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# Mega infrastructure project affordance: A new perspective to improve stakeholder management and project sustainability

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**Abstract** Mega infrastructure projects (MIPs) play crucial roles in promoting social development, regional growth, and disaster and crisis resilience. These complex projects frequently face challenges in stakeholder management, which might be a risk for their sustainability. Hence, this paper proposes affordance theory as a new theoretical framework, particularly on the basis of understanding and managing MIPs. This paper aims to achieve three main objectives: 1) conceptualizing MIP affordance, 2) documenting the influence of MIP affordance on stakeholder management and project sustainability, and 3) developing strategies for managing MIP affordance. It applies critical realism to conceptualize MIP affordance and its mechanism, and employs the expectation-confirmation theory to identify critical determinants for managing MIP affordance. The paper thus provides new knowledge and insights into the management of MIP stakeholders concerning project sustainability.

**Keywords** mega infrastructure project, affordance, project sustainability, stakeholder management, social lock-in

## 1 Introduction

Mega infrastructure projects (MIPs), such as cross-border

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transportation hubs, large-scale power plants, colossal dams, and complex telecommunication infrastructure systems, reshape human habitat environments. Their sustainability is in high demand for the development of human society and for making a difference in global development. In particular, the sustainability of MIP shall mean the holistic consideration of well-being and mitigation of negative impacts on environment, economy and society in development, delivery and operation of MIPs to maintain the natural environment during human societal development (Wang et al., 2020; Zeng et al., 2022). Therefore, stakeholder management in MIPs is considered crucial because of its direct impact on the success and sustainability of the projects (Kumaraswamy et al., 2017; Winch, 2017). On the other hand, MIPs may be drastically influenced by the continuing changing perceptions of various stakeholders, such as investors, developers, government authorities, and the respective community (Gil, 2023; Shen and Xue, 2021). This impact constantly influences the perceived usefulness and performance of MIP among its stakeholders and wider community, therefore affecting the issues of project sustainability (Florice and Brunet, 2023; Xue et al., 2020).

Previous research (e.g., Kundu et al., 2023; Machiels et al., 2023) has explored the connection between stakeholder management and project sustainability of MIPs. However, the existing academic knowledge on the intricate relationship between the MIP and its stakeholders is still limited in offering adequate theoretical descriptions for dynamic interactions between them (Li et al., 2024). Furthermore, the inherent interdependence of the MIP systems complicates the evolution of MIPs, especially with the uncertain interplay among different stakeholders (He et al., 2021 and Yan et al., 2021). Regarding the current state of existing research, there appears to be a lack of theoretical description concerning the interplay between the MIP and its stakeholders. New theoretical perspectives of MIP stakeholder management are needed to consolidate the understanding of the situation. In this

respect, we propose utilizing affordance theory to bridge this theoretical gap. The introduction of affordance theory for MIP management has become necessary as evidenced by the white elephant phenomenon that continually occurs in publicly funded projects (Robinson and Torvik 2005). For example, when the public perceives an MIP as a high cost without corresponding value, their interactions with the project can be adversarial, which in turn self-fulfills their judgment (Machiels et al., 2023). With respect to the status quo of existing research, affordance theory offers valuable insights into MIP stakeholder management and project sustainability research.

Originally, Gibson (1977) defined affordance as the environment providing an animal with potential action possibilities for interaction. In addition, Malhotra et al. (2021) introduced the concept into the context of large-scale collaboration and analyzed how the value of a project is influenced by participants' perceptions. Such research creates new opportunities whereby affordance theory can be used to rethink stakeholder management and project sustainability within MIPs. On this basis, the paper defines MIP affordance, conceptualizes the working mechanism of MIP affordance, and identifies the critical determinants. This study contributes to research by integrating affordance theory into MIP management. It presents a dualistic framework for understanding stakeholder interactions with MIPs, justifying their involvement to mitigate social lock-in, and advocates for a human-centered approach to enhance project sustainability. Specifically, the research questions (RQs) include the following:

RQ 1: What is MIP affordance and how does it function?

RQ 2: How is effective affordance management achieved with the goal of improving stakeholder management and project sustainability in MIPs?

These RQs provide a basis for discourse on the affordance of MIP while stipulating how it impacts the management of stakeholders and the sustainability of the project in steps.

## 2 Revisiting affordance and applying affordance theory into the MIP context

Given the various definitions of affordance found in the academic literature, this paper combines Gibson's original

definition with other relevant ones within the MIP context to interpret affordance, as presented in Table 1. Since its introduction by Gibson in the late 1970s, affordance theory has exerted a significant influence across various domains, including design and art, information systems, and social and organizational studies (e.g., Norman, 1999; Withagen and Costall, 2022).

As previously mentioned, affordance theory emphasizes the dynamic interaction between individuals and their environment. The MIP and its stakeholders interact in a way that aligns with affordance theory. Managing MIP stakeholders is considered somewhat an art due to the complexity of MIPs and the uncertainty of stakeholder perceptions (Machiels et al., 2023; He et al., 2021). Additionally, as Winch (2017) points out, an enduring academic debate concentrates on the stakeholder concept within the megaproject context, particularly regarding the incorporation of relevant social aggregations and the broader contextual settings. Potential issues also exist in stakeholder justification within uncertain MIP context (Florice and Brunet, 2023). Specifically, affordance theory provides a valuable framework for understanding the dynamics between the MIP and its stakeholders. Given these research concerns, this paper introduces affordance theory to MIP management, enriching the knowledge domain and advancing theory.

## 3 Conceptualizing affordance with the critical realism ontology

This paper adopts the critical realism (CR) ontology to conceptualize affordance and analyze affordance management in MIPs. According to Bhaskar (2016), CR's analysis of reality's complex and dynamic nature explains social phenomena through three ontological layers: empirical (observations and perceptions), actual (events), and real (causal mechanisms), as Table 2 presents. This ontology aligns with the traditional understanding of affordance, which includes both perceived and latent affordances (Gibson 1977; Norman, 1999). Furthermore, CR and affordance share a dynamic generative mechanism as they both focus on the relationship between a contextual framework and the actors involved (Volkoff and Strong, 2013).

As an application of Bhaskar (2016)'s CR ontology, the

**Table 1** A summary of affordance concepts and definitions applied in this study

Concept	Key definition or perspective	Context of application	Reference
Classic affordance	Surroundings of those organisms that an environment offer for an animal to perceive and behave	Ecology and animal behaviors	Gibson (1977); Gibson (2014)
Perceived affordance and real affordance	Perceived affordance refers to what is perceived, while real affordance includes what can potentially be but may not necessarily be perceived.	Design and art work	Norman (1999)
Perceived affordance, motoric affordance, nested affordance, and micro affordance	Affordance should not be restricted to a singular conceptualization but rather be contextually specific when applied	Cognitive psychology and human behaviors	Withagen and Costall (2022)

**Table 2** Table caption

	Observations and perceptions	Events	Causal mechanisms
Empirical layer	×	/	/
Actual layer	×	×	/
Real layer	×	×	×

iceberg model developed by Fletcher (2017) explains CR ontology and allows for the conceptualization of affordance within the broader context of reality, as shown in Fig. 1. In this paper, the iceberg model revitalizes the three-layer CR ontology, aligning it with the empirical, actual, and real aspects of affordance. Based on Gibson's definition, empirical affordance focuses on observed interactions, while actual affordance considers both observed and unobserved events of interactions. However, other scholars, such as Withagen and Costall (2022) and Chong and Proctor (2020), argue that real affordance stems from human behavioral patterns shaping causal mechanisms. The entire iceberg represents general affordance, while the CR layers divide it into empirical, actual, and real affordances. This conceptualization redefines the concept of affordance to apply affordance theory in the context of MIPs, providing valuable insights into the interplay between the MIP and its stakeholders.

## 4 Affordance management in MIPs

### 4.1 MIP affordance

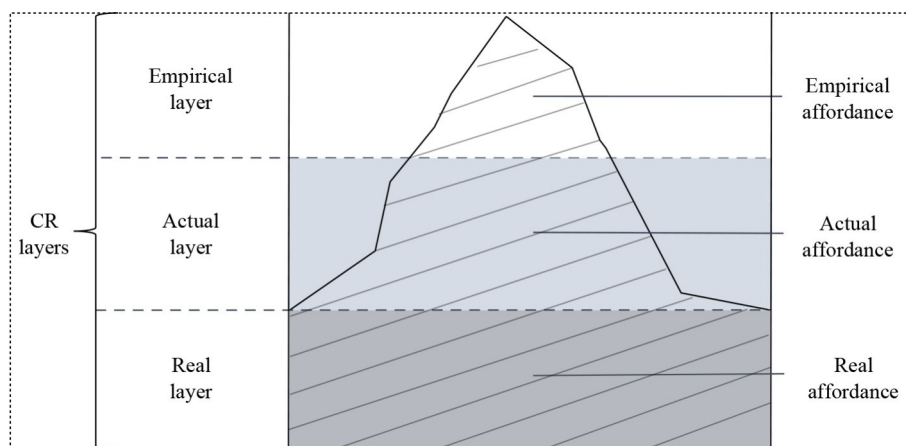
Existing definitions of affordance typically involve human actors and contextual settings, emphasizing their interaction (Gibson, 1977; Norman, 1999; Ositurak et al., 2017). Similarly, in the context of MIPs, the active human actors can include a wide range of stakeholders. Notably, MIP affordance extends beyond the infrastructure itself and includes consideration of secondary effects,

such as impacts on the regional environment and economy. This becomes evident when nations invest in MIPs to stimulate their domestic economies, but public concerns about the potential impact on the living environment may arise. This is where MIP affordance becomes significant, including the perceived capabilities, possibilities, and utilities that the MIP can provide to various stakeholders, including primary, peripheral, and community stakeholders. Specifically, the definition of MIP affordance focuses on perceived affordance, which includes empirical and actual affordances, while also implying the real affordance depicted in the iceberg model. The real affordance lies in the distinct positions and perspectives of the various stakeholders, influencing their perceptions and interactions with the MIP. Consequently, the affordance of an MIP may vary among different stakeholder groups.

### 4.2 Conceptualizing the working mechanism of MIP affordance

The conceptualization of the working mechanism of MIP affordance is grounded in two foundational works. First, Gibson (1977) explains that individuals perceive affordance differently, with both positive and negative aspects, and such perceptions can have varied effects on individuals. Second, Norman (1999) categorizes affordance into empirical and actual aspects. Figure 2 illustrates how MIP affordance influences the interaction between the MIP and its stakeholders. The interaction forms a feedback loop that depends on the empirical affordance. Therefore, it is crucial for the empirical affordance to align with the actual affordance.

However, real affordance operates independently of this feedback loop, while still serving as a fundamental basis for MIP affordance. Primarily, two key characteristics of the interactions between the MIP and its stakeholders are: 1) the complexity of the MIP, which leads to diverse stakeholder perceptions (Kumaraswamy et al., 2017; He



**Fig. 1** Iceberg model of affordance (Based on Fletcher (2017)).

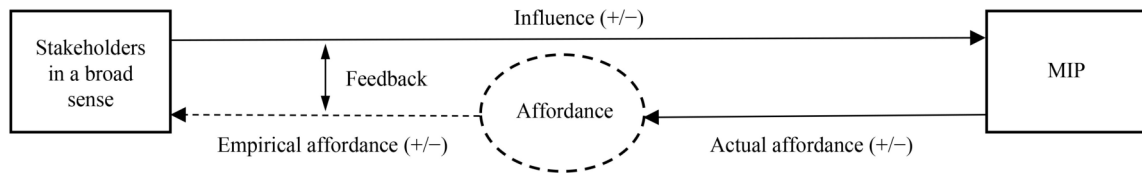


Fig. 2 Impact of MIP affordance on the interaction between the MIP and its stakeholders.

et al., 2022), and 2) the uncertainty in MIP stakeholder management due to the unclear boundaries of stakeholders and the random involvement of peripheral stakeholders from the wider community (Gil, 2023). These characteristics form the basis of real affordance and constitutes the metaphysical structure of these interactions. For all the interactions occur in real situations, only the actual and empirical affordances can be perceived.

### 4.3 The critical determinants of MIP affordance

In addition to the working mechanism, certain attributes influence MIP affordance. Expectation-confirmation theory (ECT) provides an analytical framework for explaining changes in affordance (Dhiman et al., 2022). ECT proposes that the confirmation of perceived performance (PP) or perceived usefulness (PU) with initial expectations significantly affects users’ attitudes or intentions toward a product or service (Bhattacharjee, 2001). During the pre-, during-, and post-project stages, the confirmation primarily occurs at the during- and post-project stages when there are gaps between the expectations and PP/PU, as shown in Table 3.

### 4.4 Strategies for managing MIP affordance

Constructive interactions between core and peripheral stakeholders play a vital role in ensuring the sustainability of MIP projects (Kumaraswamy et al., 2017). Effective stakeholder management in MIPs is characterized by considering public sentiment. Since MIPs often involve substantial investments in public funds and attract significant attention, monitoring and addressing the concerns of local residents, related communities, and interest groups are crucial. For example, while a newly planned major chemical plant may be beneficial to its core stakeholders, it could also potentially pose pollution risks to the local

Table 3 Critical determinants of MIP affordance in the pre-, during-, and post- project stages

	Pre-project	During-project	Post-project
Expectation	×	×	×
PP	/	×	/
PU	/	/	×
Confirmation	/	×	×
Critical determinants	Expectation	PP & Confirmation	PU & Confirmation

residents who are considered peripheral stakeholders. Therefore, managing the affordance by taking into account stakeholder expectations, PP, PU, and corresponding confirmations at different stages is crucial. It is also important to avoid involving the broader community unnecessarily, as they may not have a direct relationship with the project but could become peripheral stakeholders.

In terms of project sustainability, preventing social lock-in is a paramount issue. For example, some countries have chosen to halt new nuclear power plant projects following severe disasters. This practice creates a lock-in effect due to path dependence (Fouquet, 2016 and Hetemi et al., 2020). In such instances, a niche may emerge following the occurrence of a disaster. Public concerns can result in varying perceptions of MIP affordance, depending on whether the authorities decide to decommission the nuclear power plants or justify their performance and communicate associated risks through objective analysis. The choice made by authorities regarding decommissioning can lead to a social lock-in of these nuclear power plants, and this lock-in can persist. This interaction acts as a confirmation that strengthens path dependence, perpetuating a cycle that reinforces social lock-in, as illustrated in Fig. 2.

### 4.5 Theoretical implications for MIP stakeholder management and project sustainability

Building upon the discussions on new stakeholder theory in the field of megaproject management by Gil (2023) and Li et al. (2024), the integration of affordance theory into MIP stakeholder management can yield two theoretical insights. First, affordance theory allows for a dualistic perspective in understanding the relationship between an MIP and its stakeholders. This perspective enables more flexibility and context-dependent roles for stakeholders, thereby influencing the sustainability of the project. Second, by incorporating the affordance framework, which focuses on value creation and delivery from a human-centered viewpoint (McGahan, 2021), new stakeholder theory gains new dimensions. This proactive approach helps address challenges such as reconciling conflicts between business and social benefits, navigating uncertain stakeholder engagement, and overcoming collaborative obstacles arising from diverse stakeholder objectives. In conclusion, affordance-influenced MIP stakeholder theory provides a nuanced and adaptive

perspective on stakeholder management, with attention to the dynamic interplay between stakeholders and project environments influenced by perceived affordances.

## 5 Conclusions

This study adopts the CR approach to conceptualize MIP affordance and its working mechanism, and identify the critical determinants with ECT. The MIP affordance offers a new perspective on MIP stakeholder management, especially in managing the sentiment of the general public and closing the gap between empirical and actual affordances. It also aids in elucidating the rationale for justifying the engagement of peripheral stakeholders. These implications not only advance knowledge but also improve the practice in managing MIP stakeholders. MIP affordance helps explain and address issues related to path dependence and social lock-in. Management strategies considering the working mechanism and critical determinants of MIP affordance based on the ECT therefore empower practitioners and decision-makers to effectively manage the expectations of stakeholders and public sentiment. In this respect, enhancing the management of the MIP stakeholders and improving project sustainability can be gained. Moreover, process management of MIP affordance during the different phases of pre-, during-, and post-project enables the top management to handle public sentiment effectively and prevent social lock-in to maintain the sustainability of the project in MIP management practice.

Two limitations exist in the present study that need mentioning. The first is that this study relies on Gibson's definition of affordance and treats real affordance as a separate, underlying mechanism for the impact function, while exploring affordance through generative mechanism may contribute to the advancement of real affordance since it goes deeper into the mechanism level. Since this paper is conceptual in nature, a clear-cut definition of MIP affordance and its aspects and indicators, remains elusive. Thus, affordance as an emerging topic in MIP management research, holds significant potential for future scholarly exploration.

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