THE UTILIZATION OF LEFTOVER SPACES OF SRI LANKAN EXPRESSWAYS: INSIGHTS FROM THE KADAWATHA INTERCHANGE

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Abstract

Expressways are a relative novelty to the transportation infrastructure and landscape development of Sri Lanka. The same is true of the leftover spaces created alongside said infrastructure. Leftover spaces are places that have been severely neglected in terms of landscape design over the years. Due to the development of transportation, the number of unutilized leftover spaces has increased and led to various misuses. This investigation focuses on how these leftover spaces can be utilized appropriately by analyzing the global perspective on such spaces. Meta-analysis and summarization of outcomes based on previous research are used to formulate a theoretical framework for the aspect of human perception and user preferences.

A sequential mixed-method approach incorporating both qualitative and quantitative methods was used to evaluate physical, social, environmental, and economic aspects of expressway leftover spaces. The questionnaire (n=22) focused on the above selected aspects was given to two groups (users and experts in the field). Snowball techniques were used for data collection and statistical methods were used to gauge the importance of each factor.

Locally, a series of interchanges have been studied for their locations and distribution in a pilot study and one case study was isolated for the main study. Both the users of these areas and experts on the subject have been surveyed for insights. The research provides 19 recommendations with high preferences for creating green spaces and public artworks in these spaces. They are meant to be scalable and easy to implement across a wide variety of conditions that are likely to arise in the expressway development.

According to the survey, it is possible to create standards and guidelines that apply to most leftover highway space scenarios in Sri Lanka. Immediate utility and convenience to the user are given high importance with security being the most important aspect that should not be compromised. The survey can be used as insights for future developments.

Keywords: Counter migration, models of rural development, cluster development theory, India.

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Introduction

Transport infrastructure has constantly expanded in Sri Lanka last 2 decades. Expressways, the mainstay of the transport infrastructure have provided benefits such as reduction in travel distances, improved access to different destinations, enhanced safety for pedestrians and drivers, increased mobility, and reduced traffic congestion. The development of expressway infrastructure includes interchanges, overpasses, underpasses, bridges, and viaducts. Underneath them, generally called Leftover Spaces, are places that have been severely neglected in terms of landscape design over the years. Although a considerable amount of space has been used to develop expressway infrastructure, some of that space remains unused (Trancik, 1986). Meanwhile, these spaces provide incredible opportunities for fulfilling human needs. This paper aims to explore such transformations in previous case studies and propose what can be done to improve the conditions within Sri Lanka.

The rate of expressway infrastructure development will not be slowed in the foreseeable future. These constructions are rapidly increasing and proportional to that, the underutilized leftover spaces are also rapidly increasing. The image of the cities and suburban landscapes can be greatly improved through the effective utilization of the increasing leftover spaces. There is the ability to bring social, environmental, and economical transformation to the community while further improving the pedestrian experience. So, the main objective of the study was to evaluate the anticipated potential outcome of leftover spaces in the Sri Lankan expressway network system by providing guidelines and regulations for future developments.

Many types of spaces have been left over from the construction of expressways, and more will result from the upcoming construction of new expressways. Furthermore, the literature proves that developing countries in Asia have a high likelihood of misusing leftover spaces created by the expansion of expressways. To prevent such misuse, these leftover spaces should be utilized under proper rules and regulations. Any failure to tackle this problem effectively will have cascading effects on a social, environmental, and economic level as the leftover spaces grow in number with a high likelihood of being misused.

Objectives of this study focus on the identification of leftover spaces in the Sri Lankan expressway network system, examining the utilization of leftover spaces (selected case scenarios around the world) based on literature, and Providing guidelines and regulations for future developments. The impacts of the study findings will compound as the expansion of the expressway network continues.turn into self-sustaining systems, would be more beneficial for the long term.

Leftover Spaces of the Expressway and Their Characteristics

The construction of the expressway has created numerous large and neglected spots. These are dark, unattractive, damaged, unfinished, ill-designed, and full of girders (Akbarpour and Tabibian, 2015). They divide communities, provide unappealing views, and act as physical and psychological barriers to the pedestrian experience (Trancik, 1986). Furthermore, due to the current state of laws and regulations, existing criminal activity, and actions such as garbage dumping, many of these leftover areas appear to be off-limits to the general public. As a result, these spaces serve few social, physical, or economic purposes (Németh and Langhorst, 2014). When an expressway network is expanded as a result of rapid urbanization and population growth; city habitats and wildlife are fragmented and deteriorated. On the other hand, landscape architecture regards them as part of the urban spatial landscape system, along with land use, transportation, and public spaces (Efe et al., 2016).

Leftover Spaces of Sri Lankan Expressway Network System

Sri Lanka currently has over 277 km of designated expressways serving the southern part of the country. In addition, it has been proposed to add another 227.5 km to the expressway network in the future. (Source: www.exway.rda.gov.lk) Various categories of leftover spaces that can be identified throughout this expressway network system are shown in Table 1.

Table 1: Categorization of leftover spaces of Expressway Network System
(Source: Compiled by Author)

Category of the Leftover Space	Description
Interchanges (Three types of interchange types have been noted)	**Interchange Type 1:** The partially cloverleaf life structure with a loop creates a significant leftover space in the middle surrounded by traffic that is harder to utilize effectively compared to the other types of leftover spaces.
	Interchanges Type 2: Create a narrow but lengthy leftover space adjacent to the road, the length and area providing a better opportunity for more use.
	Interchanges Type 3: Involves large areas of land with road infrastructure surrounding them and is suitable for large-scale investments.
Overpasses	A very common occurrence in the expressway networks that have been remarkably effective at minimizing traffic congestion and allowing faster travel times.
Underpasses	Common as overpasses and it is best to approach these leftover spaces on a case-by-case basis.
Bridges	There's a large area over the ground that is covered by the bridge and these areas can be utilized as river-facing establishments and developments.
Viaducts	Consist of arches, piers, or columns, and support long elevated roads over long distances. Long stretches of land are covered in the process resulting in large, sheltered spaces.

Global View of Leftover Spaces and Their Usage

Throughout much of the developed world, leftover spaces are often regarded as an opportunity to do more with the space given and are treated as a blessing in urban areas. When large areas of leftover spaces are present, the most common response has been observed in the development and commercialization of these spaces. To ascertain the various uses of leftover spaces, it is necessary to look at the global perspective of this type of spaces and the summary of global case studies are shown in Table 2.

Table 2: Global case studies of leftover space development projects
(Source: Compiled by Author)

Project	Project Type	Project Outcome
Semangi Interchange, Indonesia, South Jakarta	Socio-Economical Landscape	A four-leaved clover shaped interchange that is defined by an architectural lighting scheme has been implemented.

Underpass Park, PFS, Studio Toronto, Canada.	Amenity Landscape	Recreational park that utilizes sports such as basketball and skateboarding as well as vendor spaces.
Burnside Park, Portland, Oregon.	Sports venue/ Public Landscape/ Recreational Landscape	As a skate park, this serves as a cornered space which facilitates lighting, music, power supplies, and power outlets.
NEXY (Northern Expressway), South Australia.	Utility Landscape	This 'Red Bellied Black Snake' inspired wall installation services spacing for parking, shelters, toilets, and camping grounds.
Historic Silver Valley Chamber, Freeway Viaduct, Wallace, Idaho.	Public Recreational Landscape	Vendors sell flea market goods at the market, and the area provides kids' games, live music, and safety for other recreational activities.
S2 Stanica Žilina-Zàriečie (The cultural center in Žilina), Zilina in Slovakia, Germany.	Cultural Landscape	This cultural hub and theatre draws audiences from around the country and even much further away continuously.
Makeshift School Metro Bridge, East Delhi.	Educational Landscape/ Cultural Landscape	The concept of 'Free School' has been developed the underpass into an open-air classroom that educates more than 200 children from close by slums every day.
Garbage Dump, Gill Road Flyover, Ludhiana, Punjab Region, India.	Service Landscape	Upon discovering that the retaining wall of the flyover had collapsed, large claims were made about alleged rat control.

The above case studies provide a glimpse into the scope and variation of what is possible with careful planning intelligent design and engineering. Most of the literature has focused on the modification and utilization of these areas for a wide variety of uses. These transformations can be categorized into 3 types (Sheng et al., 2018):

- Service spaces (bus stops, parking lots, etc.)
- Public spaces (sports venues, green spaces, parks, etc.)
- Commercial spaces (cafes, retails, buffets, small shopping malls, etc.)

Meta-Analysis of Literature

As insights gained through individual case studies could still introduce biases, a further meta-analysis can be used to fine-tune the conclusions derived. This could summarize the findings without giving bias or unnecessary prominence toward one specific type of solution. Ten research papers were taken into the Meta-Analysis and thoroughly analyzed.

Table 3: Summary of Meta-Analysis
(Source: Compiled by Author)

Study Name	Author/s	Investigation	Outcome
Elevated Highways and its Lost Spaces: A Review of Kuala Lumpur's seldom seen (2017)	Mohamed Anuar, M. I. N., and Ahmad, R.	Explores the ways to convert the spaces into productive uses based on aesthetic, ecological, historical, and recreational qualities through the qualitative method.	Interstitial spaces could be transformed into spaces that support human-scaled activities.
Reviving the lost spaces under urban highways and bridges:	Lak, A., Ramezani, M.,	Evaluates the qualities of lost spaces on urban highways with a focus on citizens'	Citizens are interested in factors such as safety and security, physical coherence,

An Empirical Study. (2019)	and Aghamolaei, R.	preferences rather than expert opinions in a mixed method.	visibility, richness, a sense of belonging and comfort.
Place making as an approach to revitalize Neglected Urban Open Spaces (NUOS): A case study on Rod El Farag Flyover in Shoubra, Cairo. (2019)	Abd El Gawad, N. S., Al-Hagla, K. S., and Nassar, D. M.	Explores the possibility of place making as an approach to develop neglected urban spaces surrounding mobility elements of transportation systems in harmony with the needs of the context.	Study has demonstrated that the selected spaces determine the appropriate Urban Revitalization technique.
Study of the leftover space in the city based on reutilization: Take the space under elevated road in Shanghai as an example. (2016)	Shi, J.	Re-Survey of the urban space, focusing on Leftover space issues related to the current status of urban development reutilization and modification.	Although the results of the survey were fairly polite, there's the need to be concerned of the negative impacts of every category since it can be widely publicly unsettling.
The Plausible Metamorphosis of the Leftover Spaces near Elevated Infrastructures. (2019)	Adnan, A.	Provide a general checklist of activities that will help to make a comprehensive design program by back and forth process of evaluation.	The selected spaces can be identified as more than 'transport corridors' and add meaning to the overall landscape by how we perceive them.
Study of Utilizing Residual Spaces under Flyovers in Lahore, Pakistan. (2020)	Ahmed, H., Malik, A. M., Mujahid, S., and Khan, R.	Identify and analyze the types of social space according to Lefebvre's concept of leftover spaces by an observational analysis.	Shows that, it is necessary to study the demand, physical characteristics, and geographic contexts of the given space.
Improvise Overpasses: Study on Utilizing Spaces below Flyover (2015)	Mydin, M. A. O., and Utaberta, N.	Identify the additional possibilities that can be considered for developing flyovers by reviewing the community activities.	Having parking spaces, cafes, food stalls, and recreational facilities is attracting users.
Undefined lands: A review of their role as an underexplored resource of landscape (2020)	Naghibi, M., Faizi, M., and Ekhlassi, A.	A systematic review of 65 publications is conducted in the study. A summary of papers based on their scope, location, methods, and commonly studied aspects is presented by Pickering and Byrne's approach.	Social and ecological approaches in resilience, environmental stewardship, difficulty in sharing expertise for realizing potential, and a lack of knowledge partnerships emerged as the areas to be concerned.
The role of user preferences in urban acupuncture: Reimagining leftover spaces in Tehran, Iran (2020)	Naghibi, M., Faizi, M., and Ekhlassi A.	Evaluates interventions in vacant plots taking into account both residents' preferences and experts' opinions by an AHP-based visual questionnaire.	Design interventions are the most preferred, focusing on the type of vegetation, its density without compromising its safety, cultural and social contexts.
Commercial Value Assessment of "Grey Space" under Overpasses: Analytic Hierarchy Process. (2018)	Sheng, j., Xu H., Zheng, J., Luo, M., and Zhou, X.	Analyze the feasibility of transforming the "grey space" under overpasses into a commercial space by quantitative methods and analytic hierarchy process.	The study's findings conclude that it is vital to be concerned about accessibility, vehicular structure, and user comfort. Retail and services were found to be ideal.

A meta-analysis approach was used to identify the aspects to be researched as there was no single source to identify that. The following aspects were identified through this analysis.

1. Due to the lack of available space in the urban area.
    a. Explore the possible usage.
    b. People use the place through their own needs and understanding.
2. Due to the occurrence of misuses.
    a. Unauthorized activities / criminal hub/ waste disposal
3. Addressing the site from a theoretical, conceptual, or methodological basis.
4. Providing a theoretical framework for the utilization of leftover spaces.
    a. Technical aspect (acts/laws)
    b. From the aspect of human perception and user preferences.

The above-mentioned type 1 and type 2 conditions have not yet appeared in the country's expressway network. An already well-functioning space is required to type 3. Further, the first point of the 4(a) type mentioned above is not a research issue but a legal one. Therefore, the most appropriate option is to build a theoretical framework through human perception and user preferences to utilize the leftover spaces as given in 4(b).

The lack of analysis of relevant data and lack of response to residents' needs leads to impractical designs for the space. So, by encompassing pedestrian needs and expectations in addition to residents' feelings, a win-win situation can be achieved in terms of the use of space while also improving its economic value. Another factor to be considered in the design process is their location being under or next to a major road. This implies that noise, vibration, dust, security, and visual quality should all be taken into consideration. (Efe et al., 2016). It is vital to enhance the aesthetics as well as the safety of the space under expressways and its perimeter. Although safety should take prominence over all else, aesthetics simply cannot be ignored if a project aims to appeal to the emotional needs of the users.

Theoretical framework

The identified factors of the literature survey were given weight, taking the potential impact they have on long-term consequences concerning the goals that we aim to reach. The research method used by Sheng et al. (2018), with further modifications was used as the framework for this study. Figure 1 illustrates how the global view and meta-analysis are taken as a starting point and 4 different determining criteria are selected based on potential identifications of the spaces.

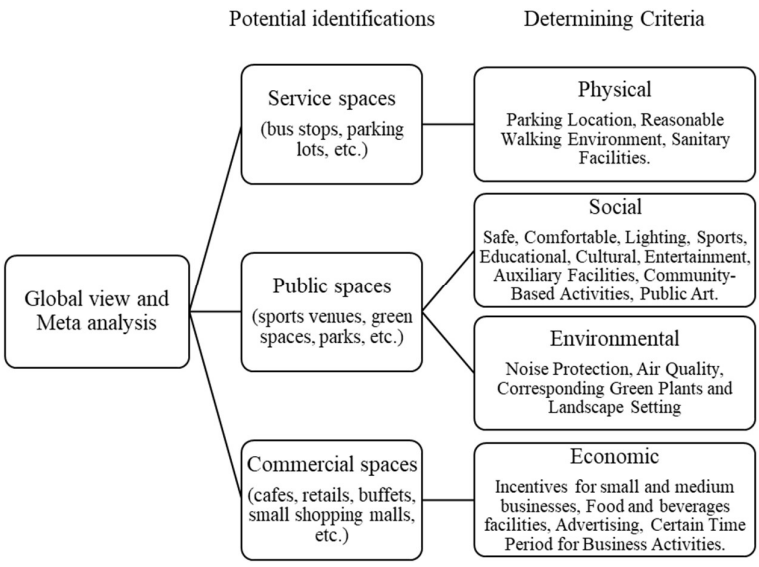

Figure 1: Theoretical framework
(Source: Compiled by Author)

Determining Criteria

According to the above theoretical framework (Figure 1), 17 criteria were selected to determine the utilization of expressway leftover spaces and they are discussed below. These have been categorized into 4 aspects based on common elements involved. Also, in addition to those 17 criteria, there is socio-economic and socio-environmental aspect considered as the 5th aspect, extracted from the potential identification of public space in terms of the social aspect.

- Socio-Economic - Sports; Educational; Cultural; Entertainment/Recreational spaces.
- Socio-Environmental - Parks; Gathering; Green spaces.

Table 4: Determining Criteria
(Source: Compiled by Author)

Aspect	Criteria	Description
Physical (A)	**A1.** Parking Area	Lack of parking space is one of the major issues in developing areas. Leftover spaces provide ample opportunity to create parking areas with minimal financial investment.
	A2. Reasonable Walking Environment	Freedom of movement and a pleasant environment is great for the mental well-being of users and to improve the image of the country that has made serious advancements in creating people-conscious infrastructure.
	A3. Sanitary/Auxiliary Facilities	Sanitary facilities are needed by everyone. Apart from being customers of a particular establishment, it is hard to find sanitary facilities within the context.
Social (B)	**B1.** Comfortable and Safe	It is of paramount importance that the users feel their safety reassured. As evident by case studies from different countries, these leftover spaces can easily become a hotbed for crime. Serious precautions must be taken to ensure the safety of citizens.

	B2. Public Art	The display of public artwork is a common example seen in the developed world. It is a beneficiary platform for local artists to showcase their talent and create a culture that appreciates art among the local population.
	B3. Lighting	If users are using a particular space at night; they are going to be more comfortable during the daytime. Knowing their comfort levels during the times of least expected safety can be a very useful method to gauge public perception regarding the state of safety and security related to the space.
	B4. Seasonal events	Exhibitions, carnivals, etc. are events that bring in a great deal of attention. It can provide a unique experience to the citizens if they are open to trying out these types of uses for the leftover spaces.
	B5. Community-Based Activities	Annual events are high-intensity and low-frequency events. In contrast, more regular activities can be polled for user interest.
Environmental (C)	**C1.** Noise Protection	Noise is a major concern whenever proximity to a road is considered. It is a factor that cannot be left out of a survey related to the expressway network.
	C2. Air Quality	Air pollution is becoming a major issue in developed countries and within more urban areas of Sri Lanka. It is important to keep an eye on the level of air quality as human health is of utmost importance.
	C3. Corresponding Green Plants	Shrubs and bushes are the most implemented utilization of leftover spaces that are considered low cost while also carrying a low risk of backfiring and causing negative consequences.
	C4. Landscape Setting	It is important to measure the need of the population for a better landscape design. If they are open to it, serious commitment can be given towards hiring experienced landscape architects in these development projects on leftover spaces.
Economic (D)	**D1.** Certain Time Period for Business Activities	If the business won't get accepted within the underutilized spaces, there wouldn't be a good reason to spend a large sum of money commercializing these spaces. It is best to know the attitudes and opinions of the population beforehand.
	D2. Incentives for small and medium businesses	Small and medium enterprises have the potential to thrive in a growing network of leftover spaces within the expressway network. Their existence and opportunity to do business should be considered.
	D3. Foods and beverages facilities	Food is a common need of travelers and shoppers. Food and beverage-related establishments and nearly a universal feature in the development of leftover spaces. They are also some of the lowest-risk ventures that can be started in a leftover space.
	D4. Temporary structures and mobile trucks	They are easier to establish and move away from if needed. This can be treated as an alternative implementation of commercialization of the space that comes with a greater degree of flexibility.
	D5. Advertising	Advertising is an easy way to monetize a leftover space with very little cost for development. It is an option worthy of exploration.
Socio-Economic or Socio-Environmental (E)	**E1.** Sports Space	Urban areas lack well-facilitated playing areas, which can be a less priority considering the number of needs an urban area should be providing. Therefore, underpasses are a solution to this need.
	E2. Gathering Space	People are attracted to gathering areas when the purpose is insinuated and the needs are facilitated. Also, in urban areas, people are always looking for a place to sit, chat or stay while waiting for someone.

	E3. Green Space	Urban areas require green spaces as much as their need to have service areas since it is vital to balance the impact that brings to the context.
	E4. Educational Space	Educational places are a unique and attractive solution for the underpass leftover spaces and might motivate certain communities who need to be motivated for their studies.
	E5. Cultural Space	Cultural places fit into underpass leftover spaces as they are semi-outdoor areas that can be morphed into various designs that attract crowds.

Research Methodology

Method of Data Collection

A thorough literature survey is conducted to gain a deeper understanding and knowledge about leftover spaces on expressways. A sequential mixed-method approach was used to conduct this study, incorporating both qualitative and quantitative methods to ensure the highest quality results. Following the literature survey and meta-analysis, a questionnaire was used to gather relevant data including the demographic data from residents and pedestrians in the expressway region in Kadawatha. 22 questions focusing on 4 different aspects which include 17 criteria and the 5th aspect which includes 5 criteria were selected and given to two groups, one consisting of the above users (50 Participants) and the other comprised of experts in the field. (3 Charted Architects/ Charted Landscape Architects, 3 Landscape Architects, 2 Lecturers, a Botanist, and an Engineer) In addition to the survey questions, experts were allowed to offer their insights regarding the situation in the form of comments under the question. Determining and comparing the most relevant social, environmental, physical, and economic variables is of primary importance. Statistical methods were used to gauge the importance of each factor.

Statistical Analysis

The above-discussed 22 criteria needed to be followed by considering their importance. So, a statistical analysis has been performed to rank those 22 criteria to gauge the importance of each factor, and, the relevant data has been included below in this study (Refer to Table 5 & Table 6).

Case Study Selection

After considering COVID-19 restrictions, nearby two locations from the Kadawatha were selected for the case study. The two areas of Kadawatha Interchange and under the overpass are located closely and users often use both locations at the same time. It is an ideal location to study two types of leftover spaces created while using the sample population for data gathering.

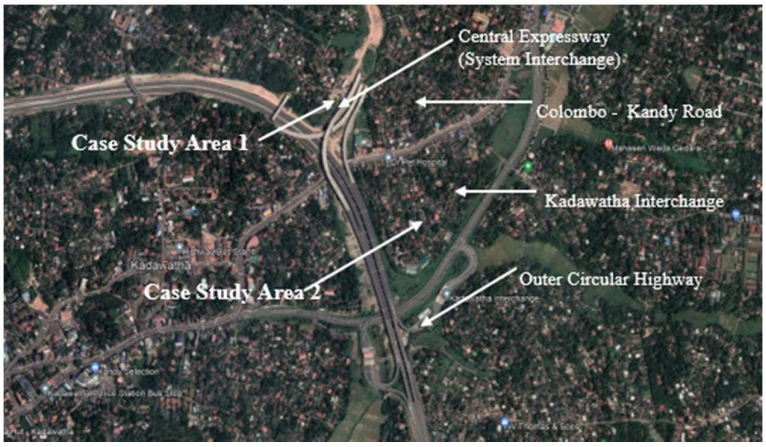

Figure 2: Selection of Case Study in Kadawatha Area
(Source: Google Earth Pro and edited by Author)

Case Study Area 1 - Kadawatha Interchange (Outer Circular Highway)	There is a long stretch of land that is of considerable width at the Kadawatha interchange of the outer circular highway. Minor modifications will have to be done to the roads to provide easy access to the developed facilities. Although it may appear as more of a hassle compared to the situation in the previous example from the central expressway, there is one major offering at the Kadawatha interchange and that is its offering of unobstructed vertical space.
Case Study Area 2 - Under the Overpass (Central Expressway)	There is a tremendous amount of leftover space that's several times the width of the road that is going under the overpass. This is a space that is easily accessible to thousands of pedestrians and motorists that are traveling past this location. Hence there contains a massive, underutilized potential in this area under the overpass that is currently of no use to anyone but animals in the vicinity. Aside from uneven ground, there are no obstructions to further development of this leftover space.

Figure 3: Selected Case Studies in Kadawatha Area
(Source: Compiled by Author)

Figure 4: Case Study Area 1
Source: Google Street View and edited by Author

Figure 5: Case Study Area 2
Source: Captured and edited by Author

Limitations of the survey

Due to the prevailing COVID-19 pandemic lock-down initiated by the government, the scope and the extent of on-site research were severely limited. It was possible to have several on-site visits during the times when restrictions were lifted. Online surveys and video conferencing helped to alleviate these issues to a large extent making it possible to complete the necessary surveys with sufficient sample size. When involving experts in the study, there were fewer sight images and

videos than envisioned available to be provided to them due to the same reasons. There were no affordable aerial photography options available for this research. Hence, satellite photography provided by Google was used. Upon further examination on-site it was clear that there were no major changes to the existing construction since the satellite photographs were taken.

Findings & Discussion

According to the Sociodemographic Data, Developments in the expressway network have consequences for various socioeconomic groups. 76% of the surveyed group go past these areas of leftover spaces at least 3 times a month. 76% of the surveyed population is also aware of the subject of leftover spaces. This is unsurprising because many of them are students or part of the active workforce of the country. Only 6% admit to being fully satisfied with the way things are. They do feel that it is possible to have better things. Although 12% admit to not caring, there is still 82% that would prefer to see a difference with 48% of them being unsatisfied with the existing state of leftover spaces they used. According to the theoretical framework, 17 criteria were selected as mentioned above to determine the utilization of expressway leftover spaces and those have been categorized into 4 aspects based on common elements involved. Further discussions about finding will go under those 4 aspects;

1. Physical Aspect

According to the physical factors analysis, all respondents generally value the physical factor, with a parking area (A1), reasonable walking environment (A2), and sanitary/auxiliary facilities (A3) being the most important factors, with an effective percentage of more than 50%. The experts point out that beautification, visually appealing space, and creating a pleasant environment as highly applicable to physical needs. According to them, the concepts of Pocket Parks, Urban forests, Rainwater Gardens, Wildlife corridors, and Plant nurseries can be adapted into these leftover spaces. There can be many innovative, interesting, and different functions that can be attached to these spaces as time goes on.

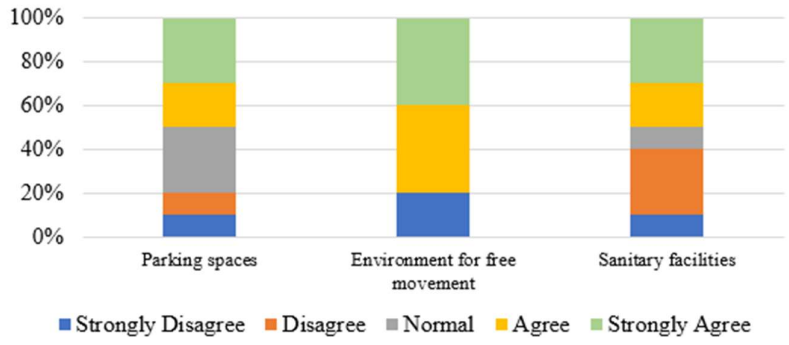

Figure 6: Graph of experts' Physical Aspects
Source: Compiled by Author

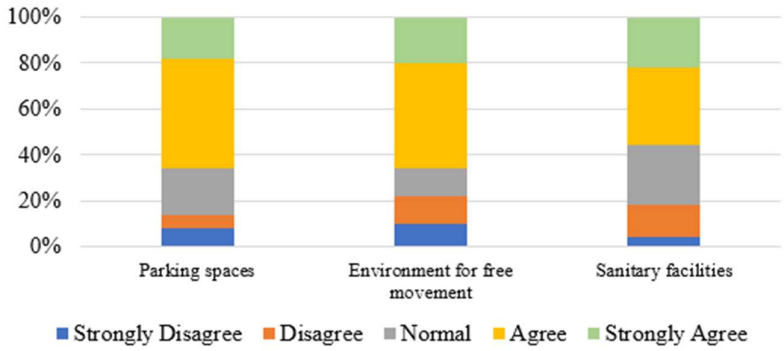

Figure 7: Graph of users' Physical Aspects
Source: Compiled by Author

2. Social Aspect

In terms of society, most respondents consider that there should be public arts (B2), and the effective percentage is more than 40%. Secondly, they have to be living in a comfortable and safe environment (B1). The ability to use it during the night (B3) is also given high importance. A much lower number of interviewees think that community-based activities are suitable (B5) and seasonal events (B4) receive the least amount of support. The everyday users are more concerned with utility and safety first and cultural events are given less of a priority. This is a very important point to be noticed by future developers. Experts' point of view is that social gatherings should depend on the safety of the location and the pollution levels. Therefore, gatherings should be limited. Community-based social activities are possible with these leftover spaces, but safety, as well as human health and well-being, should be of the highest priority. The highest level of expert support was given to public arts while the users were more concerned with the ability to use these locations at night. The two groups demonstrate different priorities. Since safety is a concern here, it is advisable to give more weight to safety-related needs when it comes to the social aspects of utilizing leftover spaces.

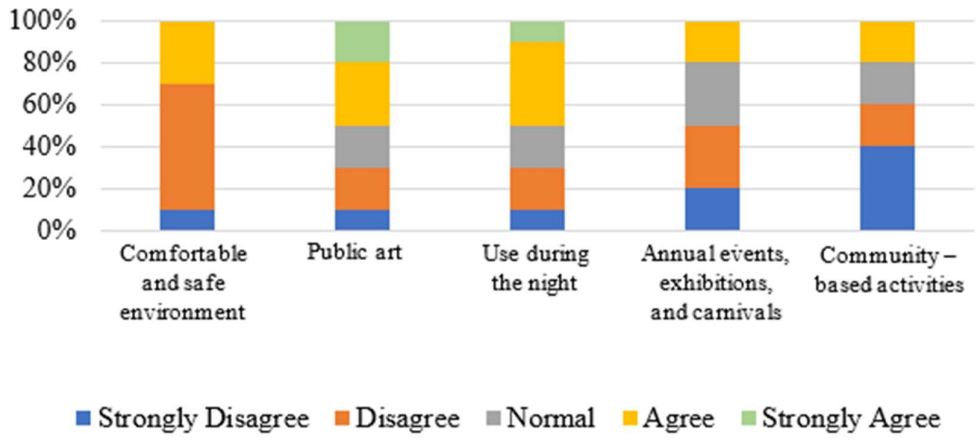

Figure 8: Graph of experts' Social Aspects
Source: Compiled by Author

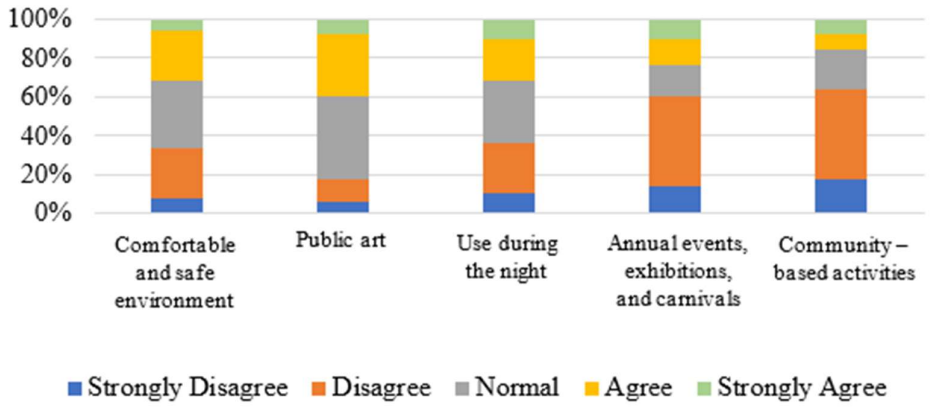

Figure 9: Graph of users' Social Aspects
Source: Compiled by Author

3. Environmental Aspect

The proper landscape setting of the leftover space (C4) among many environmental factors is what most people care about, and the effective percentage is as high as 80%. A proper landscape setting (C5) has universal approval with air quality receiving the least amount of support (C3). It's still important to note that the majority of the respondents did give importance to air quality. There are many things to consider when you're trying to make the best of the space you have. The idea of using these spaces is to make them as visually appealing as possible. The environment should also be pleasant to the eye. Experts point out that good natural vegetation will help to prevent air pollution and sound pollution. Environmental aesthetics can give great support to develop these leftover spaces and proper landscape architectural solutions are needed. If Leftover space is left free it should be allocated to nature. Then it could create a natural space for urban ecology. It will contribute to the preservation of nature and be environmentally valuable for future generations. It is to be noted that the support for proper landscaping solutions from experts wasn't as overwhelming as general users.

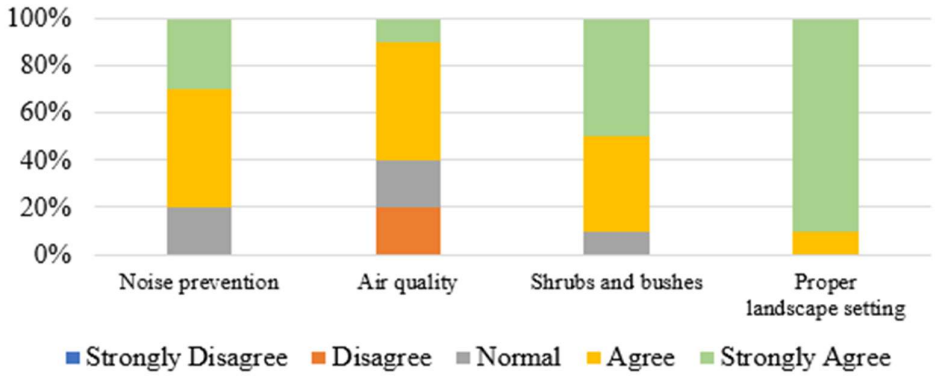

Figure 10: Graph of experts' Environmental Aspects
Source: Compiled by Author

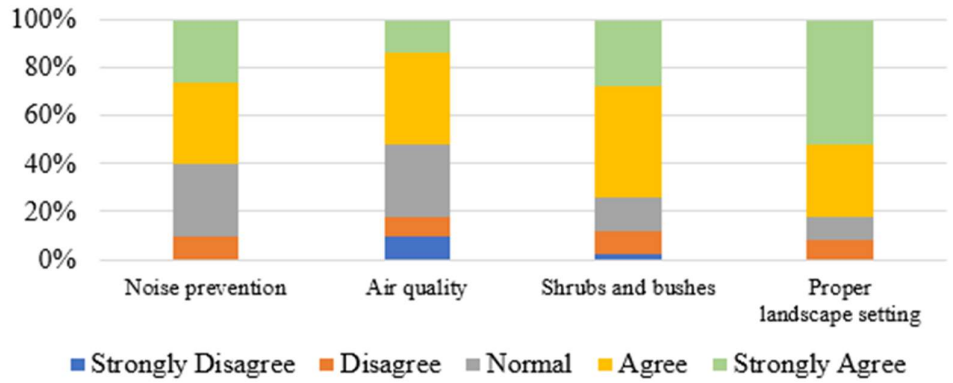

Figure 11: Graph of users' Environmental Aspects
Source: Compiled by Author

4. Economic Aspect

In terms of the economy, most users believe that the economic factors are normally important, but less so than the experts' consideration. These economic aspects received the least amount of support and in several criteria, the majority disagreed. This is in stark contrast to the physical, social, and environmental aspects analyzed in the previous graphs. Users are more likely to prefer buffets, street foods, and beverage facilities in terms of commercialization. Having small retail, shopping malls, and flower and fish shops also given less resistance. This is likely due to the immediate use cases and convenience provided by these facilities to urban dwellers and travelers. Expert opinion is that advertising must be of the appropriate scale and should be non-intrusive with little lighting and lacking in other attention-stealing aspects. High economic potential is there due to the interchange and the urban setting. The social and economic factors can be merged to create the best-utilized spaces with varying commercial activities. This will bring maximum value to the users without diminishing the value of expert opinions.

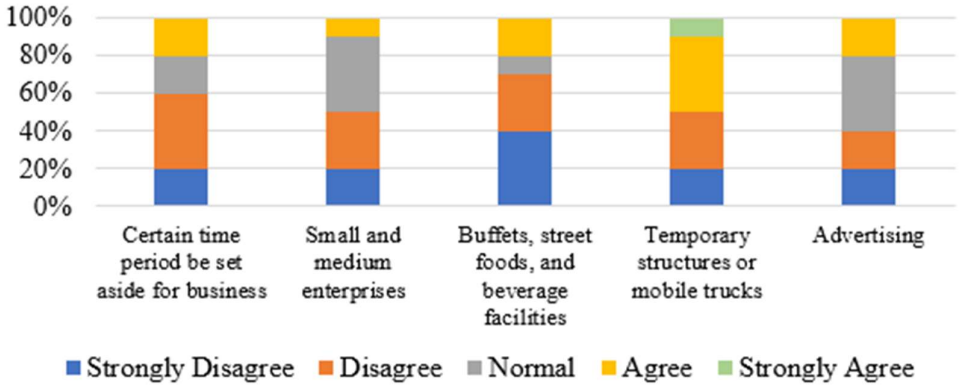

Figure 12: Graph of experts' Economical Aspects
Source: Compiled by Author

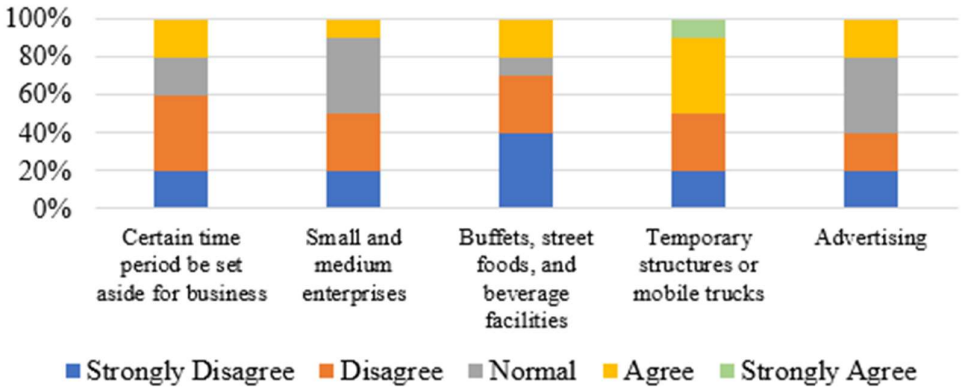

Figure 13: Graph of users' Economical Aspects
Source: Compiled by Author

Statistical Analysis

Obtain data through questionnaires, import excels, and assign values to A1, A2… and D3 through the variable view. "1 = Strongly Disagree, 2 = Disagree, 3 = Normal, 4 = Agree, and 5 = Strongly Agree" After the preliminary quantification of the questionnaire in the data view, users' data were retrieved. Table 5 and Equation 1 cover the statistical models and a comparison of criteria based on statistical methods is shown in Table 6 with their mean value and standard deviation.

Table 5: Values Assigned to the Variables
Source: Compiled by Author

	x_i	x_i^2
Strongly Disagree	1	1
Disagree	2	4
Normal	3	9
Agree	4	16
Strongly Agree	5	25

Equation 1: Mean Value and Standard Deviation
Source: Statistics – GCE AL Combined Math

$$\bar{x} = \frac{\sum_{i=1}^{n} f_i x_i}{\sum_{i=1}^{n} f_i} \qquad s = \sqrt{\frac{\sum_{i=1}^{n} f_i x_i^2}{\sum_{i=1}^{n} f_i} - (\bar{x})^2}$$

Table 6: Comparison of criteria importance
Source: Compiled by Author

No.	Main Criteria	Mean ($\bar{x}$)	Standard Deviation (s)	Rank
C4	Proper landscape setting	4.26	0.934	1
C1	Noise prevention	3.76	0.950	2
D1	Certain time period be set aside for business	2.96	0.958	3
B2	Public arts	3.24	0.971	4
C3	Shrubs and bushes	3.88	0.993	5
B1	Comfortable and safe environment	2.96	1.038	6
A1	Parking spaces	3.62	1.093	7
A3	Sanitary facilities	3.56	1.098	8
B5	Community-based activities	2.42	1.115	9
C2	Air quality	3.38	1.129	10
B3	Use during the night	2.96	1.131	11
D5	Advertising	3.06	1.139	12
D2	Small and medium enterprises	3.04	1.166	13
B4	Annual events, exhibitions, and carnivals	2.6	1.183	14
D3	Buffets, street foods, and beverage facilities	3.22	1.188	15
A2	Environment for free movement	3.54	1.220	16
D4	Temporary structures or mobile trucks	3.08	1.262	17

Socio-Economic & Socio-Environmental Aspects

Experts show their overwhelming support for green spaces and unlike in many other instances, the users are on the same page with the expert recommendation. Sports space is the least favored by both parties. These data points can help to outline a basic framework around the needs and expectations for projects working to utilize these underused spaces. While experts are more neutral regarding educational spaces, users are of a more disagreeing opinion. It is possible that their experience of noise and air pollution contributed to this decision.

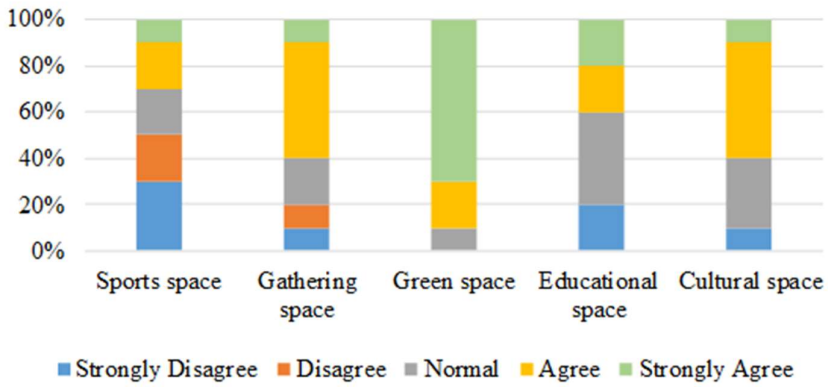

Figure 14: Graph of experts' Opinion
Source: Compiled by Author

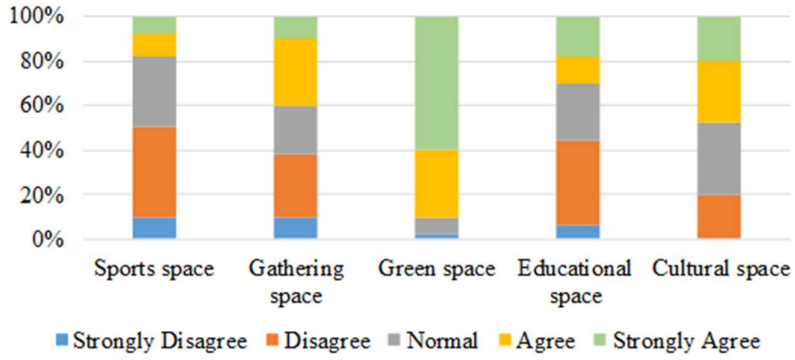

Figure 15: Graph of users' Opinion
Source: Compiled by Author

Guidelines derived from the study for future developments

From the above survey, it is evident that both general users and experts prefer green spaces. Therefore, when developing leftover space, as per the above criteria the following guidelines can be considered.

Table 7: Guidelines according to the determining criteria
Source: Compiled by Author

Guidelines	Physical	Social	Economic	Environmental
1. There should be some pausing spots along the highway that are not disturbed by sound pollution.	✓	✓		
2. Landscape design should be done with public involvement from the affected parties to deliver the most effective results for the users.		✓	✓	
3. Means of access and safety should concern for any activity.	✓	✓	✓	
4. Developers must be concerned about road safety and the distraction of drivers.	✓	✓		
5. The green of extra spaces with minimal changes is still well received by the public as well as experts.		✓		✓
6. Utilization is received with a less favorable eye compared to what is seen among the case studies of the developed world.		✓	✓	
7. Safety is of the highest priority for the users. Nighttime safety and being free of crime are of paramount importance.		✓	✓	✓
8. Green space and proper landscape settings face the least amount of resistance. These could be used as		✓	✓	✓

default low-cost solutions when in-depth research cannot be conducted.				
9. Social gatherings, annual events, and sports spaces are not well received. As these are costly endeavors anyways, it is advisable to deprioritize projects of this nature.	✓	✓	✓	
10. The display of public artwork is a great way to beautify the leftover spaces and positively deal with posters and graffiti.		✓	✓	
11. Most people are aware of the potential of these leftover spaces, and they can easily access more information through the World Wide Web. It is best not to sweep this problem of leftover spaces under the rug.		✓	✓	✓
12. Changing people's minds about the utilization of leftover spaces may take some time and without doing that, the maximum economic benefits of leftover spaces cannot be achieved.		✓	✓	
13. Users are favorable towards the kind of conveniences that aid in their daily lives such as refreshment stores or places to buy cheap household equipment. The first wave of utilization should focus on these factors.	✓	✓	✓	
14. As cities get congested with traffic, creating car parks can be a low-cost – high-value utilization of these spaces.	✓	✓	✓	✓
15. It is best to focus on scalable solutions that can be tested once and implemented at a wide range of locations without having to conduct a separate series of research for each location or cluster of locations.	✓	✓	✓	
16. Having an existing framework for dealing with leftover spaces will become extremely important as the growth of the expressway network continues.	✓	✓	✓	
17. It is best to consider the development of the leftover spaces while developing the expressway infrastructure instead of waiting till after the initial developments are complete.	✓	✓	✓	✓
18. Leftover spaces should not be treated as useless or something bad. They should be treated as an opportunity and steps		✓	✓	

should be taken to create development projects that focus on these spaces throughout the nation.				
19. Prevention is better the cure. If it's possible to minimize leftover spaces – that is the best option. Take this into account during the planning phases of highway development projects.	✓	✓	✓	✓

Above mentioned guidelines are developed considering an overall project, without only focusing on one of the four main aspects that are discussed in the previous chapter of the study.

Conclusion

It is possible to create a series of standards and guidelines that apply to most leftover space scenarios within Sri Lanka. Engineers and Landscape designers can modify the used cases and guidelines expressed in this paper to better accommodate the specific needs of the location. User surveys should not be ignored as they can give unexpected insights into future developments.

Economic development is the least well-received among both users and experts surveyed while creating green spaces as well as proper landscape settings are extremely well-received by both parties. This is a good rule of thumb to consider where public support is crucial to an expressway development project.

As discovered in the survey, immediate utility and convenience to the user are given high importance. There is low preference given towards annual events or community activities in leftover spaces. Public artworks, murals, and various other artistic constructions are also well received despite not offering easily measurable utility or convenience.

Safety is of very high importance and should not be compromised in any case. Most users are aware of the use cases for leftover spaces due to the ease of access to global information and they are not fully satisfied with the way things are in the current condition. Change is expected, especially among the students and young workforce of the country.

Development of these leftover spaces should be balanced based on expenses incurred and potential revenue that will be generated. When the funding is tight, it is best to aim for low-cost developments that are generally well-received. More expensive leftover space development projects can be reserved for highly urban areas where land is of high value.

Having no development can lead to various criminal activities and undermine the safety of the nearby area. This can have a significant negative reception from the public and therefore it is advisable to take at least steps to develop these leftover spaces regardless of having revenue generated.

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