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Innovation for Sustainable Development

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The Development of Autonomous Driving for Shared First-Last Mile Vehicle

Health Monitoring Wearable Sensors

Chula 5G Test Center

Entrepreneurial University Development Program

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Editor's note

Developing national infrastructure to prepare for rapid social and economic transformation is essential to national development. However, achieving the country's sustainability goals will necessitate parallel efforts to build a knowledge-based society based on a strong foundation of technology and innovation. While strengthening Thailand's expertise in research and development as well as technological innovation will be essential to realizing this goal, this must be coupled with advancement in the humanities and social sciences in order to address the multiple social, economic, and environmental challenges and opportunities that inevitably accompany technological change.

Because of the pervasive implications and impacts of technological innovation throughout every sector and stratum of society, a high level of stakeholder integration and participation will be a critical success factor, ensuring alignment across all economic sectors by public, private and civil society actors. Ultimately, only a high level of integration in policymaking and planning can ensure a better quality of life for Thailand's peoples.

Editorial Team

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Content

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Article

The Development of Autonomous Driving for Shared First-Last Mile Vehicle

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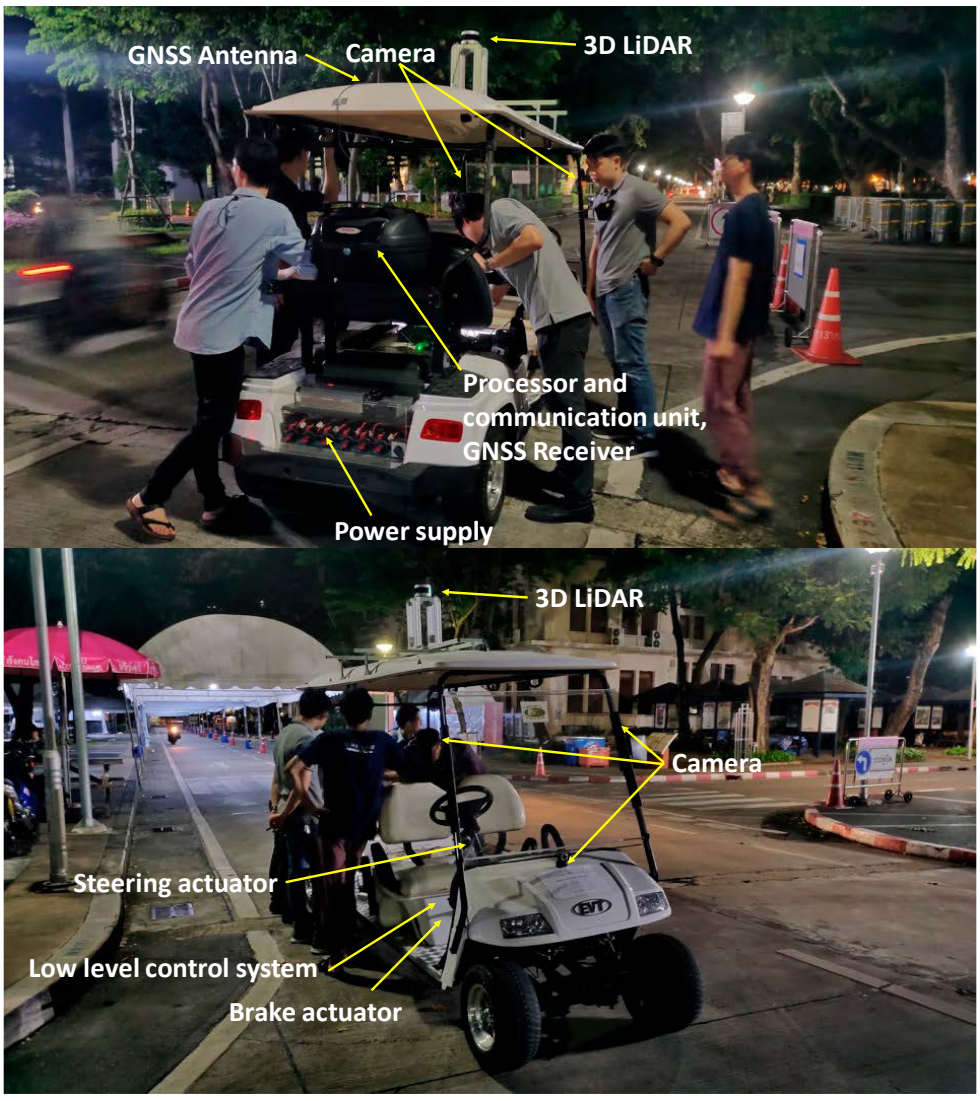
Introduction

Single-mode transportation such as the private car is a traditional way to provide door-to-door mobility. Originally efficient and convenient, urban expansion, traffic congestion and air pollution have eroded these advantages and prompted an expansion of rapid mass transit systems that are safer, quicker, cheaper and more reliable in terms of journey time. Mass transit systems such as buses, light railways, trams, monorails, underground rails have all flourished in large, densely populated urban centres around the world and today serve as the backbone of urban mobility, offering a more sustainable solution to urban transport, requiring less energy, reducing air pollution and alleviating problems associated with road congestion. However, mass transit systems alone do not offer a door-to-door service. Secondary systems are needed to serve as feeders and as last-mile connections. Feeder services are also important to boost passenger volumes and ensure the viability of primary routes through a shift in transportation behaviour from sole reliance on private cars to rapid mass transit systems supported by feeders. There are two main categories of feeders: light rail systems and buses or cars such as shuttle buses or microbus services connecting local communities to mass transit stations. Car sharing has increased in popularity and is even promoted by legislation in some municipalities. Bike sharing or on-demand rental services are also available in many major cities as well as EV car sharing. Most recently, autonomous driverless shuttles are finding increasing use on feeder routes. Designed for 9-15 passengers, these electrically powered shuttles are typically driven in dedicated road lanes, but can also operate as micro transit systems with a flexible route that can be adjusted according to passenger needs.

Conclusion

This study focused on developing automotive prototypes in 2 parts: a 5G tele-operated vehicle and a prototype Level-3 autonomous vehicle. The prototypes were developed from a 6-seater electric golf cart installed with an x-by-wire system to control speed, braking function and steering. The tele-operated cockpit was also developed to enable a remote driving control unit via the 5G network and was tested around Chulalongkorn University Stadium and the Faculty of Engineering. The study indicated that the 5G network has sufficient data transmission speed to send and receive video data from 3 vehicle webcams and send driving commands to the car. However, the high average transmission latency limited immediacy of control, placing a 30km/h limit on speed. Latency was variable and may be affected by several factors such as signal coverage and buildings in the locality. Moreover, switching from 4G to 5G also triggered additional latency during the switching period. Despite this handicap, the system was able to process and analyse transmitted data from the webcams, including detection and identification of objects and predicting collision distance in order to send corrective control instructions to the remote vehicle.

After developing a prototype 5G tele-operated vehicle, the vehicle was installed with a 3D LiDAR sensor and a satellite navigation receiver. The advanced control system of the vehicle was developed from AUTOWARE, an open-source software, coded to control a 6-seater electric golf cart. The new source code allows the car to drive autonomously and for safety reasons it was tested at night on roads around Chulalongkorn University Stadium when roads were car-free. The research indicated satisfactory performance in the driverless test run. The car was able to follow the route precisely as programmed. It did not stray off the route and showed no signs of instability in operation.



Health Monitoring Wearable Sensors

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Introduction

Modern lifestyles are increasingly focusing on healthy living, partly driven by the implications of our ageing society. Rapid advances have been made in technologies that allow us all to monitor our health directly as well to care for the elderly and hospitalized patients. Low-cost sensing devices are today widely used both for routine monitoring of vital signs as well as for disease screening. These devices have also been miniaturized, extending their versatility and even making them wearable as devices or even integrated into clothing. 'Smart textiles' incorporating wearable sensors are a fast-expanding and exciting new field, offering major new opportunities in preventive care.

Our research team has developed new chemical sensors embedded into textile-based materials. The sensors are non-invasive in order to eliminate risk of infection caused by repetitive or long-term usage as seen in conventional invasive monitoring methods. Patent applications have already been filed at national and international levels for a wearable chemical sensor, that integrate colorimetric and electrochemical sensors to obtain rapid responses and precise results.

Further clinical trials are needed to confirm and expand the use of such technologies and their integration with other enabling technologies such as real-time health monitoring via wireless/5G links, including notifications and alarm capabilities.

Conclusion

Technology convergence (integration of knowledge and enabling technologies from different spheres of research) is a major driver of innovation that can elevate our quality of life and wellness in our modern society. Rapid advances in medical technology have prolonged our life expectancy, which in turn places additional burden on managing quality of life for an ageing population. The team from Metallurgy & Materials Science Research Institute, Chulalongkorn University has integrated wearable sensors in a wearable device developed for monitoring of key symptoms of diabetes. As a result, patients can monitor their own symptoms and live a normal life while the load of public health system will be relieved. This technology has numerous potential for new applications in monitoring other severe long-term conditions and symptoms.

Article

Chula 5G Test Center

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Introduction

The 5G or New Radio (NR) is the fifth generation of mobile networks. It is an emerging wireless technology with drastically enhanced capabilities to meet the demanding requirements in the present and the future. The 5G network is highly flexible so that it is applicable for use cases in different sectors including industry, business, healthcare, education, household, etc. In addition, it can handle the transfer of big data which is anticipated to keep growing exponentially in the future. The 5G technology has three key features including extremely high speed of data transfer (Enhanced Mobile Broadband: eMBB), ultra-reliable communications with very low latency (Ultra Reliable Low Latency Communications: URLLC), and concurrent connectivity to a huge number of devices (Massive Machine Type Communications: mMTC). Moreover, the 5G network consumes less energy so that it is also considered as green technology.

Aside from its higher data transfer capacity, 5G differs fundamentally from its predecessor, 4G, in that it enables machine-to-machine (M2M) communication, whilst 4G was designed for voice as well as data. Connected in real-time via networks of sensors, a machine can analyze and make its own decision autonomously in a given situation through machine learning. Integration of technologies such as artificial intelligence (AI), big data, robotics and data analytics is enabling 5G technology to truly transform the nature of telecommunication as well as the many industries and sectors where it is deployed. Inevitably, this convergence of platform technologies also accelerates social change (quality of life, healthcare, work, and way of life), industrial operations (e.g. industrial automation, smart agriculture and logistics), and network transformation. Ultimately 5G has emerged as an ecosystem if interconnecting devices and interconnected supply chains.

The National Broadcasting and Telecommunications Commission (NBTC) has announced the 5G network rollout in Thailand in 2020, as an essential infrastructure to support the 'Thailand 4.0' policy. The auction of spectrum licensing for 5G service in Thailand was completed in February 2020. As part of the government's preparation for 5G launch in Thailand, the NBTC and Chulalongkorn University have signed the memorandum of understanding (MOU) on December 11, 2018, to establish the 5G Test Center in Chulalongkorn University. It is aimed to be an open platform for testing 5G network and devices, conducting research on 5G technology, testing 5G use cases, and developing human resource for the growing 5G industry. The MOU includes the compilation and the exchange of knowledge and expertise in 5G technology among both parties and other stakeholders. Another important mission is to organize workshops and seminars on 5G technologies and 5G measurements to share knowledge and skills to public. The Chula 5G Test Center is ready to provide initial test services to clients from all sectors and its capabilities will be continuously enhanced for providing more complete test services in the future.

Conclusion

The Chula 5G Test Center was the first laboratory in Thailand that is capable of testing 5G user equipment (UE). The center can also perform a drive test to measure signal quality of 5G networks. The test center is ready to provide testing services to clients in all sectors. The research team tested the signal quality of 5G commercial networks in some selected areas near Chulalongkorn University. The results indicated that the key parameters and signal quality of the 5G networks in those areas are sufficient for assuring good quality of service according to the 3GPP standard, which lends further confidence on the 5G network services in Thailand. Furthermore, the Chula 5G Test Center can transfer knowledge and expertise on 5G technology, standards, and testing to students and public to develop human resource for supporting the 5G deployment and exploitation in Thailand.

Entrepreneurial University Development Program

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Introduction

The world has changed from an industrial to a knowledge-based society. The role of universities as custodians of knowledge and learning is therefore ever more critical to enhancing every aspect of our lives as well as to driving international competitiveness. An *'Entrepreneurial University'* is a management concept arising from the desire of universities to be independent from government support and control, which has often proven a constraint to progress. The entrepreneurial university concept allows universities to generate income and contribute directly to economic growth and be more agile in focusing on addressing real-world problems in our society.

Today's new and fast-moving economic and social challenges highlight an increasingly important role for universities to integrate teaching and research to meet a constantly changing external environment. Responding to fill this need, entrepreneurial universities are creating new products and services, fostering innovations and innovation management skills, and facilitating technology transfer to industry and the public sector. These expected outcomes form the basis of a shift in the mission of universities towards a new and integrative paradigm.

Creating a successful entrepreneurial university requires a broad range of new skills and approaches; the following three factors are especially foundational: 1) Leaders and staff with entrepreneurial attitudes and skills; 2) Courses and curricula that nurture creativity and networking; 3) Tools, equipment and facilities that foster and support innovation; 4) Close partnership with the business sector; and 5) Flexible and agile university governance and management to support social enterprise approaches and business models to facilitate generation of new revenue streams that contribute to the university's financial sustainability.

Despite this shift towards independent status, government support remains vital to a thriving, vibrant and entrepreneurial tertiary education sector. While privatization of Thailand's universities is progressing from an institutional perspective, organizational cultures within universities are entrenched and resistant to change. As a whole, the level of entrepreneurship of universities in Thailand remains at a *"moderate"* level, with major potential for further development of entrepreneurial capability.

Conclusion

The research team hopes that this research will contribute to development of entrepreneurial universities in Thailand. The results serve to offer relevant practical guidelines to nurture mechanisms to drive the transformation to an entrepreneurial university as well as to prepare for change efficiently and effectively. The knowledge and good practice gained from this research can be used to develop strategic plans, action plans and entrepreneurial projects/activities. The Office of the National Higher Education Science Research and Innovation Policy Council (NXPO) and other organisations responsible for university policy will receive recommendations that contribute to the formulation of policies, strategies and entrepreneurial projects/activities that can be operationalized practically at national level. This will nurture Thailand's innovation and entrepreneurship ecosystem to drive the country forward, increase its global competitiveness and promote the long-term sustainability of Thai universities.

5G and National Development

Supot Tiarawut, Ph.D., President & CEO of the Digital Government Development Agency (Public Organization), a telecommunication expert, former Assistant to the President (IT and Strategy), Chulalongkorn University, and former Executive Director, Telecommunication Research and Industrial Development Institute, NBTC, offers insights on how 5G technology can be used to develop the country.

The Importance of Communication in 5th Generation

"... 5G technology ushers in a new era, in which the focus is not only on communication between humans and devices, but also among devices themselves; 5G therefore opens up many new opportunities..."

The 5G system departs radically from the first four generations of wireless technologies, which focused primarily on inter-personal communication. The 1st generation, for example, was used solely for speech communication, with SMS messaging appearing only in the 2nd generation (2G). Internet connectivity then arrived with 3G, allowing speech and data to be exchanged; 4G brought interactivity and improvements in speed, allowing a richer multimedia experience (e.g. full video streaming etc). 5G technology ushers in a new era, in which the focus is not only on communication between humans and devices, but also among devices themselves; 5G; therefore, opens up many new opportunities.

Key features of 5G include the following:

1) the capability to transfer data at very high speed using Enhanced Mobile Broadband, or eMBB, allowing real-time transmission of 3-dimensional animated pictures instead of the current video streaming. This is reason why 5G technology allows vastly expanded bandwidth that can transfer massive amounts of data, including high-resolution images, for example, medical images, with a 360-degree VR (Virtual Reality) and AR (Augmented Reality) technology as if the user is at the actual place.
2) 5G supports Massive Internet of Things (IoT) capability for communication among a large number of devices in a definite area, enabling the transmission of real-time images or video, for example, in a smart city where various measuring devices are installed such as sensors for light, air quality or vehicle speed, etc.. This allows users to see in real time changes in the locality, such as traffic conditions or other spatial parameters, monitored by a network of wirelessly-connected sensors. Wireless sensors of course have numerous industrial applications, such as automation of supply chain monitoring, which requires a complex monitoring and fault correction system.
3) 5G technology has low transmission latency, allowing virtually instantaneous responses as is critical to applications such as those in robotic tele-surgery. China has already been eager to adopt telesurgery, which allows faster, more efficient and less risky surgical operations. In Japan, 5G technology has been deployed to remotely operate autonomous vehicles for land management and harvesting operations, given the shortage of manual labour in the country's ageing society.

Thailand's readiness for 5G

"...Thailand is well prepared and positioned to support 5G technologies, particularly in terms of the required upgrading of telecommunications infrastructure..."

Thailand is well prepared and positioned to support 5G technologies, particularly in terms of the required upgrading of telecommunications infrastructure. Together, the three major telecommunication service providers already provided 4G coverage for 97–98% of the total population. Thailand, therefore, is ready in terms of infrastructure. However, more investment is necessary in terms of 5G cell sites since more 5G coverage will bring more benefits to industry and the general public and help propel the country's economy and society towards a digital transformation. 5G integration is a cost-effective path to boost productivity of automated systems; Mercedes-Benz in Germany, for example, has fully automated its vehicle production chain using 5G wireless factory, which reduces losses from faults or reconfiguration. Thailand's industrial sector has some distance to go in order to leverage 5G technologies in manufacturing, supply chain management and logistics and service delivery. On the other hand, the general public are considered ready, given their ready adoption of new technologies and digitally-enabled services and businesses. It is therefore expected that 5G will find most rapid early uptake in the realm of entertainment (e.g. movies). A second wave will follow in deployment of 5G-enabled applications for industrial and administrative applications, especially in high-density urban areas, where the return on investment is high. Nevertheless, telecommunication service providers, as well as industry actors, will need to make major strategic investments and in many cases, embrace disruptive changes to their business models. A new wave of automation will again reduce the need for humans within the workforce as they are gradually replaced by AI-enabled machine-learning algorithms connected via 5G.

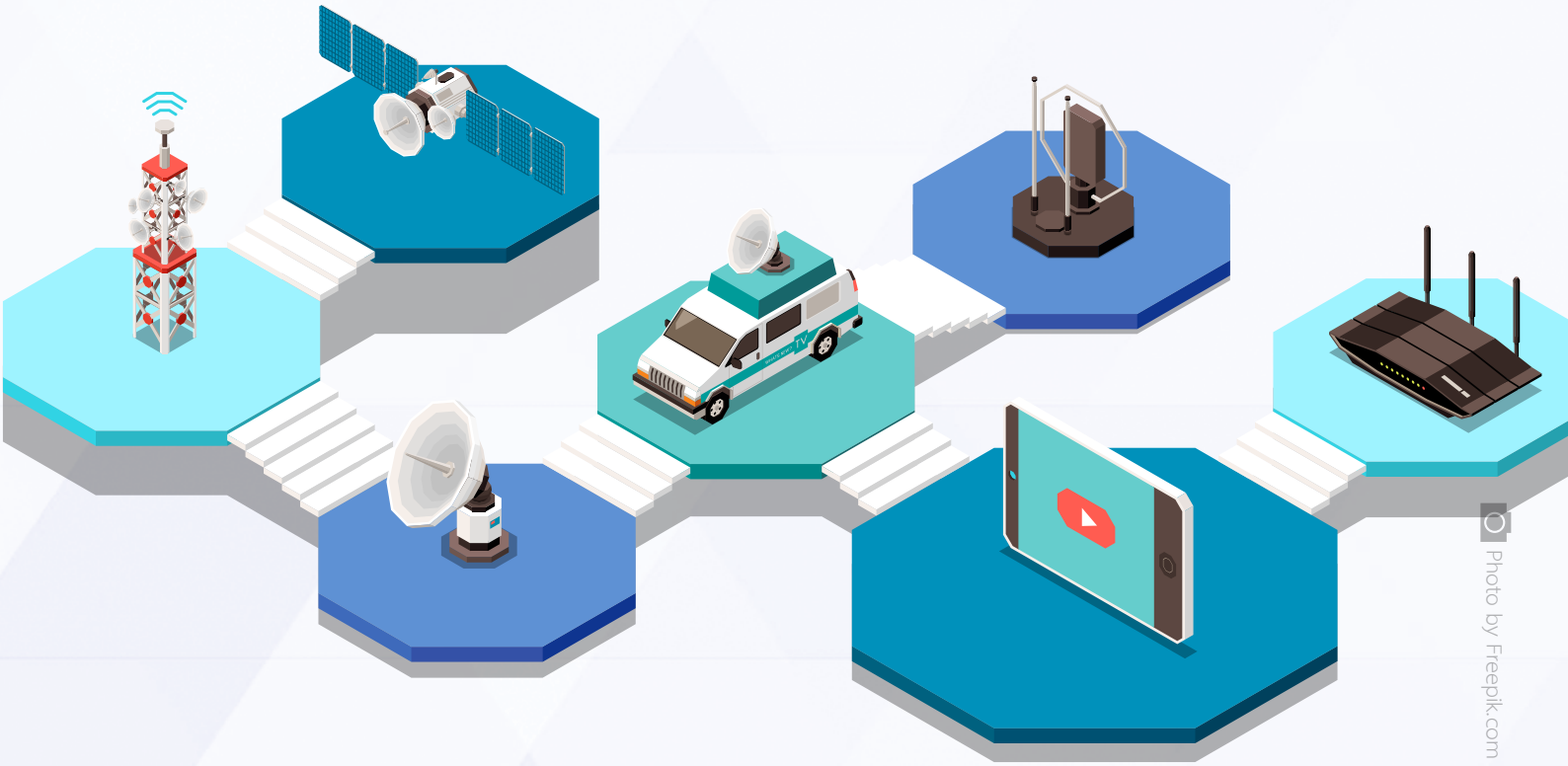
Thailand's potential to develop a world-class telecommunication system

"...Thailand was the first country in the ASEAN region to officially provide commercial 5G services; Thailand's technological and infrastructural readiness offer great potentials..."

Two years ago, Korea was the world's first country to launch 5G services, followed quickly by the United States, Japan, China, Germany, United Kingdom and many others. Thailand was the first country in the ASEAN region to officially provide commercial 5G services; Thailand's technological and infrastructural readiness offer great potential. However, realizing this potential for competitive advantage will depend on investment by government and service providers; the global COVID-19 pandemic has certainly been a major setback in delaying or forgoing such investment.

It is important to consider the utility and versatility of 5G in terms of its potential contributions across key economic sectors. The technology offers a basis for new and critically important ways of delivering public services. Telemedicine can improve access to doctors in remote areas, sharing of medical records such as X-ray/MRI images to support diagnosis and treatment, enabling a very high-speed communication between parties, and even enabling remote robotic surgery. In the transportation sector, 5G has obvious value as a key component of autonomous/smart vehicular systems and traffic management. Devices and sensors, for example, wireless smart meters, will also benefit from 5G technology. Wireless connectivity will enable dentists easily to retrieve x-ray footage for different cases at the dental unit, as well as to enrich teaching through sharing of images with large numbers of dental students.

Public investment will be important to ensure such benefits reach rural populations that might otherwise cannot(?) enjoy full 5G coverage. Medical services are a prime example where rural-urban inequities can be narrowed through public services.



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Future of Thailand's telecommunication system, benefits and development impacts

"...the government led by the Office of The National Broadcasting and Telecommunications Commission (NBTC) must focus on the distribution of 5G technology to distant communities as well to provide a comprehensive service, especially key local public service areas, as well as reduce the technological inequality..."

5G technology has arrived, but will take time to be incorporated into economic and social activity; this also depends upon the pace of expansion of coverage nationwide. Though adoption of 5G will enhance business performance and competitiveness as well as many public services such as medicine, disruption of current business models is inevitable, and clearly, automation in management as well as skilled and unskilled labour will impact on employment opportunities in all sectors.

Adjustments will also emerge as a result of changing working modalities triggered by COVID-19, particularly the prevalence of working from home. In terms of social impact, without regulation, 5G technology may exacerbate inequality through exploitation of those with limited or no access to 5G by those with greater access and opportunity. Therefore, the Office of the National Broadcasting and Telecommunications Commission (NBTC) must focus on extending 5G network coverage to remote rural communities for whom 5G could provide an economic and social lifeline, as well to provide full access to 5G-enabled public services such as health, education and public administration. This will be essential to reduce impacts of technology on rural-urban inequality.

R&D to support future change

"...NBTC should support R&D for long-term technological advancement, promote basic research and innovation, and advocate digital literacy for all..."

NBTC should leverage its existing R&D funding to advance technological innovation, focusing on patentable technologies. Malaysia, for example, began to promote research on 5G long before Thailand. Even before it was able to anticipate future applications of 5G technology, Malaysia's regulator began funding university research on the technology and drafted a regulatory framework for 5G based on a strong scientific understanding of the technology and local expertise.

Thailand's NBTC should do the following:

1) Set out a roadmap and promote research on 6G technology to ensure Thailand has the technology and expertise.
2) Support R&D for long-term technological advancement, to generate a strong cadre of expertise and to be able to embrace and deploy new technology in a timely manner.
3) Promote pure research through innovation, taking a broad-based approach in order to establish a strong foundation for the country to move fast to harness emerging complementary platform technologies such as artificial intelligence (AI), machine learning and the Internet of Things (IoT).
4) Lastly, NBTC must advocate digital literacy and build public awareness that 5G technology can be used for more than entertainment. This will help broaden the user base and boost productivity of 5G technology, e.g. through wider uptake of virtual meetings, digital sales and content, all of which may spur new startups and business models.

In addition to the above, Thailand's NBTC should play a role in regulation of quality and advocation of 5G technology to bring forth its real potential. Consideration must also be given to prioritizing activities for 5G technology be involved. In some countries, 5G services are also provided in a similar manner to a local wireless network (Wi-Fi); that is, the spectrum is allocated for a specific unit within an industrial factory, creating a "local 5G" service, which can be locally connected. The advantage of such a model is that the 5G signal can be used and owned by local entrepreneurs who see that the local signal is worth investing in. For Thailand, however, NBTC has not chosen to follow such an approach. NBTC only considers investment proposals from major telecom service providers on a case-by-case basis, which may carry unanticipated drawbacks as well as advantages. Factories that require the transmission of a large amount of data via a 5G-private network would benefit from such a model. However, if transmission is in the hands of an external operator, there is a risk that confidential information or data may be compromised. Data security remains an issue that must be addressed if industry is to fully embrace 5G technology in Thailand.

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"Around Us"

Assoc. Prof. Thavivongse Sriburi, Ph.D.

Why Big Data Matters?

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We often hear executives of government entities or private sector companies large and small, tout their organizations as more advanced than others, by announcing their commitment to introducing ***big data*** to secure competitive advantage and efficiencies. But what do they mean by the term ***big data?*** It is a term used in different ways and contexts, used by many and understood by few.

Many organizations have understood the value of data and have attempted to leverage and monetize this value by modifying or replacing their core business models. However, it is apparent that integration of big data has yet to deliver its full potential benefits, primarily because data are closely guarded and rarely shared across organizations, limiting broader utility. Technical and system compatibility constraints also create barriers to seamless data sharing that can create massive inefficiencies and costs.

Data integration across organizations requires technical, competitive and data privacy challenges to be overcome. The potential benefits of creating a massive and widely accessible data pool are many, but it is most certainly a two-edged sword, requiring a robust regulatory basis to address multiple issues and potential consequences—social as well as economic—to avoid a 'Big Brother' scenario where personal data of individuals might be continuously fed to database, and used, shared or sold for targeted commercial or political purposes. This particular scenario is of course already unfolding—over the past 4 years we've witnessed systematic and highly efficient large-scale manipulation of national elections by using big data scraped from Facebook to influence voting.

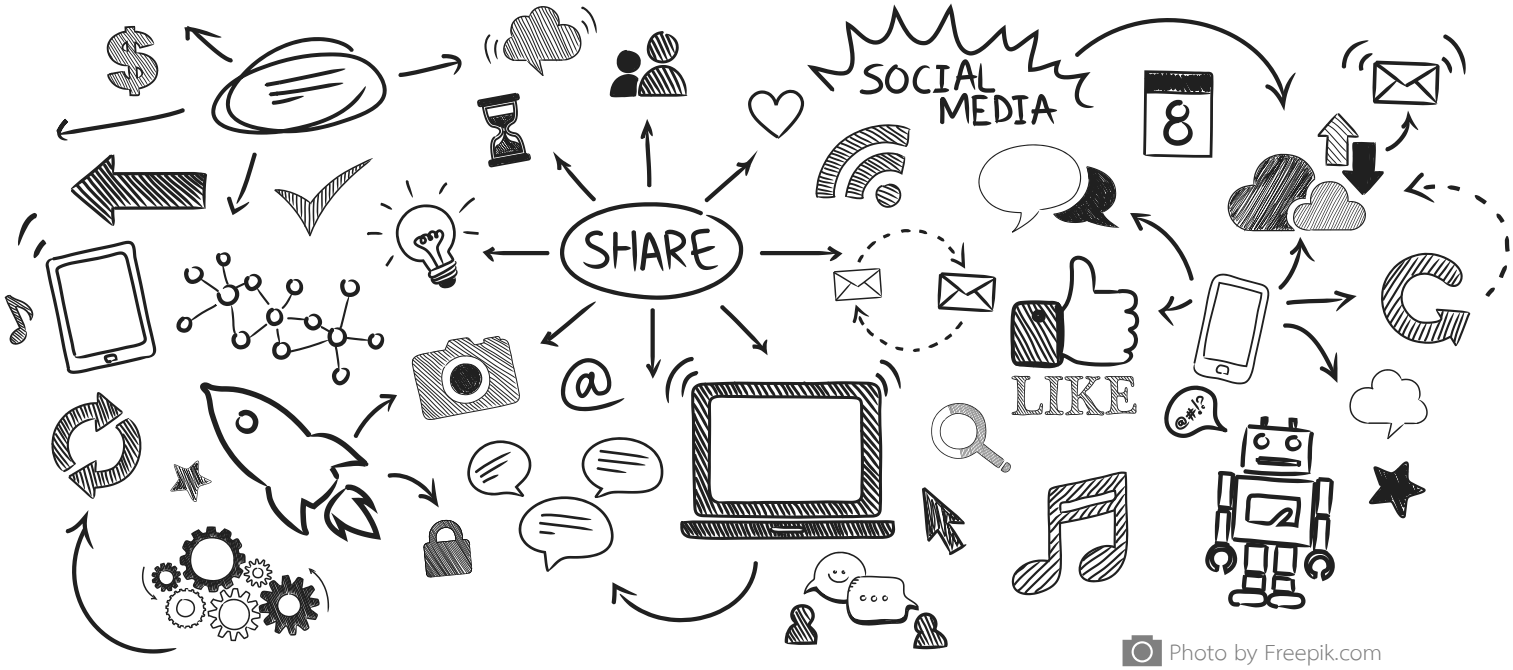
Most importantly, the public can access and use the data to approach their problems and make an informed decision on a particular issue. However, to incorporate data from different levels to create a big data system requires a comprehensive study and accurate, appropriate, and effective analyses.

Nationwide land management offers a remarkable example of how central and local agencies, as well as the public can efficiently use big data. Today, it is simple for members of the public to verify land ownership and check the appraisal value. Local agencies are able to review the accuracy of land taxation based on land use. Fascinatingly, the entire system can be accessed from anywhere, any time, via the internet. This advancement has made it easier to pay land taxes, check the nature of land use and appraise land values, benefiting both the public and local tax officials through a convenient and transparent process.

Since the COVID-19 pandemic, the public unknowingly is reaping the benefits of big data, in particular by participating in one of several campaigns launched by the government to mitigate economic hardship. The most well-known campaigns are "Pao Tang" (Wallet); "Khon La Khrueng" (Let's Go Halves); and Rao Chana (We Win) programmes, amongst many others. With each campaign attracting millions of participants, big data enables individual eligiblity to be verified and payments to be routed instantly. The government's ability to understand and address people's needs was enhanced by the availability of 'joined-up' data collected by diverse government agencies. Analysis of the big data allowed the government to design effective remedial measures and campaigns in a timely way, and to roll them out at national level cheaply and effectively via smartphones.

Although large-scale data storage and analysis has been with us for decades, the concept of big data entails analysis and deployment of big data in ways that are much more targeted and complex, often even impossible to process via traditional computing methods. The concept began to attract serious attention only in the early 2000's. Big data was defined then as requiring six key attributes- these *"6 Vs"* are described below:

1) Volume: The volume of data (sample size) should be large enough to achieve reliable and statistically valid results.
2) Variety: There should be a variety of data patterns, including structured, semi-structured, and non-structured data incorporated to allow triangulation of data and generate a richer and more comprehensive analysis.
3) Velocity: The data must be generated at great velocity and immediacy, enabling real-time analysis and immediate responses, e.g. GPS-based vehicle traffic data monitoring.
4) Veracity: Veracity refers to how accurate or truthful a dataset is. The veracity of the data is crucial and should be proven because it directly affects the quality and credibility of the output data.
5) Value: The data must be valuable and objectively or purposively related to the organization or business in question. It is worth noting that not all data are worth retention and analysis. Valuable data must be relevant to organizational objectives. For instance, to enhance the competitiveness of a new product launch, the most significant and valuable data relate to competitor information (products, sales volumes, sales territories and product quality etc).
6) Variability: The data shall be variable or adaptable to the nature of use and analyzable from various perspectives. Storage methods might vary for different types of data.



These six criteria present numerous challenges in organizing big data. Nevertheless, securing competitive advantage requires early-stage action to enhance the organization's data analysis capability, and thus its strategic intelligence. However, before state agencies and private corporates can utilize big data effectively, it is necessary to know the sources and the destinations of the data, how trustworthy the sources are, how to develop the system, and to what extent the analysis results will reach the appropriate target users. There should be a procedure to manage the "big data structure," which would incorporate traditional databases, structured, non-structured and semi-structured data. The procedure typically comprises the following five steps.

1) Devise high-level big data strategy. This is formulated to define and optimize the flow of data (receiving, validating, storage, managing, sharing and using data) both within and outside the organization. An effective big data strategy can contribute to successful strategic management and data-driven decisions based on accessing and analyzing massive datasets in real time. To develop the strategy, it is crucial to contemplate the organizational goal, current level of technology integration and current and future business models. Experimenting with big data is of paramount importance. For instance, critical data or assets could be prioritized compared with non-core assets or services provided by the organization.
2) The second step is to identify the source of big data.
   - Internet of Things (IoT) and peripheral devices that flow into the IT system from such devices such as smart cars, medical or industrial devices etc., will enhance the capability and utility of big data once IoT adoption reaches critical mass.
   - Data from social media include Facebook, YouTube, Twitter, Instagram, and other platforms. Such data include personal information, lifestyle choices, interests and political and shopping tastes and more, and are thus of special commercial interest from companies and organizations interested in 'mining' trends derived from a vast and rich dataset generated in terms of image, video, speech, text, and voice. Such data and qualitative and generally appear as structured or semi-structured data, requiring increasingly powerful artificial intelligence (AI) algorithms to analyse.
   - Public data come from large open sources of government agencies or international organizations such as the World Factbook or open portals of the European Union.
   - Other large data might come from the central storage of government agencies, the cloud system, suppliers, and customers.

3) The third step is to define rights to access and manage big data systems. Data security is especially important in large organizations owning vast amounts of commercially valuable data, so access rights and security protocols must be tightly controlled and monitored.
4) The fourth step is the analysis of big data using new tools such as grid computing, artificial intelligence and machine learning.
5) The fifth step is a timely and well-informed data-driven decision. Organizations may need to restructure and streamline decision making processs in order to make effective use of the immediacy of strategic recommendations emerging from big data systems and monetize commercial advantage.

In recent years, the development of big data has historically emphasized only 2 Vs: value and veracity, though this is changing and today, big data integration represents a high organizational cost and asset. In some large IT firms, the value of the business comes from the data stored, analyzed, and processed to add value. The fast pace of technological advancement has substantially reduced the cost of computing and storage, while today's computing speed allows previously unimaginable volumes of data to be processed in just moments. Nevertheless, it is crucial from the outset to identify systematically the objectives, critical business processes and the extent to which big data can enhance business decisions and drive competitiveness.

However, big data is not without its controversies and drawbacks. Recently this was highlighted by duplicate payments of senior citizen allowances by various agencies were revealed by a new integrated big data system, which allowed cross-checking across agencies. As a result, many senior citizens received demands for reimbursement covering many years of payments, and many were also liable to prosecution, though their claims may have been due to ignorance rather than fraud, and also to incorrect information on eligibility provided to senior citizens by officials without access to comprehensive data. Thus, while big data allows government agencies to manage payment system more efficiently, it is also important to manage potential social consequences.

Although big data management systems are being widely deployed across public and private sector organizations, efficiencies do not follow automatically. From a government perspective it is important to minimize or prevent redundancy in budget allocations, and empower governments to make effective and timely decisions. But the benefits of big data are more than financial; they can be far-reaching for our quality of life, enhancing public services such as education, health and environment. The road might be bumpy at the beginning, but once the system and supporting regulatory structires and safeguards have been improved, big data will contribute to all our lives and will help us all make more informed decisions.

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The Development of Public Investment Database and the Dissemination of Public Investment Information

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Infrastructure development is a core driver of national economic and social development, and the country's global competitiveness. Historically, the government's infrastructure investment was driven by a wide range of political factors as well as the primary strategic considerations set out in successive strategic development plans, and informed by stakeholder consultation. It follows that the analysis required as a basis to derive a comprehensive and effective long-term infrastructure investment plan must draw on a large and diverse body of data, especially those related to the capacity to service, demand volumes and current service rates, future projections and cost-benefits and impacts of proposed investments.

Recognising the critical importance of such data, the Infrastructure Development Strategy Division of the Office of the National Economic and Social Development Council (NESDB) commissioned **Chula Unisearch** to conduct a research study: *"Development of a Public Investment Database and Dissemination of Public Investment Information"* whose aim is to develop a system that can systematically gather and store data from multiple sources and domains, that are considered crucial to planning the country's future infrastructure investment. The project also developed software services to link, integrate, and report data from multiple databases related to infrastructure investment, in order to provide more in-depth data to assist in monitoring performance of ongoing projects, learn lessons and plan for effective and targeted future investment in national infrastructure.

The study was implemented according to the following framework:

1) *Develop a system for collection of infrastructure investment data,* after first reviewing the status, characteristics, patterns of data and current data archives. The data set included data from government agencies, state enterprises and other external databases. Based on analysis of the current situation, capacities and status of technological deployment, a data collection system was designed and built to meet defined functional needs. This initiative enabled collaboration with NESDB and linkages with its own electronic databases. A report was also prepared to offer guidelines on processes for gathering infrastructure investment data, covering key topics including data lists, collection formats, frequency of collection and responsible agencies etc.

2) *Develop a database to monitor and evaluate infrastructure development* by reviewing the status, characteristics, patterns of data, dissemination and networking system, and exchanges in investment data. Following this review, essential investment data points and infrastructure investment indicators were identified and catalogued, based on the requirements and goals of the Strategic Master Plan under the National Strategy and the 12th National Economic and Social Development Plan. This stage of the study also included preparation of reports and guidelines on approaches and methodologies for project monitoring.
3) *Develop a website to disseminate up-to-date data and information* by reviewing all key data pertinent to planning, monitoring and evaluation of infrastructure investment. The website is operational and fully updated to enable easy and convenient access to the latest news and information, and also facilitate data sharing and exchange among stakeholders in the public and private sectors as well as civil society. With this in mind, the website was designed to meet the needs of all categories of users.
4) *Organize academic seminars for a public hearing, academic workshops* and transfer technology in a small group setting.

This research aimed to create a comprehensive and authoritative database to provide access to multiple categories of data essential to planners and other stakeholders involved in infrastructure investment projects and state enterprise investment. The database is seamlessly linked to NESDB's main database and e-document library and includes extensive documentation on historical performance, financial information and the national policy and planning framework. To complement this resource, a second database was created to monitor project evaluation and develop indicators for infrastructure development in accordance with the National Strategy and the 12th National Economic and Social Development Plan. A website portal allows easy and convenient navigation to access and exchange investment data. The site is designed to meet the needs of stakeholders including public and private sectors, communities and civil society, allowing them to retrieve the infrastructure investment data more accurately, quickly, and in a timely way. The data provided via the portal were analysed systematically and selected to suit the country's circumstances and the project owner's readiness. A monitoring system for infrastructure development projects was also implemented for both individual projects and at a macro level. The development is now fully updated and functions effectively to support planning and design of government infrastructure projects. Moreover, the database also acts as a resource hub for investors, providing research papers and other useful government information, released in accordance with the Official Information Act, B.E. 2540 [1997].

Activities news

Technology SWOT Analysis Workshop

On Friday 4 December 2020, the Election Commission of Thailand (ECT), in collaboration with **Chula Unisearch,** organized a Technology SWOT Analysis Workshop at TK Palace Hotel & Convention, Bangkok. Pol. Col. Charoongwit Pumma, Secretary General of the Electoral Commission, presided over the opening ceremony and Mr. Krit Uawong, Deputy Secretary General of the Election Commission, was also present. Assist. Prof. Somchai Boonsiri, Ph.D., project leader and project advisors, led the workshop and shared the current status of ECT in terms of technological advancement with workshop participants. The advisory team also shared present and future technological trends. Participants were Directors-General of the Provincial Election Commission from five provinces: Chiang Mai, Songkhla, Nong Khai, Ang Thong and Samut Songkhram, together with their respective provincial IT officers. Executives and IT officers from the Election Commission of Thailand (ECT) also attended the workshop.

Press conference: Young Architect ECO Home Contest

On Tuesday 1 December 2020, a press conference was held to announce the launch of the ***Young Architect ECO Home Contest,*** with a total 1 million baht in prizes. The event was held jointly by Chulalongkorn University's Architecture Library (Faculty of Architecture), the Power Development Fund (Office of the Energy Regulatory Commission: OERC), in collaboration with **Chula Unisearch**.

Assoc. Prof. Pinraj Khanjanusthith, Ph.D., Dean of the Faculty of Architecture, Chulalongkorn University, delivered a welcome speech, followed by Assist. Prof. Sarayut Supsuk, project Leader, who provided an overview of the initiative. Atchaka Sibunruang, Ph.D., Commissioner of the OERC and Supichai Tangjaitrong, Ph.D., Managing Director of Chula Unisearch, presided over the opening ceremony and the press conference. The ***Young Architect ECO Home Contest*** aims to promote knowledge and understanding of renewable energy and encourage adoption of renewable energy to enhance quality of life. Moreover, it also seeks to instil a sense of environmental consciousness among young architects to inspire their future design directions. It is anticipated that designs developed under this initiative can be developed into energy-efficient models for construction projects or residential homes, and can be disseminated free of charge as a public good.

The press conference was followed by a seminar on ***"Energy-Efficient Homes"***, attended by a number of renowned experts including Mr. Kittipong Pinyotrakool, Deputy Secretary General, ERC, Mr. Chana Sumpalung, President of the Association of Siamese Architects under Royal Patronage (ASA), Assoc. Prof. Atch Settabut, Ph.D., Energy Consultant, and Mr. Chaiwat Anutrakulchai, Project Manager. Ms. Natapohn Tameeruks, an alumnus of the Faculty of Architecture, Chulalongkorn University, led the seminar.

Energy and environment project discussion

On 2 December 2020, Supichai Tangjaitrong, Ph.D., Managing Director of Chula Unisearch, and two deputy Managing Directors, Assoc. Prof. Chairat Wiwatwarrapan and Assist. Prof. Saowanee Wijitkosum, Ph.D., met with Polpatr Pruksananont, Ph.D., Chairman of the Clean-Bioorganic Zone (Thailand) Company Limited and company executives to explore potential collaboration on energy and environment projects. The meeting included discussions on the feasibility of creating a prototype project GreensWorld – CBZ, the development of biomaterial made from rubber. This project is part of the organic farming research for the environment, creating added value for natural rubber as well as enhancing its utilization. Collaboration on additional areas of research was also agreed. Faculty members and researchers from the wider Chulalongkorn University community also participated in the discussion including the Department of Materials Science and Department of Chemical Technology, Faculty of Science; Department of Industrial Design, Faculty of Architecture; the Petroleum and Petrochemical College and the Metallurgy and Materials Science Research Institute.

Welcoming the public relations team of TPI Polene Company Limited

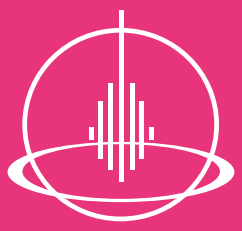
On Thursday 26 November 2020, Supichai Tangjaitrong, Ph.D., Managing Director of Chula Unisearch, welcomed the PR team of TPI Polene Company Limited at Meeting Room 406, Chulalongkorn University Research Building. The PR team was at **Chula Unisearch** to interview Assoc. Prof. Chavalit Ratanatamskul, Ph.D., a professor from the Department of Environment Engineering, Faculty of Engineering, Chulalongkorn University, regarding the Biosan project. Chavalit Ratanatamskul, Ph.D., is a project leader on the Biosan research, which focuses on using Biosan to treat water and leachates in environmental projects led by **Chula Unisearch.** The interview provided an overview and background to the research and related projects, and was scheduled to be aired on Suwannabhumi TV.

Discussion on art and culture research for community development

On Wednesday 24 March 2021, Assist. Prof. Saowanee Wijitkosum, Ph.D., Deputy Director of Chula Unisearch, Chulalongkorn University, met with Prof. Pornrat Damrhung and researchers from the Art and Culture Cluster to discuss topics including spatial research, urban development and organization of arts and cultural activities based on the context of the Rama IV area. The study aims to develop community areas and enhance its capacity to become a new tourist destination through promotion of performing arts in the community.

Celebrating Chulalongkorn University's 104th anniversary

On Friday 26 March 2021, a flower laying ceremony was held to pay homage to King Chulalongkorn and King Vajiravudh at the Two Kings Monument, Chulalongkorn University in commemoration of the 104th anniversary of the establishment of Chulalongkorn University. Presiding over the ceremony, witnessed by a number of **Chula Unisearch** executives and staff, was Supichai Tangjaitrong, Ph.D., Managing Director of Chula Unisearch, along with deputy managing directors, Assoc. Prof. Chairat Wiwatwarrapan, Assist. Prof. Saowanee Wijitkosum, Ph.D., and Assoc. Prof. Suchana Chavanich, Ph.D..



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