

THE PRINCIPLE OF DEPTH FOR UNDERGROUND LAND DEVELOPMENT: A REVIEW

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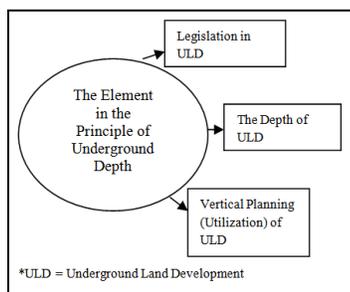
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Abstract

In this era, the developments are not taking place at the surface land, but also going downward by utilizing the underground land. The importance for developing underground land cannot be denied since worldwide has the good example of underground land development especially in the infrastructure development. In developing underground land, the depth is one of the considerations to determine how deep the construction can go underground. However, in relation with the ownership and restrictions in developing underground, the depth of the development in for underground land has become a major issue. By looking at the perspective of countries that tremendously developing underground as China, Finland and Japan; this article reviewed and discussed the three aspects related the principle of underground depth, which are the legal considerations, the depth of development also vertical planning (utilization), which have been practiced in those countries include Malaysia. As a result, the discussion shown Malaysia is ready to develop the underground land because there is a legislation that supports it. However, Malaysia must work towards the vertical planning of underground based on the depth of the utilization as the other countries do; for future development.

Keywords: Underground land, land utilization, stratum development

Abstrak

Di dalam era ini, pembangunan bukan sahaja melibatkan permukaan tanah, namun juga dibangunkan di bawah tanah. Kepentingan pembangunan tanah bawah tanah tidak dapat dinafikan lagi kerana dunia telah menunjukkan contoh terbaik bagi pembangunan tanah bawah tanah terutamanya pembangunan infrastruktur. Dalam membangunkan tanah bawah tanah, kedalaman merupakan salah satu perkara yang perlu dipertimbangkan dalam menentukan sedalam mana pembangunan itu. Walaubagaimanapun, berkaitan dengan pemilikan tanah dan sekatan-sekatan dalam membangunkan tanah bawah tanah, kedalaman pembangunan selalu menjadi isu yang utama. Dengan melihat perspektif daripada negara-negara yang pesat membangunkan tanah bawah tanah seperti China, Finland dan Jepun; artikel ini mengkaji dan membincangkan tiga aspek yang berkaitan dengan prinsip kedalaman tanah bawah tanah, iaitu pertimbangan undang-undang, kedalaman pembangunan dan juga perancangan (gunatanah), yang telah diamalkan di negara-negara ini termasuklah Malaysia. Hasilnya, perbincangan ini menunjukkan bahawa Malaysia bersedia untuk membangunkan tanah bawah tanah kerana telah terdapat undang-undang yang menyokongnya. Walau bagaimanapun, Malaysia perlu berusaha ke arah perancangan tanah bawah tanah mengikut kedalaman seperti mana negara-negara lain, bagi pembangunan di masa hadapan.

Kata kunci: Tanah bawah tanah, penggunaan tanah, pembangunan stratum

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1.0 DEVELOPING UNDERGROUND LAND – PAST, PRESENT AND FUTURE

Historically, the exploitation for utilizing the underground land started thousand years ago as a shelter, strategic and military purposes, religious building also drainage¹. Together with the demand in developing urban area also the advancement in technology for construction has lead for rapidly utilizing underground land, such as tunnelling, integrated railway system, pipeline, commercial development and others. By this, we need to agree that the underground land utilization in the past created out the interest to do something new and creative. Moreover, the concept of sustainable development helps to plan and develop the underground land in a systematic way.

Underground land development helps to contribute partial solution to the urban problems in terms of necessity, construction, and social objectives. This is because the underground land provides new spaces for infrastructure, services and utilities without claiming valuable space on the surface. The use of underground land as an underground subway system, an underground road tunnel, or parking space is the most common. Some people might think that underground construction only focusing on tunnelling, but it is more for underground land than tunnelling. Worldwide, there are good examples of museums, shopping centres, theatres and other commercial properties being built underground. Since underground land consists of three layers; i) Shallow underground ii) Deep Underground iii) Deep Subterranean Zone², they are many examples of successful development in the underground land around the world that can be explored³⁻⁴.

However, the depth of underground land development will complicate the development if it is not defined. Why is that so? Since the development is sprawling, there is a limit on how it can develop because of the national territories and boundary. The depth of the development in for underground land development has become a major issue commonly it relates to the ownership of the surface and underground land and its restrictions on the development⁵. The underground land development involves 3D development where the depth is one of the considerations to determine how deep the construction can go. Hence, this paper attempts to review the aspects related on the principle of underground depth in China, Finland and Japan that utilize underground land thoroughly. The comparison and discussion based on research element will be carried out to identify the best mechanism for developing the underground land in Malaysia.

2.0 THE PRINCIPLE OF UNDERGROUND DEPTH

2.1 Basic Rule of Underground Depth

There are four basic principles for underground depth that applied in the underground land development in other countries. Below are the detail explanations toward the basic rule.

i) The greater the depth, the lower the degree of human activity

There are links between surface space and underground space. The usage, both in surface and underground must be integrated in order to maximize its benefit. Figure 1 shows the usage of surface and underground space. Usually the underground space can be categorized into three parts; shallow underground, deep underground and deep subterranean zone. The development surface space will always have the usages integration with underground space.

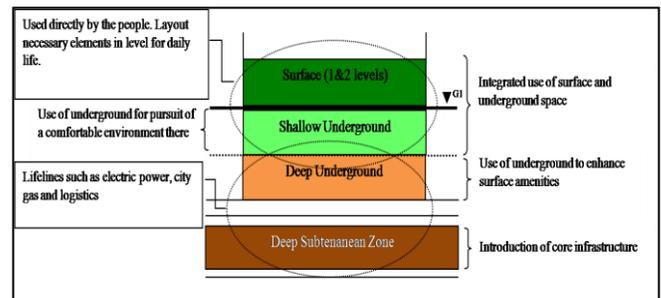


Figure 1 Use of Surface and Underground²

Based on Figure 1, the shallow underground will focus on entertainment activity, shopping centres and other human activities. Meanwhile, deep underground are use more on infrastructure and utility network and transportation activity.

ii) The deeper the building underground, the more stable the temperature and vice versa

The earth is an excellent insulator between the outdoor and the indoor environments. Soil functions as a heat retainer and processor between different seasons. Usually, the depth of the building in the earth (from 0-10 meters) determines the degree of seasonal fluctuation of the indoor temperature⁶.

iii) Design the underground land configuration to address the long term goals for underground land use (beyond first come, first served)

In Tokyo the first subway line was installed as a shallow line (10 meters) deep immediately beneath the existing layer of surface utilities. As more subway lines have been added, the new Keiyo JR line in Tokyo is 40 meters deep has been proposed. Next is

the super highway from Marunouchi to Shinjuku has been proposed to 50 meters⁷. The issue was highly demand of transportation lead to underground land utilization. But, if the layer are not well configure, the spaghetti subsurface problem will occur. Therefore, it is important to identify the need of underground land development by the depth so that the underground land development intersection is in properly order.

This is because once underground land is permanently altered and develops, it is not easily to demolish unlike the surface buildings.

iv) Difference patterns result from different planning goals

As our land includes surface and underground space, it has many resources that need to be explored for development. Therefore by going underground, the resource that lies beneath our feet will lead to utilization of underground space. But, underground utilization pattern varies in different urban contexts, depending on local culture, geographical situation, social, environment and economic need⁷. The definitions for underground layers vary from city to city and depend on goals and conditions of urban planning⁸; even in the same planning condition, the difference on planning idea can conduct the different underground vertical use patterns as shown in Figure 2.

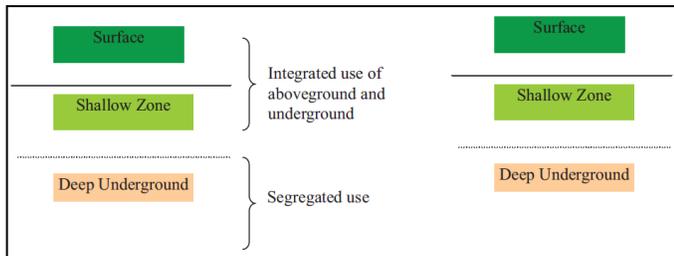


Figure 2 Schematic Model for Urban Underground Vertical Use⁸

The basic rule of underground depth is very important to set up the planning goal for a long term. That's the reason why in the early stage of planning, the layer of underground land and the depth for development need to put into consideration first.

2.2 Feasible Depth for Underground Land Development

The city will have the different utilization of underground layer in each layer based on the geological factor. Idea of the city and its underground land development has to generate and identify for the layout of vertical planning of the country. Therefore, there are three selected countries which are China, Finland and Japan; to be reviewed in this paper. These 3 countries are chosen based on

their experience in developing their underground land as an alternative urban development.

China

Due to the rapid increase in population and the economic growth in China, the exploration and utilization of underground space has been greatly reinforced. The total scale of underground space has increased 37.11 million square meters in 2003 to 132.96 million square meters in 2010⁹. Movement of underground space development in China can be seen for the purpose of preparing for war in 1960's and now the needs of the underground land is more than that. For the legal consideration, China has promulgated 32 laws and rules for legal and administrative implementation in underground land development (until July 2011)¹⁰. The laws and rules are divided into two types; the first type aims of the administration on comprehensive development and utilization of urban underground land. The second type is aimed at some section or aspect in administration on the development and utilization of urban underground land.

Basically, in China, the development of surface and underground will be divided into a few layers according use and level. This is because the underground land development can accommodate more of city functions together with the development. Due to this, the utilization for underground depth has planned to assist the development. For instance, the Underground Space Resource Plan of Shenzhen (Table 1) has divided the layers of underground development into four. First is the volume of superficial (0~10m), where the underground land resource is suitable for commercial, residential, parking lot, footpath and construction equipment. Whereas, the sub-superficial (-10m~-30m) underground land resource is for refuge facilities, subway tunnel, common ditch and public utility. The superficial and secondary superficial underground land located close to the surface, which makes it easier for people to go up and down. Therefore, this part of the underground land has the highest use value, easy to develop, and it is also the most comfortable part to people both in material and psychological.

Hence, the superficial and secondary superficial underground space should be treated as the regions that accommodating the vast majority of human activities, which is similar to the activities on the ground.

Table 1 Underground space resource plan of Shenzhen¹¹

	Civil land (Within building red line)	Public land (Road)	Public land (Park, Square)
Above the city	Office building, Commercial building, Dwelling	Elevated Road	Green open space, Nature environment,
Adjacent to the surface	Office building, Commercial building, Dwelling	Road (Roadway, Foot path)	Water, Refuge facilities
Superficial layer (0 meters ~ 10 meters)	Commercial facility, Parking plot, Footpath, Construction equipment layer	Road, Subway station, Commercial street, Parking plot, Public utility	Parking plot, Refuge facilities, Public utility, Processing system
Sub-superficial layer (11 meters ~ 30 meters)	Refuge facilities	Subway tunnel, Common ditch, Road, Public utility	

On the basis of the integrated development and utilization of above, superficial and sub-superficial ground space, deep underground land should also be included into the system of urban land's integrated development and utilization. Deep underground space has the depth of underground more than 50 meters. It is a unique region, characterized by merely non-existent of human activity. This area can provide heavy infrastructure of urban network, such as nuclear power plant in the deep underground. We can also store large amounts

of water and energy by using deep underground space's large capacity, thermal stability, and the ability of standing high pressure, high and low temperature¹⁰.

Besides Shenzhen, Beijing city also ready with the planning for underground land where in 2005, the Beijing Planning Committee has completed the major planning effort for the Beijing urban area. This plan aimed to not only encompass the current use of underground land, but also to propose requirements for future development. The planning for different subsurface level is summarized in Table 2.

Table 2 Vertical planning of underground land in Beijing¹²

DEPTH	HUMAN ACCESSIBILITY	USE OF UNDERGROUND LAND
≤ 10 meters	Excellent for access	Municipal pipelines, parking lots, commercial facilities, pedestrian transit ways, transportation hubs, utility tunnel and subway lines
10 meters – 30 meters	Good to access	Parking lots, transportation hubs, subway lines, underground roadways and underground logistics systems
30 meters – 50 meters	Hard to access	Urban infrastructure, storage and underground automobile roads
50 meters – 100 meters		

Based on the table, it can explain that the level of development can be divided into four parts which are the depth is between 0 meters to ≤ 10 meters, 10 meters to 30meters, 30meters to 50meters and 50meters to 100meters. The depth of the development is influenced by the human accessibility and this will determine the utilization of underground land in Beijing.

Finland

Helsinki, Finland is one of the best practices for underground land development in the world. Realizing the importance of underground land, the research on policy of the development has started

since 1955 in database building. Following in 1996 is the feasibility study of underground land. To enhance the regulatory framework, working group on 3D property cadastral system has started in 2006. By 2009, the Helsinki Underground Master Plan was introduced with an objective to ensure the utilization of bedrock resources is retained for the construction of public long-term projects and underground lands are well connected to each other. The master plan contains the detailed mapping of existing planned facilities and potential Geo-space, public acquisition land and legalization of underground land utilization.

According to the Finnish law, the owner of a property has control over the underground part of the property, though the vertical extent of ownership is not specifically defined in the legislation. When

interpreting the extent of ownership, the lower boundary of a property has been limited to the depth where it can be technically utilized. In practice this means the depth of 6 meters from the lowest point of the building lot. This allows the owner to build a cellar under a building for example. Anyone constructing facilities underground must obtain agreement on the right to use the underground construction site. Ownership can be established through voluntary transactions, agreements or compulsory purchases based on legislation¹³.

The utilization of underground land will not only depend on its usage, but there are other aspects that need to be considered especially the legal and administrative issues, economy, social, safety and health, technical and also Geo-environment. Not all underground structure suitable for many sites, functions and building programs, but it can be a possible alternative for development when conditions are appropriate³. Figure 3 illustrates the feasible depths of different activities involve in the surface and underground space development¹⁴⁻¹⁵.

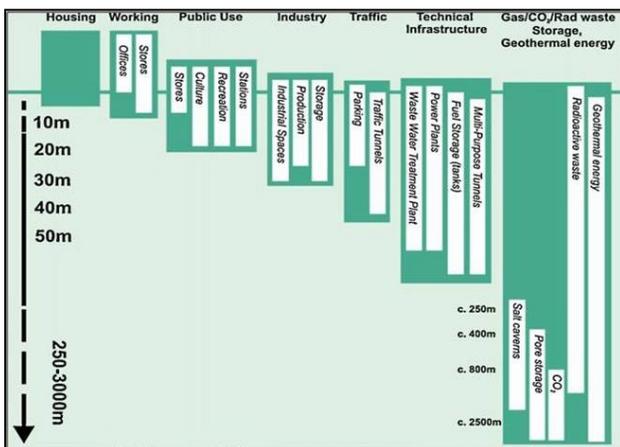


Figure 3 Feasible depth of underground development¹⁵

From the above figure, the need and importance of underground land as a part of development cannot be denied. For working and public use category will definitely focus more on surface development. Underground land will be developed only in term of car parks, shop lot and service facilities. Meanwhile, for other categories such as industry, traffic and technical infrastructure, underground space will become a major role in development. Most of the infrastructure such as subway, road, pipeline and others will be buried underground to maximize the land use.

Japan

Public right of using underground was set in the “Law on Special Measures related to Public Use of Deep Underground” with specific executive procedures, co- executed by Deep Underground Use Council and Ministry of Land, Infrastructure and Transport

(MLIT). This law aimed to benefit reduction at a construction cost by shortening the length of underground infrastructural networks and to benefit evidence on the compensation issue caused by land strata resumption. It has been officially in effect since 2001 with “Basic Policy on Public Use of Deep Underground” approved by the Cabinet Office.

Legal domain of Deep Public Underground was defined depending on existing building basement and foundation layers, starting from the depth of 40 m to more than 80m. Two types of ownership delimitation are shown in Figure 4.

Deep Underground refers to space at great depths, which are:

- Depths generally not used in the construction of basements (40m underground or deeper)
- Depths that are generally not used to establish the foundations of buildings (10m or more from the surface of the bearing strata).

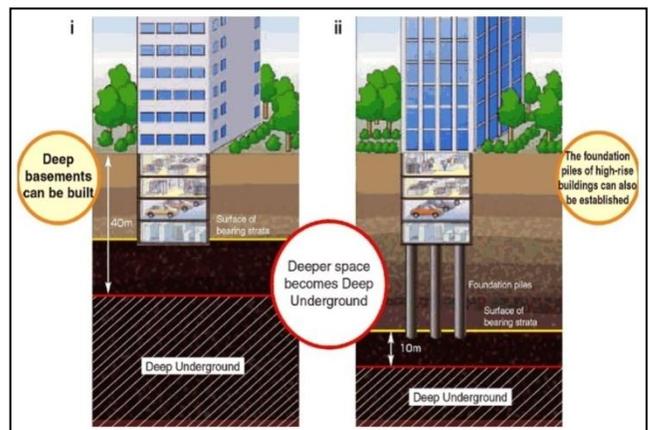


Figure 4 Japan Deep Underground Space law¹⁶

The Deep Underground refers to space that is generally not used. Consequently, losses that require compensation usually do not occur even if the project has usage rights set for public interest projects. For this reason, it has been determined that under existing laws, it is possible to set usage rights for Deep Underground projects without prior compensation. Moreover, even in exceptional cases when compensation is required, compensation is provided after usage rights have been set, following a waiting period for claims from those landowners who think that compensation is necessary.

3.0 THE COMPARISON OF ELEMENT RELATED ON PRINCIPLE OF DEPTH BETWEEN MALAYSIA, CHINA, JAPAN AND FINLAND

In other countries together with the technological advances and proper mechanism in the law and

policy, it is to believe that there will be a higher demand for underground land development in the future. Underground land development is in the form of 3D which represent, by the width, height and depth in the underground land. Different with surface land planning where it is shown clearly in 2D form, it is important to start planning and designing the patterns of underground land utilization for underground vertical planning. To review and discuss further, three main research elements highlighted in this paper in order to understand the principle of underground land depth which consists of the legal considerations, the depth of development also vertical planning (utilization).

The comparisons between the three countries are discussed together with Malaysia experience to get the best practice in each of the research elements.

a) Legislation for Underground Land Development

Discussion: Based on the Table 3, it shows that all countries include Malaysia have prepared the law and regulation of underground land development. However, there are still a few things that can be improved and clarified, especially related to the rights of surface and the underground land owner. In any condition of underground land development, the rights of surface landowners must be protected in order to ensure they can utilize their land (surface and above) in an exclusive use and enjoyable way.

Table 3 The comparison of underground land legislation

Malaysia	China	Finland	Japan
In Malaysia, the legislation related to underground land is stated in Part VA, National Land Code 1965, (Underground Land Disposal) ¹⁷ . This legislation is aimed to assist the underground land development in terms of land disposal under the alienated land and state land.	In China, the land includes underground are owned by the State, but it can be developed by any favourable party, but still the state retains the proprietary right. China has promulgated 32 laws and rules for legal and administrative implementation in underground land development (until July 2011). The laws and rules are focusing on the administration of comprehensive development and utilization of urban underground land	Helsinki Underground Master Plan: The master plan contains the detailed mapping of existing planned facilities and potential Geo-space, public acquisition land and legalization of underground land utilization.	The land ownership rights in Japan extend into upward and downward; as far as any interest may occur. The purpose of the Deep Underground Utilization Act is for easing underground land development. Basically, through the law, landowners do not have to pay any compensation to the land owners on the surface; if public projects are implemented 40 meters underground because the rights for the government or developer to use the space are prioritized over the right which residences have on the ground

b) The Depth of Underground Land Development

Discussion: The specification of depth for underground land development are various between countries as shown in Table 4. Even though Malaysia has set the minimum depth of development, it is still ambiguous, because since there is no maximum depth of the utilization. This will lead to the argument between landowner and developer; if the surface landowner claims their rights

towards the extension of ownership while the other parties only want to develop underground land without interfering other's rights. Different with China, Finland and Japan, where the depth of utilization has been set based on the layer comprises from 0 meters to 300 meters to ease the future development.

Hence, Malaysia should be prepared to determine the depth of the underground land to facilitate the future development.

Table 4 The comparison of underground land depth

Malaysia	China	Finland	Japan
Guideline for Underground Land Disposal (No.1/2008) ¹⁸ - The minimum depth for underground land owned by the surface landowner based on the categories of land:	The state authority has set up the level of underground land based on the layer of depth:	The layer of underground land utilization:	Deep Public Underground:
a) 6 meters (agricultural land)	a) 0 meters to 10 meters (Excellent for access)	a) 0 meters to 40 meters (The development, focusing for the human activities)	a) 0 meters to 40 meters (The surface landowner has the right to fully enjoy and utilize their underground land)
b) 10 meters (building land)	b) 10 meters to 30 meters (Good to access)	b) 50 meters to 300 meters (The development, focusing for the non-human activities)	b) 40 meters to 80 meters (Development of underground land)
c) 15 meters (industrial land)	c) 30 meters to 50 meters and 50 meters to 100 meters (Hard to access)		

c) Vertical Planning (Utilization) for Underground Land

Discussion: Table 5 compare the underground land utilization in selected countries. It conclude that even the demand for underground land utilization in Malaysia does critical not compare to the other countries, but the first step of underground land planning should be taken seriously to avoid major

problems for underground development in future. If we look the category of utilization in China, Finland and Japan, it is focusing more on infrastructure and utility. However, the division of the layer is based on how heavy the infrastructures are. Looking at the positive underground infrastructure development in Malaysia, it is no doubt for us to follow the strategy of utilization as the other countries discussed.

Table 5 The comparison of underground land utilization

Malaysia	China	Finland	Japan
The authority didn't specify the planning for underground land development. However, most of the development is to compliment the above use also for public purposes such as tunnelling and transportation.	China has divided the utilization based on layers of depth:	Finland has divided the utilization based on layers of depth:	Deep Public Underground is only applies in limited areas such as Tokyo, Osaka, Nagoya and suburbs, but specifically for public projects only. For instance, power lines, telephone lines, municipal water and sewage or gas piping systems, underground railways and underground malls or car parks.
	a) 0 meters to 10 meters (Pipelines, commercial facilities, pedestrian way, parking lots, transportation hub)	a) 0 meters to 40 meters (The utilization is mostly focusing on stores, office use, subway stations, recreational purposes, industrial spaces, traffic tunnel also parking spaces)	
	b) 10 meters to 30 meters (Transportation hubs, subway lines, underground logistics systems)	b) 50 meters to 300 meters (The utilization is focused on multi-purpose tunnels, power plants also the wastewater treatment plant)	
	c) 30 meters to 50 meters and 50 meters to 100 meters (Storage, underground automobile roads)		

4.0 CONCLUSION

As a summary, China, Finland and Japan are at their best in planning and utilizing the underground land for development. Even though the need of underground land in Malaysia is not that critical if compared to other developed countries, but the awareness of the possibilities using underground land

as a new type of development must be considered starting from now. The study showed Malaysia is aware going underground for development. The proof is; Malaysia is ready with the legislation for disposal of underground land also the circulation supported it. However, compare with the other discussed countries, we are not yet well-planned the utilization of underground land based on the depth. Perhaps, we could take action by determine the

category of land use for underground land utilization based on the depth of underground land as other countries. Future research is needed to look out the best practice for underground land development in Malaysia towards sustainability because once underground land has been developed; it is permanent and can't be altered. Therefore, the depth of underground land is very important in underground land development because it doesn't act only as a layer for development, but also the boundary for each and every development to differentiate the right for surface and underground land owner.

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