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SINGAPORE MODEL OF SMART CITY: A OLUTION TO GROWING URBANISATION

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Introduction:

Various cities around the world are experimenting with smart city technologies to tackle the issues of street lighting, waste collection and traffic light management, Singapore ambitiously got hold of all these issues in advance and is impressively labelled as the world's first smart city in the international community. Singapore had started the plan to transform itself from a smart city to smart nation, with plans like underground expansion of the city, and selective use of robotics to further curtail or enhance human efforts. It has a mix of urban town planning, multi layered sewage pipes with sensors to detect damage, integrated transport plan to charge less from commuters despite their long distance tours, and a change in the mode of transport with greater focus on bicycling for their daily activities rather than relying on cars. Singapore, in many respects shouldn't exist at all. The small island nation which is just one degree above the Equator with hot and humid climate all the year round lacks all the basic natural resources. It has no energy deposits, no forests, and nofarms and for years it relied on Malaysia for the supply of drinking water. It is not a natural country yet with its extraordinary intelligence it became the smartest city of the world. The smart metropolis that exists today was the vision of Lee Kuan Yew, who spoke of his dream to create a city in garden decades ago. Lee's vision of using the English language as a unifying factor and, attracting foreign investments into the country worked wonders for the island nation. The main emphasis was put on strengthening the economy and beautifying the city, but over time, the scope got broadened fostering towards liveable and healthy environment for the residents ofSingapore. It managed its journey from one of a cluttered city with less water towards the present city that has 17 water reservoirs and has water sports in

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place for tourist attraction. All this is considered a multiagency work with proper plan implementations. For every 10 years, since 1971, Singapore issues a concept plan with a 40- to 50-year time frame. Every five years it issues more detailed plans on smart growth. Many cities today engage in such master planning exercises. Unlike many of them, Singapore fully commits to transforming its plans into policy. Such a singular vision helped it to overcome major problems like traffic congestion, liveability and density. It introduced express lanes that charge higher tolls during rush hour. Singapore, in contrast to the routine measures implemented in other countries, has put forth vastly extreme measures, including strict limits on how many new vehicles can be added to roadways each year along with congestion pricing.Apart from all these features the city has a rare combination of liveability and density. Singapore is the only nation which ranks high in both. As the world gets more urbanised in the coming decades, it is this scheme of development that should be popularised for good quality of life. Singapore is thinking of becoming the world's first smart nation by looking into robotics to use it selectively in the future.

About the City:

Singapore is a promising city state in South East Asia. With more than 5.5 million residents the city was by far the second largest densely populated only after Monaco in the world. Situated just one degree above the equator (137 km), to the North of it lies Malaysia and Indonesia's Riau Islands to the south. The total area is about 597 square kilometres consisting of 62 islets and one main island. The territory has been increased since independence by 23% where fifty percent of its land is covered by tropical flora, parks and nature reserves. A megalopolis that charmed and attracted many Chinese, Malay, Indians and Eurasians is an affluent city. In today's world it is one of the great business centres, the orchard road shopping area, river side, marina bay area, financial area shenton all located in the centre. It was a modern city with large self contained residential towns all over the clean island. The economy has a massive presence of financial services, manufacturing and oil refining. It gained the rare record of being ranked number one in World Bank's ease off doing business report for nine consecutive years and has attained Asia's highest growth rate in 2010. It ranks fourth in terms of per capita income. It also maintains the magic number in the development of education, health care, personal safety, life expectancy which are key measures for social progress.

The city managed from pollution and congestion by limiting the entry of vehicles on roads charging high duties and bid for a Singaporean certificate of entitlement. Against to 5.5 million people only 0.6 million vehicles are registered and the other means of conveyance like buses, cycles, train and foot are used sincerely. Internet access is highly commendable in the city where a computer is seen in every home. Mobile phone penetration reached its peak with 137%.

Features of Singapore Model of Smart City:

Singapore has been designed in a sustainable way which makes everyone curious to know about the features it had adopted for long term benefits. The priorities of the countries remained same now and then like growth of the economy, decent standard of living, clean and green environment etc. The purpose of attaining them remained a distant dream for all the cities except Singapore. Its successful due to its holistic approach, ideal leadership, well executed planning and good governance. In the entire process of planning it followed fourfold objective, they are

- Economic: always maintain a vibrant and attractive economy.
- Environmental: excel in sustainable and sensible way.
- Social: ensuring quality life to people.
- Land and Sea: available space should be used optimally.

Public consultation and opinions are considered essentially from time to time. They play an important role in plan development and implementation. The trinity of public, private and community formulae is well established in the city. Developing in a sustainable way means preserving options for future. To achieve this Singapore used trade off now and future gain rule that is what is foregone in the past is paid in future. This can be analysed clearly by looking into the features of smart city it has designed over the years. It harnessed technology to successfully deal with challenges of transport, energy, environment, education, housing etc. The ground breaking research in innovative ways, adaptive governance enabled it to be a model smart state and smart city. Apart from these strategic planning, developing institutional infrastructure, collaborative policy formulation, long term opportunity creation and willingness to adopt change turned it smart. The list of features can be grouped into the following for better understanding:

Dynamic and GoodGovernance:

Singapore acquired gold standards in dynamic and good governance when compared among countries. Dynamic means the governance which is adaptive to the change and is relying on continuous innovation to address the emerging needs of the people. The capacity to change in a crisp short moment helped it to grow sustainably incorporating e-governance in its daily activities. In the arena of dynamic governance three critical factors are considered necessary for effective action. They are

- Thinking ahead: future is made by order that is to perceive benefits ahead of time if a project or so is implemented.
- Rethinking: not to enforce a new programme without proper assurance, to weigh the pros and cons twice for better performance.
- Thinking across: cross boundary approach which enables to learn from the experiences of other nations.

These principles of governance are specifically followed as part of smart initiative. A better example to examine the results of the above formulate will be land use pattern decisions made by the rulers 40 years ago. They are hailed by the present generation as plans made for future sustainable life. It's a hard task to manage land use within the available space. Decision makers balanced the current and future needs by flexible regular planning.

Technology:

Singapore has assimilated technology in the everyday sectors like mobility, health care, housing, smart grids which indirectly brought impact on other sectors like climate change and liveability that enabled to take a step ahead towards a smart nation. However the focus on technology in Singapore can be said as second to the liveability. The participatory city development vision is totally the other way what smart city developers in various countries think. A hefty investment in technology is lucrative but often neglects the aspect of living. The success of the city relies on following the principle of 'technology should be the top layer above infrastructure but not the foundation for any smart city. Turning itself to a living lab smart technology trials were carried in different sectors which helped to realise Singapore's ambition of being world's first smart city. The sectors are:

Transport System:

Singapore championed in providing smart services in transportation systems and managing urban mobility. The journey is going on from 10 years. The practices it implemented in achieving the intelligent transport system (ITS) are as follows:

a) Area Licensing Policy:

Singapore introduced this to tackle with the problem of traffic management during 1975-1998. After learning from the experiences of different countries that car pooling and encouraging public transport does not solve the issue adopted this policy and stood successful. It is the first congestion pricing scheme practised in the world. The driver required to buy the license to drive in the central area of the city during peak hours. A year long information campaign was organised to bring awareness among the people. An extra cost for the license means cut in the number of vehicles resulting few number of vehicles and smooth flow of traffic

As the population continued to grow vehicular density too increased in the same pace that is 129 vehicles in 1975 to 184 by 1985. They cannot be accommodated by constructing new roads and highways also. So a new scheme name vehicle quota system was designed in which new car owners should bid for certificate of entitlement before purchasing. The original intention of the scheme has lost way and the officials decided to extend the timing of ALS to evening instead of morning hours as followed earlier. Noting the nominal results of the scheme subsequently in 1998 this was succeeded by ERP with electronic gantries system replacing the manual gantries.

b) Electronic Road Pricing:

When technology became more efficient this scheme was introduced with electronic gantries fitted with radio equipment, sensors and cameras. This facilitates automatic deduction from the cash card installed in the vehicle unit reducing manual gantries. It is operated on the principle of pay as you use. Different rates are charged for different routes basing on the rush. This made motorists change routes and time of travel which helped manage congestion. The benefits accrued from the policy are human errors are eliminated, reduced traffic volume on roads, no monthly or daily licenses, fair price charge basing on the usage.Traffic congestion impacts on lot of things like losing valuable hours, environmental pollution, fuel wastage and adverse health issues. To tackle them effectively Land Transport Authority of Singapore apart from laying roads also took up measures available at hand of regulating traffic levels by ERP etc. This ensured smooth flow on roads as expected by the authorities.

c) One Motoring:

It is a one point portal serving the needs of all drivers and vehicle owners in the city. Citizens can access information related to traffic which is made available from the data collected through surveillance cameras and GPS systems in the vehicles. Snap shots taken for every five minute are uploaded along with the current ERP rates, information regarding road work and travel time calculator, traffic news, express ways images and parking space. The portal is designed in a way to be mobile friendly. The portal not only provides traffic details but also advices its customers on buying, selling and maintaining their vehicles.

d) Park and Ride System:

The scheme introduced in 1975 to control traffic in the central business district area was ceased on December 2016. Sole idea behind this was motorist would park car in specific parking lot and travel by public transport. They get a park and ride set which has EZ link card that can be used for public transport and parking ticket. But over the years the purpose of the scheme is not fulfilled and the parking space is used as a means for low cost parking. The number of people who use public transport after parking is as low as 40 %. Realising this LTA ceased the scheme. As more number of bus transit lines and rail lines are developed, now people can reach CBD easily through varied means making the scheme less relevant.

e) Vehicle Quota System:

Owing to the limited space and to address the urban living challenge this scheme was designed. It limits the vehicle population on roads by maintaining the healthy road network. Addition of new cars is regulated through certificate of entitlement system. Under this only specific number of are allowed as fixed by the LTA. If the owner attains the COE it means he got permission to possess vehicle for ten years. Vehicles are categorised into five groups, with different engine capacities and bus, motorcycle etc. COE are allotted by open bidding process conducted twice every month. The VQS and ERP are the pillars for congestion free roads in the city.

f) Express Monitoring Advisory System:

Road incidents are checked by LTA through surveillance cameras and if noticed any they alert the vehicle recovery crew to tow away the vehicle within 15 minutes to the nearby parking area. Cameras installed on special poles, street lamps, traffic light poles help the executives to monitor traffic conditions and decide on appropriate action when needed. The LTA works in

collaboration with all the taxi drivers that is the GPS installed in the taxi gives information to them regarding express ways and arterial roads.

g) Your Speed Sign and GLIDE:

Your speed sign is a smart electronic device which alerts the driver if he is crossing the set limit. It is hailed that Singapore roads does not have policemen still the rules are followed by citizens is because of the smart devices they use. The automatic advices make drivers vigilant about the safety norms to be followed. Green linking determining system is one where all traffic signals are controlled under it. It automatically decides the traffic flow, faults and pedestrians. All this is possible by the thin metal wire installed underground and before signal junctions. Real time traffic demands are analysed and traffic lights are signalled in a way to minimise the number of stops from one junction to other. This is known as green wave.

h) Smart Buses and Autonomous Autos:

Singapore tackled its traffic with smart solutions and one of the ways which is slightly different is smart bus. Bus service is made best by the use of sensors which monitors it and GPS data which allows tracking speed, gives details of passengers on board. The government is revamping bus stops by including new services like Wi-Fi, e-books and interactive maps. It is a step to make commuting enjoyable.

With innovative traffic management techniques that provide real time visibility across the transportation network ranging from electric vehicles to tolling and congestion free solutions the travel has been reduced by making daily life faster for commuters, resident and visitors.

Health Care and Ageing:

Transforming health care through smart technology is a part of smart nation initiative of Singapore. By 2030 ageing population number crosses nine lakh and with declining birth rate it is imperative to the nation to adopt pre-emptive steps to better provide health care. The ways incorporated to improve health administration are intelligent, highly resilient and cost effective. Application of computer science, data science, mechatronics, statistical IT tools along with advanced techniques the government wants to maintain robust health services. Following are some of the smart techniques that catalyse the dream of being a smart city.

a) Tele Health:

It is expected to increase the productivity in the health care system as the care is made available at homes. The professionals can deliver their services to maximum number of people offering seamless care. Through man power constraints, long distance travels, waiting for appointments are avoided enabling elderly to age in place with quality care. The initiatives are elderly monitoring system, vital signs monitoring, tele health video consultation, and smart health tele rehab.

Elderly monitoring system provide peace of mind to care givers when they are away from home. It operates with smart sensor technology installed in homes. In times of distress old people can use panic button to notify and caregivers continuously monitor through sensors. Housing and development board of Singapore conducted six month trial and was successful in its attempts so they now extended it to 3200 households from April 2016. Vital sign monitoring allow doctor to grow self-care habit in the individual by warning signs and is good monitor for post chronic attack management. For higher patient compliance work has been going on video consultation in which data transmitted through wireless sensors attached to people's limbs would reach therapist. Accordingly therapy sessions are conducted with comfort from homes.The platform will be implemented in paediatric eczema pharmacy consultation, paediatric home care services, lactation queries, and speech therapy for KKH patients; post-stroke, communicable disease, cancer patient care, and more at other institutions. Plans are formulated to induce it in National university of Singapore and National university cancer institute.

b) Health Hub Portal:

It is a digital solution for health care, launched in January 2016, is a one stop online health information and service portal. An initiative of health ministry as part of its health IT plan enabled all citizens to have greater ownership on their health and wellness. All the institutions are well connected providing information, tools and services for the continual care of patients. It allows to access several public healthcare institutions records, lab test reports (chronic diseases), further medical appointments, immunisation records, dental care records, therapist appointments, contents in the medication and known side effects, also includes referral letters of their children with a Single Password login, as well as enables them to set reminders to take medication on

time. It allows the citizens to get information regarding extensive lifestyle facilities and services provided on the island. For example like location of polyclinics, good and hygiene food stalls, eateries, sports complex. Users have the facility of redeeming points which are converted rewards by linking to NTUC link points when articles of health care are read and shared. They are popularly called health points. The application has been downloaded by 56000 people since launch and paved path for more online monitoring services. Caregiver module is a must mention here as it allows patients to grant access to caregivers about their health, medical records and appointments.

c) National Steps Challenge:

This is an app which is designed for maintaining healthy and active lifestyle for citizens. The health promotion board started a nationwide physical activity program called steps challenge, a funny way to make citizens sit less and move more. It entails registered participants a step tracker and enables them to pair it with healthy 365 mobile app which then starts tracking the accumulated steps a person walks. By employing simple data analytics feedback is received on daily progress accompanied with rewards on reaching specific targets. Launched in 2015 70 % of its participants turned active by moving 7000 steps per day and 30 % averaging 10,000 steps daily. It was well received by young and old number reaching to 1,56,000. Findings show that challenged participants too are familiar with the app giving far reaching results than formulated. It not only tracks the steps but also allows maintaining diet and counting the calorie intake aiding one's wellbeing. It is instilling responsibility on personal health and interest to develop a better lifestyle.

d) Analytics and Robotics in Health Care:

The use of technology which is attends everyone needs if applied in most needed fields like health care will strengthen various communities. It is aptly used in smart nation initiative. These techniques enhance the overall development of the individual even addressing disabled, aged in accomplishing their tasks more easily. The real difference can be pointed out when aged people start independent lives fulfilling all the tasks. Advanced techniques include dispatching medicines through drones, employing automated guided vehicles that carry food, linen and heavy objects, robotic arm usage which pick and pack a range of items like fragile things, reduce time

for daily activities and cut wait periods. Robotics proved best in handling patients as it improved mobility by avoiding movement to toilets and ended bed sores. Automated machines and droids monitor patient health helping them recover after stroke, chemotherapy and stage dementia patients by reminding about the medication. An example for assistive robotics is robocoach which helps elderly to maintain their diet, exercise in a correct way using motion sensing technology. It made a mark in helping cure post stoke disorders and Parkinson's disease.

Liveability:

Smart technology in Singapore will have many uses improving life. Liveability in a way means increasing sustainability apart from developing infrastructure or preserving environment. This includes energy efficiency, adopting smart living strategies like monitoring elderly care, reducing investment on waste collection, optimise estate maintenance, track electricity bills personally. In Yuhua province a project of this kind is implemented which entirely works noting the feedbacks of citizens, a first of its kind in the world. The city is planned in such a way to have ample space for parks, conservation reserves, water resorts etc. For example the compact city framework if noticed enables us to understand the best usage of less land available. It allowed good provision for infrastructure and transport facilities to the citizens. Around the MRT more buildings were built making the amenities nearby increasing the bondage, social contacts and reduced pollution. Though the environment becomes denser liveability is made possible with greenery, good designing, and landscape management providing visual relief.

A balance is maintained between heritage and development. Through singapore's conservation programme seven thousand buildings are protected till now. To safeguard tropical rainforests and coastal mangroves four nature reserves are conserved, leaving 18 more for future as long as possible. Planners take adequate steps to ensure buildings life in a creative way. The interesting fact is about placing community at the centre in the development process for protecting the local character of the buildings or natural heritage. They try to enhance the locality with unique identities like better pavements and planting trees. Balestier, siglap, Holland village serve as better example for places that thrive long. The three R principle is followed in conserving buildings; retention, restoration, repair. The buildings are selected on the basis of architectural importance, rarity, cultural and religious significance, contribution to environment identity,

economic impact. Creative ways are taken to increase the leisure. They are deliberate introduction of greenery and play options. The efficient way of using drainage line as park connectors linking green spaces ensures 360 km of connectors by 2020. Years from then promenades, boardwalks, and bridges are constructed to connect lush green spaces and activity nodes providing access to waterfronts and coastlines. These initiatives create exciting, new and recreational options which makes the nation much appealing and never dull. Though the country lacks resources with its modern techniques it is striving hard to empower the future generations in every way. The management of water resources by innovative long term water supply strategy termed four national taps; the city has attained robust, sustainable supply to its citizens. It is a process in which rain water is collected by specially designed drain pipes before storing in the 17 reservoirs allotted for the purpose. Water sustainability is achieved by NE water which amounts to 30% and rest are fulfilled by desalination and the former process.

The Singapore Sustainable Blueprint launched in 2015 highlights about green economy by reducing reliance on private transport, waste recycling and greater community management. Government propounded an idea to commit 1.5 billion dollars over next five years for attaining sustainable and liveable future. Prime Minister Loong advised authorities to be prepared to face extreme drought situations that happened in February that year as climate is changing. This is second blueprint, prior being in 2009. According to ministry of environment Singapore is on track to achieve the targets set in 2009. The present one will stretch the 2030 targets further be it already crossed the set limit. One such example is skyrise greenery or rooftop gardens, the limit set was 50 hectares by 2030 in 2009 blueprint but it reached 61 hectares in 2013 keeping the new target at 200 hectares.

Due to lack of land and resources sustainable innovative solutions are critical for Singapore to provide liveability and economic opportunities. This turned it to living lab for testing urbanised new ideas to build future cities. Many world leading organisations partnered with the city increasing the flow of investments (Kiong, 2014). The smarter solutions are sustainable water, largest solar test bed, smarter power grids, climate mapping and intelligent transport system. In water management it dammed all the estuaries and created reservoirs for drinking water. Focus is now on tapping the rest of the rivulets on shoreline. The national water agency mastered variable

salinity plant that enables tapping minor catchments. Through these the catchment area grows to 90 % in the city providing pure water to drink. Solar technology got impetus with the HDB project when installed in 30 public housing precincts. The scheme will enable them to enlarge to industrial needs once it becomes cost effective. A smart way to manage energy consumption is find option that balance demand and usage. Following the same principle intelligent energy system in 2009 started preparing the city for adoption of renewable source of energy throwing more choices to consumers in energy consumption. URA is implementing a climate mapping study to identify the impact of buildings, greenery, urban spaces on flow of air and temperature. The aim behind is to create a cooler environment making people's lives comfortable. Different maps drawn show hot and cooler spots in the city which can be great help while designing further strategies.

Manpower:

The IT infrastructure and networks developed in the city would be in consequential if citizens lack adaptation skills and apply IT solutions. Singapore has developed an intelligent smart talent strategy to support the future generation innovators. Literacy emphasising highly on computer skills helps prepare the youth for employment and opt digital economy. Science is made as rewarding subject in the curriculum to entice students to participate in the nations smart initiatives. The infocomm development authority of singapore created three main scholarships called the National Infocomm Scholarship, the National Cybersecurity Postgraduate Scholarship (NCPS), and theInfocomm Polytechnic Scholarship (iPoly) welcoming young people and professionals. Other than NCPS the two courses focus on infocomm studies and the former offered by national resesrch foundation working under the prime minister office from aegis allows graduates to gain more knowledge in emerging cyber security field. Government takes all necessary steps to nurture human capital by providing opportunities at all ages. For example code@SG movement was launched in 2014 which teaches coding and computational thinking in an amusing way to all primary, secondary students.

Partnerships:

Singapore's success in implementing its smart initiatives can be attributed to the various collaborations it made between multi government agencies and public private agencies. A

network of expert information technology services are established in government and private sectors. This facilitates the build-up of technical capacities in the city as the collaboration enables transfer of expertise reducing complexities and widening scope taking the IT skill to the next level. To sustain these partnerships Singapore labelled it as living lab opening its space for local and foreign companies to test, develop and commercialise innovative solutions. The entire process is mutually beneficial allowing the city to experience rich technical solutions and companies got the opportunity to harness their solutions by using the nation as reference before exporting it to the other markets in Asia and rest of the world.

Several opportunities are provided by Singapore government for the companies to kick start their business. The conducive environment created helped the city rank number one in ease of doing business. The stable government and economy, business friendly government, enhanced regulatory framework, good established judicial system developed the ideal platform for investment. It is also a transparent nation in terms of legal regulations. The start-ups may grow well due to the availability of highly skilled workforce, English speaking people along with number of Asian languages. Corporate taxes are low or negligible which turns as best place to grow business. Comprehensive networks of 80 double tax treaties were signed by it. There is no capital gains tax and withholding tax on dividends for non residents making Singapore a favourite destination to start business. The taxable proceeds include foreign sourced dividends if remitted back to the city; they too can be exempted fully if the headline tax of 15 % or higher is charged on the dividend in the country of origin.

Conclusion:

Singapore created better living for its people creating more opportunities through various initiatives. Urban density, an ageing population, enhancing healthcare and mobility, and energy sustainability are some of the challenges faced by cities around the world. As Singapore strives to become a Smart Nation, the Singapore government has taken the lead to harness data and new technologies, to develop innovative tech-enabled solutions to address some of these challenges. From transportation and public housing, to energy management and water treatment, Singapore has developed and adapted some of the world's most advanced urban solutions. Backed by a progressive leadership and firm commitment to sustainable development, the city has managed

to turn the challenges of urban development into rewarding economic opportunities. Some of these solutions have been replicated and implemented successfully in other cities.Stemming from the success, it has set targets in the areas of clean energy, IT, public safety and urban mobility to develop Urban Solutions which are smart, safe and sustainable. To achieve this, public agencies continue to partner with the private sector to co-develop innovative Urban Solutions. With these pro-business policies, strategic location, excellent global connectivity and talented workforce, Singapore is a fertile ground for companies and businesses to launch and scale up new and innovative Urban Solutions for Asia and beyond.

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