially considered when providing Tsunami awareness using POS. From the outlook, this may appear to be contradicting relationship between the location and the provision of public awareness through POS. Therefore, the following discussion clarifies how to provide public awareness through POS.

The analysis reveals that the POS can be used to provide public awareness on Tsunami resilience in three ways (Section 4.3.1.3 for more information);

1) To aware the public on Tsunami evacuation routes and safe evacuation points,
2) To remind people about the last Tsunami and thereby the importance of being pro-active and prepared and,

3) To aware the public on the importance of natural features related to Tsunami disaster mitigation.

Out of these three types of awareness, to provide the first type of awareness, any POS situated within the evacuation road network can be used.

However, to provide the second and third types of awareness using POS, location is an essential factor to consider. Notably, 'to remind people about the Tsunami and thereby the importance of being pro-active and prepared', it was identified that the design features in POS could be used as a mode to remind the last Tsunami. For instance, sculptures can be used to aware of the importance of being pro-active together with information boards.

Further, the findings suggest that the POS located in beach areas are the best places to remind people about the Tsunami and the importance of being pro-active. Furthermore, the analysis confirms (section 4.3.1.3) that locating a Tsunami related sculpture inland is not an effective way to communicate the risk as the public will not get the real feel about it. Comparably, allocating Tsunami related sculptures on the beach with the visibility of the sea, effectively remind the public about the Tsunami and the importance of being proactive and prepared for Tsunami. Confirming this aspect, Respondent C5 points out,

> *"……. people should feel to evacuate immediately, once they receive the warning and see the signboard. But people put posters on these Tsunami signs and all. People tend to forget things so soon even the Tsunami is disastrous. So, there should be reminders for people. Also, in the design part of POS on the beach, you can incorporate a few features which remind people about the Tsunami. It may be a sculpture or something to remind people. And also, once selected the places, then micro-level features also have to consider in terms of signboard and then to incorporate design features to remind people about Tsunamis." (Respondent C5 – Civil Engineer)*

The third type is the awareness of the importance of natural features related to Tsunami disaster mitigation. As it will be further discussed in section 4.3.1.3, there is a significant need for protecting natural elements associated with Tsunami mitigation and at the same time to aware people on the importance of mitigation. As a solution, findings suggest that POS located in beach areas can be used to install and display the physical features related to Tsunami mitigation while providing awareness of the importance of them. Accordingly, it can be understood the importance of considering the location factor when installing the Tsunami DRR awareness related design features.

Apart from the location factor, the size or the scale of the POS is another significant feature to consider when using POS for Tsunami disaster resilience. POS in cities are available in different sizes varying from small pocket parks, medium-sized activity squares to large scale parks and public playgrounds.

For instance, document no. 6 which is a local development plan highlights,

> *"Range of Pocket park, Mini Park, Local Park and community Parks are planned in the city development. Further, these range of parks is planned within the range of walkable distance." (Document 6 – MC development plan)*

Accordingly, findings reveal that this type of availability of POS within walking distance can be a useful resource to facilitate the emergency evacuation together with the consideration of location factor. Apart from the location factor, the following discussion explains how the different sizes of POS could contribute the emergency evacuation.

As discussed in section 4.2.1, POS can mainly contribute to emergency evacuation plan in three ways; as an emergency evacuation directing place, as a place to distribute people to safe places, as a safe place for emergency gathering. Considering the size of the POS, in Tsunami high-risk areas, POS in any size (small, medium or large) can be used as an emergency evacuation directing place. However, to use POS as a place to distribute people to safe places such POS needs to be considerably large scale than the pocket parks and small activity squares. Such POS should serve as the first gathering place especially for disabled and aged people around. Then these POS need to be well linked with the road network facilitating the vehicles in the evacuation.

The third type of use is the usage as a safe place for emergency gathering, and such POS need to be larger in scale to accommodate a significant amount of population for a shorter period until they move to safe shelters. In some local plans, these types of large scale POS are available, but those have not been identified as safe evacuation places.

Respondent C9 explains some examples for this,

> *"If we get the Viharamahadevi park, that is a good example. It is in the centre of the area. That is purely a recreational space. But say if something happens, in surrounding school or so. So, can we use it for emergency evacuation." (Respondent C9 – Urban planner and DM practitioner).*

Further, Respondent C6 confirms the value of using large scale recreational places for DRR and at the same time points out the challenges to this notion as follows,

> *"You already have restriction of the limited of urban space, then convert those into evacuation or a temporary shelter there is a challenge as the place is designed for something else. Certain cases even in SL now after the Aranayaka Landslide we have moved victims to open spaces. Schools, playgrounds…. But again, there is another point. In disasters, you have three phases. Firstly, one is immediate recovery what we call emergency management where people supposed to live in temporary shelters. That period is normally for one month. Maximum of one month. After one month if the permanent shelters take about a year, you have to provide them with one year of transition. That is call transition period." (Respondent C6 – Urban planning Practitioner)*

This discussion opens up another dimension to consider when allocating POS for emergency gathering. Accordingly, it can be identified that the space requirement for emergency gathering is different from sheltering in transition or intermediate-term because not every evacuee need shelters as some of the evacuees are visitors, commuters, residents who can go back to their houses if those are not affected.

Further, some people can find alternative accommodation such as relative's place or hotels. Therefore, more space is needed for emergency gathering, and once all the evacuees were taken out of the hazard zone, they can be distributed to safe shelters within the immediate recovery period. Therefore, when allocating POS for emergency gathering purpose, such POS needs to be larger in scale, and minimal physical development needs to be taken on the POS allowing more space to operate as a 'loose space'.

Accordingly, it can be understood that the size of the POS is importance when facilitating the emergency evacuation plan. The location factor is significant when using POS for both emergency evacuation and public awareness. The factors discussed in this section which confirm the importance of the core category 'Different POS have different uses for Tsunami DRR depending on the location and size' can be summarised as follows (Figure 4.3).

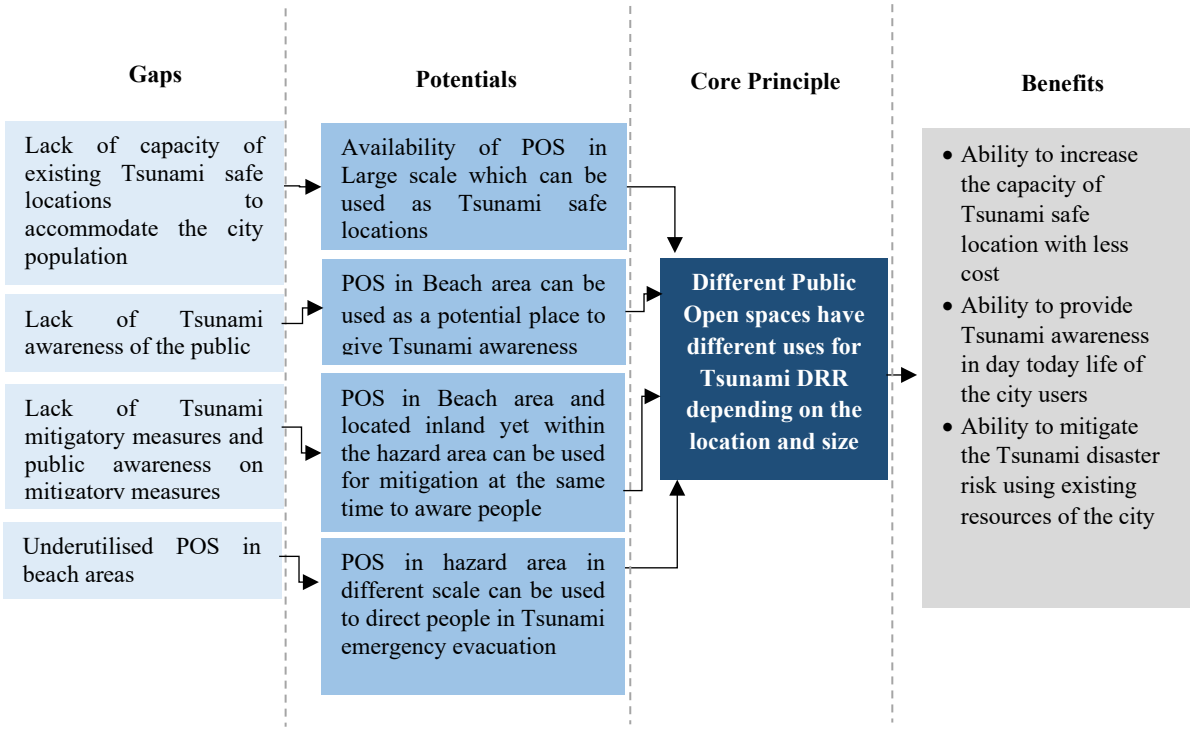


Figure 4.3- Different POS have different uses for Tsunami DRR

4.2.4 Multipurpose POS

The three core principles discussed up to now (Sections 4.2.1, 4.2.2 and 4.2.3), pointed out that POS can significantly contribute to three main aspects of Tsunami disaster resilience; emergency evacuation, mitigation and public awareness. These uses will be further discussed in section 4.3. However, it can be noted that all these uses are Tsunami disaster resilience-focused uses. Further findings suggest that if the spaces are planned and designed for the sole purpose of Tsunami resilience, that space will not be sustained in the long run. According to the analysis, there are two main reasons for this. Firstly, Tsunami is an infrequent and unpredictable disaster which may or may not occur for the next 100 or 200 years (Jayakody, Amaratunga & Haigh, 2018). Therefore, allocation and maintenance of resources for the sole purpose of Tsunami resilience can be difficult with the other demands of the city.

For instance, Respondent C5 states,

> *"The first challenge is that; Tsunami is unpredictable; it can happen maybe after 100 years or maybe after 200 years. So how we justify the occurrence of Tsunami after this much of intervals. How you can convince the politicians the need of it and to use the funding. For a rich country, they can invest in these things. So*

economically how can we afford to do that? Otherwise, it is not justifiable to implement such a thing." (Respondent C5 – Civil Engineer)

Relating this matter with the highlighted points of literature review (Section 2.6.4), it was identified that, with reference to some Earthquake planning strategies, large quantities of unstructured open spaces left for emergency evacuation in cities, have created issues to achieve liveable, diverse and sustainable urban environments (Allan & Brytan, 2010). Applying the same principle to the Tsunami planning strategies and relating this matter with the findings, if POS are allocated for the sole purpose of Tsunami resilience, in the long run, such space will get abundant and will be a threat for sustainable development. For example, allocating large quantities of open spaces only for emergency evacuation gathering results these places will get abundant in the long run and will welcome illegal activities in cities. Further, such areas will not be identified by the public in an emergency. Or else, to protect these places, there will be a huge cost of maintenance.

The second reason is, when prioritising the needs of the city, if the resources are allocated for the sole purpose of Tsunami resilience, it will be difficult to negotiate the necessity of these resources with the other priorities such as economic growth, recreational uses and tourism needs.

If the Galle city in Sri Lanka is taken as an example, Respondent G16 highlights,

"Outer Colombo, main cities like Kandy city, Anuradhapura, Galle, Matara and Ratnapura are identified as second-order cities for future development. So the main purpose of this particular project is to develop these second-order cities. Under each of these projects, we have identified several interventions. If we get Galle as an example, the main problem in Galle is Flooding. Another main problem is a lack of open spaces. So, the interventions are focused on these two aspects" (Respondent G16 – Urban Planner)

Taking another example from Batticaloa city Sri Lanka, Respondent B15 points out,

"The most common disaster here is Flooding. Therefore, we consider Flooding most of the time, but the challenge is to plan something for Tsunami which is not very common..... Even in the Kalladi park, we considered Flooding but not Tsunami." (Respondent B15 – Administrative Head, Batticaloa Municipal Council)

Likewise, every city has its priorities based on the current demands of the city and based on the most frequent disasters. Therefore, the limited funds and resources are allocated according to the priorities and where the most needed. Out of these priorities, Tsunami interventions get less prioritised as an unpredictable and infrequent disaster.

Confirming this, Respondent C4 states,

> *"We have limited fund, and we have our own agendas. So, if we put this hierarchical way where we should put disaster. Thinking about Sri Lanka as an island. I think 40 or 50% of the people live in the coastal belt. We have experienced a Tsunami; we know the value of getting ready to it. But no one can predict when we will get the next Tsunami. We are also vulnerable to Floods and Landslides. And these are more frequent……. If you get a Tsunami, we don't know when it will happen." (Respondent C4 – Sociologist and Disaster resilience expert).*

Accordingly, it can be understood that, with the limited funds and growing demands of cities, Tsunami DRR focused projects are less prioritised. Moreover, it is evident that, most of the projects initiated when the Tsunami happened in 2004. Then with the time, the importance is diminished. Therefore, most of the projects which started at the time of the Tsunami do not operate now.

Further, this is a common scenario when the projects are planned for the sole purpose of Tsunami. When Tsunami DRR interventions are taken as a separate element without linking into the other development projects, it becomes difficult to negotiate the need of the project with other priorities of the city. Therefore, Tsunami DRR focused interventions need to be multipurpose. Applying the same theory to POS related uses for Tsunami disaster resilience, if the POS or the resources within the POS are allocated for the sole purpose of Tsunami, as above discussed, it is hard to implement and maintain in the long run. This fact emphasises the need for multipurpose POS catering both Tsunami resilience and everyday life of the city.

Furthermore, in cities land is a scares resource and allocating open spaces for mitigation or emergency evacuation is challenging with the growing demands of the urbanisation. Therefore, there is a necessity to get the maximum use of the available open spaces. Besides, POS can address various demands of the city such as economic, social and environmental. Hence, the resources and the space in POS which are allocated for Tsunami disaster resilience need to be used for multipurpose. Further, open spaces are a requirement of the built fabric because of many reasons such as to retain fire spread, fire evacuation and so on. Therefore, these types of various needs should be considered when planning and designing multipurpose POS for Tsunami resilience.

Accordingly, multipurpose POS contributing both urban resilience and Tsunami disaster resilience can be placed at the center of the theory as one of the most significant core categories. In this way, multipurpose POS will ensure the effective use of space and resources while

strengthening the Tsunami disaster resilience in cities. Further, this method will negotiate the DM demands amongst the other demands of the city, welcoming diverse uses to the POS in cities. In summary, the factors which confirm the need for this core principle can be summarised as follows (Figure 4.4).

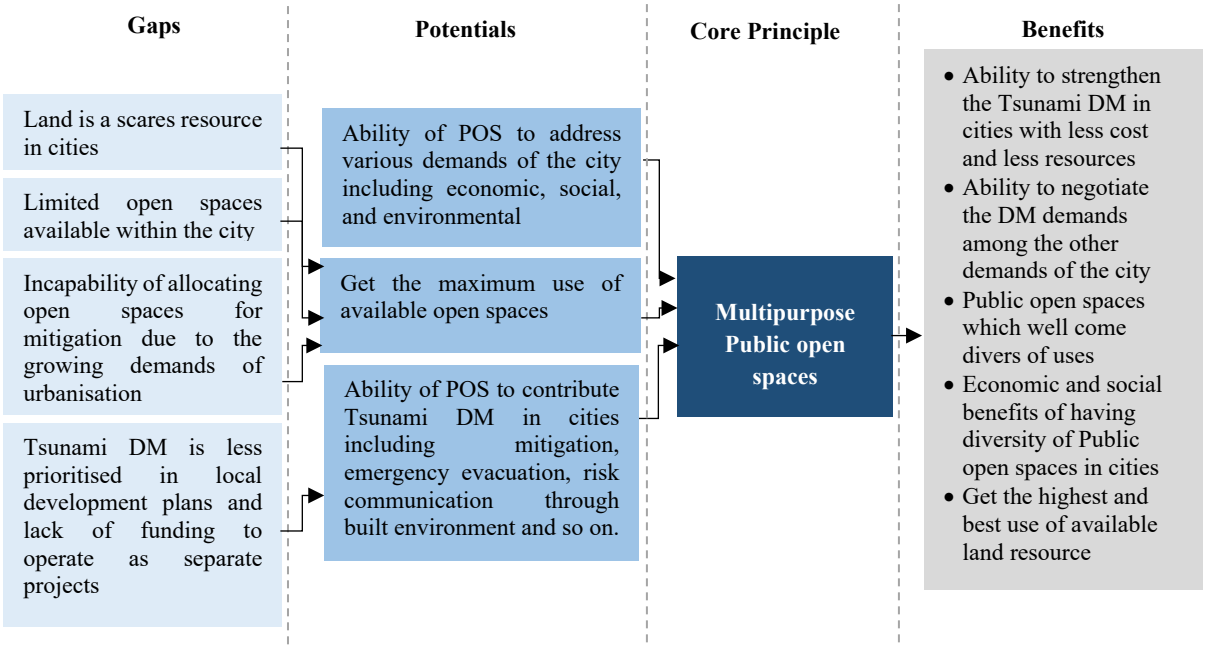


Figure 4.4- Multipurpose POS

4.2.5 Networking POS works as a DRR passage

The core categories discussed up to now highlighted that, depending on the Tsunami risk zonation, terrain quality and character, location and size, different POS can be used for different types of uses in Tsunami disaster resilience. Further, considering the effectiveness and the practical implementation to the city context, the fourth core principle (Section 4.2.4) highlighted that such POS needs to be used for multipurpose benefiting both urban resilience and disaster resilience. However, instead of harnessing these potentials of POS in isolation or distinctly, the fifth core category/ core principle suggests to connect these POS in cities as a network which can bring further benefits to both urban resilience and Tsunami disaster resilience.

As it was introduced in sections 4.2.1, 4.2.2 and 4.2.3 and will be further detailed in section 4.3, POS can be used for Tsunami disaster resilience in three ways; facilitate the emergency evacuation, mitigate the Tsunami disaster and to provide the public awareness on Tsunami disaster resilience. Further, as it will be presented in section 4.3, out of these three uses, in order to facilitate the emergency evacuation, POS in cities can act in three ways; as an

emergency evacuation directing point (Section 4.3.1.2), as an emergency evacuation distribution place (Section 4.3.2.3) and as a safe place for emergency evacuation gathering (Section 4.3.3.1). Furthermore, findings suggest that, if these three types of POS are interlinked with clear and direct evacuation road network, such POS network can act as a DRR passage.

For instance, pointing out this need, Respondent C8 states,

> *"Ok, in the first instance. Let's say in pre-disaster POS can play a preventive role. In other words, it should be used as a DRR passage. According to the way you arrange your space, the living space with the settlements and all that. It should be designed in a way that would provide to reduce disaster risk. For instance, if you take a beachfront new building construction, it should not reduce the protective features of the landscape. It may be natural vegetation; topography, and it will also be an open space." (Respondent C8 – Sociologist and Disaster Resilience Expert)*

Accordingly, it can be understood that according to the way space is designed and networked, it can work as a system to reduce the disaster risk. Through networking, set of POSs in beach area direct people to safe places, when evacuees follow that direction, another set of inland POS distribute people to gathering places, and then set of POS in Tsunami safe zone will work as gathering places. However, while the networking of POS is identified as an essential factor, lack of clear and direct evacuation road network is an issue in most parts of coastal areas in Sri Lanka. Confirming this, development plans (Document 01) have identified this need for having clear evacuation paths.

> *"Batticaloa has a high-risk of a Tsunami. The city was severely affected by the Tsunami on 26 December 2004. The vulnerability assessments indicate that Tsunami remains a high-risk to the city. Therefore, there is a need to implement clear and direct evacuation routes." (Document 01- Development Plan: Batticaloa Development Area)*

Another example from Galle (Respondent G1), further highlighted the issue of lack of evacuation paths.

> *"So, then they cannot take the long route there. Last time also water came about 6 inches this way. But this is high ground. So, people are aware of these two places. They can straight away come to this place. Sometimes they can take vehicles. But if they take the Galle road, there will be huge traffic. So, we ask them to go instead of using Galle road take the railway tracks." (Respondent G1 – DM Practitioner)*

As it was identified, the provision of the adequate, clear and direct evacuation road network is a necessity when making cities resilience to disasters. Apart from that, connecting this network

with safe location and higher grounds and developing a proper mechanism to distribute people also identified as essential factors.

Highlighting the importance of the connectivity between safe locations and highland, Respondent G16 states,

> *"Then will create and improve the pathways with easy access from the beach. At the moment these alleyways are mostly blocked by the encroachments without giving them access. So, we are going to improve it… We will use the encroached land as well. Easily accessible road. If we consider the terrain, the elevation here is lower than the here. Because of that within 10m to 15m people can run-up to the higher ground. But if these roads are blocked, the pressure will hit to the main road, and people will be stuck in the middle. That is why it is important to improve these blocked alleyways, connecting to the main pathway and highlands." (Respondent G16 – Urban Planner)*

Further, confirming the need for proper distribution mechanism, Respondent B16 highlights.

> *"They can announce the schools and hospitals for emergency evacuation. But what happens when all the people run into one place, it will create a huge rush in that place and cause traffic." (Respondent B16 – Urban Planner)*

Accordingly, it can be identified as the need for a proper mechanism in cities to distribute evacuees evenly among the safe location and the need for improving the connectivity. Further, as it was identified, POS in cities are assets to facilitate the emergency evacuation directing, distribution and as a gathering. Furthermore, through networking them with clear and direct evacuation road network will work as a DRR safe passage for the evacuees. Apart from that, findings reveal another set of benefits which can be obtained through the networking of POS as a DRR passage as follows.

- Ability to use signboard system linked with evacuation routes network and the safe places (Section 4.4.9)
- Ability to direct people in the right direction and distribute people among the safe location (Section 4.3.2.3)
- Benefits of improved access to the beach and other multipurpose use while providing adequate evacuation routes (Section 4.4.1)
- Ensure smooth evacuation flow with the enhanced connectivity and avoid congestions (Section 4.4.1)
- Ability to promote horizontal evacuation and discourage the use of vehicles in evacuation through a better-connected pedestrian road network. (Section 4.4.8)

Apart from the above benefits of POS, for Tsunami DRR which were identified from the findings, the review of literature informs that the network of POS can serve many benefits to the everyday life of the city. The literature confirms that networking POS in cities benefits the sustainability concept. The POS which are not located within the public footfall areas get underutilised and result in social problems such as antisocial behaviour and crimes.

Further, interconnected POS with better access to attractive POS encourages the walkability and physical activities of the people which can potentially contribute to the health of residents (Giles-Corti et al., 2005). In this way, the network of POS improves the connectivity and functionality of the city. Furthermore, a network of POS can act as a social space by offering the places to relax, to enjoy the urban experience, for a range of different activities (Thompson, 2002). Likewise, a network of POS brings many social, economic and environmental benefits to the city's urban resilience apart from the Tsunami DRR benefits.

Accordingly, this section highlighted the importance of the core principle 'Networking POS works as a DRR passage' both for the urban resilience and Tsunami disaster resilience. The process of identifying this core category can be illustrated as follows (Figure 4.5).

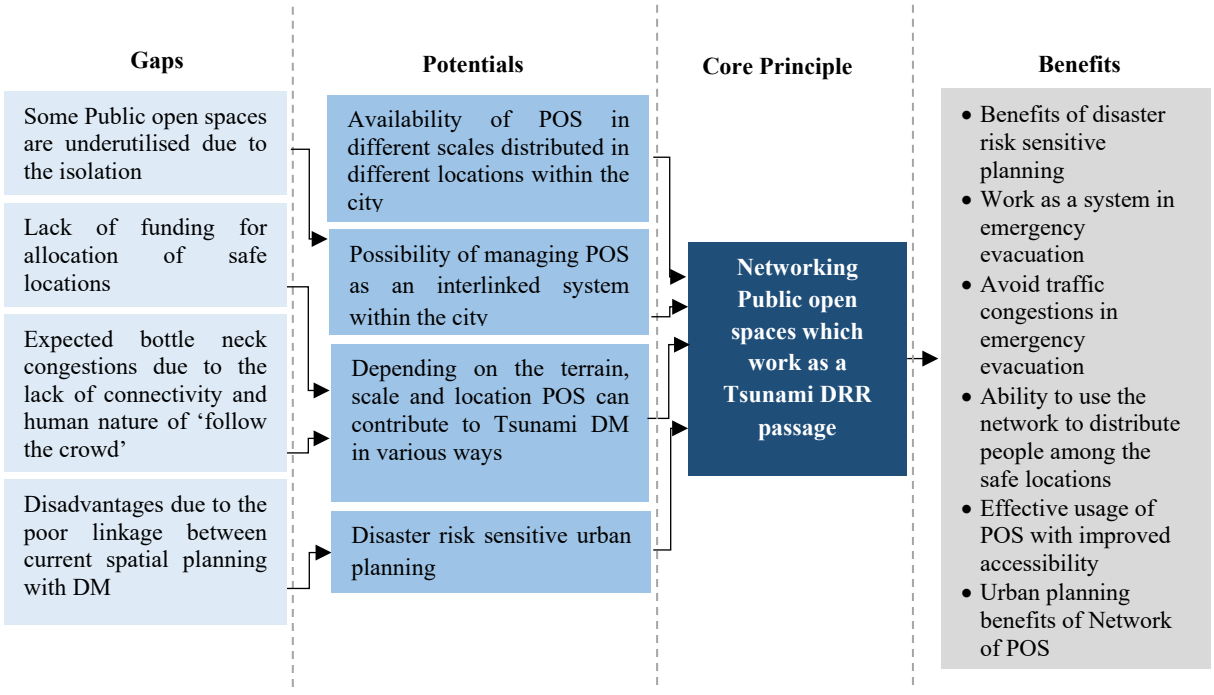


Figure 4.5- Networking POS works as a DRR passage

In summary, section 4.2 presented the emergence of five core categories through the analysis specifying the reasons for identifying those as 'core principles for planning and designing POS as a strategy for Tsunami disaster resilience'. The following section (Section 4.3) introduces three types of POS which are emerged based on above-introduced five core principles.

4.3 Three types of POS

The five core categories presented in the above section (section 4.2) introduced that, depending on the Tsunami risk zonation, terrain quality and character, location and size, different POS can be used for different purposes of Tsunami disaster resilience. Further, these POS need to be multipurpose and networked together benefiting the long-term sustainability and to work as a DRR passage in a Tsunami event.

Based on these five core categories/principles, the analysis identifies three main types of POS which can significantly contribute to Tsunami disaster resilience. Accordingly, this section presents the process of identifying these three types of POS. The following table (Table 4.1) introduces the three types of POS, characteristics and the disaster resilience uses.

Core Categories	**Type 1– Beach POS**	**Type 2– Inland POS 1**	**Type 3– Inland POS 2**
Location	Located within the beach area	Located inland	Located inland
Tsunami Risk Zonation	Tsunami high-risk zone	Tsunami moderate and low-risk zone	Tsunami safe zone
Terrain Quality and character	Flat terrain	Flat or sloping inward inland terrain	Mountainous terrain
Scale	Large or small scale	Large or small scale	Large scale
Networking POS	Networked with type 2 or 3	Networked with type 1 or 3	Networked with type 1 or 2
Multipurpose POS	Use for both day-to-day life and DRR	Use for both everyday life and DRR	Use for both daily life and DRR
Tsunami disaster resilience uses	- Mitigate the Tsunami disaster risk - Emergency evacuation directing point - Provide public awareness	- Mitigate the Tsunami disaster risk - Use large scale POS for emergency evacuation distribution - Use small scale POS for emergency evacuation directing point - Provide public awareness	- Use as an emergency evacuation gathering place and temporary sheltering - Provide essential, services and facilities in emergency response - Use as a place to distribute goods and services

Table 4.1- Identification of three types of POS based on Core principles

Accordingly, the first type of POS which are located in the beach area, within Tsunami high-risk zone, with flat terrain, in any scale, can be used to mitigate the Tsunami disaster risk, to direct the emergency evacuation and to provide public awareness. The second type of POS which are located inland still within the Tsunami risk zone, in flat terrain or terrain sloping inward inland, can be used to mitigate the Tsunami disaster risk and to provide public awareness. Further, in this type of POS, large scale POS can be used for emergency evacuation distribution and small-scale POS for emergency evacuation directing point. The third type of POS, located inland, Tsunami safe zone or mountainous terrain and if it is large scale, such POS can be used as an emergency evacuation gathering place, as a place to provide essential services and facilities in emergency response and to use as a place to distribute goods and services.

Further, as it was introduced in table 4.1, these three types of POS need to be networked together and need to be used for the day-to-day life of the city for multipurpose uses serving both urban resilience and Tsunami disaster resilience. Linking together the characteristics mentioned above, these three types of POS can be visually represented in figure 4.6. Furthermore, the analysis process of identifying these three types of POS and the Tsunami DRR uses are further detailed in sections 4.3.1, 4.3.2 and 4.3.3.

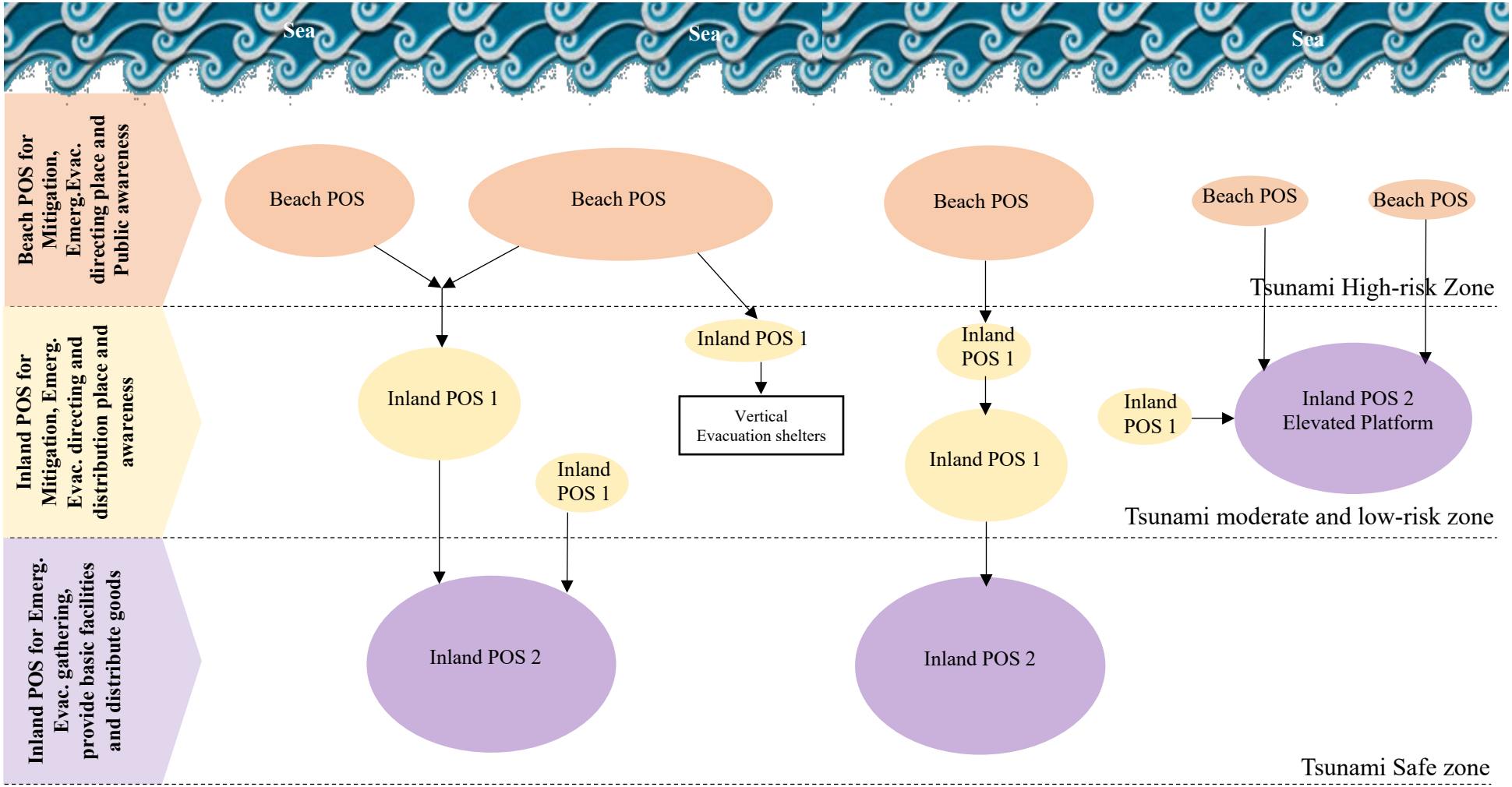


Figure 4.6- Visual illustration of three types of POS for Tsunami DR

4.3.1 Type 1 - Beach POS

Type 1 is the beach POS with the following characteristics;

- POS located in beach areas
- Located within the Tsunami high-risk zone
- With the character of flat terrain
- Any scale; large or small

The analysis revealed that if this type of POS are available or can be created, such POS are an asset to enhance Tsunami disaster resilience in three ways; to mitigate the Tsunami disaster risk, direct the emergency evacuation and provide public awareness on Tsunami. Accordingly, following three sub-sections; 4.3.1.1, 4.3.1.2 and 4.3.1.3, present how these three types of uses emerged through the data analysis and the planning and designing strategies which need to be followed in order to achieve these potentials.

4.3.1.1 To Mitigate the Risk

In most coastal cities of Sri Lanka, the land is a scares resource due to the coastal urbanisation and the linear development pattern. With a significant contribution of coastal tourism-related industries and services towards national Gross Domestic Production (GDP), coastal cities demand more space for tourism and recreation. However, despite these demands, the identified Tsunami hazard areas, especially the existing opened up land from the 2004 Tsunami are kept as open spaces for conservation and preservation. As the coastal community and coastal officers inform, these open lands are used either for plantation or just as bare-lands.

Explaining the current situation in most of the privately-owned lands in Tsunami high-risk areas, B1 states,

> *"As you know there is no buffer zone there. Only seven, eight families live there. We lost our old house. But we still own the land. There is a small hut in that land now to keep the equipment and all, not a house. We planted trees. As that place is closer to the sea, my husband goes fishing from there." (Respondent B1 – Community)*

Explaining the current situation in most of the publicly owned land in Tsunami high-risk areas, B14 informs,

> *"We are preserving these hazard areas, for sand dunes and other purposes. But here now we need to ensure to protect it. We cannot allow recreational uses to these buffer zone areas. Even for tourism activities people asking to use these buffer zone*

areas for tourism activities. The thing is we do not allow these uses. Because if we allow people, they will cut trees and other natural resources which can be a threat to disaster mitigation. Especially we are keeping this area for preservation and conservation." (Respondent B14 – DM Practitioner)

However, considering the demands of the city these types preserved and conserved land have the potential to be used for recreation and wildlife habitat, nevertheless as Respondent B14 pointed out without damaging the natural features such as vegetation and sand dunes.

Furthermore, if the land is kept just as preserved land for Tsunami mitigation, it is difficult to protect from land encroachments and illegal activities. For example, Respondent H3 states,

"We reserve land for open spaces; our local authorities have not enough capacity to maintain them. The political way of think about the land is just occupying people in valuable land; they think about the land not about purpose, people encroach land once its reserve for open spaces, it's very hard to manage." (Respondent H3 – Urban planning practitioner)

Therefore, to protect these hazard-prone areas from further development, to answer the current demands of the city and to get the highest and best use of the land, most appropriately these open lands can be converted as POS bearing in mind the necessity of protecting the natural features such as vegetation and sand dunes.

Highlighting the importance of converting the Tsunami high hazard areas into POS, Respondent C8 states,

"I think the problem is given the situation of the population along the coast in SL it is a luxury product to have just abandoned the land. You can't get abundant the coastal belt, because it is a resource. So naturally, you can put that to certain uses which would not force people for disaster. For instance, you know if you allow that if they are engaging certain recreational activity, say for instance you can use public park may be walking tracks, because those things it will not be destructive in Tsunami. It will not cause to take human life. … Say, for instance; you can have market let's say open market or you can use it to have park your boats and things like that... So, there are economic, social and cultural uses which can be benefitted not only the people who are living in the area but also the people outside which can benefit people while not exposing people to disasters." (Respondent C8 – Sociologist and Disaster Resilience Expert)

Further, informing the practicality of this type of strategy, Respondent C9 describes,

"Our first attention was that area was devastated after the Tsunami. After that, we don t want to keep that place as isolated (Vacant) because then somebody will come to an encroach and they can build something on it. Also, they can have some social

issues. Therefore, to avoid that and also to as you said to use the area for some other purposes, not only as open space it should have the open space and also can be an active-open space or a passive open space. We are thinking about a boat space and then a recreational space, not only for children and for the elderly that is a gathering place. If something happens, you need a place to evacuate." (Respondent C9 – Urban planner and DM practitioner).

Likewise, the findings inform that it is vital to protect Tsunami hazard-prone areas from the development and encroachment, by converting those preserved land into POS. The emergence of this factor which was detailed above can be summarised as follows (Figure 4.7).

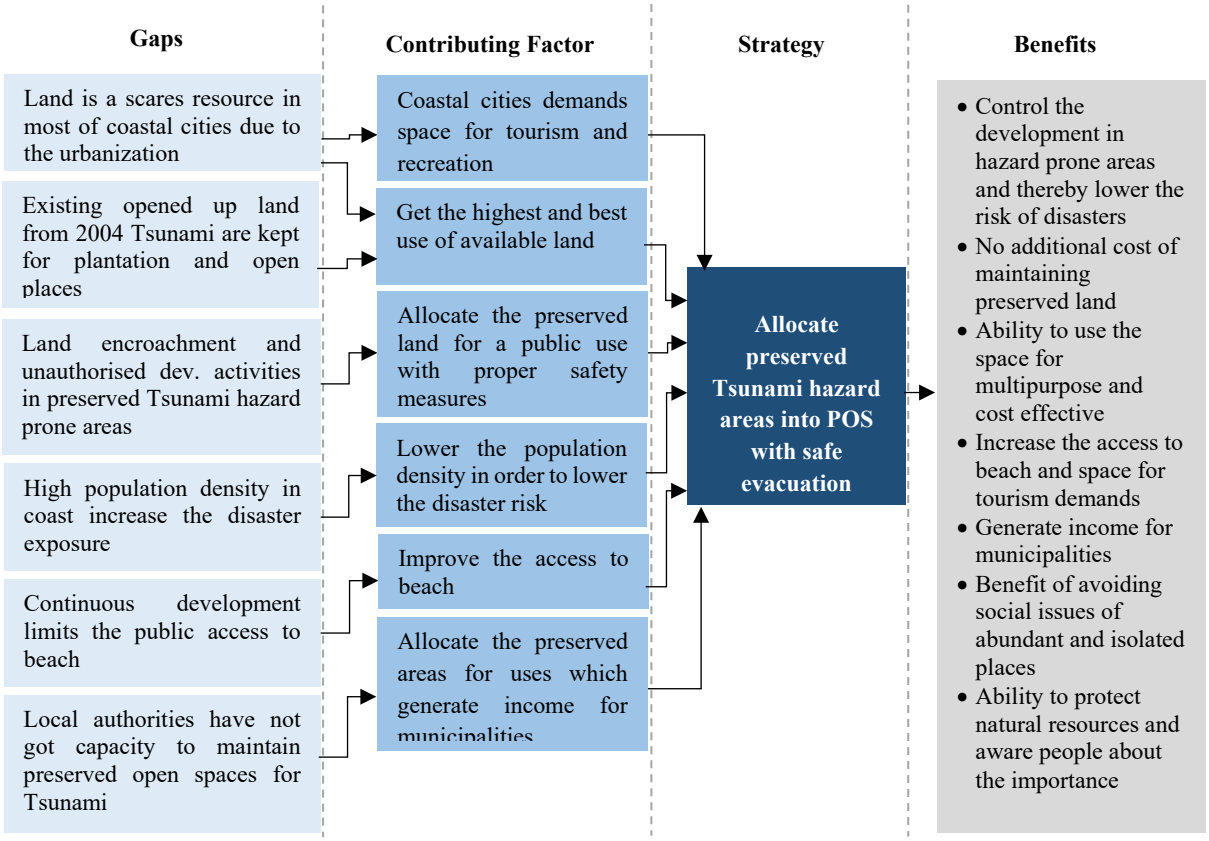


Figure 4.7- Allocate preserved Tsunami hazard areas into POS with safe evacuation

The above-identified factors confirmed that the most effective way to protect the preserved Tsunami hazard-prone in coastal areas especially from the growing demands of coastal cities and from the encroachments is to convert these preserved lands into POS. Furthermore, this factor is linked with another critical factor, which is the need of protecting mitigation related natural features in hazard-prone areas. If the Tsunami hazard-prone areas are converted to POS, this can be seen as a threat to protect mitigation related natural elements such as vegetation and sand dunes. For instance, as Respondent B14 informed above, allowing the general public to

use the space can cause damage to the vegetation and other natural resources which are allocated for disaster mitigation.

However, when discussing the importance of converting hazard areas into POS, it was also identified that protecting mitigation related natural features is already an issue due to the cost of maintenance, unauthorised development activities and encroachments. Therefore, it was determined that the best solution is to manage the space as a public space. Then the question arises, how these POS can protect the mitigation related natural features without becoming a threat to it.

Answering this question, the analysis revealed that POS is useful to protect the mitigation related natural features by amalgamating these features to the design. However, this was identified mostly as a Flood mitigation related feature rather than for Tsunami. Determining this strategy in Flood mitigation practices, one of the urban planning practitioner (Respondent B16) states,

> *"We identify wetland sensitive areas, and for those areas, we proposed public spaces, e.g. wetland park, port park. In summary, for mitigation, we use public open spaces as a strategy to protect the area from the development. We always try to convert the sensitive areas to public open spaces through that we try to preserve that area from further development." (Respondent B16 – Urban Planner)*

Accordingly, this strategy of converting Flood-prone areas into POS can be used for Tsunami mitigation. For instance, the natural vegetation and other features such as sand dunes for Tsunami mitigation need to be incorporated into POS design with a view of protecting those features. Further, some natural elements such as sand dunes can be marked out to protect them from the public footfall. After that, these protected natural features should be publicised with an information board to aware the public on the importance of mitigation which will be further discussed in section 4.3.1.3.

While the beach POS can protect the mitigation related natural features, in Sri Lanka there is a regulation that 'permanent structures cannot be constructed in POS within the development setbacks of Coast Conservation Department (CCD)'. Confirming this, Respondent B11 states,

> *"Within the development set back area No permanent structures can be built (within the buffer zone), we only allow the open spaces use with temporary structures such as cadjan houses and cabanas." (Respondent B11 – Coastal Planner)*

Accordingly, the regulation of 'no permanent structures within the development set backline' can be considered as a plus factor for Tsunami disaster mitigation. However, the development setbacks are identified mainly considering the coastal erosion, not considering the Tsunami hazard areas. Therefore, the development of setback lines, need to be revised according to the Tsunami hazard zonation. Apart from that, this regulation of minimum physical development minimises the damage which can occur from a possible Tsunami wave. At the same time, it can be used to encourage the usage of natural features protecting mitigatory measures. Above discussed factors which confirms the need for this strategy are summarized as follows (Figure 4.8).

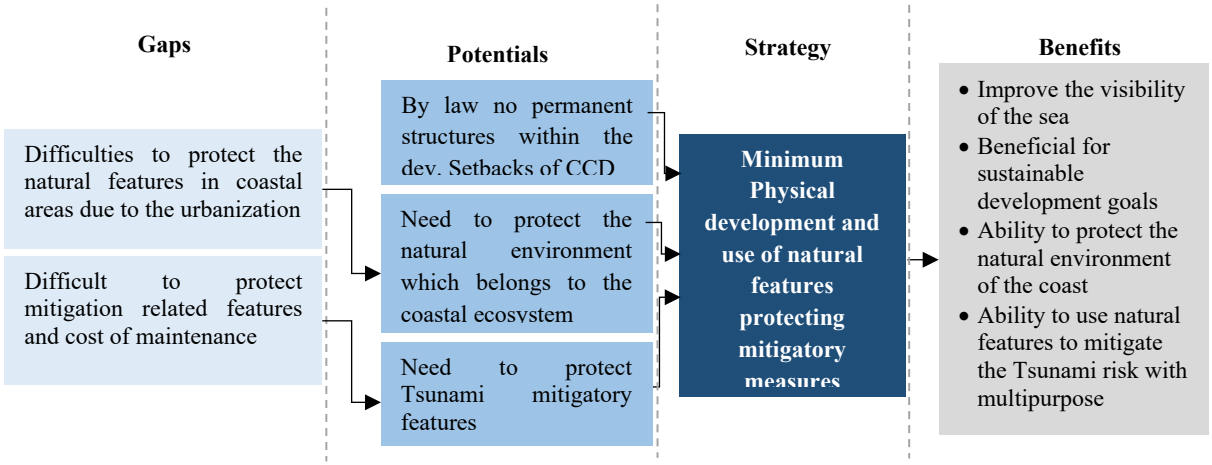


Figure 4.8- Minimum Physical development and use of natural features

Further, together with these protected Tsunami related natural elements such as sand dunes and vegetation, artificial physical features such as earth bunds, steps can be planned and designed to slow down and regulate the wave. This type of method encourages to protect natural elements in coastal areas benefiting to many other factors such as a resilient barrier to wind and tide, coastal water intrusion and benefits of greenery and so on. This factor will be further discussed in section 4.3.2.1.

In summary, this section detailed, how the POS in beach areas can be used to mitigate the Tsunami risk by allocating preserved Tsunami hazard areas into POS, minimum physical development and use of natural features protecting mitigatory measures and by using the design features to slow down and regulate the wave. Next section; 4.3.1.2 discusses the use of beach POS to direct the emergency evacuation.

4.3.1.2 To Direct the Emergency Evacuation

Section 4.3.1.1 highlighted that POS in beach areas need to be used for Tsunami disaster mitigation by converting preserved Tsunami hazard areas into POS. However, while a set of data highlighted this strategy, another collection of data brought an argument against this strategy. This argument emphasised that if the POS means a place which welcomes the public, this Type 1- Beach POS in hazard areas attract people to the hazard area. Therefore, allocating POS in the hazard area may increase the exposure of the public to a Tsunami disaster.

Among the Respondents who highlighted this argument, Respondent C8 points out,

> *"I think; it is not justifiable to implement such a thing. Such a situation it is always good to relocate without putting such expensive mitigatory measures. As an example, the Matara Pola (Fair) completely went off. So, without locating the public places in vulnerable locations, it is always good to move to a safer place." (Respondent C5 – Civil Engineer)*

Identifying the importance of this point which was raised by the data, the researcher went back to the field to confirm this and to find an answer from DM practitioners and urban planning practitioners. Accordingly, the answer was still the POS can be allocated in the hazard area rather than using the space only for conservation. However, two strategies need to be followed in such instances. The first strategy is, allocated POS in Tsunami hazard areas should not attract a large number of people as in cricket stadium or market place. It can be a place such as a beach park, wide life habitat area for the public to view which attract a manageable number of people throughout the day. However, such POS should not attract a large number of people in one go as in a cricket stadium. The second strategy is such POS should have proper evacuation planning to evacuate the number of people who are attracted to the place.

Highlighting the importance of the first strategy, Respondent C4 states,

> *"…. that means, for example, no one can give a solid solution for this….. That means you cannot have public open spaces which attract a lot of people to the hazard-prone area. But in the sense of using the open spaces, we can have a type of public open spaces which attract fewer people just like wildlife habitat that is also with proper safety measures. We can reduce the number of casualties" (Respondent C4 – Sociologist and Disaster resilience expert).*

Highlighting the importance of the second strategy, Respondent C3 states,

> *"Using open spaces for public open spaces will gather people into it, so based on the risk level it should be measured. In the case of Tsunami, early warning and*

preparedness should be available. For instance, to have a public place, there should be an early warning tower nearby. And, to place some signboards. Those improvements should be there. Because there is a huge demand in tourism disaster management, this is a part of that. In my term when encouraging people to use disaster-prone places you also have to make sure adequate emergency evacuation is available." (Respondent C3 – DM Practitioner)

Accordingly, it can be established that, when using POS in hazard areas, such POS should not attract a large number of population and need to be linked with the safe evacuation road network to evacuate the attracted amount of people to the POS. However, when connecting with the evacuation road network, the current regulatory framework of Sri Lanka enforces the need of safe evacuation routes merely for large scale developments such as hotels and cricket stadium, but not for all the public spaces including POS. Explaining the current status, Respondent G18 states,

"Now in that case, even in a beach park if they are developing a big building, the council will consider it as a place a where the public will gather and not safe in a disaster event. What are the evacuation paths to move this much of people to safe locations? If they do not have a strategy to that, we will ask them to remove these big buildings which will attract a lot of people to it without any emergency plan and only these can be allowed." (Respondent G18 – Coastal Planner)

However, though the current law does not enforce the requirement of having safe evacuation for POS, the analysis of data informs that if hazard-prone areas are converted into POS, such POS should be linked with the evacuation road network. Apart from that, in some urbanised coastal areas, there is a law to have beach access roads to every 500m.

Respondent B11 from CCD states,

"Any development in the beachfront should have an escape path (exit route) for every 500m. This law is mainly for beach access, ensure the beach access. This act as an evacuation path. So, this can ensure the recreational use and emergency evacuation as well." (Respondent B11 – Coastal Planner)

This type of law is an advantage to link the POS in hazard-prone areas with the local evacuation road network. Further, the analysis revealed another dimension to provide safe evacuation to POS in hazard areas. The analysis discovered that, when allocating evacuation paths for POS in hazard areas, the highlands which are located within walking distance can be incorporated into the POS design. By connecting nearby highlands with the POS design, it increases the

attractiveness of the POS and can be used for safe evacuation in Tsunami event for the people who gathered to POS in hazard-prone areas.

Pointing out this need, Respondent H4 explains their development example as follows.

> *"……. We divided the area into two parts. One part is for recreation, and the other part is for tourism. Open area development considered on this side with the main road and the highland. (Showing a map) This is the town centre; there are paths for people for them to for in case of emergency. With the main road, this is the zone plan, and this is the beachside, in case of a disaster they can evacuate from this side as this is the highland area as it's for recreation and open for public." (Respondent H4 – Urban Planner)*

In this way, adjacent highlands or the highlands in walking distance need to be taken into consideration when designing POS for Tsunami resilience, as it will make sure the provision of adequate emergency evacuation to the public attracted to the POS in hazard-prone areas.

The factors discussed above which confirm the need for planning safe evacuation by linking POS with the evacuation road network and neighbouring highlands into the design can be summarised as follows (Figure 4.9).

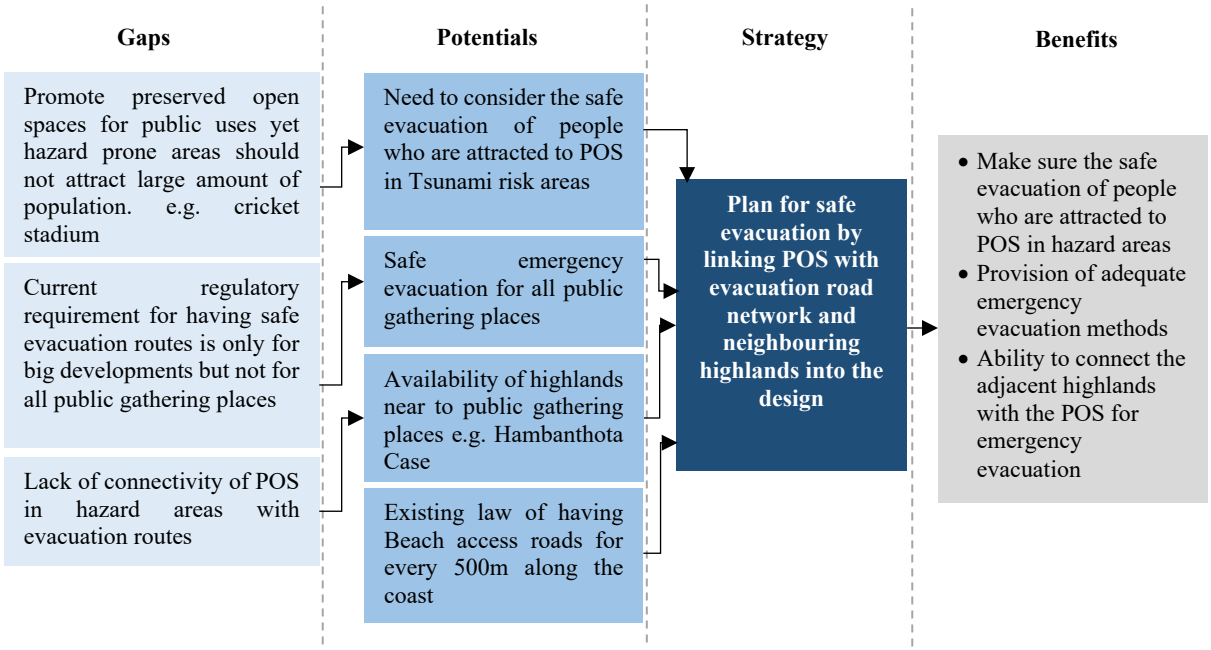


Figure 4.9- Plan for safe evacuation

4.3.1.3 To Provide Public Awareness

The strategies to provide public awareness need to cover providing the public awareness on all stages of the disaster cycle; preparation, response, recovery and mitigation. The analysis of data-informed that Tsunami DRR awareness in Sri Lanka lacks mainly in three areas. First, most commonly known lack of awareness is on Tsunami evacuation routes and safe evacuation points. Most people in coast still depend on the 2004 Tsunami experience where they believe they can survive using the same old methods.

For instance, the community in Tsunami disaster risk areas answers to the question 'do you know where to evacuate in a possible next Tsunami?' as follows.

> *"The thing is we know it now from the general knowledge. After the 'Dewata', the sea came and went away. Once the weather department informed us, we know what to do know from experience." (Respondent G9 – Community)*

> *"So, then we will run to the two-storey house or another safe place. We must go to town. We can go to temples and places as such. We know the route to go to the town. Normally, Army or police go announcing then we will go because they announce it if it is a real one only. So, we will run to a safe place either a two-storey house or a school." (Respondent B5– Community)*

> *"Now I know, the water will go back to the sea. I think it is not safe to run. Next time rather than running it is always safe to be in an upper house. Previously we did not know about the Tsunami. That is why we ran and got injured. But it is safer to run a bit to inland and find an upper house and be on the first floor rather than continuously running. There are many two-storey houses on the way we run." (Respondent B6– Community)*

Likewise, most people who live in Tsunami risk areas still depend on the 2004 Tsunami experience. They highlighted with confidence that they will follow the same evacuation route without considering the directions that are recommended by the DM officers or without considering the changes of the circumstances of a next Tsunami; the height of the next wave, time of arrival, changes occurred over the time since 2004 and so on.

Apart from that, in most of the Tsunami hazard areas, people are not aware of the evacuation routes and safe gathering places due to the issues of the current awareness programme.

As an example, some community members emphasises,

> *"For a next Tsunami, they have advised us to run inland but no evacuation route and centre." (Respondent G5– Community)*

"Next Tsunami, we will just run towards the same side. We don't know a specific route or place to run." (Respondent G11– Community)

Confirming the lack of awareness Respondent C4 states,

"The point is still we don't know what the safest place is if there is another Tsunami. Sometimes we go to a temple, school or somewhere. But that is not the safest places" (Respondent C4 – Sociologist and Disaster resilience expert)

One of the main reasons for this lack of awareness is the issues of the mock drills and awareness programmes such as inadequate coverage of the mock drills and programmes, not updated with the time and not consistent.

For instance, Respondent G10 reveals,

"There were some awareness programmes. They did rehearsals at that time they formed some Tsunami watch committees as well. Where to run and signboards to run inland, but not recently." (Respondent G10– Community)

These types of issues are even identified in local disaster preparedness plans as current challenges as follows.

"No proper training for the community on DRR." (Document 5– Batticaloa DRR preparedness plan)

Accordingly, it can be identified that 'the lack of awareness on Tsunami DRR including the awareness on evacuation routes and safe locations', is one of the significant issues which needs to be resolved. As a solution, findings suggest that without solely depending on mock drills and awareness programmes, POS can be used to provide awareness on evacuation plan in their day-to-day life of the city dwellers by displaying the evacuation maps, information boards and signboards at the POS.

"Evacuation signboards in POS- Sometimes when people go there for recreation, and they get some disaster knowledge. Sometimes it depends on the person. Some people will like it. It will register in their mind. It will not matter to them." (Respondent C10– Practitioner in Community-based disaster management)

Further, this can be identified as an effective strategy considering budget restrictions to allocate money for training programmes covering all the coastal population in hazard areas and the practicality of conducting these awareness programmes in cities. Especially as the city dwellers are not available for training events and mock drills, this can be considered as an effective method. In this way, after the initial cost of installation there will be a minimum cost of maintenance and the awareness will be given in every day and anytime for all the visitors.

However, factors such as the quality of the screen, easy to understand, and attractiveness need to be considered when designing these displays.

The second type of awareness is needed where most of the people are reluctant to be prepared for the next Tsunami and do not understand the importance of being proactive. According to the analysis, this is mainly because of two reasons. The first reason is, some people believe that the next Tsunami will not happen any sooner and trust this type of hazard will occur with a gap of 100yrs or 200yrs. Therefore, people believe that there will not be the next Tsunami in this life as they have already experienced one (2004 Tsunami). The second reason is, most people have forgotten the last Tsunami and therefore the importance of being proactive.

As an example, Respondent B8 states,

> *"However, we will not run for the next Tsunami. Tsunami will not come again. We all sleep upstairs so will be there, and we will not run. We had a massive cyclone, and this Tsunami came 36 years after that Tsunami. So, the next big event will happen with a big gap like that, not frequently. By the time we will not live." (Respondent B8– Community)*

Further, Respondent C4 highlights,

> *"They say that we don't think that there will be no other Tsunami as it comes another 100 or 500 years." (Respondent C4 – Sociologist and Disaster resilience expert).*

Due to these reasons, it was recognised that there is a need to remind people about the destruction which can cause by a Tsunami, therefore the importance of being proactive and prepared. In this instance, it was identified that POS in beach areas are the best place to remind people about the Tsunami and the importance of being proactive.

Informing this importance, Respondent C5 emphasises,

> *"But people put posters on these Tsunami signs and all. People tend to forget things so soon. Even the Tsunami is like that. So, there should be reminders for people. Also, in the design part of POS, you can incorporate a few features which remind people about the Tsunami. It may be a sculpture or something to remind people. Also, once selected the places, then micro-level features also have to consider in terms of signboard and then incorporating design features to remind people about Tsunamis." (Respondent C5 – Civil Engineer)*

Accordingly, the design features of POS can be used as a mode to remind Tsunami, E.g. Sculptures and the importance of being pro-active, e.g. information board.

Further, the location factor is significant when selecting POS to locate these types of design features. Findings suggest that the POS located in beach areas are the best places to remind people about the Tsunami and the importance of being proactive. For instance, designing a Tsunami related sculpture inland is not sufficient though it is within the hazard zone, and locating it in the beach with the visibility of the sea effectively remind people the destruction of Tsunami and the urge of being proactive and prepared for Tsunami. An example of this type of intervention was seen at the Kallady beach park, Batticaloa, Sri Lanka (Visual Image No.2) as follows (Figure 4.10).

Figure 4.10- Visual Image no.2: Kallady Beach park
Source: Photograph taken by the author in August 2016

As figure 4.10 demonstrates, the Tsunami-destroyed church part was used as a monument in Kallady beach park. This monument reminds the public about the 2004 Tsunami and aware people how destructive it can be. At the same time, if an evacuation plan is presented next to this monument, it could have been used to educate the public on Tsunami emergency actions. Likewise, these microscale planning and design elements combined with early warning and evacuation can have a significant impact on the Tsunami public awareness.

Accordingly, the findings revealed that the design features of the beach POS could be used to remind people about the Tsunami; therefore, the importance of being proactive and prepared. The above-discussed factors can be summarised as follows (Figure 4.11).

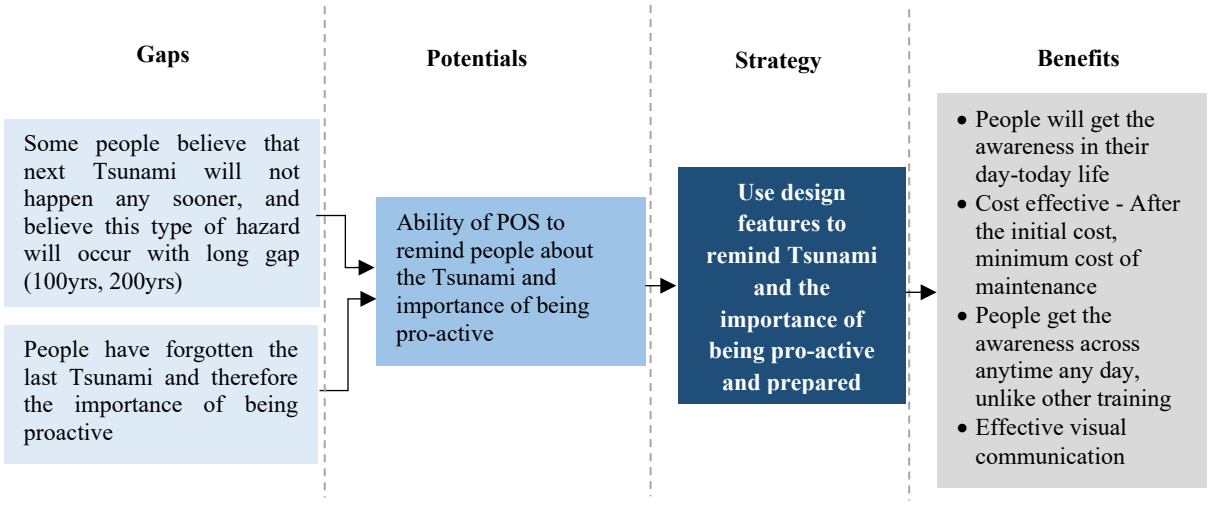


Figure 4.11- Use design features to remind Tsunami

Up to now, two types of awareness were discussed which can be achieved using the POS in beach areas. The third type is the lack of knowledge on the importance of natural features related to Tsunami disaster mitigation. In section 4.3.1.1, it was identified that to protect the mitigation related natural features in Tsunami hazard areas the best method is to incorporate them to the design. In this way, it will protect these natural features. The main reason for this situation is the lack of awareness of the people about the importance of mitigation-related design features.

Therefore, people do not protect the natural features such as sand dunes, mangroves and coastal vegetation which can act as a bio-shield for Tsunami mitigation. As an answer, there is a significant need for protecting Tsunami mitigation related to natural features and at the same time to aware people on the importance of mitigation.

For instance, Respondent G1 suggests,

> *"For the mitigation also, I think we have to aware the people. Those things are happening by the NBRO, coast conservation and BSMB, development mine and surveying. They do not have the attitude to evacuate. So, it is a difficult task. Evacuation drills also there. But the evacuation process is difficult. So, the coordination and how you are going to put this to practice are the two main areas to be considered in mitigation." (Respondent G1 – DM Practitioner)*

As a solution, findings suggest that POS in beach areas can be used to install and display the Tsunami mitigation related features while providing awareness on the importance of them, e.g. with an information board. Accordingly, section 4.3.1.1 identified that mitigation related elements should be incorporated into the design.

Further, this section establishes the need for incorporating these design features while informing the usability of the same design features to aware people on the importance of mitigation. This can be achieved by displaying those features with an information board. Through this method, people will get awareness in their day-to-day life through effective visual communication.

In summary, the emergence of this strategy can be illustrated as follows (Figure 4.12).

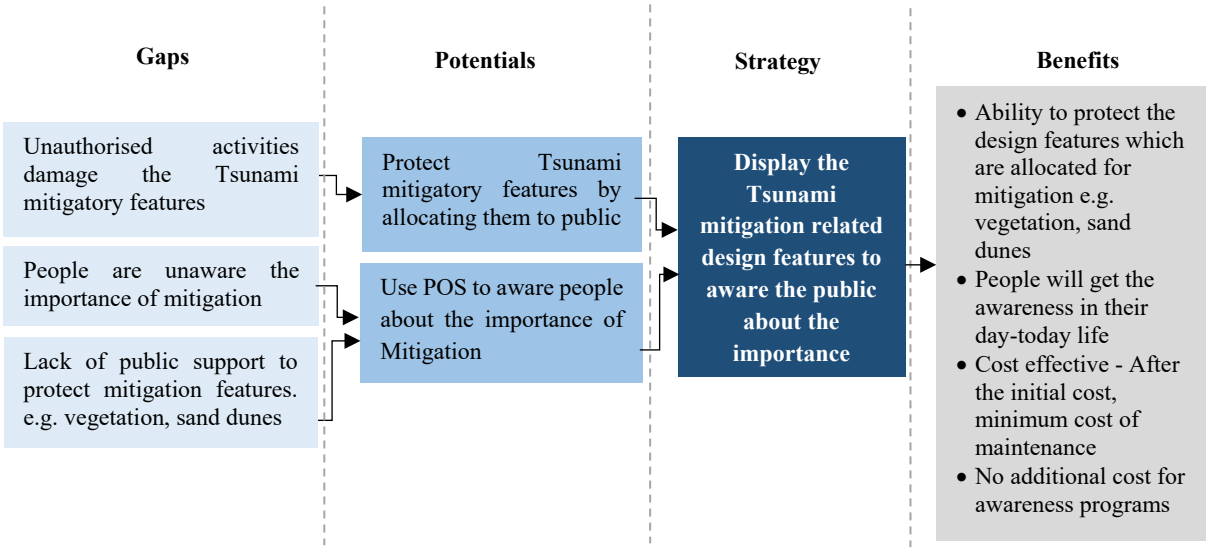


Figure 4.12- Display the Tsunami mitigation related design features

The summary of the section 4.3.1 demonstrates that the POS located in the beach area, Tsunami high-hazard area and with flat terrain are assets for three types of uses; to mitigate the Tsunami risk (Section 4.3.1.1), to direct the emergency evacuation (Section 4.3.1.2), and to provide the public awareness (Section 4.3.1.3). Further, under each section, the specific strategies which need to be followed to achieve these potentials were discussed. The following section (Section 4.3.2) details the second type of POS: Inland POS 1.

4.3.2 Inland POS 1

The second type of POS is the 'Inland POS 1' with the following characteristics;

- POS located inland
- within the Tsunami risk zone
- With the character of flat terrain
- Any scale; large or small

The analysis revealed that if this type of POS are available or can be created, such POS are an asset to enhance Tsunami disaster resilience in four ways; to mitigate the Tsunami disaster risk, direct the emergency evacuation, emergency evacuation distribution and provide public awareness on Tsunami. Accordingly, following three sub-sections; 4.3.2.1, 4.3.2.2 and 4.3.2.3, present the process of emerging these potentials through the data analysis and the planning and designing strategies which need to be followed in order to achieve these potentials.

4.3.2.1 To Mitigate the Risk

Section 4.3.1.1 highlighted the need for promoting POS in Tsunami hazard areas with a view of mitigating the disaster risk. The main benefit of this type of allocation is to lower the disaster risk by minimising exposure. This is a common strategy which has been identified for many other types of disasters.

According to Respondent C1, this is already in practice for Landslides in Sri Lanka,

> *"Then we started last year, a risk mapping programme, that's how we integrated planning concept into high-risk areas. We integrate this with the hazard map. In that, we consider building density, land-use time, open space. we categorised this into three categories, there are around 19 subcategories. (map or something gave). We have identified high-risk areas, low-risk. example in settlement areas risk is high, and in open spaces risk is low. (Showing a map) there are four sections in the hazard map." (Respondent C1 – Planner)*

However, according to the data, this strategy is not in practice for Tsunami hazard areas in Sri Lanka. Therefore, it can be identified that both beach POS and inland POS can be promoted within the Tsunami hazard areas with a view of decreasing the disaster risk exposure.

Apart from that, as it was discussed in section 4.3.1.1, Beach POS is useful to mitigate the Tsunami risk by incorporating mitigation related natural features such as vegetation and sand dunes into the design. Further, it was revealed that this strategy could protect the natural elements, and at the same time, make aware of the public on mitigation. The same theory can be applied to the inland POS which means the inland POS located within hazard areas are assets to mitigate Tsunami risk while incorporating mitigation related natural features such as vegetation into the design to protect them and to provide awareness on it. However, here the focus was given only on preserving the natural elements and on the awareness. Apart from that, both beach POS and Inland POS 1, can be used to slow down and regulate the speed of the Tsunami wave. Here the focus is not only on natural features but also on any built environment features including breakwater earth bunds, breakwater walls, steps.

As data analysis informed, especially the inland POS within risk areas, need to be used to slow down and regulate the wave because water moves fast along the roads and open spaces. At the same time, it was identified that evacuees naturally choose open roadways and open areas to evacuate. Therefore, there is a risk of these evacuees get caught to the wave as the water moves fast along these spaces.

For instance, Respondent B8 who experience the last Tsunami in 2004 states,

> *"However, the first water came along the roads and open land. Because there are objects in other areas, it was slowed down, but along the roads, it came so quickly." (Respondent B8 – Community)*

Further, people as a quick decision in emergency evacuation they select visually open areas to move without obstacles. For instance, Respondent G7 remarks,

> *"Then we all ran along the Matara road. We just ran whatever the spaces available; we did not know either there is hill land or anything. We just ran with the crowd." (Respondent B8 – Community)*

These statements confirm that when people run to inland, they take the roads or the open spaces as it is visibly earlier to move. However, it was also identified that water moves fast along the streets and open spaces as there are no obstacles to slow down the water flow. Therefore, coastal cities need to be planned with a consideration of slowing the water flow along with the open areas and roads. Among the various type of open areas, Inland POS 1 is one type which can be used to slow down and regulate the wave.

When slowing down the wave, vegetation can play a significant role, highlighting this potential, Respondent C8 states,

> *"Tsunami wave is something that is going to move along the ground; you cannot stop the wave by the vegetation, of course, you can slow down. It will certainly reduce the speed of the wave and the cause, so more vegetation the better." (Respondent C8 – Sociologist and Disaster Resilience Expert)*

Apart from slowing down the wave, vegetation in POS can provide various other benefits to the city such as city beautification, air purification and filtration, microclimatic comfort and so on. Therefore, the POS in Tsunami risk areas (both beach POS and inland POS) are an asset to introduce the vegetation to slow down the wave speed alongside the other benefits. Apart from the natural features, many other artificial design features can be incorporated into the POS design to slow down and regulate the wave.

For instance, Respondent C9 states,

> *"Just like a landscape with, introduce different types of trees suitable to the area, and some areas we can create earth bunds, some areas create retention wall." (Respondent C9 – Urban planner and DM practitioner)*

Especially, as it was mentioned in section 4.2.3, this type of strategy is beneficial when the areas below mean sea level and the terrains sloping inward the inland. In this type of instance, the landscape treatments such as earth bunds, breakwater walls can be incorporated into the POS design to break the speed of the wave as a mitigation feature. Further, all these design features including both natural and artificial need to be arranged with correct orientation to slow down and regulate the wave speed. Apart from that, use of these design features with multipurpose uses, e.g. welcoming active and passive functions to the users will add more value to the POS.

Accordingly, the factors discussed in this section, identifying the use of design features and the orientation of the POS to slow down and regulate the wave can be summarised as follows (Figure 4.13).

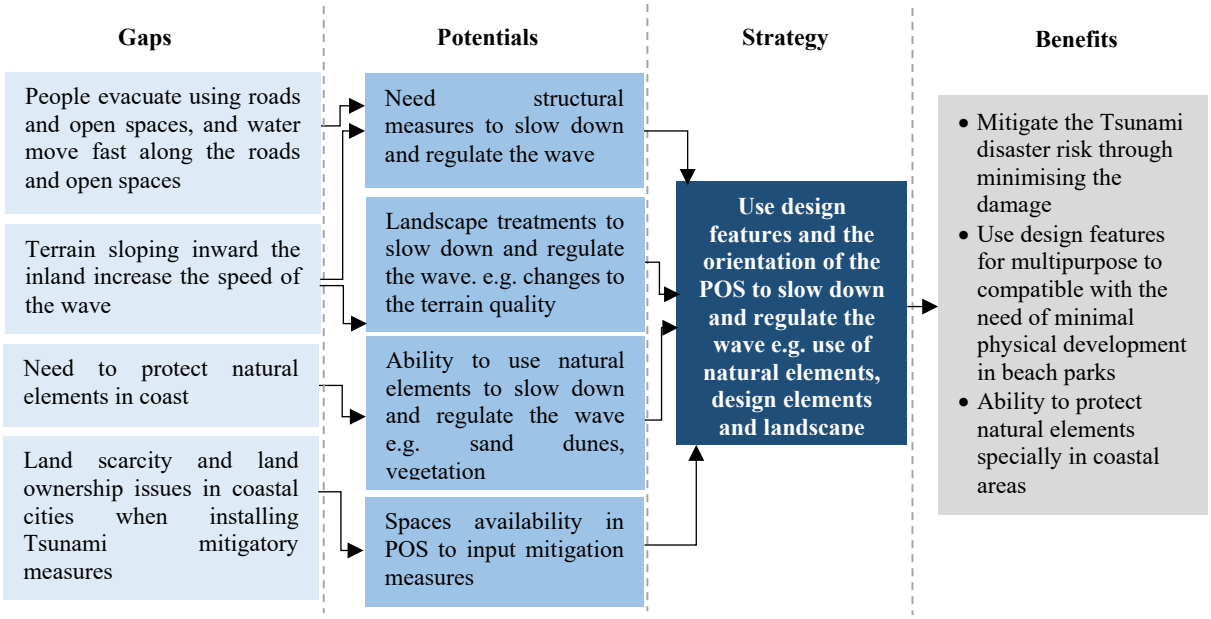


Figure 4.13- Use design features to slow down and regulate the wave

4.3.2.2 To Emergency Evacuation Distribution

Above section; 4.3.2.1 detailed, that 'inland POS1' has the potential to mitigate the Tsunami disaster risk. Further, this section details another important use of the 'inland POS1' which is the potential to act as a place to distribute people in an emergency evacuation.

The data informed that in Sri Lanka, there is no proper mechanism to distribute people among the safe locations. In most of the coast, the advice is to run inland or higher land without a strategy to distribute people among the safe places. The consequences of this type of method are the traffic congestion along the main roads because all the population will run towards one direction and some safe places may get overcrowded.

Respondent B16 brings some examples for this type of situation as follows,

> *"They can announce about the schools and hospitals; also when all the people run into one place, it will create a huge rush in that place and cause traffic. As an example, the people in Nawaladi, have to come to the bridge to come to the mainland. It caused huge traffic." (Respondent B16 – Urban Planner)*

Likewise, in most parts of the Tsunami hazard areas, the escape routes and the safe shelters have been identified. However, how people will get to know which path to select and which shelter to go, the capacity distribution among the shelters, are questions to be answered. Notably, in Sri Lanka, as the population density and the traffic congestion in coastal cities are high, a proper mechanism needs to be developed to distribute the evacuees among the safe locations. Answering this need, one option is to direct people through a landmark system in the right direction, and this will be further discussed in section 4.3.2.3.

The other option is when there is a higher population density, and when there is a long distance to safe evacuation shelters, apart from the vertical evacuation option, vehicles need to be used to evacuate people out of the hazard areas. However, when evacuating people using vehicles, modes of transportation and traffic management issues need to be considered. Further, when using vehicles in evacuation to distribute people among the safe shelters, 'Inland POS 1' which are large in scale can be used as a place to distribute evacuees with a connection of road network. In this way, people who gathered to an initial location will be distributed using the vehicles and large scale 'Inland POS 1' will facilitate as this initial location.

With an explanation of this type of use of POS, Respondent G1 informs,

> *"For an example in Rewatha college, we can do the vertical evacuation, initially. Four storey buildings are there. Then if not, If the time permits sometimes, you know sometimes it's about 40 minutes early warning. So, the initial location is here (showing a map). That will be the initial cover. But if they have time the second-best place is this. So initially with the alarm people will gather here, then we will move them to the other place with the time. People who have vehicles can directly go to second place. Even without awareness, they moved to these two places. So*

with the better awareness people will act better way." (Respondent G1 – DM Practitioner)

However, as it was discussed above, when evacuating a large number of people using vehicles, modes of transportation and traffic management issues need to be considered. Apart from that, the need for using vehicles in evacuation and the use of 'Inland POS 1' as a distribution place can be identified as a viable solution in particular scenarios. Adding to this, the data informed that there is need of using vehicles to evacuate aged and disabled people and 'Inland POS 1'can be used as the first contact point for these type of evacuees as it is a well-known place among the locality.

Identifying this need, Respondent C4 states,

"I think awareness is one thing. And, we need to think about vulnerable groups like old people, infant, children what is going to happen to them, how to save them. Blind, deaf disable people... how much time at least we need to evacuate even the last vulnerable person to the safest area depending on the evacuation call… First, we need to evacuate them first. It is very vital for us to do a vulnerability assessment before doing any plan or strategic plan. Then we know what the minimum time is and how to put strategies. Otherwise, you can go to an open space, and you can say this is the place you should run. But do we have an idea where and how vulnerable people? Do we have a network first these people need to be evacuated?" (Respondent C4 – Sociologist and Disaster resilience expert).

Adding to this, Respondent C12 notifies,

"There were old people, disabled people who need help, that is why we went to the coast, ladies didn't go, the only male. If only people who are capable run by leaving behind other vulnerable groups, it will be a problem." (Respondent C12 – Community).

In these instances, 'inland POS 1' linked with vehicle evacuation network will be a precise answer which needs to be implemented with proper traffic management.

Accordingly, the factors mentioned above which confirm the use of 'inland POS 1' as a distribution place with improved access to use vehicles in an evacuation, can be summarised as follows (Figure 4.14).

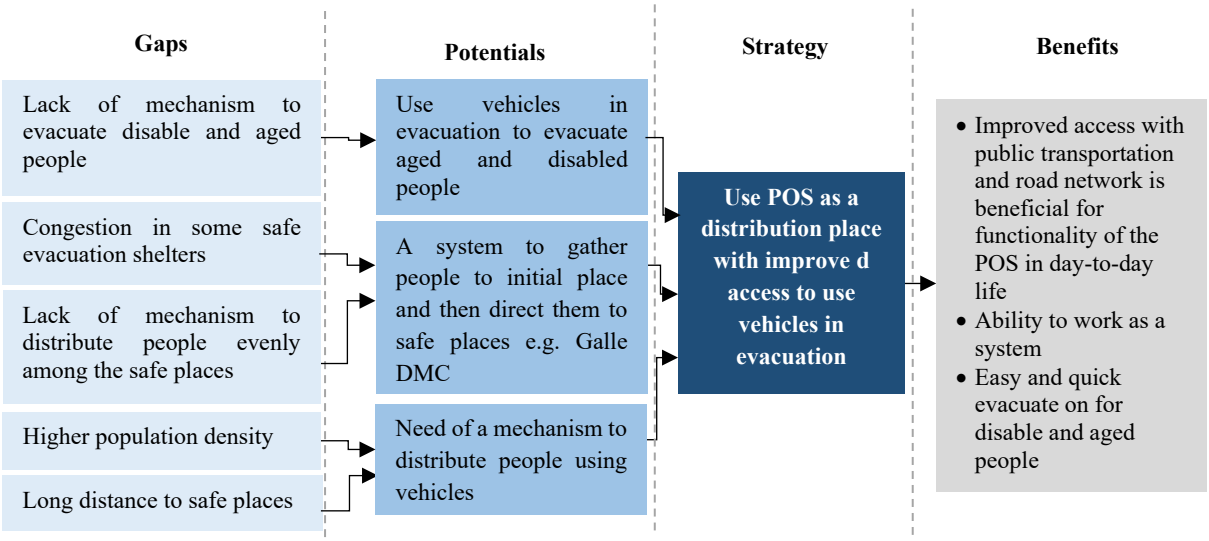


Figure 4.14- Use POS as a distribution place with improved access

4.3.2.3 To Direct in Emergency Evacuation and Public awareness

Section 4.3.2.2 detailed how the 'Inland POS 1' contributes for emergency evacuation distribution which is a need in the current context. Apart from that, the analysis revealed that the 'Inland POS 1' could direct people in the right direction in an emergency evacuation. Linking this factor with section 4.3.1.2, it was identified that the 'Beach POS' also directs people in an emergency evacuation. Further, it was also identified that these Beach POS needs to be linked with an evacuation road network to direct people in an emergency evacuation; and needs to be connected with neighbouring highlands. The same strategy can be applied to the Inland POS 1 and the factors discussed in section 4.3.1.2 can be repeated as follows (Figure 4.15).

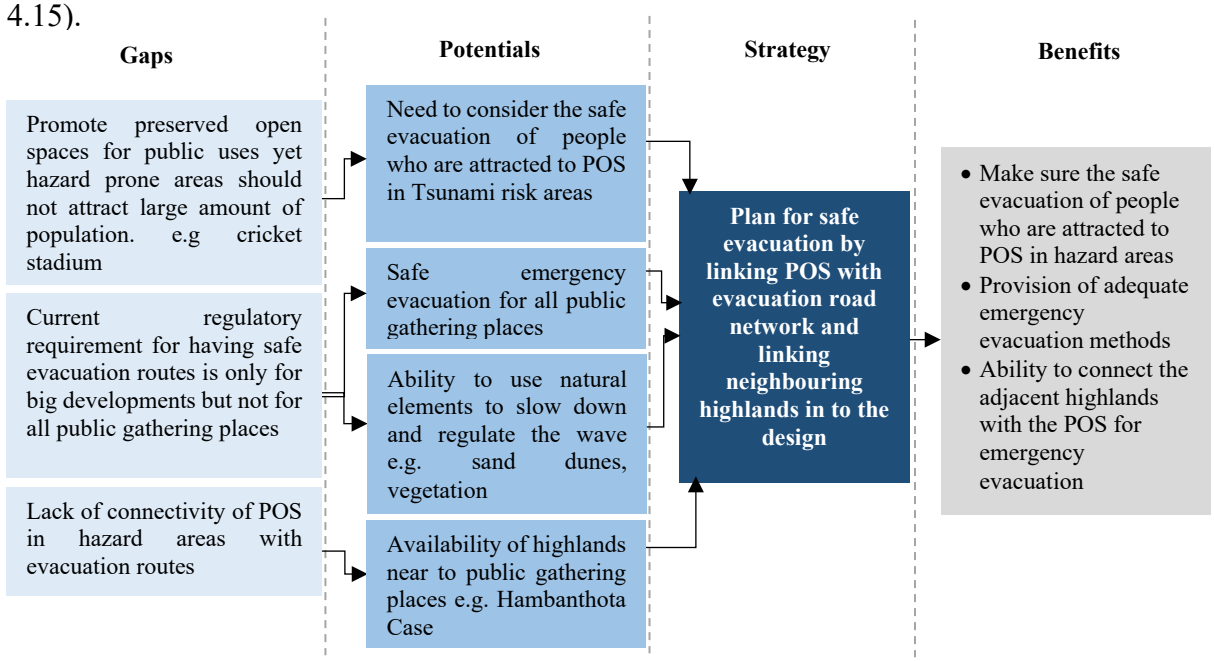


Figure 4.15- Plan for safe evacuation in Inland POS 1

Apart from the above-discussed factors, the analysis discovered that the 'Inland POS 1' is an asset to direct people in emergency evacuation through a landmark system linking with other two types of POS; Beach POS and Inland POS 2. Further, there are three main reasons which contributed to the emergence of this strategy. The first reason is the lack of awareness among the communities on where to evacuate and how to find the way in Emergency Evacuation. This was also identified in section 4.3.1.3 as one out of three significant awareness challenges. In most of the areas, the evacuation routes were identified through community mapping after the 2004 Tsunami. Further, most of these maps are not updated, and most people are not aware of identified routes and evacuation centres.

Confirming this, the communities in Tsunami hazard areas stated as follows.

> *"For a next Tsunami, they have advised us to run inland but no evacuation route and centre." (Respondent G5 – Community).*
>
> *"No, we don't know still, we will act as it is. Although there are boards and all we don't know where to go how to follow." (Respondent B1 – Community).*

Accordingly, it can be understood that there is a need to create clear and direct routes for emergency evacuation and to aware people on finding the best path for the evacuation to the safest places. Further, mostly community drills and other awareness programmes are identified as the best option to aware people. However, when conducting awareness programmes, there are two factors to be considered which confirm the constraints of these awareness programmes.

The first reason is, these community drills are conducted when the funding available and will not be continued with frequent intervals with updated information.

For instance, Respondent G12 states,

> *"There were some awareness programmes at the temple at that time, but not recently." (Respondent G12 – Community).*

Likewise, it can be understood that after the 2004 Tsunami all these programmes were launched but not continued in the long run.

The second reason is when conducting community drills and other programmes; there are various groups of communities to be covered which is costly and impractical to continue in the long run. Particularly, these various groups within the community include commuters of the city, the business community and the tourists.

For instance, commuters and business communities' comments;

> *"I do not live in town, and I come to town to do the business. I was on the bridge on the Tsunami day, and more people were there with me. What to do, I climbed on a tree. We still do not know a place or a way to run." (Respondent G7 – Community).*

> *"Next Tsunami, we will just run towards the same side. We don't know a specific route or place to run." (Respondent G11 – Community).*

Highlighting the need for focusing on Tourists, Respondent G1 states,

> *"Awareness programme vary for the community, religious people, fisheries communities, Grama Niladary, government offices and NGOs. But for Tourists, we cannot do it. We have given an awareness programme for hotel people. We don't have a system to train them. But when it is required, we can do it. We have prepared the evacuation plan with evacuation centres." (Respondent G1 – DM Practitioner)*

Adding to this, Respondent B11 informs,

> *"For tourism purpose, we do not have any signs or anything focusing especially on disaster side. We know the importance, but we don't have funding. Tsunami escape route signs were there, but now disappeared, so need to be renewed but no funding. Only the thing is we maintain the evacuation route requirement for every 500m which are exit gates that is it. Especially focusing on tourist, we should develop a signboard system because villagers know where to run and all but not the tourists." (Respondent B11 – Coastal Planner)*

This discussion highlights that the awareness programmes are not continued with the time covering all the areas and there is no proper mechanism to aware these various groups of people including tourists, commuters and business communities. Especially, As Respondent B11 emphasised that the villagers know the local area, so they know at least a direction to run, but for tourists and commuters, there should be a method to aware. As an answer, the signboard system can be considered as the best option, where there is no need to conduct community drills from time to time. However, with regards to signboards, there are problems with the implementation and maintenance of these signboards in the context of Sri Lanka. Firstly, signs are available only in some locations.

> *"Yes, at the moment they have signboards on one side. But in Kallathiv side there are not any signs. But that should be developed. Because the villages know where to go, but tourist does not know where to run or safe places." (Respondent B13 – Coastal Planner)*

When relevant authorities were interviewed regarding the absence of signboards, they informed the reasons as follows.

> *"Signs we have already placed. Especially the evacuation routes. But there is some problem, but due to the lack of awareness, people paste posters on it. One thing is challenging to maintain those. Initial; putting we have done. But local authorities have to maintain them. We do not have the capacity to maintain. But still, we are doing." (Respondent G1 – DM Practitioner)*

Accordingly, it can be understood that there are several issues in implementing and maintaining the signboards. Further, all these issues related to community drills and signboards, highlight that depending only on one system is not sufficient. In supporting this view, Respondent B16 states,

> *"Anyway, we should not depend only on this system; there should be other alternative ways to inform to public and aware of the public." (Respondent B16 – Urban Planner)*

Adding to this, Respondent C8 emphasises,

> *"No this cannot be seen in isolation of other measures that we take to reduce the disaster risk. DRR is a package, not just one or two things that you do to reduce the risk. Say, for instance; an effective early warning system will give people the confidence. You know that we make sure that people act. And of course, the way that you really use that open space." (Respondent C8 – Sociologist and Disaster Resilience Expert)*

Accordingly, this discussion confirms that there should be multiple methods to aware people on emergency evacuation including the awareness of directing people in the right direction. When considering the various methods, the built environment can play a significant role in providing public awareness and in directing people in the right direction.

Further, when considering the built environment strategies, to direct people in the right direction, it was identified that landmarks linked with the POS network could be used to direct evacuees through a landmark system. Landmark can be any object or feature which can be easily recognised from a distance. These landmarks are generally used in urban planning to locate the place or to remember the place easily. Similarly, in evacuation planning need is to make people remember the evacuation routes and evacuating shelters. Further, to make people remember the evacuation route or to easily recognised a landmark system linked with POSs could be developed networked to each other to direct people in the right direction.

Furthermore, this landmark system linked with POS can bring many other benefits such as easiness to finding the way, multipurpose use of landmarks with attractiveness to the city and enhance the disaster resilience, people will get the awareness in their day-to-day life unlike the awareness programmes, cost-effective after the initial cost, minimum cost of maintenance. Accordingly, the summary of this discussion can be presented as follows (Figure 4.16).

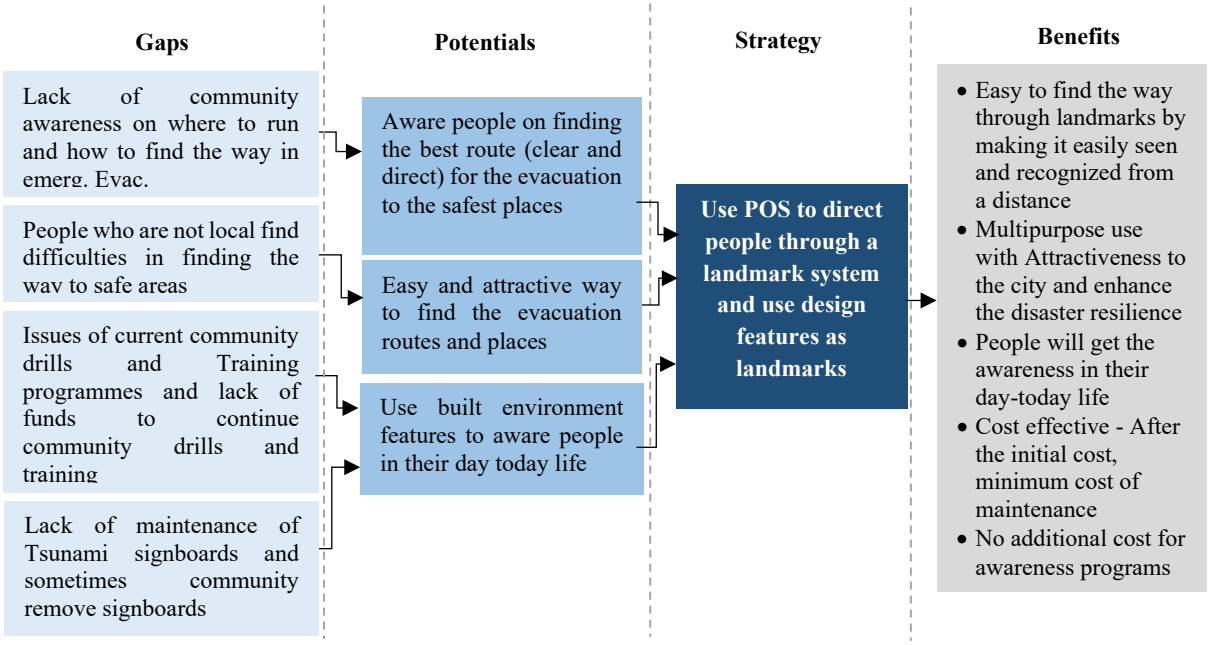


Figure 4.16- Use POS to direct people through a landmark system

In summary, this section detailed that 'Inland POS 1' can contribute the cities' resilience to Tsunamis in three ways; to mitigate the disaster risk (Section 4.3.2.1), to use as an emergency evacuation distribution place (Section 4.3.2.2) and to direct people in emergency evacuation (Section 4.3.2.3). The next section; 4.3.3 introduces the Tsunami DRR potentials and the strategies of the third type of POS; 'Inland POS 2'.

4.3.3 Inland POS 2

The third type of POS is the 'Inland POS 2' with the following characteristics;

- POS located inland
- Out of the Tsunami risk zone
- Mountainous terrain or on an elevated platform
- Large scale

The analysis revealed that if there is a POS with the characteristics mentioned above or can be created with those characteristics, such POS are an asset to enhance Tsunami disaster resilience in three ways;

1. to use as an emergency gathering place and sheltering
2. to provide essential services and facilities and
3. to use as a place to distribute goods and services within the immediate recovery period.

Accordingly, following three sub-sections; 4.3.3.1, 4.3.3.2 and 4.3.3.3, present how these potentials mentioned above emerged through the data analysis and what are the planning and designing strategies need to be followed in order to achieve the identified potentials.

4.3.3.1 To use as a place for Emergency gathering and temporary sheltering

When Sri Lanka was hit by Tsunami 2004, the country was not prepared for a Tsunami. Therefore, during the emergency evacuation, evacuees were not ready for a Tsunami and used hilly areas, high-rise buildings, schools, religious places for survival. Together with those places, the people who lost their houses had to use the available community centres, hospitals, police stations, playgrounds, warehouses and so forth. Apart from that, due to the lack of space, people were given tents for temporary settlement in wherever possible including temples, army camps, dumping sites or on any open area. According to the interviews conducted with the community who were affected by the 2004 Tsunami, it was recognised that people suffered during this period of recovery due to various issues of the safe locations and temporary settlement areas. Some of the problems that they highlighted can be listed as follows.

- Some schools were closed at the time of Tsunami
- Schools can be used only for a short period
- The space given was not comfortable to stay as the safe place was not designed for that purpose
- Problems in distributing goods and services as the safe place was not designed for that purpose
- People suffered due to the capacity issues
- Some areas were not suitable for all the groups of the society, e.g. aged and disabled people
- Limited facilities are available in identified safe locations, e.g. Sanitary, water, electricity.

Nevertheless, in 2004 the country was not prepared for the Tsunami disaster. However, now Sri Lanka has taken many attempts in order to be ready for the next Tsunami. Accordingly, Disaster management centres (DMC) in district level have used community mapping to identify the safe locations. Further, through the interviews conducted with the DM practitioners, it was recognised that most schools and religious places were identified as secure locations for emergency evacuation and recovery. However, according to the interviews conducted with the communities, many issues remain with these identified locations as follows.

- As these places are not designed for the particular purpose, most of the issues mentioned above will remain
- Villagers do not agree with the selected locations
- Long-distance to a safe area
- Schools and other places can be used only for a short period, but not for the recovery
- Inability to obtain access to the identified safe locations

Therefore, in Sri Lanka, there is a need to develop a system to locate and establish new safe places which address the issues mentioned above. However, the data further informed that within the Sri Lankan context, local governments have less capacity to maintain a separate place for safe evacuation.

Highlighting this, Respondent C2 states,

> *"Those places belong to the local government they have to maintain them. So that type of thing we have to promote. Then we have to think about our local gov. set up. Can they manage it? What are the resources available and those resources are appropriate and adequate for this thing? Because our local government cannot maintain separate locations for emergency evacuation." (Respondent C2 – DM Practitioner)*

Therefore, together with identifying the safe locations which address issues mentioned above, such a place should also be used for multiple purposes. The need for multipurpose uses was further confirmed in section 4.2.4.

Consequently, when determining the safe places for emergency evacuation and recovery, another important factor was identified through the data which is the element that 'not every evacuee need shelters after evacuation', because once the Tsunami threat is over the people whose houses were not affected by Tsunami do not need shelters. Also, especially in the city context, there are visitors, commuters and other people who can find alternative

accommodation. Therefore, these categories of people do not need temporary shelters to stay in.

For instance, these categories of people who were affected by the 2004 Tsunami stated as follows.

> *"There is no house or any building there, but just to save the life we went there and stayed till the wave go off. After that, we went to our houses and dispersed to various places." (Respondent G2 – Community).*

> *"Most of the people were in churches. All the people just went to these public places like churches and schools. Police also has told. People gave food and all. When I come from abroad after a month, my wife and two children were on a mat on the classroom floor in the school. Then I took them to Monaragala my relative's place. But the other people stayed for nearly one year in school." (Respondent B3 – Community).*

> *"We went to a house in a hilly area, then only we felt that we are safe. So, we spend the night at that house. In the morning, now we do not know what is going on with our houses. I came with someone here. But we cannot reach home because all the roads were blocked with stuff. So, we all went to another relative's house nearby. Our house was not damaged luckily. So, we refurbished and went back." (Respondent G10 – Community).*

These statements confirm that not every evacuee needs shelters during the recovery period. This means that more space needed for emergency gathering than the space required for sheltering during the recovery period. However, in Sri Lanka without identifying this difference, possible safe locations are holistically identified using the community mapping. Those designated safe evacuation shelters are also considered as a lack in capacity to cater to the population of the locality. Therefore, there is a significant need for identifying spaces for emergency evacuation gathering and temporary sheltering. Answering this need, it was identified that 'Inland POS 2' can serve the purpose with its' characteristics such as large scale and located out of the hazard zone. Therefore, such POS can be developed as a place for emergency evacuation gathering and for sheltering.

Respondent C10 brings some examples of using Inland POS 2 for other types of disasters as follows.

> *"As an example, in the Kegalle district during the Landslide, they used playgrounds of schools, so that is also open space. These are the things we normally practice. Schools and playgrounds and other playgrounds. This is what I know from my experience. Even in recent Floods, I saw that they had used the playground in*

Kolonnawa area. Playgrounds they can use for evacuation and temporary camps." (Respondent C10– Practitioner in Community-based disaster management)

Further showing the possibility of using POS for Tsunami emergency evacuation gathering, Respondent G1 and C4 state as follows,

"When using POS for Tsunami, one thing is sometimes they are under the hazard zone; the second thing is the capacity. Those are built for a specific purpose, and we are going to use it for a specific purpose. So how can we match? So, when a community goes there in an emergency event, they can stay there for 24hours, but after that, there will be a lot of problems." (Respondent G1– DM Practitioner)

"We have a lot of open places using for different purposes. For example, if you take park for recreation, we can think of converting this park, and some other open space let's say some playground places where we can evacuate affected people not all some people who are living in coastal prone areas." (Respondent C4 – Sociologist and Disaster resilience expert).

Accordingly, it can be identified that 'Inland POS 2' has a great potential to be used for emergency evacuation gathering and also for temporary sheltering. When harnessing this potential, there is another critical factor to consider which is the period the POS is required. As it was understood for emergency gathering and temporary shelter, the POS needs to be allocated for a period varying from few hours to few days, because once the evacuees are gathered and when the risk is over, set of evacuees will be moved away, and the rest can be moved to safe shelters. However, when providing shelters, there are three types of shelters which need to be provided within the recovery period.

Explaining this, Respondent C6 states,

"In disasters, you have three phases. First one is immediate recovery what we call emergency management where people will be supposed to live in temporary shelters. That period is normally for one month. Maximum of one month. After one month if the permanent shelters take about a year, you have to provide them with one year of transition. That is call transition period. So, after one month up to one year, you need a place call transition. It has to be a special open space. Sometimes in Tsunami state also we use the same site as the relocation site. Part of that is used for the transition. That is also sometimes you have that concept of owner-driven construction. They live in the same post, and they will build the house." (Respondent C6 – Urban planning Practitioner)

With this categorisation, the data analysis informed that the POS are suitable only for immediate recovery, but not for transition and long-term recovery. Long-Term recovery can be taken away from the discussion as space is well needed for permanent houses. If the

consideration is given on the transition, still POS cannot be used as the shelters need to be built using semi-permanent materials which can damage the landscape of the POS. Further, POS will not be able to use for everyday use of the city for a period between one month to one year. Apart from that, provision of temporary shelters for the immediate recovery is negotiable with the everyday uses of the POS as space will be lost for the other functions only for a short period and building makeshift shelters will not damage the landscape extensively.

In supporting this view, Respondent B14 states,

> *"Once the disaster occurs, we have places, so immediately they are moving to those places to these places playground or other open spaces. Then disaster recovery period people will be diverted to other places. That is why we need to maintain open spaces because those can be used for an emergency evacuation. Then gradually we can send them to safe locations such as schools and other public building. This is the purpose of maintaining open spaces." (Respondent B14 – DM Practitioner)*

Accordingly, it was identified that 'Inland POS 2' can be used for both emergency evacuation gathering and temporary sheltering, but not for the transition and long-term periods of recovery.

Then the next question is how to create the space within the Inland POS 2 catering the needs of emergency evacuation gathering and temporary sheltering. When considering the space required for emergency gathering, and temporary sheltering, section 4.3.1.1 identified a strategy 'minimum physical development' from the disaster mitigation perspective. Applying the same method from the emergency evacuation perspective, unlike the typical POS allocated for recreation purpose this 'Inland POS 2' need to be designed with minimum physical development leaving more space convertible for emergency evacuation gathering and temporary sheltering.

However, apart from the space requirement, there is a need for balancing two different types of requirements when designing the space in 'Inland POS 2'. For instance, if a community park is taken as an example, everyday life of the city may demand walkability, liveability, vitality which need to be fulfilled with the provision of parks with seating facilities, space for cycling, child play area, recreational facilities, green spaces, spaces for passive engagement and so on. At the same time, disaster resilience-focused 'Inland POS 2' may demand different spaces for a safe evacuation, shelters, space to distribute goods and services, and so on. Therefore, to function well in both these situations, space needs to be planned and designed in a flexible way welcoming different types of activities.

Addressing this requirement, there is an urban planning and designing concept called ‘Loose fit space’. In this instance, the researcher relates the literature with the research findings as required. Franck and Stevens (2013) introduce the 'loose-fit' concept with a view that everyday urban dwellers come across with spaces that are loose, that manifest great variety and unpredictability, which stimulate imagination and intervention. This idea promotes that ‘Loose-Fit’ environments are not planned and designed for the specific use. It is more unregulated, loose, open-ended and the user will decide the use of the space, rather than following the decisions of the urban planner or designer.

Promoting a similar view, Thompson (2002) states, 'Found' spaces often serve people’s wide range of needs in ways that a ‘designed’ spaces do not. In the similar vein, if the selected ‘Inland POS 2’ in cities can be planned and designed as a ‘loose spaces’ focusing on both Tsunami disaster resilience needs and urban planning needs, such space has more potential to be functioned well in both situations unlike the planned spaces for a specific use. Accordingly, the loose space concept can be identified as a potential strategy to integrate sustainable planning of ‘Inland POS 2’ for emergency evacuation gathering and temporary sheltering.

Accordingly, the factors discussed in this section which confirmed the need for the strategy ‘minimum physical development and designed as a loose space’ can be summarised as follows (Figure 4.17).

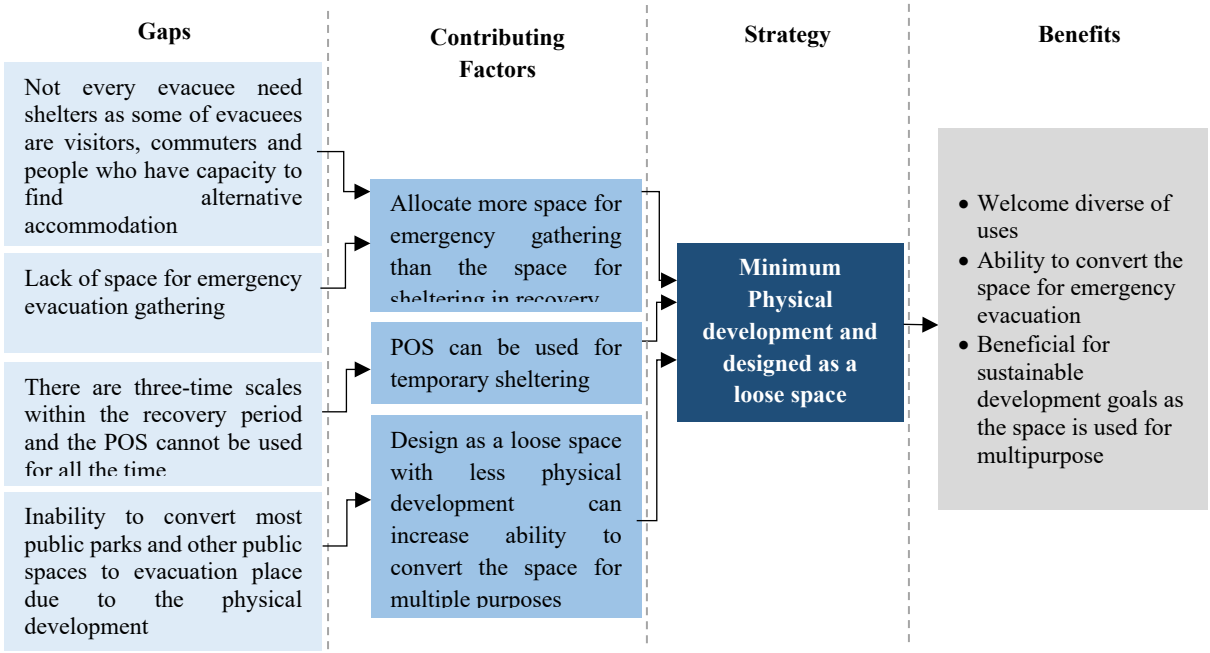


Figure 4.17- Minimum Physical development and designed as a loose space

Above section; 4.3.3.1 detailed the use of 'Inland POS 2' as a place for emergency gathering and temporary sheltering. It was also identified that these POS are suitable only for immediate recovery which may take maximum up to one month, but not for intermediate/transition or long-term recovery. The main reason for this is once a large number of people gathered to one place, if they stayed there from one day to one month, such place should provide the basic services and facilities such as water and sanitation. Therefore, the provision of basic services and facilities can be identified as the second strategy for 'Inland POS 2'.

Highlighting this necessity, Respondent C10 states,

> *"I think at the time of a disaster they may go to any place where they can survive. At that time. But if they must stay for some time, then they will consider all the facilities. Like in the evacuation centre, now the main problem is whether to develop that place as an evacuation centre or the recovery centre. But they should have all the facilities such as water, toilets and, they will not stay for the long term. If we are talking about open spaces, then we must provide shelter facilities, toilets, water, access, electricity. Everything should be available. (Respondent C10– Practitioner in Community-based disaster management)*

Further, the interviews conducted with the communities who were affected by 2004 Tsunami and DM practitioners and experts, emphasised the need of following services and facilities (Table 4.2) which need to be provided when facilitating POS as a place for emergency gathering and temporary sheltering. Further, an evidence statement for each identified facility or service were given from the data as an example to show how each type is identified.

Type of Facility or Service	Evidence statement as an example
Water sources or access to provide portable water	*"Then when you are designing it you have to incorporate those things into the design. For any kind of thing, water is a requirement. Portable water, whether it is a fire whether it is a bomb you need portable water." (Respondent C9 – Urban planner and DM practitioner)*
Sanitation facilities	*"Firstly, the problem of providing sanitary facilities mainly toilets and water. Provision of things whatever we need for the daily use. Sometimes, though we identified temples for evacuation, there are only one or two toilets in the temple which is not adequate in the case of an emergency." (Respondent H2 - DM Practitioner)*
Electricity	*The other facilities such as electricity, water, transport, whether it is accessible for other*

	service providers (Respondent G1 - DM Practitioner)
Waste management	*"Also, the major issue is the garbage issue. How we are going to manage them. That is another issue." (Respondent C4 – Sociologist and Disaster resilience expert).*
Temporary medical camps	*When I come after a month, my wife and two children were on a mat on the classroom floor in the school. There were medical camps, and they were checked. (Respondent B3 - Community)*
Children parks	*There is a children park near to the town. It is closer to the central college. Also, there is one closer to the town market. As they are just kids, with all these things. We took them to that children park. (Respondent B1 - Community)*
Storage of equipment, e.g. tents and other goods	*Otherwise once Flood or Tsunami comes we can maintain open spaces in hilly areas for storage. We are also keeping some tools and battalion and other things when disaster comes to rescue people. (Respondent B14 - DM Practitioner)*

Table 4.2- Identification of essential services and facilities for emergency

Out of these facilities, portable water, mobile toilets can be transported to the POS when required. In this instance, the accessibility to the POS both in and out need to be considered when planning the POS for this purpose. Regarding the provision of electricity, early planning needs to be done to locate electricity distribution sub-station near to the POS. Then with the provision of related other equipment, power can be distributed to temporary shelters and medical camps. When providing makeshift medical camps, space needs to be provided by the POS and the way it should be planned to leave more space for these purposes was already discussed in section 4.3.3.1. Further, the methods to provide accessibility for the vehicles which transport the equipment will be discussed in section 4.3.3.3.

Another important factor which was identified through the data is the necessity of providing children to play area within the 'Inland POS 2'. This was especially identified considering the psychological damage which can happen to the children who are among the evacuees. Most of the communities interviewed revealed that,

> *"They are just kids; they are panicked without any clue what is going on. There is a children park near to the town. It is closer to the central college. As they are just kids, with all these things. ……We took them to that children park. (Respondent B1 - Community)"*

Adding to this, a practitioner in community-based disaster management states,

> *"Even in our evacuation centres in Kegalle, we had children play area. Not immediately after the disasters. After one or two weeks. We have some books, play areas, small games for children to get their mental status back. For immediate evacuation, I don't know how that will work?" (Respondent C10– Practitioner in Community-based disaster management)*

As an answer, the 'Inland POS 2' which operates within the immediate recovery period can offer children play areas to restore the children's mental health. Accordingly, it was understood that child play area needs to be included within the design of 'Inland POS 2' catering the day-to-day functionality of the space plus to operate during the immediate recovery period.

Further, when providing temporary shelters (most commonly tents), one option is to transport them when required from the central disaster relief centre. In such an instance, the accessibility to the POS will be an important factor. The other option is to store the necessary equipment at the local level. When storing the equipment at the local level, these identified POS may be the best store. In such a case, storage facilities need to be developed within POS. Accordingly, it can be understood that when providing essential services and facilities for emergency gathering and temporary sheltering, 'Inland POS 2' need to be planned and designed facilitating the provision of basic services and facilities in various ways. Accordingly, 'facilitate the provision of basic services and facilities' can be identified as a strategy in 'Inland POS 2. The factors affecting this strategy can be summarised as follows (Figure 4.18).

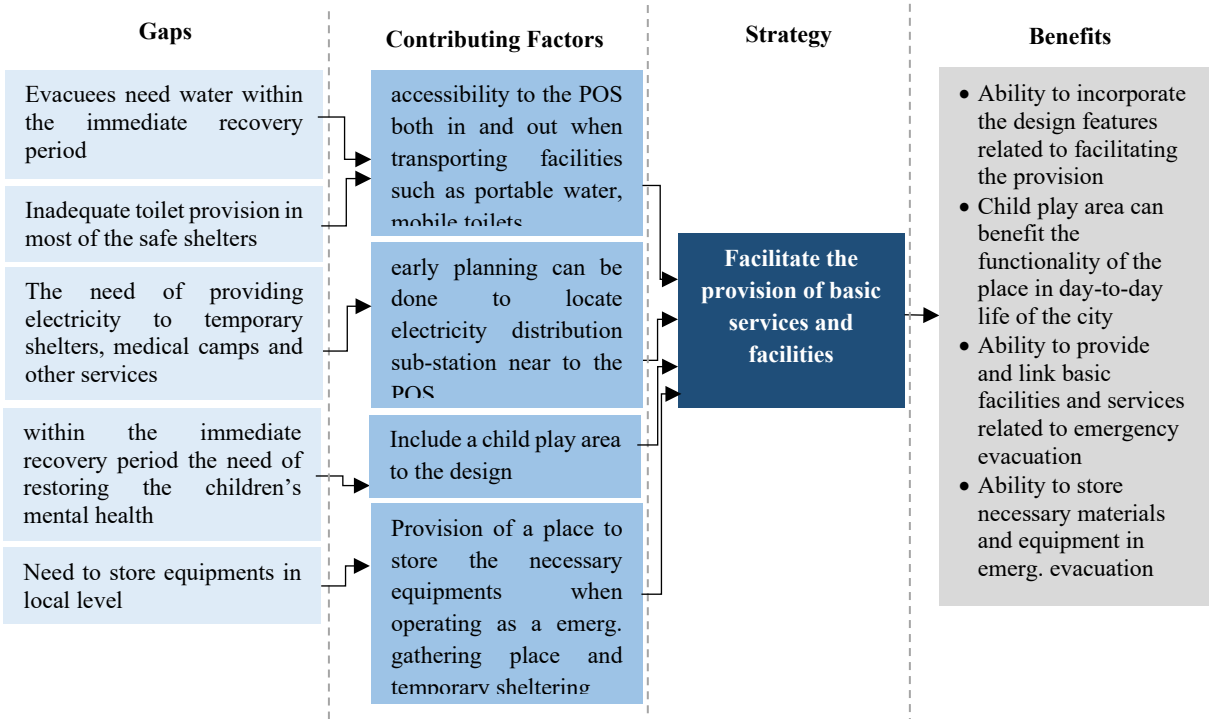


Figure 4.18- Facilitate the provision of essential services and facilities

Above discussion identified that there is a need to store the necessary equipment including tents at the local level and 'Inland POS 2' can provide a storage facility to fulfil this. Together with this identification, it was also noted that this space for storing the equipment should be compatible with the everyday activities of the POS. In this instance, the data-informed that linking the community centres with the 'Inland POS 2' is a viable solution which can benefit to many other purposes.

If the community centres can be linked with the 'Inland POS 2', these community centres or community halls can be used to store the necessary equipment in providing the basic services and facilities which are needed in emergency gathering and temporary sheltering. Together with this, if the community centres/halls are larger enough to provide safe shelters, the 'Inland POS 2' can even perform better for emergency gathering and during the recovery period.

Highlighting this importance, Respondent C3 states,

> *"We are currently doing 'post-disaster recovery need assessment survey' after 2016 Flood; schools are used as places for recovery we have identified this issue for the long term. Government has considered this not to use schools for this purpose. But due to lack of resources, this would not happen. We have submitted a proposal to the ministry to allocate some money to improve existing public spaces such as community centres, some places like community halls. local authorities must improve them and use in case of emergency." (Respondent C3 – DM Practitioner)*

Adding to this, Respondent G1 informs,

> *"One thing is we can create safe locations, especially high-rise buildings in coastal areas, also community centres. Sometimes for our awareness programme and training programmes, we can get those places to provide training facilities. And sometimes relief centres, temporary hospitals." (Respondent G1 – DM Practitioner)*

Here, Respondent G1 highlighted an important point that they anyway use these community centres for Tsunami awareness and training programme. Accordingly, if these 'Inland POS 2' serving the emergency gathering and sheltering are planned with the linkage with community centres/hall, this will be an added advantage to aware people on the same location where they should come in a Tsunami emergency. In this way, people will get familiar with the space allocated for emergency evacuation. Also, the added advantage is that it is easier to find the way to a well-known place.

Opening another dimension, Respondent C2 states,

> *"So basically, when we divided. So, all these places even in the Batticaloa some NGO and INGOs develop community centres, but those also in the Tsunami high hazard area. So, there is no use of them." (Respondent C2 – DM Practitioner)*

This means, in emergency gathering, public spaces are an asset because of the difficulties of getting consent from private places even though those are the most suitable place. Within this context, if the community centres are in hazard areas, the risk exposure is high. Therefore, such potential places will not be able to use for emergency gathering and sheltering. Thus, it is vital to allocate community centres out of the hazard area with more space, as those places are useful for emergency gathering and temporary sheltering.

Further, as it was identified in section 4.3.3.1, there are many issues of using current safe location such as schools and religious places and there is a problem of inadequate evacuation shelters. Within this context, linking community centres and halls with 'Inland POS 2', effectively answers many identified questions, at the same time can serve many benefits. In summary, the necessity of this strategy can be presented as follows (Figure 4.19).

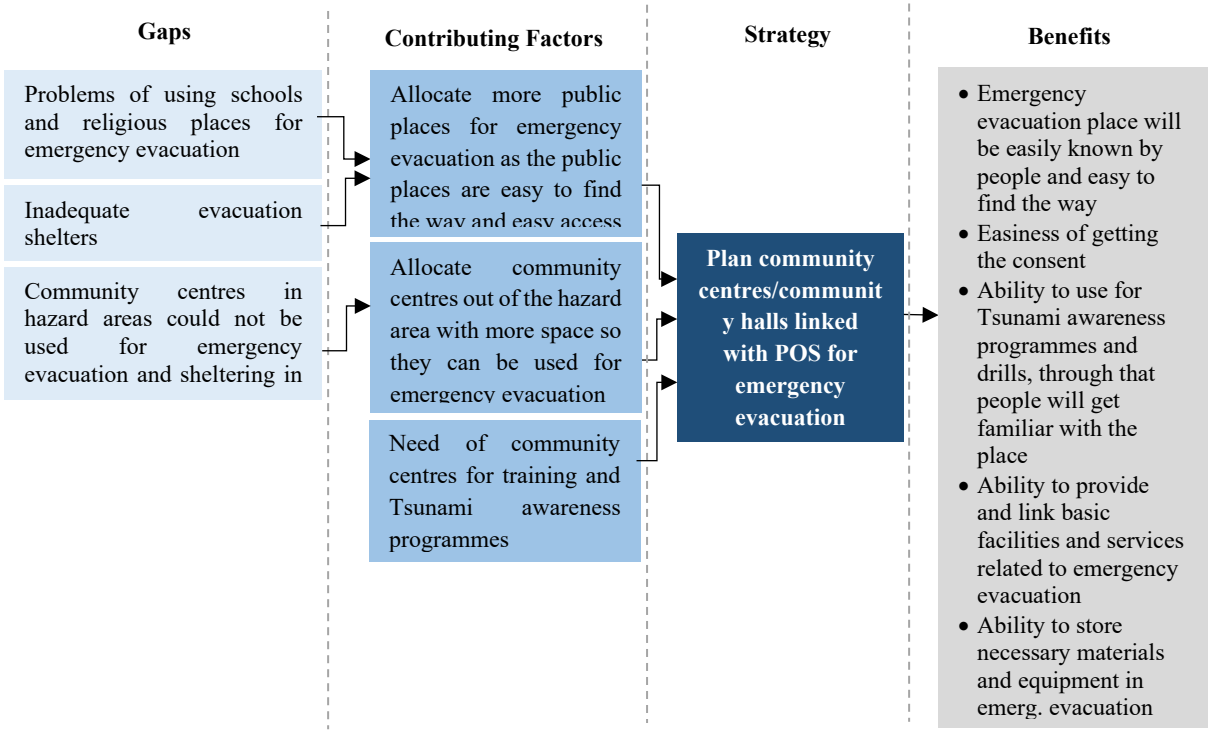


Figure 4.19- Plan community centres/ halls linked with POS for emerg.evac.

4.3.3.3 To use as a place to distribute goods and services

In Sri Lanka, when Tsunami warning call is issued, people are advised to evacuate with the 'Tsunami Malla' which means a bag with identification documents and other necessary documents. Further, the evacuees should not put any attempt to carry other belongings for the safety reasons. Therefore, as soon as they evacuate to a safe location, there are specific goods and services which evacuees would need. Practically, they need water and cooked food, then medical facilities, clothes and so on. According to the culture in Sri Lanka, apart from the government and non-governmental relief services, the neighbouring communities also help to distribute goods and services, which emphasise the value of social cohesion.

However, the issue is there is no proper mechanism in Sri Lanka to distribute goods and services. Therefore, evacuees especially who live near the main road, receive an excessive amount of goods while the evacuees in isolated locations receive nothing.

Explaining this, Respondent G10 states,

> *"Most people actually enjoyed and benefited by the Tsunami. Because a lot of vehicles just came in and distributed the goods. There was no proper channel to distribute goods to everyone in a similar way. So, some people stored those donations for their benefit. When a vehicle arrives people just drag a child from the street and beg for help and got the donations. Likewise, it happened very informal way." (Respondent G10– Community)*

These discussions pointed out the need for developing a proper channel in distributing goods and a need for central point within the locality to distribute goods and services. Development of the appropriate channel needs to be done within the institutional setup. However, it was identified that the 'Inland POS 2' has the potential to act as a central point within the locality to distribute goods and services. Since, as these POSs will be used for immediate recovery with characteristics such as a popular place within the locality and a place large in scale, 'Inland POS 2' can act as a place to distribute goods and services.

With the emphasis of using 'Inland POS 2', Respondent C7 states,

> *"When using these open spaces for rescue and recovery, next is the food and beverages. We should design in a way to distribute these things." (Respondent C7– Civil Engineer)*

Accordingly, it can be understood that 'Inland POS 2' has the potential to act as a central point within the locality to distribute goods and services, but space needs to be planned to facilitate this potential. When facilitating the distribution of goods and services, the most important

element is the accessibility. Because, if the 'Inland POS 2' act as a place to distribute goods and services, such space needs to be linked with the main road network, accessibility to large vehicles such as lorries and trucks.

With further explanation, Respondent G1 states,

> *"There should be separate locations that we identify to get access to identified places. Likely helipad location, to use for helicopter landing (not all the locations). If we have an air operation, for helicopter landing. Then we have identified nearest police station, military care." (Respondent G1 – DM Practitioner)*

This discussion highlights that, apart from the accessibility to 'Inland POS 2' the linkage with the access locations and other service providers also need to be established at the planning stage. Accordingly, the information discussed in this section can be summarised as follows (Figure 4.20).

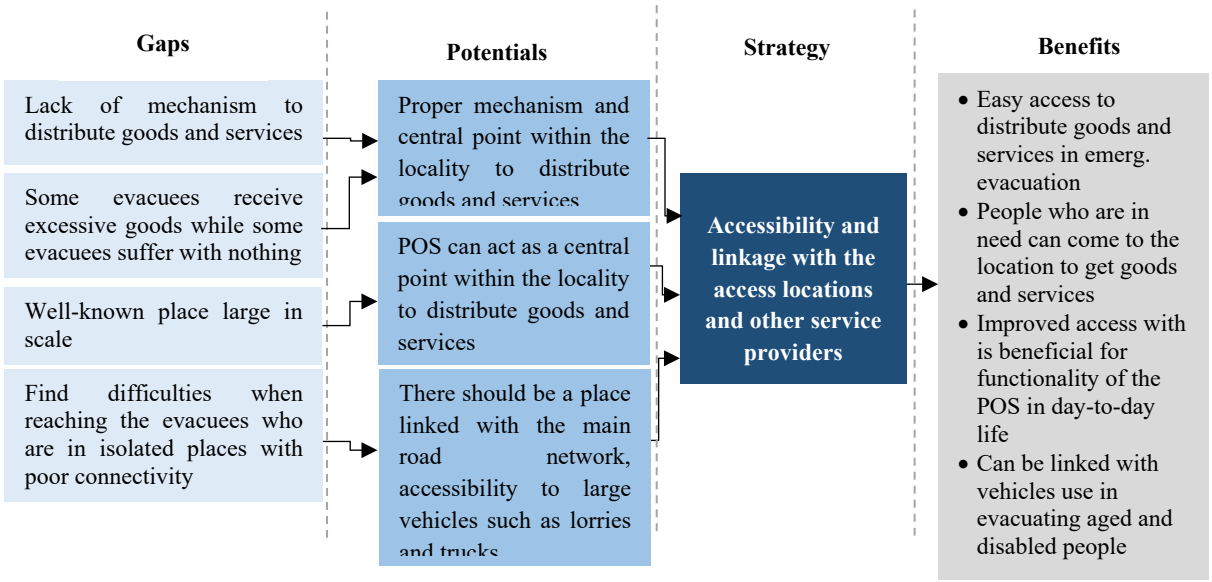


Figure 4.20- Accessibility and linkage with the access locations

In summary, section 4.3 detailed the three main types of POS and the particular strategies which were identified based on the five core categories/principles. Further, it was identified that each type of POS has different potentials towards Tsunami disaster resilience. Furthermore, to achieve the identified potentials, a specific set of strategies were identified. These identified strategies are specific to the relevant type of use of POS.

However, the data analysis revealed that in order to achieve five core principles through three types of POS, there are a set of strategies which are common to all three types of POS. Accordingly, next section; 4.4 presents these general strategies which apply to all three types of POS.

4.4 General Strategies

This section details the strategies which need to be followed by all three types of POS to achieve the five core principles; Tsunami risk zonation guided DRR uses of POS, the terrain and topographic character, Tsunami DRR uses depending on location and size, Networked POS and multipurpose POS. Accordingly, ten general strategies were identified, and the emergence of these ten general strategies will be presented from section 4.4.1 to 4.4.10.

4.4.1 Development of evacuation route network linked with POS

In section 4.2.5, it was introduced that the 'Networking POS can work as a Tsunami DRR passage' as one out of five core principles in planning POS for Tsunami disaster resilience. Further, within this core principle, it was identified that the three types of POS in Tsunami DRR need to be networked together which work as DRR passage.

In contribution to this core principle, this general strategy highlights that to work as a DRR passage, these three types of POS need to be interlinked with the clear and direct road network and need to be linked with local evacuation road network.

However, when developing this evacuation route network, two factors need to be considered in the Sri Lankan context. The first factor is, currently in many parts of coastal cities in Sri Lanka there is a law of having beach access road for every 500 meters along the coast,

Confirming this, Respondent B11 states,

> *"Any development in the beachfront should have an escape path (exit route) for every 500m. This is mainly for beach access, ensure the beach access. This act as an evacuation path. So, this can ensure the recreational use and emergency evacuation as well." (Respondent B11 – Coastal Planner)*

Accordingly, it can be understood that this beach access road is placed mainly with a focus on improving access to the beach. However, this is an added value to start the evacuation road network from the beach, and these straight paths need to be networked with the local evacuation road network and the three types of POS. Introducing straight pathways linking the beach with the local road network and the POS can bring many benefits to the city such as improve access to the beach, facilitate evacuation and control the encroachments.

Highlighting these benefits, Respondent G16 states,

"Then the other concern is the sub-roads. Apart from the main roads, there are secondary and tertiary sub-roads. These roads give access to the beach. In terms of access improvement to the beach, we will develop these sub roads to this pathway. Then will create and improve the pathways with easy access from the beach. At the moment these alleyways are mostly blocked by the encroachments without giving access. ……. So that's why we need to improve all these alleyways catering to the disaster management need... We will use the encroached land as well. Easily accessible road. If we consider the terrain, the elevation here is lower than the here. Because of that within 10m to 15m people can run-up to the higher ground. But if these roads are blocked, the pressure will hit to the main road, and people will be stuck in the middle. That is why it is important to improve these blocked alleyways, connecting to the main pathway." (Respondent G16 – Urban Planner)

Adding to this, Respondent G15 states,

"These are the Tsunami inundated area. So, the maximum extent came was 3.5m in this area, also to this area. So, I opened up entire these Tsunami inundated areas. I even did a model as well… So, the main concept that I used here is the Patric Giddens' windmill pattern system where you can get the sea breeze to the inland. I develop straight paths and open gardens and small gardens connected to get the cool air naturally to the inland. (Respondent G15 – Urban Planner)

In the above statements, Respondents G16 and G15 highlighted several benefits of linking straight pathways with Open Spaces. Improving access, get the cool air to the city through the windmill effect and clear up the evacuation pathways are some of the benefits among them. Apart from that, this networking will further benefit the strategy 'plan for safe evacuation by linking POS with the evacuation road network and linking neighbouring highlands into the design', which was identified in the section 4.3.1.2. For the reason that 'development of evacuation route network linked with POS' ensures the provision of safe evacuation for the people who gathered to the POS.

The second factor which needs to be considered when developing the evacuation route network linked with POS is, this network should promote pedestrian evacuation with improved walkability. The main reason behind this is in Sri Lanka; coastal cities contain high population density. Therefore, if evacuees use vehicles in an evacuation, it will create traffic congestion. Thus, this network linked with POS can promote the pedestrian evacuation rather the vehicles in the evacuation.

Highlighting this point, Respondent C4 states,

"We did an evacuation drill. What they said was at the evacuation time even after 2004 there were several evacuation calls, but people say they experienced a lot of heavy traffic. So, you can expect a lot of traffic along the Galle road. So, people in a panic situation everyone leading to Galle road, this will relate huge traffic anyway people will become vulnerable. There is another issue; they say that along the Galle road there is no separate lane for Lorries and three-wheeler. So, all are in one lane. So, it is going to become a huge task to sort this. For example, even if we have two or three-lane road, there are no spaces for people to move to the inland. But here we do not have that." (Respondent C4 – Sociologist and Disaster resilience expert).

This statement highlighted the risk of using the vehicles in evacuation and the need for promoting pedestrian evacuation. Furthermore, this also highlights the necessity for vertical evacuation where required. Therefore, it was identified that this network needs to be linked with vertical evacuation shelters where necessary. Especially, when there is a higher population density or when there is a long distance to higher grounds. Further, the network should work as a system to evacuate people and to manage the distribution of people towards the right direction which correspondingly links with section 4.3.2.2 on emergency evacuation distribution.

Accordingly, it can be understood that linking beach access roads with the local evacuation network and the POS network can bring multiple benefits to the city. With a DRR focus, linking POS with beach access roads and local evacuation road network benefits to create emergency evacuation passage for evacuees, ability to distribute evacuees towards right direction connected with signboard system and landmark system, promote horizontal evacuation, also can be connected with vertical evacuation shelters where necessary. Apart from the DRR benefits, this network can bring benefits to the functionality of the city with improved connectivity within the city, create straight paths cooling the city, improved accessibility to the POS and so on.

Accordingly, the factors which establish the need for 'Development of evacuation route network linking Beach Access roads and local road network with POS' can be summarised as follows (Figure 4.21).

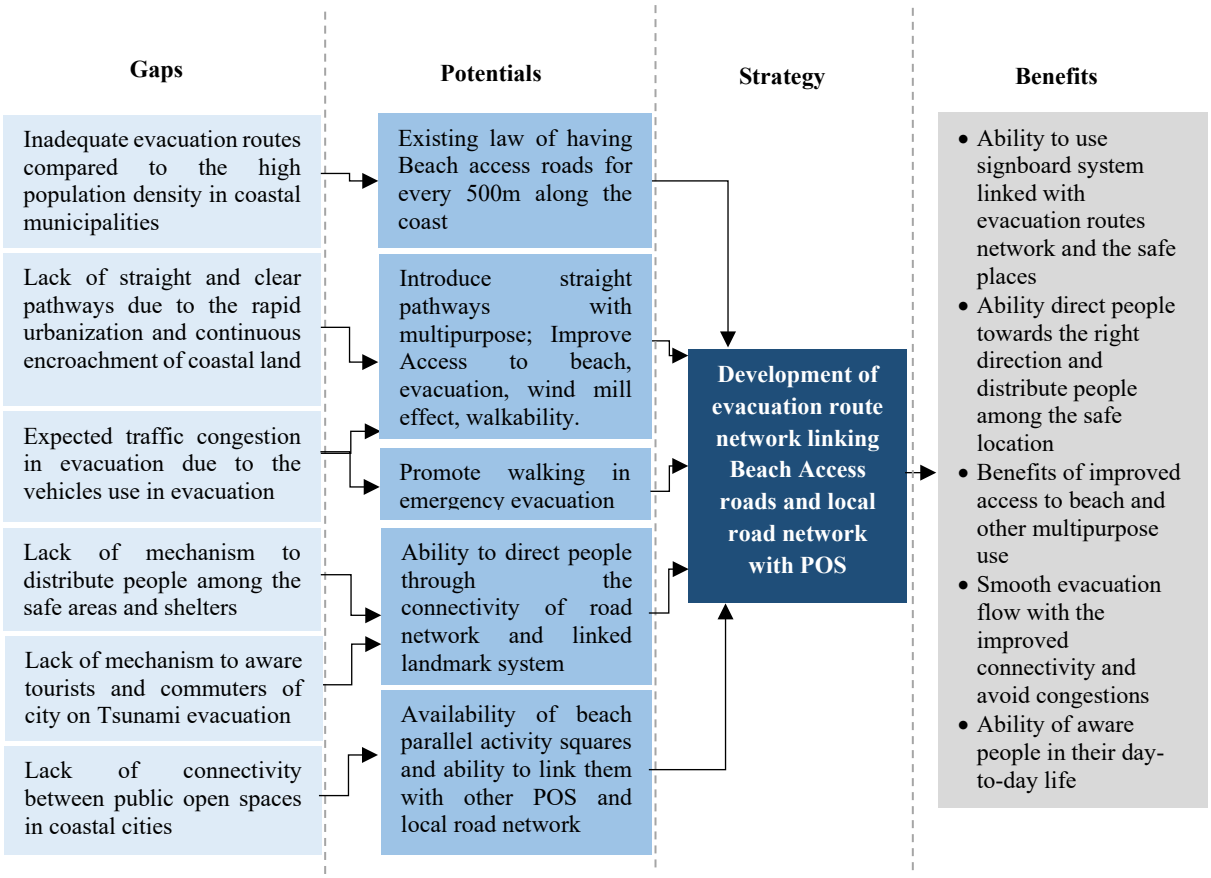


Figure 4.21- Development of evacuation route network linking with POS

4.4.2 Consider natural Human behaviour patterns

Section 4.4.1 presented the need and the benefits of developing an evacuation route network connecting three types of POS with beach access roads and local evacuation road network. Linking with this strategy, this section introduces that when developing this evacuation route network and allocating three types of POS facilitating the emergency evacuation, special consideration need to be given on the natural human behaviour pattern in an emergency.

Accordingly, the analysis identified that one of the most apparent human behaviours is as soon as the warning is issued, people always run towards the inland. Further, when people run towards inland, they always follow the crowd without following the evacuation signs or without searching the shortest direct route.

As an example, the communities who were affected by the 2004 Tsunami revealed as follows.

> *"Then we all ran along the Matara road. We just ran, we did not know either there is hill land or anything. We just ran with the crowd." (Respondent G7 – Community)*

> *"They have just run so far towards inland, and they have told so many other people to run because the sea is coming because we have not heard the word of Tsunami. Then we all went towards the inland and went up to a mountain because we were not sure whether another wave would come or not. Like that, all the people have gone to the inland." (Respondent G11 – Community)*

Likewise, evacuees always follow the crowd towards the inland. The critical factor links with the allocation of POS evacuation network is even though potential POS are located near the coast in a hilly area, people will not use it as an evacuation point if they have to go towards the coast. Evacuees have a fear of going towards the coast even they can reach to that evacuation point quicker than the inland evacuation point.

Highlighting this, Respondent C12 states,

> *"We were informed that we have to come to this temple in an emergency. But this temple is near to the sea. If there is a real Tsunami, we will always run towards far inland rather than coming to this temple. There is a hill more towards the inland. So, if something happens on real grounds, we will go to that place. Because we feel safe there than here. This place is closer to the sea, so people feel fear to come here though these officers inform us to come." (Respondent C12 – Community)*

The statement of Respondent C12 points out that, though these safe locations are identified considering all the Tsunami DM factors, if it is located towards the sea they will not select it as an option for evacuation. This notifies the need for allocating inland POS as a safe location and the evacuation road network towards the inland considering these natural human behaviour pattern of people in an emergency.

Further, another concern of the human behaviour of 'follow the crowd' is possible traffic congestion which can occur primarily along the main roads and at the bottlenecks. Furthermore, this type of blockage increases the risk of increasing mortalities due to the lack of time to evacuate to a safe place after getting through the traffic. This aspect was especially highlighted in a case at Kallady Bridge, Batticaloa as follows.

"Case Example: Kallady Bridge, Batticaloa, Sri Lanka.

Batticaloa has a high-risk of Tsunami. The city was severely affected by the Tsunami that occurred on 26 December 2004 and vulnerability assessments indicate that Tsunami remains a high-risk. During the Tsunami 2004, most of the people who were in Batticaloa coast died as it took a long time to reach to the Kallady bridge, especially People who were in areas such as Mugathuvaaram and Navalady who had long, convoluted paths to reach Kallady Bridge and caused congestion near Kallady Bridge. Hence, the local development plan proposed to establish evacuation routes considering easy accessibility to the safe locations" (Document 01- Development Plan: Batticaloa Development Area)

Figure 4.22- Case Example: Kallady Bridge, Batticaloa, Sri Lanka
Source: Document 01- Development Plan: Batticaloa Development Area

This case example emphasised the need for identifying spatial planning solutions for this type of trapped locations by providing clear and direct evacuation routes. Further consideration needs to be also given whether the Kallady bridge can get bottleneck congestion in the event of an evacuation and if there is a need for the provision of an alternative bridge across the lagoon. Likewise, this type of built environment related solutions need to be considered in development planning. Moreover, when allocation POS network linked with the evacuation road network, these type of possible bottlenecks need to be identified, and safe locations need to be allocated within walking distance.

Another type of human behaviour, specifically relate with emergency evacuation distribution is, in immediate recovery people start searching for their lost ones and once they found they always prefer to stay with the people they know (neighbours).

For instance, communities who were affected by the 2004 Tsunami stated as follows,

> *"After an hour or so people started to come mainly men, searching for their family members." (Respondent G12 – Community)*

"Mainly, when we come to this place all these people we know most of them are our neighbours or from our village. So, we are familiar with the place, so we come to this place." (Respondent C12 – Community)

"We went to school as we are closer to it. But most of the people from Kalladi were in Aanaipandi Kovil. That is a big temple near to Hospital. We were in the Hindu college that night, and we also went to Aanaipandi Kovil because we got to know most of our people is in the temple." (Respondent B1 – Community)

Likewise, in an emergency evacuation distribution and immediate recovery, people start searching for their lost ones and once they found they always prefer to stay with their neighbours. Therefore, when planning 'Inland POS 1' for distribution and 'Inland POS 2' for emergency gathering and sheltering allocation need to be done within the same locality.

Accordingly, the reasons behind the need for the strategy 'Consider natural human behaviour pattern when allocating evacuation routes and POS for safe evacuation' can be presented as follows (Figure 4.23).

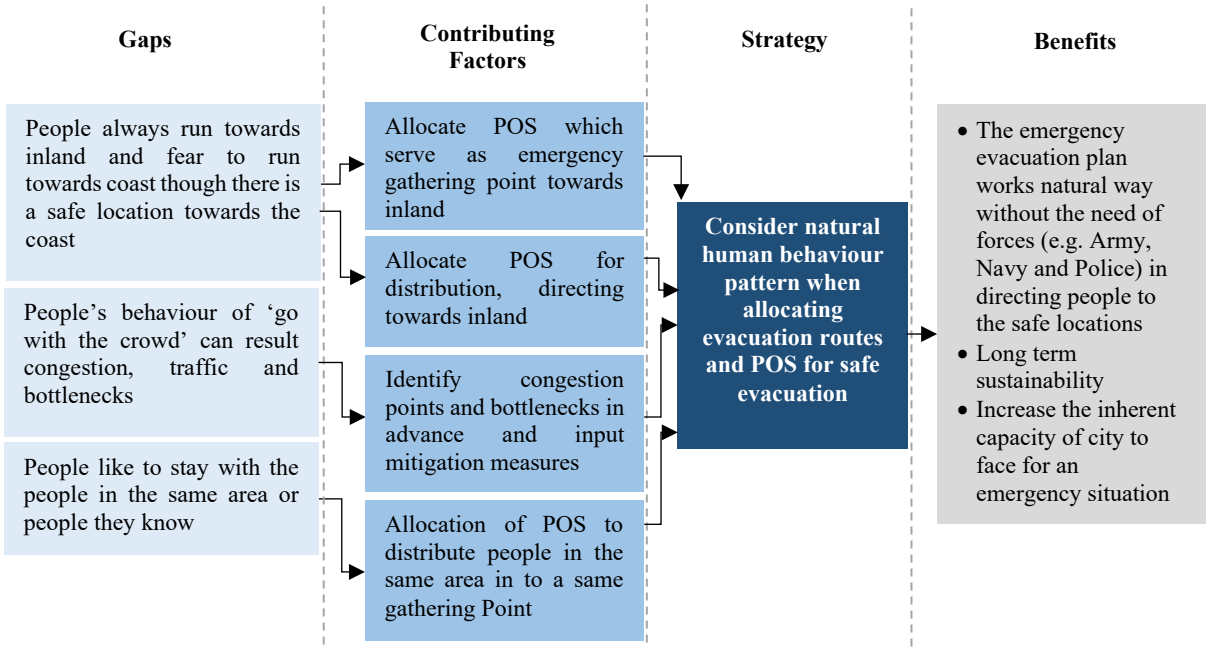


Figure 4.23- Consider natural human behaviour pattern

4.4.3 Economically feasible and socially acceptable

The third general strategy informs that these identified Tsunami DM features of POS need to be economically feasible and socially acceptable within the context. If the DM-related features are not economically viable, it is hard to implement and maintain. If those are not socially acceptable, it is difficult to get community participation and can even lead to social problems.

As an example, the green belt project was introduced to many coastal parts of Sri Lanka to mitigate the Tsunami disaster risk. The primary purpose of this green belt project is to act as a buffer for the Tsunami wave and to slow down the Tsunami wave. However, the implementation of this project to the Batticaloa area caused a social issue due to the type of the tree which was planted as the second layer out of three layers of trees.

Explaining the situation Respondent B11 states,

> *"Green Belt project, there are three layers which act as a buffer for the Tsunami wave to slow down. Different layers of plant first one are with small plants; the second layer is with Casuarina trees especially to answer the disaster side. Casuarina trees are planted by NGOs, but people complain that because of the canopy cover is thick, therefore illegal activities happening around." (Respondent B11 – Coastal Planner)*

This means whatever the introduced strategy and the elements within this strategy, need to be matched to the socio-cultural setting of the area. If not, these strategies will not be sustainable in the long run. Especially, as the study focuses on POS which is used by people in various social status the DM-related strategies need to be socially and economically matched to the context and the socio-cultural setting.

For instance, as an answer to the above-identified green belt project issue, Respondent C5 states,

> *"In a way, any project should match with the nature and the culture of the country. We are a country with a mix of poor people, gangsters. So, any project should be a balance between those things. The social and economic condition of the country. The depth of the trim of the tree may need to narrow or to face to roads like that we can design, and community monitoring system can work." (Respondent C5 – Civil Engineer)*

Likewise, DM-related strategies need to be altered to the context without losing the purpose of it. Further, instead of causing an issue, DM-related strategies should offer multiple benefits to the city which also contribute to the core principle 'multipurpose POS' (Section 4.2.4).

As an example, which brought both DM benefits and economic benefits, Respondent B11 reveals,

> *"Green Belt project, there are three layers which act as a buffer for the Tsunami wave to slow down. Different layers of plant, the first one is with small plants, the second layer is with Casuarina trees … The third layer is with a good height also*

with economic plants like coconut trees to get people participation." (Respondent B11 – Coastal Planner)

Similarly, when the strategies offer multiple benefits specially to the local community, it is easy to get community participation for these projects. Further, when introducing POS for DM purpose, the allocations may differ from the standard allocation criteria alike recreation. As an example, section 4.3.1.1 identified the potential of allocating preserved Tsunami hazard areas into POS with safe evacuation as a strategy while mitigating the risk of Tsunami. However, it was identified that this allocation of POS in beach areas and inland hazard-prone areas possibly cause conflict with other uses, especially the fishery activities along the coast.

Highlighting this point Respondent B16 states,

"Then from the community side, we have to consider the fishery activities. Fishermen say they need to do boat landing inconvenient places; especially they need a certain amount of slope to land the boat, they cannot land everywhere on the beach. So, when we plan open spaces in nice beach areas, the proposal clashes with their boat landing. So, we always try to incorporate that feature in our beach open space plans even though it is not nice on some beach park plans. We do not remove anyway, but we sometimes designate a particular area to land rather than landing everywhere because it is inconvenient to the tourists." (Respondent B16 – Urban Planner)

The discussion above highlights that, rather than limiting the fishery activities, the POS can be designed with a deck to view the fishery activities. In this way, the tourists will be attracted to the place to watch the fishery activities and get the experience. Likewise, the DM-related allocation of the POS and the design need to be socially compatible with the setting with multiple benefits.

Further strengthening this need, Respondent C4 states,

"So, whatever we implement should match with the culture of the people. Especially planners think we plan you better come and stay. But people have a different view and a different lifestyle. So, most of the time people use the features they are not using what we plan. We need to use a people-based or people-centred approach." (Respondent C4 – Sociologist and Disaster resilience expert).

These discussions highlight that Tsunami DM- related features of POS need to be economically and socially acceptable and the contributing factors can be presented as follows (Figure 4.24).

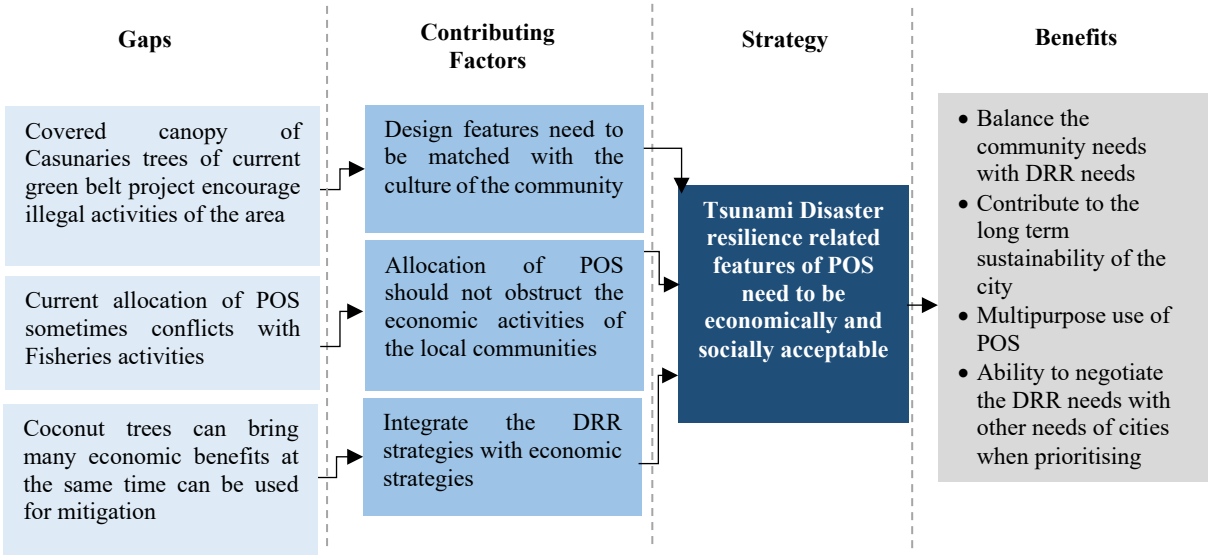


Figure 4.24- Tsunami DM related features need to be economically and socially acceptable

4.4.4 Matching with the current development patterns

The fourth general strategy informs that when planning and designing POS for Tsunami disaster resilience, such allocation needs to be matched with the current development pattern of the context. Notably, in Sri Lanka, most of the coastal cities have a linear/ribbon development pattern which means the development is concentrated along the main road. Therefore, the analysis informed that, due to this pattern of development, limited open spaces are available for Tsunami disaster resilience.

For instance, Respondent C2 states,

> *"When we consider planning point of view, all these cities are on linear development, not like in other countries we do not have the public spaces because of this linear development. One thing is whatever when there is a road going on, a lot of development takes place along that road. Then it is very difficult to develop Public Space." (Respondent C2 – DM Practitioner)*

However, it was also identified that POS have the capacity to bring many benefits for disaster resilience and urban resilience adding recreational, commercial and well-being of the city. Therefore, there is always a need for introducing POS to these cities within the linear/ribbon development pattern.

Respondent G16 brings some examples as follows,

> *"If we get Galle as an example, the main problem in Galle is Flooding. The second main problem is the lack of open spaces……. Because of the linear development*

pattern of the Galle along the Galle road, Galle city has not got many open spaces. … But once the urbanisation triggered and attracted more people to the city, the amount of POS was reduced gradually with the booming development and construction… So, what we thought under urban upgrading, to provide open spaces." (Respondent G16 – Urban Planner)

Accordingly, it can be understood that due to the development pattern some cities have lack of POS, and there is a need for providing additional POS to these cities. Within this context, planning POS for disaster resilience can benefit urban resilience. However, planning POS for disaster resilience needs to be matched with the current development pattern of the area. Otherwise, it will not function well in the long run.

Apart from that, a common issue in cities with linear/ribbon development is traffic congestion which is prevalent even in an average day.

Highlighting this point, C4 states,

"Along the Gale road on a normal day also traffic congestion is there. So, imagine a situation in an emergency. We did an evacuation drill. What they said was at the evacuation time even after 2004 there were several evacuation calls, but people say they experienced a lot of heavy traffic. So, you can expect a lot of traffic along the Galle road. So, people in a panic situation everyone leading to Galle road, this will relate huge traffic anyway people will become vulnerable." (Respondent C4 – Sociologist and Disaster resilience expert).

Accordingly, the vehicular traffic congestion can be possibly expected during evacuation due to the development pattern of most of the cities. Therefore, as it was discussed in section 4.4., the network of POS linking with local evacuation road network should promote the pedestrian evacuation with improved walkability. In relation to this, 'Inland POS 2' which serve as an emergency gathering place can be designed within walking distance matching with the linear development.

The possibility of developing parks within walking distance matching with the linear development can be identified in Hambanthota development plan. Accordingly, Hambanthota development plan proposed linear parks matching with the linear development (Hambanthota MC Development Plan, 2016). Applying this type of method, linear parks parallel to the linear development can facilitate the emergency evacuation to a safer place.

In summary, the emergence of the general strategy 'Allocation of POS needs to be matched with the current development pattern of the city', can be presented as follows (Figure 4.25).

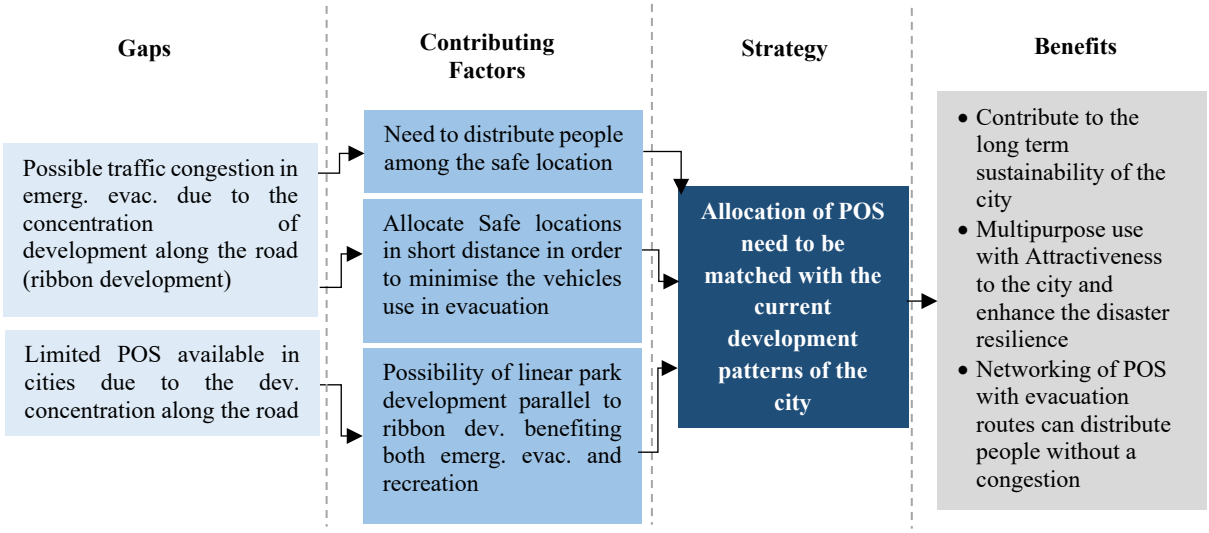


Figure 4.25- Allocation of POS needs to be matched with the development patterns

4.4.5 Mapping incorporating Local Knowledge

Section 4.3 introduced the three types of POS which can contribute to the Tsunami disaster resilience and the characteristics. Further, section 4.4.1 highlighted that these POS need to be networked with the beach access roads and local evacuation road network. In relation to these factors, this particular section highlights the strategy to map these POS and evacuation road network. When implementing both strategies mentioned above to a specific context, firstly evacuation routes and POS with specific characteristics need to be identified within the locality and mapped.

Currently, in Sri Lanka, some coastal areas have not got evacuation maps. Explaining this situation Respondent H2 and B16 state,

> *"In Sri Lanka, there is no system like that. Even in district level we still do not have a proper map." (Respondent H2 – DM Practitioner).*

> *"Also, they are telling that they have prepared the evacuation plan, but we did not see. When we want to have a look at it, they tell that they have it only as a soft copy, but no funds to print and all." (Respondent B16 – Urban Planner).*

The current situation can be further explained using the following statements.

> *"Then we are doing a mapping exercise. We ask them to draw a map they have to identify the safe locations. This is a map which was drawn by the community (showed a map)." (Respondent G1 – DM Practitioner).*

"We normally ask villagers to draw the map for the safe route and safe places through public participation. (Respondent H2 – DM Practitioner).

Accordingly, it can be understood that some districts have not developed evacuation maps and some had developed evacuation maps based on community participatory mapping which means community identify and map the safe locations and evacuation roads.

Further, community participation in mapping evacuation routes and safe places is beneficial in many ways. Since when there are limited funds available on staff allocation on evacuation mapping and fieldwork, this is a more practical solution. Correspondingly, as it was identified in section 4.4.2, when determining the routes and places matching with the natural human behaviour pattern, this participatory mapping provides a better solution. Further, as it was identified in section 4.4.2, sometimes community do not agree with safe places and routes which were selected by officers. Further, allocating safe places and routes without public consultation and ask them to use those routes and places in an emergency is more or less 'manipulation' or 'informing' stages of the Arnstein's Ladder of Citizen Participation (Arnstein, 1969). In community engagement theories it is well-established these non-participation approaches are not successful in planning and designing. Therefore, the community should be empowered in decision making on selecting safe places and routes. Within this terms, if the community engagement needs to be lifted up to 'citizen control' stage of the participation ladder (Arnstein, 1969), at least to the 'partnership' level where the planning and decision-making responsibilities are shared through community engagement. Therefore, in order to improve and maintain the community engagement, community participatory mapping can be identified as the best option when mapping evacuation routes, POS and other safe places.

Nevertheless, in the section 4.3.1.3 on public awareness, it was highlighted that the communities still depend on the last Tsunami experience which was on 2004 without considering the changes occurred during the period from 2004 to present date. Therefore, some of their decisions need to be reviewed by experts and practitioners in the DM field. Further, the selected routes, POS and other safe places need to be scientifically convinced considering the circumstance of most probable Tsunami, population density, inundation mapping and so on. Therefore, it was identified that mapping evacuation routes, POS and other safe places need to be identified integrating both local and scientific knowledge without solely depend on

community mapping. Accordingly, the factors discussed in this section can be summarised as follows (Figure 4.26).

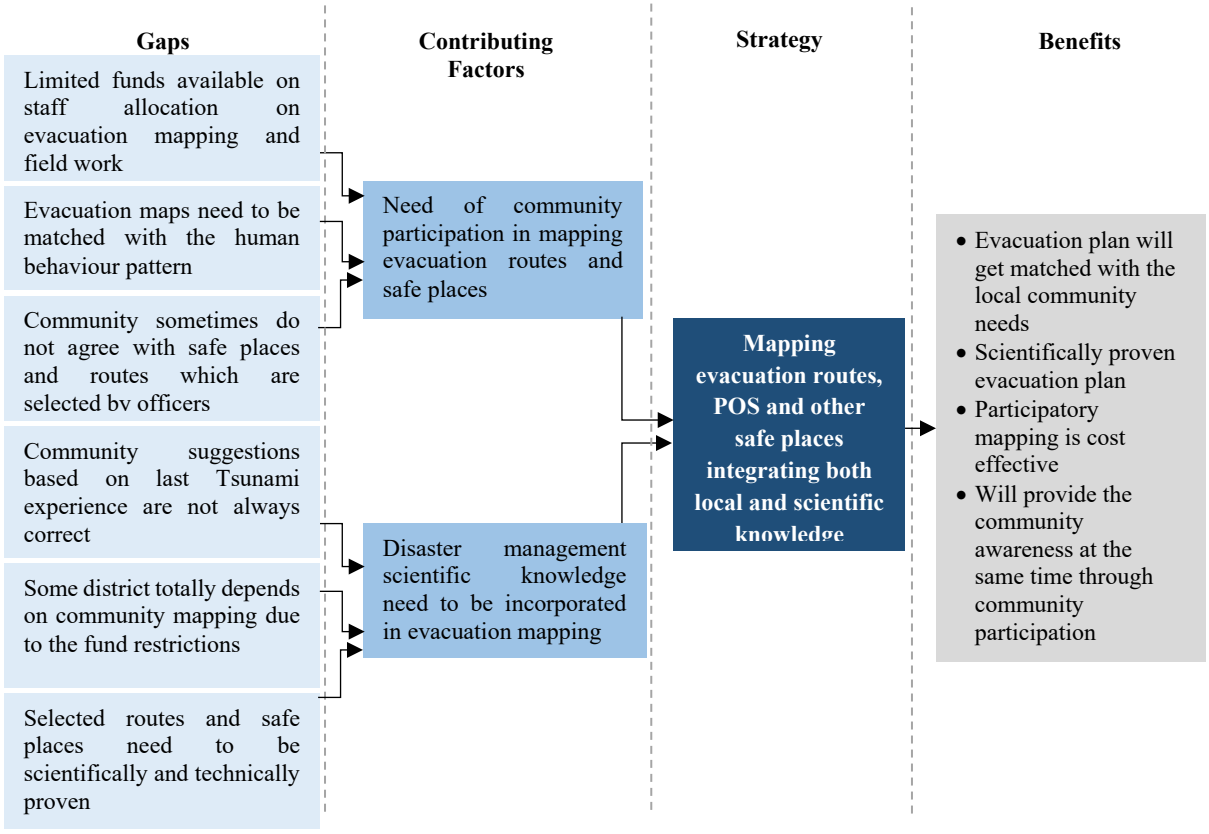


Figure 4.26- Mapping integrating both local and scientific knowledge

4.4.6 Use POS to aware people on local evacuation plans

The sixth general strategy is the 'use of POS to aware people on local evacuation plan by displaying signage and evacuation maps'. This strategy was emerged due to three main reasons.

The first reason is, as it was identified in section 4.3.2.3, the lack of awareness among the tourists and commuters of the city on emergency evacuation routes and the safe locations. Secondly, it was also identified that community drills and other awareness programmes are mostly focused on the residence of the area but not the tourists and commuters. Therefore, findings suggested that without solely depending on mock drills and awareness programmes, alternative methods need to be followed to aware people in their day-to-day life by displaying evacuation maps, information boards and signboards.

> *"Another important thing is mapping this information. We have sent all the information to our map department for mapping in Colombo. But they haven't mapped it yet. But what they have to produce is the map which will be displayed in all the GN divisions." (Respondent G1 – DM Practitioner)*

Above statement highlights that these evacuation maps need to be displayed local level to make aware the public. Further, when placing the evacuation maps, information boards and signboards, need to be placed in places where they spend time mostly. Accordingly, POS in cities and local areas can be identified as one of the most appropriate places where the tourists and commuters spend the time. In this way, POS can be used to provide awareness on the evacuation plan in their day-to-day life of the city dwellers, by displaying the evacuation maps, information boards and signboards at the POS.

Thirdly, as it was identified in section 4.3.1.3, the lack of awareness among the local community on emergency evacuation routes and the safe locations is one of the significant challenges in evacuation planning. It was also identified that this is mainly due to the community's beliefs and issues of current awareness programs. As a solution POS at the local level is a strategic place to aware people in their day-to-day life by displaying the evacuation maps, information boards and signboards at the POS.

Further, this type of strategy can bring many benefits such as cost-effectiveness as after the initial cost there is a minimum cost of maintenance, people get the awareness across anytime any day, unlike other training, ability to use effective signage to aware kids and visual methods for tourists. However, the quality of the display, easy to understand, and attractiveness need to be considered when designing the screens. In summary, the factors behind this strategy can be presented as follows (Figure 4.27).

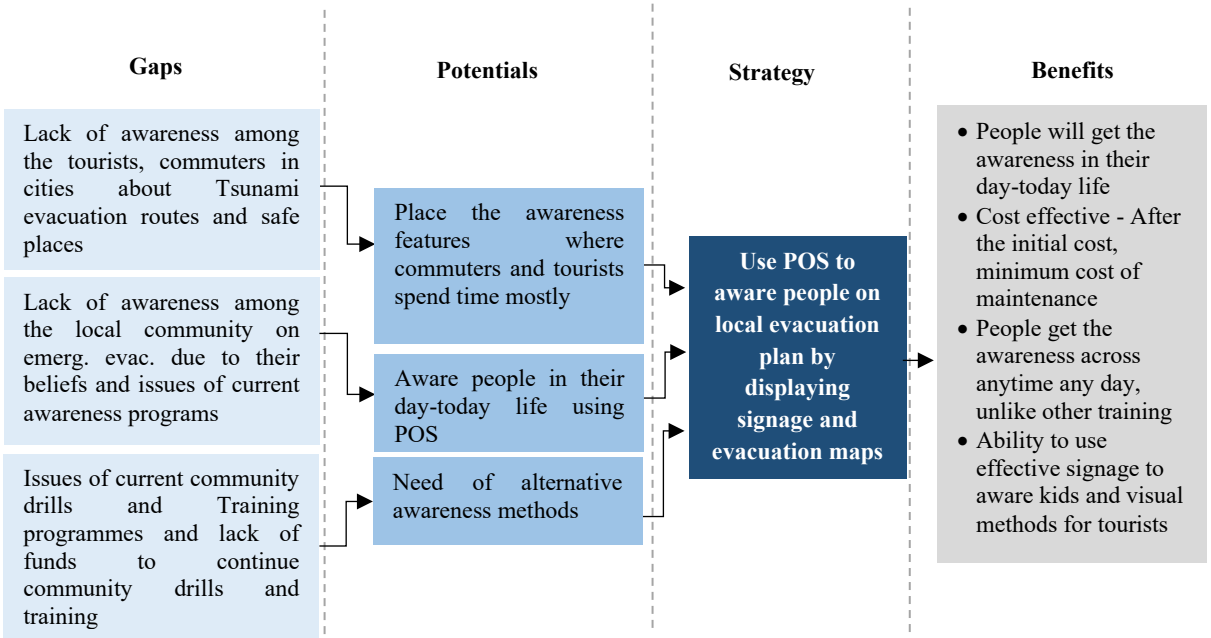


Figure 4.27- Use POS to aware people by displaying signage and evacuation maps

4.4.7 POS network to facilitate the night-time evacuation

The seventh strategy highlight that the network of POS linking the local evacuation road network can facilitate the night-time evacuation. This strategy was identified due to two reasons. The first reason is, the analysis identified that evacuation time at the night time is longer, as there is no proper mechanism to issue the warning call at the night time. Therefore, people take time to get the message and to realise and react to the warning call if it is sleeping time.

For instance, Respondent C4 states,

> *"Especially day time it is ok. How about the night. We do not know we will get the evacuation call. By the time we get the evacuation call, we do know we will have enough time to run to the place. These are the things we have to answer." (Respondent C4 – Sociologist and Disaster resilience expert).*

Therefore, there is a need to ensure rapid evacuation during the night-time. However, when ensuring the rapid evacuation during the night-time, the second reason emphasises that due to the poor lighting and poor visibility in night-time it is challenging to find the ways to the safe shelters during the night-time.

Highlighting this Respondent G12 states,

> *"People who are near to the road only will be in a problem as they have to run long distance. For us also if it comes at night, it can affect us because it is difficult to find the way." (Respondent G12 – Community).*

Accordingly, it can be understood that there should be a nigh time wayfinding strategy. In this instance, the POS network can contribute by using the spatial elements which can facilitate the night time wayfinding strategy through improved physical and visual permeability. Further, to ensure the speed evacuation during the night time and to facilitate the night time wayfinding strategy, the lighting and signage system of the POS network can be used to assist the wayfinding strategy during the night-time evacuation.

Further, this strategy benefits evacuees to find the way quickly during the night time which will ensure the Speed evacuation, ability to work as an interlinked system in the evacuation during the night time and on a typical day, it will ensure the safety at the POS during the night time. In summary, the factors discussed in this section can be summarised as follows (Figure 4.28).

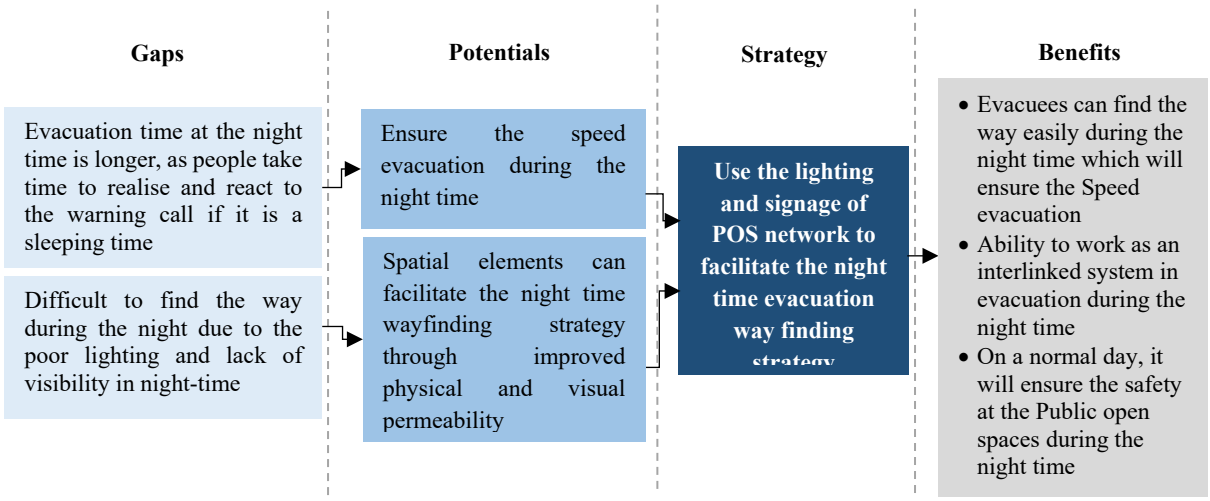


Figure 4.28- Use the lighting and signage to facilitate the night-time evacuation

4.4.8 Link the POS network with vertical evacuation shelters

Generally, there are two methods of evacuation;

1. Horizontal evacuation - moving people to a distant location or higher ground and
2. Vertical evacuation – moving people to high-rise buildings.

Out of these two options, if the higher grounds are available within reachable distance and if the time permits, horizontal evacuation can be considered as the most appropriate option. However, when evacuating a large number of people in the hazard area to safer locations may not be possible due to the inexistence of adequate and reachable higher grounds, limitation of time, infrastructure and mode of transportation.

Most of the coastal urban areas in Sri Lanka, population and building densities are high, in such case vertical evacuation can be considered as the most appropriate option. Though the situation is seen like this from the outside, the data analysis revealed that in Sri Lanka, lack of vertical evacuation shelters available for evacuation and lack of funds to build new vertical evacuation shelters. Further, if the potential buildings are identified as vertical shelters, it is hard to obtain consent from the incumbent to use it as a vertical evacuation shelter.

Further, pointing out the problems of implementing vertical evacuation, Respondent C8 states,

> *"whole the Tsunami shelter idea is a useless idea. Because you are just building a whole structure concrete structure to protect people. You are building two three-storey building for Tsunami shelters and use for other purposes. Sometimes it might*

be useful, but sometimes it will be useless. But if you can come up with a good structure to face Tsunami wave, it is good, but then you have to put that to really good use. For instance, you can use it as a special training centre, community activities. But then the point how many vertical shelters you are going to build which is not practical. So, while not excluding that idea completely it should be treated as an option in combination with another facility." (Respondent C8 – Sociologist and Disaster Resilience Expert)

Above statement highlights that there are a number of issues in implementing and using vertical evacuation shelters in Sri Lanka. Therefore, horizontal evacuation is taken as the most convenient method. However, it was also identified that when there is a higher population density or long distance to higher grounds, the best option is the vertical evacuation shelters. The POS network promotes horizontal evacuation. However, with the identification that in some instances vertical evacuation is the best option, the strategy emerged that the POS evacuation network needs to be linked with vertical evacuation shelters where necessary. The factors which contributed to the emergence of this factor can be presented as follows (Figure 4.29).

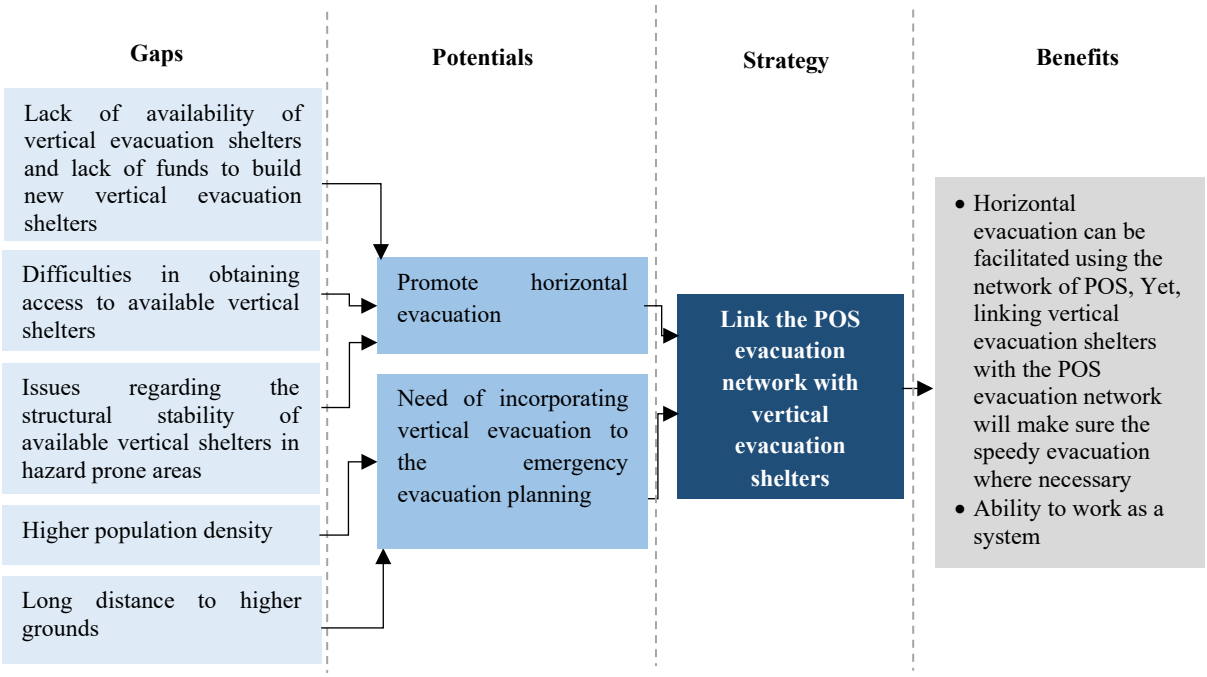


Figure 4.29- Use POS to aware people by displaying signage and evacuation maps

4.4.9 Need for Tsunami signboard systems linked with POS

A sixth general strategy which was introduced in section 4.4.6 identified that these POS are useful to aware people on local evacuation plan by displaying signage and evacuation maps. This was identified due to various awareness issues such as lack of awareness among the

commuters and tourists attracted to coastal cities on Tsunami evacuation routes and safe places, lack of awareness among the local community due to their beliefs and issues of current awareness programmes. Due to these issues, it was identified that by displaying evacuation maps and signboards in POS, people could get the awareness of emergency evacuation in their day-to-day life.

Further supporting this view, Respondent C10 highlighted,

> *"Evacuation signboards in POS- Sometimes when people go there for recreation, and they get some disaster knowledge. Sometimes it depends on the person. Some people will like it. It will register in their mind. It will not matter to them." (Respondent C10– Practitioner in Community-based disaster management)*

Accordingly, it can be understood that placing evacuation signboards is a vital strategy for aware communities in everyday life. Further, it was also identified that beach POS could direct people towards right direction (Section 4.3.1), Inland POS 1 can direct and distribute people in emergency evacuation (Section 4.3.2), and Inland POS 2 will gather people in emergency evacuation (Section 4.3.3). This means that these three types of POS should work as a system linked to each other. Further, in section 4.4.1, it was identified when linking these three types of POS, those need to be interlinked with clear and direct routes plus need to be networked with local evacuation road network. This strategy further confirmed that this POS network should work as a system linked with the local evacuation network.

In order to work this POS network as a system linked to each other, this particular general strategy introduces that this network needs to be reinforced by a Tsunami signboard system connected with the POS network. Accordingly, this signboard system direct people from beach POS towards Inland POS 1 and other evacuation shelters where necessary, then through the signboards Inland POS 1distribute and direct people towards Inland POS 2 and other evacuation shelters where appropriate. This signboard system needs to be also linked with landmark system which was introduced in section 4.3.2.3.

Further, when introducing a signboard system, the major challenge in Sri Lanka is the maintenance. Explaining this situation, Respondent G1 states,

> *"Signs we have already placed. Especially the evacuation routes. But there is a problem, due to the lack of awareness people paste posters on it. One thing is very difficult to maintain those. Initial; putting we have done. But local authorities must maintain them. We do not have the capacity to maintain. But we still we are doing." (Respondent G1– DM Practitioner)*

Likewise, it was identified that it is difficult to maintain these Tsunami evacuation boards in the Sri Lankan context. As Respondent G1 explained, it is mainly due to a lack of awareness of the community. It was identified that sometimes people even remove these signboards, believing that placing these Tsunami evacuation boards in the local area will reduce the value of their properties. Accordingly, giving proper awareness of protecting these signboards is one thing which can be done. Apart from that, placing these signboards in POS will protect those, and public-private partnership can also be potentially incorporated in maintaining the signs. In summary, the factors discussed in this section can be presented as follows (Figure 4.30).

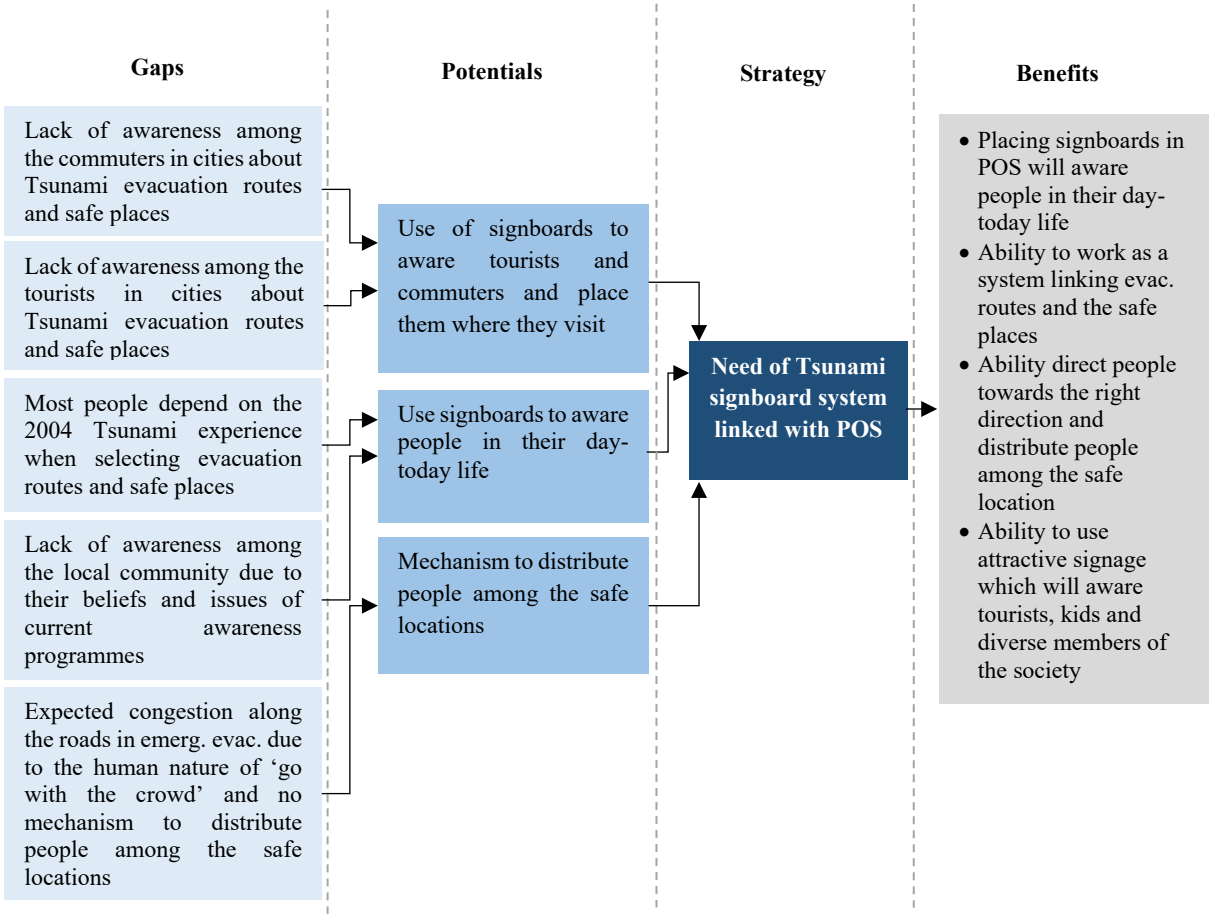


Figure 4.30- Need of Tsunami signboard system linked with POS

4.4.10 Inclusive design

The tenth general strategy is the Inclusive design with a sense of security. The underlying meaning of the term 'Inclusive design' means a design for all or a design which is accessible and usable by all groups of people in the society. Applying this concept to the POS design for Tsunami disaster resilience, such network should facilitate all the groups of people in the community including aged, disables, children and people with special needs. This concept is most suitable to aware of the public and in an emergency evacuation.

Relating the need for inclusive design to emergency evacuation, Respondent C4 states,

> *"Not only that for example in Sri Lanka a person who is suffering from cancer, he is not disabled, but he cannot run far. So many things we need to think about. Depending on the time if it is a working day children school are vulnerable. Then you need more time. It is very vital for us to do a vulnerability assessment before doing any plan or strategic plan. Then we know what the minimum time is and how to put strategies. Otherwise, you can go to an open space, and you can say this is the place you should run. But do we have an idea where and how vulnerable people? Do we have a network first these people need to be evacuated? Then these people like that. Because most of the people who are old need help. Do we have a map like vulnerability map? Do we have a strategy what time will take to evacuate these people?" (Respondent C4 – Sociologist and Disaster resilience expert).*

Above statement points out the need for facilitating the POS network linked with the local network for all categories of people. Especially, when calculation the time for evacuation and when allocating routes these measures need to be taken into consideration. As Respondent C4 suggested vulnerability mapping before identification of safe places and routes can be a possible solution. However, these vulnerability mapping data may change with the time and need to be updated with the time. Therefore, the average indicator needs to be implemented considering a most probable situation.

Within the emergency evacuation plan, emergency evacuation distribution was identified as an essential factor in section 4.3.2.2. Further, in this section, it was identified that Inland POS 1 as a distribution place could provide initial gathering place especially for disabled and aged people around and then need to be well linked with the road network to use the vehicles in transportation. Likewise, inclusive design strategies need to be included with special consideration on people with needs. Apart from the emergency evacuation distribution, emergency gathering, and temporary sheltering is another essential aspect of inclusive design. Because in an emergency, all the categories of people are gathered to one place including the above-identified people with needs. In such instance, especially the 'Inland POS 2' which cater the emergency gathering and temporary sheltering should be planned and designed considering the needs of all categories of people.

Accessibility to the POS is one crucial factor which applies to all three types of POS. As Respondent G1 points out,

"Whether disabled people can have access to there. That is also a major consideration." (Respondent G1– DM Practitioner)

Therefore, when providing accessibility to the POS, inclusive design considerations need to be given. This is well beneficial for the everyday use of the POS as well. Apart from the accessibility, the facilities available in the place, especially in 'Inland POS 2' is important. Highlighting this, Respondent H2 points out,

"No there are now places that we have identified. In future, these identified places need to be developed. That is the main thing that needs to happen. Because society is consisting of a variety of people including children, pregnant mothers aged people. So, until they settle down in their places, we should be able to keep them. That is the main problem with the facilities." (Respondent G1– DM Practitioner)

Therefore, when 'Inland POS 2' is designed to provide basic services and facilities (Section 4.3.3.2), inclusive design consideration needs to be placed. As an example, in the section 4.3.3.2, it was identified that when 'Inland POS 2' operate within the immediate recovery period, it can offer a child play area to restore the children's mental health. Accordingly, it was identified that child play areas need to be included within the design of 'Inland POS 2' catering the day-to-day functionality of the space plus to operate during the immediate recovery period.

Likewise, these types of inclusive design strategies need to be included and considered in all stages, especially when designing the signboards, lightening and signage to find the way during the night time and so on. Accordingly, the factors discussed in this section can be summarised as follows (Figure 4.31).

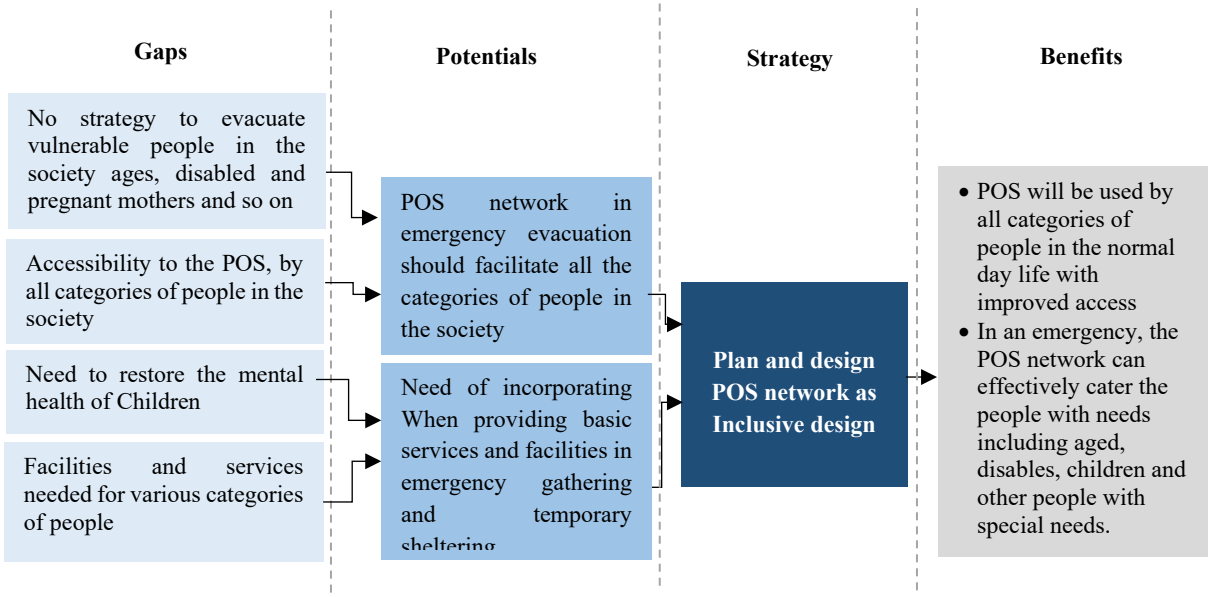


Figure 4.31- Inclusive Design

In summary of section 4.4, ten general strategies were introduced which are common to all three types of POS. Accordingly, the next section; 4.5 presents the sub findings of this research.

4.5 Additional Findings

The results which were presented up to now, including five core principles (Section 4.2), three types of POS and the specific strategies (Section 4.3) and general strategies (Section 4.4) can be identified as the key findings of the research which has emerged from the selective coding. However, when delimiting the final theory in selective coding, a set of categories were eliminated from the core findings.

The main reason for the elimination was that those categories have no direct relationship with the core findings, which means not directly related 'to plan and design POS as a strategy to enhance coastal cities resilience to Tsunamis'. However, after further examination, it was noted that most of these findings present the institutional and procedural challenges of implementing the key findings to the Sri Lankan coastal context. Further, it was also noticed that these types of problems are more common to any DM project in coastal areas, Sri Lanka. Therefore, as these challenges are not directly related to the key findings and common to most of the other DM project, the researcher decided to present these findings as additional findings of the research.

Accordingly, additional findings can be divided into two main categories; institutional challenges and procedural challenges which will be presented in the next two sections; 4.5.1 and 4.5.2.

4.5.1 Institutional Challenges

This section presents the institutional challenges which can arise when planning and designing POS for Tsunami disaster resilience in Sri Lanka. However, there can be other challenges apart from the challenges listed down in this section. Nevertheless, as the focus of this research is not to identify the institutional challenges of implementation, but to find out the strategies to plan and design POS for Tsunami disaster resilience, the researcher did not put further attempt to find all possible institutional challenges. Accordingly, the institutional challenges which were identified as a sub-finding of the research can be listed down as follows.

- Institutions are reluctant to follow DM strategies when it is not regularised; they take it as optional and never follow.

- Difficult to coordinate the DM-related institutions with Urban development-related institutions
- Deviance of responsibilities between the organisations
- Inactive district and local institutions
- Institutional coordination when providing basic services and facilities
- Limited funds – to initiate, to provide essential services and facilities
- Communication between the institutions
- Need for leadership in developing this type of framework
- Need for Public-private partnership due to the lack of capacities of local institutions
- Lack of willingness of institutions to contribute to the implementation
- Overlapping responsibilities
- Coordination is time-consuming and delaying the actions
- Less active in taking actions prior to a disaster (intense only when disaster aftermath)

4.5.2 Procedural challenges

This section introduces the procedural challenges which can arise when planning and designing POS for Tsunami disaster resilience in Sri Lanka. However, as it was discussed in section 4.5.2, there can be other challenges apart from the challenges listed down in this section. Nevertheless, as the focus of this research is not to identify the procedural challenges of implementation, but to find out the strategies to plan and design POS for Tsunami disaster resilience, the researcher did not put further attempt to find all possible procedural challenges of implementation. Accordingly, the procedural challenges which were identified as a sub-finding of the research can be listed down as follows.

- Ownership related issues as the coastal area are owned by different Government organisations (CCD, Environment ministry, tourism, UDA)
- Absence of clear guidance and lack of a mechanism to put DM related strategies to practice
- DM inputs are not prioritised in urban development, therefore limited budget allocation
- Sensitisation the politicians about the value of implementation
- Political involvement in urban development
- A lengthy procedure of implementation of urban plans, some plans even not get implemented
- Weak points in the current planning approval system and planning control

- Lack of database management and data availability

4.6 Framework Incorporating the Findings

This chapter first introduced the five core principles (Section 4.2) for planning and designing POS for Tsunami disaster resilience. These five core principles work as the underline mechanism to all the other identified strategies. Subsequently, Section 4.3 presented the three types of POS and the specific strategies which were identified based on the core principles. Further, Section 4.4 introduced the ten general strategies which are common to all three types of POS, correspondingly fulfilling the needs of underline core principles. Furthermore, section 4.5 presented the additional findings of the researcher which were eliminated from the central theory at the selective coding.

Accordingly, these five core principles, three types of POS, specific strategies and general strategies can be identified as the key findings of the research towards the development of the final theory. In summary, these key findings before the validation can be presented as follows (Figure 32).

Core Principles	Three main types of POS	Characteristics	DRR Potentials	Specific Strategies	General Strategies
Risk Zonation guide the places for Public open spaces and the benefits involved	**Beach POS for Mitigation and Emergency Evacuation directing place**	✓ Located within the Beach area ✓ Tsunami High-risk zone ✓ Flat Terrain ✓ Large or small scale	Mitigate the Tsunami Disaster Risk	- Allocate preserved Tsunami hazard areas into POS with safety measures - Minimum physical dev. and use of natural features protecting mitigatory measures - Use design features and orientation of the POS to slow down and regulate the wave	- Development of evacuation route network linking Beach Access roads and local road network with POS - Consider natural human behaviour patterns when allocating evacuation routes and POS for safe evacuation - Tsunami Disaster resilience related features need to be economically feasible and socially acceptable - Allocation of POS need to be matched with the current development patterns of the city - Mapping evacuation routes and POS for safe evacuation in-cooperating the local knowledge through participatory mapping - Use POS to aware people on local evacuation plan by displaying signage and evacuation maps - Use the lighting and signage of POS network to facilitate the night time evacuation way finding strategy - Link the POS network with vertical evacuation shelters - Need of Tsunami signboard systems linked with POS - Plan and design POS network as inclusive design
			Direct the Emergency Evacuation	- Plan for safe evacuation by linking POS with evacuation road network and linking neighbouring highlands
			Provide Public Awareness	- Use design features to remind Tsunami and importance of being pro-active - Display mitigation related features
Terrain quality and the **Topographic characters** guide the Tsunami DRR uses of POS	**Inland POS for Mitigation and Emerg. Evacuation directing and distribution place**	✓ Located inland ✓ Yet within Tsunami risk zone ✓ Flat Terrain ✓ Large or small scale	Mitigate the Tsunami Disaster Risk	- Use design features and orientation of POS to slow down and regulate the wave
			Use Large scale POS for Emergency Evacuation Distribution	- Plan for safe evacuation by linking POS with evac. road network and linking neighbouring highlands in to the design - Use POS as a distribution place with improved access to use vehicles in evac.
Different Public Open spaces have different uses for Tsunami DRR depending on the **location and size**			Use Small scale POS for Emergency Evacuation Directing point and for public awareness	- Plan for safe evacuation by linking POS with evacuation road network and linking neighbouring highlands in to the design - Direct people through a landmark system and use design features as landmarks
Multipurpose Public Open spaces	**Inland POS for Emergency evacuation gathering place and Temporary sheltering**	✓ Located inland ✓ Out of the Tsunami risk zone or on elevated platform ✓ Mountainous Terrain ✓ Large scale	Use as a place for emerg. gathering and temporary sheltering	- Minimum physical development and designed as a loose space
Networking Public open spaces work as a DRR passage			Provide basic, services and facilities in emergency response	- Facilitate the provision of basic services and facilities - Plan community centres/community halls linked with POS
			Use as a place to distribute goods and services	- Accessibility and linkage with the access locations and other service providers

Figure 4.32- Framework incorporating the Findings

4.6 Validation of the Findings

Up to now, this chapter presented the emergence of the findings through the integration of categories, sub-categories and properties (Sections 4.1 to 4.4). Further, section 4.5 introduced the additional findings which were eliminated from the core findings. Accordingly, the next step is to validate the results. As it was discussed in section 3.11.1, the validity of the research is confirmed on four factors; triangulation, grounded data, respondent validation and external validation. Out of these four factors, triangulation and grounded data were already discussed in detail in sections 3.11.1.1 and 3.11.1.2. Accordingly, this section presents the results of respondent validation and external validation.

4.6.1 Results of Respondent Validation

The need for respondent validation and the benefits involved were already discussed in section 3.11.1.3. Though it is more accurate if the findings can be validated by all the respondents, Walliman (2011) points out that it is not practical to let all the participants edit the research findings which could cause a long delay to the process. Therefore, considering the time limitation and the practicality, the researcher presented the analysis and findings to two Respondents; C1 - Urban Planning Practitioner and C4 - Sociologist and Disaster resilience expert (in Table 3.4) to validate the results.

Accordingly, both Respondents commented that it is interesting how the findings were derived through the analysis process. Further, both Respondents viewed the results of the study (Figure 4.32) and the visual interpretation (Figure 4.6) and commented that the overall concept is significantly valuable to the Sri Lankan context. Further, one of the major comments which was derived from both Respondents is that this POS network would be a new system to coastal cities. However, they pointed out that this should not interrupt the current system of the city or social activities.

Pointing this out, Respondent C4 emphasises,

> *"If we get Beaches, that is mainly focused on Tourist so you should not interrupt their use of it with DRR intervention. As a planner, you find the space and plan for this purpose. But people already use it as a place. So how can you bridge the gap? So how people perceive this new system is a question. So the minimum interruption to the current pattern of the city." (Respondent C4 – Sociologist and Disaster resilience expert)*

Accordingly, the researcher with her experience in the urban planning field viewed that this comment is an integral part of the general strategy 4.4.3-Tsunami DM-related features need to be economically and socially acceptable' and 4.4.4- Allocation of POS need to be matched with the current development pattern of the city. Apart from that, as both Respondents pointed out there is a need for matching with the current socio-cultural setting,

For instance, Respondent C1 states,

> *"Another thing is people should be trained in this new system. We can design whatever the route but we should check whether people actually use this route. We know that coastal community is a poor category. After a few years, these Open spaces result to create a change to the area." (Respondent C1 – Urban planning Practitioner)*

Answering this need, the general strategy 4.4.3-Tsunami DM-related features need to be economically and socially acceptable' was changed to 'Tsunami disaster resilience features need to be matched with the socio-cultural setting of the area and promote economic activities of the city'. Further, the general strategy 'Allocation of POS needs to be matched with the current development pattern of the city' (Section 4.4.4) can further make sure this need for positive intervention to the current system of the city.

4.6.2 Results of External Validation

The justification and the benefits of occupying external validation in this study were already discussed in section 3.11.1.4. Accordingly, this section explains how the external validation was carried out and the results. External validation is defined as the 'transferability of the concept to the wider environment' (Murphy & Yielder, 2010). With this view, the transferability of the research findings to the broader context within Sri Lanka was checked by interviewing experts in the field. Following table (Table 4.3) presents the list of experts who were interviewed for the external validation.

Expert No.	Description
E1	Civil engineering and disaster resilience expert
E2	Architect and urban design expert
E3	Higher-level officer of a government authority related to DM
E4	Environmental planning and urban planning expert

Table 4.3- List of experts- External Validation

Accordingly, the research framework (Figure 4.32) and the visual illustration (Figure 4.6) was presented to each expert, and their comments and views on each element of the framework were critically evaluated. The evaluation of expert's comments is done based on the key elements of the framework; five core principles, three types of POS, specific strategies and general strategies. The results are presented in the following three sections 4.6.2.1, 4.6.2.2 and 4.6.2.3.

4.6.2.1 Validation of the Five Core Principles

Firstly, the need for five core principles and how these five core principles guide the whole framework was presented to the experts. All expert agreed on the necessity and the importance of these five core principles. Further, E1 emphasised there are overlaps between these core principles, especially between risk zonation, terrain, location and size. However, as these are key elements of the framework and to make sure to not to miss any of the features, E1 suggested that it is better to keep them separate. Apart from that, E1 and E3 pointed out that testing/applying the first three core principles; risk zonation, terrain, location and size, to Sri Lanka will be challenging due to the lack of data availability.

For instance, E1 states,

> *"We have to go through with available data right. In Sri Lanka it is very difficult to zone them; we do not have data. It is just a very vague way of demarcation. If we get other developed countries like Japan, they have a vulnerability, risk and exposure mapping. But in Sri Lanka, we have the only case by case data but not an overall agreement on Tsunami risk zonation. So when you apply this to SL, data availability on risk zonation will be the main challenge." (Respondent E1)*

However, both E1 and E3 agreed that it is not an impossible task. Nonetheless, a lot of background study will have to take place to select POS based on these core principles due to the limited data availability.

Another major point which E1, E2 and E3 pointed out was the land availability. According to them, the selection of land-based on these five core principles will be difficult for the reason that the available land due to the high population density in Sri Lanka is limited. Further, these experts valued that for Beach POS and Inland POS 1, any size POS can be used which leave the flexibility of using all the parks within the city. However, they questioned that finding large scale POS for Inland POS 2 will be a problem in the coastal cities context in Sri Lanka due the limited land availability. Considering this point, the researcher checked the existing regulatory framework in Sri Lanka, and this search confirmed that as per the UDA law on PORS- Public

Outdoor Recreation Space it is recommended to have 'a minimum standard of 1.4 ha. (3.5 acres) Land per 1000 persons to be allocated for public outdoor recreation'(UDA, 2018). This confirms that if the population density is high, there is a need for allocation more land as open spaces. Accordingly, together with this regulatory requirement either new POS can be allocated or existing POS distributed within the area can be considered at the implementation stage of this framework.

Further, E1 asked the reason for using the term 'Terrain quality and the Topographic characters', and researcher answered the reasons with an explanation in figure 4.2. E1 particularly commented that the term 'terrain quality' can misinterpret the reader especially him as he is from a civil engineering background and 'terrain character' certainly covers the researcher's idea. After evaluating this comment critically, the researcher decided to change the term 'Terrain quality and the topographic characters' to ''Terrain and topographic character' which represent the same meaning as before to make it more clear to the reader.

In summary, the validation of the five core principles was done by establishing the five core principles at the core of the theory with the minor change of the term 'Terrain quality and the topographic characters' to ''Terrain and topographic character'.

4.6.2.2 Validation of the Three types of POS and Strategies

At the discussion on three types of POS, all experts viewed that the connection between the core principles and the three types of POS is stimulating. In particular, E2 observed that incorporating exiting POS in beach areas to this framework is easier as those are anyhow located within the coastal reservation. However, E2 pointed out that incorporating existing inland open spaces to the category of inland POS 1 and inland POS 2 will be complicated as currently most of the POS in cities are located near to the main road and depending on the road network, without considering the other factors such as scale and disaster resilience.

Explaining this E2 states,

> *"However, according to that UDA guideline priority for PORS is mainly given on the accessibility which means it should be proximity to the main road. Beach is because of the reservation. It's ok. Most of the open spaces in SL are secured because of the reservation. …. Apart from these open spaces, all the other POS in your case inland POS are coming with the road. Accessibility is the main factor. …. when it comes to inland, connection with the main road or accessibility is the main concern. So how to develop that connection is the problem." (Respondent E2)*

However, the researcher views this point as an advantage rather than a challenge, for the reason that POS in an isolated location which is allocated for Tsunami will not anyway function well in the long run. Therefore, these multipurpose POS need to be well linked with the public footfall or the road network of the city. Therefore, as it was discussed in section 4.4.1, accessibility improvement is one of the significant concerns to these POS and if it is already provided, it is an advantage.

Nevertheless, the most important thing is the continuations of these different types of POS to work as a DRR passage (Section 4.2.5). Answering to this, the specific strategy; 'use POS to direct people through a landmark system and use design features as landmarks' (Section 4.3.2.3) can make sure the continuation of this POS network together with the linkage of the direct evacuation road network. However, having reference to this specific strategy, E4 points out that according to the human psychology in an emergency evacuation, evacuees always run to a place with direct visibility therefore visual permeability is the most important thing apart from the physical permeability. Accordingly, the researcher recognised that inclusion of this factor; permeability improvement together with the landmark system can further strengthen the framework and answer the point which E2 raised on the continuation of the DRR passage. Further, this strategy is identified as a specific strategy of Beach POS and Inland POS 1. However, with the identification of the importance of this strategy to all three types of POS, this strategy is moved to the general strategy which means applicable and common to all three types of POS.

Apart from the above-discussed factors, all the experts gave special attention to Inland POS 2, because of its' DRR potentials to use as an emergency evacuation gathering place and temporary sheltering, provide essential services and facilities in emergency response and a place to distribute goods and services. Accordingly, E3 highlighted that having a place to distribute goods and services is a valuable strategy in this framework as currently, in Sri Lanka there is no allocated place or mechanism to distribute goods and services.

Pointing this out, E3 states,

> *"Another thing is there is no proper mechanism for goods distribution. One time in Floods we used helicopters to throw goods to the areas, but people fought for these goods, and people even got injured. In that sense this strategy is good," (Respondent E3)*

Further, E2 emphasised the importance of the specific strategy 'minimum physical development and designed as a loose space' as follows.

> *"There may be trees and all but not for flexibility use. Not loose fit. The new trend is that with three concepts which include loose fit, low energy and another one. Though there was typology use before, now it is going towards the loose fit. So, Flexible design is the most important thing here." (Respondent E2)*

Apart from that, E3 raised a practical issue of using open spaces for public gathering and temporary sheltering in Sri Lankan context which is the adverse effects of using single space by different people in different social stratus and socio-cultural backgrounds.

As E3 states,

> *"If we get the social stratification in the coastal area. Near to the coast, fishery community life which is the poor category. Then alongside the main road, the business community live, then towards the inland middle income, and then high-income people live. So, if we move all the people from these four different social stratus, can they gather and live in one place even for an immediate recovery period. Especially, the culture of the fishery community is completely different which do not match with others." (Respondent E3)*

However, together with the above point, it should also be noted that provision of separate safe locations as per the social division should not be a solution considering the factors such as social equity, social integration and cohesion. Nonetheless, the critical point that can be gathered from E3's statement is there may be cultural groups, ethnic groups or religious groups who have special needs and requirements. In such cases, provision of space within the 'Inland POS 2', for that particular requirement is needed within this framework. As an example, religious space for the Islamic community. Accordingly, after the critical evaluation of views of the other experts, the researcher connected that E4 suggests a strategy as an answer to the above-identified requirement.

E4 suggests,

> *"My other concern is why this Inland POS 2 is only for large scale. (researcher mentioned the purpose of large public gathering and temporary sheltering.) There is something like this. We can create subspaces, well within the large space, we can create subspaces. I engage with the Alapatha Landslides. So in that study, we had multicultural groups. So how can we design subspaces for these multicultural groups; estate community, Islamic community needs are different. Therefore, there may be a need for different cultural groups. Therefore, within this large space, we can get it as a positive point the ability to divide the large space into subspaces according to the need." (Respondent E4)*

As E4 suggests, the large scale Inland POS 2 can be designed into subspaces as per the requirements of the socio-cultural needs. In this way, the point which E3 raised can be

addressed by minimising the social issues which may arise when using one space by different groups of people. Apart from that, the researcher identified that this creation of subspaces could also be used for the provision of logistic needs; medical needs, goods distribution needs and so on. Accordingly, provision of subspaces as per the logistic requirements and socio-cultural needs in immediate recovery can be identified as a specific strategy when using Inland POS 2 as an emergency evacuation gathering place and a place for temporary sheltering.

Apart from the above-identified factors, E1 and E3 highlighted that regardless of whatever the strategy implemented, maintenance of these strategies is a significant issue in Sri Lanka. This even applies to the strategies suggested in this framework. As an example, E3 with his experience as a practitioner in the DM field emphasised that they do not have a mechanism to maintain the Tsunami signboards. Therefore, this applies to the signboard system which this framework is proposing (Section 4.4.9). Thus, he states there should be the attitudinal change among the general public plus there should be a particular institutional body to maintain these elements attached to the POS network. However, answering this issue of maintenance, E4 suggests that implementation of strategies maximising the multiple stakeholder interests is the best method to maintain these strategies. By optimizing the multiple stakeholder interests, multiple stakeholder involvement can be ensured which result in the long term maintenance of these strategies.

E4 explains,

> *"Mainly maintenance of this system is the concern, but by covering the multiple stakeholder interests within the project, we can achieve that. As an example, you propose natural vegetation as a mitigatory strategy. Mangroves can be good physical intervention. We can promote mangroves where they do not exist. Use natural features can cover this. Together with this, we can incorporate the other strategies such as increase the bio-diversity. If we include these types of strategies, we can incorporate other stakeholders such as the wildlife department or forest department to these projects. So, maximum stakeholder participation affects the successfulness of the project. So, with that view, we can include bio-diversity improvement. Then with the vegetation, we can promote vegetation which has economic value." (Respondent E4)*

E4 further brings some examples from a project which they did for the Batticaloa coast, Sri Lanka,

> *"We did a green belt project to Batticaloa. The community does not like Casoonary trees, but when we say coconut trees, they were so happy as we told that they could be given five trees from the beach to each family. Then they take care of it. Then we*

can do a vegetation mix, and we can ask them to take care of these few trees as well together with the coconut trees. So the community take ownership of the project, and we can maximise the community participation in these projects by showing the economic benefit to them." (Respondent E4)

Accordingly, it can be understood that 'Introduce strategies maximising the multiple stakeholder interests' is an effective strategy which ensures the successful implementation and long term maintenance of these Tsunami DRR focused strategies. With this reasoning, 'Introduce the strategies maximising the multiple stakeholder interests' was identified as a general strategy which applies to all three types of POS.

In summary, the validation of the three types of POS, specific strategies and general strategies was completed together with the identification of some alterations to the framework. These alterations are listed at the end of section 4.6.2.

4.6.2.3 General comments for the overall validation of the framework

Apart from the specific comments on the framework which were discussed throughout the sections 4.6.2.1 and 4.6.2.2, the experts of the external validation gave general comments to the overall concept. Accordingly, this section presents these general comments for the overall validation of the framework.

After the critical evaluation of the general comments, it was identified that all the experts have viewed the proposed framework and the concept behind it, as valuable and required to the present-day context of the city due to three main reasons. As E1 and E4 highlighted, the first reason is that this framework has a holistic view of the city as a system.

For instance, E1 states,

"This is a very good concept. Because, in Japan, we do have multi-function open spaces, they have tennis courts and all, during the Flood it works as a Flood retention zone. But they are not looking like this, especially, for Tsunami from a holistic perspective like this. But they consider each open space kind of an isolated manner but not like this considering the whole city perspective." (Respondent E1)

Secondly, E1, E2 and E3 view this as a timely study because currently, Sri Lanka is facing many challenges in developing a proper emergency evacuation system with identified shelters linked with the evacuation road network. The current methods identify mostly, schools and religious places which have many issues when using them in a practical situation. If these identified places are used for the emergency, it will affect the day-to-day functions of the schools and religious places, whereas usage of POS network will have a minimum disturbance

to the essential services of the city. Accordingly, minimum interference to other systems can be identified as the third advantage of this framework.

Summarising these points, E1 states,

> *"This is very valuable and timely study. But you should think about the ways to implement. Timely because we don't have this. If we get the schools which is the current method, we are disturbing another system. So can we propose this method as a method with minimal disturbance to normal functions of a city? That may be a justification, that is where I see the need of this study." (Respondent E1)*

Apart from the above-identified positive comments, experts pointed out the challenges of implementing this framework. The main challenge which all the experts raised was the compatibility of this framework with the current planning focus of Sri Lanka.

As E3 states,

> *"We are prone to disasters as a country. So, every element of the country should focus on this including urban planning. But when it comes to parks and playgrounds, Recreational use is the only purpose." (Respondent E3)*

Accordingly, it can be understood that currently POS in Sri Lanka are planned based on accessibility and focused on the recreational aspect. There are few cases where the Flood-prone areas are developed as POS, nevertheless not focusing on Tsunami prone areas. In coastal cities, most of the beach parks are planned for tourism purposes. Within this system, what this framework proposes is something entirely new in which urban planners or the disaster practitioners are not used to. Therefore, E1, E2 and E3 suggested that if this framework needs to be practically implemented this should come as a planning guideline which urban planners can follow.

For instance, E1 states,

> *"This study is no use if these DRR guidelines are not converted or incorporated into urban design guidelines." (Respondent E1)*

Adding to this, E2 highlighted,

> *"……., currently site selection is done mainly on accessibility but not considering these factors. So how to mainstream these DRR things to urban planning……. So my major concern is when selecting the parks, they do not have any guideline other than the accessibility. So there is a clear need of having a guideline or policy guide with these needs. So when they plan POS according to the urban development plan, the DRR need should come in an early stage. It should be a policy informed one." (Respondent E2)*

Accordingly, as these experts recommend, ‘converting this framework into an urban design and planning guide’, can be identified as a further recommendation of this study.

In summary, the critical evaluation of expert’s interviews which were conducted under respondent validation (Section 4.6.1) and the external validation (Section 4.6.2) suggested few alterations to the framework (Figure 32) and recommendations to the study. Accordingly, these alterations and recommendations can be summarised as follows.

- The terms of the core principle ‘Terrain quality and the topographic characters guide the Tsunami DRR uses of POS’ is changed to ‘‘Terrain and topographic characters guide the Tsunami DRR uses of POS’ (Section 4.6.2.1).
- The specific strategy ‘use POS to direct people through a landmark system and use design features as landmarks’ are changes to ‘Permeability improvements and Direct people through a landmark system with the use of design features of the POS’ and moved to general strategies (Section 4.6.2.2).
- ‘Provision of subspaces as per the logistic needs and socio-cultural needs in immediate recovery’ is identified as a new specific strategy when using Inland POS 2 as an emergency evacuation gathering place and a place for temporary sheltering (Section 4.6.2.2).
- ‘Introduce strategies maximising the multiple stakeholder interests’ is identified as a new general strategy (Section 4.6.2.2).
- General strategy ‘Tsunami DM-related features need to be economically and socially acceptable’ is changed to ‘Tsunami disaster resilience features need to be matched with the socio-cultural setting of the area and promote economic activities of the city’ (Section 4.6.1).
- Converting this framework into an urban design and planning guide’, is identified as a further recommendation of this study (Section 4.6.2.3).

4.7 Final Validated Framework

The key findings of this research were presented in three main sections;
Section 4.2 - Core principles for planning and designing POS for Tsunami disaster resilience
Section 4.3 - Three types of POS and the specific strategies under each type of DRR potential
Section 4.4 - General strategies which are common to all three types of POS

Further, the summary of these key findings was presented in figure 4.32. Subsequently, section 4.6 validated the key findings through the respondent validation and external validation together with the identification of few alterations to the final framework. Accordingly, these alterations identified in the validation phase has been added to the final framework (figure 4.33). Further, the visual representation of the framework is remained as same (Figure 4.6) which was introduced in section 4.3.
Referring to the methodology of this study, the final framework can be identified as a theory which is emerged from the data (following the Grounded theory data collection and analysis procedure) and validated by the experts of the field. Accordingly, the final validated framework; 'A framework to plan and design POS as a strategy to enhance the coastal city's resilience to Tsunamis', can be presented as follows (Figure 4.33).

Core Principles	Three main types of POS	Characteristics	DRR Potentials	Specific Strategies	General Strategies
Risk Zonation guides for the location of POS and the benefits involved	**Beach POS for Mitigation and Emergency Evacuation directing place**	✓ Located within the Beach area ✓ Tsunami High-risk zone ✓ Flat Terrain ✓ Large or small scale	Mitigate the Tsunami Disaster Risk	- Allocate preserved Tsunami hazard areas into POS with safety measures - Minimum Physical dev. and use natural features protecting mitigatory measures - Use design features and orientation of the POS to slow down and regulate the wave	- Development of evacuation route network linking Beach Access roads and local road network with POS - Consider natural human behaviour patterns when allocating evacuation routes and POS for safe evacuation - Tsunami disaster resilience features need to be matched with socio-cultural setting of the area and promote economic activities of the city - Allocation of POS need to be matched with the current development patterns of the city - Mapping evacuation routes, POS and other safe places integrating both local and scientific knowledge - Use POS to aware people on local evacuation plan by displaying signage and evacuation maps - Use the lighting and signage of POS network to facilitate the night time evacuation way finding strategy - Link the POS network with vertical evacuation shelters - Need of Tsunami signboard systems linked with POS - Plan and design POS network as inclusive design - Permeability improvements and Direct people through a landmark system with the use of design features of the POS - Introduce strategies maximising the multiple stakeholder interests
			Direct the Emergency Evacuation	- Plan for safe evacuation by linking POS with evacuation road network and linking neighbouring highlands
			Provide Public Awareness	- Use design features to remind Tsunami and importance of being pro-active - Display mitigation related features
Different POS have different uses for Tsunami DRR depending on the **location and size**	**Inland POS for Mitigation and Emergency Evacuation directing and distribution place**	✓ Located inland ✓ Yet within Tsunami risk zone ✓ Flat Terrain ✓ Large or small scale	Mitigate the Tsunami Disaster Risk	- Use design features and orientation of POS to slow down and regulate the wave
			Use Large scale POS for Emergency Evacuation Distribution	- Plan for safe evacuation by linking POS with evac. road network and linking neighbouring highlands in to the design - Use POS as a distribution place with improved access to use vehicles in evac.
			Use Small scale POS for Emergency Evacuation Directing point and for public awareness	- Plan for safe evacuation by linking POS with evacuation road network and linking neighbouring highlands in to the design
Multipurpose POS	**Inland POS for Emergency evacuation gathering place and Temporary sheltering**	✓ Located inland ✓ Out of the Tsunami risk zone or on elevated platform ✓ Mountainous Terrain ✓ Large scale	Use as an Emergency Evacuation gathering place and temporary sheltering	- Minimum physical development and designed as a loose space - Space for Temporary sheltering for immediate recovery - provision of subspaces as per the logistic needs and socio-cultural needs
			Provide basic, services and facilities in emergency response	- Facilitate the provision of basic services and facilities - Plan community centres/community halls linked with POS
Networking Public open spaces work as a DRR passage			Use as a place to distribute goods and services	- Accessibility and linkage with the access locations and other service providers

Figure 4.33- Final Framework

4.8 Final Framework against the 'Test of Good Theory'

Section 4.7 presented the final validated framework of the research; 'A framework to plan and design POS as a strategy to enhance coastal city's resilience to Tsunamis'. Further, methodology chapter (Chapter 3) explained that the theory of this research emerges from data as the study used the grounded theory data collection with an open mind and inductive analysis procedure and section 4.6 confirmed that these findings are validated through the expert validation.

Accordingly, in this section, the researcher attempts to critically analyse the characteristics of the final framework against the attributes of a 'good theory'. As cited in Knight and Ruddock (2008), Poole and Van de Ven (1989) define good theory as 'a limited and fairly precise picture'. This means good theory cannot cover everything but outlines the scope and limitations of a particular scope. Similarly, the theory which is the final framework of this research outlines the methods and approaches to plan and design POS as a strategy to enhance the coastal city's resilience to Tsunamis. Adding to this, As cited in Knight and Ruddock (2008), Wacker (1998) presents a list of indicators to 'test a good theory'. Accordingly, using the following table (Table 4.4), the researcher attempts to critically evaluate the characteristics of the final framework against the indicators of the good theory.

Test of Good Theory	Characteristic of the final framework
Uniqueness: means that one theory must be differentiated from another	The synthesis of the literature (Chapter 2) confirmed that it is little known in the field how to use POS for Tsunami resilience and this framework with unique features introduces a new method to use POS for Tsunami resilience and also the strategies to follow.
Conservatism: current theory can only be replaced by a new one if it is superior in important aspects	This framework is produced with a consideration of a broad spectrum of fields such as urban planning, disaster resilience, coastal planning, engineering, sociology. Therefore, it can only be replaced by adding a new lens or a field to the focus.
Generalisability: the more areas that a theory can be applied the theory more important	The central phenomenon of this framework which is the network of multipurpose POS facilitating disaster resilience can be referred for other types of disasters with the changes to the strategies within the framework.
Productive: a theory that fertile in generating new models and hypotheses	This framework is an example of using POS to enhance the inherent capacity of a city to a particular disaster which can provide insights of using POS in any city context or any other disaster

Parsimony: the fewer assumptions, the better	As this study is not context-specific, instead issue-specific answering 'how to use POS for Tsunami disaster resilience in Sri Lanka' assumptions, have been made fewer as possible
Internal consistency: the theory gives an adequate explanation for all relationships	The relationships between the core principles, three types of POS, specific strategies and general strategies are well explained within the framework.
Empirical risk: the theory should hold itself up for refutation and not hide behind limiting caveats	The framework is not limited to the specific condition as the study has been conducted minimising the limitations. This will be further discussed in section 5.6
Abstraction: the theory should be independent of time and location	This framework is not bound to any time and although the study conducted to Sri Lanka, with a background study can apply to any coastal city

Table 4.4- Evaluation of the final framework against the 'Test of a good theory.'

4.9 Summary and the Link

This chapter presented the analysis and findings of the research. Accordingly, this chapter presented the emergence of the results through the integration of categories, sub-categories and properties (Sections 4.1 to 4.4). In summary, five core principles, three types of POS, specific strategies and general strategies were identified as the key results of the study. Further, section 4.5 introduced the additional findings which were eliminated from the core findings. These additional findings of the research can be identified as the institutional and procedural challenges of planning POS for Tsunami disaster resilience in Sri Lanka.

Subsequently, the chapter detailed the validation of the results using two types of validation methods; respondent validation and external validation (Section 4.6). The final validated framework (Figure 4.33) was presented in section 4.7, and introduced as the 'framework to plan and design POS as a strategy to enhance the coastal city's resilience to Tsunamis'. Finally, this Final Framework was evaluated against the 'Test of good theory'. The next chapter (Chapter 5) discusses the conclusion of the research.

CHAPTER 5: CONCLUSIONS

5.1 Introduction

Chapter 1 of the thesis presented the background of the study, research problem, aim and objectives of the research. Chapter 2 synthesised the literature related to the study showing how this research interrelates with similar work in the field of study and established the gap of the research which need to be filled by the research findings. Chapter 3 justified the methodology of the research, followed by chapter 4, which presented the analysis and findings of the research study. Consequently, this concluding chapter reviews the research findings along with the research objectives and presents the conclusion and recommendations of the study. Accordingly, the chapter is structured as follows.

- Firstly, a summary of the research problem is discussed.
- Secondly, the summary of key findings in combination with research objectives is presented.
- Thirdly, the contribution of this research to the theory, practice, and policy are discussed.
- Finally, the limitation of the study and further research areas are identified.

5.2 Summary of Research Problem

The current focus on planning and designing POS in cities are mostly given on achieving sustainable cities through its' contribution to the three main pillars of sustainability; economic, social and environmental. Accordingly, contemporary urban planners and urban designers use POS as a strategy to improve the quality of life, aesthetic beauty, environmental health, social interaction and economic growth. However, it is known that sustainable development should encompass the strategies of creating disaster-resilient communities. Further, as section 2.6.3 detailed, the synthesis of literature discloses that the POS in cities have the potential to contribute at the three main stages of the disaster cycle; emergency response, recovery and mitigation. Nevertheless, the use of POS to enhance cities' resilience to disasters has not been fully uncovered within the current research field.

Further, as it was explained in section 2.6.4, answering this research gap to a Tsunami disaster context is even more significant due to the nature of the Tsunami disaster. It is infrequent but extremely destructive. Due to the unpredictable nature of this disaster, it is not sustainable to

allocate spaces in cities for the sole purpose of Tsunami disaster resilience. However, despite the fact of infrequency, our coastal cities should get ready for Tsunamis due to the destructive nature of this disaster. Therefore, there is a significant need for allocating multifunctional spaces for Tsunami emergency evacuation, recovery and Tsunami mitigation which can also be used for the everyday life of the city. Addressing this research need, this study focuses on finding out the potential uses of POS for Tsunami disaster resilience and methods to incorporate these potentials into the everyday life of the city. Further, the identification of this research gap leads to the research problems 'What are the potentials of POS to enhance the coastal cities' resilience to Tsunamis?' and 'How to plan and design POS in cities to enhance the Tsunami disaster resilience while obtaining the everyday uses of the city?'.

Further, the answers to these research problems need to be more specific rather than generic and may differ from one context to another due to geographical, political, environmental and socio-cultural differences. Therefore, the study was focused down to Sri Lankan context and the selection was done due to three main reasons. The first reason is Sri Lanka is one of the Tsunami prone countries located in the Indian ocean, and the 2004 Tsunami was one of the worst disasters ever recorded in Sri Lankan history. Secondly, as pointed out by UN-Habitat (2016), approximately 80% of national economic infrastructure and 70% of the urban population is concentrated in coastal cities and cities in disaster-prone areas in Sri Lanka. Hence, any adverse effect on the coastal cities will affect significantly to the country's national economy and the social setting. Thirdly, despite these vulnerabilities, the built-up area is increasingly expanding in coastal cities mostly through unplanned development activities which further increases the disaster risk in coastal cities, Sri Lanka. Therefore, it is inevitably important to find out the strategies to improve the resilience of coastal cities in Sri Lanka to Tsunamis. With the consideration of all these facts, this study focused on answering the central research problem 'How to plan and design POS as a strategy to enhance coastal cities' resilience to Tsunamis in Sri Lanka?'.

Accordingly, in order to answer this research problem, this study aimed to 'develop a framework to plan and design POS as a strategy to enhance coastal cities' resilience to Tsunamis in Sri Lanka'. In achieving this aim, section 1.3.2 introduced five inter-related objectives;

1. Identify the current relationship between the POS and Tsunami disaster resilience,
2. Explore the potentials and challenges of using POS as a strategy for Tsunami Disaster resilience,
3. Explore the planning and designing methods and approaches of using POS as a strategy for Tsunami Disaster resilience,
4. Study the relationship between the identified potentials and challenges (Objective 2) with methods and approaches (Objective 3) and
5. Develop a framework to plan and design POS as a strategy for Tsunami Disaster Resilience.

Accordingly, the following section discusses the way in which these objectives were achieved through the findings of this research.

5.3 Summary of Key Findings

This section attempts to revisit the objectives of this research which were introduced in section 1.3 and to demonstrate how the objectives have been achieved through the research findings.

5.3.1 Objective 1

The first objective was to 'identify the current relationship between the POS and Tsunami disaster resilience'. This objective was formed to understand the current role of POS in making cities resilience to Tsunami disaster. Accordingly, this objective was achieved through the literature review and presented in detail in section 2.6.

The analysis of the literature confirmed that in cities POSs are rarely used for making cities resilience to Tsunamis. Mostly, POSs are used in Tsunami events when there is no other option, rather than planning POS proactively for Tsunami disaster resilience. For instance, time to time in the history POSs have been used for emergency response and recovery providing city' providing safe assembly spaces, space for shelter, basic emergency services and utilities, such as first aids, freshwater, and electricity. However, most of this literature which discuss the use of open spaces for emergency gathering, do not discuss the public use of it which can be obtained by converting them as POS. Further, the literature which discusses public use of it, do not discourse the real-world application of this potential to an urban context and thereby balancing both disaster resilience and urban resilience.

Apart from the relationship of POS with the Tsunami emergency evacuation and recovery, another set of literature emphasises the need for acquiring Tsunami hazard areas for open-space uses and confine the uses in conservation and preservation perspective (Jayakody, Amarathunga, et al., 2018). Some of the literature arguments even suggest to use these open spaces for agriculture or scenic easement, but less consideration has been given on the use of POS as an integral part of the vitality of the city. Especially, in a coastal city where the land is a scarce resource, allocating open spaces only for mitigation cannot be considered as the best practice. In this context, using preserved hazard areas for public open space uses of a city can be regarded as a sustainable and practical solution. Accordingly, the synthesis of the literature confirmed that the relationship between the POS and Tsunami disaster resilience is less explored and established the gap of the research which is the need of finding out the potential uses of POS for Tsunami disaster resilience and methods to incorporate these potentials to the everyday life of the city.

Therefore, to fill this research gap, first, it was needed to explore the potentials and challenges of using POS as a strategy for Tsunami disaster resilience which leads to the second objective of the research; explore the potentials and challenges of using POS as a strategy for Tsunami Disaster Resilience. Accordingly, the next section;5.3.2 will discuss the way in which objective two was achieved through the findings.

5.3.2 Objective 2

The second objective was to 'explore the potentials and challenges of using POS as a strategy for Tsunami disaster resilience'. This objective was partly achieved through the literature (Section 2.6.4) and accomplished through the concurrent data collection and analysis.

As it was mentioned in section 5.3.1, literature findings confirmed that the potentials of POS for Tsunami disaster resilience are less explored in the research field. However, exploring the uses of POS for other types of disasters such as Earthquake, Landslides and Flooding, indicated the potential uses that can be obtained for Tsunami disaster resilience. Accordingly, the literature related to Earthquake events suggested that POS can be potentially used to provide safe areas for emergency evacuation, to provide necessary facilities and services in the recovery period. Further, literature findings suggested that different typologies of spaces can contribute different functions in emergency response and recovery. Further, the literature which is related to Flood mitigation suggested that the hazard-prone areas need not be kept for preservation and conservation purpose, nonetheless these spaces can be used for public uses. This suggestion

was vital for this study as this research study focuses on the city context and for the Tsunami context as Tsunami by its nature, unpredictable and infrequent. Therefore, the literature analysis suggested inquiring the potential of obtaining the public uses from the land preserved as Tsunami hazard areas.

However, apart from these potentials, literature findings also suggested challenges of using POS for Tsunami disaster resilience (Section 2.6.4 for more details). One of the significant challenges was allocating resources with a sole purpose of preventing a Tsunami disaster which may or may not occur for the next 100 or 1000 years. For instance, in some cities, large quantities of unstructured open spaces left for emergency evacuation, have created issues to achieve liveable, diverse and sustainable urban environments. Furthermore, it will be difficult to negotiate the need for these preventing measures when prioritising the resource allocation in cities. The other major challenge is most of the literature which discusses the uses of POS in cities for disasters identify the uses discretely but not as an interconnected system which can significantly enhance the cities resilience to disasters. Accordingly, the summary of potentials and challenges which were identified through the literature was presented in table 2.3 at the end of section 2.6.4.

Accordingly, these literature-informed potentials and challenges of using POS for Tsunami disaster resilience notified the research need of finding out the ways and means to harness the potentials and to overcome the challenges. Further, as some of these potentials and challenges are less explored in the Tsunami disaster context, it was needed to explore these potentials and challenges focusing on Tsunami disaster resilience. With this objective, the data collection process was started. Following the grounded theory open mind data collection process, the researcher interviewed people in various sectors (Section 3.8.5 for more information) such as communities who experienced the 2004 Tsunami disaster event, coastal planner, urban planners and so on, to find out the potentials and challenges of using POS for Tsunami disaster resilience. As section 3.9.4 detailed, list of potentials and challenges were identified in achieving this objective through the concurrent data collection and analysis procedure. In summary, these potentials and challenges are presented in Appendix 3.

However, apart from exploring these potentials and challenges of using POS for Tsunami disaster resilience, it was also needed to identify ‘How to harness these potentials and to overcome the challenges?’ and ‘What are the methods and approaches which can be

followed?'. Objective 3 was formulated to answer these questions which will be further discussed in the following section; 5.3.3.

5.3.3 Objective 3

The third objective was to 'explore the planning and designing methods and approaches of using POS as a strategy for Tsunami disaster resilience'. This objective was formed to identify the methods and approaches that can be used to plan and design POS in cities for Tsunami disaster resilience. This objective was achieved through the concurrent data collection and analysis procedure.

Following the grounded theory open mind data collection process, researcher interviewed people in various sectors (Section 3.8.5 for more information) such as urban planners, DM practitioners, sociologists and civil engineers and so on, to find out the methods and approaches of using POS for Tsunami disaster resilience (Section 3.9.4 for more information). Accordingly, the list of methods and approaches which were identified in achieving this objective is presented in appendix 4.

Some of these methods and approaches (Appendix 4) are directly related to the identified problems and challenges, and some were not. Further, as it was discussed in section 3.9.4, apart from the data found in table 5.1 and 5.2, there was another set of background data which relates with the central research question 'How to use POS as a strategy to make coastal cities resilience to Tsunamis in Sri Lanka?'. Furthermore, all these identified elements; potentials, challenges, methods, approaches and background data were standing isolated without having a connection to each other. Therefore, the fourth objective of the study was to study the relationship between these elements to develop the final framework.

5.3.4 Objective 4

The fourth objective was to 'study the relationship between the identified potentials and challenges (Objective 2) with methods and approaches (Objective 3) of using POS as a strategy for Tsunami Disaster resilience'. This was formed to identify the relationship between the data which were broken into discrete parts through the open coding (Section 3.9.4). Accordingly, axial coding procedure (Section3.9.5) was mainly used to study the relationship between data which includes potentials, challenges, methods, approaches and background data.

Accordingly, as it was described in figure 3.10, by linking the codes to each other and specifying the relationship of categories and properties, the researcher identified the

relationship between the identified potentials and challenges (Objective 2) with methods and approaches (Objective 3). Further, as it was explained using figure 3.11, list of strategies was identified which were linked with the identified potentials and challenges (Section 3.9.5 for more information). After the identification of the relationship between the data, the next step was to find a complete answer to the research question 'How to plan and design POS as a strategy to make coastal cities resilience to Tsunamis in Sri Lanka?' which will be further discussed in section 5.3.5.

5.3.5 Objective 5

The fifth objective of the study was to 'develop a framework to plan and design POS as a strategy for Tsunami Disaster resilience'. After the 'study of the relationship between the identified potentials and challenges with methods and approaches'; objective 4, by following the next coding step which is called selective coding (Section 3.9.6) the framework was developed to plan and design POS as a strategy for Tsunami Disaster Resilience. This developed framework was validated through the respondent validation and the external validation (Section 4.6) to achieve this objective comprehensively.

Accordingly, the developed framework (Figure 4.33) to plan and design POS as a strategy for Tsunami Disaster resilience was presented in section 4.7. In summary, the framework is guided by the five core principles which need to be followed when planning and designing POS as a strategy to enhance coastal cities' resilience to Tsunamis. Those five core principles are as follows.

1. Risk Zonation guide the places for POS and the benefits involved
2. Terrain quality and the Topographic characters
3. Importance of location and size of POS
4. Multipurpose POS
5. Networking POS works as a DRR passage

Based on these five core principles, the framework introduced three types of POSs which can be used to harness four types of potentials; emergency evacuation, recovery, mitigation and public awareness in Tsunami disaster resilience. In detail,

- Type 1- Beach POS has the potential to mitigate the Tsunami disaster risk, like an emergency evacuation directing point and to provide public awareness.

- Type 2- Inland POS 1 has the potential to mitigate the Tsunami disaster risk, use large scale POS for emergency evacuation distribution, use small scale POS for emergency evacuation directing point and to provide public awareness.
- Type 3– Inland POS 2, can be used for as an emergency evacuation gathering place and temporary sheltering, provide essential, services and facilities in emergency response and use as a place to distribute goods and services in recovery.

Further, to harness these potentials, the final framework introduced a set of specific strategies under each type of POS (Section 4.3). Then, the framework introduced general strategies (Section 4.4) which are common to all three types of POS to harness the identified DRR potentials.

In conclusion, the research findings suggested that POS in coastal cities can play a key role to enhance cities' resilience to Tsunamis through the following abilities,

- act as an emergency evacuation directing point,
- as an agent for emergency evacuation distribution,
- as a primary place for emergency rescue and temporary sheltering,
- as a facilitator for Tsunami disaster mitigation and
- as a mediator to provide Tsunami awareness.

Further, in order to harness these potentials, this research study suggests a framework with five core principles, three types of POS, specific strategies and general strategies which can be followed when planning and designing POS as a strategy for making cities resilience to Tsunamis.

In summary of this section, the way in which the research objectives are achieved through the research process can be illustrated as follows (Figure 5.1).

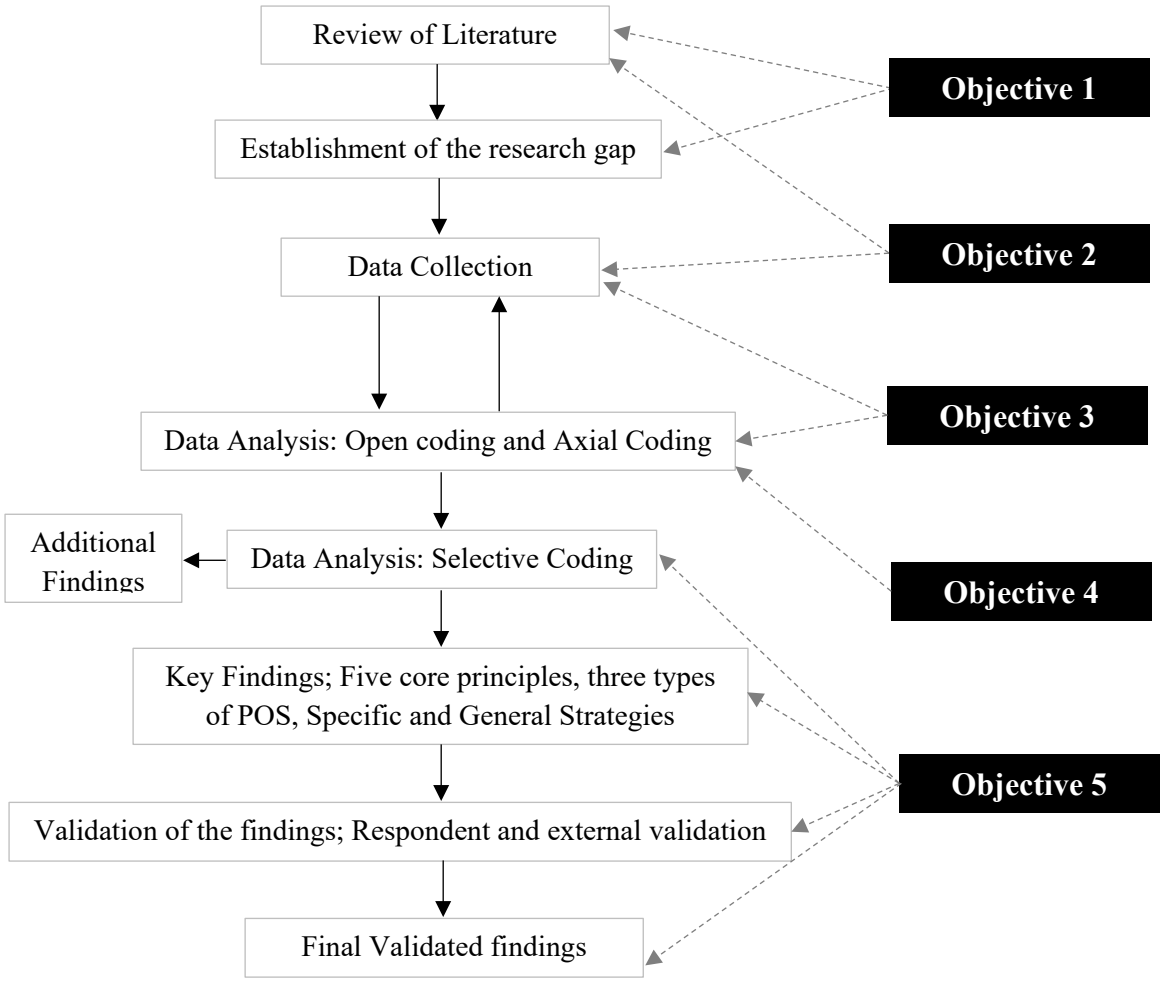


Figure 5.1- Relationship between the Research Process and Objectives

5.4 Contribution to Theory

As mentioned in chapter 2, the uses of POS in cities are mostly explored in the urban planning and designing field and less explored in disaster resilience field. The authors who discuss the use of POS for disaster resilience also primarily focus on disasters such as Earthquake and Flood, not on Tsunami disaster. Therefore, the developed framework of this research which is the 'framework to plan and design POS as a strategy to enhance coastal cities' resilience to Tsunamis in Sri Lanka' uncover the use of POS to the disaster resilience field and specifically to Tsunamis which is a novel contribution to the theory.

Further, the urban planning designing in cities can act in multiple ways contributing to sustainability, resilience and so on. However, urban planning and designing researches and disaster resilience researches follow two different paths with less integration. Accordingly, this research bridge the two research domains and will be an example for another researcher who attempts to integrate the urban planning research domain and disaster resilience domain.

Above two types of contributions to the theory are related to the field of study of this research. The third type of contribution to the theory is associated with the research method of the study which is the grounded theory method. Grounded theory is a well-established research method in social science research and most popular in nursing and health science researches. However, the usage of grounded theory as the research method within the fields such as urban planning and urban designing remains limited. This is due to the nature of most of the urban studies such as the complexity, dynamic nature, strong focus on the physical aspect of the urban environment and strong orientation on practice-based (Allen & Davey, 2017). Within this context, this study explored the usage of grounded theory within the two research fields; urban planning and disaster resilience. In this study, grounded theory allowed the researcher to go to the field with an open mind and excavate these many interlinked and overlapping themes, considerations and issues related to the phenomenon (Chapter 3 for more information). Accordingly, employment of grounded theory method brought unique benefits to the study such as explaining a phenomenon which is poorly understood within the current research field and tackling many interlinked and overlapping themes in urban planning and disaster resilience. Accordingly, this research study serves as an example for urban planning researchers who attempt to employ grounded theory in them researches and confirms that grounded theory is most suitable when understanding a complex and dynamic urban phenomenon.

5.5 Contribution to Practice

Apart from the theoretical contribution which was discussed in section 5.4, this study contributes to the practice by producing a framework which can apply to the real world coastal cities. The 'framework to plan and design POS as a strategy to enhance coastal cities' resilience to Tsunamis in Sri Lanka' applies to the coastal cities in Sri Lanka. For the reason that the framework is developed closely related with the data in the Sri Lankan context, this framework can be used as a guideline for the urban planners and urban designers in Sri Lanka when planning and designing POS to enhance coastal cities' resilience to Tsunamis. Other countries can also adopt it after a context-specific study.

Apart from the urban planning and development practitioners, the proposed framework will also benefit local government bodies to improve their local plans towards Tsunami disaster resilience. As it was identified in section 4.2.1, spatial planning in Sri Lanka is not well linked with the DRR strategies. Instead, DRR is considered mostly at the vision-mission statements

in local plans and lacking at the strategies and action project level. Therefore, by following this framework, local government bodies can link the DRR strategies to the POS related action projects at the local level.

The proposed framework will benefit the policymakers in Sri Lanka when preparing policies related to POS. For instance, the current policy UDA policy guide for PORS- Public open recreational space (UDA, 2018), consider the accessibility as the main requirement for selecting a public open recreational space. Similarly, policymakers can refer to the proposed framework of this study to set out the requirements for selecting POS in coastal cities for Tsunami disaster resilience.

5.6 Contribution to Policy

This section demonstrates the way in which the results of the study contribute to two global policies; Sendai Framework for DRR 2015-2030 (SFDRR) and Sustainable Development Goals (SDGs). As it was introduced in section 2.4.1, the SFDRR proposes seven targets and four priorities for action to reduce existing and prevent new disaster risks. Out of these four priorities, 'Priority 1; understanding disaster risk' emphasises the importance of developing effective global and regional campaigns as instruments for public awareness and education on DRR. The results of the study propose an innovative approach to knowledge the public on DM through the urban planning intervention in POS (Sections 4.3.1.3 and 4.4.6) which can be adopted as an effective global and regional campaign to aware public on DRR.

'Priority 2; Strengthening disaster risk governance to manage disaster risk' highlights the need to mainstream and integrate DRR within and across all sectors. Similarly, the findings of the study propose a cross-sectoral approach to plan and design POS for Tsunami disaster resilience tailored to Sri Lanka. With further clarification, without just limiting to the urban planning sector or DM sector, this final framework takes a cross-sectoral approach informing the strategies to mainstream and integrate DRR into urban planning. Urban planning policies and procedures can straightforwardly adopt this DM informed framework when preparing development plans. Apart from that, DM strategies can be introduced to the urban planning sector by adopting the findings as a guideline or a regulatory framework to plan and design POS. In this way, the results suggest a cross-sectoral approach across DRR, urban planning and designing, affecting policies, strategies and procedures.

Contributing to SDGs, the results of this research contributes to two global goals; 11th Goal- Safe, resilient and sustainable cities and human settlements, and 16h Goal- inclusive societies for sustainable development. Accordingly, the findings contribute to the 11th goal by introducing strategies to create disaster-resilient and sustainable cities. Especially, as it was discussed in sections 4.2.4 and 4.2.5 these Tsunami disaster resilience-focused POS need to be multipurpose and networked to achieve sustainable development within the city. With the contribution to the 16th goal, there is a general strategy highlighting that proposed POS designs need to be 'inclusive design' which welcome all the groups of the society; aged, disabled, women and children. Apart from that, in section 4.3.2.2 the findings proposed strategies to consider the disabled and people in need when providing basic services and facilities using 'Inland POS 2'. Further, it was introduced that Inland POS 2' which operate within the immediate recovery period, can offer a child play area to restore the children's mental health. Likewise, throughout the results, the strategies were introduced towards creating inclusive societies for sustainable development.

5.7 Limitations of the Study

The first limitation of the study is related to the context. As this study is conducted in Sri Lanka and data is collected within the Sri Lankan context, the framework is applicable only to Sri Lanka. However, as this study is 'issue-specific' rather than 'context-specific', the findings can be adopted by other countries after context-specific alterations are identified.

The second limitation is that the applicability and practical implications of the final framework has not been tested for a particular context or city as this is beyond the scope of this doctoral study. Within the limited time of the doctoral research, the central focus was given on developing the framework rather than testing it, as there was no framework existed to plan and design POS for Tsunami disaster resilience. Therefore, testing this framework for applicability and practical implications to a particular context or city will be a future study.

The third shortcoming of this study is related to data collection. As detailed in section3.8.5, the data was collected via community interviews and interviews with practitioners and experts related to the study. The interviews with practitioners and experts were not context-specific. However, when conducting interviews with communities who were affected by the 2004 Tsunami, interview responses were mostly context-specific. To overcome this limitation, the researcher used two methods. One is rather than depending on one context, community interviews were conducted in three different cities (Section 3.8.5.1), and secondly, community

interviews were validated using a subsequent series of interviews with practitioners and experts.

The fourth limitation is related to the research method of the study which is the possible biasness in the grounded theory method. Considering the researcher's biasness, Strauss and Corbin (1998) state that "it is not possible to be completely free from bias". Therefore, if the same set of data were collected and analysed by a different researcher, slightly different interpretations of the theory would have emerged. However, the awareness of this limitation from the early stage of the research, helped the researcher to keep the biasness to the minimum level when collecting and analysing data. Further, the researcher's previous experience in doing researches and experience in urban planning and designing field helped to maintain the maximum accurateness in data interpretation and analysis.

5.8 Further Research

In relation to the limitations (Section 5.6) of the study, as the research was conducted in the context of Sri Lanka, the findings are relevant to the city context in Sri Lanka. However, as this framework together with five core principles covers a broad area, the results may also be adapted to a different setting with careful consideration on geographic, social, economic and environmental conditions and precisely the development pattern of the area. Therefore, altering the framework to a different context/country will be further research work.

Further, as this framework is not tested in a specific context, testing for applicability and practical implications to a particular context or a city will be further research. This further research would entail a background study, matching the spatial distribution of POS with the spatial distribution of population to calculate how many people can be moved through the evacuation road network linked with the POS. This type of study may involve quantifying the capacity of this POS network against the population density. Further, this type of study also can categorise the POS according to the scale, e.g. 1. Small POS (less than 500sqm), 2. Medium POS (between 500sqm-1000sqm), 2. Large POS (more than 1000sqm). Then this categorisation can lead to quantify how many populations can be accommodated in each scale and which scale of POS can be used for distribution and emergency gathering together with other factors; risk zonation, terrain and location.

Apart from that, as it was discussed in section 4.6.2.3; under the general comments for the overall validation of the framework, the experts in the field identified as a recommendation to

‘convert this framework into an urban design and planning guide’. Accordingly, developing this framework as an urban design and planning guide will be another further research of this study.

5.9 Final Note

This chapter summarised the research problem and the findings of this research with a description of the way in which the objectives have been achieved through the findings. Thereafter, contribution to the theory, practice and policy, limitations of the study and further research were discussed. In conclusion, the primary outcome of the research is the ‘framework to plan and design POS as a strategy to enhance coastal cities’ resilience to Tsunamis in Sri Lanka’ providing novel contribution to the theory and practice. Identifying the limitations inherent to the study, the researcher has taken necessary actions to keep the limitations to the minimum level. Finally, making a connection between two different research domains, the findings of this research provides a doorway to many other further studies.

APPENDICES

Appendix 1: Sample Interview Transcript (Experts and Practitioners)

(Sample transcription of the interview which was conducted with a DM practitioner)

Question: What do you think the idea of using Public open spaces for disaster resilience?
Answer:
Actually, it is a good concept in our context. Yet, the public is not aware of these. That will be the biggest challenge of applying this type of concept. Secondly, stakeholder role play. I'm not telling about the DMC as a stakeholder but the other administrative stakeholders who are involving without any knowledge or lacking knowledge about these hazard profile.

So what do think of amalgamating this idea through a regulatory framework to urban planners?
That is a very good strategy. The other thing what I observe is they should have an integrative approach. I mean, they are working in a different compartment, and we have a different compartment. Therefore, there should be a platform for all of us to work together. Right now we have district coordinating committee. District level and divisional level committee. But they're also much prominence is not given for this type of subject. So that is the problem. Basically what I feel, before starting these process we have to educate, and we have to aware them the importance and priorities. The Sendai framework nobody is aware of. Sendai is a framework which will be there from 2016 to 2030. Will address the most problem. From policy level urban planners agree that disaster management must be considered, but in practice, this thing does not work. One thing is it is time-consuming. The other thing is the lack of awareness. Another thing is our laws and regulations are not adjusted according to the current need.

From your experience, what are the possibilities of using public open spaces for disaster resilience?
One thing is we can create safe locations, especially high-rise buildings in coastal areas, also community centres. Sometimes for our awareness programme and training programmes, we can get those places to provide training facilities. And sometimes relief centres, temporary hospitals. At the moment we are using temples, churches, community centres and schools, especially with two or three-storey school buildings. Likewise, we have already identified 238 evacuation points within this district. We are in the process of preparing maps. I will show you the Balapitiya DS division map. These are the Tsunami vulnerable places. Accordingly, these are the safe centres with numbers and all the information. Altogether we have 19 safe centres to this division. This map is not only for Tsunami but few centres for Floods as well. But for Tsunami we will use thee centres. Now, this is only for Balapitiya, likewise 19 divisions. So for Tsunami six divisions are vulnerable. So all together 238 safe locations are identified. For each location, we have a set of information including Place, GPS location, Telephone Number, contact person and what are the facilities available there. We have prepared that, to be able to use for our people. These are basic information, but we have a big network. In that, we have a lot of details including capacities, infrastructure facilities, which is lacking.

The first thing we check is the place whether it is vulnerable to any type of hazard. In the case of Tsunami height and distance. The second thing is capacity, how many people it can take, and how many buildings available. That is also we consider male and female separately. Whether disabled people can have access to there, that is also a major consideration. The third thing is we get the consent of the head of that place, incumbent. Because in case of emergency if they say they cannot allow us to use.
Another thing is sanitation facilities. Then other facilities such as electricity, water, transport, whether it is accessible for other service providers. There are separate locations that we identify to get access to identified places. Like helipad location, to use for helicopter landing (not all the locations). If we have an air operation, for helicopter landing, then we have identified nearest police station, military care. Whatever the available details we get. We have a database with all the information.
Another important thing is mapping this information. We have sent all the information to our map department for mapping in Colombo. But they haven't mapped it yet. But what they have to produce is the map which will be displayed in all the GN divisions.

Now you have these identified locations, but in the real event, how do the people know where to run which route to take?
One thing is we have already conducted the awareness programme. As an example, 130 Tsunami divisions in my area. So have conducted the awareness programme for the community, religious people, fisheries communities, Grama waka, government offices and NGOs. Likewise, ample of the spectrum we have conducted awareness programmes. Then we are doing a mapping exercise. We ask them to draw a map they have to identify the safe locations. This is a map which was drawn by the community (took photos). We asked them to draw this map to identify the locations and alternative locations. For example, in Rewatha college we can do the vertical evacuation, initially. Four stories of buildings are there. Then if not, If the time permits sometimes, you know sometimes it's about 40 minutes early warning. So then they cannot take a long route there. Last time also water came about 6 inches this way. But this is high ground. So people are aware of these two places. They can straight away come to this place. Sometimes they can take vehicles. But if they take the Galle road, there will be huge traffic. So we ask them to go instead of using Galle road take the railway tracks.

So the initial location is here. That will be the initial cover. But if they have time the second-best place is this. So initially with the alarm people will gather here, then we will move them to the other place with the time. People who have vehicles can directly go to second place. Even without awareness, they moved to these two places. So with the better awareness people will act better way.

We have a different system to disseminate the information. We have very few towers, so we use several methods, over the phone, media, megaphones, we have given a couple of maps, hand sirens, various means. So if one fails, we have backups. Once we get the information, I have a group. I have categorised the involved parties into different groups. In that group, I have police, army and hospitals and so on. So district level I will disseminate the information to the

district level. Once they get, they will distribute it to divisional level. But divisional secretariat also they get the information parallel.

So that is about the emergency evacuation side how about using public open spaces for mitigation side, what do you think about it?

Now the rule has been dissolved. The 100m buffer zone as a tool does not exist anymore. But public places generally, the government is not funding for those places. The second thing is most of the public places are away from the town but the business places. They do not have the value. But in mitigation side, as I said rules and regulation side is not strong, and there is a lot of unnecessary involvement. Therefore, this rule is not there anymore. The 100m buffer zone rule is good for the business communities, but not for the public places; government funding for these places cannot be done.

Therefore, for a country like us, we cannot do these types of mitigation activities. And we have to give the alternative. This is a strong statement. We can say that ok this land is not safe; then we have to give the land for those communities. For a fisherman, if you give land from Neluwa inland side, there is no point because his all activities are on the beach. For the tourism side, they need to live with their distance to the beach. In that sense, I think no part of the world has that type of mitigation strategy. I have visited many countries, the USA also I do not think there is strategy like this. For the mitigation also I think we have to aware the people. Those things are happening by the NBRO, coast conservation and BSMB, development mine and surveying. So for an example in Galle District, you can't build a new house without the approval of NBRO. So that type of mitigation activities is happening. But still you cannot mitigate the irregular activities, there is a lot of political involvement is there, so we have to give the alternatives for all the mitigation strategies that we put. So I think it is a difficult task to mitigate.

What are the challenges of using public open spaces for Tsunami disaster resilience?

One thing is sometimes they are under the hazard zone, the second thing is the capacity. Those are built for a specific purpose, and we are going to use it for a specific purpose. So how can we match? So when a community goes there in an emergency event, they can stay there for 24hours, but after that, there will be a lot of problems — basically, the infrastructure and the hazard profile. Then the accessibility, so there are limited places that we can get. Sometimes the place is surrounded by the Flood zone. So it depends on the water level. For Flooding, we have two types of Floods; river Flood and Flash Flood. Flash Flood is in urban areas. River Flood, they gradually moved to hilly areas. That is the concept they apply. They have an attitude. That is why I said that the attitude of the people also matters. They do not have the attitude to evacuate. So it is a difficult task. Evacuation drills also there. But the evacuation process is difficult. So the coordination and how you are going to put this to practice are the two main areas to be considered in mitigation.

We have already year marked how to use different types of open spaces for different uses. Generally, we take government lands including government Schools and public playground, community centres. But we have not discussed with private places we only consider the

government places. We have the potential to discuss with the private sector, but I don't see how far it will be successful. Using private land for people for temporary periods, we have not practised it. Playgrounds we have considered. Not only the playgrounds, but we have also considered the camping sites, hilly landings, dumping grounds, warehouses then during the raining lot of playgrounds are using.

In the Galle city area rather than identifying the parks and playgrounds, we have enough schools. Evacuation, we have used. Basically, schools and temples are used. But it is for a temporary period. The city itself is vulnerable to Tsunami. So the majority of people are vulnerable to the Tsunami in which majority who come to work. So what we believe is after the emergency evacuation they can go back to their houses. So for all of them, we do not need to think about long term recovery places. They come for different activities. So people who live in is the hazard-prone area is very limited. Especially, the business premises are vulnerable to Tsunamis. The coastal line of Galle city there is not a fishing community. Especially, after the last Tsunami, they have settled in inland. I mean Galle city itself but in other areas within the district, there are fishing communities.

As the last question, what do you think of using park and playgrounds in Galle city for Tsunami disaster resilience?

In fact, one thing is there are no much open spaces in Galle city. That is why we are focusing on vertical evacuation. It will be a very big challenge to find an open space within the city. Very rare possibility to find a place. But is you go out of the city yes you can think about that type of system. If you go Labuduuwa area, Bope, Baddegama, Hapugala, your idea can be viable. Even this place the DMC, district operational office DS office are vulnerable for a Tsunami. So we have year marked where to go in a case of emergency. One thing is a vertical evacuation. The second thing is the alternative emergency operations office in Wakwella. As you said, it is good. For example, they are developing an international stadium. But we cannot use it for emergency evacuation. Flood, of course, you can use, but for Tsunami you cannot use because it is in hazard-prone area. But the stand is developed with a focus on emergency evacuation. There is space on the rooftop; people can get and stay there. The structure also is designed in a way to face the Tsunami wave. Two floors and a rooftop as well.

What are the strategies for Tourist people?

We have given an awareness programme for hotel people. We don't have a system to train them. But when it is required, we can do it. We have prepared the evacuation plan with evacuation centres. We have given it to a couple of tourism places like a fortress, Bentota beach resort. Now the building codes and everything is coming us, tourism board, request the consent from us. So that has to come gradually. Signs we have already placed. Especially the evacuation routes. But there is some problem, but due to the lack of awareness, people paste posters on it. One thing is very difficult to maintain those. Initial; putting we have done. But local authorities have to maintain them. We do not have the capacity to maintain. But we still are doing. We can do innovations like a public, private partnership. Actually, I'm trying to do that, but they are not willing to do it even though that is for their betterment.

Appendix 2: Sample Interview Transcript (Community)

(Sample transcription of the interview which was conducted with the community-Batticaloa)

Question: How did you first get to know about the Tsunami and how did you react?

Answer:
We were in an area called Pudumuhaththuvaram. It was closer to the place where one side is a river, and the other side is the sea. We were in the middle. Near to Dutch bar. It is also called Kalladi muhaththuvaram. We were doing regular household activities that day. We saw the water in advance. Not exactly water. It was bubbles. We couldn't see the trees which were there. It was coming towards the land. First, we didn't know what to do, and we quickly moved away. We thought we are not going to live. We were living closer to the sea. We lost some of our family members. We ran to the river bank. My Father has a boat. There were 14 children. All of us got into the boat. But water quickly reached to us the wave was splashed into the boat and boat went up with the wave. Then we got down from the boat and the second wave came. With this second wave with the water, we were taken to an Army camp area which is called Upppodai. We got hold of some of the wood which was used to build centre points and escaped from drowning. We got wounded because of those woods. Then we went up to the camp. I was pregnant at that time. Then the water went away. Then we got down and walked without any idea where to go. Then we went to the Hindu college which is in walking distance.

Why did you go to Hindu college?
Somebody told us that all the displaced people are there, so we all went there. We stayed there that night. We didn't have any money. NGOs and other organisations gave Food and necessary things to us while we were in Hindu College. In that college, there were around 30 people from Kalladi area. We went to school as we are closer to it. But most of the people from Kalladi were in Aanaippandi Kovil. That is a big temple near to Hospital. We were in the Hindu college that night, and we also went to Aanaipandi Kovil because we got to know most of our people is in the temple. We were there for like one week. We got all the aids there. There also we got food, clothes and other things from NGOs. But as that is a temple, culturally and traditionally we cannot stay there for the long term, so we were moved to central college school. We were there for one month. The whole school was filled with displaced people. That was the school holiday period. Then NGOs came and helped us, and my father started working. But we found a lot of difficulties like food was not good, so we could not stay there for the long run. So went to a hotel and ate, some people even started cooking there in the school classrooms. NGOs gave all the cooking equipment as well such as cookers and all. Milk powder, Milo, plates and all the facilities were provided.

How were your children at that time, was there a place to play?
There is a children park near to the town. It is closer to the central college. Also, there is one closer to the town market as they are just kids, with all these things. We took them to that children park.

Did you have a place in mind to go before you got to know that the people are in Hindu college?
We didn't know what to do and where to go.

Now for the next Tsunami do you know what to do where to go?
No, we don't know. Still, we will act as it is. Although there are boards and all we don't know where to go how to follow. After staying in central college for a month, we moved to a school call Zahira School. They put up temporary shelters in there, and lots of us were there. After we got the land allocation in Thiraimadu for housing, we moved there and put up temporary sheds till the construction starts. Then we moved here. Inside that, they give public lectures. This area was a forest that is full of palm trees. Then the government cleared a large area to relocate the displaced people who were in schools and all. (Because once the schools started government used this area for the long term recovery period). The government built small camps for us here. We were in these camps for a long period, and NGOs and all helped us slowly to build these permanent houses for us within that time. We are not near the coast that much; however, we still do not know what to do for the next Tsunami. We will not go anywhere. (They will be in the same position as before).

What happened to the area where you were before?
Most of that land is now taken for Hotels and all. As we know, there is no buffer zone there. Only 7, eight families live there. We lost our old house. But we still own the land. There is a small hut in that land now to keep the equipment and all, not a house. We planted trees. As that place is closer to the sea, my husband goes fishing from there.

Appendix 3: Summary of Potentials and Challenges

Summary of potentials and challenges of using POS for Tsunami disaster resilience

Potentials	Challenges
• For Welfare camps • To give disaster knowledge • serve Emergency Access and escape • Relief centres, temporary hospitals • POS to lower the risk of disasters • POS to erect shelters • POS should be part of an early warning system • POS should be a disaster risk reduction passage • POS only for mitigation not for Emergency Evacuation or other • POS is one option in risk zonation • POS in hilly areas for evacuation • POS for storage • POS for multi-purpose • POS for immediate rescue and distribution • POS control unauthorised activities • Places to build temporary and transit shelters • People were given tents to build wherever • Normal day outdoor sport areas • Open spaces to create lower density • Open spaces for reservation • Open spaces for open markets • open spaces for mitigation • Not identified the community use of the space • the main purpose of POS is recreation and economic benefit • Incorporate contributing economic and trade activities to POS • for Tourism disaster management • Elevated POS for evacuation • Linkage with community centres with Training facilities	• The difficulty of matching the uses built for different purposes • Open spaces are available away from the city • Open spaces along the coast, with set back • Limited open spaces available • Available in different scale • Women and children are safer in religious places • Take safe places as per the resource capability • No system to evenly distribute people into safe locations • No evacuation plans for some areas • The need for the consent from incumbent • the need for separate access locations • Information profile for each location • Inadequate Evacuation centres • facilities needed in safe locations • Not designed for all the types of people (inclusiveness) • The capacity of existing places • villagers do not agree with the selected locations • time to evacuate last vulnerable person to the safest place • the safe place was not designed for the purpose • Problems in distributing goods and services • Unique features of the location • People live in trapped locations • Need different modes for emergency evacuation • Flatland for several kilometres

• Some open spaces are underutilised • Some areas with a lot of open spaces • Consider locational advantages; POS near Highland	• Areas with below or same as mean sea level • Institutional and procedural matters • No strategy to night time, early warning, way-finder • People like to stay with people in the same area during recovery

Appendix 4: Summary of Methods and Approaches

Summary of methods and approaches which were identified in achieving objective 3

Planning Considerations	Designing Considerations
• Take the character of most probable Tsunami • Take adjacent cities into consideration • Sense of security • safety measures of POS • POS in hazard-prone areas should attract fewer people • Need to rehearse and see first • Need to be scientifically convinced • Need for provision of facilities during evacuation and recovery • Matching with the culture of the people • Match with the current development pattern • Manage it as a system, Land scarcity • evacuating vulnerable people • environmental and ecological benefits • Emergency shelters will be used by people from all social status • DM consideration in Public gathering places • Different stages of evacuation and recovery got dif. needs • different open spaces for different uses • Culturally and socially acceptable • consider evacuating school children • Consideration of Environmental requirements • consideration of recreational use • Consideration of evacuating daily commuting people • consider the number of people attracting to POS in hazard areas • coastal characteristics are different • children's mental status during recovery • Capacity • balance the community needs with DRR	• Gather to the initial location and distribute from there • Accessibility to the POS in and out • adequate early warning methods in POS • Adequate emergency evacuation • Design features contribute to the economy • Design features result in Social issues • design features to remind people about Tsunami • Design it as DRR passage • Design to facilitate the distribution of goods and services • different design alternatives • elevated platforms in POS • Geographical constraints effects for the design • Importance of interconnected POS • Include protective features of the landscape to mitigate • Incorporate natural elements to design • Link POS with evacuation routes • Minimum physical development • Mountain parallel to the road • Natural vegetation • the need for a vulnerability mapping before the design • Need for cost-effective and multipurpose design interventions • Need to protect people from flowing items • The orientation of the POS • Possibility of networking different sized POS

needs • Participatory mapping to identify safe places • Risk zonation guide the places for POS • Risk assessment before planning • Projects with multiple achievements • Projects initiate when disaster happens then disappear	• the scale of the area, Density • Structural means. to slow down and regulate the wave • Take adjacent highland into the design consideration • Terrain quality and terrain character • use of temporary materials without using permanent • Control the water speed as it moves fast along the roads and open spaces

Appendix 5: Ethical Approval

THE UNIVERSITY OF HUDDERSFIELD

ADA

Reviewer Proforma.

Project Title:	Plan and Design Public Open Space as a strategy for Tsunami Resilient Coastal Urban Cities
Name of researcher (s):	Chathuranganee Jayakody
Supervisor (where appropriate):	Dilanthi Amaratunga
Reviewer names	Song Wu, Rowan Bailey, Lucy Montague and Craig Richardson

Issue	**Advice / Comments to applicant**
Aim / objectives of the study	
Research methodology	
Permissions for study?	
Participants	
Access to participants	
How will your data be recorded and stored?	
Confidentiality	
Anonymity	

Could the research induce psychological stress or anxiety, cause harm or negative consequences for the participants (beyond the risks encountered in normal life).	
Retrospective applications.	
Supporting documents (e.g. questionnaire, interview schedule, letters etc.)	
Other comments	

OVERALL RESPONSE

APPROVE	
APPROVE SUBJECT TO RECOMMENDATIONS [please specify]	
APPROVE SUBJECT TO CONDITIONS [please specify]	**Approved, however data must be stored using a secure university system.**
FURTHER INFORMATION REQUIRED [please specify]	
REJECT [please specify reasons]	

Date 17.05.16

Where the project is deemed to potentially represent a significant risk it should be forwarded to SREIC for consideration

Form 3

THE UNIVERSITY OF HUDDERSFIELD
School of Art, Design and Architecture

POSTGRADATE STUDENT / STAFF RESEARCH ETHICAL REVIEW
(Limited or Significant Risk)

Please complete and return via email to school research administrator (S.E.Baines@hud.ac.uk) along with the required documents (shown below).

SECTION A: TO BE COMPLETED BY THE APPLICANT

Before completing this section please refer to the School Research Ethics web pages which can be found at this link. Applicants should consult the appropriate ethical guidelines.

Please ensure that the statements in Section C are completed by the applicant (and supervisor for PGR students) prior to submission.

Project Title	Plan and Design Public Open Space as a strategy for Tsunami Resilient Coastal Urban Cities
Applicant	R.R.J Chathuranganee Jayakody
Supervisor (where applicable)	Professor Dilanthi Amarathunga
Award (where applicable)	PhD
Project start date	01/04/2015

SECTION B: PROJECT OUTLINE (TO BE COMPLETED IN FULL BY THE APPLICANT)

Issue	**Please provide sufficient detail to allow appropriate consideration of any ethical issues. Forms with insufficient detail will need to be resubmitted.**
Aims and objectives of the study. Please state the aims and objectives of the study.	The aim of this research is to develop a framework to plan and design public open spaces as a strategy to make coastal urban cities resilient to Tsunamis. The objectives of the research are as follows. 1. To understand the concept of Tsunami resilient coastal urban city 2. To identify the current role of public open spaces within existing planning and designing approaches towards Tsunami resilience 3. To identify the potential uses of public open spaces for Tsunami resilience through the study of current links between Public Open spaces and disaster resilience 4. To explore the methods and approaches that can be used to plan and design public open spaces as a strategy for Tsunami resilient coastal urban city 5. To develop a framework to plan and design public open spaces as a strategy for Tsunami resilience through the analysis and validation of identified methods
A brief overview of research methodology The methodology only needs to be explained in sufficient detail to show the approach used (e.g. survey) and explain the research methods to be used during the study.	This research study follows the grounded theory method to explore the methods and approaches to plan and design public open spaces as a strategy for Tsunami Resilience.

	Data collection will be done mainly through a series of interviews
Does your study require any permissions for study? If so, please give details	No
Participants Please outline who will participate in your research. Might any of the participants be considered 'vulnerable' (e.g. children)	Interviews will be conducted with Disaster Resilience Experts, Local Planners, Coastal Planning Experts and Communities in Tsunami Affected cities in Sri Lanka
Access to participants Please give details about how participants will be identified and contacted.	Experts will be identified by contacting the following institutions. 1. Disaster Resilience Experts- Ministry of Disaster Management, Sri Lanka / Disaster Management Experts in the University of Colombo and University of Peradeniya, Sri Lanka 2. Urban Planners- Urban Development Authority Sri Lanka/ Department of Town and Country Planning University of Moratuwa / Sri Lanka Tourism Development Authority 3. Local Planners - Galle Municipal Council / Matara Municipal Council / Batticaloa Municipal Council, Sri Lanka 4. Coastal Planning Experts- Department of Coastal Conservation Sri Lanka/ Central environment Authority Sri Lanka They will initially be contacted through email, and then by telephone conversations. Apart from that Researcher will utilize the personal contacts. The interviews will be conducted, meeting personally with the participants. 5. The community in Tsunami Affected Cities The researcher will reach the community through the local authorities i.e. Galle Municipal Council / Matara Municipal Council / Batticaloa Municipal Council, Sri Lanka. Participants will be selected in three main Tsunami affected cities in Sri Lanka (populated and urbanized cities). Consideration on inclusiveness will be given when selecting the Participants which include: • Cultural and linguistic diversity • People with disabilities • Seniors • Gender • Interest groups
How will your data be recorded and stored?	The researcher will record the interviews as audio recordings using a digital voice recorder. All the data collected will be transcribed and transferred to a computer ensuring the data protection by a password. The storage of data will comply with existing National and/or International Data Protection Laws and codes. This data will be coded and analysed with aid of NVivo package to document the findings.
Informed consent. Please outline how you will obtain informed consent.	All participants will be aware that their participation is completely voluntary and they may choose to withdraw

	at any stage during this process without having to explain why. An information sheet will be provided to all potential participants before the commencing of any research work either a hard copy or an electronic copy. This will include the following information. • Why this information is being gathered from them and what it will be used for. • Who is undertaking the engagement work and who it is be undertaking for, including contact details • How/why they were selected to be invited to take part • Even if they agree to take part, they can change their mind at any time, without giving an explanation. • What they would be asked to do if they agreed to take part. • The level of anonymity and confidentiality we can guarantee. • What the information will be used for, how it will be stored, and how long it will be kept. A participant will be asked to sign a Consent Form to record informed agreement to take part. The example provided by the University will be used as a basis for this. The informed consent letter will be provided in a language convenient for the interviewee.
Confidentiality Please outline the level of confidentiality you will offer respondents and how this will be respected. You should also outline who will have access to the data and how it will be stored. (This information should be included on Information your information sheet.)	All data will be kept secure. Any hard copies of responses received will be destroyed immediately upon entry. Any soft copies or recordings will be entered and then kept on a password-protected computer. Any backups will be kept in locked folders.
Anonymity If you offer your participants anonymity, please indicate how this will be achieved.	The identity of the participants of the community & expert interviews will be kept completely anonymous without revealing the identity of the participant. The contributor's name will be removed unless they wish to be named. However, as a researcher we may have to take more than this basic step to protect a participant's identity. Other information can help to identify people, for example, job title, age, gender, length of service, and strongly expressed opinions. However, geographical locations of the participants of the community will be included in the writings if the findings reveal any specific geographical factors.
Harm Please outline your assessment of the extent to which your research might induce psychological stress, anxiety, cause harm or negative consequences for the participants (beyond the risks encountered in normal life). If more than minimal risk, you should outline what support there will be for participants. If you believe that that there is minimal likely harm, please articulate why you believe this to be so.	Engagement will not be unduly intrusive or harm the participant in any way. The topic under investigation is not likely to cause stress, anxiety or harm. Questions will be designed to explore the use of public open spaces in a possible event of Tsunami and no questions will be asked that may recall the memories of the past Tsunami losses. Therefore, the likelihood of causing psychological harm to the participants is minimal.

Does the project include any security-sensitive information? Please explain how processing of all security-sensitive information will be in full compliance with the "Oversight of security-sensitive research material in UK universities: guidance (October 2012)" (Universities UK, recommended by the Association of Chief Police Officers)	No

Retrospective applications. If your application for Ethics approval is retrospective, please explain why this has arisen.

SECTION C – SUMMARY OF ETHICAL ISSUES (TO BE COMPLETED BY THE APPLICANT)

Please give a summary of the ethical issues and any action that will be taken to address the issue(s).

Risk	Potential impact	Likelihood (Low/Medium/High)	Mitigation
Face to face interviews regarding a destructive natural hazard which is Tsunami	- Participant might be stressed psychologically	Low	- Interviews will be conducted in a safer environment with necessary support - Offer to cease interview in case of emergency
Data collection in an unfamiliar environment with unknown participants	The researcher may be harmed physically or psychologically	Low	- Obtain necessary permissions from responsible authorities - Visit the places prior to the data collection - Establish contacts prior to the data collection

SECTION D – ADDITIONAL DOCUMENTS CHECKLIST (TO BE COMPLETED BY THE APPLICANT)
Please supply copies of all relevant supporting documentation electronically. If this is not available electronically, please provide explanation and supply a hard copy.

I have included the following documents

Information sheet	Yes	☒	Not applicable	☐
Consent form	Yes	☒	Not applicable	☐
Letters	Yes	☒	Not applicable	☐
Questionnaire	Yes	☐	Not applicable	☒
Interview schedule	Yes	☒	Not applicable	☐

SECTION E – STATEMENT BY APPLICANT

I confirm that the information I have given in this form on ethical issues is correct. (Electronic confirmation is sufficient).

Applicant name/signature: R.R.J Chathuranganee Jayakody

Date: 25/04/2016

Affirmation by Supervisor (where applicable)
I can confirm that, to the best of my understanding, the information presented by the applicant is correct and appropriate to allow an informed judgement on whether further ethical approval is required

Supervisor name/signature:

Date:

All documentation must be submitted electronically to school research administrator (S.E.Baines@hud.ac.uk).

If you have any queries relating to the completion or consideration of this form, please do not hesitate to contact school research administrator (S.E.Baines@hud.ac.uk).

Appendix 6: Sample Information sheet

Sample Information sheet
(required for submission with application for ethical approval)
University of Huddersfield
School of Art, Design and Architecture

Participant Information Sheet

Research Project Title: Plan and Design Public Open Space as a strategy for Tsunami Resilient Coastal Urban Cities

You are being invited to take part in a research project. Before you decide, it is important for you to understand why this research is being done and what it will involve. Please take time to read the following information and discuss it with others if you wish. Ask if there is anything that is not clear or if you would like more information. May I take this opportunity to thank you for taking time to read this.

What is the purpose of the project?
The research project is intended to provide the research focus for a module which forms part of my degree. It will attempt to find out planning and deigning strategies to enhance the use of public open spaces as an approach for Tsunami resilience while accommodating the everyday life of coastal urban cities

Why have I been chosen?
(There are specific reasons for the selection of each different party. Therefore, this section will be differed according to the type of participant as follows)

1. Disaster Resilience/Mgt. Experts -
You are one of the disaster resilient / disaster management experts who have the subject specific knowledge on Tsunami resilience. Therefore, you can bring the ideas related to current practices, challenges, potentials and future recommendations to use the public open space as a strategy for Tsunami resilience. Your opinion will be useful for this study to understand the use of public open spaces as an approach for Tsunami resilience.

2. Coastal/ Environmental Planners –
As a coastal/ environmental planner, you can raise the points specific to coastal areas, especially geographical answers for Tsunami disaster, how to incorporate it with public open spaces and environmental matters to consider. Therefore, your opinion will be useful for this study to understand the use of public open spaces as an approach for Tsunami resilience.

3. Urban/ Local Planners –
As a urban/ local planner, You can answer the questions related to current planning and designing practices specific to coastal cities, Policy background, challenges when plan and design public open spaces for Tsunami resilience, how to amalgamate the planning and designing strategies with Tsunami strategies. Your opinion will be useful for this study to understand the use of public open spaces as an approach for Tsunami resilience.

4. Community in Tsunami effected Cities -
As a person who experienced the Tsunami 2004 (in Sri Lanka), you can explain how you used the public open space in the event of Tsunami and possibly, the use of Public Open Space in

all stages of disaster cycle i.e. Preparedness, Emergency Management, Recovery and Mitigation. Your opinion will be useful for this study to understand the use of public open spaces as an approach for Tsunami resilience.

Do I have to take part?

Participation on this study is entirely voluntary, so please do not feel obliged to take part. Refusal will involve no penalty whatsoever and you may withdraw from the study at any stage without giving an explanation to the researcher.

What do I have to do?

You will be invited to take part in interview. This should take no more than Experts–1 hour/ Community-30 minutes of your time.

Are there any disadvantages to taking part?

There should be no foreseeable disadvantages to your participation. If you are unhappy or have further questions at any stage in the process, please address your concerns initially to the researcher if this is appropriate. Alternatively, please contact research supervisor Professor Dilanthi Amarathunga at the School of Art, Design and Architecture, University of Huddersfield.

Will all my details be kept confidential?

All information which is collected will be strictly confidential and anonymised before the data is presented in any work, in compliance with the Data Protection Act and ethical research guidelines and principles.

What will happen to the results of the research study?

The results of this research will be written up in final thesis and relevant publications. If you would like a copy please contact the researcher.

What happens to the data collected?

With the permission of participants, interview data will be audio recorded possibly with supporting notes. All the data collected, will be transcribed and transferred to a computer ensuring the data protection by password. All the data will be anonymised before storage. Name of the participants will not be revealed in any outcomes of the research. Also, other information that can help to identify people, such as job title, age, gender, length of service, and strongly expressed opinions will not be revealed in any outcome of the research.

Will I be paid for participating in the research?

No

Where will the research be conducted?

The research will be conducted in Sri Lanka focusing on Tsunami effected urban cities

Criminal Records check (if applicable)

Not Applicable

Who has reviewed and approved the study, and who can be contacted for further information?

Professor Dilanthi Amaratunga (Supervisor)
Email: d.amaratunga@hud.ac.uk

Name & Contact Details of Researcher: Mrs Chathuranganee Jayakody
Email: Chathuranganee.Jayakody@hud.ac.uk
Tel: +447909143002

Appendix 7: Sample Participant Consent Form

Sample Participant Consent Form
(required for submission with application for ethical approval)

University of Huddersfield
School of Art, Design and Architecture

Participant Consent Form

Title of Research Study: Plan and Design Public Open Space as a strategy for Tsunami Resilient Coastal Urban Cities

Name of Researcher: Mrs Chathuranganee Jayakody

Participant Identifier Number:

☐ I confirm that I have read and understood the participant Information sheet related to this research, and have had the opportunity to ask questions.

☐ I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.

☐ I understand that all my responses will be anonymised.

☐ I give permission for members of the research team to have access to my anonymised responses.

☐ I agree to take part in the above study

Name of Participant: ……

Signature of Participant: ……

Date: ……

Name of Researcher: Mrs Chathuranganee Jayakody

Signature of Researcher:

Date:

Appendix 8: Interview Schedule

Disaster Resilience/Mgt. Experts	Coastal/ Environmental Planners	Urban/ Local Planners	The community in Tsunami affected Cities
Points to start the discussion –	**Points to start the discussion –**	**Points to start the discussion –**	**Points to start the discussion –**
1) What do you think of the idea of using POS for Tsunami disaster resilience? 2) According to your view, what are the possible uses of Public Open Spaces in Tsunami resilience**?** 3) How to use different types of open spaces contribute to different aspects of Tsunami resilience?	1) What do you think of the idea of using POS for Tsunami disaster resilience? 2) What are the environmental concerns when allocating public open spaces in coastal areas? 3) What are the geographical answers for Tsunami, How can Public open spaces be used for these geographical answers? 4) What is the current use of public open spaces in coastal planning, what are the challenges?	1) What are the special factors you consider when planning are designing Public open spaces in coastal cities 2) Can we use the Public open spaces for Tsunami Disaster resilience, if not, why? If yes, How? 3) What are the challenges of planning and designing public open spaces for Tsunami resilience?	1) How did you use the open spaces when Tsunami Occurs 2) How did you use the open spaces immediately after the Tsunami 3) How did you use the open spaces within the recovery period 4) What are improvements do you recommend for the future use of Public Open space for Tsunami resilience

Appendix 9: List of Publications by the Researcher

1. Jayakody, C., Amaratunga, D., & Haigh, R. (2018). Core principles for planning public open spaces to enhance coastal cities' resilience to Tsunamis. 9th International Conference on Sustainable Built Environment 2018 (ICSBE), University of Peradeniya, Kandy, Sri Lanka.
2. Jayakody, R. R. J. C., Amaratunga, D., & Haigh, R. (2018). Plan and design public open spaces incorporating disaster management strategies with sustainable development strategies: a literature synthesis. In MATEC Web of Conferences (Vol. 229, p. 04001). EDP Sciences.
3. Jayakody, C., Amaratunga, D., & Haigh, R. (2018). Integration of disaster management strategies with planning and designing public open spaces. Procedia Engineering, 212, 954-961. DOI: 10.1016/j.proeng.2018.01.123
4. Jayakody, C., Amaratunga, D., & Haigh, R. (2017). Grounded Theory as an Approach to Explore the Use of Public Open Spaces to Enhance the Cities' Resilience to Disasters. In 10th International Conference of Faculty of Architecture Research Unit (FARU) Faculty of Architecture: University of Moratuwa.
5. Jayakody, R.R.J.C., Amaratunga, Dilanthi and Haigh, Richard (2016) Planning and designing public open spaces as a strategy for disaster resilient cities: a review of literature. In: Building the Future - sustainable and resilient built environments. FARU Proceedings (2016). Faculty of Architecture: University of Moratuwa, Colombo, Sri Lanka, pp. 156-168. ISBN 978-955- 9027- 56-0
6. Jayakody, R.R.J.C., Amaratunga, Dilanthi and Haigh, Richard (2016) The use of public open spaces to enhance the coastal urban cities' resilience to Tsunamis. In: Proceedings of the 6th International Conference on Building Resilience. Massey University / The University of Auckland, Auckland, New Zealand, pp. 1022-1030. ISBN 978-0-473-37268-2
7. Jayakody, R.R.J.C., Amaratunga, Dilanthi and Haigh, Richard (2016) The use of Public Open Spaces for Disaster Resilient Urban Cities. In: Proceedings of the 12th International Conference of the International Institute for Infrastructure Resilience and Reconstruction (IIIRR). University of Peradeniya, Kandy, Sri Lanka, pp. 146-152. ISBN 978-955-589-210-1

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