

News Article for RISUD Strategic Focus Area (SFA) Scheme

	Name	Department
1. Principal Investigator:	<u>Geoffrey Shen</u>	<u>BRE</u>
2. Name of SFA:	<u>Construction Industrialisation</u>	
3. Project Title:	<u>A technology-enabled interdisciplinary platform for innovative façade design and installation in industrialized building construction</u>	
4. Second Year Progress/Achievement		

An Innovative Industrialized Load-Bearing Service Core System for High-Rise Residential Buildings with Optimized Productivity, Adaptability, Diversity, and Sustainability

The construction industry accounts for 13% of the world's GDP, but it is often criticized for its slow improvement in productivity. According to a recent report published by McKinsey (2017), the construction industry has only managed to have about 1% annual productivity gain over the last 20 years, in comparison with 5-6% productivity improvement in other industries such as manufacturing. Hong Kong's construction industry is of no exception of this global problem, and worse still it is coupled with extremely high construction cost of housing projects, which is ranked 3rd among global cities, and many housing projects have experienced significant cost overruns and schedule delays, 15.22% delay on average in public housing projects and there are around 260,000 applicants for public housing in 2019 (Arcadis, 2019; Housing Authority, 2019). The industry is also facing extremely challenging conditions such as harsh weather, congested site, and frequent labor shortages (Li et al., 2017, 2018). These hardships strain the industry's ability to execute work efficiently, and often result in considerably high capital costs. One of the innovative solutions is Construction Industrialization (CI) where a large number of components are prefabricated offsite in modules and are transported to site for installation and assembly. Both the Singaporean and Hong Kong governments are promoting similar approaches with "Prefabricated Prefinished Volumetric Construction (PPVC)" and "Modular Integrated Construction (MiC)" programs respectively. However, the current industrialized building systems (IBS) in the market under the name of PPVC or MiC are often challenged for their poor performance in addressing the increasing need for productivity, adaptability, diversity, sustainability, some even call them "fake systems". One of the promising IBS is the load-bearing service core (LBSC) system, but its suitability for high-rise buildings in densely populated cities such as Hong Kong needs further investigation.

This research aims at developing an innovative industrialized load-bearing service core (LBSC) system for high-rise residential buildings, and an associated collaboration mechanism among stakeholders plus a digital platform in supporting the implementation of the proposed system.

This research will not only develop an innovative IBS for high-rise residential buildings, but also create a collaboration mechanism and platform of digital technologies to improve productivity, competitiveness, and performance of the construction industry. This is closely related to the priority themes of the Government as announced in the Chief Executive's 2018 Policy Address: "The Government is proactively promoting the adoption of technology and innovative construction

methods to improve productivity and cost-effectiveness.” The completion of this project will help uplift the construction industry with advanced IBS and frontier technologies of digital twin, IoT, BIM, network analysis, and simulation technologies. This research proposal has already received overwhelming support from a wide range of key stakeholders in the industry including clients, consultants, and contractors, as organizational partners. All of them believe the proposed system, mechanism and technologies have a strong advantage in optimizing the productivity, adaptability, diversity, and sustainability, and they will work with the research team closely and implement the deliverables in their business.

Potential breakthroughs and deliverables: this project will help improve the construction industry significantly and address the grand challenges faced by many high-density cities such as Hong Kong, with the following potential breakthroughs and innovative solutions:

(1) An innovative industrialized load-bearing service core (LBSC) system for high-rise residential buildings with optimized productivity, adaptability, diversity, and sustainability.

A large market is required to amortize the enormous initial investment in a process or set of processes capable of simplifying the production of a finished product. Simplifying the production is the key to real cost reduction, much more than the economy of scale. And the only way to reach the broad market required is to offer individualized/customized products, as individuals are different from each other and from themselves through time. Current solutions are also not adequate to resist vertical and lateral forces (wind and seismic), embrace strong interlocking connections, avoid cast-in-place concrete (wet) trade on-site, achieve long-span floor system, achieve product dismantling and recycling by using dry joints and avoid steel structure due to the fire safety. The concrete-oriented IBS structure also needs to reduce its weight for transportation, achieve cost efficiency, and to ease the constructability on-site. There is an urgent need for new approaches, methods, and systems to address these issues.

(2) A collaboration mechanism among stakeholders in the above value chain of construction industrialization and improved understanding of their complex relationship and interactions.

The industrialization of construction involves many stakeholders with diverse occupational and professional backgrounds, broad geographical spread, and different interests in the project. The deployment of construction industrialization, if not planned and coordinated appropriately, may adversely affect the end results and become counterproductive. IBS settings should take into account project and industry factors such as product complexity in design and construction, informatics, customization, market and profit, and involves increasing the complexity of stakeholders who could influence, inhibit and catalyze processes (Mok et al., 2015). The success of construction industrialization will depend on the level of collaboration among stakeholders (e.g., owners, designers, contractors, suppliers, and customers) (Li et al., 2017).

(3) An operational platform with enabling informatics and digital technologies to support the implementation of the proposed LBSC system for high-rise residential buildings.

Innovation in construction informatization is key to facilitate and enhance collaboration (Li et al., 2019). Construction informatization consists of a range of computing technologies including digital twin, internet of things, building information modeling, sensing and tracking technologies, and simulation technologies. Construction informatics can foster a collaborative platform for the complex network of stakeholders. Such integration of modularization with informatization would create a dynamic socio-technology system for construction industrialization.

Deliverables: A **demonstration project** in Hong Kong to illustrate the viability and the superiority of the proposed system for high-rise residential buildings which consists of a detailed description of the **innovative industrialized LBSC system** for high-rise residential buildings with optimized productivity, adaptivity, diversity, and sustainability, a guide on the **collaboration mechanism** for stakeholders in the implementation of the LBSC system, based on improved understanding of stakeholders' interests, relationships, and interactions; and an **operational platform** with enabling informatics and digital technologies to support the implementation of the proposed LBSC system for high-rise residential buildings; a number of **awareness seminars** for practitioners to introduce the latest development of the project and **hands-on workshops** for early adopters in the industry to have in-depth knowledge and know-how on the implementation of the system. **Potential beneficiaries:** **In the short term**, the proposed industrialised LBSC system for high-rise residential buildings will benefit major stakeholders such as government, contractors, designers, and suppliers in the residential development in Hong Kong, in terms of productivity, adaptability, diversity, and sustainability. The implementation of the proposed system will help resolve the urgent need for public housing to meet the need of the 260,000 applicants in the waiting list and to cater for their changing needs in the years to come. **In the medium and long term**, the general public with urgent and diversified housing needs in many high-density cities such as Hong Kong will benefit from the implementation of the system, with reduced waiting time for housing, improved adaptability and diversity, and improved sustainability in housing development.