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提升大灣區組裝合成建築法供應鏈以推動香港發展的策略性公共政策研究

Principal Investigator :

首席研究員 :

Professor Wei PAN

潘巍博士

Institution/Think Tank :

院校／智庫 :

The Hong Kong Polytechnic University

香港理工大學

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Strategic Public Policy Research Funding Scheme

**Enhancing Modular Integrated Construction (MiC)
Supply Chain in the Greater Bay Area (GBA)
for Hong Kong Development**

提升大灣區組裝合成建築法供應鏈以推動香港發展

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Final Report

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The University of Hong Kong

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Executive Summary

Background

Modular integrated construction (MiC) is the most advanced off-site construction approach, with demonstrated benefits such as enhanced quality, productivity, safety and sustainability. The Government of the Hong Kong Special Administrative Region (HKSAR) has set ambitious development goals for various sectors, including public housing, private residential, elderly homes, hostels, hospitals and hotels. Achieving these objectives will not only strengthen Hong Kong's leadership in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA) but also increase the construction industry's capacity. Since 2017, MiC has been adopted as a key policy initiative for eight consecutive years, assisting the government to achieve these development goals and address the critical challenges facing the construction industry.

The GBA supply chain creates exciting synergies and opportunities for MiC development in Hong Kong. However, the limited capacity of module supply and complex cross-boundary logistics impose challenges to the sustainable delivery of millions of modules for Hong Kong's development. Therefore, with funding support from the Strategic Public Policy Research Funding Scheme, we have conducted this research project to address the urgency and importance of understanding and enhancing the MiC supply chain in the GBA. A series of GBA-wide factory visits, questionnaire surveys, interviews, and focus group meetings have been conducted to gather perspectives and practices from stakeholders and MiC practitioners in the construction industry. Mathematical modelling and analysis have been carried out to estimate the MiC demand and supply and map their dynamic relationship. On this basis, a policy roadmap with action plans has been recommended for the short-, medium-, and long-term use of MiC in Hong Kong.

Findings

This report presents all major findings of the research project, including MiC supply chain readiness, key performance indicators for measuring the maturity of MiC supply chain, MiC supply-demand analysis, and a policy roadmap with action plans for enhancing the MiC supply chain. *First*, the top drivers and opportunities divulge a strong association with the political and regulatory perspective, while the top constraints and concerns were more related to the technical perspective. Understanding these factors can help enhance the MiC supply chain stability and maturity. It is essential to involve all stakeholders to propose effective MiC policies to amplify the drivers and opportunities while mitigating the concerns and constraints. *Second*, the multilevel measurement framework with KPIs demonstrates the complexities of MiC supply chains and highlights the importance of comprehensive efforts in process control, project goal achievement, stakeholder capability building and collaboration, and supporting environmental improvement for MiC supply chains to mature. *Third*, a significant gap is identified between the existing capacity of concrete MiC suppliers in the GBA and the anticipated future demand for concrete modules in Hong Kong for both public and private sector developments. Nevertheless, the capacity of steel MiC suppliers is deemed sufficient to meet both current and projected demand for steel modules. *Fourth*, MiC policies should help the industry optimise the supply-demand relationship by inspiring the market demand and improving the capacity and ability of both MiC systems (e.g. modules) and manpower (e.g. labour and professional services). Actions with close government-industry-university collaborations need to be taken to enhance the demand stability, process integration, and supply sustainability, such as MiC manufacturer certification and further promotion of MiC adoption in the private sector.

To support high-quality development of using MiC and expand the influence of MiC brand worldwide, continuous research and development is essential to address the complexities, uncertainties and dynamics of MiC supply chain considering the increasing demand of Hong Kong, the GBA and beyond.

Policy implications and recommendations

We suggest enhancing the maturity of MiC supply chain in the GBA for Hong Kong development by achieving **supply sustainability**, **process integration**, and **demand stability**. In the short term (by 2025/26), the goal of MiC supply chain development is to achieve an evolving MiC supply chain with sufficient supply, streamlined process, and increasing demand. In the medium term (by 2027/28), the goal is to achieve a stable MiC supply chain with competitive supply, optimised process, and booming demand. In the long term (by 2032/33), the goal is to achieve a mature MiC supply chain with sustainable supply, integrated process, and stable demand.

For achieving **demand stability**, future policies should take full account of the needs for MiC in both public and private building sectors. Short-term actions need to be taken to increase MiC demand in both public and private sectors, such as expanding the scope of mandatory use of MiC in government buildings; medium-term actions, such as promoting the use of MiC in various types of projects, focus on achieving a booming demand for MiC; and long-term actions, such as embracing both steel and concrete MiC according to the types of development, seek to achieve a stable market-driven demand for MiC.

For achieving **process integration**, future policies should focus on the improvements and enhancement of technological and management practices of MiC project delivery. Short-term actions, such as developing a series of MiC design and construction codes and standards, aim to ensure a streamlined MiC delivery process; medium-term actions, such as raising research and development (R&D) incentives, focus on achieving an optimised MiC delivery process; and long-term actions, such as developing e-submission and approval platform for efficient design approval and tendering assessment by the government, seek to contribute to an integrated MiC delivery process.

For achieving **supply sustainability**, future policies should focus on improving the capacity and ability of both MiC systems (e.g. modules) and manpower (e.g. labour and professional services) on the supply side. Short-term actions aim to maintain a sufficient MiC supply, such as enhancing market information sharing led by various government departments to bolster collaboration; medium-term actions, such as setting up an MiC manufacturer rating system, focus on encouraging a competitive MiC supply; and long-term actions, such as establishing a flexible working mechanism between the governments of Guangdong and Hong Kong to encourage cross-boundary logistics and supervision, seek to achieve a sustainable MiC supply.

In summary, it is essential to keep close collaborations between the government, universities, and industry for delivering effective and efficient MiC policies and regulations. The policies should drive continuous innovations from both supply and demand sides and form both technological and managerial perspectives of the MiC supply chain. To make MiC an international brand, future policies should focus on the market in not only Hong Kong but also the whole GBA and overseas.

執行摘要

研究背景

模塊組合建造（MiC）是最先進的工業化預製建造方式，其提升建造質量、生產力、安全性及可持續性的優點已被廣泛證實。香港特別行政區政府為各行各業制定了雄心勃勃的發展目標，包括公營房屋、私人住宅、安老院、學生宿舍、醫院及酒店。實現這些目標不僅能鞏固香港在粵港澳大灣區的領導地位，還能提高建造業的產能。自2017年起，MiC已連續八年被採納為一項重要的政策措施，協助政府實現其發展目標，並解決建造業面臨的嚴峻挑戰。

大灣區供應鏈為香港MiC的發展創造了令人振奮的協同效應和機會。然而，由於模塊供應能力有限及跨境物流的複雜性，要為香港發展可持續的提供數以百萬計的模塊，實在面對不少挑戰。因此，在策略性公共政策研究資助計劃的資助下，我們進行了相關研究，以強調認識並加強大灣區MiC供應鏈的迫切性與重要性。我們進行了一系列的大灣區工廠訪問、問卷調查、訪談和焦點小組會議，以收集建造業相關持份者及MiC從業人員的觀點和作法。並進行數學建模與分析，以估算MiC的供需狀況，繪製其動態關係圖。在此基礎上，為香港的短期、中期和長期的MiC應用建議了政策路線圖及行動計劃。

研究結果

這份報告介紹了本研究項目的主要結果，包括：MiC供應鏈就緒程度、測評MiC供應鏈成熟度的關鍵績效指標、MiC供需分析，以及加強MiC供應鏈的政策路線圖和行動計劃。第一，最重要的驅動因素和機遇與政策及法規密切相關，而最重要的限制和關注則更多地與技術相關。瞭解這些因素有助於增強MiC供應鏈的穩定性和成熟度。只有所有相關持份者參與才能提出有效的MiC政策以擴大MiC供應鏈的驅動因素和機遇，同時減少限制和關注。第二，基於KPI的多層次測評框架既顯示出MiC供應鏈的複雜性，也強調了在流程控制、項目目標實現、利益相關者能力建設與合作，以及支持環境改善等方面的綜合努力對MiC供應鏈走向成熟的重要性。第三，大灣區混凝土MiC模塊供應商的現有產能與香港未來公營房屋及私人樓宇對混凝土模塊的預期需求之間存在顯著差距。第四，MiC政策應通過激發市場需求、提升MiC系統（如模塊）與人力（如勞工與專業服務）的產能與能力等，以協助產業優化供需關係。政府、業界和大學需緊密合作並採取行動，以提高需求穩定性、過程集成度以及供應可續性，例如MiC製造商認證和進一步推動私人發展商採用MiC。

為了支持MiC的高品質發展，並擴大MiC品牌在全球的影響力，考慮到香港、大灣區及其他地區日益增加的需求，持續的研究開發對於解決MiC供應鏈的複雜性、不確定性、動態性而言至關重要。

政策影響與建議

我們建議藉由提升供應可續性、流程集成度與需求穩定性，來提升大灣區MiC供應鏈的成熟度，以促進香港發展。短期目標是到2025/26年達成供應充足、過程順暢、需求增長的演進的MiC供應鏈，中期目標是到2027/28年達成供應競爭、過程優化、需求多樣

的穩定的MiC供應鏈，長期目標是到2032/33年達成供應可續、過程集成、需求穩定的成熟的MiC供應鏈。

對於實現需求穩定性，未來的政策應充分考量公營部門與私營機構對MiC的需求。短期行動的目標是增加公營部門與私營機構對MiC的需求，例如擴大政府建築強制使用MiC的範圍；中期行動的重點是實現對MiC的蓬勃需求，例如推動不同類型的項目使用MiC；而長期行動的目標則是實現市場對MiC的穩定需求，例如在不同類型的項目中考慮使用鋼結構及混凝土MiC。

對於實現過程集成度，未來的政策應著重於改善與提升MiC項目交付流程的技術實力與管理效率。短期行動的目標是確保簡化的MiC交付流程，例如制定一系列的MiC設計和施工規範/標準；中期行動的重點是實現優化的MiC交付流程，例如提高研發的激勵措施；而長期行動的目標是為整合的MiC交付流程做出貢獻，例如開發電子提交和審批平臺以提高設計審批和政府招標評估的效率。

對於實現供應可續性，未來的政策應著重於改善供應端的MiC體系（如模塊）與人力資源（如勞動力、專業服務）的能力。短期行動的目標是維持足夠的MiC供應，例如各政府部門加強市場資訊的共享以促進合作；中期行動的重點是鼓勵具競爭力的MiC供應，例如建立MiC製造商評級制度；長期行動的目標是實現可續的MiC供應，例如建立粵港兩地政府之間的彈性工作機制以鼓勵跨境物流和監督。

總括而言，政府、大學與業界之間必須保持緊密合作，以提供有效且高效率的 MiC 政策與法規。這些政策應推動供需雙方以及 MiC 供應鏈的技術與管理兩方面的持續創新。為促進 MiC 成為國際品牌，未來的政策不僅要著眼於香港市場，還要放眼於整個大灣區，甚至海外市場。

Contents

Acknowledgements.....	i
Confidentiality and Disclaimer	i
Executive Summary	ii
執行摘要.....	iv
Contents.....	vi
List of Figures	viii
List of Tables.....	ix
1. Introduction	1
1.1 Background.....	1
1.2 Research Objectives and Work Packages	1
1.3 Report Structure.....	2
2. Research Methodology.....	3
2.1 Methods for Achieving Research Objective 1	3
2.2 Methods for Achieving Research Objective 2	4
2.3 Methods for Achieving Research Objective 3	6
2.4 Methods for Achieving Research Objective 4.....	7
2.5 Methods for Achieving Research Objective 5	8
3. Results and Analyses of Work Package 1.....	10
3.1 Drivers for Enhancing the MiC Supply Chain in the GBA.....	10
3.2 Opportunities for Enhancing the MiC Supply Chain in the GBA.....	12
3.3 Constraints Perceived by Stakeholders.....	14
3.4 Concerns Perceived by Stakeholders.....	16
3.5 Measures for Enhancing MiC Supply Chain in the GBA	18
3.6 Strategies for Enhancing of MiC Supply Chain in the GBA.....	21
3.7 Summary.....	23
4. Results and Analyses of Work Package 2.....	25
4.1 Profile of the Survey Participants.....	25
4.2 A Dialectical System Framework of MiC Supply Chain	25
4.3 KPIs for MiC Supply Chain Performance Measurement	26
4.4 Summary.....	29
5. Results and Analyses of Work Package 3.....	30
5.1 MiC Module Demand Analysis	30
5.2 MiC Module Supply Analysis	36
5.3 MiC Module Supply-Demand Analysis	39
5.4 Summary.....	42
6. Results and Analyses of Work Package 4.....	44
6.1 MiC Supply Chain Policy Roadmap	44
6.2 Action Plan for Enhancing MiC Supply Chain Demand Stability	45
6.3 Action Plan for Enhancing MiC Supply Chain Process Integration	48
6.4 Action Plan for Enhancing MiC Supply Chain Supply Sustainability...	51
6.5 Summary.....	55
7. Results and Analyses of Work Package 5.....	56
7.1 Questionnaire Survey	56

7.2	Focus Group Meetings.....	58
7.3	Public Policy Forum	59
8.	Policy Implications and Recommendations	60
9.	Knowledge Dissemination.....	63
9.1	Lectures, Seminars, Webinars and International Conferences	63
9.2	Public Policy Forum and Booklet Launch Event	65
9.3	Web Portal	69
10.	Conclusions	70
	References	73
	Appendices	75
	Appendix I – Abbreviations	75
	Appendix II – Scripts of Q Surveys (key questions).....	77
	Appendix III – Scripts of Interviews (key questions)	82
	Appendix IV – Scripts of FGMs/Workshops (key questions).....	84
	Appendix V – List of Publications	86
	Appendix VI – MiC Module Suppliers (as of Apr 2024).....	89
	Appendix VII – List of MiC Projects in HK (as of Oct 2024).....	91
	Appendix VIII – Research Team.....	97
	Appendix IX – Research & Knowledge Dissemination Activities	98

List of Figures

Figure 1-1	Work packages and research workflow of the research project	1
Figure 2-1	Overall research design	3
Figure 3-1	Top five drivers for MiC supply chain identification and enhancement in the GBA	10
Figure 3-2	Top five opportunities for MiC supply chain enhancement in the GBA.....	12
Figure 3-3	Top five constraints for MiC supply chain enhancement in the GBA	14
Figure 3-4	Top five concerns for MiC supply chain enhancement in the GBA	16
Figure 3-5	Evaluation of drivers, opportunities, constraints and concerns	18
Figure 3-6	Top five measures for MiC supply chain enhancement in the GBA.....	19
Figure 3-7	Top five strategies for MiC supply chain enhancement in the GBA.....	21
Figure 4-1	Profile of participants in the questionnaire survey	25
Figure 4-2	A dialectical system framework of MiC supply chain	26
Figure 4-3	Top indicators at each level selected by each stakeholder group	27
Figure 4-4	MiC supply chain measurement framework and KPIs.....	27
Figure 5-1	Scope of MiC demand, supply, and supply-demand analysis	30
Figure 5-2	Framework of critical considerations of MiC module demand analysis	30
Figure 5-3	Yearly distribution of public housing completions	31
Figure 5-4	Scenarios of MiC adoption in public housing developments	32
Figure 5-5	Estimated MiC demand in public housing developments in HK (2023/24-32/33).....	32
Figure 5-6	Yearly distribution of private residential completions	33
Figure 5-7	Scenarios of MiC adoption in private residential	34
Figure 5-8	Estimated MiC demand in private residential buildings in Hong Kong (2023/24-2032/33)	34
Figure 5-9	Estimated MiC demand in other types of development in Hong Kong.....	35
Figure 5-10	Framework of critical considerations of MiC supply analysis	36
Figure 5-11	Identification and categorisation of MiC module suppliers	37
Figure 5-12	Concrete MiC supply-demand analysis for Hong Kong development.....	40
Figure 5-13	Steel MiC supply-demand analysis for Hong Kong development	41
Figure 5-14	MiC supply-demand analysis for other cities in the GBA.....	41
Figure 6-1	System boundaries of MiC supply chain policy roadmap	44
Figure 6-2	Vision and goals of MiC supply chain policy roadmap	45
Figure 6-3	Overall framework of action plan for enhancing demand stability	46
Figure 6-4	Overall framework of action plan for enhancing process integration	49
Figure 6-5	Overall framework of action plan for enhancing supply sustainability.....	52
Figure 7-1	Experience of questionnaire respondents	56
Figure 7-2	Perception of Supply-Demand analysis for overall industry (concrete).....	57
Figure 7-3	Perception of Supply-Demand analysis for overall industry (steel).....	57
Figure 7-4	Perception of the policy roadmap with action plan	58
Figure 9-1	Guests and speakers at the Booklet Launch Event, HKU, 10 Dec 2021	65
Figure 9-2	Guests and speakers at the 1 st forum, HKU, 30 Aug 2023	67
Figure 9-3	Physical participants at the 1 st forum, HKU, 30 Aug 2023	67
Figure 9-4	Speakers at the 2 nd forum, Zoom webinar, 14 Nov 2024	68
Figure 9-5	Speakers Prof Wei Pan (L) and Prof CK Mak (R) at the 2 nd forum	68
Figure 9-6	Booklet launched at the 2 nd forum	69
Figure 9-7	Web portal for sharing MiC demand-and-supply information.....	69

List of Tables

Table 2-1	Research activities conducted for WP1	3
Table 2-2	Research activities conducted for WP2.....	4
Table 2-3	Research activities conducted for WP3.....	6
Table 2-4	Research activities conducted for WP4.....	7
Table 2-5	Research activities conducted for WP5.....	8
Table 3-1	Respondents' views on the drivers for MiC supply chain enhancement	11
Table 3-2	Respondents' views on the opportunities for MiC supply chain enhancement	13
Table 3-3	Respondents' views on the constraints for MiC supply chain enhancement	15
Table 3-4	Respondents' views on the concerns for MiC supply chain enhancement	17
Table 3-5	Respondents' views on the measures for MiC supply chain enhancement	19
Table 3-6	Respondents' views on the strategies for MiC supply chain enhancement	22
Table 5-1	Estimated MiC demand in Shenzhen and Guangzhou by the GFA of modular construction (m ²).....	36
Table 5-2	Estimated MiC demand in Shenzhen and Guangzhou by the number of modules	36
Table 5-3	Number of MiC module suppliers of various categories (as of Apr 2024).....	38
Table 5-4	Concrete MiC module supply capacity (as of Apr 2024)	38
Table 5-5	Steel MiC module supply capacity (as of Apr 2024).....	39
Table 6-1	Short-term actions for increasing demand	46
Table 6-2	Medium-term actions for booming demand.....	47
Table 6-3	Long-term actions for stable demand.....	48
Table 6-4	Short-term actions for streamlined process.....	49
Table 6-5	Medium-term actions for optimised process.....	50
Table 6-6	Long-term actions for integrated process.....	51
Table 6-7	Short-term actions for sufficient supply.....	52
Table 6-8	Medium-term actions for competitive supply	53
Table 6-9	Long-term actions for sustainable supply	54

1. Introduction

1.1 Background

Modular integrated construction (MiC) has been increasingly adopted in Hong Kong (HK) and the Guangdong–Hong Kong–Macao Greater Bay Area (GBA) since 2017 to address critical challenges facing the construction industry, such as an ageing workforce and cost escalations (Pan et al. 2019). MiC builds on the modular construction approach that transforms fragmented site-based construction into integrated factory production followed by site assembly (Gibb 1999). The concept of MiC has been defined as *a game-changing disruptively-innovative approach to transforming fragmented site-based construction of buildings and facilities into integrated value-driven production and assembly of pre-finished modules with the opportunity to realise enhanced quality, productivity, safety and sustainability* (Pan and Hon 2020).

In Hong Kong, MiC has been adopted to deliver more than 100 building projects covering various types of projects in both public and private sectors. These real-life projects have showcased enhanced construction sustainability of using MiC for building project delivery, such as faster project delivery, less waste, and enhanced safety (Pan and Zhang 2023). Nevertheless, the supply chain faces critical challenges in delivering MiC high-rises, such as the supply of millions of high-quality modules and cross-boundary logistics (Zhang et al. 2024). These factors collectively increase the uncertainty, dynamics, and complexity of the MiC supply chain in the GBA.

To establish a favourable business environment and recommend a policy roadmap with action plan for enhancing MiC supply chain in the GBA for Hong Kong development, the MiC Laboratory (MiCLab) and the Centre for Innovation in Construction and Infrastructure Development (CICID) of The University of Hong Kong (HKU) have led a research project entitled ‘Enhancing Modular Integrated Construction Supply Chain in the GBA for Hong Kong Development’. The project is funded by the Chief Executive Policy Unit (CEPU) of the Government of the Hong Kong Special Administrative Region (HKSAR) under the Strategic Public Policy Research (SPPR) Funding Scheme. The project started from 23 May 2020, with the project period to 22 November 2024.

1.2 Research Objectives and Work Packages

The project involves five objectives and interrelated work packages (WPs) (Figure 1-1).

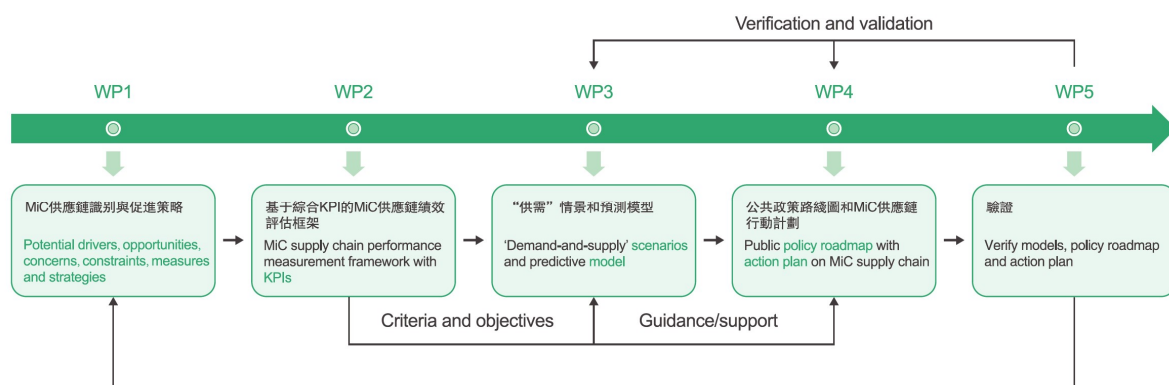


Figure 1-1 Work packages and research workflow of the research project

WP1: MiC supply chain identification and enhancement strategies

For achieving Objective 1: To contribute a better understanding of the supply chain complexity and dynamics of MiC in relation to Hong Kong development, their relevant regulatory and business drivers and opportunities as well as constraints and concerns, and develop and verify strategies for MiC supply chain identification and enhancement in the Greater Bay Area (GBA) for Hong Kong.

WP2: Systemic MiC supply chain measurement framework & KPIs

For achieving Objective 2: To develop a systemic MiC supply chain measurement framework and KPIs to support Hong Kong industries' and community's decision making of MiC supply chain selection and evaluation for optimal performance on productivity, cost-effectiveness, quality, safety and sustainability of delivered buildings and society, validate the framework and KPIs via participatory action research case study with three MiC pilot projects, and help enhance the maturity of MiC supply chain and its supporting industries in the GBA for Hong Kong development.

WP3: MiC supply chain scenarios and 'demand-and-supply' model

For achieving Objective 3: To investigate the complex and dynamic relationships between the demand for MiC in different building sectors of Hong Kong (e.g. public housing, private housing, student hostel, staff quarter, hospital and hotel) and the supply of MiC by relevant industries along the MiC supply chain in the GBA, and develop a MiC 'demand-and-supply' predictive model with scenario analysis to guide MiC adoption and development in Hong Kong in a robust and fast-responsive manner.

WP4: Public policy roadmap with action plan for MiC supply chains

For achieving Objective 4: To recommend a public policy roadmap with action plan for addressing the relevant regulatory and business constraints and concerns and achieving mature MiC supply chain for Hong Kong development, which leverages government buying power as well as private-sector market driver in Hong Kong and capitalises on the motivated industries in the GBA.

WP5: Verification of models, public policy roadmap and action plan

For achieving Objective 5: To verify the developed MiC 'demand-and-supply' predictive model, public policy roadmap and action plan through mixed methods research that includes GBA-wide questionnaire survey, focus group meeting, research workshop and policy forum for maximised sharing and impact of the research on knowledge, practice and policy in the wide community of Hong Kong and the GBA.

1.3 Report Structure

The structure of the report is presented as follows.

Chapter 1 introduces the research background, clarifies the research objectives and corresponding work packages, and presents the structure of the report.

Chapter 2 outlines the research methodology for achieving each research objective.

Chapters 3 to 7 elaborate in detail on the major results and findings of each work package.

Chapter 8 discusses the policy implications and recommendations of the research.

Chapter 9 introduces the activities for disseminating the knowledge established in this research.

Chapter 10 concludes the report by reviewing the achievement of each research objective and highlights the way forward.

Appendices and References are provided at the end of this report.

2. Research Methodology

This project has been conducted over a 54-month period in five interrelated stages for achieving the five objectives (Figure 2-1).

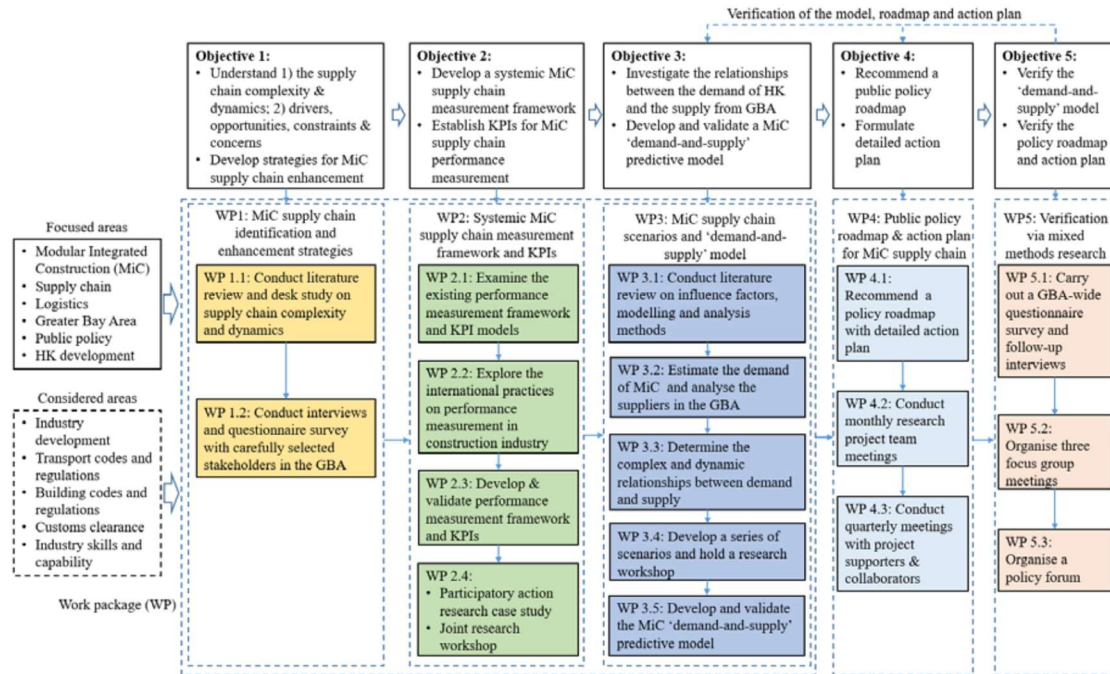


Figure 2-1 Overall research design

2.1 Methods for Achieving Research Objective 1

To accomplish Objective 1, a mixed-method design was adopted to collect multiple forms of evidence to ensure the reliability of the results. The methods included a comprehensive literature review, a questionnaire survey with industry stakeholders, and follow-up interviews with experts (See Table 2-1), facilitating a nuanced and comprehensive exploration of the drivers, opportunities, constraints, concerns, strategies, and measures regarding MiC supply chain enhancement in the GBA for HK development.

Table 2-1 Research activities conducted for WP1

Activities	Purposes of the research activities	Number of Participants
Literature review and desk study	To review supply chain complexity and dynamics, as well as relevant regulatory and business drivers, opportunities, constraints, and concerns; and to develop preliminary strategies and measures for MiC supply chain identification and enhancement in the GBA for HK	Not applicable (N.A.)
A questionnaire survey	To examine and explore the potential drivers, opportunities, constraints and concerns, as well as recommended strategies and measures associated with the MiC supply chain in the GBA	712 (valid responses)
Follow-up individual and group interviews	To collect more details about the respondents' experiences and perceptions of the studied items to verify the questionnaire results	80

First, we conducted a comprehensive literature review and in-depth desk study on supply chain complexity and dynamics in order to strengthen the theoretical foundation for MiC supply chain identification and enhancement in relation to HK development. The review and desk study covered the relevant regulatory and business drivers and opportunities as well as constraints and concerns. Drawing on our preliminary research into MiC supply chain, we mainly examined the following aspects aligned with the building project delivery process: (1) MiC pre-approval scheme, (2) building plan pre-submission requirement, (3) building codes and regulations (e.g. structural safety, fire safety, wind effect and forthcoming seismic effect), (4) QAQC in module production and inspections, (5) transport codes and regulations, (6) customs clearance, (7) site supervision. We particularly looked into the different regulatory requirements in HK and other places in the GBA and recommended measures to reach consensus or fill gaps. With the identified regulatory and business drivers and opportunities as well as constraints and concerns, we developed preliminary strategies for MiC supply chain identification and enhancement in the GBA for HK.

Second, we conducted an industry-wide questionnaire survey and follow-up interviews with carefully selected informed stakeholders in the GBA to verify the recommended measures and developed preliminary strategies in a macro-business environment. The questionnaire survey participants were selected using a two-stage stratified random sampling strategy (Bryman, 2016). First, a pool of professionals was identified from six stakeholder groups using the publicly available databases of stakeholders and the contact networks developed by the researchers, covering (i) government (policy and regulation), (ii) client (development), (iii) architect (planning and design), (iv) engineer (planning and design), (v) MiC manufacturer and supplier (manufacturing and supply), (vi) main contractor (project management), (vii) specialist contractor (installation and construction), (viii) institution/university (research and development). Then, participants were randomly selected from each group to mitigate the human bias in sampling. This two-stage process yielded a sample of 2,644 professionals in the GBA invited to the questionnaire survey. From March 2021 to September 2021, 975 questionnaires had been returned, 712 of which were effective responses, yielding a response rate of 26.92%. To verify the questionnaire results and further explore the participants' insightful perceptions of and attitudes towards MiC supply chain identification and enhancement in the GBA for HK's development, we conducted 80 follow-up individual and group interviews from April 2021 to November 2021. The interview participants were targeted from the participants in the questionnaire survey who were willing to join follow-up interviews and selected through purposive sampling to ensure that the chosen interviewees have extensive knowledge and work experiences with MiC, covering the six stakeholder groups.

2.2 Methods for Achieving Research Objective 2

To achieve Objective 2, we have conducted the research activities listed in **Table 2-2** for WP2, including literature review, three participatory action research case studies that integrated focus group meetings (FGMs), expert interviews, and site visits, one additional value-adding questionnaire survey, and one joint research workshop for verification.

Table 2-2 Research activities conducted for WP2

Activities	Purposes of the research activities	Number of Participants
Literature review	To examine the existing performance measurement framework and KPI models, the international practices on performance measurement in construction industry.	N.A.

Three FGMs	To examine the MiC supply chain measurement framework and the preliminary list of indicators	9; 13; 14
Twelve semi-structured interviews		12
Site visits	To observe MiC project delivery to get better understanding of the supply chain performance	51
A Q survey	To analyse the importance of each indicator quantitatively and identify the KPIs	147
A research workshop	To elicit common learning among the participants and to invite comments to help recommend the way forward	34

We first examined the existing performance measurement framework and KPI models through the comprehensive literature review to form the scientific foundation. In parallel we reviewed the international practices on performance measurement in the construction industry to identify established KPI systems at the different levels of project, organisation, industry as well as process due to the process-oriented nature of supply chain. We then analysed the similarities and differences between HK and other places in the GBA in terms of MiC supply chain to identify the critical success factors. Blending the results from these research activities, we developed a preliminary systemic MiC supply chain measurement framework and KPIs for the purpose of supporting HK industries' and community's decision making of MiC supply chain selection and evaluation for optimal performance on productivity, cost-effectiveness, quality, safety and sustainability of delivered buildings and society of HK.

We next validated the developed preliminary systemic MiC supply chain measurement framework and KPIs through participatory action research case study with the three MiC pilot projects in HK, i.e. (1) the five 16- to 17-storey blocks of staff quarter for Fire Services Department by Architectural Services Department (ArchSD); (2) the 17-storey block of research staff quarter at the Hong Kong Science and Technology Parks Corporation; and (3) the two 17-storey blocks of student hostel at HKU Wong Chuk Hang site. Participatory action research case study is a novel research methodology that integrates the use of action research and case study methods with researchers actively participating in and influencing the case under study for enhanced practices. In this project, this was achieved by a project-based FGM, expert interviews, and site visits. The FGMs were conducted, each with a pilot MiC project team. Each FGM took approximately two hours to allow an in-depth discussion to examine the measurement framework and list of indicators. To supplement the FGMs, a total of 12 expert interviews were conducted with (1) participants from the government; (2) participants who were unable to attend the FGMs; and (3) FGM participants who had more details to share. Each interview lasted for 45 minutes to 2 hours, as needed, to exhaust the questions and discussion. The research team also visited the project sites for participatory observation.

We finally conducted a joint research workshop with the three MiC pilot project teams as well as relevant government bureaux (e.g. DEVB) and departments (e.g. BD, ArchSD, TD), industry organisations (e.g. CIC, HKCA) and the three MiC manufacturers and suppliers to elicit common learning in order to enhance the maturity of MiC supply chain and its supporting industries in the GBA for HK development. Additionally, to investigate the importance of each preliminary indicator for supply chain performance measurement based on the results and findings from focus group meetings and interviews, we conducted an extended questionnaire survey to enhance the statistical reliability of the results.

2.3 Methods for Achieving Research Objective 3

To achieve Objective 3, we have conducted the research activities listed in **Table 2-2** for WP3, including literature review, an additional value-adding questionnaire survey, site visits, twelve expert interviews, factory visits and a research workshop, regarding the development of the MiC ‘demand-and-supply’ model with scenario analysis.

Table 2-3 Research activities conducted for WP3

Activities	Purposes of the research activities	Number of Participants
Literature review	To explore influencing factors to the complex and dynamic relationships between the MiC demand and supply	N.A.
A questionnaire survey	To collect information on MiC factories’ layout, production facility, product types, production capacity, etc.	55
Twelve interviews	To collect information: 1) MiC factories’ layout, production facility, product types, production capacity, etc.; 2) MiC demand in public and private sector	12 (Suppliers and clients)
Site / factory visits	To observe MiC project delivery processes of the pilot MiC project to get a better understanding of the supply chain performance and issues. To investigate and gain deeper understanding of MiC factories’ layout, production facility, product types, production capacity, etc.	122
Supply-demand analysis	To analyse the future MiC demand and supply of concrete and steel systems, respectively, within a ten-year time frame and envision three scenarios	N.A.
A joint research workshop	To explore MiC practitioners’ opinions on future MiC supply and demand and collect feedback on the results of MiC supply and demand analysis	30

We first conducted a literature review to identify internal and external influencing factors to the complex and dynamic relationships between the demand for MiC in different building sectors of HK (e.g. public housing, private housing, student hostel, staff quarter, hospital and hotel) and the supply of MiC by relevant industries along the MiC supply chain in the GBA. In parallel we defined the scope, system boundaries and variables of the proposed ‘demand-and-supply’ model.

We then reviewed established and innovative modelling and optimisation methods to design a tailor-made ‘demand-and-supply’ model with scenario analysis to guide MiC adoption and development in HK in a robust and fast-responsive manner. We examined the individual or collective use of forecasting methods, such as time series analysis (e.g. Box-Jenkins), econometric model (e.g. multiple regression analysis, vector autoregressive), simulation (e.g. system dynamics, agent-based modelling), and artificial intelligence (e.g. artificial neural network, support vector machine). We also examined the use of scenario approaches that have been widely applied to predict and understand the future uncertainties of complicated long-term development for investment and policy strategising. Scenario planning could provide a clear link between future prognosis and strategic actions, considering a range of possible futures, thereby allowing stakeholders to have multiple views of the future for making correct decisions.

We next estimated the demand for MiC from various building sectors in HK (e.g. public housing, private housing, student hostel, staff quarter, hospital and hotel) in three timeframes, i.e. up-to-3-year (for immediate actions), 5-year (for medium-term prediction) and 10-year (for long-term vision). To further collect the MiC demand information and to get a better understanding of the supply chain performance and issues, we conducted several site visits, engaging the major clients of public and private sectors and their main contractors in the visits. In parallel, we analysed the available MiC suppliers in the GBA in terms of their production capacity, skills and experience, product system, location and logistics feasibility for supplying and delivering modules to HK. We conducted an additional questionnaire survey to gather information on the production capacity of suppliers in the GBA and organised factory visits to investigate and gain deeper understanding of the MiC factories' layout, production facility, product types, production capacity, etc.. Blending these two-fold results we determined the complex and dynamic relationships between the demand for and supply of MiC. Drawing on the identified influencing factors, estimated demand, analysed supply and determined relationships, we developed three scenarios with considerations of political, market and technological, and organisational aspects.

Finally, the MiC demand-and-supply scenarios and the developed model were validated and fine-tuned through 12 expert interviews and a research workshop with representatives from major clients, regulators and MiC suppliers of the studied building sectors.

2.4 Methods for Achieving Research Objective 4

Based on the analyses and findings in WP1-3, we recommended a public policy roadmap with detailed action plan for addressing the relevant regulatory and business constraints and concerns and achieving mature MiC supply chain for HK development, through the accomplishment of the research activities listed in **Table 2-4**.

Table 2-4 Research activities conducted for WP4

Activities	Purposes of the research activities	Number of Participants
Literature review and desk study	To review policy regarding MiC supply chain enhancement in international practices	N.A.
Regularly research project meetings	To conduct monthly research project meetings to ensure smooth progressing of the project and successful achievement of the research work packages and activities.	Around 12~21 participants for each quarterly meeting
	To conduct quarterly meetings to guide the research direction and facilitate the recommendation of the public policy roadmap and action plan	
1 st public policy forum	To share the preliminary public policy roadmap with action plan for the MiC supply chain and to solicit feedback from various stakeholders	244
Development of web portal	To develop a web portal demo to facilitate the stakeholder engagement and consultation	N.A.

We conducted monthly research project team meetings with the PI, Co-Is and researchers to ensure smooth progressing of the project and successful achievement of the research work packages and activities.

We also conducted quarterly meetings with the research project team as well as representatives of the project supporters and collaborators to guide the research direction and facilitate the recommendation of the public policy roadmap and action plan, which included the following key elements and functions:

- (1) Time-line: The public policy roadmap is with short- (up-to-3-year), medium- (5-year), and long-term (10-year) milestones in line with the Outline Development Plan for the GBA, Chief Executive's Policy Address, and the Development Bureau's 'Construction 2.0' agenda.
- (2) Industry sector-wise: The policy roadmap covers different building sectors of HK (e.g. public housing, private housing, student hostel, staff quarter, hospital and hotel) and the supply of MiC by relevant industries along the MiC supply chain in the GBA.
- (3) Scenario-wise: The policy roadmap refers to the results of MiC supply and demand prediction and the developed scenarios.
- (4) Industry and public engagement: The action plan provides mechanisms for industry and public engagement for verification and refinement. A web portal has been developed to facilitate the engagement and consultation.
- (5) Leverage government buying power: The action plan takes into account the MiC pilot projects and public-sector projects for which MiC is a preferred solution.
- (6) Private-sector market driver: The action plan takes into account the private-sector projects for which MiC is an encouraged solution.
- (7) Motivate supporting industries in the GBA: The public policy roadmap and action plan are fully communicated via various media means and research activities proposed in this project to motivate the MiC supply chain and supporting industries in the GBA.

Besides, we held the first public policy forum to share key research findings of WP1-4 and the preliminary public policy roadmap with action plan for enhancing the MiC supply chain and to solicit feedback from various stakeholders. The forum was held in a hybrid mode (i.e. attend physically or via Zoom) to maximise the involvement of GBA stakeholders, with a total of 244 participants attended. The forum featured briefings on the project findings by the research team, keynotes by government officials and industry leaders, as well as sharing by overseas and local experts in MiC and supply chain management. The forum contributed to raising attention to MiC supply chain enhancement and gathering the perspectives and suggestions from the stakeholders for refining the preliminary public policy roadmap with action plan.

Last but not least, we developed a web portal demo, which is prepared for facilitating industry and public engagement in and access to MiC demand-and-supply information as well as the proposed public policy roadmap and action plans.

2.5 Methods for Achieving Research Objective 5

For achieving Objective 5, we verified the developed MiC 'demand-and-supply' predictive model, public policy roadmap and action plan through mixed methods research, including a questionnaire survey, three FGMs and a public policy forum (See **Table 2-5**).

Table 2-5 Research activities conducted for WP5

Activities	Purposes of the research activities	Number of Participants
A questionnaire survey	To validate the key findings of MiC 'demand-and-supply' predictive model and scenarios, as well as the	158 (valid

	proposed public policy roadmap and action plan.	responses)
Three FGMs	To further verify the key findings of MiC ‘demand-and-supply’ predictive model and scenarios, as well as the proposed public policy roadmap and action plan.	25; 31; 31
2 nd public policy forum	To disseminate the key findings of the research project and launch the research deliverable	280

First, we carried out a GBA-wide questionnaire survey with stakeholders from the MiC projects, regulatory departments, industry and community. Through various channels (e.g. emails, professional bodies, industry institutions and social media), this survey approached a sample size of over 4,000 informed stakeholders of MiC supply chain and supporting industries in the GBA. The participants were identified and selected using purposive sampling and cluster sampling strategies. By the former, industry stakeholders with knowledge or experience in MiC will be engaged to ensure data relevance and validity. By the latter, the participants together will cover the following clusters of roles: (i) government (policy and regulation), (ii) client (development), (iii) architect (planning and design), (iv) engineer (planning and design), (v) MiC manufacturer and supplier (manufacturing and supply), (vi) main contractor (project management), (vii) specialist contractor (installation and construction), (viii) institution/university (research and development) to ensure data reliability. The questionnaire survey contributed to an overview of the perspectives of various stakeholders regarding the key findings, helping us to identify the areas that need further validation.

Second, we organised three FGMs to enable in-depth discussion (around 2 hours for each) about three key deliverables of this project, i.e. (1) MiC ‘demand-and-supply’ predictive model; (2) MiC supply chain scenarios; and (3) public policy roadmap and action plan. The FGMs gathered representatives from government bureaux and department, public clients, private developers, contractors, suppliers, institutions and universities, ensuring the generalisability of the research. Moreover, all FGM participants have got MiC project experiences, ensuring that their feedback and comments on the research findings are reliable. Noteworthy, the questionnaire survey and FGMs conducted in WP5 and the interviews and workshops of WP3 and WP4 all together contributed to the data verification and results validation, ensuring the reliability of the research results.

Finally, we organised the second public policy forum, with over 280 participants covering the professional roles listed above in the HK construction industry and the GBA to maximise the learning and impact of the research on knowledge, practice and policy in the wide community. The PI reported the project findings and launched the research deliverable in the form of a booklet. The 2nd forum also featured insightful knowledge and experience sharing by leaders from the government departments, clients/developers and suppliers.

We have regularly presented the major findings to the main MiC policy and regulatory bureaux and departments such as DEVB along the research process, and incorporated their comments in our various publications and deliverables such as booklets and the final report.

3. Results and Analyses of Work Package 1

3.1 Drivers for Enhancing the MiC Supply Chain in the GBA

Drivers are defined here as factors that identify and enhance the MiC supply chain in the GBA for HK's development. Overall, the participants' perceptions of the importance of drivers for enhancing the MiC supply chain were measured in four dimensions, with the highest level of importance attached to political and regulatory drivers (3.572), followed by socio-economic (3.525), technical (3.516) and geographical (3.215) drivers (Table 3-1). **Figure 3-1** shows the top five drivers of MiC supply chain identification and enhancement in the GBA (in descending order of importance as perceived by the respondents):

- (1) An effective supply chain is critical to MiC project success (3.762);
- (2) The need for fast housing supply to address HK's housing shortage (3.648);
- (3) The need for rapid delivery of facilities against disruptive events (e.g., COVID-19 pandemic) (3.648);
- (4) The need for consistent MiC quality assurance/quality control (QA/QC) mechanism in the GBA (3.635); and
- (5) The need for policy initiatives to promote MiC for HK's development (3.596).

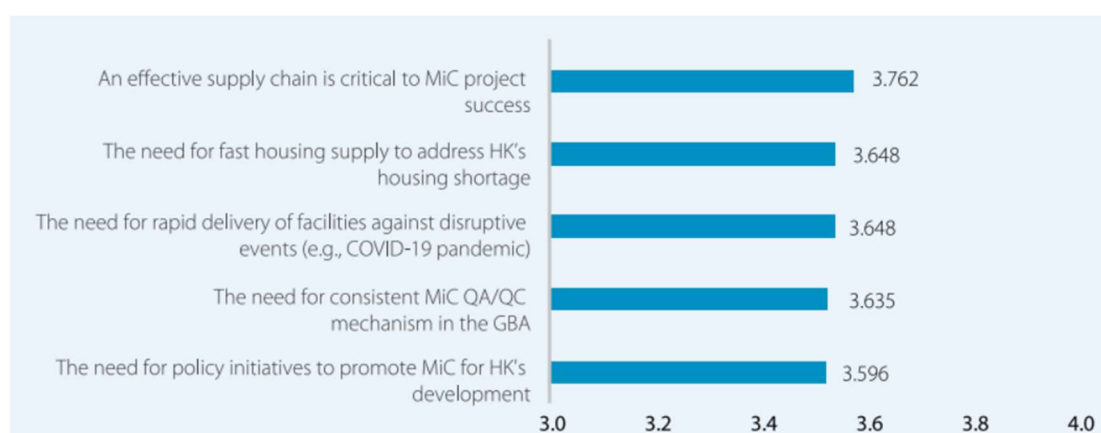


Figure 3-1 Top five drivers for MiC supply chain identification and enhancement in the GBA
Note: $n = 614$

As shown in **Table 3-1**, the overall ranking of the importance of the drivers was relatively similar across all of the effective respondents (All Group), respondents who work primarily in HK (H Group) and respondents who have been involved in at least one MiC project (I Group). However, there were noticeable differences among the rankings of the top five drivers. The H Group ranked the driver '*the need for consistent MiC QA/QC mechanism in the GBA*' as the second most important. Different from the top five drivers selected by the All Group, the H Group and I Group perceived other two drivers of higher significance: '*the need to increase cost and time certainty of module delivery*' and '*the need for consistent MiC building codes and regulations in the GBA*'.

Table 3-1 Respondents' views on the drivers for MiC supply chain enhancement

Drivers	Mean			Ranking by All/H/I
	All Group	H Group	I Group	
An effective supply chain is critical to MiC project success (TD1)	3.762	3.927	3.860	1/1/1
The need for fast housing supply to address HK's housing shortage (SD1)	3.648	3.687	3.705	2/4/3
The need for rapid delivery of facilities against disruptive events (e.g., COVID-19 pandemic) (SD2)	3.648	3.608	3.761	2/7/2
The need for consistent MiC QA/QC mechanism in the GBA (PD1)	3.635	3.741	3.700	4/2/4
The need for policy initiatives to promote MiC for HK's development (PD2)	3.596	3.728	3.680	5/3/6
The need to improve module installation efficiency and quality on-site (TD2)	3.593	3.661	3.651	6/6/8
The need for consistent MiC building codes and regulations in the GBA (PD3)	3.588	3.608	3.687	7/7/5
The need to increase cost and time certainty of module delivery (TD3)	3.564	3.674	3.653	8/5/7
HK contractors & GBA suppliers need long-term relationship (SD3)	3.507	3.566	3.572	9/9/10
The need to achieve economies of scale via mass production of modules (SD4)	3.505	3.557	3.581	10/10/9
The need for MiC transport codes and regulations in the GBA (PD4)	3.471	3.487	3.532	11/11/11
HK market needs to identify eligible MiC suppliers and products efficiently (TD4)	3.349	3.484	3.412	12/12/12
The increasing need to procure modules outside Hong Kong (SD5)	3.318	3.418	3.401	13/14/13
Main contractors are highly reliant on MiC suppliers and subcontractors (TD5)	3.311	3.453	3.381	14/13/14
HK is an important MiC market in the GBA with geographic advantages (GD1)	3.215	3.203	3.306	15/15/15

Note: Calculations based on a 5-point Likert scale consisting of 'No important' as 1, 'Somewhat important' as 2, 'Important' as 3, 'Very important' as 4, 'Extremely important' as 5.

All Group: All effective respondents (n=614); H Group: All respondents who work primarily in HK (n=316); I Group: All respondents who have been involved in at least one MiC project (n=444).

TD1-TD5: Technical drivers; PD1-PD4: Political and regulatory drivers; SD1-SD5: Socio-economic drivers; GD1: Geographical drivers.

The follow-up interviews and focus group meetings were in line with the questionnaire survey, with most of the participants agreeing that enhancing the MiC supply chain in the GBA is important to help address challenges facing by the HK construction industry, such as severe labour shortage, expensive labour and material costs, dirty and dangerous work environments and low productivity. Moreover, the urgent need for the rapid delivery of quarantine facilities amid COVID-19 and the large demand for public housing have increased the adoption of MiC. An integrated MiC supply chain is needed to achieve cost-efficiency, productivity, customer satisfaction and competitive advantage. The participants also highlighted other drivers. For example, the need to reduce in-situ work and construction time, the need to provide land for module manufacturing and storage, and the need to meet China's net-zero carbon goal for 2060.

3.2 Opportunities for Enhancing the MiC Supply Chain in the GBA

Opportunities are defined here as occasions or situations that identify and enhance the MiC supply chain in the GBA for HK’s development. Overall, the participants’ perceptions of the importance of opportunities for enhancing the MiC supply chain were measured in four dimensions, with the highest level of importance attached to political and regulatory opportunities (3.510), followed by technical opportunities (3.442), geographical opportunities (3.439) and socio-economic opportunities (3.386) (Table 3-2). As illustrated in **Figure 3-2**, the survey revealed the top five opportunities for MiC supply chain identification and enhancement in the GBA (in descending order of importance as perceived by the respondents):

- (1) The 6% of MiC floor area (MFA) exemption from gross floor area (GFA) calculation can drive MiC demand (3.572),
- (2) Relevant guidance has been formulated for MiC design and inspection (3.539),
- (3) Digital techniques enable remote inspection of module production (3.525),
- (4) Smart technologies (e.g., IoT, AI) can enhance MiC supply chain (3.525),
- (5) MiC pre-approval mechanism can facilitate project planning and design (3.522).

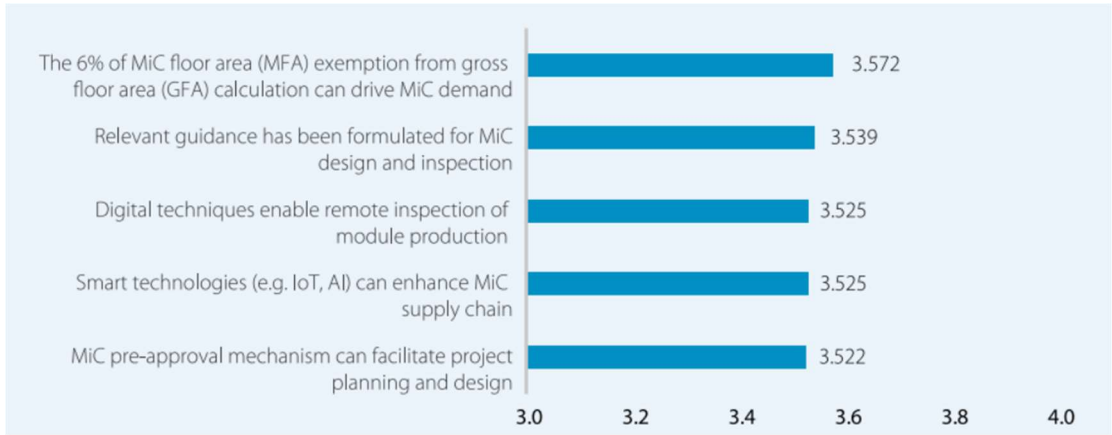


Figure 3-2 Top five opportunities for MiC supply chain enhancement in the GBA
Note: n = 579

As shown in **Table 3-2**, the overall ranking of the importance of the opportunities was similar across all of the effective respondents (All Group), respondents who work primarily in HK (H Group) and respondents who have been involved in at least one MiC project (I Group). All three groups agreed on the primary role of the 6% MFA exemption from GFA calculation in driving MiC demand and promoting the MiC supply chain, indicating that commercial-related policies are critical to enhance stakeholders’ willingness in adopting MiC and boost its development. The established MiC-related guidance and pre-approval mechanism, as well as the potential use of digital and smart technologies, were also perceived as important ways to support the adoption of MiC and to enhance the MiC supply chain.

Table 3-2 Respondents' views on the opportunities for MiC supply chain enhancement

Opportunities	Mean			Ranking by All/H/I
	All Group	H Group	I Group	
The 6% of MiC floor area (MFA) exemption from gross floor area (GFA) calculation can drive MiC demand (PO1)	3.572	3.632	3.703	1/1/1
Relevant guidance has been formulated for MiC design and inspection (PO2)	3.539	3.605	3.614	2/3/2
Digital techniques enable remote inspection of module production (TO1)	3.525	3.622	3.583	3/2/4
Smart technologies (e.g., IoT, AI) can enhance MiC supply chain (TO2)	3.525	3.592	3.582	3/4/5
MiC pre-approval mechanism can facilitate project planning and design (PO3)	3.522	3.572	3.607	5/5/3
MiC-related training will improve the practitioners' MiC capabilities (SO1)	3.514	3.495	3.540	6/7/6
Some inspection and approval requirements for service installation (fire, plumbing and electricity) are the same in MiC and traditional projects (PO4)	3.501	3.559	3.537	7/6/7
Business opportunities for clients/developers to work with pre-approved MiC suppliers (SO2)	3.458	3.441	3.511	8/11/8
Transportation risk is controllable given the geographic closeness (GO1)	3.441	3.428	3.501	9/12/10
Inspection in factory is realisable given the geographic closeness (GO2)	3.436	3.465	3.473	10/9/11
GBA cities adopt electronic import/export declaration systems, providing opportunities for setting up one-stop digital declaration system for MiC (PO5)	3.415	3.428	3.502	11/12/9
The low import-export duty rates of HK is financially favourable for procuring modules in the GBA (SO3)	3.406	3.368	3.468	12/14/12
Mature practices in HK to import certificated building materials & products (TO3)	3.400	3.485	3.463	13/8/13
Demonstrated benefits of MiC and established guidebooks for MiC performance measurements (TO4)	3.397	3.465	3.454	14/9/14
MiC suppliers in GBA experienced in overseas modular high-rise projects (TO5)	3.364	3.358	3.422	15/15/15
HK as a major GBA MiC market due to global geopolitical and epidemic situations (SO4)	3.166	3.094	3.233	16/16/16

Note: All Group: All effective respondents (n=579); H Group: All respondents who work primarily in HK (n=299); I Group: All respondents who have been involved in at least one MiC project (n=417).

TO1-TO5: Technical opportunities; PO1-PO5: Political and regulatory opportunities; SO1-SO4: Socio-economic opportunities; GO1-GO2: Geographical opportunities.

Similarly, during the follow-up interviews and focus group meetings, most of the participants recognised the positive role of GFA concession policy in encouraging more uptake of MiC, but expressed concern that the current MFA exemption rate may not cover the increased cost of adopting MiC and suggested raising the exemption rate to attract wider MiC adoption in the private sector. Aside from the relatively comprehensive MiC guidance and mechanism in HK,

most interviewees agreed that the geographic proximity and cultural similarities between GBA cities and source advantage in the Mainland (e.g., labour, material, land and technology) are important opportunities to develop the MiC supply chain in the GBA for HK's development. The interviewees also raised other opportunities. For example, the Construction Innovation and Technology Fund (CITF) has provided financial support to encourage the development and adoption of new MiC materials and innovative MiC systems in the local industry. Besides, compared to overseas suppliers, more factories in the GBA are familiar with BD's requirements and have relevant HK-recognised certificates, strengthening the advantages of developing the MiC supply chain in the GBA.

3.3 Constraints Perceived by Stakeholders

Constraints in this context are defined as factors that hinder the identification and enhancement of the MiC supply chain in the GBA for HK's development. The overall constraints were measured in four dimensions, with most of constraints related to political and regulatory (3.316), followed by geographical (3.259), technical (3.235) and socio-economic (3.235), which suggest relevant regulatory bodies to lead MiC development in HK (Table 3-3). As illustrated in **Figure 3-3**, the survey revealed the top five significant constraints on MiC supply chain identification and enhancement in the GBA (in descending order of significance as perceived by the respondents):

- (1) Challenges to freeze design specification early(3.391),
- (2) Current HK transport regulations restrict the delivery of large modules (3.384),
- (3) The narrow streets of HK constrain module transportation (3.378),
- (4) The industry is reluctant to use MiC due to the cost-driven culture (3.376),
- (5) Some HK building codes are too stringent to facilitate early design freeze (3.309).

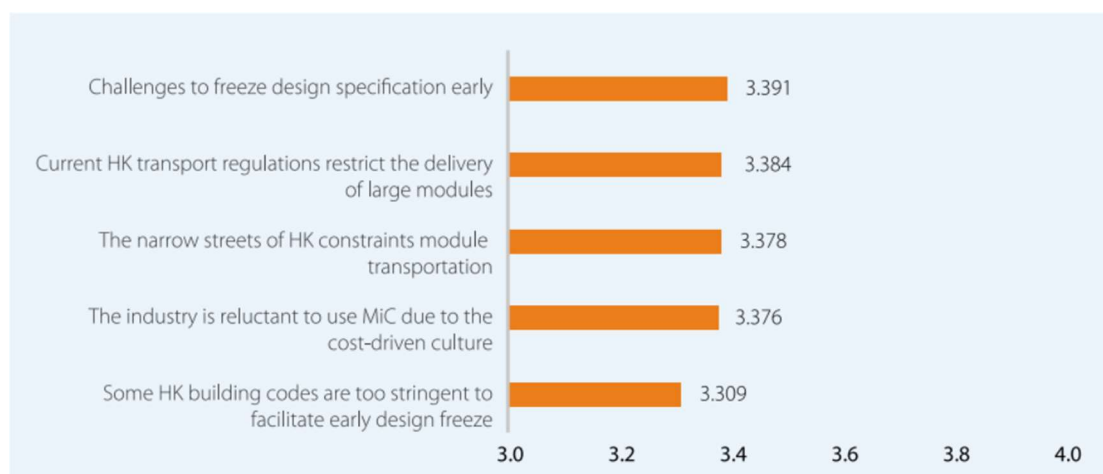


Figure 3-3 Top five constraints for MiC supply chain enhancement in the GBA

Note: n = 550

As shown in **Table 3-3**, the overall ranking of the significance of the constraints was slightly different among all effective respondents (All Group), respondents who work primarily in HK (H Group) and respondents who have been involved in at least one MiC project (I Group). The H Group attached greater significance to the constraint 'high initial capital cost for developing MiC factories', indicating that the local stakeholders are hindered by cash flow and investment return issues. However, the I Group thought that the cost-driven nature of the industry is the primary constraint on the development of MiC and its supply chain.

Table 3-3 Respondents' views on the constraints for MiC supply chain enhancement

Constraints	Mean			Ranking by All/H/I
	All Group	H Group	I Group	
Challenges to freeze design specification early (TCS1)	3.391	3.629	3.457	1/1/2
Current HK transport regulations restrict the delivery of large modules (PCS1)	3.384	3.521	3.447	2/2/3
The narrow streets of HK constrain module transportation (GCS1)	3.378	3.507	3.432	3/3/4
The industry is reluctant to use MiC due to the cost-driven culture (SCS1)	3.376	3.444	3.470	4/5/1
Some HK building codes are too stringent to facilitate early design freeze (PCS2)	3.309	3.392	3.392	5/8/5
Lack of effective governmental incentives, subsidies and promotions (PCS3)	3.307	3.392	3.357	6/8/6
Incomprehensive building codes and regulations for MiC in Hong Kong (PCS4)	3.300	3.402	3.339	7/6/7
High initial capital cost for developing MiC factories (SCS2)	3.287	3.507	3.327	8/3/8
Lack of public policy on MiC supply chain (PCS5)	3.278	3.322	3.304	9/12/9
Challenges in inter-disciplinary collaboration due to industry fragmentation (TCS2)	3.255	3.381	3.289	10/11/11
Heavy machinery for module erection is not widely used in HK and may not be suitable for congested sites (TCS3)	3.255	3.392	3.284	10/8/12
Complicated QA/QC liability issues (e.g., responsibility allocation and product warranty) when MiC suppliers are outside of HK (TCS4)	3.249	3.402	3.246	12/6/13
Market demand for MiC remains low (SCS3)	3.202	3.290	3.296	13/13/10
The hilly landscape of HK constraints module transportation (GCS2)	3.140	3.227	3.178	14/14/14
Lack of effective MiC procurement methods (SCS4)	3.073	3.164	3.151	15/15/15
Limited use of new technologies (e.g., IoT) in MiC supply chain (TCS5)	3.027	3.150	3.048	16/16/16

Note: All Group: All effective respondents (n=550); H Group: All respondents who work primarily in HK (n=286); I Group: All respondents who have been involved in at least one MiC project (n=398).
TCS1-TCS5: Technical constraints; PCS1-PCS5: Political and regulatory constraints; SCS1-SCS4: Socio-economic constraints; GCS1-GCS2: Geographical constraints.

According to the interviewees, the uncertainty of the profitability of MiC projects is also an important constraint, especially for the private sector, which demands more customised design with little standardisation. The design of private projects changes frequently to cater to market preference, making it hard to reach early design freeze and raising higher requirements for

supply chain responsiveness. The interviewees also highlighted the political and regulatory constraints on MiC adoption. For example, the time for IPA approval is long; some regulatory requirements for MiC are too stringent; overdesign increases the time and cost of MiC projects; complicated material standards and testing requirements limit the range of suppliers for selection and increase the cost; and the lack of extra points specific to adopting MiC for BEAM Plus assessments decreases client's interest in using MiC for their projects. Some interviewees also mentioned the constraints caused by governmental incentives and subsidies; for example, CITF funding can only be applied once per consultant or contractor for a specific context, reducing their willingness to continuously conduct R&D work on MiC.

Furthermore, the interviewees identified other constraints more or less related to the socio-economic aspect such as MiC promotion education, low user preference for MiC buildings, a lack of demand and supply information sharing, a lack of understanding of MiC among the general public, and a lack of educational content on and training in MiC for university students/young engineers. According to the interviews, the current communication, understanding and collaboration among various stakeholders are insufficient and need to be enhanced. For example, some clients and contractors complained that the requirement to install cavity barriers between modules is unnecessary, but respondents from the regulatory department explained that the requirement is based on similar practices in other countries (e.g., Singapore) and no stakeholders had told them that the requirement is too stringent. Some suppliers felt that they lacked involvement at early design stage.

3.4 Concerns Perceived by Stakeholders

Concerns in this context are defined as problems or issues that should be addressed to support MiC supply chain identification and involvement in the GBA for HK's development. Overall, the participants' perceptions of the importance of opportunities for enhancing the MiC supply chain were measured in four dimensions, with the highest level of importance given to political and regulatory concerns (3.213), followed by technical (3.186), socio-economic (3.946), and geographical concerns (2.875) (Table 3-4). As illustrated in **Figure 3-4**, the survey revealed the top five significant concerns regarding MiC supply chain identification and enhancement in the GBA (in descending order of significance as perceived by the respondents):

- (1) Inefficient review and approval if authorities are unfamiliar with MiC (3.354),
- (2) Lack of module storage areas in HK (3.312),
- (3) Inconsistent building codes and regulations for MiC in the GBA (3.271),
- (4) Increased transportation and logistics consideration in MiC (3.261),
- (5) MiC introduces significant changes to payment terms and cash flows (3.231).

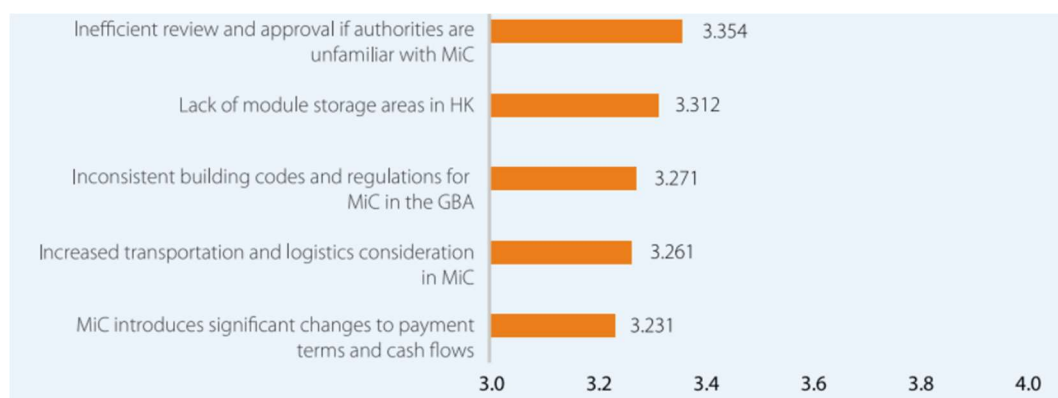


Figure 3-4 Top five concerns for MiC supply chain enhancement in the GBA

Note: $n = 537$

As shown in **Table 3-4**, the top five significant concerns were consistent for all of the effective respondents (All Group), respondents who work primarily in HK (H Group) and respondents who have been involved in at least one MiC project (I Group). The overall ranking of the significance of these concerns was similar across the groups. The H Group ranked ‘lack of module storage areas in HK’ as the top concern, indicating that the local industry is particularly concerned about the uncertainty of module transportation and logistics and needs module storage areas in HK. Similar to the perception of constraints, the I Group attached more attention to payment and cash flow changes associated with MiC projects, ranking the relevant concerns in the fourth place.

Table 3-4 Respondents’ views on the concerns for MiC supply chain enhancement

Concerns	Mean			Ranking by All/H/I
	All Group	H Group	I Group	
Inefficient review and approval if authorities are unfamiliar with MiC (PCC1)	3.354	3.560	3.395	1/2/1
Lack of module storage areas in HK (TCC1)	3.312	3.599	3.332	2/1/2
Inconsistent building codes and regulations for MiC in the GBA (PCC2)	3.271	3.433	3.308	3/4/3
Increased transportation and logistics consideration in MiC (TCC2)	3.261	3.444	3.290	4/3/5
MiC introduces significant changes to payment terms and cash flows (SCC1)	3.231	3.415	3.303	5/5/4
GBA MiC suppliers no familiar with HK construction practices (TCC3)	3.177	3.274	3.249	6/7/6
Inconsistent transport codes and regulations for MiC in the GBA (PCC3)	3.174	3.318	3.190	7/6/7
Existing MiC QA/QC regulations lack practicability (PCC4)	3.146	3.264	3.172	8/8/8
No cargo clearance and declaration guidance note specific for MiC (PCC5)	3.123	3.220	3.159	9/10/9
Increased equipment costs for powerful lifting (SCC2)	3.119	3.264	3.138	10/8/11
Lack of collaboration platform for MiC projects (TCC4)	3.103	3.217	3.151	11/11/10
Lack of skilled workers for MiC supply and implementation (SCC3)	3.093	3.202	3.108	12/12/12
Concerns on module manufacturing performance as no mandatory requirement for factory workers to obtain qualification certificates (TCC5)	3.078	3.181	3.095	13/13/13
Transportation time is impacted by the opening hours of land control points (GCC1)	2.875	2.982	2.920	14/14/14
Uncertainties in the currency exchange rate (SCC4)	2.647	2.747	2.669	15/15/15
Inefficient communication due to language barrier (e.g., different terms used in practices) (SCC5)	2.640	2.704	2.636	16/16/16

Note: All Group: All effective respondents (n=537); H Group: All respondents who work primarily in HK (n=277); I Group: All respondents who have been involved in at least one MiC project (n=390).

TCC1-TCC5: Technical concerns; PCC1-PCC5: Political and regulatory concerns; SCC1-SCC5: Socio-economic concerns; GCC1: Geographical concerns.

The interviewees also expressed concerns about the payment method and cash flow issues. Although clients can pay for MiC projects in the same way as conventional ones, contractors need advance payment to suppliers before delivering modules to HK. One contractor said that ‘early payment for MiC modules increases cash flow pressure and brings higher financial risk for main contractors’. Some participants also mentioned that non-local MiC suppliers are unfamiliar with HK’s standards and regulations, increasing main contractors’ responsibilities and risks regarding local regulatory compliance. Other concerns raised by the participants include:

- Lack of mandatory MiC rate requirements for new projects;
- Factories’ low level of automation that affects the efficiency of the MiC supply chain;
- Limited MiC supplier options, especially for high-rise buildings;
- Difficulties in maintaining a long-term strategic partnership between clients/contractors and suppliers to achieve the lowest possible costs;
- Cost-driven nature of the construction industry may lead to poor quality MiC;
- Lack of knowledge and experience in operating and maintaining MiC buildings.

Although the GBA MiC supply chain faces several constraints and challenges, most of the participants agreed or strongly agreed that its drivers and opportunities outweigh its concerns and constraints (**Figure 3-5**). Most interviewees recognised that identifying and enhancing the MiC supply chain in the GBA would make significant contributions to HK’s development in terms of relieving labour shortages, lowering labour and material costs, enhancing quality, productivity and safety in the local construction industry, promoting knowledge and information exchange, as well as upskilling the workforce in the whole GBA.

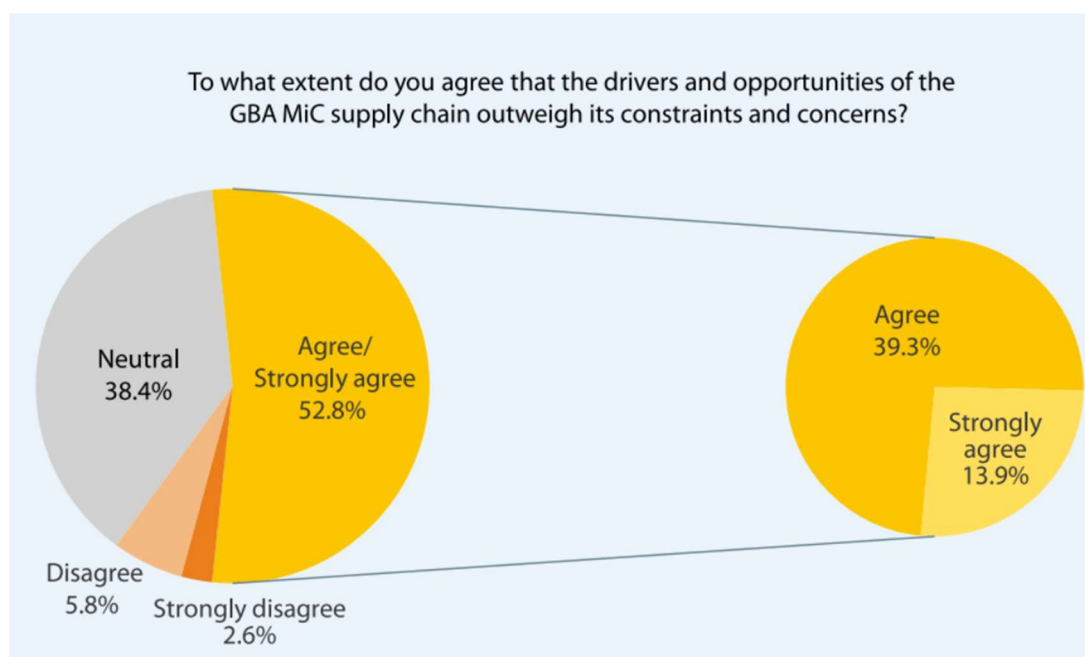


Figure 3-5 Evaluation of drivers, opportunities, constraints and concerns

Note: n = 534

3.5 Measures for Enhancing MiC Supply Chain in the GBA

Measures are defined here as methods or actions for amplifying drivers/opportunities and/or mitigating constraints/concerns regarding MiC supply chain identification and enhancement. Overall, the participants ranked the importance of measures for enhancing the MiC supply chain

as follows: socio-economic (3.492) measures, political and regulatory measures (3.461), geographical measures (3.269) and technical measures (3.267) (Table 3-5). As illustrated in **Figure 3-6**, the survey revealed the top five measures for MiC supply chain identification and enhancement in the GBA (in descending order of importance as perceived by the respondents):

- (1) Government takes the lead to promote and adopt MiC (3.777),
- (2) Streamline design approval process for improved efficiency (3.618),
- (3) Increase the comprehensiveness of MiC related codes and regulations (3.567),
- (4) Adopt MiC in new development areas in HK (3.550),
- (5) Increase training to enhance MiC practitioners' knowledge and skills (3.494).

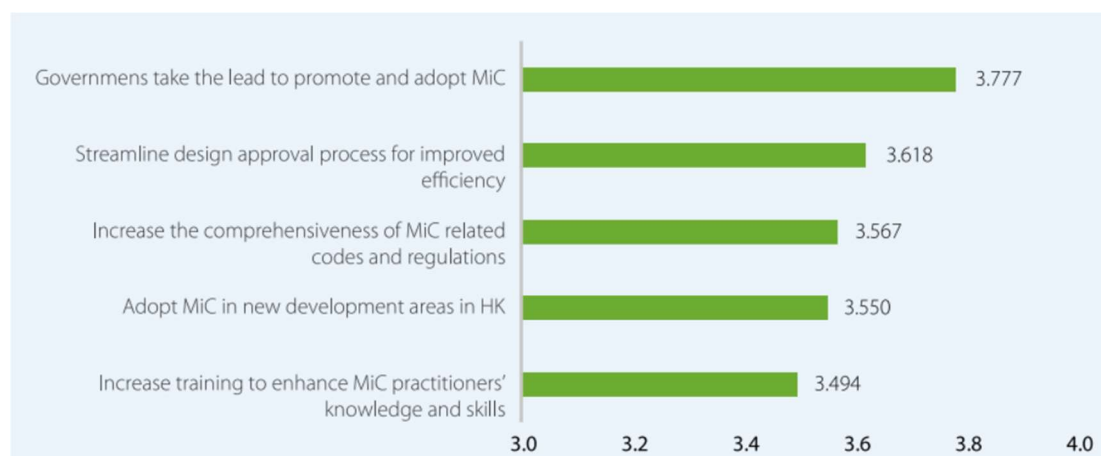


Figure 3-6 Top five measures for MiC supply chain enhancement in the GBA

Note: $n = 529$

As shown in **Table 3-5**, the top five measures were consistent across all of the effective respondents (All Group), respondents who work primarily in HK (H Group) and respondents who have been involved in at least one MiC project (I Group). The entire ranking of the importance of the measures is similar in all three groups. However, I group rated the driver 'Adopt MiC in new development areas in HK' as more important, ranking the relevant measures in third place.

Table 3-5 Respondents' views on the measures for MiC supply chain enhancement

Measures	Mean			Ranking by All/H/I
	All Group	H Group	I Group	
Government takes the lead to promote and adopt MiC (SM1)	3.777	3.818	3.896	1/1/1
Streamline design approval process for improved efficiency (PM1)	3.618	3.669	3.696	2/2/2
Increase the comprehensiveness of MiC related codes and regulations (PM1)	3.567	3.625	3.624	3/3/4
Adopt MiC in new development areas in HK (GM1)	3.550	3.611	3.642	4/4/3
Increase training to enhance MiC practitioners' knowledge and skills (SM2)	3.494	3.545	3.540	5/5/5
Develop a one-stop platform that includes all relevant regulatory bodies, to facilitate expedited evaluation and enhance the regulatory approval process (PM3)	3.469	3.469	3.527	6/8/7

Increase professional training for MiC inspectors (SM3)	3.460	3.505	3.512	7/7/8
Develop GBA one-stop approval system for MiC transport permission (PM4)	3.450	3.455	3.512	8/11/8
Develop MiC cost codes for cost evaluation and benchmarking (SM4)	3.445	3.404	3.504	9/15/10
Improve the practicability of current MiC QA/QC system (PM5)	3.443	3.469	3.492	10/8/13
Consider MiC adoption from urban planning stage (GM2)	3.437	3.451	3.535	11/12/6
Refine transport regulation to facilitate the adoption of MiC (PM6)	3.433	3.469	3.496	12/8/11
Increase industry knowledge sharing (SM5)	3.433	3.524	3.493	12/6/12
Develop GBA one-stop customs clearance system specific for MiC (PM7)	3.418	3.447	3.486	14/13/14
Establish GBA MiC supply chain database (TM1)	3.395	3.382	3.454	15/17/16
Develop seismic design code for MiC in Hong Kong (PM8)	3.389	3.360	3.429	16/18/17
Develop collaboration platform for MiC supply chain management (TM2)	3.378	3.400	3.457	17/16/15
Develop guidance on import/export declaration specific for MiC (PM9)	3.359	3.316	3.428	18/20/18
Identify innovative MiC procurement methods (SM6)	3.345	3.353	3.418	19/19/19
Use smart technologies to facilitate MiC site inspection processes (TM3)	3.302	3.407	3.350	20/14/21
GBA suppliers to team up with local designers for pre-approval application (TM4)	3.288	3.309	3.368	21/21/20
GBA prefab factories transfer to supply volumetric modules for MiC (TM5)	3.267	3.287	3.321	22/23/22
Develop third party agency for overseas offsite manufacturing inspection (TM6)	3.252	3.309	3.285	23/21/23
Mandatory use of BIM for pre-submission (TM7)	3.193	3.280	3.231	24/24/24
Digitalise transport impact assessment to facilitate regulatory approval (TM8)	3.189	3.211	3.230	25/25/25
Encourage MiC professional inspectors in the Mainland to register in HK (TM9)	3.139	3.124	3.201	26/26/26
Develop MiC factories in HK (GM3)	2.821	2.996	2.830	27/27/27

Note: All Group: All effective respondents (n=529); H Group: All respondents who work primarily in HK (n=275); I Group: All respondents who have been involved in at least one MiC project (n=383). TM1-TM9: Technical measures; PM1-PM9: Political and regulatory measures; SM1-SM6: Socio-economic measures; GM1-GM3: Geographical measures.

Most of the interviewees agreed that the government should lead the way in promoting MiC adoption at this stage. Some interviewees suggested that the government should enhance mutual recognition of relevant standards (e.g., materials standards) and professional qualifications (e.g., off-site inspection qualification for the Mainland professionals) between HK and the Mainland to enhance the cost and time efficiency of the MiC supply chain. Most of the participants emphasised the importance of information sharing and knowledge exchange and recommended setting up relevant platforms to provide MiC demand–supply information (e.g., upcoming projects in HK and eligible supplies in the GBA), MiC project experience and skills sharing,

MiC courses and training information, and the latest MiC-related R&D findings and technologies sharing.

Other measures suggested by the participants include the following:

- Set up timelines/schedules to promote MiC projects steadily and continuously, based on the supply chain capacity.
- Enhance MiC promotion and education for the general public and industry to enhance market acceptance, e.g., holding biennial MiC expos to enable citizens to experience MiC products and technologies, providing funding schemes for students to visit MiC projects in HK and the GBA.
- Encourage HK contractors to build their factories in the GBA to supply the HK market.
- Use advanced technologies (e.g., robotics) for QA/QC to enhance off-site construction reliability.
- Provide a pilot scheme for developers to conduct hypothetical studies to compare the in-situ method and MiC to explore the performance of MiC projects.
- Develop HK as an R&D base and the GBA as a manufacturing base to take full advantage of each other’s strengths.
- Provide flexibility to partially adopt MiC regarding building types to encourage the wider adoption of MiC.
- Extend free MiC storage period at the port to reduce logistics costs.

3.6 Strategies for Enhancing of MiC Supply Chain in the GBA

Strategies are defined as short-term or long-term plans to guide or facilitate the implementation of measures. As illustrated in **Figure 3-7**, the survey revealed the top five strategies for MiC supply chain identification and enhancement in the GBA (in descending order of importance as perceived by the respondents):

- (1) Encourage intra-government department collaboration on MiC (3.609),
- (2) Provide policy support to streamline relevant regulatory approval process (3.607),
- (3) Provide policy support to attract experts and young talents to MiC industry (3.548),
- (4) Enhance research and development on smart MiC (3.517),
- (5) Enhance HK regulatory bodies’ understanding of MiC (3.513).

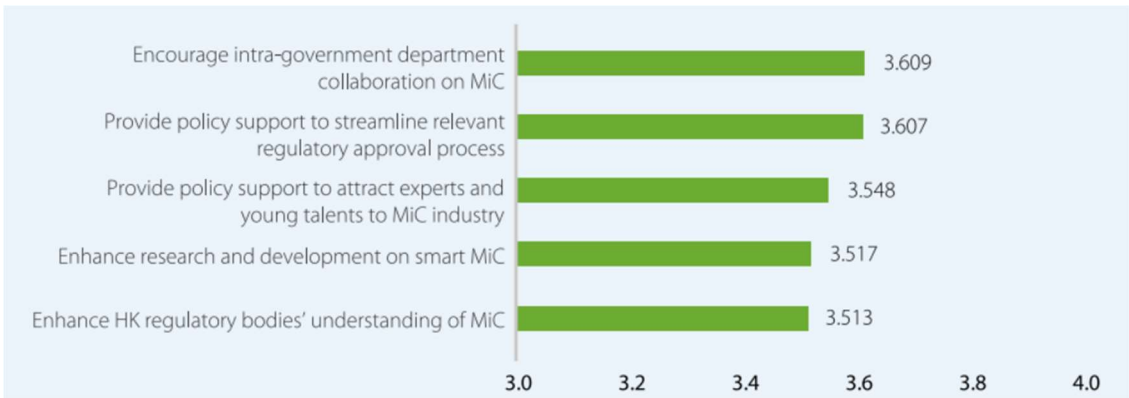


Figure 3-7 Top five strategies for MiC supply chain enhancement in the GBA

Note: n = 522

As shown in **Table 3-6**, the top five strategies were consistent across all of the effective respondents (All Group), respondents who work primarily in HK (H Group) and respondents who have been involved in at least one MiC project (I Group). The overall ranking of the importance of the strategies was similar across the three groups. Noticeably, the I Group ranked ‘provide policy support to streamline relevant regulatory approval process’ as the primary strategy. The H Group also attached more importance to the strategy that could enhance local regulatory departments’ knowledge of MiC, ranking the relevant strategy in third place.

Table 3-6 Respondents’ views on the strategies for MiC supply chain enhancement

Strategies	Mean			Ranking by All/H/I
	All Group	H Group	I Group	
Encourage intra-government department collaboration on MiC	3.609	3.694	3.691	1/1/2
Provide policy support to streamline relevant regulatory approval process	3.607	3.661	3.699	2/2/1
Provide policy support to attract experts and young talents to MiC industry	3.548	3.565	3.625	3/5/3
Enhance research and development on smart MiC	3.517	3.590	3.596	4/4/4
Enhance HK regulatory bodies’ understanding of MiC	3.513	3.649	3.580	5/3/5
Provide policy support to attract more GBA MiC suppliers to HK market	3.489	3.524	3.562	6/6/6
Establish innovative funding schemes to attract more MiC suppliers to HK	3.466	3.432	3.557	7/12/8
Streamline the procedures of customs declaration and clearance for MiC	3.458	3.428	3.559	8/13/7
Promote MiC digital design to enhance multi-disciplinary collaboration	3.454	3.502	3.493	9/7/12
Build up BIM model repository specific for MiC	3.439	3.443	3.515	10/10/9
Provide incentives for MiC suppliers to digitalise the manufacturing process	3.427	3.461	3.504	11/9/10
Provide technical support to attract more GBA MiC suppliers to HK market	3.420	3.428	3.501	12/13/11
Provide GBA-wide MiC training courses for practitioners	3.412	3.443	3.454	13/10/14
Provide logistics-supporting facilities (e.g., factory, warehouse) in HK	3.402	3.476	3.456	14/8/13
Public consultation and discussions on MiC related codes and regulations	3.318	3.314	3.359	15/15/15

Note: All Group: All effective respondents (n=522); H Group: All respondents who work primarily in HK (n=379); I Group: All respondents who have been involved in at least one MiC project (n=271).

Some interviewees emphasised that the development of the MiC supply chain should be market-driven, and that it is vital to maintain steady market demand for MiC. Besides, HK must demonstrate technological superiority in the whole GBA. Some interviewees proposed to develop MiC supply chain from semi-automation to high-level automation, combining technologies such as IoT, AI, VR and AR. Moreover, some interviewees showed a strong desire for a comprehensive performance measurement method and empirical data sharing of MiC projects.

Several interviewees suggested setting up an MiC supplier ranking system based on suppliers' ability to construct high-rise and low-rise buildings, enabling clients to compare suppliers' quality and cost-effectiveness. One of them explained that 'It is important to introduce a rating system to assess MiC manufacturers' performance in terms of management capability, quality, stock control, safety, sustainability, supply chain integrity, etc.' Thus, a more comprehensive and effective procurement strategy could be developed in selecting the MiC suppliers and manufacturers. Moreover, some suggested that the government should further study MiC project performance in relation to cost, time, building energy consumption, and operation management. The government should publish performance data on MiC buildings to enhance the industry's willingness and confidence in adopting MiC. Other interviewees also mentioned the need to build up trust between GBA manufacturers, clients and contractors to mitigate QA/QC concerns and increase the efficiency of the MiC supply chain, such as establishing a quality reliability mechanism and enhancing the brand effect of MiC suppliers.

The identified measures and strategies indicated the government's important role in supporting MiC supply chain identification and involvement in the GBA for HK's development. Relevant public policies should be formulated with full consideration of the needs of various stakeholders in terms of political and regulatory, technical, socio-economic and geographical aspects. The government – a vital link between various stakeholders along the supply chain – should facilitate understanding, communication and interaction among various stakeholders and support the industry's strategic planning for enhancing the MiC supply chain for HK's development.

3.7 Summary

An extensive questionnaire survey, follow-up interviews and FGMs were conducted to identify drivers, opportunities, constraints, concerns, measures and strategies associated with the enhancement of the MiC supply chain. The key findings of this section are summarised below.

The MiC supply chain was found to be highly complex and dynamic in terms of the technical system (i.e., MiC supply chain), stakeholders (i.e., demand, supply, regulation and institution groups), and different influencing contexts (i.e., political and regulatory, socio-economic and geographical contexts).

The importance and urgency of identifying and enhancing the MiC supply chain were clearly recognised by the stakeholders. The MiC supply chain was agreed to have a strong or very strong impact on the development of MiC in the GBA. Enhanced supply chain would not only gather more capable MiC suppliers and material suppliers for the HK market but also help to train MiC professionals and practitioners in the Mainland.

The top five most important **drivers** of the enhancement of the MiC supply chain in the GBA were as follows (in descending order of importance as perceived by the respondents):

- (1) An effective supply chain is critical to MiC project success;
- (2) A rapidly expanded housing supply to address HK's housing shortage;
- (3) Rapid delivery of facilities against disruptive events (e.g., COVID-19 pandemic).
- (4) A consistent MiC QA/QC mechanism in the GBA; and
- (5) Policy initiatives to promote MiC for HK's development.

The top five most important **opportunities** for the enhancement of the MiC supply chain in the GBA were as follows (in descending order of importance as perceived by the respondents):

- (1) The 6% of MiC floor area (MFA) exemption from gross floor area (GFA) calculation can drive MiC demand;
- (2) Relevant guidance has been formulated for MiC design and inspection;
- (3) Digital techniques enable remote inspection of module production;
- (4) Smart technologies (e.g. IoT, AI) can enhance MiC supply chain; and
- (5) MiC pre-approval mechanism can facilitate project planning and design

The top five most significant **constraints** on the enhancement of the MiC supply chain in the GBA were as follows (in descending order of significance as perceived by the respondents):

- (1) Challenges to freeze design specification early;
- (2) Current HK transport regulations restrict the delivery of large modules;
- (3) The narrow streets of HK constrain module transportation;
- (4) The industry is reluctant to use MiC due to the cost-driven culture; and
- (5) Some HK building codes are too stringent to facilitate early design freeze.

The top five most significant **concerns** regarding the enhancement of the MiC supply chain in the GBA were as follows (in descending order of significance as perceived by the respondents):

- (1) Inefficient review and approval if authorities are unfamiliar with MiC;
- (2) Lack of module storage areas in HK;
- (3) Inconsistent building codes and regulations for MiC in the GBA;
- (4) Increased transportation and logistics consideration in MiC; and
- (5) MiC introduces significant changes to payment terms and cash flows.

Drivers and opportunities of the GBA MiC supply chain outperform the concerns and constraints. Identifying and enhancing the MiC supply chain in the GBA would make significant contributions to HK's development in terms of relieving labour shortage, lowering labour and material cost, enhancing quality, productivity and safety in the local construction industry, promoting knowledge exchange as well as upskilling the workforce in the GBA.

The top five most important **measures** for the enhancement of the MiC supply chain in the GBA were as follows (in descending order of importance as perceived by the respondents):

- (1) Government takes the lead to promote and adopt MiC;
- (2) Streamline design approval process for improved efficiency;
- (3) Increase the comprehensiveness of MiC related codes and regulations;
- (4) Adopt MiC in new development areas in HK; and
- (5) Increase training to enhance MiC practitioners' knowledge and skills.

The top five most important **strategies** for the enhancement of the MiC supply chain in the GBA were as follows (in descending order of importance as perceived by the respondents):

- (1) Encourage intra-government department collaboration on MiC;
- (2) Provide policy support to streamline relevant regulatory approval process;
- (3) Provide policy support to attract experts and young talents to MiC industry;
- (4) Enhance research and development on smart MiC; and
- (5) Enhance HK regulatory bodies' understanding of MiC.

Other measures and strategies directly and indirectly related to enhancing the commercial merit of MiC were also frequently mentioned. For example, the government should set up a demand-and-supply information platform to enhance market information sharing, generate policies and incentives to sustain steady and consistent MiC demand, and publish empirical data on MiC project performance to boost stakeholders' confidence in adopting MiC.

4. Results and Analyses of Work Package 2

4.1 Profile of the Survey Participants

This section presents the information of participants of the surveys conducted for WP2. First, three FGMs involving 9, 13, and 14 participants and twelve semi-structured interviews were conducted to gather the views of the relevant stakeholders regarding the initial indicators. Second, an additional value-adding questionnaire survey was conducted to enhance the statistical reliability of the results, with 371 participants approached via emails, covering a wide range of stakeholders. From October 2022 to March 2023, out of 371 participants approached, we have received 147 valid responses, yielding a response rate of 39.6% (see **Figure 4-1**).

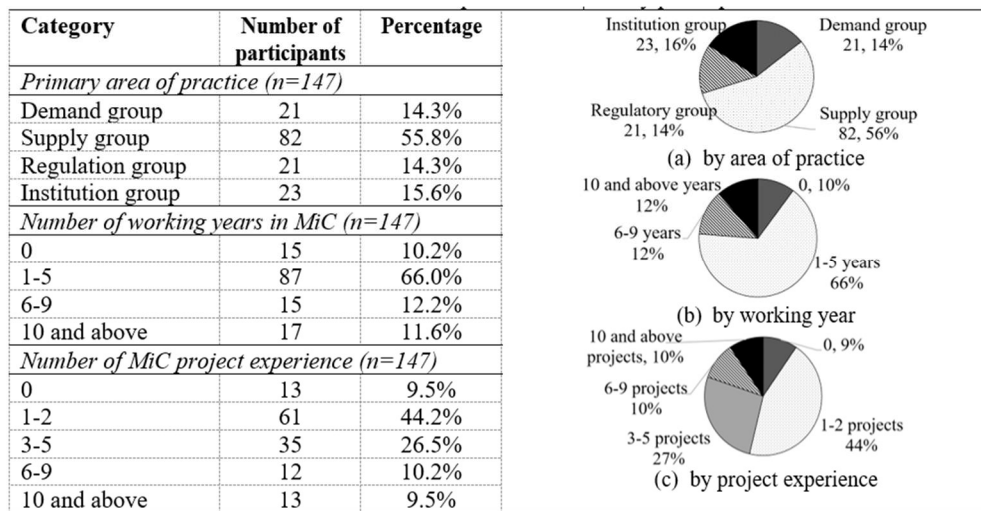


Figure 4-1 Profile of participants in the questionnaire survey

Finally, a research workshop was conducted with 34 participants from the key stakeholder groups to solicit feedback for the final validation of the refined KPIs. All of them hold senior positions in their organisations or had firsthand experience in the three case projects.

4.2 A Dialectical System Framework of MiC Supply Chain

The dialectical systems theory helps deconstruct MiC supply chain and identify the most critical performance areas and indicators. A novel measurement framework is adapted from the work by Pan et al. (2023) to delineate the scope and constituents of MiC supply chain at four levels (**Figure 4-2**). The four levels are:

Process level refers to the individual critical activities in MiC supply chain: (1) pre-approval, (2) building plan pre-submission, (3) detailed design, (4) module production, (5) logistics and customs clearance, (6) module installation, and (7) quality assurance and quality control.

Project level is the collection of all critical supply chain activities, and project-level measurement focuses on the overall delivery performance.

Organisation level denotes the stakeholders involved, including the demand group (e.g., clients and developers), supply group (e.g., contractors, MiC manufacturers and suppliers, and professional advisors), regulation group (e.g., the government and its agencies), and institution group (e.g., universities and professional bodies).

Industry level refers to the broad built environment, covering political and regulatory, socio-economic, and geographical contexts.

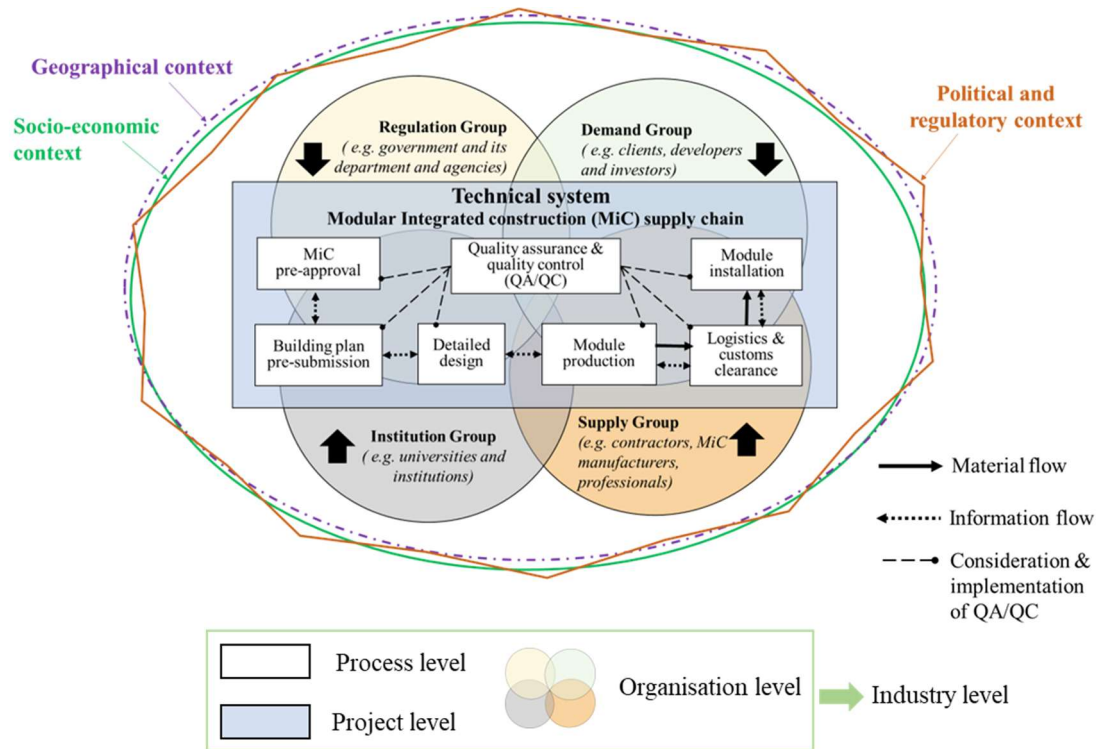


Figure 4-2 A dialectical system framework of MiC supply chain
(adapted from Pan et al. 2023)

4.3 KPIs for MiC Supply Chain Performance Measurement

Drawing on the review by Zhang et al. (2021) and the findings from FGMs and interviews, a preliminary list of 63 indicators with their descriptions or measurement methods was identified through literature review for measuring MiC supply chain performance at the process, project, organisation, and industry levels.

A questionnaire survey was developed based on the preliminary indicators. Based on the stakeholders' responses, this study performed scale ranking and fuzzy set theory analysis to determine the KPIs.

Based on the stakeholders' responses, this study performed scale ranking and fuzzy set theory analysis to determine the KPIs. As shown in **Figure 4-3**, we have identified the top three indicators at each level selected by each stakeholder group. If two indicators have the same mean value, the one with a smaller SD is deemed more important. Given the conflicting goals and interests of different stakeholder groups, there exists some disagreement.

	Process level	Project level	Organization level	Industry level
Regulation Group	Manufacturability of module design 4.125	Community's satisfaction 3.905	MiC experience of supply group 3.905	Supply capacity 4.095
	Time variance of module production 4.125	Stakeholders' satisfaction 3.905	Market share of supply group 3.905	Availability of MiC professionals 4.048
	Design change cost 3.905	Time variance 3.810	Efficiency of communication and collaboration 3.810	End-users' acceptance 3.905
Demand Group	Just-in-time fulfilment 4.143	Stakeholders' satisfaction 4.000	Efficiency of approval procedure 4.143	Incentive effectiveness 4.286
	Manufacturability of module design 4.063	Community's satisfaction 4.000	MiC experience of supply group 4.143	End-users' acceptance 4.286
	Process stability of module production 3.762	Responsiveness to external risks 3.952	Technology application of supply group 3.905	Regulatory flexibility of design 4.190
Supply Group	Manufacturability of module design 4.130	Time variance 3.963	Efficiency of approval procedure 4.037	Regulatory flexibility of design 3.988
	Design change cost 3.902	Stakeholders' satisfaction 3.817	Assurance of supply 3.988	Regulatory flexibility of material 3.927
	Just-in-time fulfilment 3.878	Cost variance 3.780	MiC experience of supply group 3.878	End-users' acceptance 3.902
Institution Group	Manufacturability of module design 4.353	Stakeholders' satisfaction 4.217	Assurance of supply 4.348	Demand increase 4.435
	Just-in-time fulfilment 4.130	Time variance 4.130	MiC experience of supply group 4.174	Supply capacity 4.087
	Unit cost of module production 4.043	Unit cost 4.087	Efficiency of approval procedure 4.087	End-users' acceptance 4.087

Figure 4-3 Top indicators at each level selected by each stakeholder group

Indicators ranked in the top half across the four stakeholder groups or with an integrated $m_{\bar{A}}$ of above 0.6 are selected as KPIs. As shown in **Figure 4-4**, 15 KPIs were selected for MiC supply chain performance measurement.

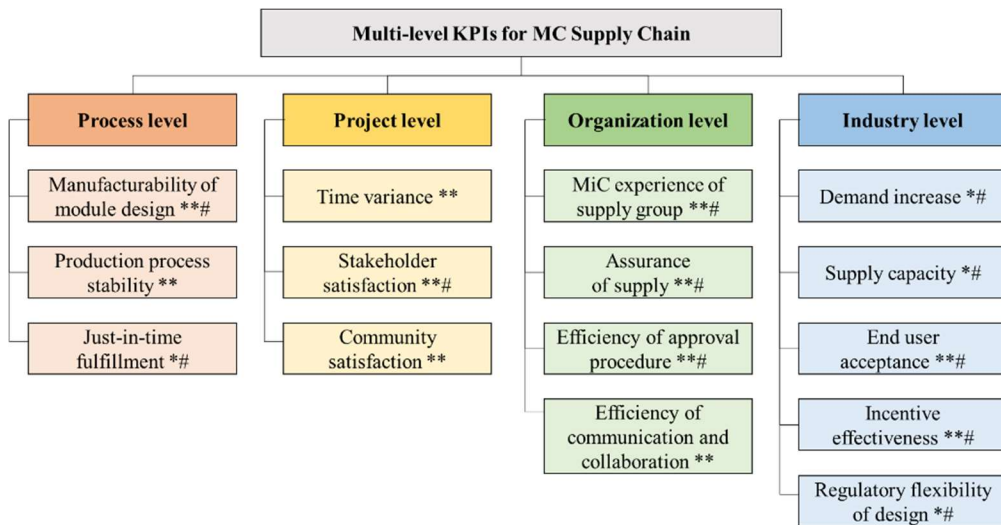


Figure 4-4 MiC supply chain measurement framework and KPIs

Note:

- Based on the results of mean-based scale ranking, 1) indicators ranked top 30 by three distinct stakeholder groups were marked with *; and 2) indicators ranked top 30 by four distinct stakeholder groups were marked with **.
- Based on the results of fuzzy set analysis, indicators that have an integrated degree of membership greater than 0.6 were marked with #.

The framework and KPIs can help benchmark the maturity of the MiC supply chain and support Hong Kong industry's and community's decision making of MiC supply chain selection and evaluation for optimal performance. The MiC supply chain measurement framework and KPIs are elaborated as follows:

Process level KPIs included “*manufacturability of module design*”, “*production process stability*”, and “*just-in-time fulfillment*”, highlighting module design, production, and logistics as key processes.

- “**Manufacturability of module design**” refers to the performance of design in reducing the complexity of manufacturing operations and total production costs, which could be scored by relevant professional engineers.
- “**Production process stability**” is used to interpret state changes in module manufacturing systems (Yang et al. 2022). This KPI is measured by the percentage of effective production time (excluding time spent in re-production and stagnation) to total production time.
- “**Just-in-time fulfillment**” refers to providing the correct type of modules or components in right quantities and quality when needed. It is suggested to measure the number of delivery batches accomplished within a specified timeframe.

Project level KPIs were identified as “*time variance*”, “*stakeholder satisfaction*”, and “*community satisfaction*”. All three KPIs met the criterion of scale ranking, and “stakeholder satisfaction” also reached the threshold set for fuzzy set analysis.

- “**Time variance**” is measured by the percentage of the difference between the planned and actual MiC project delivery (from MiC design to module installation) to the planned timeframe, reflecting supply chain reliability.
- “**Stakeholder satisfaction**” refers to the level of contentment experienced by project teams with the overall project delivery, which can be assessed through interviews to reflect the overall satisfaction, such as profitability, productivity, and efficiency (Zhang et al., 2022).
- “**Community satisfaction**” measures how satisfied local communities are with the impact of MiC project deliveries on neighbourhood residents and their surroundings (e.g. traffic) (Pan and Zhang 2023).

Organisation level KPIs were “*MiC experience of supply group*”, “*assurance of supply*”, “*efficiency of the approval procedures*” and “*efficiency of communication and collaboration*”. The first three met both criteria for KPI selection, and the last received unanimous endorsements from all four groups.

- “**MiC experience of supply group**” reflects the experience level of the supply group. Companies with MiC experience tend to process a deep understanding of risk mitigation and resource allocation during operations, which can help them gain more project opportunities and bring higher confidence to clients and developers (O’Connor et al. 2014).
- “**Assurance of supply**” is the priority and essence of an organisation’s operations (Issar and Navon 2016). This KPI provides a comprehensive picture of the supply group’s capability in terms of physical facility (e.g., factory areas, production lines) and management level (e.g., financial management, human resource management) to guarantee module delivery.
- “**Efficiency of approval procedures**” refers to the regulation group’s capability of efficiently implementing approval procedures (Choi et al., 2019). This KPI is influenced by various factors, such as the number of and the knowledge level of government officers involved in MiC approvals, the extent of e-platform application, and government intradepartmental collaboration.
- “**Efficiency of communication and collaboration**” refers to the collaboration effectiveness among client-contractor and contractor’s network and the information accessibility by stakeholders.

Industry level KPIs included “*demand increase*”, “*supply capacity*”, “*end-user acceptance*”, “*incentive effectiveness*”, and “*regulatory flexibility of design*”.

- “**Demand increase**” reflects the importance of “demand pull” in innovation diffusion, expressed as a yearly increase in the quantity of modules required. It can be used to monitor demand patterns and help stakeholders proactively respond to market dynamics.
- “**Supply capacity**” measures the growth rate of module production capacity of all the MiC manufacturers in the GBA, reflecting the overall MiC market condition and its growth.
- “**End-user acceptance**” reflects the degree of improvement in end-users’ attitudes toward MiC. Changing people’s perceptions of MiC is a fundamental strategy to increase the MiC adoption of, and commitment is required from the entire supply chain.
- “**Incentive effectiveness**” measures how incentives achieved their intended objectives of MiC supply chain enhancement (Xu et al., 2020). This KPI aids the government in setting realistic policy expectations and formulating suitable policy instruments for different MiC development stages, facilitating a more efficient use of the financial resources.
- “**Regulatory flexibility of design**” measures the flexibility of the statutory requirements for design work, which is decisive in maximising MiC advantages. It is a qualitative KPI that needs to be evaluated using interviews or scale-based questionnaire.

4.4 Summary

This study systematically explored the performance measurement of MiC supply chain from a multi-level dialectical systems perspective. The research combined a literature review, focus group meetings and interviews, a questionnaire survey, and a research workshop. A total of 15 KPIs for measuring MiC supply chain performance were highlighted out of 63 initially identified indicators from process, project, organisation, and industry levels through scale ranking and fuzzy set analysis.

- At Process level, “manufacturability of module design”, “production process stability”, and “just-in-time fulfillment” were identified KPIs, signifying key procedures (i.e. detailed design, module production, and logistics and customs clearance) necessitate rigorous process control.
- At Project level, KPIs covered “time variance”, “stakeholder satisfaction”, and “community satisfaction”, underscoring the focus of supply chain management on schedule performance and satisfaction achievement.
- At Organisation level, “MiC experience of supply group”, “assurance of supply”, “efficiency of approval procedures”, and “efficiency of stakeholder communication and collaboration” were selected, highlighting the role of supply and regulation groups and cross-disciplinary collaboration.
- At Industry level, KPIs included “demand increase”, “supply capacity”, “end-user acceptance”, “incentive effectiveness”, and “regulatory flexibility of design”, emphasising the significance of business and regulatory environment readiness.

The multi-level measurement framework with KPIs demonstrates the complexities of MiC supply chains and highlights the importance of comprehensive efforts in process control, project goal achievement, stakeholder capability building and collaboration, and supporting environmental improvement for MiC supply chains to mature.

5. Results and Analyses of Work Package 3

Blending various research methods mentioned in Section 2.3, we conducted MiC module demand, supply, and supply-demand analysis, covering influencing factors (organised as critical considerations), demand and supply estimation (including a series of scenarios of MiC adoption), and supply-demand prediction (reflecting the complex and dynamic relationships between demand and supply).

The scope is confined to clients' demand for modules for residential and non-residential buildings and the supply of concrete and steel modules by MiC suppliers in the GBA, as shown in **Figure 5-1**.

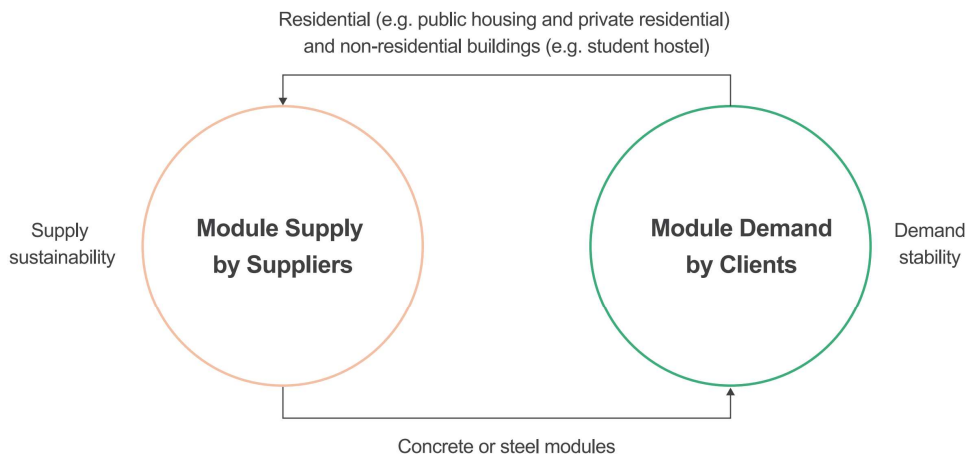


Figure 5-1 Scope of MiC demand, supply, and supply-demand analysis

5.1 MiC Module Demand Analysis

A three-fold framework was designed through a comprehensive review of literature and documents, such as various government official documents and online materials, and interviews with industry stakeholders, such as the Housing Authority (HA), Hong Kong Housing Society (HKHS), ArchSD, and several representative private developers, to disclose the combined effect of technical, political, and organisational factors on the demand for MiC modules (see **Figure 5-2**).

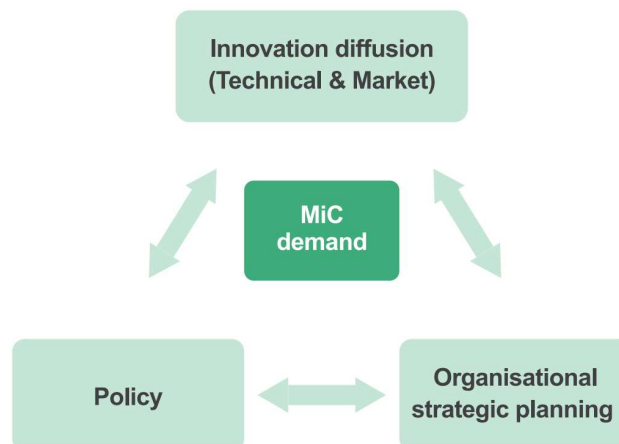


Figure 5-2 Framework of critical considerations of MiC module demand analysis

The influencing factors are multifaceted (Zhang et al. 2024). From technical and market perspectives, MiC is an innovative construction approach, and its adoption trajectory is expected to follow the typical evolutionary patterns from introduction to maturity (Porter 1980). Currently, MiC development in Hong Kong is mainly driven by policy initiatives, exemplified by the Chief Executive's 2022 Policy Address regarding the adoption rate of MiC in new public housing developments (CE 2022). In response to strong government support for MiC, relevant organisations are expected to adjust their practices, shifting from conventional construction to MiC, which will affect the future demand for MiC.

5.1.1 MiC Demand in Hong Kong

The MiC module demand analysis mainly focused on estimating the module demand across building sectors in Hong Kong. MiC adoption rate and the number of modules required for each sector were considered to derive the projections of future MiC module demand in Hong Kong.

a. Public housing

The demand for MiC modules in public housing developments was estimated using the following formula.

$$\begin{aligned} &\text{Number of modules required for public housing} \\ &= \sum \text{Public housing flats} \times \text{Percentage of public housing types} \\ &\quad \times \text{MiC adoption rate} \times \text{Flat modularisation ratio} \end{aligned}$$

The number of public housing flats (see **Figure 5-3**) was sourced from the annual report of the Long Term Housing Strategy and Public Housing Production Forecast (HB 2022). Percentages of public housing types were estimated using the distribution of public housing units of Types A, B, C, D, and E over the years, which can be found in The Hong Kong Annual Digest of Statistics (C&SD 2023). Flat modularisation ratios were assumed as Type A = 2, Type B = 3, Type C = 3, Type D = 4, and Type E = 4 based on suggestions from MiC professionals for the module segmentation of different types of public housing. It is noted that Types A to D are the prevailing types of public housing developments (CIC 2021).

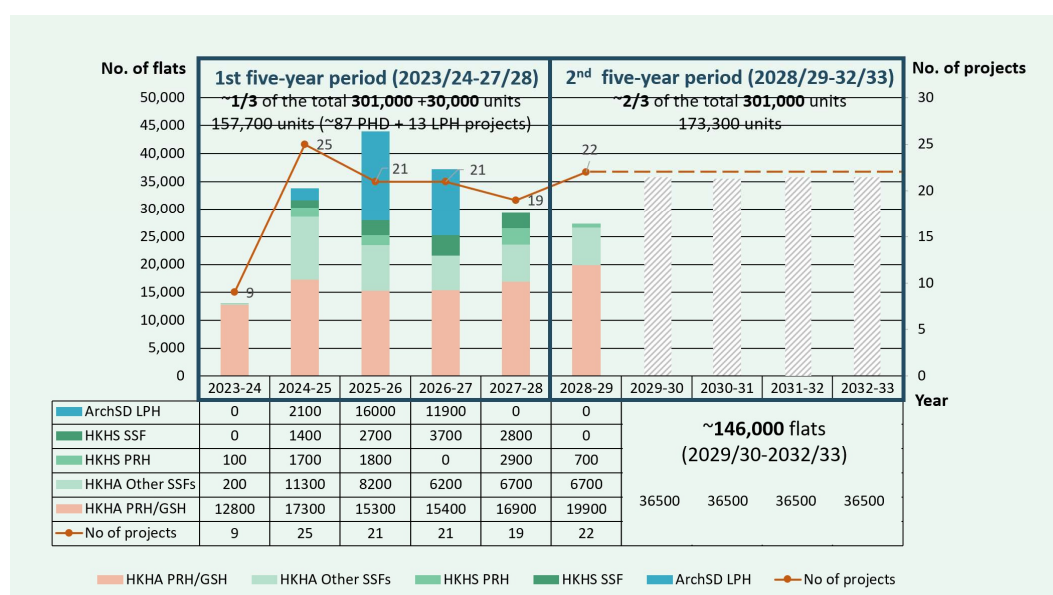


Figure 5-3 Yearly distribution of public housing completions

The scenarios of MiC adoption (see **Figure 5-4**) were derived based on technical & market, policy, and organisational considerations, especially the CE’s 2022 PA (CE 2022). Scenario 1 is the baseline and assumes that an average adoption rate of 50% is achieved in the second five-year period (i.e. 2028/29-2032/33). This approximately aligns with the HA’s 50% MiC adoption goal outlined in the CE’s 2022 PA. Scenario 2 is the intermediate scenario, envisioning a more optimistic trajectory and assuming an annual adoption rate starting at 50% in 2028/29 and peaking at 75% by the period’s end. Scenario 3 is the most aggressive scenario and assumes an adoption rate of 50% in 2025/26.



Figure 5-4 Scenarios of MiC adoption in public housing developments

Figure 5-5 presents the estimated MiC demand in public housing developments in Hong Kong, encompassing public housing projects of the HA and HKHS and light public housing projects of ArchSD. Among the three scenarios, Scenario 2 is believed to be the most plausible. Under this scenario, the annual module demand remains at 45,000 modules in the first five-year period and reaches 90,000 modules in the second five-year period.

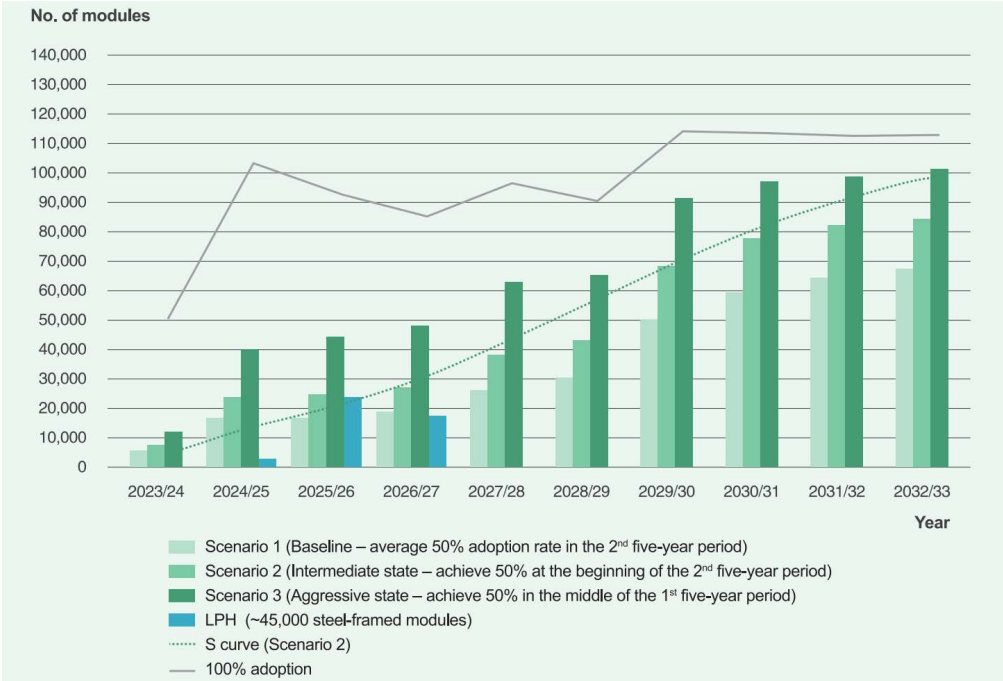


Figure 5-5 Estimated MiC demand in public housing developments in HK (2023/24-32/33)

b. Private residential

The demand for MiC modules in private residential was estimated using the following formula.

Number of modules required for private residential

$$= \sum \text{Private residential flats} \times \text{Percentage of private residential types} \\ \times \text{MiC adoption rate} \times \text{Flat modularisation ratio}$$

The number of private residential flats (see **Figure 5-6**) was estimated based on the CE's 2023 PA (CE 2023), Long Term Housing Strategy (HB 2022), and 2024-2025 Budget (FS 2023). Percentages of private residential types were estimated based on the distribution of private residential flats of Class A, B, C, D, and E over the years, which can be found in The Hong Kong Annual Digest of Statistics (C&SD 2023). Flat modularisation ratios were assumed as Class A = 2, Class B = 4, Class C = 6, Class D = 8, and Class E = 12 based on suggestions from MiC professionals on module segmentation of Classes A and B and area conversion for Classes C to E. It is noted that Classes A to C are the prevailing types of private residential (CIC 2021).

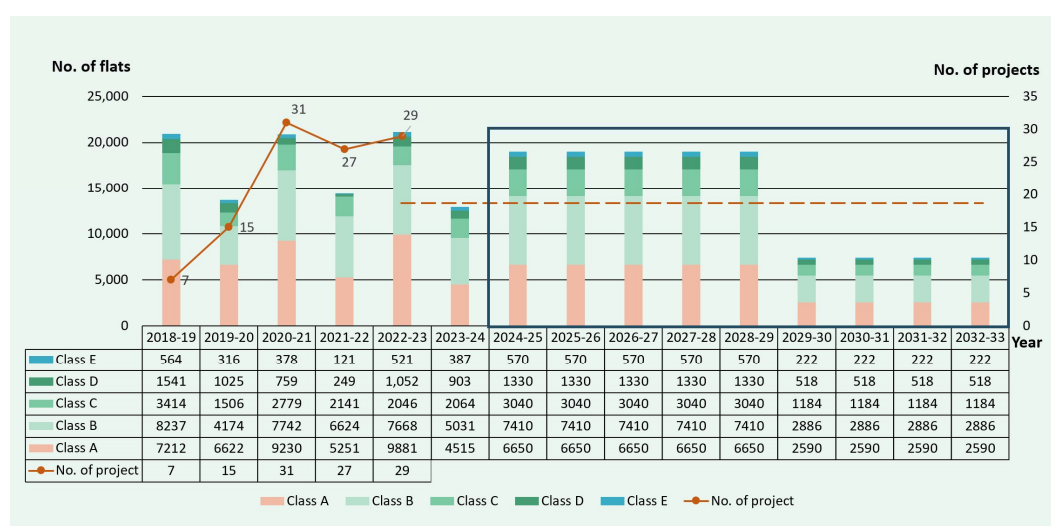


Figure 5-6 Yearly distribution of private residential completions

The scenarios of MiC adoption (see **Figure 5-7**) were derived based on technical & market, policy, and organisational considerations, especially the innovation diffusion theory (Porter 1980). Scenario 1 is the baseline and assumes an average adoption rate of 16% in 2032/33, whereas Scenarios 2 and 3 are the intermediate and aggressive scenarios and assume MiC adoption rates of 33% and 50%, respectively.

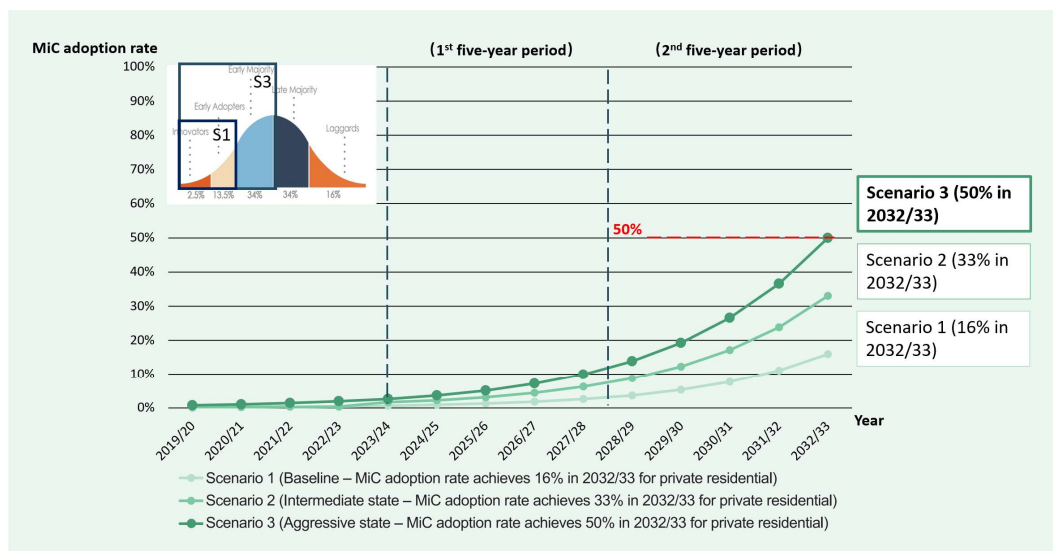


Figure 5-7 Scenarios of MiC adoption in private residential

Figure 5-8 presents the projected demand for MiC modules in private residential in Hong Kong. Given the delayed adoption of MiC in private residential relative to public housing developments, Scenario 3 is believed to be the most possible trend of development. As such, the annual module demand in private residential reaches 8,000 modules in 2027/28 and peaks at 45,000 modules in 2032/33.

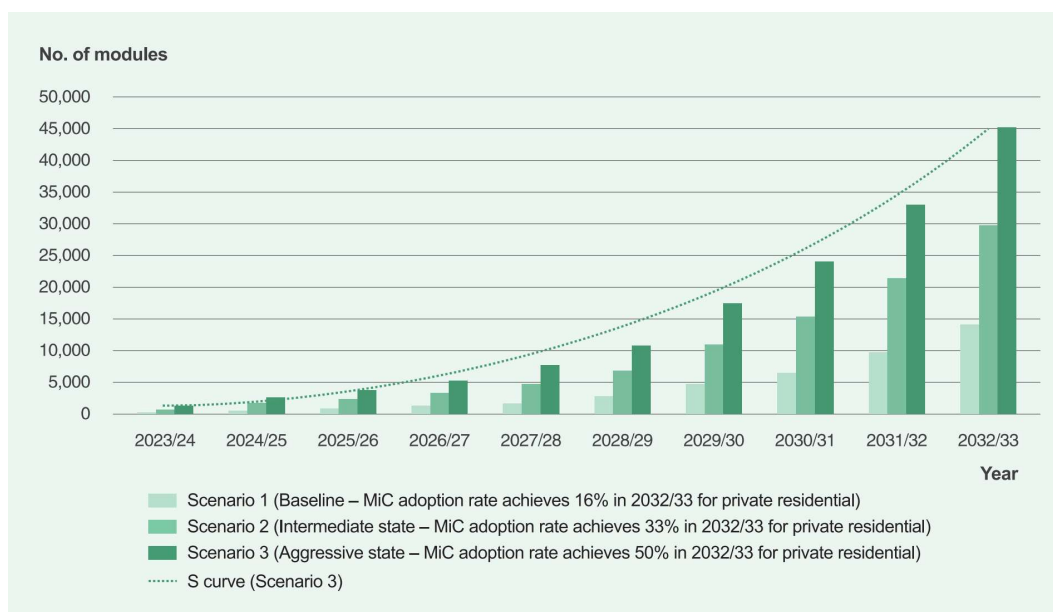


Figure 5-8 Estimated MiC demand in private residential buildings in Hong Kong (2023/24-2032/33)

c. Other types of development

A similar approach was applied to the analysis of MiC demand in other building sectors. **Figure 5-9** presents the final results for covering hotels, hostels, staff quarters, hospitals, and schools.

Hotels:

The total demand for hotel rooms was estimated using historical data on the annual completion of rooms from The *Hong Kong Annual Digest of Statistics*, whereas the MiC adoption rate

followed trends of private residential. The annual room demand remains at 10,000 rooms in the first five-year period and reaches 11,000 rooms in the second five-year period. As such, the predicted MiC demand in hotels is approximately 100 modules annually during the first five-year period and approximately 600 modules annually during the second five-year period.

Hostels:
The number of hostel places to be completed over the next decade was taken from the Hostel Development Fund for universities funded by the University Grants Council (UGC) and the Youth Hostel Scheme (YHS) (CE 2017). The projected demand is an average of 1,400 modules annually from 2023/24, assuming 10 of the total 24 hostel projects adopt MiC.

Staff quarters:
Interviews with ArchSD revealed that the development of staff quarters is contingent on public works priorities and may fluctuate accordingly. Therefore, based on previous practice and the existing development plan, the predicted MiC demand is approximately 1,600 modules annually in the first five-year period and approximately 3,000 modules annually in the second five-year period.

Hospitals:
The two latest *Ten-year Hospital Development Plans* in Hong Kong set out by the Hospital Authority indicated that a total of 6543 beds will be delivered by 2027/28 and approximately 4600 more will be delivered by 2032/33. Given a MiC adoption rate of 50%, the predicted MiC demand is approximately 1,000 modules annually during the first five-year period and approximately 700 modules annually during the second five-year period.

Schools:
Interviews with ArchSD indicated that there are 15 schools under construction or in planning. As all the school projects will adopt MiC, the annual MiC demand is expected to be 300 modules on average in the first five-year period and 200 modules in the second five-year period.

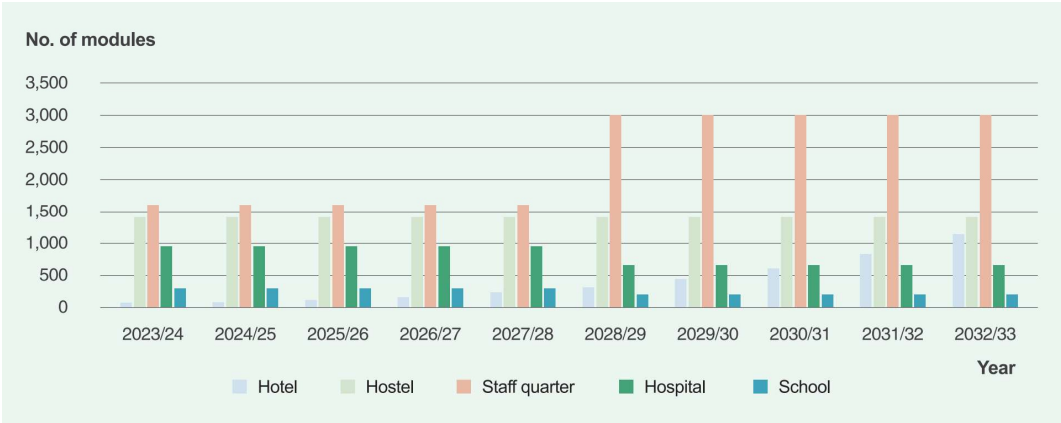


Figure 5-9 Estimated MiC demand in other types of development in Hong Kong

5.1.2 MiC Demand in Other GBA Cities

The MiC module demand analysis also addressed the module demand in other GBA cities. Among these cities, Shenzhen and Guangzhou have taken the lead role in adopting MiC and have explicitly issued policy initiatives to promote MiC. The *Three-Year Action Plan (2024-2026) to Promote the Development of Modern Engineering Services in Shenzhen* states that the total area of modular construction in Shenzhen should be no less than 2,000,000 m² by 2026

(SZMGO 2024). The *Five-Year Action Plan (2024-2028) to Accelerate New Construction Industrialisation in Guangzhou* states that the total area of modular construction should be no less than 100,000 m² in 2024 and should increase by 300,000 m² per year (GZMHUDB 2024). Moreover, starting from 2028, the annual land supply for modular construction in Guangzhou should be no less than 30%, and the adoption rate of modular construction in new urban renewal projects and affordable housing should be no less than 30%.

Based on these two documents, **Table 5-1** gives the MiC demand in Shenzhen and Guangzhou estimated by the area of modular construction. As the residential land for sale in Guangzhou is approximately 6,000,000 m² in 2024, the area of modular construction in 2028 is predicted to be 1,800,000 m² considering a 30% adoption rate. **Table 5-2** gives the MiC demand in Shenzhen and Guangzhou estimated by the number of modules, assuming that each module is 20 m².

Table 5-1 Estimated MiC demand in Shenzhen and Guangzhou by the GFA of modular construction (m²)

Year	2024	2025	2026	2027	2028
Shenzhen	660,000	660,000	660,000	1,000,000	1,000,000
Guangzhou	100,000	400,000	700,000	1,000,000	1,800,000

Table 5-2 Estimated MiC demand in Shenzhen and Guangzhou by the number of modules

Year	2024	2025	2026	2027	2028
Shenzhen	33,000	33,000	33,000	50,000	50,000
Guangzhou	5,000	20,000	35,000	50,000	90,000

5.2 MiC Module Supply Analysis

A three-fold framework was developed through a comprehensive literature and document review, expert consultation, and validation via a questionnaire survey (see **Figure 5-10**). The proposed framework will serve to understand the MiC module supply from economic, technical, and political perspectives in terms of market demand, manufacturing capacity and capability, and the policy and regulatory environment.

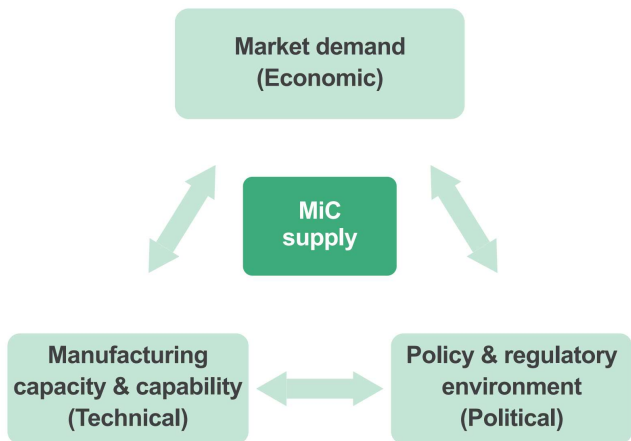


Figure 5-10 Framework of critical considerations of MiC supply analysis

From the economic perspective, market demand is perceived as the most important factor affecting MiC supply. For MiC to succeed and remain sustainable, it could begin under government leadership but should gradually shift towards a market-driven model. Progressively improving government incentives, building codes and standards, and regulatory procedures,

also affects the adoption and implementation of MiC. From the technical perspective, manufacturing capacities and capabilities, such as production facilities, workforce skills, production scalability, and technology capabilities, directly determine the volume and quality of module supply as well as the ability to respond swiftly and adapt to market demand.

5.2.1 Categories of MiC Suppliers

In this research, ‘MiC module supplier’ refers to companies with competencies in designing and manufacturing MiC building modules. **Figure 5-11** presents the identification and categorisation of MiC module suppliers.

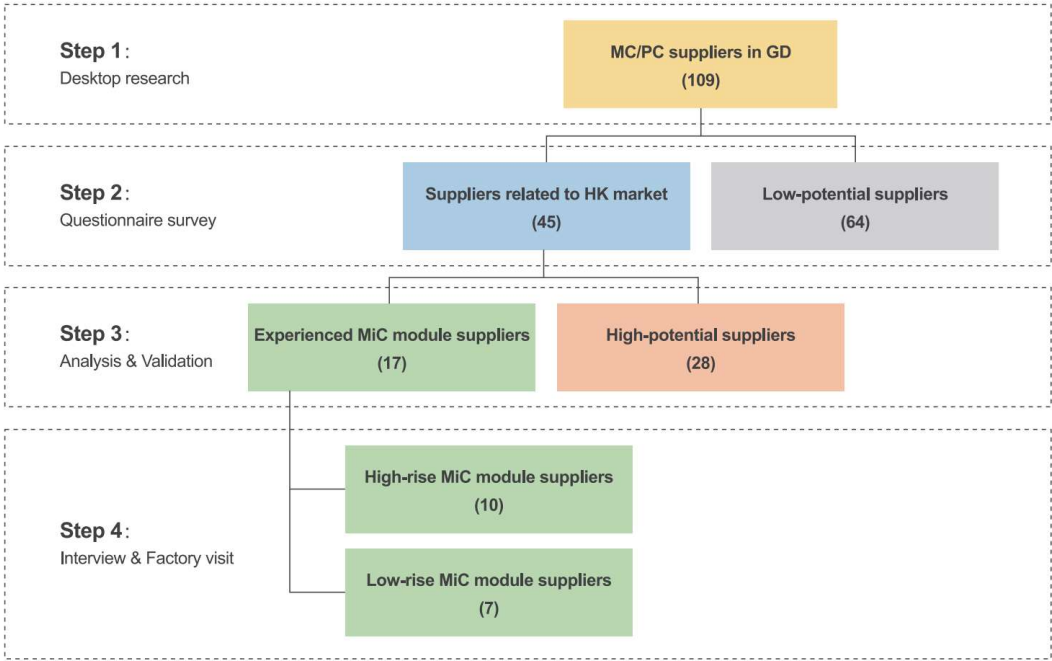


Figure 5-11 Identification and categorisation of MiC module suppliers

As of April 2024, a supplier database of 109 off-site construction (i.e. MiC and PC) suppliers in Guangdong who serve the GBA market has been created, with reference to information available from sources in the public domain (e.g. the BD’s list of pre-accepted MiC systems, websites of industry institutions and suppliers, and MiC-related conferences). Among these suppliers, 45 were identified as relevant to the Hong Kong market (see Appendix VI for the detailed list), and the remaining suppliers were classified as low-potential suppliers, i.e. PC suppliers primarily focusing on the Guangdong market. The 45 suppliers relevant to the Hong Kong market were further categorised into ‘experienced MiC module suppliers’ and ‘high-potential suppliers’ according to their capabilities. ‘Experienced MiC module suppliers’ are suppliers who have high-rise or low-rise MiC project experience in Hong Kong. They include 10 high-rise MiC module suppliers and 7 low-rise MiC module suppliers. ‘High-potential suppliers’ are 28 PC suppliers included in the government department’s supplier list for the Hong Kong market and suppliers involved in Hong Kong’s pre-acceptance list (i.e. In-Principle Acceptance - IPA).

Moreover, the 109 PC/MiC module suppliers can be classified according to the major types of MiC systems they produce (see **Table 5-3**). It is noteworthy that there are more experienced steel MiC module suppliers than experienced concrete MiC module suppliers. However, among the potential suppliers, the majority can produce concrete products.

Table 5-3 Number of MiC module suppliers of various categories (as of Apr 2024)

Category	A	B	C	D
	High-rise MiC module suppliers	Low-rise MiC module suppliers	High-potential suppliers	Low-potential suppliers
Concrete MiC	4	3	13	58
Steel MiC	6	4	15	6

5.2.2 MiC Module Supply in the GBA

Considering the capability and readiness of the suppliers, ‘experienced MiC module suppliers’ (A and B) and ‘high-potential suppliers’ (C) are the main forces driving the supply of MiC modules in the Hong Kong market. Therefore, the module supply capacity was estimated across three categories.

Category A:

The capacity of ‘high-rise MiC module suppliers’ (A) is the existing capacity (A1) and expanded capacity (A2) of suppliers with high-rise MiC job references in Hong Kong.

Category B:

The capacity of ‘low-rise MiC module suppliers’ (B) is the existing capacity of suppliers with low-rise MiC job references in Hong Kong.

Category C:

The capacity of ‘high-potential suppliers’ (C) is the existing capacity of suppliers who have been granted IPAs and suppliers of precast concrete for the Hong Kong market.

Supply capacity data were initially collected through factory visits, interviews, and questionnaire surveys, targeting the production capacity of suppliers in the GBA. These data were supplemented with information obtained from publicly available sources, such as supplier websites and MiC-related conferences. To ensure accuracy, the data were validated through a follow-up questionnaire survey and in-depth discussions held during FGMs.

The concrete MiC module supply presented in **Table 5-4** illustrates the existing and potential supply capacities of concrete modules in terms of the number of modules per year. It is seen that the combined supply capacity of high-rise concrete MiC module suppliers (A1+A2) ranges from 55,000 to 65,000 modules per year, whereas the total supply capacity of experienced concrete MiC module suppliers (A1+A2+B) is estimated to be between 85,000 and 100,000 modules per year. With the inclusion of the capacity of high-potential suppliers (C), the overall supply capacity is projected to increase to a range of 155,000 to 175,000 modules per year.

Table 5-4 Concrete MiC module supply capacity (as of Apr 2024)

Capacity of concrete MiC suppliers	Modules/year
Existing capacity of high-rise MiC module suppliers (A1)	35,000~40,000
Expanded capacity of high-rise MiC module suppliers (A2)	20,000~25,000
Subtotal (A1+A2)	55,000~65,000
Existing capacity of low-rise MiC module supplier (B)	30,000~35,000
Subtotal (A1+A2+B)	85,000~100,000
Existing capacity of high-potential suppliers (C)	70,000~75,000
Total (A1+A2+B+C)	155,000~175,000

Likewise, an analysis of the steel MiC module supply capacity is presented in **Table 5-5**. It is seen that the total supply capacity of high-rise steel MiC module suppliers (A1+A2) is

approximately 115,000 to 125,000 modules per year, and the total supply capacity of experienced steel MiC module suppliers (A1+A2+B) ranges from 180,000 to 195,000 modules per year. Factoring in the capacity of high-potential steel suppliers (C), the overall capacity reaches between 230,000 and 250,000 modules per year.

Table 5-5 Steel MiC module supply capacity (as of Apr 2024)

Capacity of steel MiC suppliers	Modules/year
Existing capacity of high-rise MiC module suppliers (A1)	80,000~85,000
Expanded capacity of high-rise MiC module suppliers (A2)	35,000~40,000
Subtotal (A1+A2)	115,000~125,000
Existing capacity of low-rise MiC module supplier (B)	65,000~70,000
Subtotal (A1+A2+B)	180,000~195,000
Existing capacity of high-potential suppliers (C)	50,000~55,000
Total (A1+A2+B+C)	230,000~250,000

5.3 MiC Module Supply-Demand Analysis

In MiC module supply-demand analysis, capacity utilisation (CU) is a pivotal metric used to evaluate the supply chain's ability to effectively meet market demand. CU is defined as the percentage of production capabilities that are being utilised at a given time to satisfy the market demand for a product (e.g. MiC modules). In a pull-based supply chain, CU can be used to estimate the optimal supply required when the demand for MiC modules is determined.

Determining the optimal CU requires evidence from multiple sources. First, two-thirds of the key MiC suppliers that participated in the survey indicated that factories break even when CU is between 50% and 70%, whereas some others believed the CU needs to be more than 70% to achieve the breakeven point. The existing literature suggests that an optimal range of CU is 79% to 83% for heavy industries, such as construction (Han et al. 2011). As MiC projects implement a just-in-time practice, there is a need for a greater buffer capacity to bolster production resilience. Therefore, the ideal range of CU is set at 60% (i.e. breakeven achievable) to 80% (i.e. satisfactory profit margins achievable) to estimate the production capacity required for the MiC demand. When CU falls below 60%, the MiC market experiences oversupply and intensified competition. Conversely, when CU exceeds 80%, the market faces undersupply, potentially leading to higher costs, unfulfilled orders, and delivery delays.

5.3.1 Concrete MiC Supply-Demand Analysis for Hong Kong Development

Figure 5-12 presents the concrete MiC supply-demand analysis for Hong Kong development. The annual demand for concrete MiC modules in Hong Kong spanning from 2023/24 to 2032/33 was calculated by consolidating the sectorial demand for concrete modules in public housing, private residential, and other types of development. It was assumed that all the housing projects adopt concrete MiC, whereas half of the other building types utilise concrete MiC, with the remaining half opting for steel MiC. To accommodate the project demand, the upper (i.e. 80%) and lower (i.e. 60%) of the ideal CU range were used to derive the range of required supply capacity. The intermediate blue area in the figure indicates moderate capacity, where both the clients and suppliers make reasonable profits. The green area represents overcapacity, whereas the yellow area indicates undercapacity. When production capacity falls into the yellow zone, there is a shortfall in capacity and thus an immediate need to increase capacity.

Compared with the capacity of concrete MiC suppliers illustrated in **Table 5-4**, it is estimated

that Capacity A (i.e. the existing and expanded capacity of suppliers with high-rise concrete MiC job references) cannot maintain a moderate supply to meet the short-term concrete MiC demand by 2025/26. Therefore, low-rise MiC suppliers are expected to become involved in high-rise MiC projects, and clients are encouraged to consider using steel MiC to alleviate the burden on concrete MiC suppliers. The combined capacity (A+B) (i.e. the total supply capacity of concrete modules of suppliers with MiC job references) is unable to maintain a moderate supply to meet the medium-term concrete MiC demand by 2027/28. Facing this shortage, the existing precast suppliers for the Hong Kong market are encouraged to upgrade to MiC suppliers within five years, by 2027/28. The combined capacity (A+B+C) (i.e. the capacity of high-potential suppliers is considered) may fail to maintain a moderate supply to meet the long-term concrete MiC demand by 2030/31. More precast suppliers in Guangdong are encouraged to enter the market in the second five-year period by 2030/31.

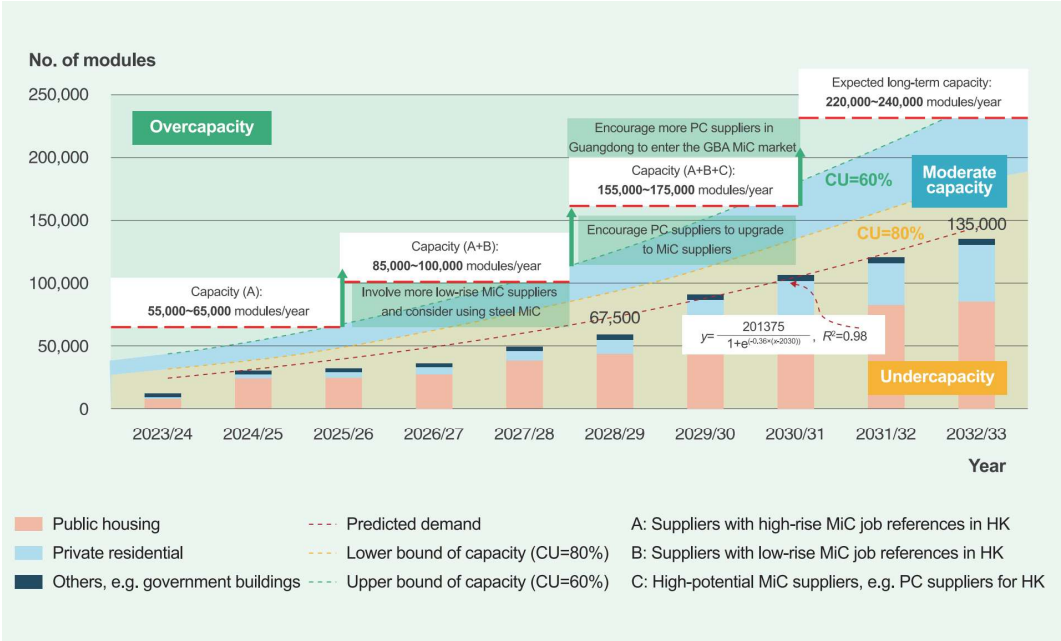


Figure 5-12 Concrete MiC supply-demand analysis for Hong Kong development

5.3.2 Steel MiC Supply-Demand Analysis for Hong Kong Development

Figure 5-13 presents the supply-demand analysis for steel MiC modules in Hong Kong development. The demand for steel MiC modules predominantly comes from light public housing projects, which rely entirely on steel MiC, along with other building projects, for which 50% of the modules are steel MiC modules. As shown in **Table 5-5**, capacity (A) (i.e. the existing capacity of steel MiC suppliers) is sufficient to address the current and future demands of steel MiC in the overall industry of steel modules in Hong Kong.

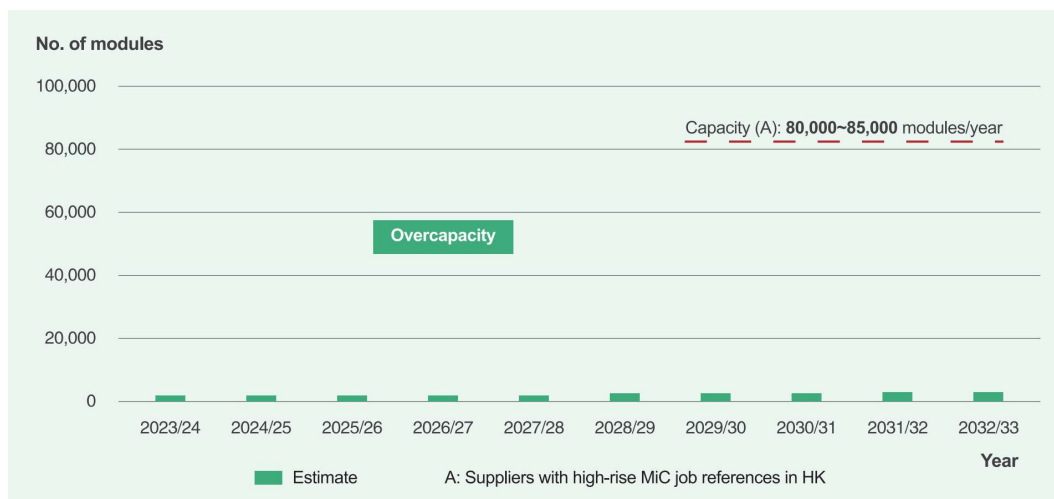


Figure 5-13 Steel MiC supply-demand analysis for Hong Kong development

5.3.3 MiC Supply-Demand Analysis for Other Cities in the GBA

Figure 5-14 presents the MiC supply-demand analysis for Shenzhen and Guangzhou, two key cities in the GBA. The analysis assumes that (1) the MiC demand in both cities consists entirely of concrete modules for residential developments and (2) the supply capacity of Guangdong PC suppliers is geared exclusively towards the MiC demand of other GBA cities, such as Shenzhen and Guangzhou. Based on these assumptions, the demand for concrete MiC modules in Shenzhen and Guangzhou grows from 38,000 to 140,000 modules/year between 2023 and 2028. The analysis reveals that the combined production capacity (categories A, B, and C) of MiC suppliers in the GBA cannot meet the demand in Shenzhen and Guangzhou by 2027/28. Therefore, Guangdong's prefabricated suppliers are expected to prepare for the Guangdong MiC market by 2026/27.

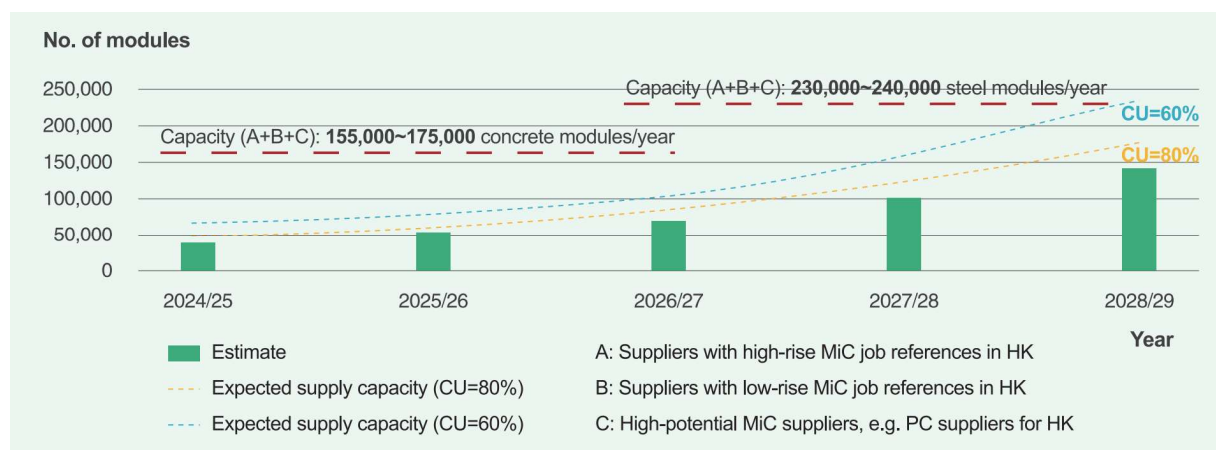


Figure 5-14 MiC supply-demand analysis for other cities in the GBA

5.4 Summary

The section demonstrates the status quo and projection of MiC module demand and supply in Hong Kong and other GBA cities, as well as the dynamic demand-supply analysis for MiC module in the GBA for Hong Kong development. Extensive data collection via multiple channels, such as public domains, questionnaire surveys, interviews, and focus group meetings with various stakeholders was conducted and critical considerations, including technical, economic, political, and organisational strategy, were employed to predict the demand for and supply of MiC modules in various building sectors (i.e. public housing, private residential, and other types of development) in the next decades. Based on this, the concept of CU was introduced to disclose how to sustain a moderate capacity for the demand-supply relationships of concrete and steel modules in Hong Kong and other cities in the GBA. The key findings of this section are summarised below.

MiC Demand

- (1) The presented research estimated MiC module demand in **various building sectors**, including public housing, light public housing, private residential, hotels, student hostels, staff quarters, hospitals, and schools. This estimation covered three timeframes: **3-year (by 2025/26), 5-year (by 2027/28), and 10-year (by 2032/33)**, starting from the baseline year of 2023/24. Taking into account technology, market dynamics, policy, and organisational considerations, three scenarios – **baseline, intermediate, and aggressive** – were proposed, indicating the lower, most possible, and upper bound of MiC demand, respectively.
- (2) In the most likely scenario, the **overall concrete MiC module demand** in Hong Kong was estimated to reach approximately 40,000 modules in 2025/26, approximately 60,000 modules in 2027/28, and approximately 135,000 modules in 2032/33. The **overall steel MiC module demand** was estimated to reach approximately 2,000 modules in 2025/26, approximately 2,200 modules in 2027/28, and approximately 3,200 modules in 2032/33.
- (3) In Hong Kong, **public housing** is the main driver of the demand for MiC modules, accounting for approximately **60%–75%** of the total demand. In comparison with the 50% MiC adoption target for public housing and the mandatory use of MiC in government buildings, the adoption rate in the private sector falls far short, indicating the need for further efforts to stimulate the private sector. However, care should be taken to interpret the demand analysis in the **private sector**, as the demand may rapidly increase should the external context change, e.g. the real estate market.
- (4) Among **other GBA cities**, Shenzhen and Guangzhou lead the adoption of MiC. It is predicted that the demand for MiC modules in these two cities will escalate from 38,000 to 140,000 modules per year between 2023/24 and 2028/29.

MiC Supply

- (1) As of April 2024, the presented research identified **45 MiC suppliers** in Guangdong relevant to the Hong Kong market, including **17 experienced MiC module suppliers** (i.e. suppliers having Hong Kong high-rise/low-rise MiC job references) and **28 high-potential suppliers** (i.e. PC suppliers listed in the government department's supplier list for Hong Kong and those who have been involved in an IPA).
- (2) Regarding **concrete MiC module supply**, there are **four** high-rise concrete MiC module suppliers, three low-rise concrete MiC module suppliers, and **13** high-potential suppliers. The supply capacity of **high-rise concrete module MiC suppliers** ranges from **55,000 to 65,000 modules per year**, whereas the total supply capacity of **experienced concrete MiC module suppliers** (i.e. high-rise and low-rise MiC module suppliers) is estimated to be between **85,000 and 100,000 modules per year**. With the inclusion of the capacity of high-

potential suppliers, the overall supply capacity is projected to increase to a range of 155,000 to 175,000 modules per year.

- (3) In terms of **steel MiC module supply**, there are **six** high-rise steel MiC module suppliers, **five** low-rise steel MiC module suppliers, and 15 high-potential suppliers. The total supply capacity of **high-rise steel MiC module suppliers** is approximately **115,000 to 125,000 modules per year**, and the total supply capacity of **experienced steel MiC module suppliers** ranges from **180,000 to 195,000 modules per year**. Factoring in the capacity of high-potential steel suppliers, the overall capacity for MiC module supply is predicted to reach between 230,000 and 250,000 modules per year.
- (4) The supply capacity of experienced steel MiC module suppliers is **nearly double** that of experienced concrete MiC module suppliers. Similarly, the projected total supply capacity of both experienced and high-potential steel MiC suppliers far surpasses that of concrete MiC suppliers.

MiC Supply–Demand Analysis

- (1) In the MiC supply-demand analysis, the concept of **capacity utilisation (CU)** was introduced to evaluate the supply chain's ability to effectively meet market demand. The ideal range of CU is **60% to 80%**. When CU is below 60% or over 80%, the MiC market experiences overcapacity or undercapacity, respectively.
- (2) Regarding **concrete MiC**, the research suggested that (i) the capacity of MiC suppliers (category A) cannot maintain a moderate supply to meet the market demand for concrete MiC modules by **2025/26**, necessitating the engagement of suppliers with low-rise MiC job references; (ii) the capacity of MiC suppliers (categories A and B) will be inadequate to effectively fulfil the demand for concrete MiC modules by **2027/28**, urging the transition of current precast suppliers to MiC suppliers; and (iii) the capacity of MiC suppliers (categories A, B, and C) will reach its limits in meeting the concrete MiC demand by **2030/31**, requiring additional PC suppliers in Guangdong to enter the Hong Kong market.
- (3) Regarding **steel MiC**, the capacity of MiC suppliers (category A) is considered adequate to cater to both the present and future demand for steel MiC modules in Hong Kong.
- (4) The **overall supply capacity** of both existing and potential MiC suppliers is insufficient to meet the demand for concrete MiC modules for the GBA by 2027/28. Given this situation, prefabricated suppliers in Guangdong are expected to prepare for entry into the MiC market by 2026/27.
- (5) The demand and supply sides, as well as the Hong Kong and other cities in the GBA, affect each other **dynamically**. The future development of the MiC supply chain may lead to a very promising MiC industry with **professional services** primarily from Hong Kong and **manufacturing capability** largely in the GBA.

6. Results and Analyses of Work Package 4

In Work Package 4, we suggest a policy roadmap with action plans for enhancing the maturity of the MiC supply chain in terms of demand, process, and supply.

6.1 MiC Supply Chain Policy Roadmap

A map of system boundaries (Figure 6-1) was designed to guide the development of a systematic policy roadmap and action plans for the MiC supply chain.

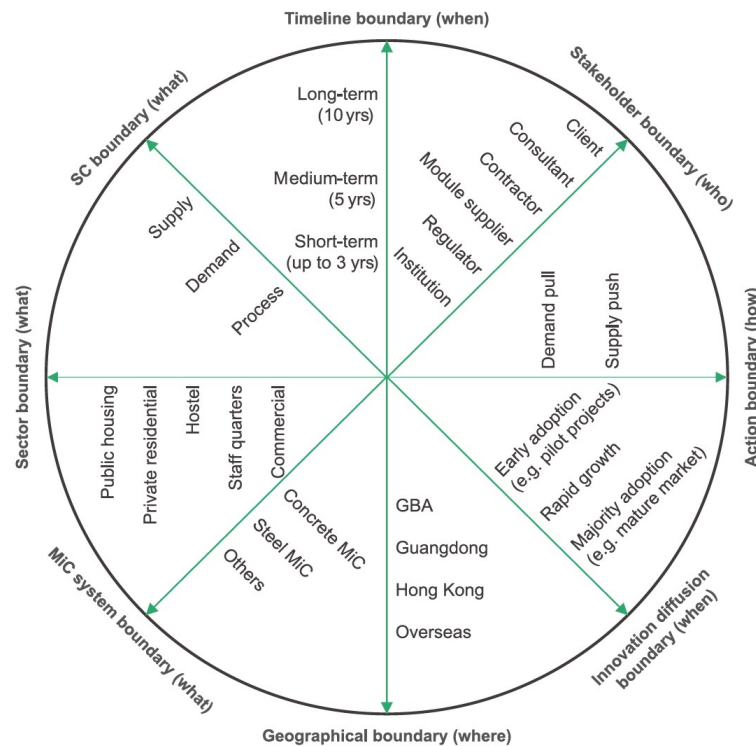


Figure 6-1 System boundaries of MiC supply chain policy roadmap

The system boundaries define key elements of the policy roadmap, addressing the questions of *when*, *where*, *what*, *who*, and *how*:

- **Timeline (*when*):** The public policy roadmap is designed with short-term (up to 3 years), medium-term (5 years), and long-term (10 years) milestones in line with the *Outline Development Plan for the GBA* and the *HKSAR Chief Executive's Policy Address*.
- **Innovation diffusion (*when*):** There is a focus on MiC early adoption, rapid growth, and majority adoption.
- **Geographical (*where*):** There is a focus on the MiC supply chain in the GBA for Hong Kong's development.
- **Aspect (*what*):** There is a focus on enhancing supply quality, process integration, and demand stability.
- **Sector (*what*):** The policy roadmap covers different building sectors in Hong Kong, such as public housing, private residential, student hostels, staff quarters, hospitals, and hotels.
- **MiC system (*what*):** Both concrete and steel MiC are considered.
- **Stakeholder (*who*):** There is engagement with government, industry, and institutions.
- **Action (*how*):** Both demand-pull and supply-push strategies are adopted.

Based on the framework of the MiC supply chain and its system boundaries, the review of global MiC policy by Ji et al. (2024), and the results of MiC supply–demand analysis, an MiC supply chain policy roadmap is proposed. The roadmap focuses on three aspects (i.e. supply, process, and demand) and spans four stages (i.e. stages 0 to 3) (see **Figure 6-2**). The timeline starts with the piloting *Stage 0 – Early MiC adoption (0, 1]*, representing early MiC adoption as of 2023/24. This roadmap encompasses a spectrum of vision and goals for Stages 1 to 3.

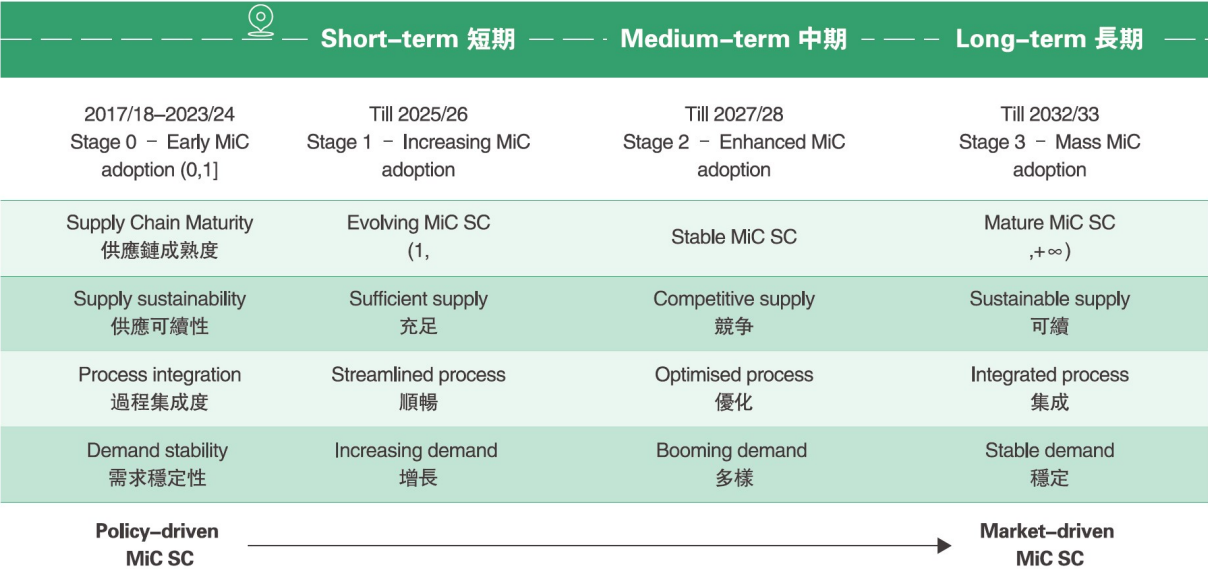


Figure 6-2 Vision and goals of MiC supply chain policy roadmap

The vision of the policy roadmap is to enhance the maturity of the MiC supply chain in the GBA to support the development of Hong Kong by improving supply quality, process integration, and demand stability. The specific goals of the policy roadmap are outlined according to the timeline for supply chain development:

- In the *short term*, the goal is to achieve an evolving MiC supply chain with sufficient supply, streamlined processes, and increasing demand by 2025/26.
- In the *medium term*, the goal is to achieve a stable MiC supply chain with competitive supply, optimised processes, and booming demand by 2027/28.
- In the *long term*, the goal is to achieve a mature MiC supply chain with sustainable supply, integrated processes, and stable demand by 2032/33.

In summary, the policy roadmap is expected to facilitate the development of the MiC supply chain from a policy-oriented approach to a market-driven approach.

6.2 Action Plan for Enhancing MiC Supply Chain Demand Stability

The construction industry has largely resisted adopting new technologies and innovations due to its risk-averse culture. As such, the initial demand for MiC has primarily been driven by policies and dominated by public sector involvement, with very few private projects adopting MiC. Although certain policy initiatives have been established, such as 6%–10% gross floor area (GFA) concessions, target MiC adoption rates in public housing, and the mandatory use of MiC in designated government building projects, the market demand for MiC remains low. Therefore, the action plan for enhancing demand stability takes full account of the needs of MiC in both public and private building sectors. Short-, medium-, and long-term actions are proposed based on the major findings of supply–demand analysis and the policy roadmap (**Figure 6-3**).

Demand Stability 需求穩定性		Short-term 短期 - Medium-term 中期 - Long-term 長期			
		2018–2023 Stage 0–1	Till 2025/26 Stage 1	Till 2027/28 Stage 2	Till 2032/33 Stage 3
Sector 部門/機構		Increasing demand 增長	Booming demand 多樣	Stable demand 穩定	
Public Sector 公營部門	<ul style="list-style-type: none">• Launched pilot projects• Leveraged the government buying power to generate sufficient demand, e.g. all gov. buildings to adopt MiC• Prioritised MiC in public housing developments, e.g. to use more in 1st 5 years; no less than 50% in 2nd 5 years	<ul style="list-style-type: none">• To expand the scope of mandatory use of MiC in government buildings• To prioritise the use of MiC in new development areas	<ul style="list-style-type: none">• To enhance standardisation by continuously designing innovative MiC systems• To promote the use of MiC in various types of projects	<ul style="list-style-type: none">• To develop an MiC rating system to support the decision of MiC adoption in public housing developments• To embrace both steel and concrete MiC considering the types of development• To provide timely supply information	
Private Sector 私營機構	<ul style="list-style-type: none">• Several private projects started using MiC• Provided incentives to stimulate MiC adoption, e.g. 6%-10% GFA concession	<ul style="list-style-type: none">• To raise developer & public awareness of MiC and its benefits using the pilot projects• To consider MiC adoption as land sales requirement	<ul style="list-style-type: none">• To set MiC adoption as a criterion for industry awards• To provide incentives to homebuyers• To trial the use of mature steel or hybrid MiC modular systems	<ul style="list-style-type: none">• To issue flexible incentive policies• To foster end-user engagement of MiC for better customisation	

Figure 6-3 Overall framework of action plan for enhancing demand stability

6.2.1 Short-term Actions for Increasing Demand

Short-term actions to boost MiC demand in both the public and private sectors are listed in Table 6-1.

Table 6-1 Short-term actions for increasing demand

Sector	Action	Leading stakeholder	Supporting stakeholder
Public Sector	To expand the scope of mandatory use of MiC in government buildings	Government	Govt. Departments
	To prioritise the use of MiC in new development areas	Government	Govt. Departments
Private Sector	To raise developer & public awareness of MiC and its benefits using the pilot projects	Government Professional Bodies	Universities and Research Institutes Industry Institutions
	To consider MiC adoption as land sales requirement	Government	Developers

Public Sector: It should be noted that the DEVB has expanded the scope of the mandatory use

of MiC in government buildings as specified in the updated Technical Circular (Works) No. 4/2024 (DEVB 2024b). Furthermore, the government may consider prioritising the use of MiC in new development areas, such as the North Metropolis.

Private Sector: Leveraging pilot projects is important in raising awareness of MiC and its benefits among developers and the public. This initiative should be coordinated by government and professional bodies (e.g. Hong Kong Institution of Architects (HKIA), Hong Kong Institution of Engineers (HKIE)) and supported by universities and research institutes (e.g. HKU MiCLab) and industry institutions (e.g. CIC). In addition, the government may consider the inclusion of MiC adoption as a land sales requirement.

6.2.2 Medium-term Actions for Booming Demand

Medium-term actions aimed at booming demand for MiC are listed in **Table 6-2**.

Table 6-2 Medium-term actions for booming demand			
Sector	Action	Leading stakeholder	Supporting stakeholder
Public Sector	To enhance standardisation by continuously designing innovative MiC systems	Govt. Departments	Professional Bodies Universities and Research Institutes
	To promote the use of MiC in various types of projects	Govt. Departments	Professional Bodies
Private Sector	To set MiC adoption as a criterion for construction industry awards	Government	Industry Institutions
	To provide incentives to homebuyers	Government	Developers
	To trial the use of mature steel or hybrid MiC modular systems	Developers	Professional Bodies Universities and Research Institutes

Public Sector: The main action is to enhance standardisation by continuously designing innovative MiC systems for public housing and staff quarters, such as the MiC-oriented modular flat design (MFD). This initiative should be led by government departments and supported by various professional bodies, universities and research institutes. It should be noted that the DEVB has expanded the building types for mandatory use of MiC in government buildings as specified in the updated Technical Circular (Works) No. 4/2024 (DEVB 2024).

Private Sector: The major actions for increasing the private sector’s willingness to adopt MiC include piloting MiC implementation in various types of buildings to examine suitability, setting MiC adoption as a criterion for industry awards, and providing incentives to homebuyers, such as loan support to purchase MiC flats. All the measures require close collaboration among the government and industry (e.g. developers and supporting institutions). In addition, private developers are encouraged to trial the use of mature steel or hybrid MiC modular systems, with technical support from professional bodies, universities and research institutes.

6.2.3 Long-term Actions for Stable Demand

Long-term actions aimed at establishing a stable market-driven demand for MiC are listed in Table 6-3.

Table 6-3 Long-term actions for stable demand

Sector	Action	Leading stakeholder	Supporting stakeholder
Public Sector	To develop an MiC rating system to support the decision-making of MiC adoption in public housing developments	Govt. Departments	Universities and Research Institutes
	To embrace both steel and concrete MiC considering the types of development	Govt. Departments	Professional Bodies Universities and Research Institutes
	To provide timely supply information	Government	Govt. Departments Industry Institutions Universities and Research Institutes
Private Sector	To issue flexible incentive policies	Government	Govt. Departments Industry Institutions
	To foster end-user engagement of MiC for better customisation	Developers	Industry Institutions Consultants

Public Sector: It is suggested that a MiC rating system with specific criteria be developed to help evaluate MiC applicability and support decision making regarding MiC adoption in public housing developments. In addition, adopting both steel and concrete MiC in public housing developments is critical to fully capitalising on the diverse benefits offered by different structural systems, considering the type of public housing development. Moreover, the government may collaborate with departments and industrial institutions to disseminate the housing supply plan in a timely manner, facilitating the business practices of suppliers. Leading universities and research institutes can provide support for these initiatives.

Private Sector: The government is recommended to consider flexible incentive policies, such as more flexible GFA concessions tailored to MiC design, rather than a uniform incentive (e.g. 10%) across all cases to encourage continuous innovations on MiC. To stabilise demand in the private sector, another approach is to foster end-user engagement for better customisation, which will, in turn, increase the acceptance of MiC.

6.3 Action Plan for Enhancing MiC Supply Chain Process Integration

Various MiC systems, such as MiC 1.0 for public housing development, have been designed, and a series of MiC guidebooks have been issued by the project team to ensure technical feasibility. Performance evaluations of several pilot and representative projects have demonstrated the merits of MiC in Hong Kong and identified opportunities for further improvement in management efficiency. To enhance the ‘process integration’ of MiC project delivery, the action plan focused on improvements to the technology and management practices of the MiC project delivery process. Actions for achieving streamlined, optimised, and integrated processes in short-, medium-, and long terms are recommended (Figure 6-4).

Process Integration 過程集成度		 — Short-term 短期 — Medium-term 中期 — Long-term 長期 —			
		2018–2023 Stage 0–1	Till 2025/26 Stage 1	Till 2027/28 Stage 2	Till 2032/33 Stage 3
Process 過程		Streamlined process 順暢	Optimised process 優化	Integrated process 集成	
Technical Competence 技術實力	<ul style="list-style-type: none">Designed various MiC systems, e.g. MiC 1.0 for public housing developmentIssued MiC guidebooks	<ul style="list-style-type: none">To develop a series of MiC design and construction codes/standardsTo continuously explore innovative MiC systemsTo adopt digital planning and monitoring platform	<ul style="list-style-type: none">To raise research & development (R&D) incentivesTo adopt smart systems for achieving remote QA/QCTo establish flexible production line	<ul style="list-style-type: none">To adopt robotics integrated production and installation technologies for achieving autonomous MiC deliveryTo adopt an integrated digital project delivery through the building lifecycle	
Management Efficiency 管理效率	<ul style="list-style-type: none">Conducted performance measurement and identified opportunities for further improvement	<ul style="list-style-type: none">To continuously monitor the project performance and develop central monitoring platformTo explore novel procurement practicesTo streamline statutory procedures such as custom clearance & cross-boundary QA/QC	<ul style="list-style-type: none">To learn from manufacturing industry for better QA/QCTo establish a cyber-physical MiC logistics management network in the GBATo set up MiC dispatch hub in HK for efficient mass adoption of MiC	<ul style="list-style-type: none">To develop city-level digital twin platform for MiC projects monitoringTo develop e-submission & approval platform for efficient design approval and tendering assessment	

Figure 6-4 Overall framework of action plan for enhancing process integration

6.3.1 Short-term Actions for Streamlined Process

Short-term actions for ensuring a streamlined MiC delivery process are listed in **Table 6-4**.

Table 6-4 Short-term actions for streamlined process

Process	Action	Leading stakeholder	Supporting stakeholder
Technical competence	To develop a series of MiC design and construction codes/standards	BTRi Universities and Research Institutes	Govt. Departments Professional Bodies
	To continuously explore innovative MiC systems	BTRi Universities and Research Institutes	Professional Bodies Suppliers
	To adopt digital planning and monitoring platform	Clients/Developers	Consultants, Contractors Suppliers
Management efficiency	To continuously monitor the MiC project performance and develop central monitoring platform	Government	Govt. Departments Universities and Research Institutes
	To explore novel procurement practices	Clients/Developers	Consultants, Contractors Suppliers
	To streamline statutory procedures such as cross-boundary QA/QC	Government	Govt. Departments Consultants, Contractors

Technical Competence: The newly established Building Technology Research Institute (BTRi) may collaborate with research institutes to develop a series of MiC design and construction codes or standards. This initiative will ensure consistency and quality of MiC projects. Moreover, continuous exploration of innovative, cost-effective, and practical MiC systems for public housing development is recommended. Contributions should come from various project stakeholders, including departments, clients/developers, professional bodies, consultants, contractors, and suppliers, with support from universities and research institutes. In addition, project teams are encouraged to adopt digital planning and monitoring platforms.

Management Efficiency: An important action for improving management efficiency is to continuously monitor the MiC project performance and develop a central monitoring platform. According to handbooks published by HKU (e.g. Pan et al. 2020), the performance measurements of several pilot and representative projects have shown the benefits of MiC in Hong Kong. Continuous monitoring will help identify opportunities for further improvement in management efficiency. In addition, project teams can consider exploring novel procurement practices to enhance design and construction performance by involving the contractor/supplier at an early stage. Moreover, the governments of Guangdong and Hong Kong can collaborate to streamline statutory procedures, such as customs clearance and cross-border quality assurance/quality control (QA/QC), with support from other government departments.

6.3.2 Medium-term Actions for Optimised Process

Medium-term actions for achieving optimised MiC delivery processes are listed in **Table 6-5**.

Table 6-5 Medium-term actions for optimised process

Process	Action	Leading stakeholder	Supporting stakeholder
Technical competence	To raise research & development (R&D) incentives	Government Funding bodies	Industry Institutions Universities and Research Institutes
	To adopt smart systems for achieving remote QA/QC	Govt. Departments Clients/Developers	Contractors Suppliers
	To establish flexible production line	Suppliers	Industry Institutions
Management efficiency	To learn from manufacturing industry for better QA/QC	Govt. Departments	Industry
	To establish a cyber-physical MiC logistics management network in the GBA	Government (HK & GD)	Universities and Research Institutes
	To set up MiC dispatch hub in HK for efficient mass adoption of MiC	Government	Suppliers

Technical Competence: Various funding bodies, such as the Research Grants Council (RGC), Innovation and Technology Bureau (ITB), and CIC, can consider raising R&D incentives regarding MiC technologies, with the support of various universities and research institutes. Based on the statutory procedures streamlined in the short term, government departments can adopt smart systems for remote QA/QC with the collaboration of project teams. In addition, various MiC suppliers can consider establishing flexible production lines at this stage, with support from funding bodies, to optimise the delivery process.

Management Efficiency: Both regulatory parties and project teams should learn from the manufacturing industry about how to improve QA/QC practices. To facilitate an optimised delivery process, a strong collaboration between the governments of Guangdong and Hong Kong is essential for establishing a cyber-physical MiC logistics management network in the GBA. The research outputs from local universities and research institutes (e.g. HKU MiCLab) will play a crucial role in this effort. In addition, it is suggested that the government set up MiC dispatch hubs at suitable positions in Hong Kong for the efficient mass adoption of MiC. This will require support from other government departments and the involvement of various MiC suppliers.

6.3.3 Long-term Actions for Integrated Process

Long-term actions for establishing an integrated MiC delivery process are listed in **Table 6-6**.

Table 6-6 Long-term actions for integrated process

Process	Action	Leading stakeholder	Supporting stakeholder
Technical competence	To adopt robotics integrated production and installation technologies for achieving autonomous MiC delivery	Industry	Universities and Research Institutes Industry Institutions
	To adopt an integrated digital project delivery through the building lifecycle	Industry	Universities and Research Institutes
Management efficiency	To develop city-level digital twin platform for MiC projects monitoring	Government	Govt. Departments Universities and Research Institutes
	To develop e-submission & approval platform for efficient design approval and tendering assessment	Government	Govt. Departments Professional bodies

Technical Competence: Utilising cutting-edge smart construction technologies developed by the industry and research institutes, project teams can begin to adopt robotics-integrated production and installation technologies for autonomous MiC delivery. They should also adopt an integrated digital project delivery approach throughout the building lifecycle. These initiatives should be financially supported by funding bodies and be technically assisted by research institutes.

Management Efficiency: To enhance management efficiency, the government is recommended to develop a city-level digital twin platform for MiC project monitoring and an e-submission and approval platform for efficient design approval and tendering assessment. Collaboration among government departments, professional bodies, universities and research institutes will be essential for achieving this integrated MiC project delivery.

6.4 Action Plan for Enhancing MiC Supply Chain Supply Sustainability

In the early stage of MiC development, the government implemented measures to facilitate the entry (e.g. the IPA mechanism) and establishment (e.g. MiC seminars and training sessions) of MiC-supporting industries in the Hong Kong market, laying the foundation for MiC supply. To ensure ‘supply sustainability’, actions focus on improving the capacity and ability of both MiC systems (e.g. modules) and manpower (e.g. labour and professional services) on the supply side.

Recommended key actions and relevant action parties are outlined from the perspectives of short-, medium-, and long-term initiatives (**Figure 6-5**).

Supply Sustainability 供應可續性		Short-term 短期 – Medium-term 中期 – Long-term 長期			
		2018–2023 Stage 0–1	Till 2025/26 Stage 1	Till 2027/28 Stage 2	Till 2032/33 Stage 3
Aspect 方面		Sufficient supply 充足	Competitive supply 競爭	Sustainable supply 可續	
MiC systems (e.g. modules) MiC體系(如模塊)	<ul style="list-style-type: none"> Conducted a mapping of existing and prospective suppliers Promoted the IPA mechanism across the GBA and encouraged relevant organisations to apply for Offered monetary incentives to consultants and contractors 	<ul style="list-style-type: none"> To enhance the material procurement scheme To establish a systematic MiC manufacturer certification system To enhance market information sharing to bolster collaboration To encourage low-rise MiC suppliers to get qualified with high-rise MiC 	<ul style="list-style-type: none"> To set up an MiC manufacturer rating system To provide flexible and performance-oriented incentives for MiC suppliers and main contractors To encourage PC suppliers to enter MiC market by upgrading their production lines 	<ul style="list-style-type: none"> To establish a digital platform for GBA demand information sharing To collaborate with Mainland government to provide land support for manufacturers To set up MiC industrial park To encourage GD PC suppliers to enter the MiC market 	
Manpower (e.g. labour & professional services) 人力資源(如勞動力、專業服務)	<ul style="list-style-type: none"> Organised seminars on MiC statutory requirements and pilot project sharing for local practitioners Organised training sessions to issue MiC certificates for labour (e.g. foreman, lifting supervisor) & project manager 	<ul style="list-style-type: none"> To organise webinars on MiC statutory and tendering requirements for Mainland practitioners To provide training for Mainland technician/workers to obtain HK certificates 	<ul style="list-style-type: none"> To provide training courses for labourers and professionals to obtain mutual recognition To provide training/CPD subsidies for MiC professionals and labourers To support local universities to provide relevant courses 	<ul style="list-style-type: none"> To establish a GBA MiC training centre to provide certificates To establish a flexible working mechanism to encourage cross-boundary logistics and supervision 	

Figure 6-5 Overall framework of action plan for enhancing supply sustainability

6.4.1 Short-term Actions for Sufficient Supply

Short-term actions in the supply domain focus on ensuring sufficient MiC supply (**Table 6-7**).

Table 6-7 Short-term actions for sufficient supply

Aspect	Action	Leading stakeholder	Supporting stakeholder
MiC system (e.g. modules)	To enhance the material procurement scheme	Govt. Departments	Industry
	To establish a systematic MiC manufacturer certification system	BTRi	Suppliers
	To enhance market information sharing to bolster collaboration	Govt. Departments	Universities and Research Institutes Industry Institutions

	To encourage low-rise MiC suppliers to get qualified with high-rise MiC	Government	Suppliers Universities and Research Institutes
Manpower (e.g. labour & professional services)	To organise webinars on MiC statutory and tendering requirements for Mainland practitioners	Government (HK & GD)	Universities and Research Institutes
	To provide training for Mainland technicians/workers to obtain HK certificates	Government (HK & GD)	Industry Institutions Universities and Research Institutes

MiC System: It should be noted that the BTRi will launch a MiC Manufacturer Certification Scheme by the end of 2024 in synergy with production bases in the Mainland. To facilitate the material procurement in GBA, departments are recommended to publish a list of eligible raw-material suppliers used in public works projects. This initiative will enhance market information sharing and bolster collaboration. Moreover, the government can encourage low-rise MiC suppliers to become qualified for high-rise MiC to accommodate the rising demand for MiC.

Manpower: To enhance labour and professional services, a strong collaboration between the governments of Hong Kong and Guangdong is needed. Such collaboration will facilitate knowledge diffusion through the hosting of webinars on MiC statutory and tendering requirements for Mainland practitioners. In addition, it will provide training for Mainland technicians/workers to obtain Hong Kong certifications, with support from industry institutions and research institutes.

6.4.2 Medium-term Actions for Competitive Supply

Medium-term actions focused on ensuring a competitive supply are listed in **Table 6-8**.

Table 6-8 Medium-term actions for competitive supply

Aspect	Action	Leading stakeholder	Supporting stakeholder
(e.g. modules)	To set up a MiC manufacturer rating system	Government	Universities and Research Institutes
	To provide flexible and performance-oriented incentives for MiC suppliers and main contractors		Industry Institutions
	To encourage PC suppliers to enter MiC market by upgrading their production lines	Government	Clients/Developers Suppliers
Manpower (e.g. labour & professional services)	To provide training courses for labourers and professionals to obtain mutual recognition	Government (HK & GD)	Universities and Research Institutes
	To provide training/CPD subsidies for MiC professionals and labourers	Industry Institutions Universities and Research Institutes	Consultants Professional Bodies
	To support local universities to provide relevant courses	Government	Universities and Research Institutes

MiC System: The government, with assistance from universities and research institutes, can establish a MiC manufacturer rating system and provide flexible and performance-oriented incentives for MiC suppliers and main contractors. With the support of government departments and industry institutions, this initiative will encourage the continuous development of novel and innovative MiC systems for future projects. In addition, the government may encourage more PC suppliers to enter the MiC market by upgrading their production lines.

Manpower: To address manpower needs, the governments of Hong Kong and Guangdong can provide training courses for labourers and professionals to obtain mutual recognition. The industry institutions, research institutes, and professional bodies are expected to provide training and Continuing Professional Development (CPD) subsidies for MiC professionals and labourers, and the RGC is expected to support local universities in providing relevant courses. These initiatives will foster a competitive market that promotes cost effectiveness while ensuring quality and facilitating healthy competition in the market.

6.4.3 Long-term Actions for Sustainable Supply

Long-term actions aimed at achieving a sustainable MiC supply are outlined in **Table 6-9**.

Table 6-9 Long-term actions for sustainable supply

Aspect	Action	Leading stakeholder	Supporting stakeholder
MiC system (e.g. modules)	To establish a digital platform for GBA demand information sharing	Government (HK & GD)	Universities and Research Institutes
	To collaborate with Mainland Gov to provide land support for manufacturers	Government (GD)	Government (HK)
	To set up MiC industrial park	Government (GD)	Government (HK)
	To encourage GD PC suppliers to enter the MiC market	Government (HK & GD)	Suppliers
Manpower (e.g. labour & professional services)	To establish a GBA MiC training centre to provide certificates	Government (HK & GD)	Universities and Research Institutes
	To establish a flexible working mechanism to encourage cross-boundary logistics and supervision	Government (HK & GD)	Universities and Research Institutes

MiC System: A stronger connection and collaboration between the governments of Hong Kong and Guangdong is essential in the long term. The government of Guangdong is expected to provide land support for manufacturers and set up MiC industrial parks in the GBA. In addition, the governments can expand data interconnection by establishing a digital platform with the help of universities and research institutes for the GBA, to facilitate the sharing of information on MiC demand in the GBA.

Manpower: Regarding labour and professional services, the governments of Hong Kong and Guangdong should consider establishing a GBA MiC training centre to provide certification and creating a flexible working mechanism to encourage cross-boundary logistics and supervision. With the support of various government departments and research institutes, these initiatives are expected to steer the MiC market from competitive supply to sustainable supply. This shift aims to ensure the continuous delivery of high-quality, reliable MiC products and services that ultimately foster the development of a mature and sustainable market.

6.5 Summary

The section suggests a policy roadmap with action plans for enhancing the maturity of the MiC supply chain in terms of demand, process, and supply. Literature review and desk study were conducted to review policy regarding MiC supply chain enhancement in international practices. Based on this, regular research project meetings were conducted to develop policy roadmap and action plan based on the results and findings of WPs 1 to 3. The key findings of this section are summarised below.

- (1) The MiC supply chain policy roadmap aims to enhance the maturity of the MiC supply chain in the GBA for Hong Kong development by enhancing supply sustainability, process integration, and demand stability. In the short term, the goal is to achieve an evolving MiC supply chain with sufficient supply, streamlined process, and increasing demand by 2025/26. In the medium term, the goal is to achieve a stable MiC supply chain with competitive supply, optimised process, and booming demand by 2027/28. In the long term, the goal is to achieve a mature MiC supply chain with sustainable supply, integrated process, and stable demand by 2032/33.
- (2) As the demand for MiC in the initial stage is primarily driven by policies and dominated by public sector involvement, with very few private projects adopting MiC, the action plan for enhancing demand stability takes full account of the needs of MiC in both public and private building sectors. Short-term actions aim to increase MiC demand in both public and private sectors, medium-term actions focus on achieving a booming demand for MiC, and long-term actions seek to achieve a stable market-driven demand for MiC.
- (3) As various MiC systems have been designed, and a series of MiC guidebooks have been issued by the project team to ensure technical feasibility, the action plan for enhancing process integration focuses on the improvements and enhancement of technology and management practices of the MiC project delivery process. Short-term actions aim to ensure a streamlined MiC delivery process, medium-term actions focus on achieving an optimised MiC delivery process, and long-term actions seek to contribute to an integrated MiC delivery process.
- (4) As the government has progressively implemented a series of measures (LegCo 2024) to strengthen the supply chain of MiC modules, these measures aim to facilitate the entry and establishment of MiC-supporting industries into the Hong Kong market, laying the foundation for MiC supply, the actions for enhancing supply capability focus on improving the capacity and ability of both MiC systems (e.g. modules) and manpower (e.g. labour and professional services) on the supply side. Short-term actions aim to maintain a sufficient MiC supply, medium-term actions focus on encouraging a competitive MiC supply, and long-term actions seek to achieve a sustainable MiC supply.

7. Results and Analyses of Work Package 5

7.1 Questionnaire Survey

From September 2024 to November 2024, we conducted a GBA-wide questionnaire survey with stakeholders from the MiC projects, regulatory departments and the industry and community, to validate and disseminate the developed MiC ‘demand-and-supply’ predictive models and public policy roadmap with an action plan. The questionnaire was distributed via a combination of an online version, an editable PDF file version attached to a cover email. Also, we distributed the questionnaire survey via professional bodies/ industry institutions (e.g. GDCIA, BIAS, HKIE, HKCA), and social media (e.g. WeChat).

Through various channels, we approached 1,026 organisations with around 4,200 stakeholders in the GBA, covering government bureaux and departments, clients, consultants, suppliers, contractors, institutions and universities. As of November 2024, a total of 333 stakeholders had participated the questionnaire survey, with 158 valid responses received. As shown in **Figure 7-1**, the majority of respondents (nearly 94%) have working experience with MC or MiC and over 88% of respondents have been involved in MiC projects, indicating that the respondents have a certain knowledge of MiC, which ensures the reliability of the survey results.

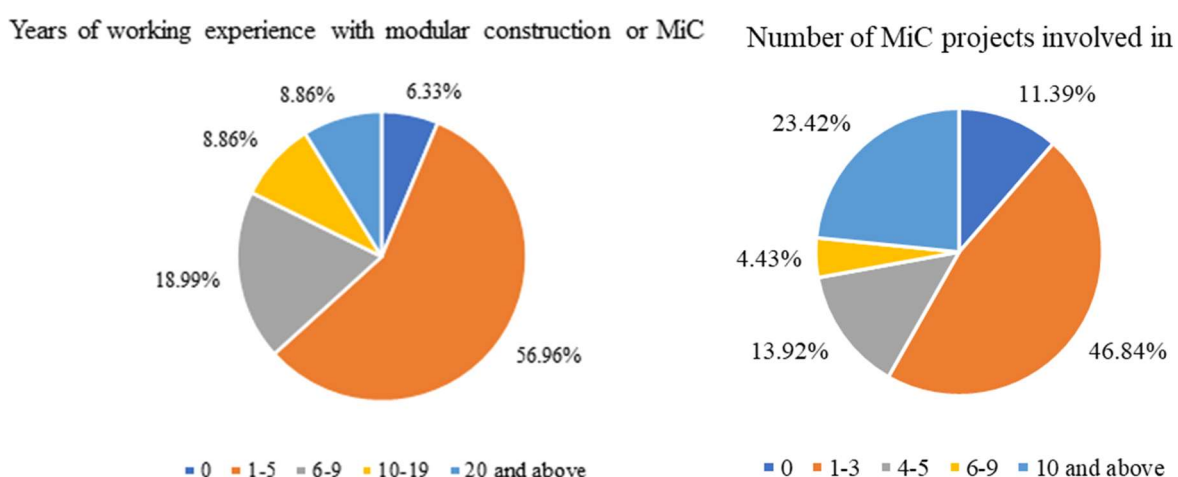


Figure 7-1 Experience of questionnaire respondents

Overall, the survey results showed that most participants agreed on the supply-demand prediction and the proposed policy roadmap with action plans. According to **Figure 7-2** and **7-3**, over 76% of respondents agreed with the concrete module supply-demand analysis for the overall industry, while nearly 95% of respondents agreed with the steel module supply-demand prediction. It can be seen in **Figure 7-4** that the majority of respondents (over 65%) agree or strongly agree with the proposed objectives of the policy roadmap with action plans.

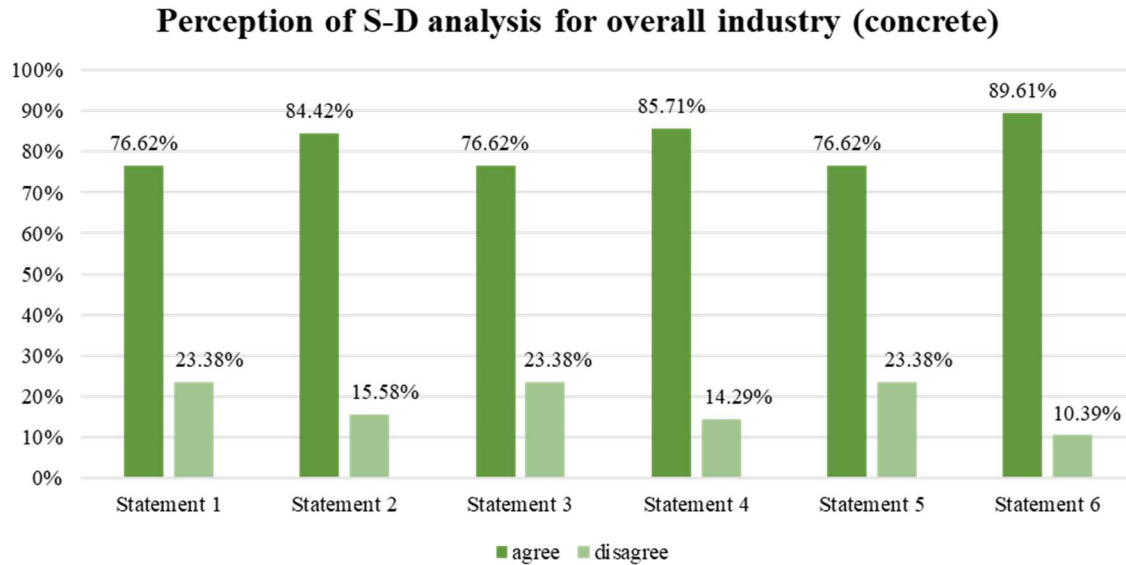


Figure 7-2 Perception of Supply-Demand analysis for overall industry (concrete)

Note: n=75

Statement 1: Short-term (i.e. 2023/24 – 2025/26) -The existing capacity of Category A suppliers cannot meet the short-term MiC demand for the overall industry in HK. There is a need to expand the capacity of these suppliers, which has been planned to be completed by 2024/25.

Statement 2: Short-term (i.e. 2023/24 – 2025/26) -The existing and expanded capacity of Category A suppliers can meet the short-term MiC demand for the overall industry in HK, but it is approaching saturation.

Statement 3: Medium-term (i.e. 2026/27- 2027/28) - The existing and expanded capacity of Category A suppliers cannot meet the medium-term MiC demand for the overall industry in HK. There is a need to involve more low-rise MiC suppliers or consider adopting more steel MiC system.

Statement 4: Medium-term (i.e. 2026/27- 2027/28) - The capacity of Category A and B suppliers can meet the medium-term MiC demand for the overall industry in HK.

Statement 5: Long-term (i.e. 2028/29- 2032/33) - The capacity of Category A and B suppliers cannot meet the long-term MiC demand for the overall industry in HK. There is a need to encourage prefabricated suppliers to upgrade to MiC suppliers for HK.

Statement 6: Long-term (i.e. 2028/29- 2032/33) - The capacity of Category A, B and C suppliers can meet the long-term MiC demand for the overall industry in HK and the GBA, but it is approaching saturation.

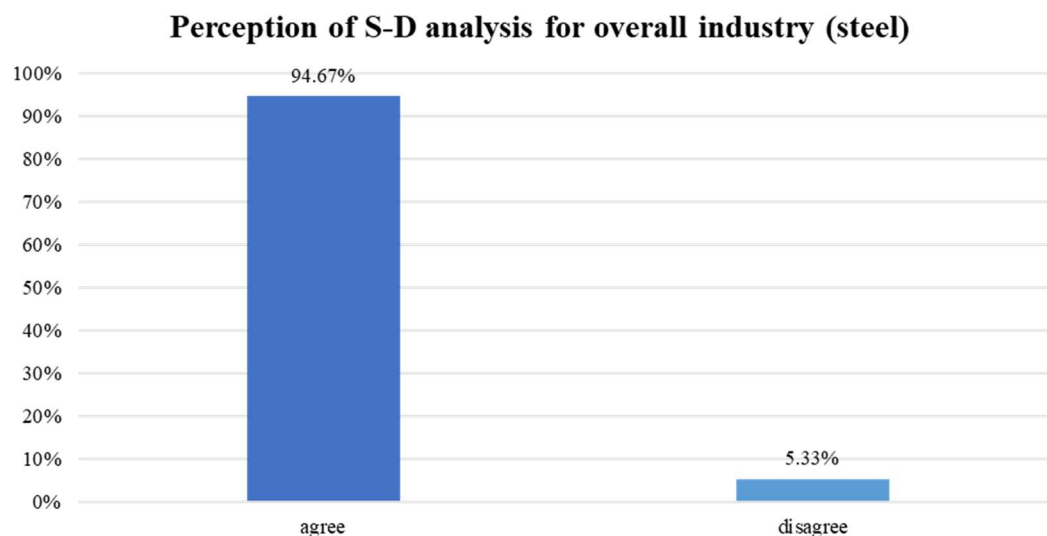


Figure 7-3 Perception of Supply-Demand analysis for overall industry (steel)

Note: n=75

Statement: The existing capacity of Category A and B suppliers can address the current and future needs of steel modules in HK.

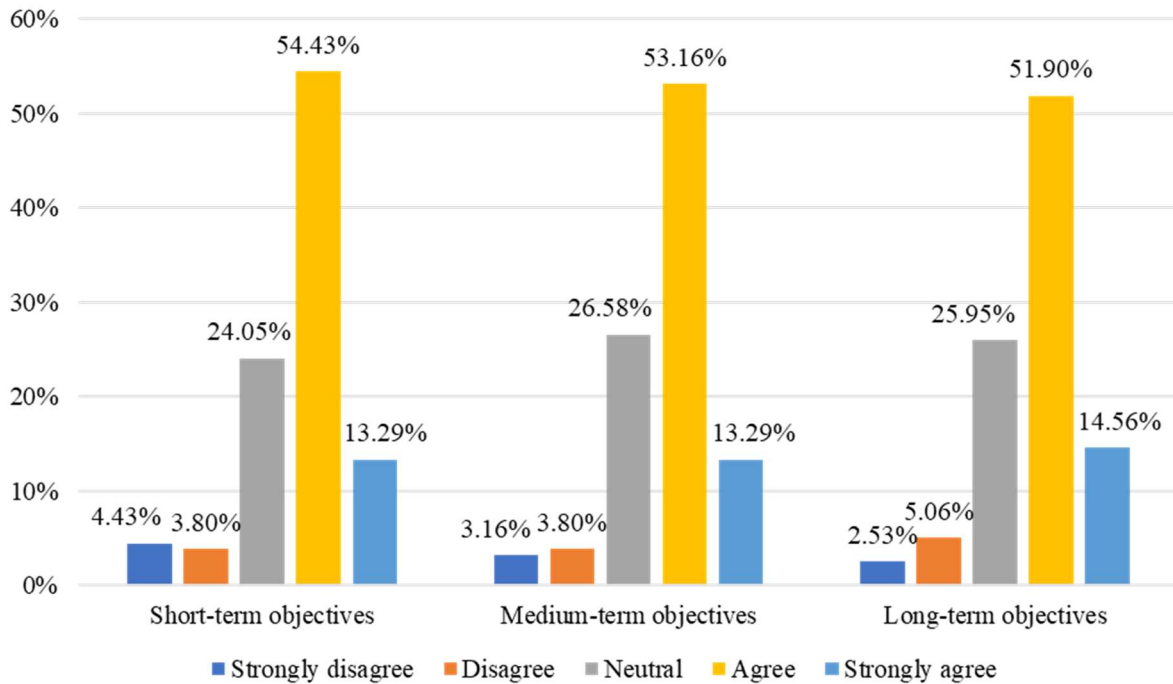


Figure 7-4 Perception of the policy roadmap with action plan

Note: n=158

Short-term objectives: to achieve an evolving MiC supply chain with sufficient supply, streamlined processes, and increasing demand by 2025/26.

Medium-term objectives: to achieve a stable MiC supply chain with competitive supply, optimised processes, and booming demand by 2027/28.

Long-term objectives: to achieve a mature MiC supply chain with sustainable supply, integrated processes, and stable demand by 2032/33.

7.2 Focus Group Meetings

The developed MiC ‘demand-and-supply’ predictive model, public policy roadmap and action plan were also validated through organising three FGMs. *First*, we conducted a FGM with the major clients of public housing (i.e. HKHA and HKHS) in May 2024, to verify the MiC supply-demand forecast and the proposed policy roadmap and action plans for public housing developments. *Second*, we held two FGMs in Oct 2024, to validate the overall research findings of MiC Supply-Demand Analysis and MiC Policy Roadmap with Action Plan.

These FGMs involved 31 representatives from government bureaux and departments (e.g. DEVB, TD, BD), clients/developers (e.g. ArchSD, HKHS, HKUEO, New World, Henderson Land), contractors (e.g. Yau Lee, Chevalier, Gammon), suppliers (e.g. Hailong, CIMC, i-Box, Yau Lee Wah), institutions (e.g. CIC, GDCIA, BIAS) and universities. The participants shared valuable insights and information on the supply and demand of MiC in the GBA as well as provided suggestions for MiC supply chain enhancement.

Throughout the FGMs, we identified the following key considerations for further improving the MiC ‘demand-and-supply’ analysis and public policy roadmap and action plan:

- (1) Future research should include cost analysis and optimisation in order to further encourage MiC take-up in both public and private sectors;
- (2) Care should be taken to interpret the demand analysis in the private sector. This is because by nature MiC should bring in much more benefits to private developments.

Thus, the demand for MiC in the private sector may rapidly increase should the external context change, e.g. the real estates market.

- (3) The future development of MiC supply chain may lead to very promising MiC industry with professional services from HK and manufacturing capability in the GBA.
- (4) The demand and supply sides affect each other dynamically. The HK and rest-of-GBA sides also affect each other dynamically. All these should be considered in dynamic supply-and-demand modelling in future research.

7.3 Public Policy Forum

We held the 2nd Public Policy Forum via a Webinar and launched the Booklet entitled “*Modular Integrated Construction Supply Chain in the Greater Bay Area for Hong Kong Development: Supply-Demand Analysis and Policy Roadmap*” on November 14, 2024. The event gathered distinguished speakers from government, industry and academia to discuss the latest advancements and insights in MiC supply chain policies and practices with an audience of over 280 stakeholders.

Ir Ricky LAU, JP, Permanent Secretary for Development (Works) of the Development Bureau of HKSAR Government, wrote the Foreword for the Booklet, in which he commented: “*The Government has been leading by example and mandating the use of MiC in public works projects... The Centre for Innovation in Construction and Infrastructure Development (CICID)’s dedication to research and development, as well as its knowledge transfer efforts, have been instrumental in advancing MiC development in Hong Kong... I am confident that this research will strengthen the leadership and competitiveness of the Hong Kong construction industry in MiC and construction innovation*”.

Professor Wei Pan (PI), reviewed the MiC developments in Hong Kong, reported the major findings of the research project especially on the MiC supply and demand analysis and policy roadmap with an action plan, and outlined the recommendations.

The Forum also included two panel sessions on the future MiC development in the private and public sectors, involving leaders from the government departments, clients/developers and suppliers.

The Forum enabled insightful knowledge and experience sharing regarding current and future MiC development in HK and provided direction for enhancing the MiC supply chain in the GBA for HK development. It strengthened communication and knowledge between various stakeholders and called for closer collaboration between the industry and academic to further enhance the MiC supply chain. Some participants commented that the Forum has been a most informative and inspiring one in terms of MiC supply chain.

8. Policy Implications and Recommendations

This chapter discloses the policy implications of the major findings of this research project and provides corresponding policy recommendations for enhancing the MiC supply chain in the GBA for Hong Kong development.

The GBA creates exciting synergies and opportunities for Hong Kong development. The HKSAR Government has set ambitious development plans for various sectors including public housing, private residential, elderly home, hostel, hospital, and hotel. Realising these plans will not only strengthen Hong Kong's leadership in the GBA, but also raise challenges to the Hong Kong construction industry in its capacity and capability.

The Chief Executive's 2017 Policy Address started to promote the wide use of MiC for enhancing quality, productivity, safety, and competitiveness. In Hong Kong, 45 MiC projects have been completed since 2018 and another 44 are under construction, all largely relying on supply chains in the GBA. However, there are currently limited choices of MiC systems and suppliers for Hong Kong development. Also, cross-boundary logistics and supply chains are perceived as a significant barrier to MiC adoption in Hong Kong. Thus, it is critical to enhance the MiC supply chain with maturity and stability.

As this research project is significant in relation to MiC policy in Hong Kong, detailed policy implications and recommendations from the research findings of each Work Package are discussed as follows.

First, the identified complexity and dynamics with **drivers, opportunities, concerns, and constraints** of the MiC supply chain in the GBA, and suggested measures and strategies for amplifying the **drivers and opportunities** while mitigating the concerns and constraints, will sustainably raise the awareness of the industry and community of the importance and necessity of enhancing the MiC supply chain and facilitating relevant communication and discussion.

- The identified drivers, opportunities, constraints, concerns, measures, and strategies provide a valuable foundation and should inform practice and policies for enhancing the MiC supply chain in the GBA for Hong Kong's development in the political and regulatory, technical, socio-economic, and geographical dimensions.
- The conflicting interests and concerns among different stakeholders in the MiC supply chain highlight the importance of multistakeholder engagement along the entire supply chain in formulating effective MiC policies for Hong Kong within the context of the GBA.
- The identified measures and strategies offer valuable references for MiC supply chain policy development in Hong Kong and the broader GBA context, mainly innovation and technology, financial services, transportation and logistics, clearance facilitation, creative industries, environmental protection and sustainable development, building safety, nurturing talent, healthcare, land and housing, labour and welfare.

Second, the developed **systematic MiC supply chain measurement framework with KPIs** will facilitate enhanced decision-making by providing clear metrics for performance evaluation. This framework will promote standardisation and data-driven insights and encourage collaboration among stakeholders.

- The established systematic MiC supply chain measurement framework with KPIs should inform policymaking in streamlining workflows, enabling timely project adjustments, promoting organisational accountability and innovation, and encouraging standardisation and collaboration across the whole industry.

Third, in terms of **demand, supply, and supply-demand analyses**, on the **demand side**, the project will support Hong Kong industry's and community's decision-making of MiC supply chain selection and evaluation based on optimal performance on productivity, cost-effectiveness, quality, safety, and sustainability through using KPIs. On the **supply side**, the project will enhance MiC supply chain maturity in the GBA for providing services including module production, transport and installation for Hong Kong development. On **demand-and-supply relation**, the project will help achieve a robust and fast-responsive supply of modules from the GBA to meet ambitious development plans for different sectors in Hong Kong through using the predictive model and scenarios.

- The demand analysis reveals that the initial demand for MiC has been primarily driven by policies and dominated by public sector involvement. Policymakers should be informed to inspire the market demand for MiC to enhance demand stability.
- The supply analysis discloses that governmental measures (e.g. the IPA mechanism) facilitate the entry of MiC suppliers and lay the foundation for MiC supply. Policymakers should be informed to improve the capacity and ability of both MiC systems (e.g. modules) and manpower (e.g. labour and professional services) to respond flexibly to the demand-based supply chain.
- The supply-demand analysis provides policymakers with evidence that the MiC supply chain is pull-based. The supply capacity of steel MiC module suppliers far surpasses that of concrete MiC module suppliers. Policies should address the undercapacity of concrete module supply at critical time points to maintain a moderate supply to meet the short-, medium-, and long-term concrete MiC demand and the overcapacity of steel module supply by making full use of the excess capacity.

Fourth, the recommended **policy roadmap** with short- (up-to-3-year), medium- (5-year) and long-term (10-year) timeframes and **action plans** will help establish and refine relevant MiC design, production, transport, quality assurance and installation codes and regulations, and leverage government buying power and private-sector market driver in Hong Kong. All these will contribute to the wider adoption of MiC and evidence-based MiC policy implementation.

- The proposed policy roadmap employs three aspects (i.e. supply, process, and demand) and spans four stages (early, increasing, enhanced, and mass MiC adoption). This roadmap should provide useful references for MiC supply chain policy development in Hong Kong and the GBA as a whole, in terms of the vision and goals of the MiC supply chain for short-, medium-, and long-term development.
- The recommended action plan offers frameworks and detailed short-, medium-, and long-term actions for enhancing demand stability, process integration, and supply sustainability to policymakers for reference.

With the above, we again highlight the suggested actions to be implemented by the government for enhancing the maturity of the MiC supply chain in terms of demand, process, and supply.

For achieving the MiC supply chain demand stability:

- In the short term, the government may consider prioritising the use of MiC in new development areas, leveraging pilot projects in private sectors, and including MiC adoption as a land sales requirement.
- In the medium term, the government may consider enhancing standardisation by continuously designing innovative MiC systems, piloting MiC implementation in various types of buildings to examine suitability, setting MiC adoption as a criterion for industry awards, and providing incentives to homebuyers.
- In the long term, the government may consider developing an MiC rating system with specific criteria, adopting both steel and concrete MiC in public housing developments, disseminating the housing supply plan in a timely manner, and proposing flexible incentive policies.

For achieving the MiC supply chain process integration:

- In the short term, the government may consider developing MiC design and construction codes or standards, exploring innovative, cost-effective, and practical MiC systems for public housing development, monitoring the MiC project performance and developing a central monitoring platform, and streamlining statutory procedures.
- In the medium term, the government may consider raising R&D incentives regarding MiC technologies, adopting smart systems for remote QA/QC, establishing a cyber-physical MiC logistics management network in the GBA, and setting up MiC dispatch hubs at suitable positions in Hong Kong.
- In the long term, the government may consider developing a city-level digital twin platform for MiC project monitoring and an e-submission and approval platform for efficient design approval and tendering assessment.

For achieving the MiC supply chain supply sustainability:

- In the short term, the government may consider publishing a list of eligible raw-material suppliers used in public works projects, encouraging low-rise MiC suppliers to become qualified for high-rise MiC, and facilitating knowledge diffusion through the hosting of webinars on MiC statutory and tendering requirements for Mainland practitioners.
- In the medium term, the government may consider establishing a MiC manufacturer rating system, providing flexible and performance-oriented incentives for MiC suppliers and main contractors, encouraging more PC suppliers to enter the MiC market by upgrading their production lines, and providing training courses for labourers and professionals to obtain mutual recognition.
- In the long term, the government may consider establishing a digital platform to facilitate the sharing of information on MiC demand in the GBA, establishing a GBA MiC training centre to provide certification, and creating a flexible working mechanism to encourage cross-boundary logistics and supervision.

9. Knowledge Dissemination

The chapter presents the dissemination activities of this research project. Despite the strict travel restrictions and social distancing rules imposed by governments worldwide following the outbreak of the COVID-19 pandemic since January 2020, we have made necessary alternative arrangements to conduct the research activities and tried our best to disseminate our research findings through various channels. During the research period, we had conducted 33 research activities and 23 knowledge dissemination activities such as keynote speeches, which together benefited over 5,000 participants/stakeholders. A summary table is provided in **Appendix IX**.

9.1 Lectures, Seminars, Webinars and International Conferences

We disseminated the project and research findings by attending an array of lectures, seminars, webinars and international conferences, listed as below:

- (1) Conference paper entitled “A Novel Methodological Framework of Smart Project Delivery of Modular Integrated Construction” presented by Prof Wei Pan (PI) at the 37th International Symposium on Automation and Robotics in Construction (ISARC 2020) on Oct 2020.
- (2) Talk entitled “Smart MiC technology and project delivery” delivered by Prof Wei Pan (PI) at the CPD seminar on Building Quarantine Camps to Combat COVID-19 – Smart MiC organised by HKIA on 6 May 2021.
- (3) Talk entitled “Build Smart – Innovation in Construction” delivered by Prof Wei Pan (PI) at the InnoEdge Talk organised by the Innovation Academy of The University of Hong Kong on 28 April 2021.
- (4) Talk entitled “MiC Past, Present and Prospective” delivered by Prof Wei Pan (PI) at the seminar organised by HKIE Civil Division on 14 April 2021.
- (5) Talk entitled “High Productivity Construction - Modular Integrated Construction” delivered by Prof W Pan (PI) at Construction R&D Forum – “Bringing Applied R&D to a New Height” organised by The Development Bureau (DEVB) and the University-Government-Industry (UGI) Consortium on 4 November 2021.
- (6) Conference paper entitled “Automated Crane-lift Path Planning Using Modified Particle Swarm Optimization for High-rise Modular Integrated Construction” presented by Mr Aimin Zhu at the 38th International Symposium on Automation and Robotics in Construction (ISARC), Dubai, UAE, on 2-5 November 2021.
- (7) Conference paper entitled “Key Performance Indicators of Offsite Construction Supply Chains: A Review” presented by Ms Yidan Zhang at the 38th International Symposium on Automation and Robotics in Construction (ISARC), Dubai, UAE, on 2-5 November 2021.
- (8) Conference paper entitled “A systematic review of quality management of offsite construction” presented by Mr Botchway, S. Y. at the 2022 Modular and Offsite Construction (MOC) Summit, Alberta, Canada, on 27-29 July 2022.
- (9) Presentation entitled ‘Future Building, Future Construction Management’ delivered by Prof Wei Pan (PI) at the CRIOCM 27th International Symposium on Advancement of Construction Management and Real Estate, on 5 December 2022.
- (10) Presentation entitled “An overview of the landscape of MiC in the construction industry” delivered by Prof Wei Pan (PI), for CIC master class on MiC project implementation (Project managers) on 6 January 2023.

- (11) Presentation entitled “Innovation in Construction and Infrastructure Development - Modular Integrated Construction” delivered by Prof Wei Pan (PI) at the SCUT on 30 March 2023.
- (12) Conference paper entitled “A novel index for measuring the level of modularization in building construction” delivered by Dr Zhang Zhiqian (Researcher) in the CRIOCM 28th International Symposium on Advancement of Construction Management and Real Estate on 5 Aug 2023.
- (13) Presentation entitled “建造創新與組裝合成” delivered by Prof Wei Pan (PI) at Tongji University on 31 Jul 2023, Shanghai Jiaotong University on 1 Aug 2023, and Southeast University on 3 Aug 2023.
- (14) Presentation entitled “模块化組合建造發展與前沿” by Prof Wei Pan (PI) at Modular Building Forum organised by the Ministry of Housing and Urban-Rural Construction (MOHURD) in Nanning, Guangxi Province on 4 September 2023.
- (15) Keynote Speech entitled “模块組合建造高質量發展創新前沿” delivered by Prof Wei Pan (PI) for the 2023 Summit & Shenzhen Architecture 20-year of Achievement Exhibition on Building Industrialization Development in Shenzhen, Guangdong Province on 15 Sept 2023.
- (16) Keynote Speech entitled “MiC Enhanced High-Productivity and Sustainable Construction” delivered by Prof Wei Pan (PI) at the Global Construction Sustainability Forum and Exhibition organised by the DEVB and CIC in Hong Kong on 20 Nov 2023.
- (17) Guest of Honour talk entitled “MiC for Sustainable Development” delivered by Prof Wei Pan (PI) at the ASCE Greater China Section Annual Dinner on 13 Dec 2023.
- (18) Keynote Speech entitled “MiC Past, Present and Prospect” delivered by Prof Wei Pan (PI) at the MiC Supply Chain Conference co-organised by the DEVB of the HKSAR Government, Huizhou Municipal People’s Government, and Department of Housing and Urban-Rural Development of Guangdong Province in Huizhou on 23 Jan 2024.
- (19) Invited speech entitled “Accelerating Sustainable Housing Supply through MiC Innovations” delivered by Prof Wei Pan (PI) at the Hong Kong Green Week - Leveraging BuildTech and Green Finance in Public Housing Event organised by the Housing Bureau of the HKSAR Government and held at HKU on 29 Feb 2024.
- (20) Conference paper entitled “PESTEL analysis of factors influencing the demand and supply of modular construction: Perspectives from Hong Kong” delivered by Ms Yidan Zhang at the 41th International Symposium on Automation and Robotics in Construction (ISARC 2024), Lille, France, during the period 3-7 June, 2024.
- (21) Public lecture entitled “Modular Integrated Construction (MiC) and Low-Carbon Building Research” delivered by Prof Wei Pan (PI) at Tsinghua University, Beijing, on 22 Jul 2024.
- (22) Conference paper entitled “Digitalizing Volumetric Module Transport for Modular Integrated Construction” delivered by Prof Wei Pan (PI) at the 2024 ASCE International Conference on Computing in Civil Engineering, Pittsburgh, US, 28-31 Jul 2024.
- (23) Conference paper entitled “A dialectical system framework of modular construction policies” delivered by Mr Chenyi Ji at the 2nd International Conference on Construction Project Management and Construction Engineering, Sydney, Australia, 20-23 Nov 2024.
- (24) Keynote Speech entitled “Decarbonising the Building Industry through Modular Integrated Construction” delivered by Prof Wei Pan (PI) at the Decarbonising the Building Industry, Melbourne, Australia, during the period 18-19 Nov 2024.
- (25) Keynote Speech entitled “Modular integrated construction disrupts the way we build and manage” delivered by Prof Wei Pan at the 2nd International Conference on Construction Project Management and Construction Engineering, Sydney, Australia, 20-23 Nov 2024.

9.2 Public Policy Forum and Booklet Launch Event

We held a booklet launch event and two strategic public policy forums to disseminate the project findings and research deliverables to the HK and GBA construction industry, covering stakeholders from government bureaux and departments, clients/developers, consultants, contractors, suppliers, institutions and universities. The events are beneficial to maximise the learning and impact of the MiC supply chain research on knowledge, practice and policy in the wide community.

9.2.1 Booklet Launch Event

To publish the first Public Policy Deliverable, entitled “*Modular Integrated Construction Supply Chain in the Greater Bay Area for Hong Kong Development: Drivers, Opportunities, Constraints, Concerns, Measures and Strategies*”, we held the MiC booklet launch event on 10 December 2021. The event has achieved wide industry participation, with 25 VIP guests from government departments, developers, contractors, institutions and universities in HK attending physically, and 180 participants from HK and outside attending online. At the event, four guest speakers from government departments and institutions in HK and Guangdong delivered speeches and messages to highlight the significance of MiC and its supply chain for HK’s development and the importance of this research study. For example, the Permanent Secretary for Development (Works) of DEVB indicated the crucial role of the GBA supply chain to MiC development in HK and advocated for the widespread adoption of MiC by appealing to the industry to help promote its use. In addition, a panel discussion session was conducted to further elicit the insights of the guest speakers on the identification and enhancement of the MiC supply chain. A presentation was conducted by the PI on the MiC booklet launch event to elaborate on the development of MiC in HK and share the key findings of the drivers, opportunities, constraints, concerns, measures and strategies for the MiC supply chain. Media coverage is as follows:

- HKU website: <https://www.hku.hk/press/press-releases/detail/23722.html>.



Figure 9-1 Guests and speakers at the Booklet Launch Event, HKU, 10 Dec 2021

9.2.2 1st Public Policy Forum

We held the first public policy forum titled “*Modular Integrated Construction (MiC) Supply Chain in the Greater Bay Area for Hong Kong Development: Preliminary Policy Roadmap and Action Plan*” on 30 August 2023 at HKU.

Renowned speakers were invited from government, industry and academia to share state-of-the-art research, practice and policy for MiC supply chain and enable exchange of innovative ideas and practices. A total of 244 participants attended the forum, either joining in person or via Zoom, including representatives from government departments, developers, contractors, suppliers, institutions and universities.

During the forum, the PI, Professor Wei Pan, delivered the Welcome Remarks and introduced the preliminary public policy roadmap with action plan and the key findings of the project. The Permanent Secretary for Development (Works) of DEVB delivered the Opening and Keynote speech, who believed that this forum is a very timely occasion that brings together different industry leaders to offer views on how to enable the healthy development of MiC supply chain in the GBA and represents the collaborative effort of the whole industry in developing the MiC technology and transforming our construction process. Other distinguished speakers shared their expertise, experience and insights regarding the MiC supply chain in the GBA to facilitate Hong Kong’s development.

To maximise the influence of the Forum and garner more attention from the industry, we have produced a press release and a video highlight for effective dissemination and outreach. Media coverage in HK and the GBA are as follows:

- HKU website: <https://www.hku.hk/press/press-releases/detail/26526.html>
- Oriental daily: https://orientaldaily.on.cc/content/%E8%A6%81%E8%81%9E%E6%B8%AF%E8%81%9E/odn-20230901-0901_00176_223/%E4%BF%83%E9%80%B2%E7%B5%84%E8%A3%9D%E5%90%88%E6%88%90%E7%99%BC%E5%B1%95--%E6%B8%AF%E5%A4%A7%E5%BB%BA%E7%AF%89%E7%BD%B2%E5%90%88%E4%BD%9C
- Sina: <https://portal.sina.com.hk/finance/finance-mediaoutreachnewswire/media-outreach/2023/08/31/498537/%E7%AD%96%E7%95%A5%E6%80%A7%E5%85%AC%E5%85%B1%E6%94%BF%E7%AD%96%E8%AE%BA%E5%9D%9B%EF%BC%9A%E6%8F%90%E5%8D%87%E5%A4%A7%E6%B9%BE%E5%8C%BA%E7%BB%84%E8%A3%85%E5%90%88%E6%88%90%E5%BB%BA%E7%AD%91%E6%B3%95/>
- MediaOutReach: <https://www.media-outreach.com/news/hong-kong/2023/08/31/243028/%E7%AD%96%E7%95%A5%E6%80%A7%E5%85%AC%E5%85%B1%E6%94%BF%E7%AD%96%E8%AE%BA%E5%9D%9B%EF%BC%9A%E6%8F%90%E5%8D%87%E5%A4%A7%E6%B9%BE%E5%8C%BA%E7%BB%84%E8%A3%85%E5%90%88%E6%88%90%E5%BB%BA%E7%AD%91%E6%B3%95/>
- GDCIA: <https://mp.weixin.qq.com/s/l5GIG1s3wM1kiJcTEN2YlQ>
- BIAS: https://mp.weixin.qq.com/s/6BY_ZaJ5yc3_p4FLMjEeBQ
- Yahgee: <https://mp.weixin.qq.com/s/w5G8xg0gEG0v7cCW15AkPA>
- CICID WeChat: <https://mp.weixin.qq.com/s/HiucfWsoGFybxlsJpUr4ow>
- CICID website: <https://www.civil.hku.hk/cicid/events.html>

Video highlight: <https://www.civil.hku.hk/cicid/>



Figure 9-2 Guests and speakers at the 1st forum, HKU, 30 Aug 2023



Figure 9-3 Physical participants at the 1st forum, HKU, 30 Aug 2023

9.2.3 2nd Public Policy Forum

We held the second Public Policy Forum via a Webinar and launched the Booklet entitled “*Modular Integrated Construction Supply Chain in the Greater Bay Area for Hong Kong Development: Supply-Demand Analysis and Policy Roadmap*” on November 14, 2024. Distinguished speakers from government, industry and academia were invited. The event also gathered industry and company leaders and MiC practitioners in the GBA, which could

motivate the implementation of the policy roadmap and action plans for MiC supply chain enhancement.

To maximise the influence of the Forum and this study, we promoted the events via various channels. Media coverage in HK and the GBA are as follows:

- HKU website: https://www.hku.hk/press/news_detail_27891.html
- MiCLab website: <https://www.miclab.hk/sppr-forum-2024>
- CICID website: <https://www.civil.hku.hk/cicid/index.html>
- Prof Pan's Homepage: <https://www.civil.hku.hk/wpan/news.html>
- CICID Wechat: <https://mp.weixin.qq.com/s/VvIprc7iJq6WWeF74fcDzw>
- CICID LinkedIn: <https://www.linkedin.com/company/hkucicid/posts/>
- Miragenews: https://www.miragenews.com/gba-supply-chain-forum-maps-hk-development-1358255/#google_vignette
- BIAS: <https://mp.weixin.qq.com/s/gYfqT-0Q0RYT2ZLb1qg01A>
- CIMC: https://mp.weixin.qq.com/s/89nc9zABCqGhEEwf3_vcGQ



Figure 9-4 Speakers at the 2nd forum, Zoom webinar, 14 Nov 2024



Figure 9-5 Speakers Prof Wei Pan (L) and Prof CK Mak (R) at the 2nd forum



Figure 9-6 Booklet launched at the 2nd forum

9.3 Web Portal

We developed a web portal demo for facilitating industry and public engagement in and access to MiC demand-and-supply information as well as the public policy roadmap and action plans.

The link for accessing/reviewing the web portal is <http://www.micsc.miclab.hk/>.

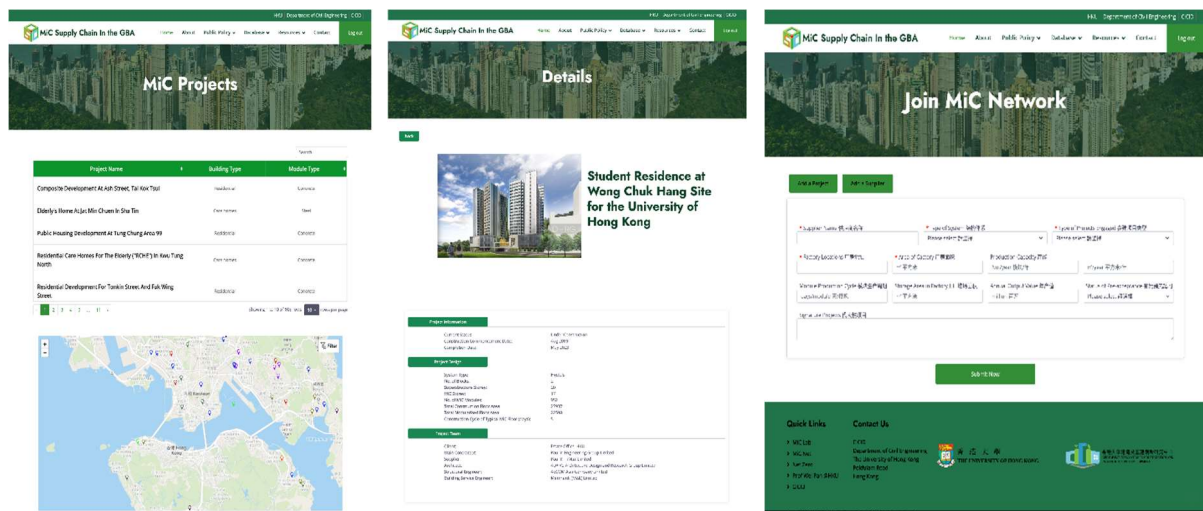


Figure 9-7 Web portal for sharing MiC demand-and-supply information

10. Conclusions

This research project has enhanced the MiC supply chain in the GBA for Hong Kong development, through identifying the MiC supply chain drivers and opportunities, constraints and concerns, and strategies and measures, establishing the KPIs, analysing the module supply and demand, and proposing the policy roadmap with action plans. The project objectives were achieved by conducting 104 interviews, 6 focus group meetings, 2 workshops, 7 factory visits, 5 site visits, 4 rounds of questionnaire surveys, 1 booklet launch event and 2 public policy forums. Throughout the project, the research team has published 17 journal articles, 8 conference papers and presentations at international conference, and 2 public policy research reports in the form of booklets. The key findings of the project are summarised below.

MiC Supply Chain Readiness

The findings unveiled a multifaceted landscape of the drivers, opportunities, constraints, concerns, strategies, and measures of MiC supply chain from technical, political and regulatory, socio-economic, and geographical perspectives. Specifically,

- (1) the most important **drivers** for MiC supply chain enhancement were derived from its significance in guaranteeing MiC project success, the potential to address housing shortage and disruptive events, the imperative for consistent MiC QA/QC mechanism, and the response to MiC policy initiatives in Hong Kong;
- (2) the most significant **opportunities** rested on the provided policy incentives and relevant guidance for MiC design and inspection, digital and smart techniques for remote inspection, and the established MiC pre-approval mechanism;
- (3) the primary **constraints** were related to the challenges of the early freeze of design specifications, regulatory and geographical constraints on large module delivery, reluctance to embrace MiC, and stringent building codes;
- (4) the most critical **concerns** were inefficient review and approval, the lack of module storage areas, inconsistent building codes and regulations across the GBA, increased transportation and logistics considerations, and significant changes in payment terms and cash flows;
- (5) the most promising **strategies** were to encourage intra-government department collaboration, streamline regulatory approval processes, attract experts and young talents, enhance R&D on smart MiC, and improve the regulatory bodies' understanding of MiC; and
- (6) the most important **measures** were to promote MiC adoption, streamline design approval processes, increase the comprehensiveness of MiC related codes and regulations, adopt MiC in new development areas, and increase training for MiC practitioners.

In general, the positive impact of the drivers and opportunities was considered to outweigh the negative impact of the constraints and concerns. The key to amplifying the drivers and opportunities and mitigating the constraints and concerns lies in fostering a vibrant MiC market, improving the regulatory environment, empowering MiC supply chain with innovations and also embedding the geographical impacts on MiC supply chain enhancement.

MiC Supply Chain KPIs

The project established 15 KPIs for measuring the maturity of MiC supply chain at process, project, organisation and industry levels. Specifically,

- (1) At Process-level, “manufacturability of module design”, “production process stability”, and “just-in-time fulfillment” were identified KPIs, signifying key procedures (i.e. detailed design, module production, and logistics and customs clearance) necessitate rigorous process control.
- (2) At Project level, KPIs covered “time variance”, “stakeholder satisfaction”, and “community satisfaction”, underscoring the focus of supply chain management on schedule performance and satisfaction achievement.
- (3) At Organisation level, “MiC experience of supply group”, “assurance of supply”, “efficiency of approval procedures”, and “efficiency of stakeholder communication and collaboration” were selected, highlighting the role of supply and regulation groups and cross-disciplinary collaboration.
- (4) At Industry level, KPIs included “demand increase”, “supply capacity”, “end-user acceptance”, “incentive effectiveness”, and “regulatory flexibility of design”, emphasising the significance of business and regulatory environment readiness.

The multilevel measurement framework with KPIs demonstrates the complexities of MiC supply chains and highlights the importance of comprehensive efforts in process control, project goal achievement, stakeholder capability building and collaboration, and supporting environmental improvement for MiC supply chains to mature.

MiC Supply Chain Supply-Demand Analysis

The MiC module demand in Hong Kong and supply from the GBA were systematically modelled, predicted and analysed based on technological development, market acceptance and government policies.

MiC module demand in Hong Kong was predicted for the following 10 years for both private and public sectors:

- (1) Three scenarios of future MiC demand were built, i.e. baseline, intermediate and aggressive scenarios.
- (2) The demand in public sector (i.e. public housing and government buildings) keep increasing and will be stabilised in five years and can reach 60-75% of new development. Notably, the number of concrete modules for public housing development will reach 40,000 modules/year by 2027/28 and 80,000 modules/year by 2032/33.
- (3) The demand in the private sector (i.e. private residential and non-residential) is currently under pilot adoption and it is expected there will be an increasing adoption should the pilot adoption demonstrates the benefits of MiC for private developments. It is estimated that there will be 50% of MiC adoption for private residential by 2032/33.

The module supply capacity was estimated by analysing all existing and potential MiC suppliers in the GBA:

- (1) Both concrete and steel MiC module suppliers were analysed to estimate the existing and future manufacturing capacity of the GBA.
- (2) A total of 45 suppliers were analysed and categorised into 17 experienced MiC module suppliers (i.e. suppliers having Hong Kong high-rise/ low-rise MiC job references), and 28 high-potential suppliers (i.e. PC suppliers listed in the government department's supplier list for Hong Kong and those who have been involved in an IPA), based on their capability and job references.
- (3) The existing capacity of experienced high-rise concrete MiC module suppliers is 35,000-4,000 modules/year, and the potential capacity will be 85,000 to 100,000

modules/year by introducing the expanded capacity of high-rise concrete MiC module suppliers and existing capacity of low-rise concrete MiC module suppliers.

- (4) The existing capacity of high-rise steel MiC module suppliers is 80,000 to 85,000 modules/year.

Supply-demand analysis was conducted through conducting systems modeling:

- (1) The existing capacity of experienced high-rise concrete MiC module suppliers (i.e. 35,000-40,000 modules/year) is insufficient for future demand of HK, while the existing capacity of experienced high-rise steel MiC module suppliers (i.e. 80,000-85,000 modules/year) is sufficient for future demand of HK.
- (2) The manufacturing capacity of concrete MiC needs to be enhanced, such as by expanding factories, introducing PC and low-rise MiC suppliers.

MiC Supply Chain Policy Roadmap with Action Plans

Policy roadmap was proposed for short-, medium- and long-term development of MiC in Hong Kong. The roadmap and actions plans were recommended to enhance MiC supply chain maturity in terms of demand stability, process integration, and supply sustainability:

- (1) to achieve **stable demand** for both private and public sectors by taking actions such as increase MiC demand in both public and private residential;
- (2) to achieve **integrated process** from both technological and managerial perspectives by taking actions such as integrating smart technologies in project delivery; and
- (3) To achieve **sustainable supply** of modules and other resources such as labour by taking actions such as establishing MiC manufacturer certification and labour training schemes.

Way Forward of MiC Supply Chain Enhancement

The existing MiC supply chain is still under maturity and needs to be further enhanced. The identified drivers and opportunities highlight the significance of policy support to incentivise the MiC market in private sector and the necessity of regulatory measures to ensure the quality of supply. With the policy roadmap proposed, strategies should focus on foresting a vibrant MiC market, improving the regulatory environment, leveraging innovations, and embedding the geographical impacts, to address the various constraints and concerns.

Looking ahead, the MiCLab at HKU will closely collaborate with the government and industry and continuously monitor and measure the supply chain performance using the KPIs established, in order to further enhance MiC cost-competitiveness, structural safety, manufacturing quality, construction efficiency, and supply chain sustainability. In the future, we will work together with the government and industry to co-develop MiC into a high-value industry and promote it in ASEAN and Belt-and-Road countries and the beyond.

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Appendices

Appendix I – Abbreviations

ArchSD	Architectural Services Department, HKSAR Government
BD	Buildings Department, HKSAR Government
BIAS	Building Industrialization Association of Shenzhen
BTRi	Building Technology Research Institute
CE	Chief Executive, HKSAR
CIC	Construction Industry Council
CICID	Centre for Innovation in Construction and Infrastructure Development
CPD	Continuing Professional Development
CU	Capacity Utilisation
DEVB	Development Bureau, HKSAR Government
FGM	Focus Group Meeting
FS	Financial Secretary
GBA	Guangdong-Hong Kong-Macao Greater Bay Area
GD	Guangdong
GDCLA	Guangdong Construction Industry Association
GFA	Gross Floor Area
HA	Housing Authority, HKSAR Government
HB	Housing Bureau, HKSAR Government
HK	Hong Kong
HKCA	Hong Kong Construction Association
HKHS	Hong Kong Housing Society
HKIE	The Hong Kong Institution of Engineers
HKRPF	Hong Kong Real Property Federation
HKSAR	Hong Kong Special Administrative Region
HKU	The University of Hong Kong
ITB	Innovation, Technology and Industry Bureau, HKSAR Government
IPA	In-principle Acceptance
KPI	Key Performance Indicator
LegCo	Legislative Council of the Hong Kong Special Administrative Region
LPH	Light Public Housing
MC	Modular Construction

MiC	Modular Integrated Construction
MiCLab	MiC Laboratory
PA	Policy Address
PC	Prefabricated Construction
PH	Public Housing
QA/QC	Quality Assurance / Quality Control
R&D	Research & Development
RGC	Research Grants Council
TD	Transport Department, HKSAR Government
WP	Work Package

Appendix II – Scripts of Q Surveys (key questions)

Questionnaire Script 1 (WP1)

I INFORMATION OF PARTICIPANTS

1. Your primary area of practice
2. Number of years working in the building sector
3. Main building sectors you have been involved
4. Number of years of work experience with modular construction/MiC
5. Number of MiC projects you have been involved

II PERCEPTIONS ON MiC SUPPLY CHAIN FOR HONG KONG

1. How important do you view the following drivers for MiC supply chain identification & enhancement in the GBA? (1 = not important, 2 = somewhat important, 3 = important, 4 = very important, and 5 = extremely important) [Note: this question is provided with 15 drivers for assessment]
2. How important do you view the following opportunities for MiC supply chain identification & enhancement in the GBA? (1 = not important, 2 = somewhat important, 3 = important, 4 = very important, and 5 = extremely important)) [Note: this question is provided with 14 opportunities for assessment]
3. How significant do you view the following constraints for MiC supply chain identification & enhancement in the GBA? (1 = not important, 2 = somewhat important, 3 = important, 4 = very important, and 5 = extremely important) [Note: this question is provided with 16 constraints for assessment]
4. How significant do you view the following concerns for MiC supply chain identification & enhancement in the GBA? (1 = not important, 2 = somewhat important, 3 = important, 4 = very important, and 5 = extremely important) [Note: this question is provided with 16 concerns for assessment]
5. How do you agree with the statement that “the drivers and opportunities for MiC supply chain enhancement in the GBA outperform the constraints and concerns”? (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree)How important do you view the following measures for MiC supply chain identification & enhancement in the GBA? (1 = not important, 2 = somewhat important, 3 = important, 4 = very important, and 5 = extremely important) [Note: this question is provided with 15 strategies for assessment]
6. How important do you view the following strategies to guide/facilitate the recommended measures for MiC supply chain identification & enhancement in the GBA? (1 = not important, 2 = somewhat important, 3 = important, 4 = very important, and 5 = extremely important)

If you have any other comments on MiC supply chain enhancement, please specify. [Note: this question is provided with 27 measures for assessment]

Questionnaire Script 2 (WP2)

I INFORMATION OF PARTICIPANTS

1. Your primary area of practice
2. Number of years of work experience with modular construction/MiC
3. Number of MiC projects you have been involved in
4. The following MiC projects in HK that you have engaged
5. Main type(s) of MiC systems you have been involved in

II PERCEPTION ON MIC SUPPLY CHAIN PERFORMANCE INDICATORS

1. How important do you view the following indicators for measuring the MiC supply chain performance at the process level? (1= Not important, 2=somewhat important, 3=important, 4=very important, 5=extremely important) [Note: this question is provided with 20 indicators for assessment]
2. How important do you view the following indicators for measuring the MiC supply chain performance at the project level? (1= Not important, 2=somewhat important, 3=important, 4=very important, 5=extremely important) [Note: this question is provided with 12 indicators for assessment]
3. How important do you view the following indicators for measuring the MiC supply chain performance at the organisation level? (1= Not important, 2=somewhat important, 3=important, 4=very important, 5=extremely important) [Note: this question is provided with 14 indicators for assessment]
4. How important do you view the following indicators for measuring the MiC supply chain performance at the industry level? (1= Not important, 2=somewhat important, 3=important, 4=very important, 5=extremely important) [Note: this question is provided with 17 indicators for assessment]
5. If you have any other comments on the MiC supply chain performance measurement in general, please specify.

Questionnaire Script 3 (WP3)

I 基本信息

1. 贵单位名称是
2. 贵单位属于哪个领域?
3. 贵单位在 MiC/模块化建筑领域工作多少年了?
4. 贵单位在装配式建筑领域工作多少年了?
5. 贵单位曾参与过多少个 MiC/模块化建筑项目?
6. 贵单位曾参与过多少个装配式建筑项目?
7. 贵单位曾参与的建筑类型是?
8. 贵单位参与的项目主要在哪个国家/地区?
9. 贵单位主要生产的模块或预制件类型?
10. 贵单位是否已获得香港预先认可组装合成建筑法证书 (IPA) ?

II 产能信息

1. 贵单位有几个厂房?
2. 贵单位厂房总面积是多少?
3. 贵单位共有多少条 MiC/模块生产线?
4. 贵单位共有多少条装配式构件生产线?
5. 贵单位每年最多可生产多少平方米的模块?
6. 贵单位平均每月生产多少个模块?
7. 贵单位的模块平均生产周期是多少天?
8. 贵单位厂房可临时储存多少个模块?
9. 贵单位每年最多可生产多少万立方米的装配式预制混凝土构件?
10. 贵单位厂房可临时储存多少万立方米的装配式预制混凝土构件?
11. 贵单位每年最多可生产多少万吨的装配式预制钢结构构件?
12. 贵单位厂房可临时储存多少万吨装配式预制钢结构构件?
13. 如果您对收集大湾区 MiC/模块化/装配式建筑供应商信息有其他建议或看法, 请说明。

Questionnaire Script 4 (WP5)

PART I - INFORMATION OF PARTICIPANTS

1. Your primary area of practice
2. Number of years of working experience with modular construction or MiC
3. Number of MiC projects you have been involved in
4. Main type(s) of MiC systems you have been involved

PART II – PERCEPTION OF MIC DEMAND ANALYSIS

(Part II only applies to participants from Government and Client groups)

1. If you are from HK, please tick which scenario you agree most with the predicted MiC adoption rate; otherwise please provide what you think the adoption rate is for each sector and scenario. [Note: this question is provided with 3 sectors with 3 scenarios for assessment]
2. Please provide your view on the significance of the following factors affecting MiC demand. [Note: this question is provided with 18 factors for assessment]
3. If you are from Guangzhou or Shenzhen, please indicate whether you agree with the predicted MiC demand; otherwise please specify the demand that you think should be.

PART III – PERCEPTION OF MIC SUPPLY ANALYSIS

(Part III only applies to participants from Contractor and supplier groups)

1. Please indicate whether you agree with the following statements about the classification of suppliers in Guangdong and the supply capacity; if disagree, please specify the number/range (modules/year) that you think should be. [Note: this question is provided with 10 statements for assessment]
2. Please provide your view on the significance of the following factors affecting MiC supply capacity for the HK market. [Note: this question is provided with 19 factors for assessment]
3. Please indicate whether you agree with the range of CU for each scenario; if disagree, please specify the range of CU that you think should be.

PART IV – PERCEPTION OF MIC ‘SUPPLY-DEMAND’ ANALYSIS

(Part IV only applies to participants from government, client, contractor and supplier groups)

1. Please indicate whether you agree with the following statements about the MiC supply-demand analysis for public housing developments in HK; if disagree, please provide your reasons. [Note: this question is provided with 5 statements for assessment]
2. Please indicate whether you agree with the following statements about the concrete MiC supply-demand for the overall industry in HK; if disagree, please provide your reasons. [Note: this question is provided with 6 statements for assessment]
3. Please indicate whether you agree with the following statement about the steel MiC supply-demand for the overall industry in HK; if disagree, please provide your reasons. [Note: this question is provided with one statement for assessment]

PART V – PERCEPTION OF THE POLICY ROADMAP WITH ACTION PLAN

(Part V applies to all participants)

1. Please provide your view on the following statements about the policy roadmap for enhancing the maturity of MiC supply chain in the GBA. [Note: this question is provided with 3 statements for assessment]
2. Please tick the most proper period for implementing each action below for enhancing demand stability for the MiC supply chain. [Note: this question is provided with 8 actions for assessment]
3. Please tick the most proper period for implementing each action below for ensuring supply quality for the MiC supply chain. [Note: this question is provided with 15 actions for assessment]
4. Please tick the most proper period for implementing each action below for enhancing process integration for the MiC supply chain. [Note: this question is provided with 15 actions for assessment]

What do you think are other aspects of MiC that need to be addressed?

Appendix III – Scripts of Interviews (key questions)

Interview Script 1 (WP2)

Section 1: Information of Participants (no personal identifier)

1. What is the primary role of your organisation in the construction industry? (e.g., government, developer/client and institution)
2. What are the main stages of project development that you/your organisation is involved in? (e.g., planning, design, manufacturing, logistics, construction)
3. Could you briefly describe your knowledge and work experience in modular construction/MiC?

Section 2: Perceptions on the MiC supply chain measurement framework and KPIs

1. How would you comment on measuring MiC supply chain performance from the perspectives of process, project, organisation and industry levels?
2. Based on your experience, what are the most important MiC supply chain performance indicators at the process level?
3. Based on your experience, what are the most important MiC supply chain performance indicators at the project level?
4. Based on your experience, what are the most important MiC supply chain performance indicators at the organisation level?
5. Based on your experience, what are the most important MiC supply chain performance indicators at the industry level?
6. Based on your experience, do you have any other comments on MiC supply chain performance measurement?

Interview Script 2 (WP3&4)

Section 1: Current MiC adoption in government building developments

1. How many projects do you have that have adopted MiC, either under design or construction?
2. What are the current application status of MiC in government building developments in the major types of buildings, e.g. staff quarter, office building, hospital, school?
3. What is the number (or %) of government building projects that utilise concrete MiC system and steel MiC system, respectively?
4. How many shortlisted MiC suppliers/contractors for government building developments?
5. How do you evaluate the capability of MiC suppliers and contractors?
6. Is there any gaps between MiC demand and module supply?

Section 2: Future MiC adoption in government building developments

1. How many government building projects do you plan in the future ten years, e.g. for staff quarter, office building, school projects?
2. How many projects (or %) are mandatory to adopt MiC according to Technical Circular (Works) No. 2/2020? How is your plan about MiC adoption in the other projects that are not forced to use MiC?
3. Do you think MiC adoption will follow the trend of PC developments for government building developments?
4. How do you evaluate the demand of modules, e.g. using no. of modules or CFA?

Section 3: Action plans for enhancing MiC supply chain for government building

developments

1. What do you think are the major influencing factors of stable MiC demand and sufficient and quality module supply for government building developments in HK?
2. What do you think are other influencing factors of successful MiC adoption in government building developments?
3. What are ArchSD's action plans for enhancing MiC supply chain for government building developments, e.g. enhancing demand stability, supply capability, process integration?
4. What are your suggestions to other key stakeholders (e.g. regulatory departments, main contractor and supplier) for enhancing MiC supply chain?

Interview Script 3 (WP3&4)

Section 1: Current and future MiC adoption in public housing developments

1. How many projects do you have that have adopted MiC, either under design or construction?
2. What are the percentage of 1P/2P flats, 2P/3P flats, 3P/4P flats, 4P/5P flats and 5+PF?
3. How many shortlisted MiC suppliers/contractors for public housing developments?
4. How do you evaluate the capability of MiC suppliers and contractors?
5. Is there any gaps between MiC demand and module supply?

Section 2: Future MiC adoption in public housing developments

1. How many public housing units do your organisation plan to produce in the next 10 years?
2. How many projects (or %) do you plan to adopt MiC, i.e. in the 1st and 2nd five years? What is your roadmap of MiC adoption, e.g. from pilot projects to mass adoption?
3. Do you think MiC adoption will follow the trend of PC developments for public housing developments?
4. How do you evaluate the demand of modules, e.g. using no. of modules or CFA?

Section 3: Influencing factors of MiC adoption in public housing developments

1. What factors do you think will influence your organisation's plan about the supply of public housing (e.g. land and capital resources, interest rate, households in need) ?
2. What factors do you think will influence your organisation's adoption decision of MiC in public housing developments (e.g. policy initiatives, MiC advantages, sustainable development target, shortage of onsite workers, availability of MiC professionals) ?
3. What factors do you think will influence sufficient and quality supply of modules for public housing developments in HK (e.g. MiC demand, investment and profit earning)?

Section 4: Action plans for enhancing MiC supply chain for public housing developments

1. What are your action plans for enhancing MiC supply chain for public housing developments?
2. What are your suggestions to the industry, e.g. actions for enhancing supply capability?

Appendix IV – Scripts of FGMs/Workshops (key questions)

Script 1 (WP2)

Section 1: Information of Participants (no personal identifier)

1. What is the primary role of your organisation in the construction industry?
2. (e.g., government, developer/client, architect, engineer, MiC manufacturer and supplier; main contractor; specialist contractor)
3. What are the main stages of project development that you/your organisation is involved in?
4. (e.g., planning, design, manufacturing, logistics, construction)
5. Could you briefly describe your knowledge and work experience in modular construction/MiC?

Section 2: Perceptions on the MiC supply chain measurement framework and KPIs

1. How would you comment on measuring MiC supply chain performance from the perspectives of process, project, organisation and industry levels?
2. Based on your experience in the PSKDQ/WCH/InnoCell project, what are the most important MiC supply chain performance indicators at the process level?
3. Based on your experience in the PSKDQ/WCH/InnoCell project, what are the most important MiC supply chain performance indicators at the project level?
4. Based on your experience in the PSKDQ/WCH/InnoCell project, what are the most important MiC supply chain performance indicators at the organisation level?
5. Based on your experience in the PSKDQ/WCH/InnoCell project, what are the most important MiC supply chain performance indicators at the industry level?
6. Based on your experience in the PSKDQ/WCH/InnoCell project, do you have any other comments on MiC supply chain performance measurement?

Script 2 (WP3, 4&5)

Section 1: Perceptions on the MiC demand and supply

1. What do you see as the future of MiC in different building sectors? Please share your comments on the suitability and future development of MiC in HK, considering the characteristics of different building sectors (e.g., design standardisation, socio-economic benefits, market scale).
2. How do you evaluate the findings?
3. What do you think are the driving forces or inhibiting factors influencing MiC adoption in different building sectors in Hong Kong?
4. What do you think of the prediction from the current view?
5. How to improve the methodology/the predicted adoption rates for different building sectors?
6. How you perceive supply in the GBA can meet the future growing demand for MiC in HK? What important factors do you think can influence the supply of MiC for HK?

Section 2: Strategies and Measures for MiC Supply Chain Enhancement

1. What strategies and measures could be put in place in short- (up-to-3-year), medium- (5 year) or long- (10 year) term for MiC supply chain enhancement to accommodate the growing MiC demand?

Script 3 (WP3&5)

1. How would you comment on the MiC demand scenarios and analysis?
2. How would you comment on the MiC supplier categories and the supply capacity analysis?
3. How would you comment on the MiC demand-and-supply analysis?
4. Do you have any other comments/suggestions on the MiC demand-and-supply analysis?

Script 4 (WP4&5)

5. How would you comment on the proposed MiC Policy Roadmap?
6. How would you comment on the recommended actions for enhancing demand stability for the MiC supply chain?
7. How would you comment on the recommended actions for ensuring supply quality for the MiC supply chain?
8. How would you comment on the recommended actions for enhancing process integration for the MiC supply chain?
9. Do you have any other comments/suggestions on the proposed MiC Policy Roadmap?
10. Do you have any other comments/suggestions on the recommended action plans?
11. Do you have any other comments/suggestions on the enhancement of the MiC supply chain?

Appendix V – List of Publications

No.	Date	Category	Publications / Outputs
1	05/2021	Journal Paper	Yang, Y., Pan, M., Pan, W. , & Zhang, Z. (2021). Sources of Uncertainties in Offsite Logistics of Modular Construction for High-Rise Building Projects. <i>Journal of Management in Engineering</i> , 37(3), 04021011. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000905
2	03/2021	Journal Paper	Xu, J., Ng, C. T. , & Cheng, T. C. E. (2021). Remanufacturing strategies under product take-back regulation. <i>International Journal of Production Economics</i> , 235, 108091. https://doi.org/10.1016/j.ijpe.2021.108091
3	08/2021	Journal Paper	Dong, C., Chen, C., Shi, X., & Ng, C. T. (2021). Operations strategy for supply chain finance with asset-backed securitization: Centralization and blockchain adoption. <i>International Journal of Production Economics</i> , 241, 108261. https://doi.org/10.1016/j.ijpe.2021.108261
4	09/2021	Journal Paper	Jiang, Y., Liu, X., Kang, K., Wang, Z., Zhong, R. Y. and Huang, G. Q. (2021). Blockchain-enabled cyber-physical smart modular integrated construction. <i>Computers in Industry</i> , 133, December 2021, 103553. https://doi.org/10.1016/j.compind.2021.103553
5	10/2021	Journal Paper	Liu, X., Jiang, Y., Wang, Z., Zhong, R. Y., Cheung, H. H., & Huang, G. Q. (2021). imseStudio: blockchain-enabled secure digital twin platform for service manufacturing. <i>International Journal of Production Research</i> , 1-20. https://doi.org/10.1080/00207543.2021.2003462
6	06/2022	Journal Paper	Yang, Y., Pan, M., & Pan, W. (2022). Integrated offsite logistics scheduling approach for high-rise modular building projects. <i>Journal of Construction Engineering and Management</i> , 148(6), 04022032. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002280
7	04/2022	Journal Paper	Jiang, Y., Li, M., Guo, D., Wu, W., Zhong, R. Y., & Huang, G. Q. (2022). Digital twin-enabled smart modular integrated construction system for on-site assembly. <i>Computers in Industry</i> , 136, 103594. https://doi.org/10.1016/j.compind.2021.103594
8	09/2022	Journal Paper	Jiang, Y., Li, M., Li, M. X., Liu, X., Zhong, R. Y. Pan, W. , Huang, G. Q. (2022). Digital twin-enabled real-time synchronization for planning, scheduling, and execution in precast on-site assembly. <i>Automation in Construction</i> , 141, 104397. https://doi.org/10.1016/j.autcon.2022.104397
9	09/2022	Journal Paper	Pan, M., Yang, Y., Zheng, Z., & Pan, W. (2022). Artificial Intelligence and Robotics for Prefabricated and Modular Construction: A Systematic Literature Review. <i>Journal of Construction Engineering and Management</i> , 148(9), 03122004. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002324
10	08/2022	Journal Paper	Pan, W. , Yang, Y., & Pan, M. (2022). Implementing Modular Construction in High-rise High-density Cities: Perspectives in Hong Kong. <i>Building Research & Information</i> , 1-15. https://doi.org/10.1080/09613218.2022.2113024
11	09/2022	Journal Paper	Pan, W. , Zhang, Z. (2022). Evaluating Modular Healthcare Facilities for COVID-19 Emergency Response—A Case of Hong Kong. <i>Buildings</i> , 12(9), 1430. https://doi.org/10.3390/buildings12091430
12	02/2023	Journal Paper	Jia, S., Pei, X., Yao, W., & Wong, S. C. (2023). Self-Supervised Depth Estimation Leveraging Global Perception and Geometric Smoothness. <i>IEEE Transactions on Intelligent Transportation</i>

			<i>Systems</i> , 1–16. https://doi.org/10.1109/TITS.2022.3219604
13	01/2023	Journal Paper	Jiang, Y., Liu, X., Wang, Z., Li, M., Zhong, R. Y., & Huang, G. Q. (2023). Blockchain-enabled digital twin collaboration platform for fit-out operations in modular integrated construction. <i>Automation in Construction</i> , 148, 104747. https://doi.org/10.1016/j.autcon.2023.104747
14	08/2023	Journal Paper	Chen, C., Dong, C., Ng, C. T. , & Shi, X. (2023). Operations strategy for a construction supply chain: modular integrated construction and blockchain adoption. <i>International Transactions in Operational Research</i> . https://doi.org/10.1111/itor.13367
15	08/2023	Journal Paper	Pan, W. , Pan, M., & Yang, Y. (2023). A dialectical system framework for enhancing the modular construction supply chain. <i>Proceedings of the Institution of Civil Engineers-Engineering Sustainability</i> , 177 (4), 187-199. https://doi.org/10.1680/jensu.23.00039
16	03/2024	Journal Paper	Zhang, Y., Pan, M., Pan, W. , Yang, Y., & Wu, J. (2024). Enhancing modular construction supply chain: Drivers, opportunities, constraints, concerns, strategies, and measures. <i>Developments in the Built Environment</i> , 18, 100408. https://doi.org/10.1016/j.dibe.2024.100408
17	2024	Journal Paper (working)	Zhang, Y., Pan, M., Pan, W. , & Wu, J. (2024). Multi-level Systematic Key Performance Indicators for Modular Construction Supply Chain: The Case of Hong Kong. (Under review)
18	10/2020	Conference Paper	Pan, W. , Pan, M. and Zheng, Z. (2020). A Novel Methodological Framework of Smart Project Delivery of Modular Integrated Construction. In: <i>Proceedings of the 37th International Symposium on Automation and Robotics in Construction (ISARC)</i> . https://doi.org/10.22260/ISARC2020/0150
19	03/2021	Conference Paper	Pan, W. , Zhang, Z., & Yang, Y. (2021). Briefing: Bringing clarity and new understanding of smart and modular integrated construction. <i>Proceedings of the Institution of Civil Engineers-Smart Infrastructure and Construction</i> , 173 (1): 175-179. https://doi.org/10.1680/jsmic.21.00002
20	11/2021	Conference Paper	Zhu, A. and Pan, W. (2021). Automated Crane-lift Path Planning Using Modified Particle Swarm Optimization for High-rise Modular Integrated Construction. <i>Proceedings of the 38th International Symposium on Automation and Robotics in Construction (ISARC)</i> , Dubai, UAE, November 2-5, 2021. https://doi.org/10.22260/ISARC2021/0113
21	11/2021	Conference Paper	Zhang, Y., Yang, Y., Pan, W. , and Pan, M. (2021). Key Performance Indicators of Offsite Construction Supply Chains: A Review. <i>Proceedings of the 38th International Symposium on Automation and Robotics in Construction (ISARC)</i> , Dubai, UAE, November 2-5, 2021. https://doi.org/10.22260/ISARC2021/0128
22	07/2022	Conference Paper	Botchway, S. Y., & Pan, W. (2022). A systematic review of quality management of offsite construction. <i>Modular and Offsite Construction (MOC) Summit Proceedings</i> , 193-200. https://doi.org/10.29173/mocs282
23	08/2023	Conference Paper	Zhang, Z., Li, Y. and Pan, W. (2023) A Novel Index for Measuring the Level of Modularization in Building Construction. In <i>Proceedings of the 28th International Symposium on Advancement of Construction Management and Real Estate. CRIOCM</i> , Nanjing, China. Aug 5-6, 2023.
24	06/2024	Conference	Zhang, Y., Pan, W. , & Pan, M. (2024). PESTEL analysis of factors

		Paper	influencing the demand and supply of modular construction: Perspectives from Hong Kong. In <i>Proceedings of 41th International Symposium on Automation and Robotics in Construction (ISARC 2024)</i> , Lille, France. https://doi.org/10.22260/ISARC2024/0157
25	11/2024	Conference Paper	Ji, C., Zhang, Y., Pan, M. , Pan, W., & Ping, T. (2024). A dialectical system framework of modular construction policies. In <i>Proceedings of the 2nd International Conference on Construction Project Management and Construction Engineering (iCCPMCE)</i> , Sydney, Australia. (under publishing)
26	12/2021	Staged Report/Booklet	Pan, W. , Wu, J., Xie, M., Zhang, Y., Pan, M., & Yang, Y. (2021). Modular Integrated Construction Supply Chain in the Greater Bay Area for Hong Kong Development: Drivers, Opportunities, Constraints, Concerns, Measures and Strategies. The University of Hong Kong, Hong Kong. ISBN: 978-962-8014-30-9.
27	11/2024	Staged Report/Booklet	Pan, W. , Zhang, Y., Wu, J., Ji, C., Ping, T., & Zhang, Z. (2024). Modular Integrated Construction Supply Chain in the Greater Bay Area for Hong Kong Development: Supply-Demand Analysis and Policy Roadmap. The University of Hong Kong, Hong Kong. ISBN: 978-962-8014-31-6.
28	06/2023	Newspaper Article	潘巍 (2023 年 6 月 5 日)。「組裝合成」建造從零到一 從一到無窮。星島日報, F2。 https://www.civil.hku.hk/cicid/news/20230605/news_20230605.pdf

Appendix VI – MiC Module Suppliers (as of Apr 2024)

Supplier	Supplier name	Factory	Factory location	MiC system
1	AluHouse Company Limited	1	Zhaoqing	Steel, Concrete
2	China State Hailong Construction Technology Company Limited	2	Zhuhai	Steel, Concrete
		3	Shenzhen	Steel, Concrete
		4	Jiangmen	Steel, Concrete
3	CIMC Modular Building Systems Company Limited	5	Jiangmen	Steel
4	China Construction Science and Industry Corporation Limited	6	Huizhou	Steel
5	China Construction Integrated Science & Technology Co., Ltd.	7	Shenzhen	Steel
6	Dongguan Pristine Metal Works Limited	8	Dongguan	Steel
7	Dongguan Lap Kei Steel and Metal Work Company Limited	9	Dongguan	Steel
8	Dongguan Taigo Construction Steel Products Company Limited	10	Dongguan	Steel
9	Dongguan Jinrui Container Company Limited	11	Dongguan	Steel
10	DIT Group Limited	12	Huizhou	Concrete
11	Foshan Jianzhuang Construction Technology Company Limited	13	Foshan	Concrete
12	Foshan South Xinlian Logistics Equipment Manufacturing Company Limited	14	Foshan	Steel
13	Foshan Zhujian Modular House Company Limited	15	Foshan	Steel
14	Foshan Global Housing Technology Company Limited	16	Foshan	Steel
15	Fortress Precast Units Limited	17	Guangzhou	Concrete
16	Guangzhou Shipyard International Company Limited	18	Zhongshan	Steel
17	Guangdong Kezu Steel Structure Design and Installation Company Limited	19	Guangzhou	Steel
18	Guangzhou Moneybox Steel Structure Engineering Company Limited	20	Guangzhou	Steel
19	Guangzhou Wanyou Concrete Structure Company Limited	21	Guangzhou	Concrete
20	Guangzhou Meizong Metal Product Company Limited	22	Foshan	Steel
21	GMC Grand-bay Intelligent Manufacturing and Technology Company Limited	23	Guangzhou	Concrete
		24	Qingyuan	Concrete
22	Goldwave Steel Structure Engineering Limited	25	Jiangmen	Steel
23	Green Build Precast Concrete Company Limited	26	Huizhou	Concrete
24	Guangzhou Sanjiasan Construction and Installation Engineering Company Limited	27	Guangzhou	Steel
25	Huizhou Remac PB Technology Company Limited	28	Huizhou	Concrete
26	i-Box Modular Housing Limited	29	Foshan	Concrete
27	Kong Sing Federal Engineering Company	30	Jiangmen	Steel

Supplier	Supplier name	Factory	Factory location	MiC system
	Limited			
28	Konwo Modular House Limited	31	Dongguan	Steel
		32	Foshan	Steel
29	MDM Group Incorporated Limited	33	Huizhou	Concrete
30	Nova Deko Modular Building Company Limited	34	Foshan	Steel
31	Orientfunds Precast Limited	35	Dongguan	Concrete
32	Redland Construction Materials Ltd.	36	Dongguan	Concrete
33	Shenzhen Yahgee Modular House Company Limited	37	Foshan	Steel
34	Shenzhen Longxi Ka Lam Company Limited	38	Shenzhen	Steel
35	Shen Zhen Sun Wah Concrete Products Company Limited	39	Shenzhen	Concrete
		40	Zhongshan	Concrete
36	Shunde Lunjiao Quon Hing Construction Material Company Limited	41	Foshan	Concrete
37	Shanghai Electric Kecheng (Yingde) Construction Technology Company Limited	42	Qingyuan	Concrete
38	Unicon Concrete Products (H.K.) Limited	43	Dongguan	Concrete
39	Wing Hong Shun Enterprises Limited	44	Huizhou	Concrete
40	Wing Kei Structural Metalworks Company Limited	45	Dongguan	Steel
41	Winstand - Ho Jet (JV) Limited	46	Shenzhen	Concrete
42	Yau Lee Wah Concrete Precast Products Company Limited	47	Huizhou	Concrete
43	Zhuhai Oriental Heavy Industry Company Limited	48	Zhuhai	Steel
44	Zhuhai Yue Xin Steel Structure Engineering Company Limited	49	Zhuhai	Steel
45	Zhuhai Huimao Environmental Protection Technology Company Limited	50	Zhuhai	Concrete

Note:

- (1) “Experienced MiC module suppliers” are suppliers who have high-rise or low-rise MiC project experience in Hong Kong.
- (2) “High-potential suppliers” are PC suppliers included in the government department’s supplier list for the Hong Kong market and suppliers involved in Hong Kong’s pre-acceptance list (i.e. IPA).
- (3) The list is sorted alphabetically from A to Z.
- (4) Data source: public domains (e.g. BD’s list of pre-accepted MiC systems, CIC website) and MiCLab survey (e.g. interviews with the MiC suppliers and relevant institutions in the GBA).

Appendix VII – List of MiC Projects in HK (as of Oct 2024)

Project	Project name	Building type	Total storey	MiC system	Status
1	MiC Display Centre	Others	2	Steel	Completed
2	Relocation of Sha Tin Sewage Treatment Caverns Project - Community Liaison Centre	Others	1	Steel	Completed
3	FEHD Skylight Market at Tin Shui Wai	Others	1	Steel	Completed
4	InnoCell at Hong Kong Science and Technology Park	Hostel	17	Steel	Completed
5	Transitional Homes at Nam Cheong Street in Sham Shui Po	Transitional housing	4	Steel	Completed
6	Disciplined Services Quarters for the Fire Services Department at Pak Shing Kok, Tseung Kwan O	Staff quarter	17	Concrete	Completed
7	Student Residence at Wong Chuk Hang Site for the University of Hong Kong	Hostel	20	Steel	Completed
8	Temporary Quarantine Facilities in Lei Yue Mun Park and Holiday Village	Quarantine camp	1~2	Steel	Completed
9	Temporary Quarantine Facilities in Pat Heung	Quarantine camp	2	Steel	Completed
10	Sai Kung Temporary Quarantine Facilities	Quarantine camp	2	Steel	Completed
11	Quarantine Camp in Penny's Bay	Quarantine camp	2	Steel	Completed
12	Modular Social Housing Scheme - Junction of Sung Wong Toi Road and To Kwa Wan Road Project	Transitional housing	3	Steel	Completed
13	Hong Kong Infection Control Centre, North Lantau Hospital	Hospital	2	Steel	Completed
14	Residential Care Homes for the Elderly ("RCHE") in Kwu Tung North	Public housing	8	Concrete	Completed
15	Tsing Yi community isolation facility	Quarantine Camp	1	Steel	Completed
16	San Tin community isolation facility	Quarantine Camp	1	Steel	Completed
17	Hong Kong-Zhuhai-Macao Bridge community isolation facility	Quarantine Camp	1	Steel	Completed
18	Fanling community isolation facility	Quarantine Camp	1	Steel	Completed
19	Hung Shui Kiu community isolation facility	Quarantine Camp	1	Steel	Completed
20	Yuen Long community isolation facility	Quarantine Camp	1	Steel	Completed
21	Penny's Bay community isolation facility	Quarantine Camp	2	Steel	Completed
22	Lok Ma Chau community isolation facility	Quarantine Camp	1	Steel	Completed
23	Kai Tak community isolation	Quarantine	4	Steel	Completed

Project	Project name	Building type	Total storey	MiC system	Status
	facility	Camp			
24	Yen Chow Street Modular Social Housing Project	Transitional housing	4	Steel	Completed
25	Transitional Housing Project at United Court, Tung Tau, Yuen Long	Transitional housing	4	Steel	Completed
26	Ying Wa Module Community	Transitional housing	4	Steel	Completed
27	Transitional Homes at Yip Shing Street in Kwai Chung	Transitional housing	4	Steel	Completed
28	Transitional Housing Project at Pok Oi Kong Ha Wai Village (Phase 1 & 2)	Transitional housing	4	Steel	Completed
29	Construction of a 36-classroom primary school at Area 9, Tai Po	School	6~8	Concrete	Completed
30	Elderly's Home at Jat Min Chuen in Sha Tin	Public housing	10	Steel	Completed
31	Transitional Housing Project at "Yan Oi House" at Hung Shui Kiu	Transitional Housing	4	Steel	Completed
32	Transitional Housing at Yau Ma Hom Road and Cheung Wing Road	Transitional Housing	4	Steel	Completed
33	Transitional Housing at Area 1B2 Muk On Street, Kai Tak	Transitional Housing	4	Steel	Completed
34	Transitional Housing Project at "Tsuen Fook Kui" at Luen Yan Street, Tsuen Wan	Transitional housing	4	Steel	Completed
35	Transitional Housing in Wong Yue Tan, Tai Po	Transitional housing	4	Steel	Completed
36	Transitional Housing at Cheung Shun Street, Cheung Sha Wan	Transitional housing	4	Steel	Completed
37	Transitional Housing at Tong Yin Street, Tseung Kwan O	Transitional housing	4	Steel	Completed
38	Transitional Housing at Chi Shin Street, Tseung Kwan O	Transitional housing	4	Steel	Completed
39	Transitional Housing Project at "CONCORDIA Sheung Yue River" at Fan Kam Road, Yuen Long	Transitional housing	4	Steel	Completed
40	Transitional Housing at Junction at Hoi Hing Road and Hoi Kok Street, Tsuen Wan	Transitional housing	2	Steel	Completed
41	Transitional Housing at Lot 2160 RP (Part) in D.D. 106 and Adjoining Government Land in Kam Tin, Yuen Long	Transitional housing	4	Steel	Completed
42	Transitional Housing Project at "T-Loft@Lok Wo" at Lok Wo Sha Lane, Ma On Shan	Transitional housing	4	Steel	Completed
43	Transitional Housing at Po Lam Road North, Tseung Kwan O	Transitional housing	4	Concrete	Completed
44	Transitional Housing at Sheung On Street, Chai Wan	Transitional housing	4	Concrete	Completed
45	Transitional Housing at Wong Tai	Transitional	4	Steel	Completed

Project	Project name	Building type	Total storey	MiC system	Status
	Sin Road	housing			
46	Transitional housing development at Carmel Road, Stanley	Transitional housing	3	Concrete	Completed
47	Transitional Housing Project at “Wellness Lodge” Castle Peak Road, Tsing Lung Tau	Transitional Housing	3	Steel	Completed
48	Transitional Housing Project at Light Village	Transitional housing	3	Steel	Completed
49	Transitional Housing Project at Choi Hing Road, Choi Hung	Transitional Housing	8	Steel	Completed
50	Transitional Housing at Ngau Tam Mei South (Chun Shin Road), Yuen Long	Transitional housing	4	Steel	Completed
51	Transitional Housing at Ngau Tam Mei North (Sam Tam Road), Yuen Long	Transitional housing	4	Steel	Completed
52	Transitional Housing Project at Lau Fau Shan, Yuen Long	Transitional housing	4	Steel	Completed
53	Former Wing On School	Transitional housing	4	Steel	Completed
54	Reconstruction of Lai Wan Market	Others	1	Steel	Completed
55	Transitional Housing Project at Hung Lok Road, Hung Hom	Transitional housing	4	Steel	Completed
56	A 24-classroom primary school at Au Pui Wan Street, Fo Tan	School	4	Concrete	Completed
57	Two special schools at Renfrew Road, Kowloon Tong	School	6	Concrete	Completed
58	New Acute Hospital at Kai Tak Development Area	Hospital	12~21	Steel	Ongoing
59	Redevelopment of Prince of Wales Hospital - New In-patient Extension Block	Hospital	TBA	Steel	Ongoing
60	High West Site Development	Hostel	20	Steel	Ongoing
61	In-situ Reprovisioning of Sha Tin Water Treatment Works (South Works) – Administration Building	Others	5	Steel	Ongoing
62	Composite development at Ash Street, Tai Kok Tsui	Private residential	26	Concrete	Ongoing
63	Residential Development for Tonkin Street and Fuk Wing Street	Private residential	28	Concrete	Ongoing
64	Subsidised Sale Flats Project in Hung Shui Kiu	Public housing	28	Concrete	Ongoing
65	A 30-classroom primary school in Tsuen Wan West Station, Tsuen Wan	School	6	Concrete	Ongoing
66	A 30-classroom Primary School at Site 1B-4, Kai Tak Development	School	6	Concrete	Ongoing
67	A 30-classroom Primary School, Development of Anderson Road Quarry Site, Sai Kung	School	6	Concrete	Ongoing
68	Transitional Housing Project at “CONCORDIA Tsat Sing Kong” at	Transitional Housing	4	Steel	Ongoing

Project	Project name	Building type	Total storey	MiC system	Status
	Tsat Sing Kong, Pat Heung and Kam Tin, Yuen Long				
69	A 30-classroom Primary School at Site KT2a, Development at Anderson Road, Kwun Tong	School	7	Concrete	Ongoing
70	The Hong Kong Girl Guides Association Headquarter and Youth Hostel	Hostel	26	Steel	Ongoing
71	Transitional Housing at Area 1B3 Muk On Street, Kai Tak	Transitional housing	4	Steel	Ongoing
72	Transitional Housing Project at “Pok Oi Sing Ping Village” at Ping Che Road, Ta Kwu Ling	Transitional housing	4	Steel	Ongoing
73	Public Housing Development at Tung Chung Area 99	Public housing	12	Concrete	Ongoing
74	Design and Construction of the Expansion of the Legislative Council Complex	Others	/	Steel	Ongoing
75	Student Hostels for City University of Hong Kong	Hostel	17	Steel	Ongoing
76	Western Police Married Quarters	Staff quarter	28~29	Concrete	Ongoing
77	PolyU Student Hostel at Tat Hong Avenue, Kowloon Tong	Hostel	15	Steel	Ongoing
78	Chinese Medicine Hospital and Government Chinese Medicine Testing Institute in Tseung Kwan O	Hospital	9	Steel & Concrete	Ongoing
79	Public Housing Development at Anderson Road Quarry Site R2-6 and R2-7	Public housing	17~28	Concrete	Ongoing
80	LPH 518: Yau Pok Road, Yuen Long	Light public housing	3	Steel	Ongoing
81	LPH 518: Area 3A, Tsing Fuk Lane, Tuen Mun	Light public housing	18	Steel	Ongoing
82	LPH 518: Choi Hing Road, Nagu Tau Kok	Light public housing	18	Steel	Ongoing
83	LPH 519: Olympic Avenue, Kai Tak	Light public housing	17~19	Steel	Ongoing
84	LPH 521: Area 54, Yan Po Road, Tuen Mun	Light public housing	17~19	Steel	Ongoing
85	Construction of Public Housing Development at Kwu Tung North Area 19 Phase 1A and 1B	Public housing	38~40	Concrete	Ongoing
86	Joint Cavern Development at Anderson Road Quarry Site	Others	3	Concrete	Ongoing
87	Cyberport Expansion Project	Others	TBA	Steel	Ongoing
88	PolyU Student Hostel at Ho Man Tin Slope Campus	Hostel	11	Steel	Ongoing
89	LPH 520: Hang Kwong Street, Ma On Shan	Light public housing	3	Steel	Ongoing
90	LPH 521: Sheung On Street, Chai Wan	Light public housing	4	Steel	Ongoing
91	LPH 520: Lok On Pai, Tsing Fat	Light public	17~19	Steel	Ongoing

Project	Project name	Building type	Total storey	MiC system	Status
	Street, Siu Lam	housing			
92	A 24-classroom Primary School at Luk Lau Avenue, Wong Tai Sin	School	TBA	Concrete	Ongoing
93	Tung Chung Private residential building	Private residential	46	Concrete	Ongoing
94	Henderson project at Temple Street	Private residential	TBA	Concrete	Ongoing
95	Fire Station--cum--ambulance Depot, Departmental Quarters in Area 72, Tseung Kwan O	Staff quarters	17	Concrete	Ongoing
96	Construction of Public Housing Development at Fanling North Area 15 East Phase 1	Public housing	40	Concrete	Ongoing
97	Chai Wan Ambulance Depot and Departmental Quarters	Staff quarters	TBA	TBA	Ongoing
98	Health Centre and Social Welfare Facilities Building in Siu Sai Wan	Others	13	TBA	Ongoing
99	A 30-classroom Primary School & a 30-classroom Secondary School at Site E2 & E3, Development of Anderson Road Quarry Site, Sai Kung	School	TBA	Concrete	Ongoing
100	Public Housing Development at Tak Tin Street, Lam Tin	Public housing	>20	Concrete	Ongoing
101	Clinical Training Amenities Centre (CTAC) at No.6 Sassoon Road	Hostel	TBA	TBA	Ongoing
102	A 30-classroom Primary School at Lin Cheung Road, Sham Shui Po	School	3~5	Concrete	Ongoing
103	Heritage Conservation and Resource Centre	Others	TBA	Steel	Ongoing
104	Construction of Columbarium at Wo Hop Shek Cemetery - Phase 2	Others	TBA	Steel	Ongoing
105	Columbarium at Siu Ho Wan, Lantau	Others	TBA	Steel	Ongoing
106	Educational Field Study Centre at Little Palm Beach	Others	TBA	Steel	Ongoing
107	Youth Hostel Development at 9 Arran Street	Hostel	22	Steel	Ongoing
108	A 30-classroom primary school at Site KT2c, Development at Anderson Road, Kwun Tong	School	6	Concrete	Ongoing
109	Redevelopment of Grantham Hospital	Hospital	TBA	Steel	Ongoing
110	Redevelopment of Our Lady of Maryknoll Hospital - Main Works	Hospital	12	Steel	Ongoing
111	Youth Hostel Scheme – construction works of the youth hostel project by Tung Wah Group of Hospitals	Hostel	21	Steel	Ongoing
112	Construction of Public Housing Development at Kwu Tung North Area 19 Phase 2	Public housing	38~39	Concrete	Ongoing

Project	Project name	Building type	Total storey	MiC system	Status
113	Community Health Centre Building at Shek Kip Mei	Hospital	TBA	Steel	Ongoing
114	Construction of a 12-classroom Special School at Oi Kwan Road, Wan Chai	School	TBA	Concrete	Ongoing
115	Design and Construction of Joint-user Complex with Market in Area 67, Tseung Kwan O	Others	TBA	Steel	Ongoing
116	Construction of a 30-classroom Primary School at Area 89 (Northern side), Tung Chung	School	TBA	Concrete	Ongoing
117	Design and Construction of Hoi Ting Road Joint User Complex	Others	TBA	Steel	Ongoing
118	Kwai Chung Hospital (Phase 2)	Hospital	TBA	Steel	Ongoing
119	Kwun Tong Composite Development Project	Others	TBA	TBA	Ongoing
120	Construction of a 30-classroom Primary School at Area 17, Fanling North	School	TBA	Concrete	Ongoing

Note:

(1) MiC projects refer to projects with the superstructure constructed by free-standing integrated modules, excluding projects built with volumetric precast bathrooms/kitchens.

(2) “Completed” means the project has been granted the OP as of October 2024.

(3) “Ongoing” means the project is either under design or construction.

(4) Data source: public domains (e.g. CIC and ArchSD website) and MiCLab survey (e.g. interviews with the public sector clients, private developers, and main contractors).

Appendix VIII – Research Team

Role	Name	Organisation
Principal Investigator	Prof. Wei Pan	The University of Hong Kong
Co-Investigator (Co-I)	Prof. S.C. Wong	The University of Hong Kong
Co-I	Prof. Francis T.K. Au	The University of Hong Kong
Co-I	Prof. Thomas S.T. Ng	The City University of Hong Kong
Co-I	Prof. George Q. Huang	The Hong Kong Polytechnic University
Co-I	Prof. Ben Young	The Hong Kong Polytechnic University
Co-I	Prof. Daniel Chi To Ng	The Hong Kong Polytechnic University
Co-I	Prof. Cheng Su	South China University of Technology
Co-I	Dr. Sanyuan Niu	Development Research Center
Co-I	Dr. Xiaojing Zhao	Beijing Institute of Technology
Researcher	Dr. Mi Pan	The University of Hong Kong
Researcher	Dr. Yi Yang	The University of Hong Kong
Researcher	Dr. Zhiqian Zhang	The University of Hong Kong
Researcher	Dr. Zhenjie Zheng	The University of Hong Kong
Researcher	Dr. Tianyao Ping	The University of Hong Kong
Researcher	Ms. Jiewen Wu	The University of Hong Kong
Researcher	Ms. Yidan Zhang	The University of Hong Kong
Researcher	Mr. Chenyi Ji	The University of Hong Kong

Appendix IX – Research & Knowledge Dissemination Activities

No.	Category	Date	Location	Activity Description	WP	No. of Participants
1	Questionnaire survey	03/2021-09/2021	Online & PDF version	To examine and explore the potential drivers, opportunities, constraints and concerns, as well as recommended strategies and measures associated with the MiC supply chain in the GBA	WP1	Approached 2,644 975 returned 712 valid responses
2	Questionnaire survey	10/2022-03/2023	Online & PDF version	To analyse the importance of each indicator quantitatively and identify the KPIs	WP2	Approached 371 147 valid responses
3	Questionnaire survey	07/2022-01/2023	Online & PDF version	To collect information on MiC factories' layout, production facility, product types, production capacity, etc.	WP3	Approached 140 55 valid responses
4	Questionnaire survey	09/2024-11/2024	Online & PDF version	To validate the key findings of MiC 'demand-and-supply' predictive model and scenarios, as well as the proposed public policy roadmap and action plan.	WP3-5	Approached 4,121 333 returned 158 valid responses
5	Interview	04/2021-11/2021	Zoom/ phone call	To collect more details about the respondents' experiences and perceptions of the studied items to verify the questionnaire results	WP1	80
6	Interview	06/2022-11/2022	Zoom	To examine the MiC supply chain measurement framework and the preliminary list of indicators	WP2	12
7	Interview	01/2024-02/2024	Zoom or Physically	To collect information on: 1) MiC factories' layout, production facility, product types, production capacity, etc.; 2) MiC demand in public and private sector	WP3-5	12

No.	Category	Date	Location	Activity Description	WP	No. of Participants
8	Focus group meeting (FGM)	05/2022	Zoom	To examine the MiC supply chain measurement framework and the preliminary list of indicators	WP2	14
9	FGM	06/2022	Zoom	To examine the MiC supply chain measurement framework and the preliminary list of indicators	WP2	13
10	FGM	07/2022	Zoom	To examine the MiC supply chain measurement framework and the preliminary list of indicators	WP2	9
11	FGM	05/2024	HKU	To further verify the key findings of MiC ‘demand-and-supply’ predictive model and scenarios, as well as the proposed public policy roadmap and action plan.	WP3-5	25
12	FGM	10/2024	HKU	To further verify the key findings of MiC ‘demand-and-supply’ predictive model and scenarios, as well as the proposed public policy roadmap and action plan.	WP3-5	31
13	FGM	10/2024	HKU	To further verify the key findings of MiC ‘demand-and-supply’ predictive model and scenarios, as well as the proposed public policy roadmap and action plan.	WP3-5	31
14	Site visit	06/2021	InnoCell site	To observe the performanc of the completed pilot MiC project to get a better understanding of the supply chain performance and issues	WP2	40
15	Site visit	11/2022	Wong Chuk Hang site	To observe MiC project delivery processes of the pilot MiC project to get a better understanding of the supply chain performance and issues	WP2	11

No.	Category	Date	Location	Activity Description	WP	No. of Participants
16	Site visit	01/2024	HKU High West site	To observe MiC project delivery processes of the pilot MiC project to get a better understanding of the supply chain performance and issues	WP3-5	20
17	Site visit	01/2024	Anderson Road site	To observe MiC project delivery processes of the pilot MiC project to get a better understanding of the supply chain performance and issues	WP3-5	20
18	Site visit	05/204	Jat Min Chuen site	To observe MiC project delivery processes of the pilot MiC project to get a better understanding of the supply chain performance and issues	WP3-5	20
19	Factory visit	03/2023-04/2023	GBA	1) To investigate and gain deeper understanding of MiC factories' layout, production facility, product types, production capacity, etc.	WP3-5	30
20	Factory visit	04/2024-04/2024	GBA	To investigate and gain deeper understanding of MiC factories' layout, production facility, product types, production capacity, etc.	WP3-5	32
21	Workshop	11/2022	Zoom	To elicit common learning among the participants and to invite comments to help recommend the way forward of this study	WP2	34
22	Workshop	03/2024	Guangzhou	To explore MiC practitioners' opinions on future MiC supply and demand and collect feedback of the results of MiC supply and demand analysis	WP3-5	30

No.	Category	Date	Location	Activity Description	WP	No. of Participants
23	Booklet Launch	12/2021	HKU & Zoom	To publish the first public policy deliverable and further explore participants' insights on the identification and enhancement of the MiC supply chain	WP1	205
24	Forum	08/2023	HKU & Zoom	To share the preliminary public policy roadmap with action plan for the supply chain and to solicit feedback from various stakeholders	WP3-5	244
25	Forum	11/2024	Zoom	To disseminate the key findings of the research project and launch the research deliverable	WP3-5	280
26	Research project meetings	11/2020	Zoom	To guide the research direction and facilitate the recommendation of the public policy roadmap and action plan	WP1-5	21
27	Research project meetings	05/2021	Zoom	To guide the research direction and facilitate the recommendation of the public policy roadmap and action plan	WP1-5	20
28	Research project meetings	11/2021	Zoom	To guide the research direction and facilitate the recommendation of the public policy roadmap and action plan	WP1-5	12
29	Research project meetings	05/2022	Zoom	To guide the research direction and facilitate the recommendation of the public policy roadmap and action plan	WP1-5	19
30	Research project meetings	11/2022	Zoom	To guide the research direction and facilitate the recommendation of the public policy roadmap and action plan	WP1-5	15
31	Research project meetings	05/2023	Zoom	To guide the research direction and facilitate the recommendation of the public policy roadmap and action plan	WP3-5	20

No.	Category	Date	Location	Activity Description	WP	No. of Participants
32	Research project meetings	11/2023	Zoom	To guide the research direction and facilitate the recommendation of the public policy roadmap and action plan	WP3-5	18
33	Research project meetings	05/2024	Zoom	To guide the research direction and facilitate the recommendation of the public policy roadmap and action plan	WP3-5	20
34	Conference presentation	10/2020	Zoom	Conference paper entitled “A Novel Methodological Framework of Smart Project Delivery of Modular Integrated Construction” presented by Prof Wei Pan (PI) at the 37th International Symposium on Automation and Robotics in Construction (ISARC 2020)	N/A	>200
35	Conference presentation	11/2021	Zoom	Conference paper entitled “Automated Crane-lift Path Planning Using Modified Particle Swarm Optimization for High-rise Modular Integrated Construction” presented by Mr Aimin Zhu at the 38th International Symposium on Automation and Robotics in Construction (ISARC), Dubai, UAE	N/A	~50
36	Conference presentation	11/2021	Zoom	Conference paper entitled “Key Performance Indicators of Offsite Construction Supply Chains: A Review” presented by Ms Yidan Zhang at the 38th International Symposium on Automation and Robotics in Construction (ISARC), Dubai, UAE	WP2	~50
37	Conference presentation	07/2022	Zoom	Conference paper entitled “A systematic review of quality management of offsite construction” presented by Mr Botchway, S. Y. at the 2022 Modular and Offsite Construction (MOC) Summit, Alberta,	WP1-2	~50

No.	Category	Date	Location	Activity Description	WP	No. of Participants
				Canada		
38	Conference presentation	08/2023	Nanjing	Conference paper entitled “A novel index for measuring the level of modularization in building construction” delivered by Dr Zhang Zhiqian (Researcher) in the CRIOCM 28th International Symposium on Advancement of Construction Management and Real Estate	WP2	~50
39	Conference presentation	06/2024	France	Conference paper entitled “PESTEL analysis of factors influencing the demand and supply of modular construction: Perspectives from Hong Kong” delivered by Ms Yidan Zhang at the 41th International Symposium on Automation and Robotics in Construction (ISARC 2024)	WP3	~50
40	Conference presentation	07/2024	US	Conference paper entitled “Digitalizing Volumetric Module Transport for Modular Integrated Construction” delivered by Prof Wei Pan (PI) at the 2024 ASCE International Conference on Computing in Civil Engineering	N/A	~50
41	Conference presentation	11/2024	Australia	Conference paper entitled “A dialectical system framework of modular construction policies” delivered by Mr Chenyi Ji at the 2nd International Conference on Construction Project Management and Construction Engineering (iCCPMCE 2024)	WP4	~50
42	Lecture/ Seminar	05/2021	Hong Kong	Talk entitled “Smart MiC technology and project delivery” delivered by Prof Wei Pan (PI) at the CPD seminar on Building Quarantine Camps to Combat COVID-19 – Smart MiC organised by HKIA	N/A	>100

No.	Category	Date	Location	Activity Description	WP	No. of Participants
43	Lecture/ Seminar	04/2021	Hong Kong	Talk entitled “Build Smart – Innovation in Construction” delivered by Prof Wei Pan (PI) at the InnoEdge Talk organised by the Innovation Academy of The University of Hong Kong	N/A	~50
44	Lecture/ Seminar	04/2021	Hong Kong	Talk entitled “MiC Past, Present and Prospective” delivered by Prof Wei Pan (PI) at the seminar organised by HKIE Civil Division	N/A	>100
45	Lecture/ Seminar	11/2021	Hong Kong	Talk entitled “High Productivity Construction - Modular Integrated Construction” delivered by Prof W Pan (PI) at Construction R&D Forum – “Bringing Applied R&D to a New Height” organised by DEVB and the University-Government-Industry (UGI) Consortium	N/A	>200
46	Lecture/ Seminar	12/2022	Hong Kong	Presentation entitled ‘Future Building, Future Construction Management’ delivered by Prof Wei Pan (PI) at the CRIOCM 27th International Symposium on Advancement of Construction Management and Real Estate	N/A	>200
47	Lecture/ Seminar	01/2023	Hong Kong	Presentation entitled “An overview of the landscape of MiC in the construction industry” delivered by Prof Wei Pan (PI), for CIC master class on MiC project implementation (Project managers)	N/A	~50
48	Lecture/ Seminar	03/2023	Guangzhou	Presentation entitled “Innovation in Construction and Infrastructure Development - Modular Integrated Construction” delivered by Prof Wei Pan (PI) at the South China University of Technology	N/A	~50

No.	Category	Date	Location	Activity Description	WP	No. of Participants
49	Lecture/ Seminar	07/2023- 08/2023	Shanghai, Nanjing	Presentation entitled “建造創新與組裝合成” delivered by Prof Wei Pan (PI) at Tongji University, Shanghai Jiaotong University and Southeast University	N/A	~50
50	Lecture/ Seminar	09/2023	Nanning	Presentation entitled “模块化組合建造發展與前沿” by Prof Wei Pan (PI) at Modular Building Forum organised by the Ministry of Housing and Urban-Rural Construction (MOHURD)	N/A	~50
51	Lecture/ Seminar	09/2023	Shenzhen	Keynote Speech entitled “模块組合建造高質量發展創新前沿” delivered by Prof Wei Pan (PI) for the 2023 Summit & Shenzhen Architecture 20-year of Achievement Exhibition on Building Industrialization Development	N/A	~50
52	Lecture/ Seminar	11/2023	Hong Kong	Keynote Speech entitled “MiC Enhanced High-Productivity and Sustainable Construction” delivered by Prof Wei Pan (PI) at the Global Construction Sustainability Forum and Exhibition organised by the DEVB of the HKSAR Government and the CIC	N/A	>200
53	Lecture/ Seminar	12/2023	Hong Kong	Guest of Honour talk entitled “MiC for Sustainable Development” delivered by Prof Wei Pan (PI) at the ASCE Greater China Section Annual Dinner	N/A	~50
54	Lecture/ Seminar	01/2024	Huizhou	Keynote Speech entitled “MiC Past, Present and Prospect” delivered by Prof Wei Pan (PI) at the MiC Supply Chain Conference co-organised by the DEVB of the HKSAR	N/A	>200

No.	Category	Date	Location	Activity Description	WP	No. of Participants
				Government, Huizhou Municipal People's Government, and Department of Housing and Urban-Rural Development of Guangdong Province		
55	Lecture/ Seminar	02/2024	Hong Kong	Invited speech entitled “Accelerating Sustainable Housing Supply through MiC Innovations” delivered by Prof Wei Pan (PI) at the Hong Kong Green Week - Leveraging BuildTech and Green Finance in Public Housing Event organised by the Housing Bureau of the HKSAR Government	N/A	>200
56	Lecture/ Seminar	07/2024	Beijing	Public lecture entitled “Modular Integrated Construction (MiC) and Low-Carbon Building Research” delivered by Prof Wei Pan (PI) at Tsinghua University	N/A	~50
Total	Over 56 times of research and knowledge dissemination activities					>5,000