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The Long Road to Sustainable Tunnelling Works in the Malaysian Construction Industry: The Past, Present and Future

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Article Info
Volume 81
Page Number: 867 - 875
Publication Issue:
November-December 2019

Article History
Article Received: *3 January 2019*
Revised: *25 March 2019*
Accepted: *28 July 2019*
Publication: *25 November 2019*

Abstract

Today, the greater part of the total population is living in urban areas, where the figure will scale in all respects rapidly to accomplish 60.4% in 2030, leading to scenario where urban communities are progressively blocked and stuffed. The rapid development in urban zone to address human issues are therefore observed to be unparallel with the rule of sustainable development. Moreover, the highly demanded space with extraordinary weight for residential and infrastructure will result in high-profile environmental issues. To tackle this compacted space, Malaysia has fully utilised the underground space, beginning with the foundation of shop parts underneath the Merdeka Square in 2003, at that point pursued by Petronas Twin Towers, Light Rail Transit (LRT), Storm water Management and Road Tunnel (SMART), and the latest is a progressive undertaking of Mass Rapid Transit (MRT). Looking on decidedly for the underground improvement for foundation, this paper aims at appraising the past, present and future utilisation of underground space via sustainable tunnelling works in Malaysia by exploring the level of awareness of 144 construction stakeholders in Kuala Lumpur and Selangor through structured questionnaire survey. The investigation attempts to have an insight towards sustainable tunnelling works and a way forward to incorporate sustainability with the complex projects such as tunnelling projects in the Malaysian construction industry.

Keywords: *Sustainability; tunnelling works; Malaysian; construction industry*

1. INTRODUCTION

As the world is moving into the 21st century, one of the essential tasks to the urban design is to refurnishing the urban space as the counterparts to the new urban design [1];[2]. Apparently, infrastructure becomes fundamental to the continuity and experience of a contemporary city, thus the demand for improved live ability and environmental protection have created a strong demand for new underground development. This process gradually moves the population from rural to urban areas and if this is combined with the overall growth, there may be more than 2.5

billion people by 2050 in urban areas, which increase up to 90 percent taking place in Africa and Asia [3]. Undeniably, urbanisation percentage in most of developed countries is increasing due to the increasing number of urban populations and will continue to increase to almost 85.9% in 2050. By then, the world can be therefore categorised as urban area.

Increasing demand for surface space has led to development on marginal land, including soft soils, slopes, waterfronts and brown field sites [4][5]. Construction industry has expanded the scope to develop a space into residential and infrastructure without considering the lacking of green space, pollutions and traffic congestion [4][6][7]. As many mega cities show, there is a limit of how far cities can sprawl [8][9]. Thus, deeper discussion on the potential of underground space is seen as practical to be discussed. Underground space by definition is a space that location beneath ground level [10][11]. According to National Land Code 1965, Section 92A, underground land is a land below the surface of the Earth, which means anything below the surface land can be considered as underground land. Hence, the possible solution is to go for the third dimension of the urban areas as a final resort to develop a sustainable urban space. Underground development will create more space above ground for many purposes especially for social and healthy life style by developing a new green residential. Looking back, the underground space has been misused for military purposes for over thousand years [6]. It is only later that the underground is become an alternative for transportation, commercial building and other infrastructure, such as tunnelling and integrated railway transport.

Malaysia is also facing these increasing urbanisation issues, hence the consideration for using urban underground space for development is compulsory. Malaysia started underground space development in 2003 with the building of shop lots below the Merdeka Square followed by Stormwater Management and Road Tunnel (SMART), Light Rail Transit (LRT) and Petronas Twin Towers [12] and new on-going Mass Rapid Transit (MRT). Although with lack of experience and emerging issues on legislation enforcement over the development process and the protection of the existing structure and tenants' safety, those developments proved that Malaysian are now looking forwards for new sustainable approaches [13]. These issues are due to underground utilisation pattern varies in different urban contexts, depending on the local culture, geographical situation, social environment and economic needs [14] [15]. This paper hence focuses on the current and future use of underground space in Malaysia in relation with the sustainable tunnelling works, and eventually exploring the level of awareness of construction stakeholders on sustainable tunneling works.

2 UNDERGROUND SPACE DEVELOPMENT

Since numerous reasons have encouraged mankind to use and develop underground space over the years, it is necessary to keep in mind on certain fundamental characteristics of underground space for a better understanding of these reasons [16]. Firstly, the underground area is a space that allows for infrastructure activities which characteristically known as troublesome, unthinkable, naturally unwanted or less gainful to introduce over the ground. The natural protection offers to whatever is

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placed underground as a typical characteristic of underground space lies in. There are acoustical, thermal and simultaneously mechanical. Secondly, underground structures create advantages to protect the surface environment from the risks and/or disturbances inherent in certain types of activities especially construction. Finally, the darkness of the direct feature offers the natural visual screen which only visible at the points where it links to the surface created by the geological medium.

There are connections between surface space and underground space that must be integrated to maximise its benefit. There are three parts of underground: shallow underground, deep underground and deep subterranean zone. The development surface is the space of usage integration with underground space. The utilisation of underground space will not only depend on its usage, but other aspects need to be considered, especially on the legal and administrative, economic, social, safety and health, technical and also geo-environmental issues. Most of underground structures are suitable for many sites, functions and building programmes, thus becomes an alternative for development when conditions are appropriate [17][15]. Figure 1 illustrates the feasible depths of different activities involved in the surface and underground space development [18][11].

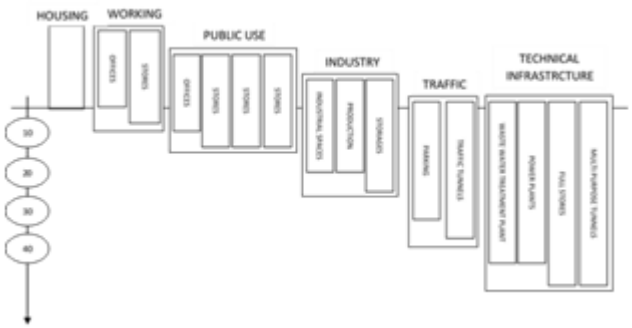

Figure 1. Underground Development – Feasible Depth. Source: [18][11]

Based on Figure 1, it is apparent that the need and importance of underground space as a part of development are undeniable. Underground space is developed only for car parks, shop lots, and service facilities. Most of the infrastructure, such as subway, road, pipeline and others are buried underground to maximise land use. Therefore, the underground resource will lead to utilisation of underground space. The utilisation pattern are varies in different urban contexts, depending on local culture, geographical situation, social, environment and economic need [14][15]. There are many reasons for and benefits from going underground for development.

Firstly, it is the land use and location [7], where in many cases, underground space utilisation results from a non-appearance of the surface space. There are numerous sorts of infrastructures that are ideal or essentially set underground in light of the fact that their physical nearness superficially is undesirable, for example open utilities, stockpiling of less-alluring materials, and vehicle carparks. Secondly is about the environmental preservation [19], whereas the ground additionally gives an assortment of points of interest as for environmental protection, these are quite significant viewpoints in structuring facilities with a low environmental impact. Thirdly is about topographic reason [16], where in the sloping or rugged territories, the utilisation of tunnels improves or makes doable different transportation alternatives, for example streets, railroads, canals, and so on. Tunnels are additionally a significant alternative in stream, straits, and harbour intersections. Underground space use offers numerous favourable circumstances as to the format of facilities and infrastructures. These preferences basically from the opportunity

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inside the geographical, cost, and land possession constraints to plan facilities in three dimensions and from the evacuation of physical boundaries on the land. Finally, is aesthetic [20] as by going underground, it helps in evacuating ugly structures. In accordance with that, more surface space can be provided for other development options.

3 SUSTAINABLE TUNNELLING WORKS

The construction stakeholders are looking for new ways to allow for economic growth while preserving the natural environment towards sustainable development, where the best sustainable way is through proper planning. Underground development must be acknowledged whether it is legally possible, economically practical and socially and politically worthy [7]. Therefore, research of urban underground space development should be done, focusing on the above elements. More extensive use of the urban underground can help cities to reach the goal of sustainable development, but this can only be achieved under the conditions of a long-term planning. Therefore, more research should be conducted in order to help define the potential use of urban underground resources and to evaluate the effect of a use upon another, considering space and time

Since city centres are densely built areas, building underground can accommodate many functions, relieving pressure on the surface and it can be an attractive solution for solving traffic problems and increasing mobility. Users of urban underground space can be divided into two categories; functional infrastructures and passing and living spaces [10]. Functional infrastructures here relate to urban daily functions such as public utility, storage facility, and energy exploitation system. Meanwhile, passing and living space mostly relates to spaces for human activities such as transportation network and underground commercial centre. Usually, underground development supports the utilisation of the underground space of urban areas, as an integral part of physical planning and zoning, for the alleviation of the surface problems and the improvement of the quality of life and the environmental conditions [21]. According to [22] and [23], Japan has listed the actual solutions for urbanisation with underground spaces since 20 years ago. Malaysia also advancing in underground urban space solution with the innovative Storm water Management and Road Tunnel (SMART) by solving traffic congestion issues and flash flood in Kuala Lumpur. Unfortunately, due to lacking of expertise in urban underground space development, massive flooding occurred at Merdeka Square's underground. Nowadays, research on urban underground space has advanced globally. It is possible today to develop urban underground space for underground commercial centres since the trend now is moving towards maximisation of space use whether on surface or underground. Through the development of underground commercial centres, open spaces can be utilised as well as having the potential to reduce the cost of land acquisition.

4 RESEARCH METHODOLOGY

This paper began with a comprehensive literature review on the sustainable construction, which subsequently led to the development of questionnaires that underwent a pilot study on 13 professionals from construction industry. According to [24], through pilot study, the Cronbach alpha coefficient value should be greater than 0.70. The Cronbach Alpha results generated via

pilot study to test the reliability of questionnaires were recorded between 0.860 to 0.986, which indicate that the questionnaire survey was appropriate and reliable for the actual questionnaire survey. Content validity was performed to ensure that the measurement implies adequate and representative set of items that according to the concept [25].Relative Importance Index (RII) technique was also utilised for investigating the sustainable construction (SC) barriers and critical success factors (CSF).

400 Grade G7 construction workers from Kuala Lumpur and Selangor were chosen from Construction Industry Development Board (CIDB) Malaysia database. Grade G7 are those who engaged in a large-scale construction business with no financial constraint. By removing invalid and incomplete responses, a total of 144 completed questionnaires were taken into account. With a total 36% of response rate, this response rate is well acceptable in the view of this paper as the outcome of a web-based survey for the construction industry is usually in the range of 20-30 percent [33][34]. Thus, the current percentages of feedbacks are good enough for a meaningful analysis.

5 RESULTS AND DISCUSSION

Based on Table 1, majority of respondents claimed that they did not receive education/information about sustainable tunnelling issues related to their daily work, hence this is seen as the most awareness needs to be taken care of towards the implementation of sustainable tunnelling works in Malaysia. This is followed by they intended to know more about sustainable tunnelling works (RII=0.825), they rarely heard about sustainable tunnelling works (RII: 0.808) and they disregarded the importance of sustainable tunnelling works as part of the community development in the infrastructure projects in Malaysian construction industry (RII = 0.800). Lack of awareness among professionals, lack of professional knowledge, lack of awareness among clients, lack of awareness of benefits, ignorance or misunderstanding about sustainability, lack of education and knowledge in sustainable design due to a lack of information were common to most stakeholders in the construction industry. In several cases, stakeholders admitted to not being aware of sustainable measures or alternatives that fall within their remit. Similarly, installing sustainable technologies and materials requires new forms of competencies and knowledge, yet it was evident from the previous studies namely[35][36][37]that not all those with responsibilities in this area had the necessary experience or expertise to meet the challenge. Since the construction industry is made up of different actors with different opinions (clients, consultants and contractors) who have to come to work together as a team in order to ensure the successful completion of a project, there is the need to create, improve and expand the awareness and knowledge of sustainability tunnelling amongst the various actors in the construction industry in Malaysian construction industry.

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Table 2. RII for awareness of sustainable tunnelling works among construction players in Malaysia

Awareness on Sustainable Tunnelling Works amongst Construction Players in Malaysia	Responses					RII
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
I have received education/information about sustainable tunnelling issues related to my daily work in Malaysian construction industry	0	6 (4%)	12(8%)	78 (54%)	48 (33%)	0.833
I am interested to know more about sustainable tunnelling projects in Malaysian construction industry	0	6 (4%)	6(4%)	96 (67%)	36 (25%)	0.825
I have heard about sustainable construction in tunnelling projects in Malaysian construction industry	0	6 (4%)	12 (8%)	96(67%)	30 (21%)	0.808
Sustainable tunnelling works are important as a part of community development in infrastructure projects in Malaysian construction industry	0	6 (4%)	12 (8%)	102 (71%)	24 (17%)	0.800

6 CONCLUSION

The need for urban underground space in Malaysia is not that critical compared to other developing countries. However, awareness about the possibility of using urban underground space as a new type of development must be considered. Due to rapid growth of development, the demand for land also increases and, in the future, Malaysia has already showed its commitment towards sustainability since the Tenth Malaysian Plan (10MP) until the recent Eleventh Malaysian Plan (11MP) and recently through Industrial Revolution 4.0. They seem to utilise all surface and underground spaces for achieving its mission towards sustainability even though the implementation has not been firmly seized due to the very low awareness of its practice and their misleading perceptions about the field. Finally, the development of urban underground space must conform to a required standard of sustainable development since it has impacts on the physical, social, and economic environment of the surface area. Suggested future research in this context must touch on the legal aspects, planning policy, urban underground resources, and other related issues.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the Institution of Engineering and Technology (IET) for providing the financial support under the Institution of Engineering Travel Awards 2019for this paper to be published.

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