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Smart cities and urban management

Singapore Management University

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SMART CITIES & URBAN MANAGEMENT



SMU

SINGAPORE MANAGEMENT
UNIVERSITY



SMU RESEARCH
& EDUCATION

INTRODUCTION

Singapore Management University (SMU) is a dynamic city university in the heart of Singapore. We are a specialised university focused on Management, Social Sciences and Technology, and their intersections.

We adopt an integrated research-teaching-learning-practice approach that fosters innovative learning experiences, develops influential change agents and leaders, and creates positive impact on business, government and society in Asia and beyond.

In this booklet, read about our research and initiatives related to smart cities and urban management, and how we strive to make meaningful impact on business, government and society for Singapore and beyond.

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In the pursuit of becoming a Smart Nation, one important aspect is to enhance the way we live and improve the quality of life. Technology can inspire participation to build a closer, more inclusive community and create sustainable ageing-in-place measures for elderly residents. Artificial Intelligence (AI) can also be tapped on to “play cupid” and encourage smarter and healthier eating.

In this section, find out more about how SMU is impacting society on this front.

COMMUNITY PARTICIPATION THROUGH MOBILE CROWDSOURCING

As part of Singapore's drive towards becoming a Smart Nation, it is important that its citizens and residents are part of the movement as well. This drive led to the design of HelpBuddy, a mobile app jointly developed by SMU and Singapore's Municipal Services Office (MSO). This project, led by Professor Archan Misra, aims to encourage residents to take ownership of their living environment, facilitate volunteerism and community participation.

Powered by mobile crowdsourcing technology, HelpBuddy recommends activities to its users based on their preferences, task history and the anticipated proximity of their commuting paths to an activity's location. Through this app, public agencies can also help facilitate the execution of community-centric activities, and keep citizens aware of civic improvements resulting from community feedback.

The app is currently undergoing nationwide trials in partnership with more than seven public agencies, and the data collected from the trials will help better assess the behavioural preferences of residents towards a variety of civic reporting and community-centric activities. Public agencies can also utilise the trial to understand users' attitudes and behaviours towards this new initiative and determine its effectiveness, prior to embedding the technologies within a larger suite of Smart Nation services.



Play your part and download the HelpBuddy App today!



BE INVOLVED! IT STARTS WITH YOU



Checking of State Land for Community Use (SLA)



Trees in Bloom (NParks)



Find Lost Dogs (Animal Welfare Groups/AVA)



Volunteer Medical Escort (MCCV/SGCares)



Share Item (MCCV/SGCares)



Memories of Heritage Sites (NHB)



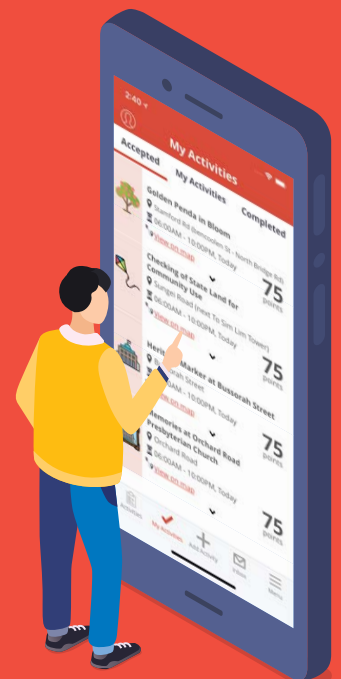
Memories of Dairy Farm (NParks)



Checking of EPS Gantry (HDB)



Checking of Gravitraps (NEA)





Smart Food Recognition with the state-of-the-art Visual Recognition technology

[Try our Demo](#)



SMARTER, HEALTHIER EATING WITH FOODAI™

Healthier eating has become a mantra of health buffs, professionals and executives who lead busy lives and constantly look for different options to achieve a healthy lifestyle.

As part of a broader SMU effort on technology-enhanced interventions to support healthy eating, a team led by Professor Steven Hoi developed FoodAI™, a system that offers automated food image recognition technologies with cutting-edge machine learning techniques.

In its partnership with the Singapore Health Promotion Board (HPB), the team built a comprehensive food image database on Singapore food, trained state-of-the-art food image recognition models using deep

learning, and integrated the food image recognition technology with HPB's Healthy 365 app for Smart Food Logging. Users of the Healthy 365 app will find it convenient to keep track of the food they consumed simply by taking a photograph of it using the app. The technology will recognise the food and the corresponding information will automatically be logged to their profile.

To encourage collaborators and other developers to integrate FoodAI™ into their applications, the team also built an open Application Programming Interface engine of the food image recognition services to facilitate sharing of the technology.

With the aim to advance AI in food and healthcare, the team plans to take the project further by expanding the current food image database to cover more food that are popular and facilitate the process of adding new food, as well as to improve the accuracy of the food recognition models.

DATA-DRIVEN COMMUNITY ELDERCARE PLATFORM FOR SUSTAINABLE AGEING-IN-PLACE

About 200 community dwelling seniors who are living alone under the care of various health groups and care organisations are benefitting from initiatives seeded by *SHINESeniors*, developed by the SMU-TCS iCity Lab which is helmed by Professor Tan Hwee-Pink. This initiative was developed by the iCity Lab research team in anticipation of Singapore's silver tsunami, where one in four Singaporeans will be over 65 years of age by Year 2030.

The team leveraged on sensing, analytics, the Internet of Things (IoT) platform and AI technologies to build an end-to-end community care platform. More specifically, non-intrusive motion sensors were installed in the houses of the seniors and this feature brought about a paradigm shift for caregiving. The installed sensors helped to ascertain the possibilities of a fall, a fainting episode or missed medication through anomalous event detection. This information would then be communicated to caregivers in a timely and reliable manner through a specific triggered signal. Over time, along with data from periodic psychosocial surveys, AI techniques can be applied to inform preventive care, where elderly at risk of deterioration in specific well-being measures can be detected early so that caregivers can plan for intervention.

In designing the approach, the team ensured that the solution would meet the needs of key stakeholders in its ecosystem that included elderly people living in the community, especially those living alone; community care organisations looking after the well-being of elderly in their community; public authorities responsible for elderly people and their well-being; and technology & system providers. The team also ensured

that the system was scalable, easily maintained and accessible, and had technological, social and behavioural aspects integrally designed within the platform to meet each stakeholder's specific needs.

SMU-TCS iCITY LAB COMMUNITY CARE PLATFORM



Medication Consumption



Call for Help



Data Analytics



Reactive Care



Care Intervention



Motion Sensing

A DATE WITH AI



Birth rates have fallen to dismal figures across the developed world, and in Singapore, the total fertility rate fell to 1.16 in Year 2017, the second lowest figure ever recorded for the country.

Having difficulties finding partners could be a contributing factor to the low fertility rate, and even though the emergence of dating applications has helped match singles together, there were concerns arising from the usage of those dating applications, such as fake profiles, online love frauds, abuse of users' data, and dating-app fatigue, amongst others.

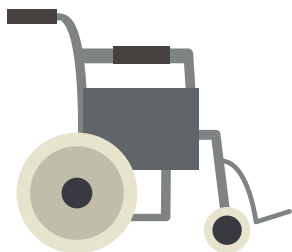
Lunch Actually, Singapore's homegrown dating and matchmaking agency, is looking at changing the scene with its latest project known as Viola.AI, with SMU as one of its research partners. Viola.AI is envisioned to be the first holistic AI mobile platform that provides dating and relationship solutions, and has a unique verification system that uses real-time face scan, photo and social media checks to provide their clients assurance that they are meeting genuine singles. Not only will it match potential couples, it can also suggest places for dinner, remind them of dates, and give advice on relationship issues.

As part of the collaboration, SMU Professors Paulin Straughan and Jiang Jing will conduct research to feed data and enhance the matching engine to ensure quality matches.

From a social aspect, Professor Paulin Straughan will carry out thorough literature review on spouse selection, family formation and related works; as well as the analysis of datasets, such as users' date preferences. Focus groups and surveys will also be conducted to gain a better understanding on the needs and expectations of the younger generation.

From a technical aspect, Professor Jiang Jing will combine content-analysis and collaborative filtering approaches to improve the current matching recommendation mechanism, and will also enhance Viola.AI's existing chatbot on providing dating advice.

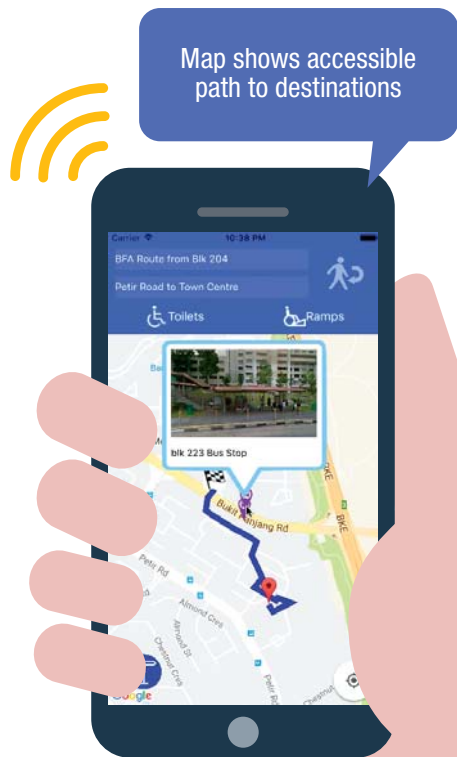
SMART MOBILITY & ACCESSIBILITY FOR BARRIER-FREE ACCESS



Sensors are installed on wheelchairs



Sensor data is analysed



Map shows accessible path to destinations

The greying population of Singapore presents challenges that the Government is seeking to tackle through various means, including the use of technology. In addition, the Government is also making deliberate efforts towards creating an inclusive society for the less-privileged, the seniors, and the less-abled.

The Smart Mobility & Accessibility for Barrier-free Access (SmartBFA) project builds on this emphasis to allow people with disabilities and other barrier-free access users – such as elderly people with mobility aids and parents with push prams – to live, work and play in Singapore in an inclusive, fair and dignified manner.

The project team that comprises Professors Tan Hwee-Xian and Tan Hwee-Pink, along with Trampoline Limited (a non-profit organisation which develops technological solutions for the social sector), capitalises on crowdsourced sensor data from resident volunteers to locate obstacles and barrier-free access routes in Singapore. It identifies first- and last-mile barrier-free access paths and transportation hub-to-hub routes and uses this information to determine the shortest and most accessible routes for these residents.

The project has a total of seven runs and works with volunteers who provide crowdsourced sensor data. With preliminary analysis showing the usefulness of sensor data in determining road conditions (such as bumpiness and presence of obstacles), the team will be looking at expanding the scope to map barrier-free paths across the whole of Singapore.

FOOD SECURITY

In Singapore's push towards becoming a smart nation, the ubiquity of technology has far-reaching implications on the daily lives of Singaporeans. Technology has been used to bridge the gaps in many areas of life including payment with mobile wallets such as PayLah or securing transportation with applications like Grab.

Professor John Donaldson and his research team spotted a gap in personal food security that could potentially be resolved by technology. This gap manifests itself in a paradox that has implications for urban management. On the one hand, there are hundreds of groups distributing nutritious food around the island while on the other, many Singaporeans continue to face food insecurity – a status that includes those who are currently hungry, as well as those who do not know where their next meal is coming from.

Through a survey of more than 300 low-income Singaporean families about their ability to acquire food, and 100 in-depth interviews with them, the research team found that about 40% of the families

surveyed faced some degree of food insecurity, with about half of them facing severe forms of food insecurity, such as going without food for at least an entire day. The team found out that some families they spoke to did not see themselves as in need; they felt that there were people in worse situations than them. Others were too proud to ask for or accept help.

Through the analysis of data, the team seeks to identify patterns of need that will allow technology to link food donors with those in need. At a macro-level, the team also hopes to identify root causes behind food insecurity, and identify ways – including applying technology – to enhance the food security of every Singaporean household.



OPTIMISATION & RESOURCE MANAGEMENT

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The Fordism efficiency-driven model has evolved by leaps and bounds ever since its inception during the industrial age. In our current Industry 4.0 era, many of the processes in managing resources have been revolutionised by marrying Big Data analysis with artificial intelligence.

From taxis and ride-hailing services to delivery and crowd management, efficiency remains the operative word of the day. Every wasted moment can have cost implications downstream.

Read on to find out more about how our SMU research teams are bringing efficiency to the next level across various industries through technology.



- > Logistics Service Providers' booking requests
- > Malls' dock capacity and availability
- > Retailers' requested delivery timings
- > In-mall distribution operational constraints

CUDO PLATFORM



Logistics Service Providers



Delivery routes + Dock schedules



Retail Malls

COLLABORATIVE URBAN DELIVERY OPTIMISATION

Urban logistics is a complex phenomenon which faces an inevitable conflict – where businesses hope to reduce operating costs on one hand, while urban planners seek to minimise traffic congestion on the other.

Faced with the challenge of optimising logistics and transportation activities in Singapore, the research team at the Fujitsu-SMU Urban Computing and Engineering Corp. Lab (UNiCEN), helmed by Professor Lau Hoong Chuin, designed a national platform that coordinates urban logistics activities in collaboration with the Infocomm Media Development Authority of Singapore.

Statistics show that there were 160,000 trucks on the road, which was more than twice the number of cars and private-hire vehicles. Having this platform will enable Singapore to move towards a “truck-lite nation” while preserving operational efficiencies.

The Collaborative Urban Delivery Optimisation (CUDO) platform is a one-stop resource planning and scheduling tool for logistics service providers. CUDO optimises mall deliveries by consolidating delivery plans and optimising route schedules for delivering goods to the malls. The CUDO engine continuously learns an in-mall traffic data to provide a realistic inference or estimates on uncontrolled parameters such as service and arrival times. It also adds value by providing specialised services that include dock reservation and geospatial services.

With CUDO, the bottleneck problem for deliveries (which in turn affects productivity) could be resolved, delivery congestions reduced at malls, and overall safety improved in the city.

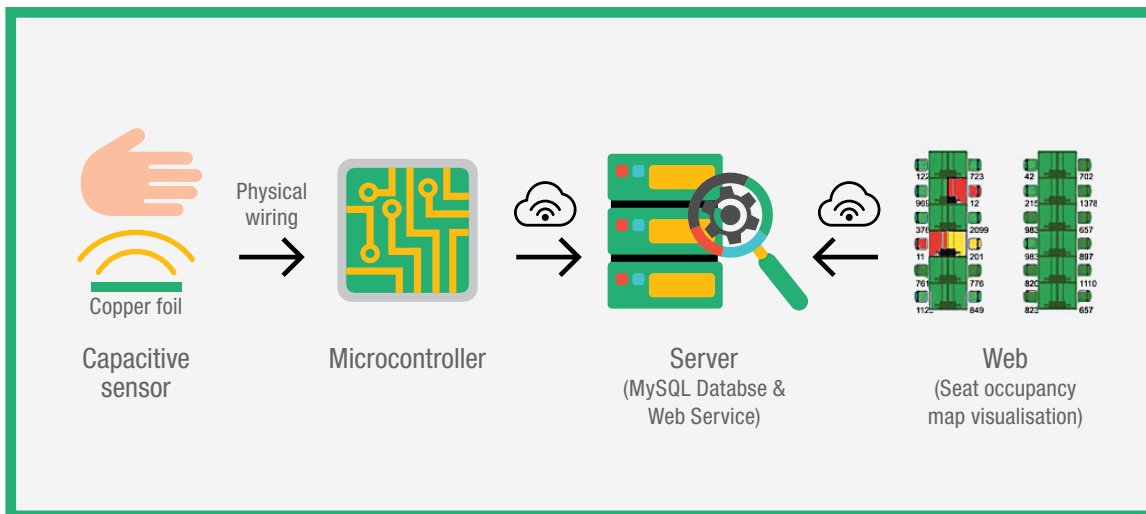
SEAT OCCUPANCY DETECTION THROUGH CAPACITANCE SENSING

Managing the seating capacity of a business, especially during peak periods, can be stressful and daunting. Particularly in Singapore where the “chope” culture (reserving seats using items such as tissue packets, name cards, umbrellas) is common, sourcing for an empty table can pose as a challenge.

To tackle this problem, Professor Rajesh Balan and the research team at SMU’s LiveLabs Urban Lifestyle Innovation Platform (LiveLabs) built a sensor known as *Cap* to detect occupancy of tables. *Cap* employs capacitive sensing solutions, and by placing the sensors under the table (hidden from public view), it is able to detect three different occupancy states: unoccupied, people-occupied, and object-occupied. With the goal to make *Cap* inexpensive

for deployment, the team designed the sensor using simple algorithms and low-cost materials. To date, the sensors have been deployed in the SMU library (to detect free seats) and a public food court (to identify tables to be cleaned).

The team found that even with simple algorithms coupled with noisy real-world environments, *Cap* can detect the occupancy status of tables with 80% accuracy. Through further experimentation, the team also demonstrated that *Cap* can be used to detect human activities and that its accuracy can be significantly enhanced to over 90% accuracy in situations where more complicated algorithms, such as deep neural networks, are employed.



System flowchart for seat occupancy detection using capacitive sensor.

LARGE-SCALE CROWD SIMULATION BASED ON REAL-WORLD DATA

Crowd management in a safe and efficient manner within a large indoor facility is a challenging and critical task, especially when faced with the prospects of uncertain crowd behaviour. To evaluate the best way to resolve issues from large-scale events, a simulation of realistic crowd behaviours will need to be created for assessment and analysis.

The research team at UNiCEN took on the task of developing such a simulation platform, with mobility traces collected via the Wi-Fi localisation technology. Due to the availability of a critical mass of data on crowd trajectories, the team was able to create a realistic crowd simulation model according to event types.

The various data points that were used to triangulate and predict crowd movements included video analysis from multiple surveillance cameras covering different parts of the venue. These points were helpful in extracting and analysing finer crowd features such as group segments, flow rates and crowd densities.

The simulator was successfully tested at one of Singapore's convention centres and it can be customised for different venue operators' needs. Venue operators can benefit from the simulator through the designing and implementation of personalised efficient crowd-control strategies to enhance the experience of their visitors.



GAINING INSIGHTS THROUGH WI-FI TECHNOLOGY

Despite the ubiquitous and extensive nature of Wi-Fi, Wi-Fi-based indoor localisation in large public venues has not been as prevalent due to its high adoption cost. To reduce this adoption cost, SMU's LiveLabs developed a solution that can locate any Wi-Fi enabled device using the pre-existing Wi-Fi infrastructure – so no infrastructure changes or software installation for device users are necessary.

The team then created a platform to provide customised analytics on indoor movement and behavioural patterns of visitors. Known as the Location Analytics platform, it offers both retrospective and predictive insights of movement data to users. Business managers of venues such as shopping malls, theme parks and airports will benefit from the platform

as it can provide them information to fine-tune operational functions such as safety and surveillance (e.g. sending security staff to areas with unusual visitor density) or energy management (e.g. adjusting heating, ventilation and air conditioning based on anticipated occupancy levels).

Leveraging on the location analytics capability, the team also came up with a program that can enable business managers to send location- and group-specific advertisements to their customers' mobile devices. For instance, a mall operator can identify people shopping together as a group in the mall and push out a 1-for-1 meal promotion via their mobile devices to entice them to visit a specific restaurant.

With Wi-Fi infrastructure progressively rolled out across Southeast Asia, the research team has confidence in the potential of its technology and hopes that the technology will contribute to Singapore's Smart Nation initiative. This solution is currently being used daily by a number of partners including SMU and Suntec Singapore International Convention & Exhibition Centre.



TAXI DRIVER GUIDANCE SYSTEM

Companies like Grab and Uber are arguably the biggest names in the ride-hailing industry, accounting for the lion's share of the markets they are in. This has posed a challenge to traditional taxi companies responding to this disruption.

The research team at UNiCEN, led by Professor Cheng Shih-Fen, saw the possibility of developing a technology to level the playing field for traditional taxi drivers, which led to the birth of the DGS technology.

DGS, or Driver Guidance System, aims to help taxi drivers compete against ride-hailing technologies by providing guidance to them on finding the next passenger.

Delivered through a smartphone app, this system is hands-free and automatically provides the best recommendations for drivers based on their

locations. Powered by stream data processing, demand prediction, and a driver-sensitive decision support system, the app would direct taxi drivers to zones or spots where there is potential demand for their services, thereby increasing their chances to pick up passengers, and minimising their empty cruising time.

An interesting innovative feature of the DGS is its ability to generate real-time personalised recommendations for thousands of drivers by dynamically accounting for the status of all taxis and the demand occurrences. Through the DGS, taxi drivers have the ability to anticipate demand, reduce empty taxi cruising time, which could lead to more income through an expected increase of trips by at least 10%.



EFFICIENCY OF SURGE PRICING IN ALLOCATION OF RIDE-HAILING RESOURCES

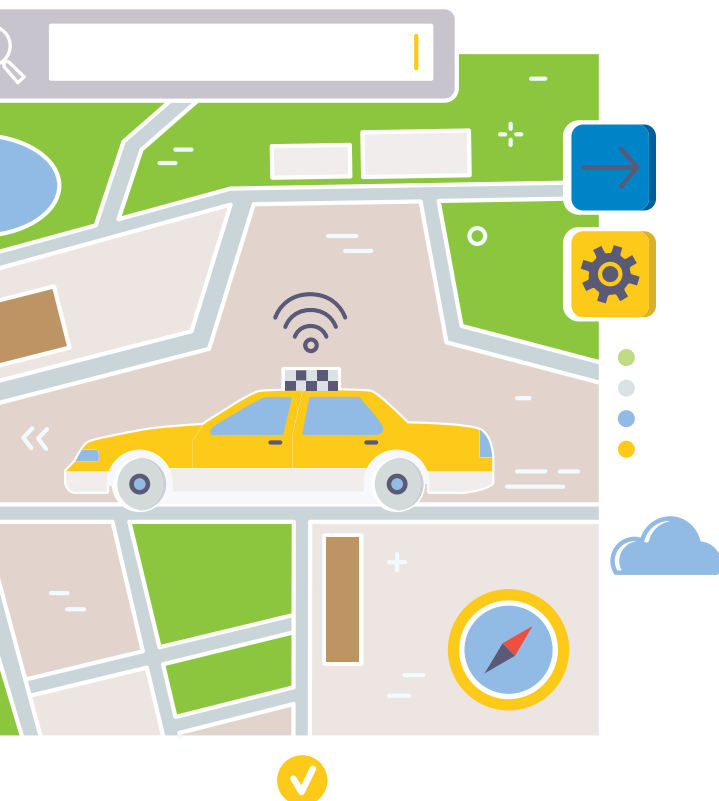
Grab, Uber, Go-Jek, Didi Chuxing and other similar apps have surged in popularity over the last few years in the ride-hailing space and have impacted both consumers as well as the service providers. For consumers, these apps have displaced traditional taxis as the primary go-to option for private hire transportation. For the service providers, these apps have created jobs for freelance drivers as well as an additional marketplace of opportunities for existing taxi drivers.

In Singapore, Grab (and previously Uber) employs surge pricing in its bid to allocate passengers to the right drivers. With this, prices can soar to high rates especially when demand is high, with the rationale that this arrangement enhances the efficiency of matching drivers and consumers.

A team of researchers from SMU's School of Economics and School of Information Systems is in the midst of finding out if surge pricing does indeed help to allocate passengers to the right drivers. Through the analysis of data on taxis in Singapore before and after the implementation of ride-hailing apps, Professors Cheng Shih-Fen, Hsu Wen-Tai, and Li Jing are studying how, on the supply front, drivers respond to price signals to draw an initial set of implications on the efficiency of taxi resource allocations.

Through the research, the team will determine if traditional taxi drivers, after having equipped with ride-hailing apps, are less likely to show up in areas with rigid price surcharge imposed under the traditional fare scheme (such as in the airport and the Central Business District areas) and more likely to serve in the previously under-served areas. In addition, the data will also allow the team to observe the responsiveness of taxi drivers in relation to external factors, such as rainy days, and estimate the supply curve of taxi drivers.

A research that would likely be of interest to governments and consumer watchdogs, the research team hopes to uncover new insights and provide primary evidence for whether the price mechanism at play has indeed helped improve market efficiency compared to the traditionally imposed fixed surcharges.



MOBILE SAFETY & SECURITY

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With the rapid advancements of technology and the ubiquity of data sharing, many different forms of vulnerabilities have emerged. From tech giants to small- and medium-sized companies and even individuals, the thought of being compromised is daunting, particularly when the costs can be astronomical.

Hacking, malware, authentication, trust, and encryption are the common issues that pertain to cybersecurity and in the last seven years, market revenues in this sector have ballooned from US\$55 billion (Year 2011) to nearly US\$100 billion (Year 2018).

In this section, SMU research teams deal with teething problems within the mobile security sector. Read on to find out more about how they are impacting this sector.

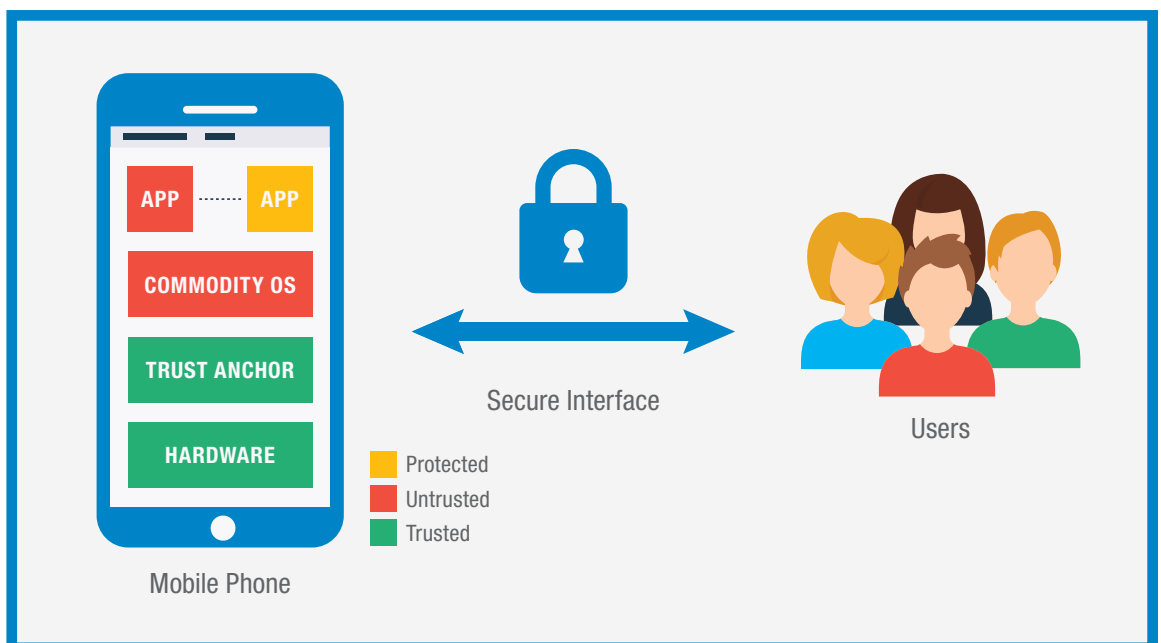
FORTIFYING MOBILE PLATFORMS WITH A USER-CENTRIC TRUST ANCHOR

In a hyper-connected world, the issues of trust, privacy, and data protection pertaining to information flow and exchanges will continue to grow in prominence. From the perspective of mobile communications security, Professor Ding XuHua and his team at the SMU Secure Mobile Centre (SMC) found limitations in the existing solutions that commodity mobile devices were operating on to establish “trustworthiness” with each other.

One of the existing solutions used by mobile devices is the TrustZone-based approach which is inflexible and results in course-granularity, a form of inefficiency where certain tasks process the bulk of the data workload while others remained idle. This approach also requires the support of hardware manufacturers which renders it cumbersome. The other existing solution is the microkernel-based approach which is incompatible with commodity systems and comes with a higher cost to implement and maintain. To compound to the limitations, both solutions are also not user-centric.

To address the limitations, the team took the fundamental approach of implementing a user-centric trust anchor with a secure user-anchor interface. The security framework relied on this trust anchor to protect critical resources in an on-demand fashion. This trust anchor would be deployable for mobile devices with ARM* architecture and would have the potential to create highly secure mobile platforms for niche markets.

At this stage, the team has completed its preliminary design of a secure hypervisor-user interface that enforces inter-process information flow control with self-protection on availability and integrity. The team is working towards designing a full-fledged trust-anchor with a secure user interface and a security framework based on the trust-anchor supporting secure execution environment, device control, input/output data protection and user data protection.



*ARM – Advanced RISC (Reduced Instruction Set Computing) Machine.

ANALYSING, DETECTING AND CONTAINING MOBILE MALWARE

Mobile malware is highly disruptive and a serious threat in the digital world. These malicious programs exist in the forms of computer viruses, worms, Trojans, spyware, adware, amongst others, that are designed and deployed to steal information, damage data and disable operating systems.

To better understand how mobile malware is propagated, Professor Gao Debin and his team from SMC set out to conduct a user study among SMU students to monitor how malware is spread.

While the entire setup was limited to the x-86 platform which is the world's predominant personal computer CPU platform, the team was able to create an app that simulated mobile malware propagation.

Through the process, the team was able to understand the strategies of malware writers and customise the Android ROM (Read Only Memory) with a malware detection and containment system. The detection system robustly and systemically detected malware

by spotting system anomalies, whilst the containment system followed a privilege separation framework and minimised privileges, a move that severely limited the capability of malware, especially the ones that had somehow successfully evaded malware detection.

To date, the team has constructed behavioural models of the top 50,000 Android apps for use in anomaly detection and has completed the system design of the communication mechanism of a modified Android framework for “split execution” – allowing them to replicate – which provides greater scalability for this work.



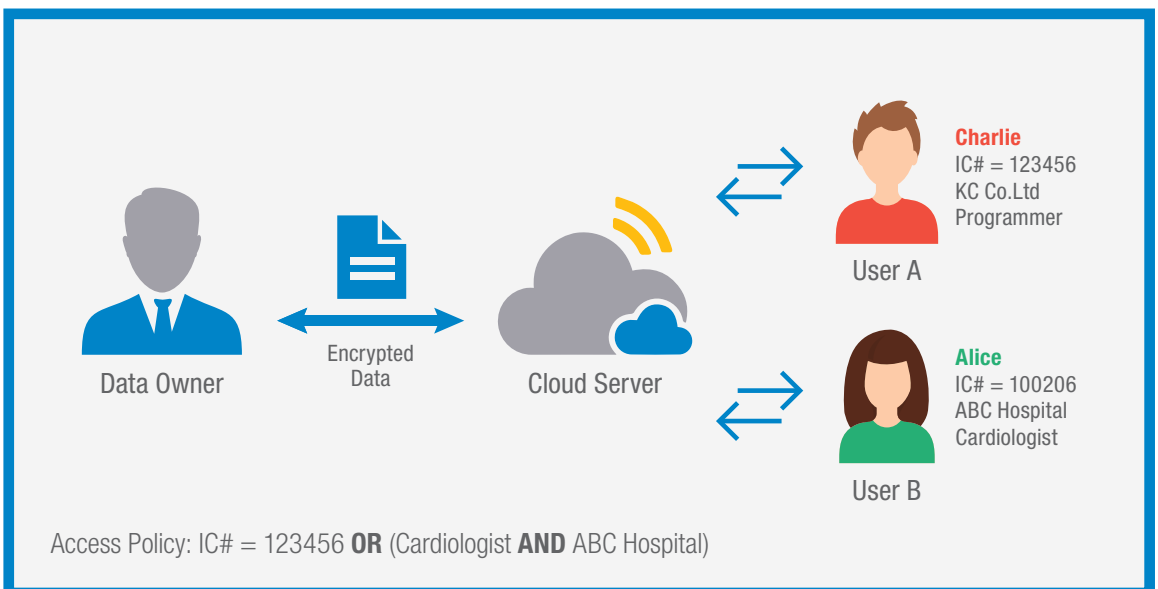
SYSTEM FOR SCALABLE ACCESS CONTROL OF ENCRYPTED DATA IN UNTRUSTED SERVERS

Cloud computing has manifested itself in commonly used services like Box, Dropbox, Google Drive and OneDrive, and these services have brought about tremendous convenience to users. The major benefits of cloud computing are real-time shared collaboration and seamless access; however, when it comes to implementing access control for encrypted data on cloud servers, existing solutions are neither scalable nor secure.

Professor Robert Deng, the Centre Director of SMC, and his team felt that this warranted addressing and decided to create a scalable access control system for encrypted data in untrusted servers. This would allow for a practical deployment to support both mobile and non-mobile users.

The team designed a prototype for access control of encrypted data in a group chat system/application with the view of supporting mobile devices and efficient user management, including user revocations. Having created a suite of protocols and algorithms for highly efficient decryption and user revocation in attribute-based encryption systems, the team implemented an attribute-based secure messaging system based on its patented technology.

With this innovation, data owners can now encrypt their data and specify access policies where users can access the data if their attributes satisfy the access policies accordingly. Its impact is one that is practical, scalable and secure for encrypted data sharing in the cloud.



SECURE AND USABLE AUTHENTICATION SYSTEMS IN MOBILE COMPUTING

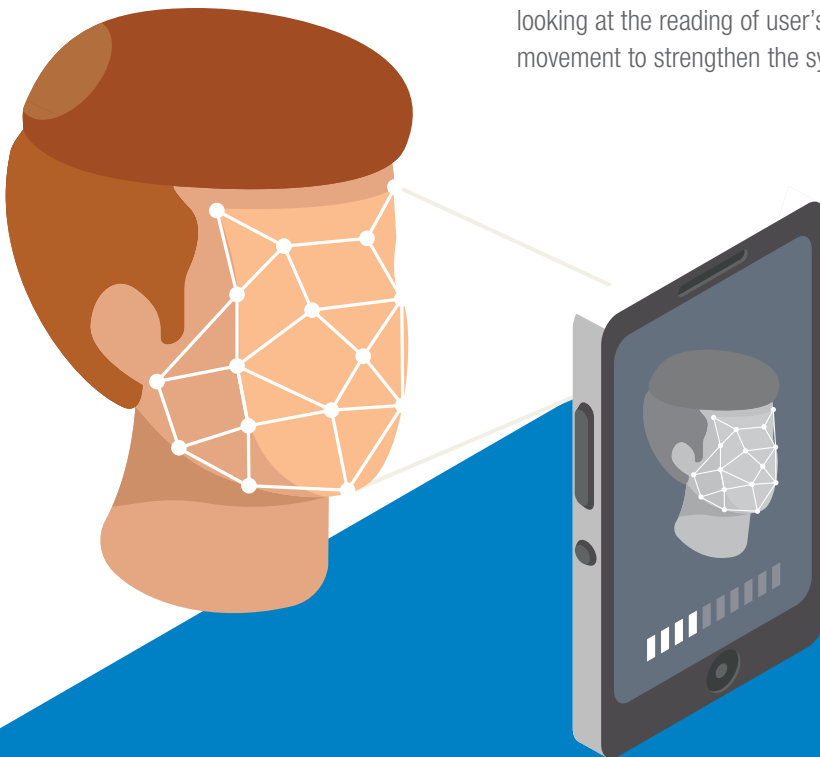
The ubiquity of visual communication devices brings about many benefits in bridging distances and improving communication intimacy as opposed to a pure audio connection. Communication device manufacturers are also continually seeking ways to improve authentication features as it remains a priority among users.

In their quest to improve mobile device authentication, Professor Li Yingjiu and his team at SMC found that the most popular password-over-SSL/TLS* system suffers from a large attack surface, and there are usability issues as well, such as the need to manage multiple passwords. Existing solutions such as the common password-based and face-based authentication features are also prone to many pressing attacks.

*SSL – Secure Sockets Layer
TLS – Transport Layer Security

To that end, the team designed FaceLive, a face authentication technology that seeks to act as another layer of security for the current facial recognition technology (which has been susceptible to biometric hacks). To use FaceLive, the user is required to hold and move a mobile device in front of his/her face over a short distance. FaceLive uses the front-facing camera of the mobile device to capture a video of the user's face, and uses an accelerometer and a gyroscope to record motion data of the device simultaneously. The live user is then authenticated if changes in head movement in the video are consistent with the movements recorded by the device. FaceLive can also operate under complex lighting conditions and compensate for a range of cumulative errors that can occur while detecting head movements during the process of face authentication.

The team is currently working with i-Sprint Innovations Pte Ltd, a Singapore-based solution provider in identity, credential and access management, for potential application of FaceLive. The team is also looking at the reading of user's expressions and facial movement to strengthen the system.



PLANNING, POLICY, EDUCATION & GOVERNANCE

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With Singapore's aim at becoming a smart nation for the future, effective urban planning plays an important and integral role in smart city management, particularly when it comes to issues like housing policies, data governance and mobility, amongst others. However, given the complex nature of policy and governance, it is a constant challenge for policymakers and urban planners alike to navigate through different situations as they emerge.

In this section, our university and the various research teams take on the “hard”, “soft” and “heart” issues that pertain to policy and governance. Read on to find out more.

SMART RETAIL GEOSPATIAL PLANNING

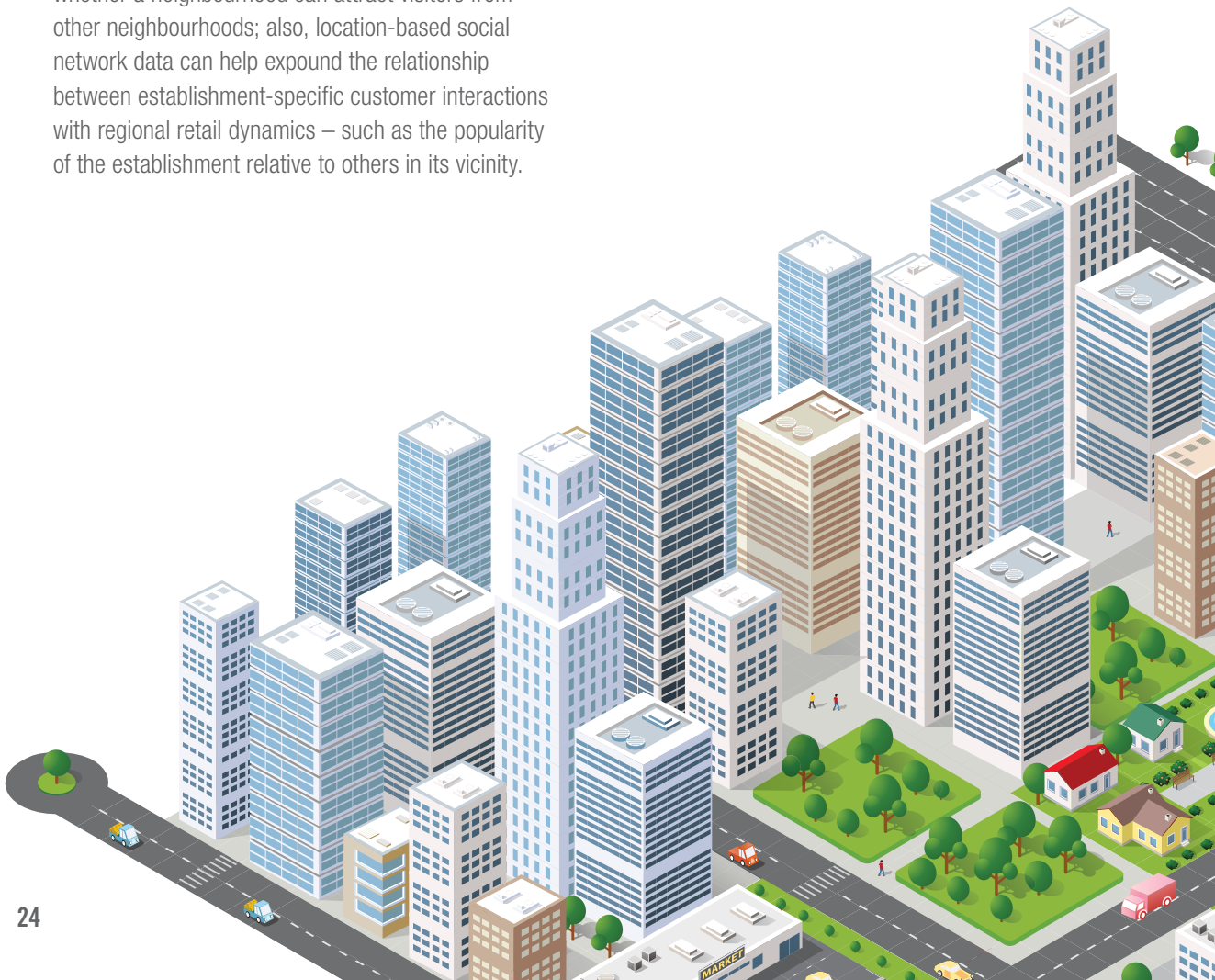
Big data has created a new digital landscape for efficient urban planning. This is especially useful when it comes to guiding urban planners in making more informed and dynamic land use decisions.

In a recent collaboration with the University of Cambridge, Professor Archan Misra and his team of researchers demonstrated that it is possible to accurately predict the viability of individual retail business establishments. This effort was made possible by employing high-fidelity sampling of environmental factors from the combination of urban mobility and social media data, as well as public agency records.

The team discovered that mobility data can reveal the urban dynamics of different locations – such as whether a neighbourhood can attract visitors from other neighbourhoods; also, location-based social network data can help expound the relationship between establishment-specific customer interactions with regional retail dynamics – such as the popularity of the establishment relative to others in its vicinity.

Armed with this concept, the team is working with the Singapore Urban Redevelopment Authority (URA) to build a Retail Space Planning Analytics Platform. The platform will address key questions related to the interdependency of urban mobility and city land use with the consideration of additional urban data (such as licensing permits and property rental records), as well as additional mobility and social media inputs. The key problems that are being studied include viability of key retail trades in neighbourhoods across the island; future demand prediction of new establishments; and the predicted impact of proposed new establishments on a neighbourhood's local congestion.

With the translation of the research into appropriate analytics tools and visualisation portals, URA as well as business owners can make more informed and proactive land use decisions.



PEOPLE-CENTRIC APPROACH TO URBAN PLANNING

Singapore has embarked on its ambitious journey to be a smart city. Its policymakers and city planners face the challenge of creating urban solutions in an ecosystem that will achieve the simultaneous goals of a global city and a cohesive country where its people enjoy a good quality of life.

To that end, Professor David Chan advocates adopting a people-centric approach to urban planning because liveability is about people's evaluations, experiences and encounters when they interact with their physical and social environments. This approach recognises the need to treat social and behavioural factors as necessities to be incorporated and integrated when designing and implementing urban policies and interventions.

In adopting this approach, Professor Chan highlighted three points. Firstly, because there are many constructs that comprise different aspects, it will be important to take an evidence-based approach rooted in the rigour and relevance of the social and behavioural sciences. This translates into clarity in implementation as well as precision in refining any measures given over the long-term for urban planners.

Secondly, in incorporating social and behavioural sciences factors, urban planners will need to adequately capture the experiences of various segments of the population. It is critical to note, for example, that the same built environment can impact different groups of people differently or impact people differently over time.

Finally, policymakers and planners should anticipate how needs and wants may change over time and across demographic groups. Professor Chan notes that this is especially relevant when using social attitude surveys to gather public sentiments as inputs for town planning – it is necessary to think about the dynamic change in needs and wants, the different demographics, and how environmental change can actually influence people's expectations.





HOUSING POLICY INNOVATIONS FOR AFFORDABLE HOUSING IN SINGAPORE

Urban planners worldwide are facing challenges related to unaffordable housing, increasing economic inequality and divided cities. It is in this light that they and policymakers in particular, are seeking out alternative systems as solutions to affordable housing.

Professor Phang Sock Yong's research as an urban economist working on Singapore's housing policies points to Singapore's globally renowned success in making it possible for 90% of its resident population to own homes. Singapore's experience is a prime example to many cities in terms of the organisational feasibility for a single housing authority to build, sell and manage housing estates for a majority of the population; its use of housing policies and fiscal measures to curb housing speculation; its decision to build ethnically inclusive communities; and laudable attempts to reduce housing wealth inequality.

Professor Phang's research notes that in order for Singapore's success to be transferable to another city, factors like high economic growth rates, low unemployment rates, and ability to control the entry of migrants who can impose a strain on the housing service sector will have to be in place. It is also important for policymakers and urban planners seeking to replicate Singapore's success to juxtapose local political and social contexts, as the same set of policies adopted in another context can lead to very different outcomes.

Professor Phang's recent research focuses on home equity extraction for retirement financing and is also likely to be of interest to governments who are interested in implementing policies that can help retirees unlock the value of their homes.

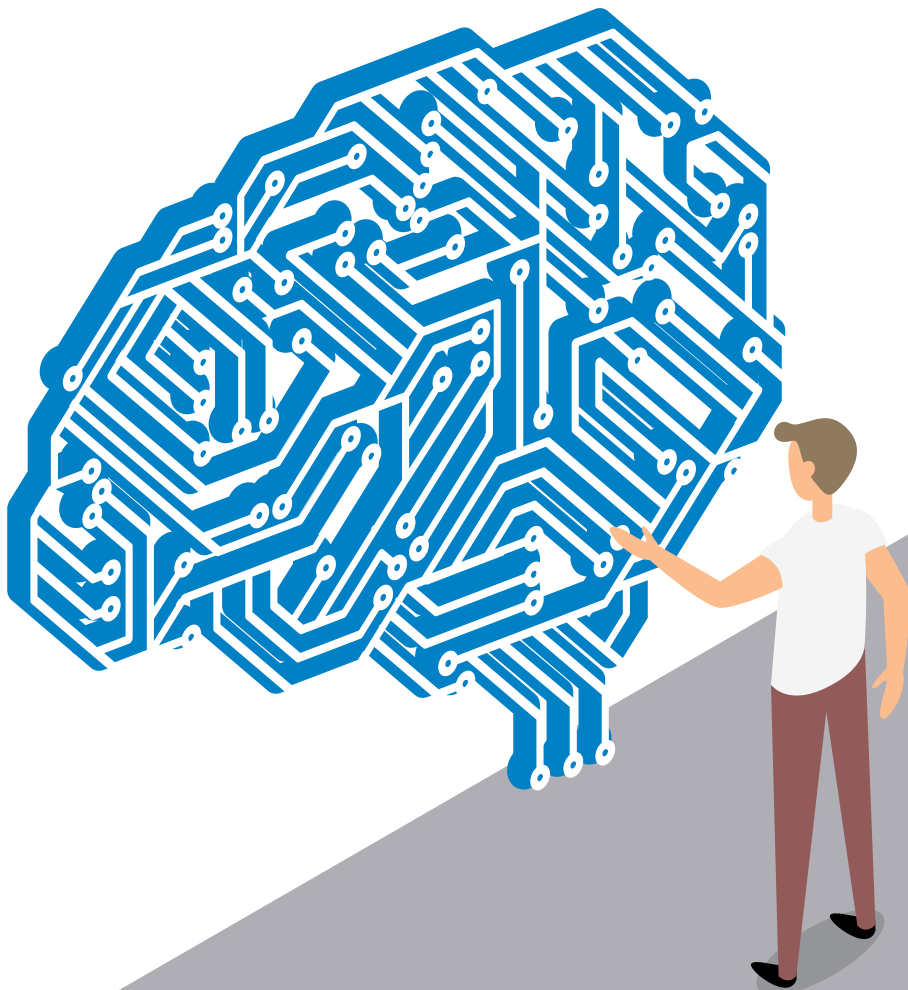
CENTRE FOR AI & DATA GOVERNANCE

In preparation for an AI-enabled and data-driven Singapore, the SMU School of Law, led by Professor Goh Yihan, will be setting up a new research centre to generate deep expertise and build sustainable domestic capacity in the fields of AI and data governance. The establishment of the centre was made possible with a funding of S\$4.5 million awarded by the Singapore National Research Foundation.

The research programme consists of three research streams – *AI and Society*, where social issues such as trust in AI, privacy and data protection as well as cybersecurity will be focused on; *AI and Industry*, where AI's impact on the labour force,

transport and dispute resolution will be studied; and *AI and Commercialisation*, where challenges (such as intellectual property) that arise from the commercialisation of AI will be addressed.

The policy frameworks that emerge from the streams will serve as a guide to the legal treatment of AI and position Singapore as a leader in the domain. The Centre will also create knowledge and governance solutions for government, industry and civil society, and develop pragmatic legal frameworks through legal and ethical research to enable AI as an economic driver and ensure its beneficial uses.



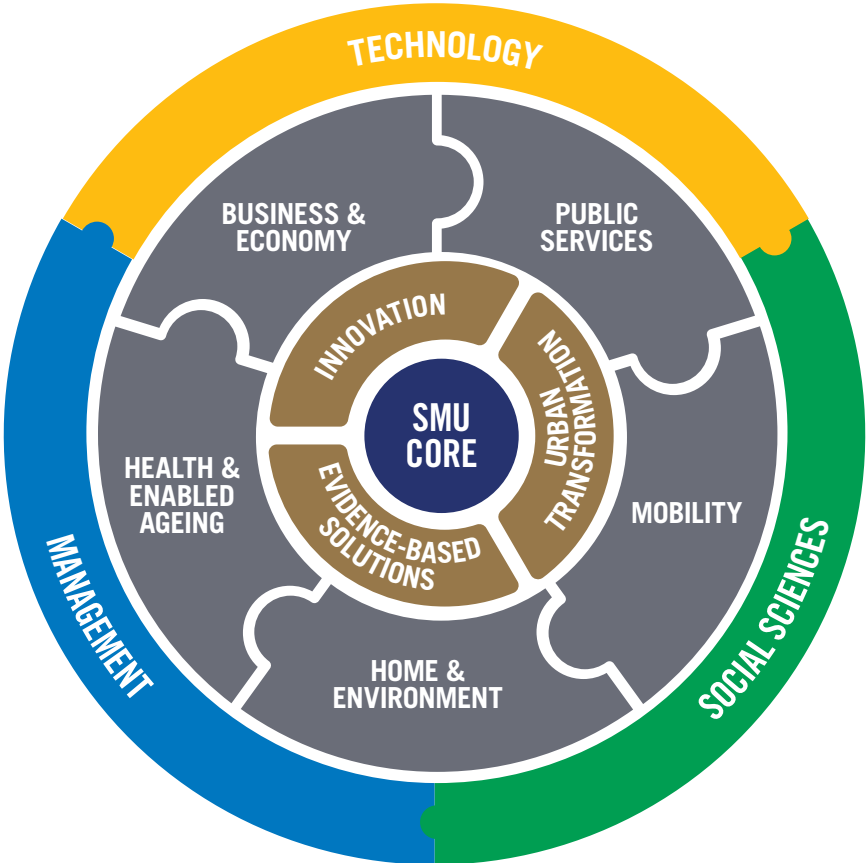
EDUCATION FOR SMART CITY MANAGEMENT AND TECHNOLOGY

As cities around the world continue their socio-technological evolution into smart cities, policymakers are constantly challenged to improve economy and the lives of their citizens with digital innovations while ensuring that people do not get left behind in the rapid changes and technology adoptions. One way to do so is to nurture and equip the next generation workforce with the right combination of technology, social and management skills to thrive in the changing environment.

As the Programme Director of SMU's new Smart-City Management and Technology major, Professor Tan Kar Way could not agree more. She also shared her experience in India, where she visited an emerging smart city and witnessed how collaborative and inclusive thinking in urban planning and policymaking

has helped solve the city's issues with digital adoptions, and left a positive impact on its people, businesses and the environment. The experiences brought her new understanding on the workings of a smart city, and also helped reinforce the design for the programme.

The Smart-City Management and Technology major uniquely draws from several disciplines with the aim of developing the skills of students in analysis, critical thinking and integrating technology, social sciences and management for innovating smart city solutions. Students will be empowered to design innovative and sustainable solutions to tackle urbanisation challenges in areas such as (but not limited to) business and economy, health and enabled ageing, home and environment, mobility, and public service.



Students can look forward to becoming professionals who understand not just the technology that underpin the workings of a smart city, but also influence policy, social and business issues to positively impact the lives of people.

5 KEY SMART CITY DOMAINS

BUSINESS & ECONOMY



FINANCIAL TECHNOLOGY



SHARING ECONOMY



SMART RETAIL

HEALTH & ENABLED AGEING



AGEING-IN-PLACE WITH TECHNOLOGY



COLLABORATIVE CARE SYSTEM



PREVENTIVE HEALTHCARE

HOME & ENVIRONMENT



DATA DRIVEN URBAN PLANNING



INTELLIGENT SUSTAINABLE SOLUTIONS



SMART BUILDING

MOBILITY



DYNAMIC CROWD MANAGEMENT



URBAN & TRANSPORTATION SOLUTIONS



SUSTAINABLE LOGISTICS

PUBLIC SERVICES



PUBLIC SAFETY



URBAN COMMUNITY & LIVEABILITY



SOCIAL SENSING

CONTACTS

Community participation through mobile crowdsourcing

Archan MISRA
Professor of Information Systems
Associate Dean (Research)
Director, Centre for Applied Smart-Nation Analytics
Lee Kuan Yew Fellow

Smarter, healthier eating with FoodAI™

Steven HOI
Associate Professor of Information Systems
Lee Kuan Yew Fellow

Data-driven community eldercare platform for sustainable ageing-in-place

TAN Hwee-Pink
Academic Director, SMU-TCS iCity Lab
Associate Professor of Information Systems (Practice)

A date with AI

Paulin STRAUGHAN
Professor of Sociology (Practice)
Dean of Students

JIANG Jing
Associate Professor of Information Systems
Deputy Director, Living Analytics Research Centre

Smart mobility & accessibility for barrier-free access

TAN Hwee-Xian
Assistant Professor of Information Systems (Practice)

TAN Hwee-Pink
Associate Professor of Information Systems (Practice)
Academic Director, SMU-TCS iCity Lab

Food security

John DONALDSON
Associate Professor of Political Science

Collaborative urban delivery optimisation

LAU Hoong Chuin
Professor of Information Systems
Director, Fujitsu-SMU Urban Computing & Engineering Corp Lab

Seat occupancy detection through capacitance sensing

Rajesh BALAN
Associate Professor of Information Systems
Director, Livelabs Urban Lifestyle Innovation Platform

Large-scale crowd simulation based on real-world data

LAU Hoong Chuin
Professor of Information Systems
Director, Fujitsu-SMU Urban Computing & Engineering Corp Lab

Gaining insights through Wi-Fi technology

Rajesh BALAN
Associate Professor of Information Systems
Director, Livelabs Urban Lifestyle Innovation Platform

Taxi driver guidance system

CHENG Shih-Fen
Associate Professor of Information Systems
Deputy Director (Research), Fujitsu-SMU Urban Computing & Engineering Corp Lab

Efficiency of surge pricing in allocation of ride-hailing resources

CHENG Shih-Fen
Associate Professor of Information Systems
Deputy Director (Research), Fujitsu-SMU Urban Computing & Engineering Corp Lab

HSU Wen-Tai
Associate Professor of Economics

LI Jing
Assistant Professor of Economics
Lee Kong Chian Fellow

Fortifying mobile platforms with a user-centric trust anchor

DING XuHua
Associate Professor of Information Systems
Coordinator, BSc (IS) Cybersecurity Track
Lee Kong Chian Fellow

Analysing, detecting and containing mobile malware

GAO Debin
Associate Professor of Information Systems
Faculty Manager, SMU BSc (IS)-CMU Fast-Track Programme

System for scalable access control of encrypted data in untrusted servers

Robert DENG
Director, Secure Mobile Centre
AXA Chair Professor of Cybersecurity
Deputy Dean, Faculty & Research

Secure and usable authentication systems in mobile computing

LI Yingjiu
Associate Professor of Information Systems
Member, University Tribunal
Lee Kong Chian Fellow

Smart retail geospatial planning

Archan MISRA
Professor of Information Systems
Associate Dean (Research)
Director, Centre for Applied Smart-Nation Analytics
Lee Kuan Yew Fellow

People-centric approach to urban planning

David CHAN
Professor of Psychology
Director, Behavioural Sciences Institute

Housing policy innovations for affordable housing in Singapore

PHANG Sock Yong
Celia Moh Chair Professor of Economics
Vice Provost (Faculty Matters)

Centre for AI & data governance

GOH Yihan
Dean, School of Law
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Education for smart city management and technology

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