# MATURITY MODELS AS BOUNDARY OBJECTS IN HEALTHCARE DIGITAL TRANSFORMATION

*Completed Research Paper*

Fabrizio Amarilli, Dublin City University, Dublin, Ireland, fabrizio.amarilli@dcu.ie

Giada Porcelli, Fondazione Politecnico di Milano, Milan, Italy, giada.porcelli@fondazione.polimi.it

Giorgia Bravin, Fondazione Politecnico di Milano, Milan, Italy, giorgia.bravin@fondazione.polimi.it

Paolo Locatelli, Fondazione Politecnico di Milano, Milan, Italy, paolo.locatelli@fondazione.polimi.it

## Abstract

*This study investigates how digital maturity models mediate cross-stakeholder alignment in healthcare digital transformation. While maturity models proliferate across healthcare contexts, existing research provides limited explanation of how they facilitate alignment among heterogeneous stakeholders in practice. Drawing on boundary object theory and an ethnographic case study of a national Health Big Data project involving research hospitals across four clinical networks, we examine how a digital maturity model enabled coordination among IT professionals, data managers, research coordinators, and administrative leaders spanning diverse organizational priorities and technical backgrounds. Our findings make three contributions: we reconceptualize digital maturity models as active coordination devices rather than passive diagnostic instruments; we extend boundary object theory by identifying three emergent properties crucial for mediating alignment - operational generativity, temporal scalability, and institutional anchoring; and we provide empirical insight into how maturity models shape sensemaking, negotiation, and coordinated action in federated healthcare ecosystems.*

*Keywords: Digital Maturity Models, Boundary Objects, Healthcare Digital Transformation.*

## 1 Introduction

Digital transformation has become a critical priority for healthcare systems worldwide, promising to improve clinical processes, integrate research and care pathways, and enable data-driven health innovation. However, realising these ambitions requires collaboration among diverse stakeholders, such as clinicians, IT specialists, researchers, administrators, and managers, who operate according to distinct professional norms, technological infrastructures, and institutional logics (Agarwal et al., 2010; Heavin, 2017). Despite substantial investments in health information systems and data platforms, many digital transformation initiatives remain fragmented or difficult to scale due to persistent misalignment among these actors (Doctor et al., 2023; Fichman et al., 2011). In this context, digital maturity has emerged as a widely used instrument for assessing and guiding transformation in various domains. However, while maturity models proliferate across healthcare sectors, from analytics to eHealth (Carvalho et al., 2016) and public health digitalization (Doctor et al., 2023), their role in fostering alignment and coordination among diverse stakeholders remains insufficiently understood (Poeppelbuss et al., 2011).

Existing maturity model research has been criticized for being predominantly assessment-oriented, treating maturity as a static property expressed in linear stages or capability levels (Becker et al., 2009; Mettler, 2011; Tarhan et al., 2016). Recent empirical work claims that maturity models may serve purposes beyond measurement, acting as coordination devices that structure discussion, facilitate negotiation, and help institutions converge on shared priorities (Doctor et al., 2023; Mikalef et al., 2020). This observation is particularly relevant in healthcare, where the coexistence of multiple institutional logics, highly heterogeneous data infrastructures, and federated governance structures make stakeholder alignment especially challenging (Agarwal et al., 2010; Currie & Guah, 2007; Doctor et al., 2023). What remains unclear and undertheorized is how maturity assessments actually mediate alignment in practice, in particular in complex federated healthcare ecosystems. To address this gap, this paper poses the following research question: *How does digital maturity mediate cross-stakeholder alignment in the digital transformation of healthcare organizations*?

To answer the research question, we draw on boundary object theory (Carlile, 2002, 2004; Levina & Vaast, 2005; Star & Griesemer, 1989). Boundary objects are artifacts shared across different social worlds yet interpreted locally, enabling coordination without requiring full consensus. They combine interpretive flexibility with stable structure, facilitating translation, alignment, and collective action across heterogeneous groups. This lens is well suited to digital maturity, which operates simultaneously as a technical construct and a social artifact used in negotiation, sensemaking, and planning.

We investigate these dynamics through an ethnographic case study of the Health Big Data (HBD) project, a multi-year national initiative promoted by the Italian Ministry of Economy and Finance and the Ministry of Health, involving 51 research hospitals (RHs) organized into four clinical and research networks. Through model development involving multiple hospitals, we conducted maturity assessments and collected data from 17 research hospitals, which form the empirical basis for this study. We observed how the maturity model was interpreted, contested, and mobilized across diverse organizational contexts. Our analysis reveals that the maturity model functioned as a boundary object that enabled heterogeneous stakeholders to articulate needs, negotiate priorities, coordinate activities, and align digital transformation trajectories.

This paper makes three contributions. First, it reconceptualizes digital maturity as an organizational boundary object rather than a static diagnostic tool. Second, it explains the mechanisms through which maturity assessments mediate cross-stakeholder alignment in digital transformation. Third, it provides empirical insights from a large national healthcare initiative involving multiple research hospitals, illustrating how maturity models shape sensemaking, negotiation, and coordinated action.

# 2 Literature Review and Theoretical Framework

In our literature review, we first assess maturity models as tools for evaluating digital capabilities, noting their assumptions and limitations (Section 2.1).We then explore the unique characteristics of digital transformation in healthcare that complicate stakeholder alignment and encourage the use of maturity models for coordination (Section 2.2). Finally, we present boundary object theory to understand how shared artifacts facilitate alignment in complex healthcare environments (Section 2.3).

## 2.1 Maturity Models in Digital Transformation Research

Maturity models have become pervasive instruments for describing and benchmarking organizational capabilities across domains including software development, business process management, data analytics, and digital health (Becker et al., 2009; de Bruin et al., 2005). Typically defined as structured artifacts that conceptualize capability development along predefined dimensions and successive maturity levels, their appeal stems from simplicity, comparability, and actionability, offering shared vocabulary for diagnosing current practices, identifying gaps, and planning improvement trajectories (Poeppelbuss et al., 2011; Röglinger et al., 2012). Despite widespread adoption, maturity model research exhibits conceptual ambiguity regarding what maturity models are, how they function, and what organizational effects they produce.

Early information systems work adopted a diagnostic-staged perspective, conceptualizing maturity in linear terms where organizations evolve from ad hoc practices toward increasingly formalized processes (Becker et al., 2009; de Bruin et al., 2005). This approach continues to inform influential healthcare models (Carvalho et al., 2016), enabling cross-institutional comparison through measurable categories. However, critics argue that linear trajectories obscure the iterative, path-dependent, and context-specific nature of digital transformation (Mettler, 2011; Tarhan et al., 2016). Responding to these critiques, a processual development perspective reconceptualizes maturity as an emergent outcome of iterative learning, organizational adaptation, and socio-technical change (Röglinger et al., 2012), offering more realistic accounts of capability development in contexts where practices across different organizational functions evolve unevenly.

Work adopting a configurational perspective challenges single-path assumptions by demonstrating that multiple capability combinations can produce equivalent performance (Korsten et al., 2024; Remane et al., 2016). This perspective suggests organizations achieve digital maturity through different configurations depending on strategic priorities, resource endowments, and environmental contexts (Korsten et al., 2024), which is especially relevant in research hospitals where transformation trajectories differ by clinical specialization, research intensity, governance arrangements, and legacy infrastructures.

A growing body of work foregrounds organizational, communicative, and socio-political dimensions of maturity models, examining how they function as sensemaking and coordination artifacts that structure conversations, expose discrepancies between current and desired practices, trigger governance realignment, and produce organizational consequences such as new roles and accountability structures (Carvalho et al., 2016; Doctor et al., 2023; Korsten et al., 2024; Mettler, 2011; Poeppelbuss et al., 2011). While the literature increasingly acknowledges these active functions, it provides limited explanation of how alignment actually occurs in practice (Table 1).

| **Perspective** | **Description** | **Implications for Digital Transformation** | **Key references** |
|---|---|---|---|
| 1. Diagnostic–Staged Perspective | Maturity is expressed through linear, predefined levels describing progressively sophisticated organizational capabilities. | Enables benchmarking and standardized assessments; often reduces complexity to staged progression. | Becker et al. (2009); de Bruin et al. (2005); Mettler (2011); Tarhan et al. (2016). |
| 2. Processual Development Perspective | Maturity emerges through iterative socio-technical processes shaped by local contingencies and organizational learning. | Highlights path-dependence, incremental change, and organizational evolution rather than discrete stages. | Röglinger et al. (2012); Korsten et al. (2024). |
| 3. Configurational Perspective | Multiple capability configurations, rather than a single path, can lead to comparable maturity outcomes. | Undermines stage logic; supports context-specific capability portfolios and non-linear trajectories. | Remane et al. (2016); Korsten et al. (2024). |
| 4. Organizational and Communicative Perspective | Maturity models provide shared vocabularies and cognitive scaffolds that influence organizational sensemaking and planning. | Frames maturity models as tools that structure discussion, decision-making, and strategic alignment. | Mettler (2011); Poeppelbuss et al. (2011); Doctor et al. (2023); Mikalef et al. (2020). |
| 5. Socio-Political Perspective | Maturity models are not neutral; they shape and are shaped by organizational power, governance, and institutional routines. | Can trigger new roles, resource allocation, accountability structures, and organizational change. | Carvalho et al. (2016); Doctor et al. (2023); Korsten et al. (2024). |

*Table 1. Key perspectives on maturity models in literature.*

## 2.2 Digital Transformation in Healthcare

Healthcare presents a distinctively complex context that warrants explicit theoretical attention in Digital Transformation. Four characteristics make healthcare DT particularly challenging and consequential for understanding alignment mechanisms. First, healthcare organizations operate under multiple coexisting institutional logics, clinical, research, administrative, and regulatory, each generating distinct priorities, vocabularies, and accountability structures that render alignment inherently contested (Currie & Guah, 2007). Second, healthcare data is among the most heterogeneous and sensitive of any domain, combining structured clinical records, imaging, genomic data, and administrative information, making interoperability simultaneously a technical, ethical, and governance challenge (Agarwal et al., 2010; Fichman et al., 2011). Third, healthcare systems are typically governed through federated structures - networks of hospitals, regional bodies, ministries, and professional associations each holding partial authority - creating coordination challenges that cannot be resolved through hierarchical mandate alone (Doctor et al., 2023; Heavin, 2017). Fourth, research hospitals must simultaneously serve clinical care and generate generalizable scientific knowledge, creating inherent tension between the standardization required for research and the flexibility required for clinical practice. Together, these characteristics explain both why maturity models have proliferated in healthcare and why their role as coordination devices rather than purely diagnostic instruments deserves deeper investigation.

## 2.3 Boundary Objects and Cross-Stakeholder Alignment

While maturity model research increasingly recognizes social and organizational dimensions of assessments, it lacks coherent theoretical framing for explaining how maturity models mediate alignment across heterogeneous stakeholders. Boundary object theory offers a promising lens for addressing this gap.

Introduced by Star and Griesemer (1989), boundary objects are artifacts that exist in multiple social worlds. They maintain a common structure to facilitate alignment while being adaptable to local contexts. This unique combination of shared and locally relevant characteristics allows for coordination without the necessity of full consensus. As a result, boundary objects are especially crucial in environments marked by professional diversity, distributed expertise, and the need for alignment across organizational boundaries, conditions that closely match the challenges of digital transformation in healthcare. Alignment in this context operates across social, operational, and strategic dimensions: heterogeneous actors develop shared understanding and vocabulary, coordinate their practices and workflows, and converge on shared institutional priorities and governance directions (Chan & Reich, 2007). Rather than treating alignment as a single undifferentiated outcome, this study examines the mechanisms through which a shared artifact mediates the three forms simultaneously in a federated healthcare ecosystem.

Boundary objects possess several interrelated properties. Interpretive flexibility enables different communities to understand and use the object differently while maintaining coherence (Star, 2010). Structural stability provides a common reference point enabling communication, comparability, and shared baselines across groups (Carlile, 2002). Balancing flexibility and stability is central to boundary object functioning as excessive flexibility leads to incoherence, while excessive rigidity prevents local adaptation. Carlile (2002, 2004) further conceptualizes boundary object work by identifying three knowledge boundaries they traverse: syntactic boundaries require common definitions for knowledge transfer; semantic boundaries require translation across professional vocabularies; and pragmatic boundaries require negotiation to reconcile conflicting interests. These dynamics are relevant to healthcare digital transformation, which requires bridging differences between clinical practice, IT architecture, research protocols, and administrative governance (Heavin, 2017).

Information systems research demonstrates boundary objects in practice through prototypes, design documents, process models, and data schemas that enable coordination among developers, users, and managers (Levina & Vaast, 2005). Levina and Vaast (2005) extend the theory by emphasising boundary spanners, individuals who actively engage with boundary objects to create cross-community connections. In healthcare, clinical guidelines, shared datasets, electronic health records, and

interoperability standards support cross-disciplinary collaboration (Doolin & McLeod, 2012). Sociomaterial extensions emphasize that boundary objects can generate new practices, roles, and structures through enactment over time (Doolin & McLeod, 2012), a generative capacity that remains underexplored but may be particularly relevant for understanding how maturity models influence digital transformation.

Drawing on these insights, our study conceptualizes digital maturity models as boundary objects and examines how maturity assessments mediate alignment across heterogeneous stakeholders in large-scale healthcare digital transformation. This framing moves beyond viewing maturity models as purely diagnostic instruments, revealing organizational mechanisms through which they support coordination, negotiation, and institutional change. By applying boundary object theory to maturity models, we address a key gap in both literatures: maturity model research lacks theoretical grounding for understanding alignment processes, while boundary object theory has not examined how evaluative frameworks function as boundary objects in transformation contexts.

# 3 Methodology of the Study

## 3.1 Research Design and Context: An Ethnographic Case Study

This study uses an ethnographic case study methodology to explore how a digital maturity model serves as a boundary object within the Health Big Data project, a national initiative aiming to create a federated platform for collecting, standardizing, and analyzing diverse clinical and research data. Ethnography is well-suited for examining information systems in complex, socio-technical environments where meaning-making and negotiation are central (Myers, 1999; Walsham, 2006). Maturity models, often seen as neutral evaluative artifacts, gain meaning through their use and are interpreted and adapted differently by various actors. Capturing these processes requires deep immersion rather than detached observation.

The HBD project provided an ideal setting for ethnographic inquiry. Across the four clinical networks (Cardiac, Cancer, Neuroscience & Rehabilitation, and Paediatric), the 51 participating institutes differ considerably in digital infrastructure, governance mechanisms, data practices, and strategic priorities, creating significant interpretive variability. The maturity model was introduced as a shared reference artifact to support digital transformation, harmonize expectations, and guide institutes in assessing their readiness for participation in the federated platform. As the model travelled across this distributed multi-organizational structure, researchers observed how it was enacted, how its meanings shifted, and how it mediated interactions between clinicians, IT units, data officers, researchers, and top management. Given these features, an ethnographic case study was methodologically appropriate to uncover how the maturity model acquired its boundary object characteristics in practice and how it supported coordination and transformation.

The maturity model was developed and implemented over four years, from 2021 to 2025. The research team conducted initial interviews with 16 research hospitals, presenting an early qualitative version of the model with defined but unquantified domains, levels, and analytical dimensions (June 2021 - July 2022). A second round of presentations and interviews with 7 hospitals (January - October 2023) refined the model and led to the preparation of a structured data collection instrument. The questionnaire was administered across 18 hospitals, collecting 17 valid responses (January - September 2024). Individual analyses were prepared, and results were presented to each hospital through feedback workshops, mapping institutions within the maturity framework and discussing improvement recommendations (November 2024 - March 2025). Following these meetings, several hospitals produced formal written reports on assessment findings and strategic implications (April - October 2025). These 17 complete assessments constitute the primary empirical corpus for this study.

We were embedded in the HBD project for over four years, participating in working groups, co-designing the model, facilitating data collection, conducting workshops, and presenting results to hospital leadership. This involvement created a productive insider-outsider dynamic: as participants, we gained detailed access to interactions, tensions, and informal exchanges; as analysts, we maintained

theoretical distance through systematic memoing and interpretive cycles. Immersion extended beyond formal meetings to include corridor conversations, email exchanges questioning dimension meanings, and moments revealing strategic use of maturity results, exposing how the model was interpreted and mobilized in ways that would not have been visible through interviews or document analysis alone.

Critically, our dual role as model designers and assessors carries epistemological implications that must be acknowledged. Hospitals were assessed using a framework we had co-developed, which may have introduced social desirability dynamics, where institutions presented their practices in terms they believed we valued, and may have favoured findings that aligned with our theoretical framing. We aimed to mitigate these risks through systematic cross-case comparisons, critical analysis of strategically framed responses, and member checking of interpretations with network participants. However, we recognize that these measures reduce rather than eliminate the influence of researcher positionality.

## 3.2 Data Collection

Data collection followed ethnographic principles of multi-modal, longitudinal, and iterative evidence accumulation (Myers, 1999). While the model development process involved consultations with multiple hospitals across the four-year period, the empirical analysis focuses on the 17 research hospitals for which complete maturity assessments were conducted and comprehensive data were systematically collected. Table 2 provides the data sources and their contribution to analysis.

| Data Source | Description | Contribution to Analysis | Examples |
|---|---|---|---|
| Participant observation | >40 meetings across networks, working groups, executive committees, hospital presentations, and mapping workshops (2021–2024). | Revealed real-time interactions, negotiations, interpretations, and tensions around the maturity model. | Network coordination meetings, plenary sessions, hospital-specific assessment workshops. |
| Artifacts and documents | Maturity model drafts (2021–2023); questionnaires; 17 hospital mapping presentations; institutional reports; internal memos; governance documents; maturity score datasets | Allowed tracing the model's evolution, comparing interpretations across hospitals, and identifying patterns in stakeholder engagement. | PowerPoint assessment decks, hospital self-reflection reports, project governance documents. |
| Informal conversations | Clinical staff, IT leaders, data managers, hospital directors, network coordinators. | Provided insight into hidden assumptions, local constraints, strategic priorities, and informal uses of the model. | Corridor conversations after workshops, email exchanges questioning dimension definitions. |
| Fieldnotes and analytic memos | Daily/weekly reflections; observations during model development and hospital interactions; analytical hunches and interpretive shifts. | Supported reflexive analysis; captured emerging themes; documented the researchers' evolving understanding. | Observation notes from workshops, analytical reflections on interpretive tensions. |
| Secondary sources | Public communications about HBD; national policy guidelines on health data infrastructure; network-level documentation. | Contextualized organizational pressures, institutional trends, and policy environment shaping digital transformation. | Ministry of Health directives, HBD project announcements, network strategic plans. |

*Table 2. Summary of data sources.*

This multi-modal data collection strategy enabled the research team to observe the maturity model "in action" across multiple contexts, capturing both its formal uses in structured assessments and governance meetings and its informal mobilizations in corridor conversations, email exchanges, and

strategic negotiations. The longitudinal nature was essential for understanding how the model's boundary object properties emerged and evolved over time.

## 3.3 Data Analysis

The analysis followed an iterative, interpretive approach aligned with hermeneutic principles for IS field studies (Klein & Myers, 1999). Analysis proceeded through successive cycles of familiarization, open coding, theoretical coding, cross-case comparison, and abductive interpretation. Table 3 describes each analytical stages with examples showing how we moved from empirical data to the identification of characteristics and roles presented in the Results section.

| **Analytical Stage** | **Process Description** | **Example: Identifying Characteristics** | **Examples: Identifying Roles** |
|---|---|---|---|
| Stage 1: Familiarization and open coding | Multiple readings of fieldnotes, documents, and transcripts; open coding to identify recurrent themes, interpretive tensions, and points of interaction around the maturity model. | Noted recurring theme: different stakeholder groups (IT vs. clinicians) framed "data quality" differently but both engaged productively with the model → Initial code: "multiple legitimate interpretations." | Observed pattern: After presenting low governance scores, several hospitals established new committees or appointed data officers → Initial code: "model triggers organizational action." |
| Stage 2: Theoretical coding | Refined codes using boundary object theory into analytical categories: interpretive flexibility, structure and stability, shared reference point, facilitation of translation. | The "multiple legitimate interpretations" code mapped to interpretive flexibility - e.g., researh hospital 1 (RH1) focused on research data tools (REDCap, Research Electronic Data Capture) while RH2 emphasized clinical standards (OMOP/FHIR). | The "model triggers organizational action" code informed the triggering transformation role - e.g., RH3's medical director asking "Who is responsible for data governance?" leading to CDO appointment. |
| Stage 3: Cross-case comparison | Systematic comparison of 17 hospital mappings to identify patterns of convergence and divergence across dimensions. | Compared how hospitals interpreted "Data Governance" dimension: high divergence (research vs. clinical vs. IT perspectives) but all used the same stable five-dimension framework → Confirmed structure and stability characteristic. | Compared post-assessment actions: 12 of 17 hospitals launched concrete initiatives (HBD specialists hiring, new committees, infrastructure projects) → Confirmed triggering transformation was systematic, not isolated. |
| Stage 4: Process tracing | Traced sequences where the model catalyzed organizational action; examined how characteristics enabled specific roles. | Traced how RH4 moved from abstract "improve data governance" (assessment finding) to concrete "automated REDCap flows and pseudonymization pipelines" (implemented solution) → Showed facilitation of translation characteristic in action. | Traced RH5 nine departmental OMOP presentations following maturity assessment → Documented how model enabled bridging stakeholder groups role by creating shared narrative across clinical units. |
| Stage 5: Abductive theorizing | Brought empirical themes and theoretical constructs into dialogue; identified extensions to boundary object theory. | Observed that model didn't just coordinate but *generated* new HBD specialists roles, governance structures, reporting routines → | Observed that model helped hospitals standardize practices (e.g., RH1's REDCap templates) to enable coordination → |

| | | | |
|---|---|---|---|
| | | Theorized operational generativity as extension beyond classical boundary object properties. | Theorized aligning and converging actions role as mechanism for cross-departmental synchronization |

*Table 3. Analytical process: from data to theory.*

This analytical process was iterative moving back and forth between stages as new insights emerged. For instance, recognizing operational generativity in Stage 5 prompted to return to Stage 3 to systematically examine all hospitals for evidence of newly created roles and structures, which strengthened confidence in this emergent characteristic.

Rigor was ensured through established principles for interpretive Information Systems research (Klein & Myers, 1999). The analysis moved iteratively between individual episodes and broader patterns: specific cases were interpreted within the HBD context, while overall patterns were validated against detailed cases. We documented each hospital's organizational context, digital transformation trajectory, and strategic priorities to enable contextual interpretation. We systematically compared how different stakeholders, such as IT staff, researchers, and administrators, interpreted the same maturity dimensions to capture multiple perspectives. We exercised critical awareness when maturity scores were used strategically to justify resource claims, distinguishing genuine alignment from political positioning. We maintained reflexivity through analytic memos and internal debriefings that examined how our embedded role shaped observations. Finally, we shared preliminary findings with network members during HBD meetings to validate interpretations and incorporate feedback.

# 4 Results

Results are organized in three main parts. First, we present the development of the HBD digital maturity model (Section 4.1). Second, we examine how this model functioned as a boundary object, identifying both classical and emergent characteristics (Section 4.2). Third, we analyze the four distinct roles the model played in supporting digital transformation (Section 4.3).

## 4.1 Development of the HBD Digital Maturity Model

The HBD maturity model development unfolded through iterative cycles of conceptual work, operational refinement, and engagement with participating research hospitals between 2021 and 2023. Early iterations were grounded in digital transformation and maturity model literature (Becker et al., 2009; Mettler, 2011) but were heavily shaped by feedback from IT managers, clinicians, data analysts, and research staff across the network gathered through interviews and workshops. During the first round of consultations (June 2021 - July 2022), stakeholders emphasized that the assessment framework needed to balance standardization with local adaptation, enabling hospitals to reflect on their digital practices rather than being subjected to external auditing. The research team responded to substantial heterogeneity in local infrastructures and digital strategies by defining five high-level dimensions - Digital Support, Data Lifecycle, Organization & Competences, Data-oriented Strategy, and Privacy & Security - each articulated across four maturity levels (Level 1: Initial/Fragmented; Level 2: Emerging/Structured; Level 3: Established/Integrated; Level 4: Transformational/Learning). This structure provided sufficient commonality to enable cross-institutional comparison while maintaining interpretive flexibility for local contexts. The designed maturity model is presented in Figure 1.

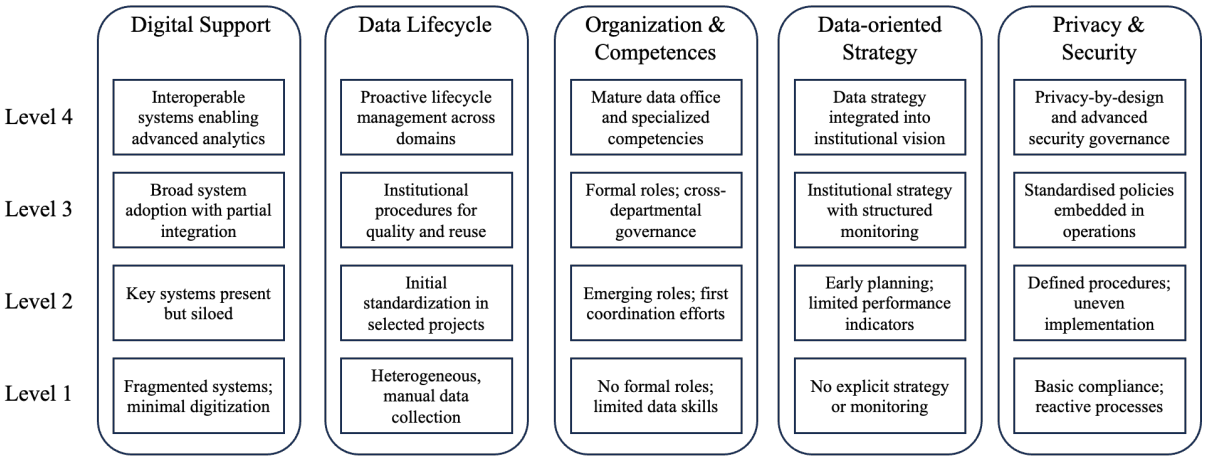


*Figure 1. HBD Maturity Model: five dimensions and four levels of maturity.*

The model was piloted in 17 research hospitals, with each organization completing a detailed questionnaire followed by workshops where institutional profiles were presented and collectively interpreted by cross-functional teams including clinicians, IT staff, researchers, and administrative leaders. These workshops played a central role in validating indicators' clarity, surfacing misalignments between perceived and measured maturity, and stimulating cross-stakeholder dialogue. During Research Hospital 2 (RH2) assessment workshop, the digital health program director described how the process revealed gaps across the entire data lifecycle: "*Indicator gaps have been identified with respect to the data lifecycle [collection, management, utilization, integration] which were subsequently shared with infrastructure leaders for follow-up actions.*" This illustrates how assessment made visible systematic weaknesses across data lifecycle, which were then escalated to infrastructure leaders for remediation.

## 4.2 Characteristics of the HBD Maturity Model as a Boundary Object

Empirical application across research hospitals demonstrated that the model exhibits four classical boundary object characteristics (interpretive flexibility, structure and stability, shared reference point, facilitation of translation) and three emergent properties that extend boundary object theory (operational generativity, temporal scalability, and institutional anchoring) as summarized in Table 4.

| **Characteristic** | **Definition** | **Empirical evidence** |
|---|---|---|
| Interpretive flexibility | Different stakeholder groups interpret and use the model in distinct ways while maintaining coherence. | IT staff focused on interoperability standards (FHIR, OMOP); clinicians emphasized workflow digitization; researchers concentrated on data lifecycle; managers viewed through strategic alignment lens. |
| Structure and stability | Model maintains stable core (dimensions, indicators, levels) shared across contexts. | All 17 RHs used same five dimensions and four-level scoring scheme; consistent framework enabled comparison and longitudinal tracking. |
| Shared reference point | Provides common vocabulary and framework for coordination despite contested meanings. | Used in plenaries, network meetings, and working groups to discuss progress, identify gaps, and negotiate priorities. |
| Facilitation of translation | Mediates communication across heterogeneous expertize and professional logics. | HBD specialists used model to explain technical constraints to clinicians and clinical needs to IT teams; workshops enabled mutual understanding. |
| Operational generativity | Artifact produces new work practices, organizational roles, and institutional structures. | Led to hiring of FTEs; created new reporting routines, data extraction activities, quality checks; triggered governance changes (Minimum Data Set definition, interoperability procedures). |

| | | |
|---|---|---|
| Temporal scalability | Model structures alignment across time, supporting evolution tracking and planning. | Model evolved (2021→2023); repeat assessments planned; supports cross-time comparison; embeds "frontiera" (target state). |
| Institutional anchoring | Artifact becomes embedded in formal governance, staffing, and accountability structures. | Incorporated into working groups, network governance, RH planning; used for Ministry reporting; embedded in HBD specialists job descriptions; influences budgeting. |

*Table 4. Characteristics of the maturity model as a boundary object.*

### 4.2.1 Classical Boundary Object Characteristics

*Interpretive flexibility* emerged as different stakeholder groups activated distinct meanings while maintaining the model's coherence. During the assessment workshop at Research Hospital 1 (RH1), the research coordinator linked maturity gaps to their adoption of research data management tools, explaining: "*Among the objectives... creation of data collection forms... and data analysis/interrogation*" through REDCap, ATLAS, and cBioPortal, reflecting a research-centric interpretation. In contrast, the IT director at RH2 emphasized clinical continuity during their feedback meeting, stating: "*Analysis of the state of omics data management, eCRFs and clinical records... structuring data according to OMOP-CDM and FHIR standards,*" prioritizing how digital systems support patient care and longitudinal health records. These contrasting interpretations demonstrate how the same model addressed locally meaningful challenges without losing coherence. *Structure and stability* was simultaneously maintained through the five dimensions and four maturity levels, providing a stable classification system that all 17 hospitals used consistently, enabling cross-institutional comparison and longitudinal tracking.

The model functioned as a *shared reference point* enabling different units to align discussions around common categories and shared goals. During the presentation at Research Hospital 6 (RH6), the Chief Information Officer observed that the assessment created shared context for coordinating clinical data repository design across research, IT, and privacy units, noting: "*Internal project for collection and standardization of clinical data... analysis of storage requirements... enhancement of computational infrastructure.*"

*Facilitation of translation* was demonstrated through the model's provision of accessible vocabulary for translating technical concepts across professional boundaries. During one cardiac hospital presentation (RH2), observed during the assessment workshop, the Chief Information Officer turned to the hospital director and said: "*This explains why we need to invest in the data lake next year; otherwise, we will remain blocked at level 2.*" This remark revealed how the model enabled strategic translation of technical infrastructure needs into language resonating with executive decision-makers.

### 4.2.2 Emergent Characteristics: Extension to Boundary Object Theory

Beyond classical properties, three additional characteristics extend boundary object theory.

*Operational generativity* emerged as the model did not merely coordinate existing work but actively generated new organizational capabilities, roles, and structures. Most significantly, it led directly to hiring new HBD specialists with hybrid competencies spanning clinical knowledge, data science, and information technology. These boundary-spanning professionals were explicitly tasked with addressing maturity gaps identified through assessment, with role definitions referencing model dimensions and responsibilities including data extraction, integration pipeline management, and metadata standardization. This generative capacity was evident across multiple hospitals: Research Hospital 5 (RH5) IT and research teams documented the creation of new reporting routines, including monthly OMOP database updates and presentations to nine clinical departments, representing organizational work directly generated by engagement with the model. At Research Hospital 3 (RH3), a low governance score surprized leadership. During the assessment meeting, the medical director paused and asked the Chief Information Officer: "*Who is actually responsible for our data governance processes?*" This question triggered recognition that no formal governance structure existed; within two months, the

institute appointed a Chief Data Officer and created a cross-departmental committee. This operational generativity, producing new organizational forms rather than just coordinating existing work, represents a significant extension to boundary object theory by highlighting its productive and constitutive effects.

*Temporal scalability* was demonstrated as the model structured alignment not only in the present but across time. It evolved through successive versions incorporating feedback, became longitudinal through planned repeat assessments enabling baseline versus follow-up tracking, and embedded a "frontiera" (target maturity state) toward which hospitals oriented strategic planning. During a planning discussion at RH1, the data governance coordinator described how standardization would enable future capabilities: "*by maintaining the same data structure it is possible to automatically activate integration channels*" in subsequent infrastructure development phases. This temporal dimension, rare in boundary object literature, suggests that digital maturity models function as temporal boundary objects aligning actors around shared understandings of past, present, and future digital trajectories rather than merely coordinating action at a single point in time.

*Institutional anchoring* manifested as the model became embedded in formal governance structures, organizational roles, and accountability mechanisms, giving it substantial organizational weight. It appeared regularly in network-level plenaries, working group agendas, and executive reports; was explicitly tied to HBD specialist roles with job descriptions referencing model dimensions; influenced formal budgeting and staffing decisions; and became a Ministry of Health reporting requirement. In their post-assessment report, RH2's project leadership explicitly described formal escalation: "*The areas for improvement... have been shared with those responsible for technological infrastructure in order to verify their application in the Institute.*" Several hospitals, including RH3, established new governance bodies, data management committees, interoperability working groups, directly in response to governance gaps identified through assessment, demonstrating how boundary objects can become constitutive elements of organizational infrastructure rather than remaining peripheral coordination devices.

## 4.3 Roles Played by the Maturity Model in Digital Transformation

Analysis across 17 hospitals reveals four primary roles of boundary objects - bridging stakeholder groups, translating abstract concepts into actionable tasks, triggering organizational transformation, and aligning actions to enable convergence – and the enabling characteristics (Table 5).

| Role | Description | Enabling characteristics | Empirical evidence |
|---|---|---|---|
| 1. Bridging stakeholder groups | Creates shared dialogue spaces between clinical leadership, IT, research units, and administrators. | Interpretive flexibility; Shared reference point. | RH5 used OMOP presentations to engage cardiology, pneumology, neurology units (9 departmental meetings) in data standization dialogue. |
| 2. Translating concepts into actionable tasks | Converts abstract ideas (interoperability, governance, analytics) into specific work items. | Structure & stability; Reflexivity | RH4 implemented automated REDCap flows and pseudonymization pipelines addressing governance gaps. |
| 3. Triggering organizational transformation | Reveals gaps prompting new initiatives, restructuring, or strategic reorientation. | Reflexivity; Actionability; Operational generativity | RH2 launched OMOP/FHIR alignment, privacy evaluations, data-lifecycle improvements after surfacing governance gaps. |
| 4. Aligning and converging actions | Aligns departments around shared priorities and synchronizes digital strategy. | Structure & stability; Shared reference point; Temporal scalability | RH1 standardized REDCap templates and OMOP workflows, aligning research, IT, and data governance. |

*Table 5. Roles of the maturity model in the analyzed case.*

### 4.3.1 Bridging Stakeholder Groups

The maturity model acted as a bridge between communities traditionally operating in parallel - IT professionals, clinical leadership, administrative managers, and research coordinators. At RH5, the maturity model fostered collaboration among groups that had previously operated independently: the ETL/OMOP technical team, clinical departments, and research staff. The assessment highlighted the interdependencies between their data practices. These interdependencies had gone unrecognized until the maturity framework provided a common lens for examination. This led to the establishment of a standardized set of tables, creating a shared representational infrastructure for clinicians responsible for patient care, researchers designing studies, and data officers maintaining collection standards. As a result, they could all work with the same patient data using consistent categories. What had previously required manual reconciliation across incompatible formats became a structured, reusable workflow, creating a shared organizational narrative about data quality, standardization, and reuse that transcended professional boundaries. During a network coordination meeting, RH1's IT manager illustrated this bridging at the network level, reflecting: "*Many of the pipelines... had OMOP mapping as their endpoint. If we could also work internally on similar projects, we could make a greater contribution,*" showing how the model enabled local IT staff, clinical researchers, and HBD-wide data architecture to align around shared goals.

### 4.3.2 Translating Abstract Concepts into Actionable Tasks

The model translated broad transformation concepts, such as "improve data integration" and "enhance digital competencies," into concrete organizational components and specific initiatives. At Research Hospital 4 (RH4), the assessment surfaced the absence of structured data collection protocols for clinical research, catalyzing the deployment of an integrated platform connecting eCRFs built in REDCap with hospital systems. The platform introduced pseudonymization through randomized alphanumeric coding and enabled automatic extraction of structured laboratory data into research workflows, reducing manual data entry and transforming previously informal coordination among clinical researchers, IT staff, and privacy officers into structured, outcomes-oriented practice. Similarly, at RH6, analytics capability gaps prompted exploration of large language models for automated clinical summarization, showing how abstract maturity dimensions translated into concrete technology initiatives. Across all 17 hospitals, the four maturity levels consistently provided structured roadmaps that transformed general improvement aspirations into actionable tasks with defined scopes and timelines.

### 4.3.3 Triggering Organizational Transformation

The model triggered organizational transformation by revealing strategic misalignments and creating catalytic moments stimulating change. This triggering role was systematic rather than isolated: 12 hospitals launched concrete initiatives following their assessments, ranging from infrastructure projects and new hiring to governance restructuring. Following their assessment workshop, RH2's digital transformation steering committee initiated multiple strategic reviews: "*To analyze the state of privacy management... and patient involvement... related to clinical data and its management.*" The assessment prompted formal analysis of privacy management and patient consent processes that had previously been handled informally or inconsistently across departments, a process that had never been collectively examined until the maturity model made their fragmentation visible. This led to a structured escalation process in which improvement areas were formally shared with those responsible for technological infrastructure, creating cross-departmental accountability.

### 4.3.4 Aligning Actions and Enabling Convergence

The model supported alignment across departments and helped institutions converge on shared strategic priorities. Because the model made visible interdependencies across dimensions, hospitals began coordinating initiatives previously fragmented across units. In their follow-up planning session, RH1's research and IT leadership demonstrated effective alignment through standardization, with the data governance coordinator explaining: "*A minimum standard template has been defined... by maintaining*

*the same data structure it is possible to automatically activate integration channels.*" Standardizing REDCap templates created alignment between clinical studies (needing flexible data collection), IT systems (requiring consistent data structures), and data governance units (ensuring quality and compliance). The workshops revealed that the model facilitated alignment of short-term operational goals with long-term strategic ambitions.

# 5 Discussion

This study investigated how digital maturity mediates cross-stakeholder alignment in healthcare digital transformation, a context where multiple institutional logics, federated governance structures, and heterogeneous data infrastructures make alignment both more necessary and more difficult to achieve (Agarwal et al., 2010; Currie & Guah, 2007). Drawing on a multi-year ethnographic case study of the Health Big Data project, our findings show that the maturity model functioned as a boundary object enabling heterogeneous actors to articulate needs, negotiate priorities, and align toward shared data governance trajectories, coordination challenges that are especially acute in federated ecosystems where no single authority can mandate convergence, while also producing organizational effects including institutionalized workflows and embedded governance routines. Responding to calls for deeper understanding of alignment mechanisms in complex healthcare DT initiatives (Doctor et al., 2023; Heavin, 2017), the paper makes two theoretical contributions and one empirical contribution (Table 6): it reconceptualizes digital maturity as an organizational boundary object; it extends boundary object theory with three emergent properties, operational generativity, temporal scalability, and institutional anchoring; and it provides micro-level empirical insight into how maturity models shape sensemaking, negotiation, and coordinated action across federated healthcare ecosystems.

| Key finding | Contribution |
|---|---|
| Maturity model functioned as a boundary object exhibiting four classical characteristics (interpretive flexibility, structure and stability, shared reference point, and facilitation of translation) enabling heterogeneous stakeholders to engage with a common artifact while retaining locally meaningful interpretations | Reconceptualizes digital maturity models as active coordination devices rather than passive diagnostic instruments, shifting attention from what maturity models measure to what they enable organizationally. |
| The maturity model exhibited three emergent properties beyond classical boundary object theory: operational generativity (producing new roles, routines, and governance structures), temporal scalability (structuring alignment across time through evolving versions and target states), and institutional anchoring (embedding in formal governance, job descriptions, and reporting requirements). | Extends boundary object theory by identifying three properties crucial for mediating sustained alignment in complex digital transformation initiatives, addressing a gap in both maturity model research and boundary object theory. |
| Maturity model played four distinct roles in practice - bridging stakeholder groups, translating abstract concepts into actionable tasks, triggering organizational transformation, and aligning and converging actions - shaping sensemaking, negotiation, and coordinated action across a federated healthcare ecosystem. | Provides empirical insight into the micro-practices through which maturity models govern digital transformation in complex multi-stakeholder healthcare settings, with practical implications for managers leading transformation initiatives. |

*Table 6. Key findings and contributions of the study.*

## 5.1 Reconceptualising Digital Maturity as Organizational Boundary Object

Existing research conceptualizes maturity models largely as diagnostic instruments that measure organizational capabilities along predefined levels (Becker et al., 2009; de Bruin et al., 2005; Mettler, 2011). Even when maturity models guide digital transformation (Korsten et al., 2024; Röglinger et al., 2012), they are typically presented as technical artifacts that classify organizations. This perspective limits understanding of how maturity assessments function in practice, particularly in complex, multi-

stakeholder contexts such as healthcare, where digital transformation requires negotiation, coordination, and shared meaning-making across diverse actors (Heavin, 2017; Doctor et al., 2023).

Our findings extend this literature by demonstrating that digital maturity operated as a boundary object: an artifact both sufficiently stable to provide shared reference across communities and sufficiently flexible to be interpreted and used differently in local contexts (Carlile, 2002; Star & Griesemer, 1989). This reconceptualization shifts attention from what maturity models measure to what they enable organizationally. Rather than treating maturity as an organizational attribute existing independently of assessment, we show that maturity models are active participants in organizational processes: they structure meetings, guide cross-institutional workshops, anchor discussions, and serve as reference points for negotiation. This is especially significant for digital transformation in healthcare, where the coexistence of multiple institutional logics and federated governance structures means that no single authority can mandate convergence, making the availability of a shared artifact that enables alignment without requiring consensus organizationally consequential (Currie & Guah, 2007; Doctor et al., 2023). While sociomaterial perspectives similarly recognize that artifacts shape organizational life through enactment (Doolin & McLeod, 2012), they focus primarily on situated local practice rather than on how artifacts coordinate alignment across heterogeneous organizations operating under different professional logics. By reconceptualizing maturity models as boundary objects that operate across organizational boundaries and governance regimes, this study extends the sociomaterial perspective from its traditional focus on situated practice to the cross-institutional coordination challenges that characterize large-scale digital transformation in federated healthcare ecosystems.

## 5.2 Mechanisms of Alignment: Extending Boundary Object Theory

The second contribution articulates how digital maturity supports alignment across diverse stakeholders. While prior work acknowledges alignment's importance for digital transformation (Mikalef et al., 2020; Poeppelbuss et al., 2011), it provides limited insight into mechanisms enabling alignment in practice. Boundary object theory offers properties such as interpretive flexibility, shared structure, and translation (Carlile, 2004; Star, 2010), but most studies treat these as static characteristics rather than examining how they work dynamically.

Our findings extend boundary object theory by identifying three emergent properties crucial for mediating alignment: operational generativity, temporal scalability, and institutional anchoring. Unexpectedly, operational generativity captures how the maturity model did not merely facilitate communication among existing roles but actively generated new organizational capabilities, roles, and structures. This extends boundary object theory beyond its traditional focus on communication and coordination to highlight productive and constitutive effects: how boundary objects create the organizational forms through which alignment is achieved. The hiring of hybrid professionals tasked with addressing maturity gaps, the establishment of new governance committees, and the creation of standardized data workflows exemplify how maturity assessments generate organizational infrastructure for digital transformation rather than simply describing existing capabilities.

Temporal scalability illustrates how maturity models structure alignment not only in the present but also over time. Through evolving versions that incorporate stakeholder feedback, planned repeat assessments for longitudinal tracking, and explicit target states that guide strategic planning, maturity models become temporal boundary objects. This temporal dimension, rarely addressed in boundary object literature that focuses on static contexts, is crucial for understanding how stakeholders maintain alignment during extended transformation initiatives. It clarifies how organizations coordinate long-term investments in data infrastructure, training programmes, and interoperability projects around shared understandings of past performance, current capabilities, and future aspirations.

Institutional anchoring illustrates how maturity models become embedded in formal governance structures, job descriptions, budgeting decisions, and external reporting requirements, transitioning from tools used by organizations to integral elements of organizational infrastructure. This anchoring gives maturity models significant organizational weight and durability, ensuring they continue to shape behaviour and decision-making even as personnel change and organizational priorities evolve. The

integration of maturity assessments in reporting, incorporation into job descriptions for data specialists, and influence on budgeting cycles demonstrate how boundary objects can acquire institutional permanence that reinforces and sustains stakeholder alignment over time.

Together, these three mechanisms explain how maturity models mediate sustained alignment in complex digital transformation initiatives. The mechanisms work synergistically as generated roles create capacity for ongoing alignment work, temporal scaffolding orients this work toward shared trajectories, and institutional embedding ensures continuity and accountability.

This theoretical extension directly addresses the challenges of digital transformation in complex healthcare ecosystems, where transformation unfolds over years, federated governance prevents hierarchical mandates, and alignment must be sustained through personnel changes and shifting policy priorities (Currie & Guah, 2007; Doctor et al., 2023). These conditions explain why operational generativity, temporal scalability, and institutional anchoring matter beyond the single-organization, single-moment contexts that boundary object and sociomaterial perspectives have primarily examined (Carvalho et al., 2016; Doolin & McLeod, 2012): they are the properties through which a shared artifact acquires the organizational durability and reach needed to sustain alignment in federated, multi-stakeholder digital transformation initiatives.

## 5.3 Empirical Insights: Maturity Models in Practice

The third contribution is empirical, providing access to the micro-practices through which the four roles identified in Table 5 actually unfold in organizational life. While most maturity model research focuses on model design or validation, with limited attention to how models are used, interpreted, and mobilized in practice (Mettler, 2011; Tarhan et al., 2016), our study reveals that maturity models are active participants in the governance and execution of digital transformation, shaping which problems become visible, which solutions gain legitimacy, and how resources are allocated across competing priorities.

The role of bridging stakeholder groups materializes in practice through the creation of shared data infrastructures that make cross-functional collaboration structurally possible. The RH5 case illustrates this mechanism: the maturity model did not merely connect existing groups but made their interdependencies visible, creating the organizational conditions for shared infrastructure development. For managers initiating digital transformation, this suggests that data standardization should be treated not merely as a technical task but as an organizational intervention that bridges professional communities by giving them a common language and a common object to work with.

The role of translating abstract concepts into actionable tasks is illustrated by how assessment findings create structured accountability for resolving previously unacknowledged gaps. RH4 case exemplifies this mechanism: what began as an abstract maturity gap in data collection protocols became a concrete platform deployment with defined scope, involving clinical researchers, IT staff, and privacy officers in structured, outcomes-oriented coordination that had previously been informal and fragmented. For managers, this suggests that assessment findings should function as organizational mandates rather than recommendations: their practical value lies not in the score itself but in the legitimacy they confer on improvement initiatives, transforming vague intentions into projects with defined accountability.

The roles of triggering organizational transformation and aligning and converging actions often operate in sequence, with a single assessment moment catalyzing both. At RH3, a low governance score prompted the medical director to question who was responsible for data governance, exposing a structural blind spot that no internal process had surfaced and leading to the appointment of a Chief Data Officer and a formal cross-departmental governance committee. At RH1, a parallel dynamic produced alignment rather than restructuring: the identification of data that could not be managed through automated pipelines prompted the definition of a minimal dataset, making patient data reusable across multiple studies and aligning the practices of clinicians, researchers, and data managers around a common infrastructure. These cases demonstrate that the most consequential outcome of a maturity assessment is often not the score itself but the organizational questions and capability gaps it surfaces, making structural problems visible and creating the legitimacy required for cross-stakeholder action.

### 5.4 Limitations and Future Research

This study has limitations pointing to areas for future work. First, while our embedded approach provides deep insight into a single national initiative, generalizability may be constrained by characteristics of the research hospitals network and its governance structure. Additionally, our dual role as model designers and ethnographic observers represents a reflexivity limitation as the maturity model itself reflects our conceptual choices, and hospitals' responses may have been shaped by awareness of our involvement. Future studies could examine whether similar boundary object dynamics emerge in other healthcare systems or non-healthcare contexts and benefit from independent replication of the assessment in comparable settings. Furthermore, the institutionalization of maturity models carries potential risks that future research should examine, including rigidity that may disadvantage lower-maturity hospitals, symbolic compliance where institutions perform maturity rather than enacting it, and political distortion of self-assessment scores to justify resource claims or meet reporting requirements. Second, our analysis draws primarily on qualitative data. Although these provide rich insight into alignment mechanisms, future research could complement this with quantitative measures of alignment, digital performance, or transformation outcomes, allowing triangulation and validation. Our ethnographic access primarily captured data governance, IT, and research stakeholders; future work could examine engagement with front-line clinical staff. Third, additional work is needed to specify conditions under which boundary objects acquire the properties identified here. Comparative studies across digital transformation programs could illuminate what factors enable or constrain their emergence. Future research could also explore long-term model evolution, tracking how repeated assessments and governance routines influence alignment over time as boundary objects that shape, and are shaped by, organizational transformation.

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