總而言之，本文提出了一種嶄新的「iCampus 數位神經系統」概念，描繪出建立全方位智慧校園環境所需涵蓋的各個領域。儘管文中多數核心構想僅以概略，但未來仍可依據各校具體情境進一步擴充與細化。
需注意的是：與理想中的「全域整合智慧校園」不同，實際應用上不需全面實施所有構面。根據不同校園的需求與資源條件，可採取不同程度與形式的智慧化導入，甚至只實行部分模組，也能有效提升整體智能水平。

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此外，這項概念的實施與深化，仰賴多學科領域的專業合作。
最後，也值得指出的是：iCampus 並不限於教育機構場域，其核心概念與系統架構亦可擴展應用於其他智慧生態系統（如智慧辦公室、智慧城市等），具有高度通用性與可轉移性

# *The Intelligent Campus (iCampus)*

## *End-to-end learning lifecycle of a knowledge ecosystem*

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合型智慧校園（iCampus）」。它的目的是要讓整個學習過程變得更豐富、更有效，甚至徹底改變學習的方式

***Abstract* – A new paradigm of thinking pertaining to a novel holistic intelligent campus (*iCampus*) environment is proposed, in this paper, in order to enrich and enhance, as well as to transform, the end-to-end learning lifecycle of a knowledge ecosystem. Analogous to the different functions of a biological brain, the central digital nervous system of the campus is comprised of various different interconnected functional intelligences. Each of these intelligent areas is set to perform its specified functional role in a dynamic and coherent inter- and intra-integrative manner within the environment itself. A generalized roadmap has also been devised to encapsulate the concept from within an existing or a new campus setting. Note that the nature of the *iCampus* proposition is inherently multi-disciplinary and has multi-applicability to other forms of intelligent environment. To capture part of the essence of the concept, some of the key challenges pertinent to the *iCampus* ecosystem have also been highlighted within the campus value proposition framework.**

***Keywords* – *iCampus; intelligent environment; smart building***

### I. INTRODUCTION

The intelligent campus – a central digital nervous system that dictates the end-to-end learning lifecycle of a knowledge ecosystem. This is a paradigm shift from the "smart" era to the "intelligent" era. The former is defined as "having the capability of making adjustments in response to the changing circumstances" which is often used to refer to "smart phone", "smart building", or "smart home". The latter, on the other hand, as used herein, refers to not just smart but also intelligent; an intelligence that is often defined as "having the faculty of thinking, reasoning and understanding, with the capability of not only making adjustments but also learning and adapting in response to the changing circumstances". To put it simply, when applied to a device application example, a "smart device" will be able to do tricks while an "intelligent device" will be able to learn tricks in accordance with the changing environment. The word "intelligent campus", also known as "*iCampus*", is not new. The concept has been explored initially in MIT, under the MIT-Microsoft Alliance program, with a radical purpose of revolutionizing the practice of higher education [1]. A number of research projects have since been proposed within the initiative which has come to a successful closure recently. The proposition of this paper seeks to extend and deepen such research through a holistic intelligent campus framework. Analogous to the different functions of a biological brain, this holistic framework helps to define the different operational components of the campus in terms of its key functional intelligence categorization. These interconnected functional intelligence components thus form the main coherent backbone behind the central digital nervous system of the intelligent campus, with its overall holistic framework possessing a larger inherent meaning and synergetic impact than the sum of its individual simple components.

Unlike the proposed holistic intelligence framework, varying level of smartness or intelligence, in the form of smart campus [2-4] and intelligent campus [5-8], have since been researched and reported in several literatures. Some have also developed partial aspect of the concept and put it to implementation in their own campuses. For instance, the University of Southern California (USC) with its smart campus building management system [9], the New Jersey Institute of Technology (NJIT) with its innovative campus social computing technologies [10], and the University of Texas at El Paso (UTEP) with its smart campus access solution [11]. Other notable campuses that have, as a result, gained widespread recognition include: the Ave Maria University in Florida which has not only gained international visibility but also realized substantial CAPEX and OPEX financial savings [12], the College of Nyiregyhaza which has now become a leading university in Hungary despite its inherent remote and less-privileged location [13], and the Unitedworld School of Business in India which has attained a global stature by being able to tap intelligently into resources from reputed institutions like Wharton School of Business, Harvard, MIT, Cambridge University, and others [14]. And in the Middle East region, campuses such as the Prince Sultan University [15] and the King Fahd University [16-17] have also looked into the various potential aspects of the smart campus solution.

Notice that, thus far, many of the studies have covered either the "research and experimentation" or the "development and implementation" of a partial aspect of the concept. Few works have been carried out with a holistic intelligent campus perspective. The aim of this paper is to put forward the "research" and "development" elements of the holistic concept in order to create a world-class intelligent campus (*iCampus*). The former element is to push the research boundary of the concept; and the latter element is to develop and implement the concept based on what can be achieved now as well as what can be obtained from research. The goal is to construct the campus as a leading model that embodies the centre of excellence for education and research. Unlike others who have to conform their intelligent campus solution around existing buildings and infrastructural setups, the intention of this paper is to propose the conceptualization of the *iCampus* design right at the start of the campus master planning and design process. The idea is to build the first campus in the world that incorporates the holistic *iCampus* concept right from the beginning, preferably even before the campus is being built. This is to avoid constraining the full potential of the concept

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iCampus智慧化校園 涵蓋六大智慧領域:
1. iLearning 聚焦於學習
2. iManagement 聚焦校園管理
3. iGovernance 聚焦校園治理
4. iSocial 聚焦社交互動
5. iHealth 聚焦健康關懷
6. iGreen 聚焦環境永續

intelligent（智能的）：指系統能根據不同程度與類型表現出智能行為，例如智慧感測網路可以來自於裝置本身的智慧，也可以是來自於後端虛擬資料處理的智慧。
integrative（整合的）：代表這些智慧領域在功能內部（intra）與彼此之間（inter）必須緊密整合，形成一個全域智慧管理（TIM）架構。

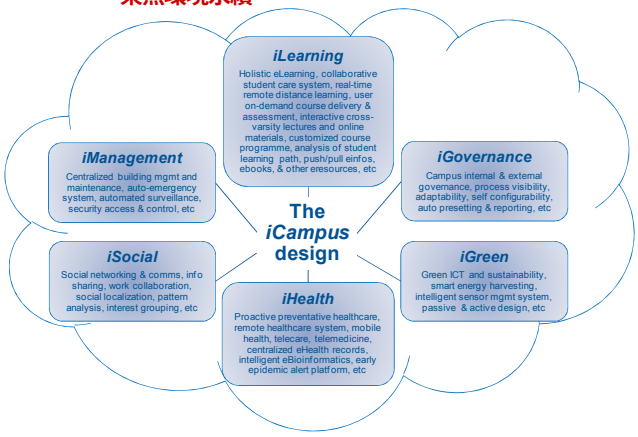


**Figure 1: Diagrammatic overview of the *iCampus* concept**

and to allow free mutual interactions between the concept solution and the campus design. With that, the campus can then be looked upon as a dominant role model that is set at the forefront of cutting-edge *iCampus* technologies. But, more importantly, the intelligent campus can then be positioned as a new revolutionary icon, not just within the region but also internationally, capable of transforming the varsity learning environment to a world-class educational standard.

## II. AN OVERVIEW OF THE *iCAMPUS* CONCEPT

The *iCampus* concept encompasses several areas of intelligence, each of which serves to ensure the proper operation of each function of the campus nervous system. Without limiting its scope, Figure 1 attempts to depict some of those key areas by means of a top-level diagrammatic representation of the concept. As illustrated in the figure, the digital nervous system of the intelligent campus (*iCampus*) can be divided into six main key areas of intelligence, namely (1) *iLearning* (which is concerned with the "learning" aspect of the campus), (2) *iManagement* (which is concerned with the "management" aspect of the campus), (3) *iGovernance* (which is concerned with the "governance" aspect of the campus), (4) *iSocial* (which is concerned with the "social" aspect of the campus), (5) *iHealth* (which is concerned with the "health" aspect of the campus), and (6) *iGreen* (which is concerned with the "green" aspect of the campus).

In each pillar of the *iCampus* theme, the prefix "*i*" has both an "intelligent" and "integrative" connotation. The former "intelligent" connotation signifies a two-dimensional intelligence spectrum of the *iCampus* elements, with one axial dimension denoting the different degree of intelligence and the other axial dimension denoting the diverse form of intelligence. For instance, a smart wireless sensor network system can have various depth of intelligent level, ranging from a mix of physical and virtual form of intelligence. At both the extreme ends of the dimension, the sensor network could comprise of a set of smart sophisticated sensors operating in a simple data network system or a set of dumb simple sensors operating in a smart co-operative information network system. In the first extreme end, the depth of the intelligence is derived solely from the physical sensors themselves; whereas in the second extreme end, the depth of the intelligence is derived solely from the virtual information-collation network system. A different hybrid mix of the two hence constitutes its overall two-dimensional intelligence spectrum. The latter "integrative" connotation, on the other hand, signifies an intra and inter integration of the various *iCampus* elements. As shown in the figure, each of the functional areas in the *iCampus* design contains an exemplification of its corresponding subareas-of-interests that are meant to act in a coherent intra-integrative manner in order to carry out that particular intelligent function of the knowledge ecosystem. These functional intelligent areas, on the other hand, act in an interactive inter-integrative manner to create the Total Intelligence Management (TIM) framework of the campus. Notice that the subject matter covered in the concept is inherently multidisciplinary, crossing over computing, engineering, medicine as well as information management, social networking, behavioral science and several other disciplines of studies. Apart from that, the proposition has a multi-applicability implication. Although, herein, the proposition is applied in a campus environment setting, part or whole of the concept is readily applicable to other intelligent ecosystems as well, for instance, in an intelligent office environment or in an intelligent city environment.

For the intelligent campus environment, the core focus of the concept proposition is centered around the enrichment of the student's end-to-end learning life-cycle. The need for differentiation in the midst of intense competition has forced the campus to try to deliver a high value education environment. The key here is to devise an effective learning model so as to maximize the learning potential of the students and, as such, improve the overall quality of learning. With that, the institution can then be seen to go beyond churning out "book-smart" students for the region, to nurturing "life-smart" individuals who are able to take on key leadership roles in the outside world. Note that the *iCampus* concept not only brings about a whole new learning experience to the students, but also enables a new set of teaching and management capabilities to the faculty and management. The solution offers a multi-faceted methodology to address the needs of the students, faculty and management alike. It can help the institutions to attract new students, increase productivity, decrease operating costs, drive collaborative learning, and extend their reach for better learning opportunities without any boundary constraints. Below is a summary of some of the key values/benefits pertaining to the *iCampus* proposition:

- Draw and retain top students and faculty
- Extend reach without facility expansion
- Enable higher efficiency and productivity
- Enrich learning, teaching, and research environment
- Allow collaborative learning, teaching and research with no boundaries.
- Improve communications among students, faculty and management
- Provide ease and clarity in campus governance and management
- Resolve traditional learning barriers via technological enablers
- Lower capital expenditure (CAPEX) and operating expenditure (OPEX) costs
- Generate new income streams

Apart from the external stakeholders, the holistic impact, brought about by the concept, can fall upon the three key internal stakeholders of the campus environment – namely, the students, faculty and management. However the impact experienced by each of the stakeholders can vary depending on the final concept solution that has been adopted. For instance an intelligent campus information system, consisting of a Student Information System (SIS), a Faculty Information System (FIS), and a Management Information System (MIS), can each bring about different degree of impact to the various key stakeholders concerned. As with the *iCampus* digital nervous ecosystem being adaptable and evolutionary with time, such impact experienced by each and every of the relevant key stakeholders is also inherently dynamical.

## III. THE *iCAMPUS* ROADMAP

The roadmap of the *iCampus* proposition can be summarized as shown in Figure 2. To fully realize the impact of the concept, the roadmap has incorporated two elements, the "research and development" element and the "development and implementation" element. As seen from the figure, the roadmap for the *iCampus* theme is made up of four key phases of development: first is the core technological and network infrastructure that enables the facilitation of the intelligent campus environment, second is the basic applications and services that are essential for the *iCampus* setup, third is the value-added applications and services that add value to the *iCampus* environment, and fourth is the premium applications and services that bring out the pinnacle of the *iCampus* concept. From a research and innovation perspective, the first phase covers the core fundamental development and implementation, and the second, third and fourth phase cover the short, medium and long term research and development respectively. All these four phases are designed to fall hand-in-hand under its overall programme build and delivery.

高階應用

附加價值

基本應用與服務

核心技術與網路基礎建設

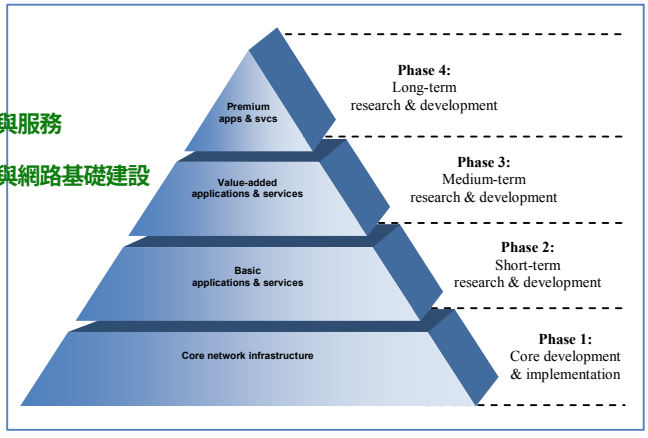


**Figure 2: A pictorial illustration of the *iCampus* roadmap**

iCampus最佳導入時間點是剛開始

As mentioned before, the realization of the *iCampus* concept is best performed at the start of the new campus master planning and design process so as to be able to reap the full rewards of the intelligent campus solution. The main focus in the phase one work is hence to ensure the construction of the new campus infrastructural platform is in agreement with the facilitation of a holistic *iCampus* concept. This phase is portrayed to lay the foundation for the rest of the phases, as illustrated in the figure, and is often deemed as the most cost effective and efficient approach if this part of the work is taken into consideration at the earliest stage of the new campus construction. This is in contrast with others who have to design their smart campus solutions around existing buildings and infrastructures. In these cases, there is little flexibility left that can be incorporated in the phase one stage and much of the activities in the phase two, three and four will therefore have to fall back, and be accommodated and interfaced to suit the current technological and network infrastructural setups.

With the new campus's phase one foundation being put in place, the remaining phases of the *iCampus* concept can then be researched, developed, and implemented in a structured step-wise manner within the programme. Note that the devised roadmap is designed to follow a full innovation circle model. The continual outputs from the research activities carried out at the upper parts of the pyramid are meant to be developed, implemented and tested at the bottom platform of the pyramid. Upon field trials and evaluations, constant refinement can then be fed-back and input to the upper pyramid to be further developed, implemented and tested at the bottom pyramid, so on and so forth. In addition to that, this model also helps to ensure the germination of new research ideas originated from the bottom, based on problems existing in the real world, to feedback as well as to guide the upper research activities conducted in the labs. This continuous loop thus creates the full circle of innovation, capable of encompassing the entire end-to-end research chain.

## IV. THE *iCAMPUS* VALUE PROPOSITION

The value proposition of the *iCampus* concept covers six areas of innovation domains, as previously described in Figure 1. However, contrary to the illustration which has been drawn for simplicity purposes, these innovation domains do not always exist in isolation. Oftentimes, the innovation value arisen from one domain has subsequent direct or indirect repercussions upon the other domain(s). This hence forms an interactive *iCampus* model, as depicted in Figure 3, where the origination of its value extraction needs not necessary come from a single domain, but could overlap over one or several other domains. Take for instance, a holistic eLearning system which has the capability of supporting both remote distance learning and online student workgroup forum. Though the system is designed to centre mainly on the *iLearning* domain, its former

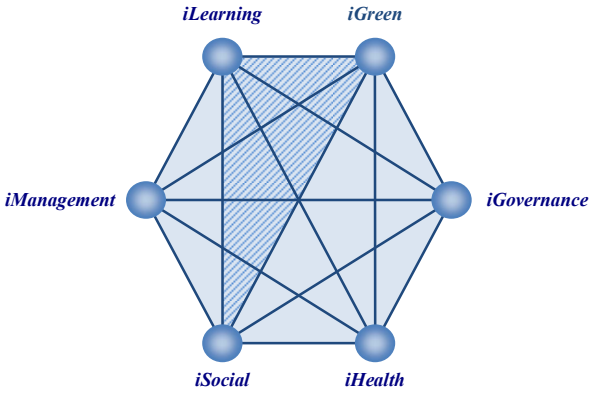


**Figure 3: The *iCampus* interactive model**

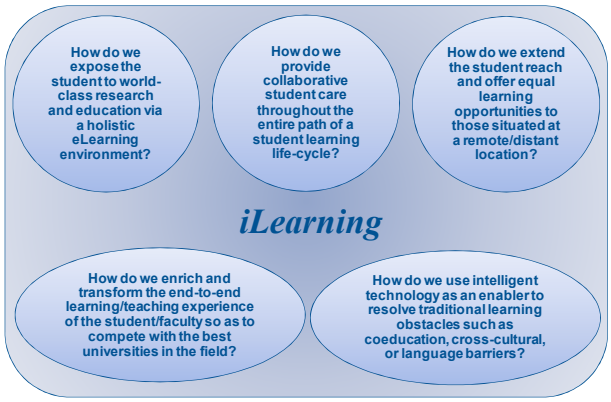


**Figure 4: Some examples of the *iLearning* key challenges**

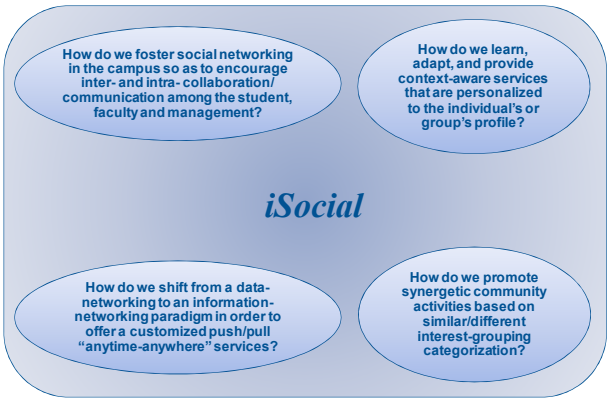


**Figure 5: Some examples of the *iSocial* key challenges**

capability has essentially crossed over to the *iGreen* domain as well as its latter capability crossed over to the *iSocial* domain. Such overlap thus creates a triangular interaction and bidirectional exchanges between the three domains as can be seen from Figure 3. This synergetic overlap is especially true in the world of a modern hyper-connected digital learner undergoing a typical social learning, also known as a collaborative learning, process. Its innovation value is therefore no longer founded from just the *iLearning* domain alone; instead it is derived from the entire three-domain triangular configuration.

To put that in perspective, let's examine some of the key challenges that are centered on each of the domains. Note that these challenges are not meant to be exhaustive, but rather to provide an exemplification of some of the key areas that warrant further research and development. Bear in mind also that, although these research challenges are described under its own individual innovation ecosystem, its research domain could have a synergetic overlap with the other domain(s) as well, as has been previously illustrated in Figure 3.

### *A. The challenges of the iLearning domain*

The way of learning has evolved with a broad spectrum of technologies, creating several challenges in the traditional educational system. Figure 4 gives a summary of some of the high-level challenges pertaining to that domain. Note that, in a conventional system, there are normally two actors involved in the learning process: one is the teachers who teach and the other is the learners who learn. Some of the following challenges relate more to the former, some relate more to the latter, and some relate to both. As can be seen from the figure, learning is no longer dependent only on a formal direct classroom system, but also on an informal collaborative learning system. The formal system is often deemed to follow a passive learning process, while the informal system is often deemed to follow an active learning process. "Pull learning" rather than "push learning" is also one of the key aspects here – content being pulled, rather than being pushed, whenever and wherever required. This is sometimes referred to as "content-on-demand" learning, a term that is analogous to "video-on-demand". The learners and the teachers, on each side of the conventional equation, no longer need to be present at the same place or even at the same time anymore. Course delivery and assessment can be performed remotely; live lectures/tutorials can be conducted at distant locations; customized course programme can be picked and selected from shared open content; student/faculty collaboration can be carried out across varsities; student care system can be employed to analyze, assist and follow the student learning lifecycle; intelligent technological enablers can be used to resolve traditional learning barriers such as coeducation, cross-cultural or language barriers; and many other new paradigms of thinking. In here, the *iLearning* domain plays a central role in the entire intelligent campus concept. There are still many other opportunities that have yet to be explored and investigated, which could potentially enrich and enhance the end-to-end learning/teaching value chain of the campus.

### *B. The challenges of the iSocial domain*

The social aspect of the campus has become an important subject in the field due to the recent mass uptake of social networking technologies. Figure 5 lists some of the challenges related to the *iSocial* domain of an intelligent campus environment. There are basically three main areas of concern with regards to the campus social domain: first is that involving the campus core curriculum activities, second is that involving the campus extra-curricular activities, and third is that involving the campus general social activities. As highlighted in the previous section, collaborative learning is an active social process. People tend to pick up new knowledge and information through dialogue and interaction with others. The three social areas hence play a critical part in any educational institution environment. For instance, utilizing social networking tools as part of the course programme to facilitate workgroup collaboration or information sharing; grouping similar- or different-interest individuals together to enable synergetic extra-curricular activities within, say, the varsity clubs or societies; providing localized or context-aware services (e.g. accessing today class schedule, finding appropriate library resources, getting preferred cafeteria information, etc) that are personalized to the profile of the subject; and others. With the recent move from a data-networking to an information-networking era, one of the key aspects here is to turn and process the bulks of data to useful and relevant information so that they could be made available and be channeled not just to the right person/group (or to the right applications and services) but also at the right place and at the right time. Bear in mind that these are only some examples of the high-level challenges that are pertinent to the *iSocial* domain which, as with the others, still have rooms for further expansion and elaboration.

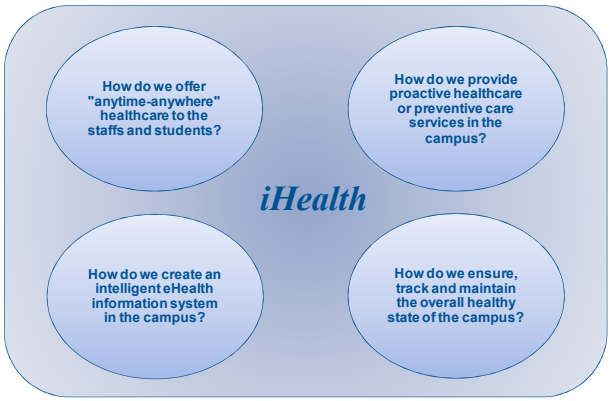


**Figure 6: Some examples of the *iHealth* key challenges**

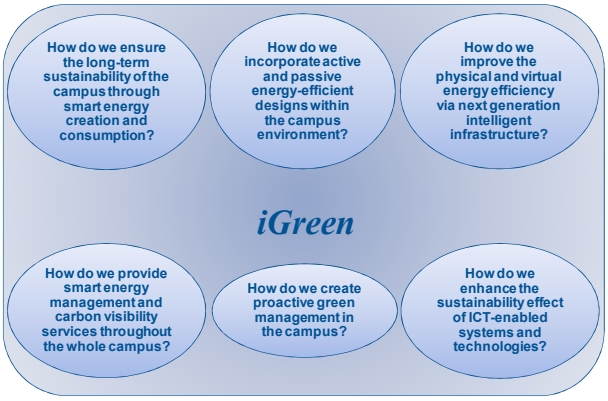


**Figure 7: Some examples of the *iGreen* key challenges**

### *C. The challenges of the iHealth domain*

Apart from the social aspect, the health condition of the campus is also of importance in an intelligent environment. Some of its high-level challenges are as shown in Figure 6. However, depending on the individual circumstances of the campus (such as its size, location, etc), its degree of importance can vary from campus to campus. Oftentimes, its operation is kept hidden in the background, so much so that its participants within the intelligent environment do not even realize its existence. The key challenge here is therefore "to ensure, track and maintain the overall healthy state of the campus, such as its staffs and students, without introducing much intrusion to its existing settings" – that is, technologies that are less- or non-intrusive and do not require much or any form of compliance from its participants. There are several works that have been done in the field which could be extended to the applicability of a campus environment, such as telemedicine, telecare, mobile health, remote healthcare, preventative care, bioinformatics, etc. With that, the campus can then be able to provide "anytime-anywhere" healthcare services to both its staffs and students, be it in the lecture theatres or in the student dormitories. An intelligent eHealth information system linked to the internal and/or external healthcare network could also be maintained to offer services such as personalized health monitoring, individual healthy lifestyle tracking, early epidemic warning system, or even to alert and facilitate smooth transition to the hospital in any emergency cases. Note that the *iHealth* domain is also applicable to those healthy subgroups such as health-conscious individuals, athletics or sportsmen who want to keep track and monitor the progress of their performance. All these aid to infuse the mindset and foster the significance of physical education and healthy living within the campus environment itself.

### *D. The challenges of the iGreen domain*

From the health of the individuals, let's now move to the green and sustainability aspect of the campus. Due to the recent concern over climate change, different terms have been coined to describe such campus environment – some have called it the "green campus", some have called it the "sustainable campus", and some have called it the "smart energy campus" or "renewable energy campus". All these campuses are often deemed to promote healthy living both in the indoor and outdoor environments. Figure 7 depicts some of the related key challenges in the area. To summarize, the overall objective of this *iGreen* domain is to reduce the carbon footprint due to the campus environment as a whole. There are several ways to do this: through smart energy creation and consumption, active and passive energy-efficient campus designs, intelligent energy network infrastructure, smart energy management services, proactive green management, as well as other green ICT systems and technologies. The campus should be able to take advantage of its surrounding local environment condition (i.e. climate, etc) so as to reduce its overall $CO_2$ emissions and, at the same time, be responsive to the needs of the individual. As it is known, intelligent campus needs not be green, green campus needs not be intelligent. The idea here is to create a campus environment that is not only intelligent but could also articulate a holistic Green vision.

關注整個校園的管理系統: 1. 智慧建築管理 2. 智慧人員管理

### *E. The challenges of the iManagement domain*

The *iManagement* domain is concerned with the overall management of the campus. Some of its key challenges are as described in Figure 8. There are basically two parts to the management: the first is smart building management and the second is smart people management. The former is more about the facilities and infrastructures of the campus, while the latter is more about the staffs, students and visitors within the campus. Examples of its building management aspect include an integrated building management system which could track and control the heating, ventilating and air-conditioning systems in the buildings; a centralized building maintenance system which could perform auto-alerting, fault-finding, or self-recovery in the event of any facility breakdown; a smart lighting system which could automatically turn on, off and dim the lights in, say, the lecture theatres, classrooms or offices as and when needed; an intelligent emergency system, such as a fire alarm system, which could trigger the fire alarm network, isolate the affected ventilation, unlock all access-control doors and guide the people to the nearest exit, in the event of an emergency; and many others. And examples of its people management aspect include an automated surveillance and security system which could provide auto-face recognition and identification, automatic analysis and monitoring of video surveillance, tracking and tracing of abnormal activities, and automated security alerts/alarms in the event of any security breach; a smart access and control system, such as a smartcard system, which could offer all-in-one smart services ranging from secure ID card identification and access to, say, lecture theatres, dormitories, carpark, lockers and sport facilities as well as class attendance and exam registration, cashless

此領域的關鍵優勢在於：大多數功能皆可整合於單一網路平台中統一管理，例如使用 IP 網路來達成全面協調與監控。

在此治理架構下，可以透過以下幾種方式實現 iGovernance (智慧治理)：
建立一個校園治理平台，用以協調內部與外部利害關係人的權責與溝通；
建置流程治理系統，用來視覺化管理整體治理流程，包含分析、優化、追蹤與溯源；
發展資源管理平台，針對校園的短期、中期與長期營運進行智慧化規劃；
導入智慧工作流程系統，支援自動化排程、紀錄、回報與學習調適等功能，實現自我設定與優化的能力。

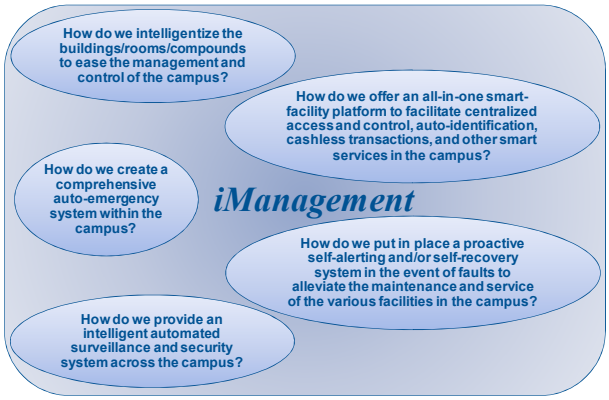


**Figure 8: Some examples of the *iManagement* key challenges**


**Figure 9: Some examples of the *iGovernance* key challenges**

cashcard transactions at bookstores, cafeterias, vending machines, photocopiers, laundry services etc, to other smartcard applications such as library card, ATM card, public transport card or even a customer loyalty card; and many others. Note that the core beauty in this domain is its simplicity – most or all of the above, sitting across either the building management or people management aspects of the campus, could be run and managed centrally over one single unified network, for instance, the Internet Protocol (IP) network.

### *F. The challenges of the iGovernance domain*

Finally, let's look at the *iGovernance* domain of the campus. With the significant progression of the educational institutions, the governance of a campus is no longer that simple and straightforward anymore; oftentimes, its governing process could involve several different key stakeholders. Figure 9 attempts to highlight some of the high-level challenges related to that domain. In contrast to the *iManagement* domain, the aim of this domain is to alleviate the governance of the campus, as like a business corporation, in accordance with a certain set of governing policies specified within the campus. There are a few ways to achieve this. For instance, a campus governance platform that could manage the internal and external governance of the campus among the different stakeholders; a process governance system that could aid to view, analyze, optimize, and track and trace the end-to-end governing process within the campus; a resource management platform that could govern the short, medium and long term operation of the campus; a workflow management system that could perform automated scheduling and planning, auto-logging and reporting as well as learning and adapting with self-configurability capability; and others. Note that this domain, as like the others, forms an integral and important part of the *iCampus* concept. In fact, it is the only key governing domain in the proposition that helps to ensure the continual effectiveness and efficiency of the overall campus environment.

## V. CONCLUDING REMARKS

In summary, this paper has presented a proposition of a novel *iCampus* digital nervous ecosystem, in conjunction with a framework depicting the various domains required to set up a holistic intelligent campus environment. Although many of the key ideas have been captured herein in a generalized manner, additional work could be carried out to further expand and refine the concept based on the specific context of the individual campus. Bear in mind that, in contrast to an ideal holistic situation, not every aspect of the domains needs to be implemented in order to fully intelligenize the campus. Different degree and form of intelligence, or even a partial aspect of the holistic concept, can be adopted to suit the needs of the local campus environment. Note also that the adoption, including the advancement, of the proposed concept proposition demands multi-disciplinary areas of expertise. Though not explicitly stated, the different domains of the concept have essentially covered several fields of disciplines, such as artificial intelligence, information science, computer engineering and others, so as to realize the necessary intelligent campus environment. But take note that the application of the concept is not solely constrained to just within a campus environment setting; oftentimes, part or whole of the concept is also readily applicable to other intelligent ecosystems as well.

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