DEVELOPING UNDERGROUND SPACE: A VIEW FROM SINGAPORE

Key considerations to set a sustainable course

Singapore is exploring ways to further develop underground space. Subterranean spaces already house transport and utility infrastructure, pedestrian links and retail. To tap into Singapore’s underground potential, the government is using Building Information Modelling (BIM) and Geographic Information System (GIS) technologies to capture and integrate data for visualization and advanced analyses for future development.

In the following Q&A, Cheryl Zi Du Lee, Executive Director of Transport & Infrastructure, Singapore, discusses key considerations and possibilities as this island nation—approximately 709 square kilometres, or 274 square miles, populated by nearly 5.7 million people—continues to develop and maximize the use of underground space.

Why is it important to develop the underground space in Singapore, and what usage is currently planned?

Cheryl Lee: Developing underground space is important to sustainably support growth in a land-scarce country like Singapore.

Over the years, land reclamation was applied to create usable land for Changi Airport, Jurong Island and Tuas Port. Traditionally, land reclamation efforts require infilling with sand. The drawback of this method is that it is unsustainable in the long term due to both the impact on the surrounding ecosystems and the global shortage of sand. Singapore has since adopted the Dutch polder concept as a more cost-effective method with less environmental impacts on surrounding marine ecosystems.

Considering this reality, it makes sense to enhance the future utility of underground spaces to advance urban development solutions. This will help reduce overbuilding, which results in surface congestion, and free up surface land for livable uses, such as housing, more green spaces and parks in what is already a metropolis with dense green areas. The efficient use of underground space can thereby support preservation of natural resources, promote sustainable development and improve urban environments. Also important, our underground systems are designed to anticipate and protect from the effects of climate change.

Underground development offers a sustainable way to expand public transportation networks—decreasing reliance on cars and carbon emissions—and support population growth. As established in the Land Transport Master Plan 2040, the Singapore government continues to improve the transport system so that 8 in 10 households will be within a 10-minute distance of a train station and be able to reach different parts of Singapore with ease.

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1 “The remarkable history of Dutch polder systems in the Netherlands,” Food and Agriculture Organization of the United Nations (FAO), 2010
Nearer to the ground, more space is planned around people-centric activities. Current usage includes carparks, retail space, pedestrian links, offices, an MRT [mass rapid transit] station and tunnels for commuter trains. Spaces that further away from the ground surface, are more suitable for road tunnels, utilities, storage of liquid hydrocarbons in rock caverns, and a deep tunnel sewerage system, to name some major existing uses.

This is a pivotal time to influence and set a proper course for sustainable development in Singapore, as agencies and businesses are vying for underground space.

Figure 1 – The illustration above shows underground space usage in Singapore. The electrical substations, which are connected to the underground cabling network, currently reside at the ground level but can be housed underground. A common services tunnel in Marina Bay houses utilities together in a common corridor. Also in Marina Bay, there is an underground district cooling system, which centralizes the production of chilled water that is piped into buildings within the district to support their air-conditioning systems; it has helped customers achieve significant energy savings. Plans call for the rollout of more district cooling systems over time.

What are the essentials for realizing the full potential of underground development?

Cheryl Lee: There are several key factors. Effective planning is the starting point in the process. In 2014, the Urban Redevelopment Authority in Singapore called for an underground study to support the efficient and coordinated use of Singapore’s underground resource. Ongoing, effective use of underground space requires the Singapore government to develop comprehensive regulations that effectively guide the use of underground space.

Integrated master planning is essential, and this requires coordination and inclusion of government and private stakeholders, and the public, especially to properly link underground infrastructure to existing surface infrastructure. These steps also apply to underground development around the world.

Underground construction involves its own set of safety considerations. Of course, technical expertise is another necessity. Cost of construction is a major factor; underground construction is typically more expensive than above-ground build. However, with the introduction of more state-of-the-art technology, underground excavation can become safer, quicker, less costly and more easily achievable.

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2 Charting Singapore’s Low-Carbon and Climate Resilient Future, National Climate Change Secretariat Strategy Group, Prime Minister’s Office, 2020
It is difficult to overstate the value of planning properly for the use of underground space—considering the social, environmental and economic impacts of use. It is also important that governments and institutional leaders possess the financial capacities to fund underground construction. Feasibility studies and cost-benefit analysis help to identify major cost and time savings, as well as areas where productivity can be enhanced during the construction phases.

**Can you explore the potential impact of subterranean development on Singapore’s central business district [CBD]?**

**Cheryl Lee:** Singapore’s CBD consists of both new and old buildings, skyscrapers and conserved buildings, along major roads with frequent traffic and pedestrian movement—very densely populated areas.

It is important to keep in mind the potential impact of subterranean development on the CBD during construction. Here is where the necessary factors discussed earlier come into play—such as safety for underground construction and the overall site to ensure that the ground settlement is controlled well to avoid damages to surrounding buildings. Detailed damage assessments would also be required and conducted to ensure the existing CBD buildings within the precinct are kept in a safe and serviceable condition.

Subterranean development can certainly bring positive impact for pedestrians; underground networks provide convenient and seamless connections between, transport facilities, key spaces and attractions, and the advantage of all-weather comfort.

**How can the experience with the pandemic inform the planning and design of underground spaces?**

**Cheryl Lee:** The pandemic has changed lifestyles drastically. We now rely on technology to enable people to work from home, students to learn from home, and people to take care of their daily shopping needs online, such as banking and shopping for groceries; almost everything can be done from home without the need to walk out of our front door. But it is important to also consider what communities want urban places to provide—their purpose—and how infrastructure can support more livable cities.

Safe distancing and other measures to create healthier environments, both aboveground and below, will continue to be considered in our designs. For example, the overall underground ventilation system could be improved to reduce the spread of viruses and airborne contaminants. All common touch points and common area surfaces should be coated with a self-disinfecting coating. Public toilets in the underground space should be specially designed with improved hygiene. These steps, which also apply to aboveground infrastructure, can go a long way in designing spaces that support people’s health and wellbeing in the underground environment over the long term.

**Looking ahead, what are possible uses of underground space?**

**Cheryl Lee:** Current use of underground space in Singapore reflects functionality and adaptation to human activities. Going forward, there are numerous possibilities such as farming or urban agriculture through hydroponics. Other potential areas are laboratories, light-industry factories, data centres and swimming pools.

We should also think about how we can maximize the value and usage of these
underground spaces. For example, an underground farm can be designed with a secondary purpose by functioning as a public park; underground carparks can also be utilized as driving schools or for recreational purposes such as a go-cart track; facilities to accommodate large capacities—theatres, concert halls or sports arenas—can be located underground, freeing up more land aboveground.

As I mentioned earlier, this is a pivotal time to influence and set a proper course for sustainable development in Singapore. Although we have some regulations in place for underground development, considering the objectives of the recent COP26 [2021 United Nations Climate Change Conference], the big question is, How can we do more with underground space and advance toward net-zero carbon emissions?

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