

A Dialectical System Framework of Modular Construction Policies

Chenyi Ji^{1*}, Yidan Zhang¹, Mi Pan², Wei Pan³, and Tianyao Ping⁴

¹Ph.D Candidate, Department of Civil Engineering, The University of Hong Kong, Hong Kong, China

²Assistant Professor, University of Macau, Macau, China

³Professor, Department of Civil Engineering, The University of Hong Kong, Hong Kong, China

⁴Postdoctoral Fellow, Department of Civil Engineering, The University of Hong Kong, Hong Kong

Corresponding author's E-mail: chenyesi@connect.hku.hk

Abstract

Modular construction (MC) is an innovative construction method for enhancing productivity and sustainability. Various countries and regions have adopted explicit policies to promote MC, but the complexity of relevant policies impairs understanding and knowledge sharing. This study develops a dialectical system framework of MC policies through the combination of literature review and content analysis and validates its effectiveness in the case of modular integrated construction (MiC) policies in Hong Kong. The framework addresses MC policies as complex dialectical systems, consisting of the technical system, stakeholder network, and the embedded political, economic, social, technological, environmental, and legal (PESTEL) contexts. The technical system further interprets MC policies in terms of four key components, namely, target and timeline, definition and scope, knowledge and labor, and capital. The framework underscores the interdependency between the technical elements of the policy within their complex and interactive broad contexts. Focusing solely on the technical system is inadequate to understand the policy intentions and may hinder effective policy implementation, highlighting the need to incorporate human behaviors and PESTEL contexts. The case study validates the framework as a theoretical lens to understand and analyze the complexity of MC policies, demonstrating the policy evolution on the four technical components and shaped by the broader PESTEL contexts. The developed framework can provide a foundation to review current policies and guide future policy development of MC.

Keywords: Modular construction, Policy, Dialectical system, PESTEL, Modular integrated construction.

1. INTRODUCTION

Modular construction (MC) represents the highest level of off-site construction by transferring fragmented site-based construction activities to a highly controlled manufacturing environment (Alam et al., 2019, Pan and Hon, 2020). Various countries and regions use different terminologies to describe MC, e.g., modular integrated construction (MiC) in Hong Kong, prefabricated prefinished volumetric construction (PPVC) in Singapore, modern methods of construction (MMC) in the United Kingdom (UK), and volumetric modular construction in Australia (Pan et al., 2020). In this paper, the term “modular construction” (MC) is collectively adopted while maintaining the original terms when referring to specific contexts. Various countries and regions, such as Singapore (BCA, 2013), Hong Kong (Chief Executive, 2022), and the UK (DLUHC, 2022, DLUHC, 2023), have proposed targets for MC development as part of relevant policies. Despite the policy impetus, there are gaps between policy intentions and actual practices. On the one hand, policymakers acknowledge the lack of clear and comprehensive MC policies beyond target and timeline considerations (Jin et al., 2022). On the other, previous research has noted the industry’s insufficient awareness and understanding of MC policies (Wuni and Shen, 2020, Kolugala et al., 2022). To support the implementation and knowledge sharing of MC policies, it is important to understand MC policies in a systems manner. This paper

addressed MC policies as a complex dialectical system. The aim of this paper is to develop and verify a dialectical system framework for systematically understanding MC policies. Following the introduction, the paper explains the research methodology, presents a dialectical system framework of MC policies, and validates the framework with the case of MiC policies in Hong Kong. Finally, the paper draws conclusions.

2. METHODOLOGY

The research was carried out in three interrelated stages drawing on the dialectical systems theory (see in Figure 1). The first stage was a literature review to develop a dialectical framework that conceptualizes the complex characteristics of MC policies and guides the review of MiC policies in Hong Kong. The second stage was content analysis to synthesize existing knowledge on dialectics of MC policies and refine the framework. The third stage was a case study of MiC policies in Hong Kong to contextualize and validate the established dialectical system framework.

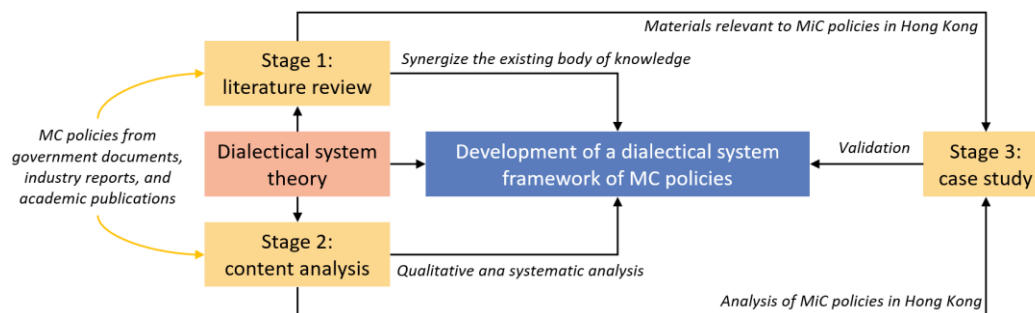


Figure 1. Overall research design

3. DIALECTICAL SYSTEM FRAMEWORK OF MC POLICIES

A dialectical system framework of MC policies is adapted from Pan and Ning (2015) and shown in Figure 2. This framework captures the complexity of MC policies, concerning the interdependence between the technical elements of MC policies within the stakeholder network and the broad contexts. The technical system of MC policies encompasses four interconnected components: target and timeline; definition and scope; knowledge and labor; and capital. Stakeholders are categorized into four groups: demand group (e.g., clients, end users, and the general public), supply group (e.g., manufacturers, contractors, and advisors in different disciplines), regulation group (e.g., the government and its departments and agencies), and institution group (e.g., universities and institutions) (Pan and Pan, 2020). Contexts are framed as political, economic, social, technological, environmental, and legal (PESTEL) (Jin et al., 2022).

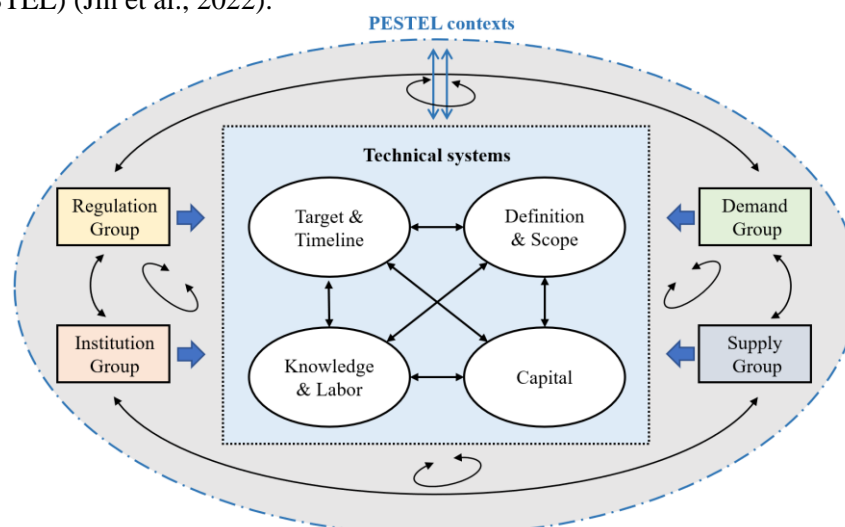


Figure 2. Dialectical system framework of modular construction policies

3.1. Target and timeline

Target and timeline of MC policies refers to the specific goals and timeframes set by policymakers to promote MC adoption, which should be tailored to different types and sectors of buildings, e.g., residential or non-residential, public or private, and government or non-government buildings (Sun et al., 2020). The MC policy initiatives with explicit targets are often prompted by the housing crisis in the social context, high-rise high-density environmental contexts, and unaffordable houses in the economic context (Bertram et al., 2019). Some countries and regions have set their MC policy initiatives with explicit or implicit targets and timelines (see Table 1). These MC policy initiatives complement the political and legal contexts, refining the target and timeline. For instance, the revision of the target and timeline in the UK reflects changes in political priority and reduces the pressure on the housing market. The demand group, primarily driven by the public sector, is directly impacted by targets and timelines set in MC policies (Woźniak-Szpakiewicz, 2016). The favorable political and technological contexts in Singapore and Hong Kong have fostered the development of PPVC and MiC, leading to the establishment of specific targets for MC adoption.

Table 1. MC policy initiatives with targets and timelines

Country/region	MC policy initiatives	Targets and timelines
UK	Fixing Our Broken Housing Market (DCLG, 2017)	25% of public housing must be built using MMC.
UK	Homes England strategic plan 2023 to 2028 (DLUHC, 2023)	25% of homes delivered through strategic partnerships must be built using MMC by 2026.
Singapore	Building Our Future (BCA Annual Report 2013/2014) (BCA, 2013)	PPVC is mandatory for selected non-landed residential Government Land Sale (GLS) sites from 1 November 2014.
Hong Kong	The Chief Executive's 2022 Policy Address (Chief Executive, 2022)	No less than 50% of the public housing projects will adopt the MiC approach from 2023 to 2027.

3.2. Definition and scope

Definition of MC (e.g., PPVC in Singapore) and the temporal scope (i.e., which stage of MC is addressed) are critical in MC policies. The social context shapes the cultural preference in different regions, leading to different terms specified for MC by the regulation group in MC policies in different regions. For instance, Singapore uses the words 'prefinished' and 'volumetric' in PPVC to emphasize the highest level of offsite construction. In the UK, MMC is collectively used in relevant policies to cover all modern methods of construction, including MC. In the United States (US), prefabrication, preassembly, modularization, and offsite fabrication (PPMOF) are collectively used in relevant policies. Regarding the dimension of scope, the Building and Construction Authority (BCA) in Singapore has set a series of Building Innovation Panel Checklists in the PPVC policy to guide different requirements of module design, manufacturing, quality inspection, transportation, installation, and maintenance (BCA, 2022).

3.3. Knowledge and labor

Knowledge and labor are important elements in MC policies to support the wider adoption and development of MC via knowledge transfer and workforce upskilling (Ferdous et al., 2019, Kolugala et al., 2022). During the early development stage, several regions, such as Singapore, the UK, and Australia, have adopted pilot or demonstration MC projects as part of MC policies to raise public awareness and support knowledge sharing. Once the socio-economic context of MC becomes favorable, policies for technological innovation, professional training, and academic research are then issued to support institutional work and develop supply capacity. The UK launched a joint venture

investing in skills and apprenticeships for MC in 2018 (DLUHC, 2023). Australia has set up talent introduction and training programmes for MC as part of the New Industries Fund (DF, 2022).

3.4. Capital

Capital denotes the financial resources and investments required for the successful implementation of MC, including funding allocation, budget planning, and financial mechanisms designed for MC adoption and development in policies. MC policies should specify the connection between economic incentives in various forms, such as dedicated funding, gross floor area (GFA) concessions, and the prescriptive requirements of MC adoption (Pan et al., 2019, Chan et al., 2023). Most MC policies consisting of capital directly set up earmarked funding schemes to subsidize special housing programmes, e.g., the Home Building Fund in the UK (DCLG, 2017); modular home programmes, e.g., the Building Bonus Grant in Australia (DF, 2022); registered construction companies part of the costs in PPVC application, e.g., the BuildSG Transformation Fund in Singapore (BCA, 2017); and technology adoption in MC, e.g., the CITF in Hong Kong (Chief Executive, 2018).

4. CASE OF MC POLICIES IN HONG KONG

The developed dialectical system framework is examined using the case of MiC policies in Hong Kong. The case study adopted the Chief Executive’s (CE’s) Policy Addresses (PAs) as the data source, as it outlines the high-level policy directions and key measures in Hong Kong. The overview of MiC relevant policies extracted from CE’s PAs in terms of target and timeline, definition and scope, knowledge and labor, and capital is shown in Figure 3.

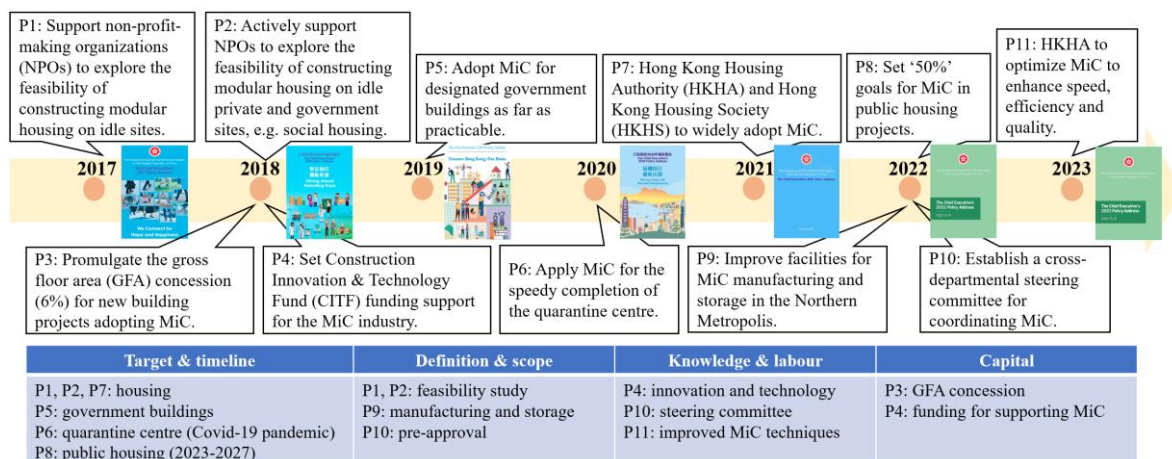


Figure 3. Overview of key MiC policies in Hong Kong

4.1. Target and timeline

MiC was introduced as a new policy initiative to promote innovative construction (Chief Executive, 2017, Pan et al., 2019). Hong Kong first targeted non-profit-making organizations to explore the feasibility of constructing modular housing on idle private and government sites (Chief Executive, 2017, Chief Executive, 2018). As the political contexts of MiC policies became favorable, MiC was required for designated government buildings as far as practicable by the policy (Chief Executive, 2019). Currently, MiC adoption is primarily observed in the public sector, particularly in public housing development and quarantine center construction (Chief Executive, 2020, Chief Executive, 2022). The adoption of MiC in public housing is driven by the economic and social contexts, where the affordability gap and high demand for housing in Hong Kong necessitate the efficient and quality construction of public housing through MiC (Pan et al., 2019). The adoption of MiC in quarantine center construction is influenced by the social context of the COVID-19 pandemic, requiring a speedy project delivery (Zhang et al., 2020).

4.2. Definition and scope

Hong Kong uses the word ‘integrated’ in MiC to highlight the integration of diverse construction activities and stakeholders. In line with the target of MiC policies in 2017 and 2018, early MiC policies focused on the feasibility study stage (Chief Executive, 2017, Chief Executive, 2018). Along with the increasing demand, new problems of MiC emerged, such as concerns for the supply capacity and transportation complexities (Zheng et al., 2023). In this regard, MiC policies emphasize the need to improve facilities for MiC manufacturing and storage in the Northern Metropolis and establish a cross-departmental steering committee for streamlining related approval processes to remove barriers for the MiC industry (Chief Executive, 2022).

4.3. Knowledge and labor

MiC policies tend to support knowledge and labor by capital (in the form of funding) or initiatives. The CITF was set to support the MiC industry (The Chief Executive, 2018). At the organization level, MiC policies initiated the Hong Kong Development Bureau (DEVB) to establish a cross-departmental steering committee for coordinating MiC knowledge and labor (The Chief Executive, 2022) and the Hong Kong Housing Authority (HKHA) to apply more innovative technologies to improve MiC techniques (The Chief Executive, 2023).

4.4. Capital

To enhance MiC policies, the political and legal contexts of MiC policies were boosted through mechanisms, such as granting in-principle acceptance (IPA) to individual MiC systems (BD, 2017) and providing a 6% gross floor area (GFA) concession for MiC projects (BD, 2019). Initially introduced as a policy incentive (Chief Executive, 2018), this GFA concession has proven effective in promoting MiC adoption and was raised to 10% in 2022 (BD et al., 2022). Relevant design considerations and requirements for MiC’s compliance with the Building Ordinance were outlined to lay the foundation for developing MiC-related regulations, codes, and standards, supplementing the legal contexts of MiC policies (BD, 2017).

5. CONCLUSIONS

This study develops a dialectical system framework to understand and analyze MC policies in terms of the technical system, stakeholders, and PESTEL contexts. The technical system encompasses four interconnected components: target and timeline, definition and scope, knowledge and labor, and capital. These components interact with various stakeholders embedded in the PESTEL contexts. Theoretically, this study provides a novel framework for understanding and analyzing MC policies. Practically, it serves as a baseline for reviewing current policies and guiding the future development of MC policies. Future research could enhance the international benchmarking of MC policies by incorporating a broader range of countries and regions. Valuable insights can be gained by validating the framework’s generalizability and exploring policy recommendations through empirical studies.

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