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-RESEARCH ARTICLE-

MODELLING DYNAMIC CAPABILITIES AS GENERATIVE MECHANISMS IN INTER-ORGANIZATIONAL COORDINATION: EVIDENCE FROM CHIANG MAI'S WILDFIRE RISK MANAGEMENT NETWORK

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—Abstract—

This investigation formulates a layered, digitally enabled causal framework to explain inter-organisational coordination within Wildfire Risk Management Networks (WRMNs). Using a Critical Realist (CR) perspective alongside Grounded Theory (GT), the study redefines Dynamic Capabilities (DCs) as Generative Mechanisms (GMs) functioning within the "real" domain. Empirical evidence was derived from 54 comprehensive interviews undertaken in three sequential rounds with 20 stakeholders located in Chiang Mai, Thailand. The analysis reveals four principal DCs—connective, absorptive, desorptive, and transformative—which serve as the central mechanisms supporting coordination activities. The findings additionally indicate that these mechanisms function through interdependent cybernetic feedback cycles, wherein DCs perform the roles of sensors, integrators, and effectors. These processes are significantly supported and channelled through digital infrastructures and e-government systems, enabling real-time information exchange and synchronised responses. By combining DCs, cybernetics, Complex Adaptive Systems (CAS), and ecosystem theory within an integrated CR lens, the study offers a mechanistic interpretation of coordination. It

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demonstrates how digitally enabled capabilities create, organise, and reshape inter-organisational coordination across complex multi-actor settings. Consequently, the research contributes to organisational theory and digital governance by linking capability-oriented and socio-technical interpretations of coordination, while offering important practical implications for designing digitally enabled governance systems in complex disaster management contexts.

Keywords: Dynamic Capabilities; Inter-Organizational Coordination; Wildfire Risk Management; Generative Mechanisms; Critical Realism; Digital Governance; E-Government; Feedback Loops

INTRODUCTION

Wildfires have progressively shifted from isolated environmental disturbances to systemic and transboundary risks that challenge conventional governance and management models. Their increasing severity is shaped by interactions among climate change, land-use change, vegetation and fuel conditions, and human activities. This changing risk environment highlights the limitations of suppression-oriented and reactive approaches and calls for a transition towards integrated, adaptive, and system-oriented wildfire risk governance (Miller et al., 2022) This transition is not solely ecological but equally organisational, as it reveals the inadequacy of traditional hierarchical coordination structures in managing complex multi-actor contexts.

In Thailand, particularly Chiang Mai province, wildfire risk provides a salient example of such systemic complexity. Available evidence shows that the northern region contributed nearly 65.58% of wildfire incidents recorded between 1998 and 2023, with Chiang Mai identified as the most severely affected province. Doi Suthep-Pui National Park illustrates a socio-ecological setting where environmental fragility intersects with concentrated human settlements, producing recurring crises that extend beyond ecological damage to include public health emergencies, economic disruption, and governance pressures. Despite the magnitude and persistence of this challenge, prior scholarship has predominantly concentrated on biophysical consequences, including vegetation decline, soil deterioration, and atmospheric pollution, while giving insufficient theoretical attention to the organisational and relational dimensions of wildfire risk management systems. This imbalance reflects a broader epistemological tendency within disaster studies, where technical and environmental perspectives frequently dominate analyses of coordination processes and institutional dynamics. As a result, the “black box” of inter-organisational coordination remains inadequately examined, especially in fragmented governance environments marked by uneven resource distribution.

From a theoretical perspective, WRMNs may be understood as CAS in which diverse actors interact, adapt, and co-evolve under conditions of environmental uncertainty.

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Although CAS offers a valuable macro-level perspective for interpreting systemic behaviour, it often provides limited explanatory depth at the micro-level, particularly regarding how coordination emerges, stabilises, or breaks down. This limitation indicates the need for a complementary perspective capable of identifying the underlying causal forces that shape coordination outcomes. DCs theory offers a strong basis for such inquiry. Originally developed within strategic management, DCs describe an organisation's capacity to integrate, develop, and reconfigure internal and external resources in response to rapidly changing environments (David J. Teece, 1997). Nevertheless, much of the dominant DCs literature remains firm-centred and performance-driven, with comparatively limited attention to non-profit, inter-organisational, or disaster management settings. More importantly, DCs are frequently treated as abstract constructs or dependent outcomes rather than causal forces embedded in relational and systemic processes.

Recent conceptual developments support the reinterpretation of DCs as GMs, namely underlying causal structures that generate observable coordination patterns. From a CR standpoint, this shift is especially important. CR argues that social outcomes arise from deep and often unobservable mechanisms operating across stratified domains of reality: empirical, actual, and real. Applied to WRMNs, this suggests that coordination effectiveness is not merely determined by visible activities such as communication or resource exchange, but by deeper capability configurations that enable, restrict, and shape those interactions. This reinterpretation resolves an important limitation shared by both DCs and CAS scholarship: the weak integration between micro-level capabilities and macro-level system behaviour. While CAS emphasises emergence and adaptation, and DCs focuses on organisational capability development, neither sufficiently explains how such capabilities are activated, sequenced, and interconnected to generate coordinated action across organisational boundaries. Furthermore, relevant scholarship remains dispersed across several domains, including cybernetics, ecosystem theory, and disaster risk management, without a coherent framework capturing their mutual dependence.

Cybernetics, particularly through the concept of feedback loops, adds further analytical value. Negative feedback loops contribute to system stabilisation, whereas positive feedback loops amplify change processes. These loops represent core mechanisms through which systems regulate behaviour and respond to environmental shifts. Within organisational settings, however, such loops are not purely technical processes; they are mediated through capabilities involving information processing, sensemaking, and decision-making. Existing studies rarely investigate how DCs operate as the functional components of these loops, performing the roles of sensors, integrators, and effectors within coordination systems. Likewise, the concept of Business Ecosystems (BE) provides useful insight into actor co-evolution and capability interdependence. Yet conventional BE theory, particularly that advanced by Moore (1996), is largely rooted

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in commercial environments and does not sufficiently address non-profit ecosystems such as WRMNs. This creates significant theoretical questions concerning the transferability and adaptation of ecosystem concepts to public governance and disaster management contexts. Collectively, these gaps indicate the absence of an integrated framework capable of explaining:

1. How coordination emerges within complex multi-actor systems
2. What role DCs perform in enabling coordination
3. How these capabilities interact through feedback mechanisms
4. How coordination structures evolve over time under environmental pressures

This study responds to these deficiencies by proposing a multi-theoretical synthesis that combines DCs, CR, cybernetics, CAS, and ecosystem theory. In doing so, it moves beyond fragmented and descriptive interpretations towards a causal-explanatory model of inter-organisational coordination. Empirically, the research examines the WRMN in Chiang Mai through a CR and GT approach to identify the character, activation sequences, and structural configurations of DCs as GMs. This enables the opening of the coordination "black box" by linking micro-level processes, namely capabilities, with macro-level outcomes such as system coordination and overall performance. Theoretically, the study contributes to three principal debates. First, it extends DCs theory beyond the firm level by positioning DCs as relational and systemic constructs. Second, it strengthens CR scholarship through empirical evidence of GMs operating in complex organisational environments. Third, it reinterprets ecosystem theory by demonstrating that non-profit, disaster-oriented networks can display ecosystemic characteristics, thereby broadening the scope of existing ecosystem literature.

Overall, this research addresses an empirical gap in wildfire risk management while advancing a critical and integrated theoretical perspective that repositions coordination as a capability-driven, systemically embedded, and dynamically evolving phenomenon. Within contemporary governance systems, coordination is increasingly mediated through digital infrastructures and e-government platforms that support real-time sensing, information integration, and synchronised response across organisational boundaries. However, the contribution of such digital infrastructures to capability-driven coordination remains insufficiently explored.

RESEARCH OBJECTIVES

The principal aim of this study is to investigate and model the mechanisms that underpin inter-organisational coordination in wildfire risk management. More specifically, the study seeks to:

1. Identify the GMs involved in WRMN coordination processes
2. Examine whether these mechanisms are constituted through DCs

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3. Analyse the activation sequences of DCs within coordination processes
4. Model the structural interrelationships among DCs, including the existence of feedback loops

These objectives are aligned with the central proposition that DCs operate as primary drivers of coordination effectiveness within complex networked systems.

RESEARCH METHODOLOGY

Research Design

This study employs a qualitative research design to examine the underlying mechanisms of inter-organisational coordination within WRMNs. A qualitative strategy is appropriate due to the complex, context-specific, and multi-actor character of the phenomenon, which requires detailed understanding of processes, interactions, and meanings rather than reliance on variable-centred measurement. To fulfil the research objectives, the study combines CR and GT. This methodological integration facilitates both the identification of empirical patterns and the explanation of the causal mechanisms (GMs) that generate such patterns within complex systems. Whereas GT supports inductive theory development grounded in data, CR offers a philosophical basis for revealing deeper causal structures beyond directly observable events.

Research Paradigm

The study is situated within the CR paradigm, which posits that reality is stratified into three domains: the empirical (experienced events), the actual (events that occur), and the real (underlying causal mechanisms). This ontological stance enables the researcher to move beyond visible coordination practices and examine the causal powers embedded within organisational capabilities and network structures. From an epistemological perspective, the study adopts a retroductive logic of inquiry, involving continual movement between empirical observations and theoretical abstraction to identify the most credible explanations for observed phenomena. This approach is particularly appropriate for opening the "black box" of inter-organisational coordination and connecting observable practices with underlying DCs.

Data Collection

Data were gathered through in-depth Semi-Structured Interviews (SSIs), which provide the flexibility and analytical depth required to investigate complex organisational processes. A total of 54 interviews were undertaken across three iterative rounds involving 20 key informants drawn from four stakeholder categories:

- Government agencies
- State enterprises

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- Private organisations
- Local communities

Although the number of key informants (n=20) may appear modest, theoretical saturation was achieved through iterative data collection and longitudinal coverage. The 54 interview sessions conducted over three rounds captured coordination experiences across a four-year period involving 37 wildfire events. Saturation was evaluated not through response frequency, but through the consistency of identified mechanisms across stakeholder groups and temporal stages. The repeated emergence of the same four core DCs across prevention, detection, and suppression activities—irrespective of organisational category—demonstrates saturation at the level of GMs rather than superficial thematic patterns. The inclusion of multiple stakeholder groups ensured a comprehensive understanding of coordination processes across organisational boundaries. The iterative data collection design corresponds with the CR retroductive cycle:

- Round 1: Exploratory stage centred on participants' experiences (empirical domain)
- Round 2: Analytical refinement of emerging patterns (actual domain)
- Round 3: Validation and identification of causal mechanisms (real domain)

All interviews were audio-recorded and transcribed verbatim. The four-year temporal coverage of wildfire incidents enabled a diachronic examination of coordination processes.

3.4 Data Analysis

Data analysis followed the systematic procedures of Grounded Theory, consisting of three stages:

- Open coding: Identification of initial concepts and emerging patterns from raw data
- Axial coding: Development of linkages between categories and sub-categories
- Selective coding: Integration of categories into a coherent theoretical model

The analysis resulted in:

- 91 themes
- 31 sub-categories
- 13 core categories

These categories form the basis for modelling DCs as GMs of coordination. To enhance analytical rigour, NVivo 14 software was utilised to support data management, coding consistency, and transparency.

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3.5 Research Rigor

To ensure the quality and trustworthiness of the study, several strategies were employed:

- **Construct Validity:** Achieved through triangulation across multiple stakeholder groups
- **Internal Validity:** Ensured through iterative data collection and retroductive reasoning
- **Reliability:** Supported by transparent coding procedures and audit trails
- **Reflexivity:** Maintained through continuous critical reflection on interpretations

These measures strengthen the credibility and robustness of the findings in accordance with qualitative research standards. To enhance transparency, the retroductive process was undertaken through a structured three-step analytical logic. First, empirical themes identified through open and axial coding were grouped into recurring coordination patterns (empirical domain). Second, these patterns were examined against observed sequences of action across wildfire events to identify stable relational configurations (actual domain). Third, these configurations were subjected to theoretical abstraction to infer the most plausible underlying causal powers, namely GMs, consistent with CR logic (real domain For example, repeated patterns of cross-organisational information exchange, joint decision-making, and resource mobilisation were retroductively interpreted as manifestations of connective and absorptive DCs. Accordingly, the identification of GMs was not purely inductive; rather, it emerged through iterative movement between data and theory, supported by audit trails and coding matrices generated through NVivo analysis.

Methodological Contribution

The integration of CR and GT represents a central methodological contribution of this study. This combination facilitates the development of a causal-explanatory model, shifting the analysis beyond descriptive representation towards the identification of mechanisms that generate coordination processes. By merging inductive theory generation with a realist ontological stance, the study establishes a novel methodological pathway for examining complex inter-organisational systems.

REVIEW OF LITERATURE

The study of inter-organizational coordination in WRMNs requires an integrative theoretical perspective that connects multiple domains of knowledge. This section consolidates five key theoretical streams—DCs, BE, CAS, cybernetics, and DRM—to develop a comprehensive analytical foundation. Although each of these areas has been widely examined in existing literature, their combined application remains limited,

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particularly in non-profit, multi-actor disaster governance settings. DCs constitute one of the most influential frameworks for explaining how organizations adapt to environmental change. Initially developed by David J. Teece (1997), DCs refer to an organization's capacity to integrate, build, and reconfigure internal and external competencies in response to environmental turbulence. Later developments emphasised their role in enabling strategic flexibility, innovation, and sustained performance (Kathleen M. Eisenhardt, 2000; Teece, 2007). However, the prevailing interpretation remains firm-centred and oriented towards competitive advantage in market contexts, limiting its relevance to disaster management environments where coordination across actors is more critical than competition.

To overcome this limitation, the study adopts the typology proposed by Lichtenthaler and Lichtenthaler (2009), which conceptualises DCs along knowledge and relational dimensions. This framework identifies six capabilities: connective, absorptive, desorptive, transformative, innovative, and inventive. Connective capability supports inter-organisational linkage and collaboration, while absorptive capability enables the acquisition and assimilation of external knowledge (Cohen & Levinthal, 1990). Desorptive capability refers to outward knowledge transfer, whereas transformative capability involves internal recombination of resources and knowledge. Innovative and inventive capabilities relate to the generation of novel knowledge and solutions. This typology is particularly suited to networked environments as it captures dynamic interactions between internal organisational processes and external relations. Nevertheless, empirical work treating DCs as mechanisms of inter-organisational coordination remains limited.

In parallel, BE offers a macro-level lens for understanding organisational interaction and co-evolution. Originally introduced by (Moore, 1996), BE refers to networks of interdependent actors that co-create value through collaboration and mutual adaptation. Subsequent work highlights ecosystem characteristics such as interdependence, shared value creation, and dynamic leadership (Adner, 2017; Iansiti & Levien, 2004). However, the majority of BE literature is grounded in profit-driven contexts such as innovation ecosystems and digital platforms, creating a conceptual mismatch when applied to non-profit systems like WRMNs. In such contexts, actors cooperate not for competitive gain but for collective outcomes such as risk mitigation and environmental safety. This necessitates a reconceptualisation of ecosystems to include public-oriented, non-profit configurations, thereby extending existing theoretical boundaries.

The complexity of WRMNs can further be interpreted through CAS theory. CAS describes systems composed of interacting agents that adapt and self-organise in response to environmental changes (Holland, 1992; Levin, 1998). In wildfire contexts, actors such as government agencies, communities, and private organisations continuously adjust their actions in response to evolving conditions, producing

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emergent coordination patterns. While CAS is useful for explaining system-level dynamics, it provides limited insight into the micro-level mechanisms that generate these dynamics, highlighting the need for complementary explanatory frameworks. Cybernetics, particularly feedback loop theory, provides additional analytical depth for understanding system regulation and adaptation. Feedback loops may be negative, contributing to system stability, or positive, amplifying change processes (Åström & Murray, 2019). Within organisational settings, feedback loops support coordination through information flow, decision processes, and adaptive responses. However, traditional cybernetic models tend to be mechanistic and often overlook the role of organisational capabilities in enabling these processes. This study addresses this limitation by conceptualising DCs as the functional components of feedback loops, operating as sensors, integrators, and effectors within coordination systems. This provides an analytical bridge between technical system regulation and organisational behaviour.

Finally, DRM provides the broader institutional and policy context for WRMNs. DRM frameworks emphasise resilience, preparedness, and adaptive capacity in managing risk (UNDRR, 2015). Resilience refers to a system's ability to absorb shocks, adapt to change, and recover from disruptions (Masys, 2015). Effective DRM requires coordination across multiple stakeholders and the integration of knowledge, resources, and capabilities across organisational boundaries. However, DRM literature has primarily focused on governance arrangements and policy structures, with limited attention to the underlying mechanisms that enable coordination. Collectively, the literature reveals a significant theoretical gap. DCs explain organisational adaptation but are rarely integrated into system-level coordination models. CAS explains emergent behaviour but lacks micro-level causal mechanisms. BE focuses on co-evolution but remains largely confined to profit-oriented contexts. Cybernetics explains system regulation but neglects capability-based processes, while DRM identifies coordination requirements without explaining how coordination is achieved. As demonstrated in prior research, no study has integrated these five domains into a unified framework in the context of WRMNs.

This study addresses this gap by proposing a multi-theoretical integration in which DCs are positioned as GMs linking micro-level processes with macro-level system outcomes. This advances understanding of inter-organisational coordination as a capability-driven, systemically embedded, and dynamically evolving phenomenon. To avoid conceptual fragmentation, DCs, CAS, BE, cybernetics, and CR are not treated as independent analytical lenses. Instead, they are organised within a stratified explanatory structure consistent with CR ontology. Specifically, DCs are conceptualised as GMs operating within the "real" domain; cybernetic feedback loops represent their operational expression; CAS captures emergent system behaviour within the "actual" domain; and BE provides the relational configuration within which these mechanisms

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operate. Importantly, value creation in BE is reinterpreted from a profit-based logic to a public value and risk-reduction orientation. Within WRMNs, value is not economically appropriated but collectively realised through improved resilience, coordination efficiency, and risk mitigation. This extends (Moore, 1996) BE framework towards non-profit business ecosystems (NPBEs), consistent with empirical evidence from Chiang Mai.

Recent work in e-government and digital governance highlights the role of digital infrastructures in enabling coordination within complex public-sector systems (Dunleavy et al., 2006; Janssen & Estevez, 2013). Digital platforms support real-time information exchange, interoperability, and coordinated decision-making, thereby improving system responsiveness. However, the relationship between digital infrastructures and capability-based coordination remains underexplored. This study addresses this gap by positioning digital infrastructure as an enabling condition for DCs within coordination systems. Unlike prior research that treats these theoretical domains separately, this study integrates them within a CR stratified ontology to produce a unified causal explanation of inter-organisational coordination. This enables a transition from fragmented and descriptive accounts toward a coherent causal understanding of coordination processes.

RESEARCH MODEL

As illustrated in Figure 1, the model specifies a stratified and digitally mediated causal architecture of inter-organizational coordination. The revised framework conceptualises coordination within WRMNs as a layered, capability-centred, and digitally enabled causal process. At the foundational stratum, digital infrastructure—situated within the e-government layer—operates as an enabling condition that supports inter-organisational information exchange, communication, and data integration. Rather than being treated as an external or purely technical artefact, this digital layer is embedded within the coordination system and functions as a precondition for the activation and enactment of DCs. Within the CR ontology, DCs are located in the "real" domain and conceptualised as GMs, representing underlying causal powers that structure coordination processes. In this study, connective, absorptive, desorptive, and transformative capabilities are identified as the primary GMs driving inter-organisational coordination. These capabilities are not directly observable; instead, they are inferred through their causal effects on coordination practices and outcomes. The operational expression of these GMs occurs through cybernetic feedback loops, which constitute the functional interface between causal structures and observable system behaviour. Within this configuration, DCs operate as sensors, integrators, and effectors, enabling the system to detect environmental signals, process information, and generate adaptive responses.

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These feedback dynamics produce coordination processes located in the "actual" domain, where inter-actor interactions unfold through structured sequences such as prevention, detection, and suppression activities. Accordingly, coordination is understood not as a fixed organisational arrangement but as an emergent outcome of capability-driven feedback mechanisms. At the system level, these processes generate behaviours characteristic of CAS and ecosystem dynamics. The WRMN evolves through co-adaptive and co-evolutionary interactions among heterogeneous actors, reflecting both system resilience and the continuous reconfiguration of inter-organisational relationships over time. Overall, the model advances a multi-layered causal explanation that integrates digital infrastructure, DCs, cybernetic regulation, and system-level emergence within a unified CR framework. This approach moves beyond descriptive accounts of coordination and offers a mechanistic explanation of how coordination is generated, sustained, and transformed in complex multi-actor environments. This model is also consistent with the growing importance of digitally enabled governance architectures in coordinating complex public-sector systems.

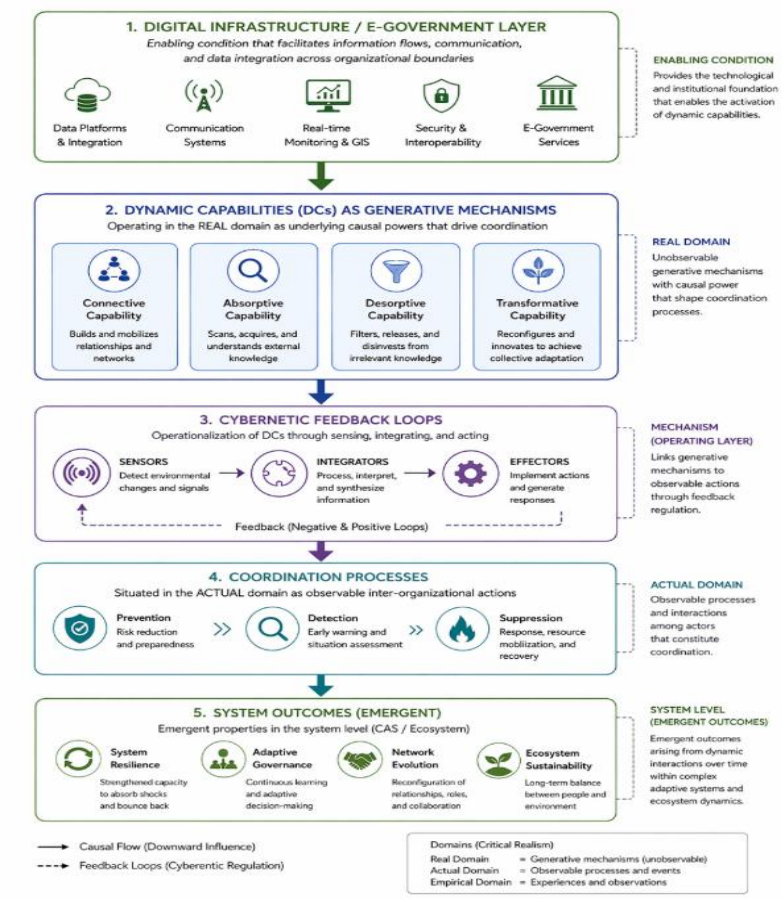

Figure 1: A Stratified and Digitally Mediated Model of Inter-Organizational Coordination

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RESULTS AND ANALYSIS

Identification of Dynamic Capabilities

The findings indicate that four DCs—connective, absorptive, desorptive, and transformative—consistently operate as GMs underpinning inter-organisational coordination within WRMNs. These capabilities were repeatedly identified across all phases of wildfire management, highlighting their central function in enabling coordination processes. Connective capability supports the formation and maintenance of inter-organisational relationships, thereby enabling information exchange and collaborative action. Absorptive capability facilitates the acquisition and interpretation of external knowledge, which is particularly critical in rapidly evolving wildfire contexts (Cohen & Levinthal, 1990). Desorptive capability enables the outward transfer of knowledge and resources across organisational boundaries, whereas transformative capability allows for the recombination and reconfiguration of both internal and external resources to produce coordinated responses. In contrast, innovative and inventive capabilities were activated less frequently and were primarily associated with preparedness-oriented activities. This pattern suggests that although higher-order capabilities contribute to longer-term system development, operational coordination processes rely more heavily on relational and knowledge-integration capabilities than on innovation-driven mechanisms. Overall, these findings support the interpretation of DCs as GMs operating within the "real" domain of CR.

Activation Sequences

The analysis identified nine distinct activation sequences of DCs across key wildfire management activities, including prevention, preparedness, detection, and suppression. These sequences demonstrate that coordination processes are not random but instead follow structured, context-sensitive patterns of capability activation. A central finding is that DCs are first activated at the intra-organisational level before extending to the inter-organisational level. This indicates that internal readiness—encompassing knowledge processing, decision-making, and resource mobilisation—functions as a necessary precondition for effective coordination across organisations. Once these internal capabilities are activated, they initiate inter-organisational interactions that enable collective action. This sequential pattern challenges static conceptualisations of coordination and instead supports a processual interpretation in which coordination emerges through the temporal interplay of capabilities (Teece, 2007). It further underscores the significance of micro-level mechanisms in shaping system-level coordination outcomes. This sequence reflects the activation of DCs within the "real" domain, as conceptualised in the proposed model.

Feedback Loop Structures

The study identifies two primary types of feedback loops that structure coordination

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processes within WRMNs:

- Negative feedback loops, associated with prevention and detection activities, function to stabilise the system through continuous monitoring and corrective adjustment. These loops enable routine coordination and maintain systemic equilibrium.
- Positive feedback loops, associated with wildfire suppression, intensify system responses by accelerating decision-making and mobilising resources during critical incidents.

Importantly, these feedback structures are interdependent and collectively form a layered cybernetic architecture. The interaction between negative and positive loops enables the system to simultaneously maintain stability and support adaptability, a defining feature of CAS (Holland, 1992). The findings further indicate that DCs operate as the functional components of these feedback loops, enabling sensing (information acquisition), integration (decision-making), and action (implementation). This extends conventional cybernetic interpretations by embedding feedback regulation within organisational capability structures (Åström & Murray, 2019).

A concrete illustration of a negative feedback loop is observed in wildfire detection activities at sub-district checkpoints. Local volunteers detect early fire signals (sensor), transmit information to the wildfire control station (integrator), and initiate rapid containment actions (effector). This loop stabilises the system by preventing escalation. In contrast, positive feedback loops become prominent during large-scale suppression operations. When a wildfire exceeds local containment capacity, escalation protocols are activated, mobilising additional resources across multiple organisations and thereby amplifying response intensity. While necessary for effective suppression, this amplification increases systemic pressure and must be counterbalanced by negative feedback mechanisms such as monitoring and control to prevent overload. Overall, these findings provide strong evidence that feedback loops constitute the operational layer linking GMs to observable coordination processes.

Ecosystem Characteristics

The empirical findings indicate that the WRMN displays strong correspondence with both CAS and BE characteristics. The network comprises multiple interdependent actors that continuously adapt and interact, producing emergent coordination patterns (Holland, 1992; Moore, 1996). In particular, the presence of co-evolutionary dynamics suggests that organisations within the network develop their capabilities in response to both environmental change and interactions with other actors. This reinforces the interpretation of WRMNs as ecosystemic configurations rather than conventional hierarchical structures. Furthermore, the network appears to be in an early expansion phase of its lifecycle, characterised by increasing interdependence and the gradual

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formation of coordination mechanisms. However, this stage is also associated with structural constraints, including uneven capability distribution and incomplete integration across actors. Overall, these findings align with the system-level outcomes specified in the proposed model, reflecting CAS behaviour and ecosystem dynamics.

CONCLUSION

This study makes substantial theoretical and empirical contributions to understanding inter-organisational coordination within WRMNs. Grounded in CR and GT, the findings provide strong evidence that DCs operate as GMs underpinning coordination processes across multiple organisational levels. First, the study demonstrates that coordination in WRMNs cannot be adequately explained by structural arrangements or resource availability alone. Instead, it is fundamentally driven by the activation and interaction of DCs. In particular, connective, absorptive, desorptive, and transformative capabilities consistently emerge as core mechanisms enabling coordination across prevention, preparedness, detection, and suppression activities. This extends DCs theory by showing that these capabilities operate not only within organisational boundaries but also across them, functioning as relational and systemic drivers of coordination rather than firm-level resources.

Second, the findings reveal that coordination processes are structured through interconnected cybernetic feedback loops, forming a regulatory and adaptive system. Negative feedback loops support system stabilisation through prevention and detection, while positive feedback loops intensify responses during suppression events. The coupling of these loops enables a dynamic balance between stability and responsiveness, thereby enhancing coordination effectiveness. Importantly, DCs function as the operational components of these feedback structures, linking sensing, interpretation, and action across organisational boundaries. From an e-government perspective, DCs are increasingly enabled and shaped by digital infrastructures. In the Chiang Mai WRMN, coordination operates not only as a social process but also as a digitally mediated one, supported by information systems, communication platforms, and integrated data infrastructures centred on the wildfire control station.

Within this configuration, digital tools function as cybernetic components of feedback loops: detection technologies (such as satellite systems and reporting mechanisms) operate as sensors; communication and coordination platforms act as integrators; and resource mobilisation systems function as effectors. This digital layer transforms connective and absorptive capabilities into technologically mediated processes, highlighting the central role of e-government systems in enabling real-time coordination, knowledge exchange, and adaptive response. This interpretation aligns with the view that digital infrastructures actively shape organisational coordination rather than merely supporting it. Third, the study provides strong empirical support for

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conceptualising WRMNs as non-profit business ecosystems. The network exhibits key ecosystem properties, including interdependence among actors, co-evolution of capabilities, and collective value creation. However, unlike conventional ecosystems, WRMNs are not driven by competition or profit maximisation but by shared objectives related to risk reduction and environmental protection. This challenges the traditional boundaries of ecosystem theory and supports its extension to non-profit and public-sector contexts.

Fourth, and most importantly, the study contributes to opening the "black box" of inter-organisational coordination. By identifying DCs, their activation sequences, and their structural interconnections, the research develops a causal-explanatory account of coordination processes, addressing a key limitation in prior literature that has largely remained descriptive or correlational. The integration of DCs, cybernetics, CAS, and ecosystem theory represents a significant theoretical advancement. Rather than treating these domains separately, this study demonstrates how they can be unified within a coherent explanatory framework in which coordination is understood as a dynamic, capability-driven, and systemically embedded phenomenon. This bridges the micro–macro divide by linking organisational capabilities and interactions to system-level coordination and adaptation outcomes. From a broader perspective, the findings suggest that improving coordination in WRMNs requires not only institutional or structural reforms but also the deliberate development and activation of DCs across organisations. This has important implications for designing more adaptive and resilient disaster management systems.

These findings reconceptualise DCs in WRMNs as socio-technical mechanisms embedded within digitally mediated coordination systems. In doing so, they challenge the conventional view of coordination as a structurally predetermined or policy-driven process. Instead, coordination emerges as a capability-driven and digitally enacted phenomenon, produced through the interaction of underlying causal mechanisms and cybernetic regulation processes. This shifts the analytical focus from static governance arrangements to dynamic, multi-layered systems in which coordination is continuously generated and transformed. This positions the study not only as an extension of DCs theory but also as a reconceptualisation of coordination itself as a generative, capability-driven, and digitally mediated phenomenon. For policymakers, the findings imply that investments in digital infrastructure should be systematically aligned with the development of organisational capabilities to enhance coordination effectiveness in complex disaster management environments.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

Limitations

Despite its contributions, this study is subject to several limitations that warrant

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consideration. First, the research is based on a single-case design situated in Chiang Mai, focusing specifically on the WRMN centred around the Phuping wildfire control station. Although this setting provides rich and contextually grounded insights into inter-organisational coordination, it may constrain the transferability of findings to other geographical or institutional contexts. The socio-cultural, environmental, and governance conditions in Chiang Mai are distinctive, and coordination dynamics may differ in other regions with alternative institutional configurations. Second, the study employs a qualitative research design, prioritising depth of explanation over statistical generalisability. While the inclusion of multiple stakeholder groups and iterative rounds of data collection strengthens analytical robustness, the findings are not statistically generalisable. Instead, they should be interpreted as analytical generalisations that contribute to theory development rather than population-level inference (Yin, 2017).

Third, the findings are inherently context-dependent, reflecting the specific characteristics of wildfire governance in Northern Thailand. Variations in institutional arrangements, resource distribution, and community participation significantly shape coordination processes. Consequently, the DCs and feedback structures identified in this study may manifest differently in alternative disaster settings or organisational environments. Finally, consistent with qualitative CR research, the identification of GMs relies on interpretive analysis. Although methodological rigour was ensured through triangulation, iterative coding, and retroductive reasoning, the influence of researcher interpretation on analytical outcomes cannot be entirely excluded.

Future Research Directions

Building on these limitations, several directions for future research are proposed. First, comparative studies across different regions or countries are recommended to assess whether the identified coordination mechanisms and DCs are stable across diverse contexts. Such cross-contextual analyses would strengthen the external validity of the proposed model and generate deeper insight into how institutional arrangements, cultural conditions, and environmental factors shape coordination dynamics. Second, the proposed framework could be further refined through quantitative validation. Future research may operationalise DCs and coordination outcomes into measurable constructs and examine their relationships using statistical modelling techniques. This would complement the current qualitative findings and enhance the broader empirical generalisability of the model.

Third, further work is needed on the micro-foundations of DCs. While this study identifies key capabilities at organisational and inter-organisational levels, future research could investigate how these capabilities emerge from individual behaviours, routines, and interaction patterns. This would enable a more fine-grained understanding of how coordination is generated and sustained within complex systems (Teppo Felin, 2012). Fourth, future studies could examine the role of digital technologies in enhancing

coordination within WRMNs. Emerging tools such as AI, IoT, and data analytics may significantly improve real-time information sharing, predictive capacity, and decision-making processes, thereby strengthening both negative and positive feedback mechanisms in disaster management systems. Finally, the model may be extended to other disaster risk domains, including floods, earthquakes, and pandemics, to evaluate the broader applicability of DCs as GMs in complex multi-actor environments.

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