Research on the Pathways for Building Dynamic Capabilities of SMEs in the Context of Digital Transformation

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Abstract: *Digital transformation alters how SMEs orchestrate their resources and search for opportunities when building dynamic capabilities require capability boundaries, evolutionary mechanisms, and pathway combinations. The paper delineates the theoretical boundaries of dynamic capabilities in a digital context and its dimensions of sensing, integrating, and reconfiguring; analyzes reshaping capability structure via digital embeddedness with heterogeneous manifestation under resource constraints; explains mechanisms of digital opportunity sensing, data flows and organizational learning, and platform connections and relationship reconfiguration; proposes three construction pathways: sensing, integrating, and reconfiguring. Capability modularization and balance between connective invocation and internal absorption provides an explanatory framework for SMEs formulate adjusting, replaceable, and recoverable portfolio of capabilities.*

Keywords: *Digital transformation; SMEs; dynamic capabilities; sensing, integrating, and reconfiguring; construction pathways*

Introduction

The environment where SMEs create capabilities changes as data, platforms, and external connections become an integral part of their daily activities; The speed and boundary of opportunities' identification, resources' orchestration, and structure's update change. Most studies about dynamic capabilities focus on large enterprises, explaining the resource constraint, relational dependence, and cognitive boundaries of SMEs is still inadequate. Even though the threshold of acquiring digital tools decreases, capability accumulation isn't automatic, it will easily appear a disconnect between connective invocation and internal absorption, constructing pathways of dynamic capabilities becomes a question needing answering. Significance of this study lies in put dynamic capability theory at the intersection of the digital context and SME constraints, clarify the dimensional connotation and evolutionary mechanism of sensing, integrating, and reconfiguring without directly transferring the capability logic from large enterprise. Necessity of this study lies in upgrading SME capability can't rely only on system deployment or platform access, identify the connection rules among signals, data, tasks, and relationships should be done. Analysis based on theoretical boundaries, evolutionary mechanisms, and construction pathways provide a conceptual basis for further research regarding measurement, comparison, and pathway combination.

1. Theoretical Boundaries and Dimensional Structure of Dynamic Capabilities of SMEs in the Context of Digital Transformation

1.1 The Reshaping of SME Capability Structures through Digital Technology Embeddedness

The digital technology embeddedness in SMEs does not mean installing software or platforms but forces data, algorithms, and connective relationships into its day-to-day operations. The element-level data moves from auxiliary information to input for forming capabilities as well as employees, processes, customer connections, and external services are recombined at the process level: some decisions move from experiential judgment to rule triggers with real-time feedback and capability updating can no longer rely solely on long cycle accumulation anymore. Relational level resource gains which were once hard to internalize via platform interfaces, cloud services and external collaboration networks extends the boundaries of capabilities outwardly. Resource orchestration moves from stock possession

to connective invocation, there's an increasing degree of capability modularization, and organizational inertia become a hidden resistance during reconfiguration process.

Today, capabilities are no longer just inside the enterprise – they are in connection with external nodes too! The adjustability of capability structure increases due to digital affordances, but their replicability does not improve as data quality, employees' digital literacy, and stability of external connections influence capability's performance. Digital technology embeddedness increases the openness of SME capability structures which become dependently maintained. This means: digital tools give us a lever, we have to catch it, stabilize it and reuse it. Balance connective invocation and internal absorption or else capabilities will be superficial (systems exist but usage is unaltered). Key to reshape capability structures is whether data flows can enter task rules and transforming relational connections to reusable capabilities[1].

1.2 The Sensing, Integrating, and Reconfiguring Dimensions of Dynamic Capabilities in the Digital Context

The dynamic capabilities in a digital context still follows the three dimensions: sensing, integrating, and reconfiguring but with different connotations for each one. Rather than depending solely on managers' intuition about market signals, the sensing dimension captures continuously multi-source data, platform feedback, and weak signals. SMEs are resource-limited organizations which usually have a narrow sensing scope. Expanding its information reach through digital tools comes along with an information overload. Orchestration of external data, internal processes, and collaborative relationships into useful portfolio of capabilities is involved in the integrating dimension. Leaning towards distributed collaboration in the digital context, where data interfaces, task modules, and even external service providers could enter this process. Adjustment of processes, replacement of capability modules, and reconfiguration of organizational relationships point out the reconfiguring dimension.

These dimensions do not follow each other; after sensing an opportunity, integrating capability will decide whether it can invoke resources whereas reconfiguring capability decides whether it can transform resources into a new capability structure. Changes due to reconfiguration influence the scope of sensing and mode of integration. In contrast, dynamic capabilities in the digital context behave like feedback loops instead of three separate modules. Path dependence slows down the speed of reconfiguration whilst organizational learning can mitigate lock-in to some degree so that capability evolution becomes continuous and has a sense of direction. Viewing dynamic capabilities as a contextualized feedback system explains how SMEs achieve different capability outcomes despite having similar digital investments and offers a mechanism for further pathway design.

1.3 Heterogeneous Characteristics and Boundaries of Dynamic Capabilities of SMEs under Resource Constraints

Resource constraint of SME is not a background variable but intervene in the process of dynamic capability formation. The limited stock of capital, talent, data, and relational networks lead to different combination of sensing, integrating, and reconfiguring among SMEs: some enterprise has keen sensing that can quickly sense digital opportunities, however lack integrating resources to conduct follow-up action. Some enterprise has stable external connection with relatively strong integrating capabilities, however lack enough internal motivation for sensing and reconfiguring. Others have relatively strong reconfiguring capabilities within certain relational networks, when the network position change, the capability performance will fluctuate. They demonstrate heterogeneity of SME dynamic capabilities which cannot be measured under one unified standard.

There are theoretical boundaries – Scale boundary affecting capability coverage; Cognitive boundary affecting manager's understanding about digital opportunities; Relational boundary affecting the radius of resource invocation; Data boundary affecting precision of sensing and integration. Outside boundaries, dynamic capabilities will degrade into routine operational capabilities or depend on external service providers. Pathways towards SME dynamic capabilities must consider the presence of boundaries while looking for an operable combination in them. In plain words, not all SMEs may have similar routes of capability upgrade; what they can do, what they should do first and who they should do it with depends on their type of resource constraints and digital connectivity position that they occupy. Optimization of combination within boundaries could be a basic approach to design pathways making capability construction closer to resource realities and connectivity conditions[2].

2. Mechanisms Driving the Evolution of SME Dynamic Capabilities through Digital Transformation

2.1 Triggering Mechanisms of Digital Opportunity Sensing

We don't find digital opportunities objectively: it is co-constructed by technological affordance, managerial attention and external signals. Daily customer interaction, platform feedback, equipment data or external collaboration interface in SMEs generate a set of signals that needs to pass filter, interpret and judgement inside an organization boundary to become opportunity cognition. Sensing threshold depends on resource stock while attention allocation depends upon managers' cognitive framework. Digital tools extend the scope of signal but brings noise and overload. Not about more, the better for opportunity sensing rather, it is about finding those signals match your own resources with limited attention. Filtering process is selective too – which signals will be amplified and ignored depend on the organization's existing task structure and relational network.

Characterizing feature of trigger process is continuous matching: Experience, digital literacy and position in relational network affect the result of signal interpretation. Failure of opportunity window to match with resource invocation capability means sensed opportunities cannot enter into any further action at all. Evolution of SME's sensing capabilities usually transitions from passive response to active scanning and dependency on single point information to multi source cross validation. Lightweight data monitoring, external partner feedback and platform interface information reduces the cost for sensing but limits the sensing scope by platform rules and extent of interface openness. What you see depends on where your enterprise looks and what kind of digital connections are you attached to. Sensing triggering is a cyclic process of signal entry, interpretation, matching and re-filtering; how fast and well it runs decides the updating efficiency of opportunity cognition[3].

2.2 The Integrating Mechanism of Data Flows and Organizational Learning

Integration via data flows: Orchestrating scattered resources The core is the fact that data are capability modules which are invocable, combinable and adjustable between departments, processes or external nodes. Explorative learning plays transformative role for experimenting on new use of data whereas exploitative learning allows SMEs solidify their experience with stable rules. Absorptive capacity affects how external data will be internalized; data governance, interface standards and permission arrangements impact flow efficiency. Usually having a small data stock and a short decision-making chain, the pace of learning feedback might become an integrating advantage. Direction and rhythm of data flows depend on task structure – the clearer the task, the clearer the data filtering criteria, the higher the integrating efficiency.

Data will never be capabilities simply because it is stored there, we need tasks receiving them, processes undertaking them, and feedback revising them. Integrating mechanism is matching the data with tasks instead of amount of data. Codifying knowledge transforms individual's experience into reusable rules whereas socializing knowledge transform rules into shared understanding. It is manifesting the integrating dimension of dynamic capabilities. Due to organization inertia the data flows might stay on the surface so that systems exists without changing its usage. Small step adjustments towards task can make data flows and organizational learning reinforcing each other: learning changes data filtering criteria whilst data feedback corrects the direction of learning. Integration is not combining resources but making resources combine in new ways via flow. We should pay attention to all stages from data input to rule formation as well as the transformation nodes of organizational learning in this chain to explain why different integrating outcomes occurs when facing same data conditions[4].

2.3 The Feedback Mechanism of Platform Connections and Relationship Reconfiguration

Change of platform connections influences relationship structures for SMEs. Platform as transaction channel and resource interface, carrier of rules and feedback channels. Relationship reconfiguration means replacing connection objects, changing strength of connections and shifting network positions. Feedback mechanism implies that outcome from relational changes return back to the capability structure – new connections brings new data and new resources which will affect the sensing scope; rupture of relations or altering platform rules force enterprises to adjust their integration methods and reconfiguration direction. In this process SME obtains supplementing external capabilities via platforms, forming new dependency relationships simultaneously. The relationship reconfiguration

not only increases/decreases number of connections, but also has variations on connection qualities and network position, affecting the enterprise's bargaining condition and adjustment space when invoking resources.

Two kinds of feedback loops – positive and negative. Increase in connections increases data, increased data improves integrating efficiency attracting more connections where capability evolved as an expansion loop. Deepened dependence reduces bargaining space limiting relationship adjustment difficulty to reconfigure capability. Platform interface change, partner replacement or migration of network positions all triggers feedback. SMEs have to balance between connection efficiency versus autonomous capability without replacing internal capability accumulation through external connections. This feedback mechanism connects sensing, integrating, reconfiguring into a loop allowing dynamic capability evolution which is not only influenced by previous paths, it also has space for contextual adjustments. Construction pathways in Chapter 3 seeks operable entry points exactly from this loop. Feedback loops means capability evolution is cumulative and directional, initial choice of connections affect later adjustment room: when we design pathways we need to pay attention to the adjustability of connection structure and the efficiency of finding feedback signals.

3. Construction Pathways of Dynamic Capabilities of SMEs in the Context of Digital Transformation

3.1 Construction Pathways of Sensing Capability Oriented toward Digital Opportunities

The first stage of sensing is allocating attention. Managers don't have enough attention – scanning everything spreads their judgment. Design pathways via key digital touchpoints: include customer interactions, platform feedback, equipment operating data, and partner interfaces for regular monitoring (lightweight signal pool) Once you enter signals, we need relevance filtering and resource matching assessment to avoid flooding our decision-making channel with all kinds of information. Need a manual judgment step on sensing rules because digital tools extend reach but cannot replace managers' interpretation of the value of signals. Keep up the signal pool by cleaning and updating it regularly so that old signals do not interfere with judgment or redundant ones crowd out attention resources. Dynamically adjusting filtering criteria has become a routine action in the sensing pathway[5].

Construction of sensing capability requires external information interfaces and internal cognition updates for advancing synchronization: external interface decides what signals are available to enterprises whereas internal cognition defines if it's understandable. SMEs may extend its sensing radius by external partners, platform interfaces and industry data services, correct cognitive bias by regular reviews or cross-position communication. Sensing pathway emphasizes improvement of matching efficiency instead of maximization of information. Seeing opportunities is not the real skill, judging which opportunity can be caught is the mark that sensing capability really takes root. Construction of sensing capability should connect a chain between signal filtering rules, resource-matching criteria and cognitive updating mechanism from signal entry to judgment formation, the shorter the chain and faster the feedback will lead to high sensing efficiency.

3.2 Construction Pathways of Integrating Capability Oriented toward Data Collaboration

The building of integrating capability means data flowing through tasks. Because of their low data stock, the integration path begins with data interfaces and permission arrangement for key tasks. Data standards, interface rules, and permission boundaries are bound by some tasks that are invocable and combinable capability modules. We don't need cross-departmental collaboration in full synchronization; we can start with a small-scale data closed loop at places such as order, delivery, and customer feedback first, then expand. With increasing data flow efficiency, the resource orchestration will shift from reliance on individual experience to rely on rules and feedback. Level of standardization of data interfaces decide the connection cost between modules – the more uniformity of the interfaces, the easier it is to replace or reorganize capability modules.

Organizational learning with integrative transformational effect: Exploratory learning allows SMEs to experiment new application of data while exploitative learning stabilizes successful practice as stable rules. Knowledge codification converts individual experience into reuseable document and process rule, and knowledge socialization makes rules become shared understanding. External service provider or platform interface can complement internal capabilities, however we must keep internal absorption

steps so that data collaboration will not end at external dependence. In plain words, it's not just about pilling up data, but receiving, using and revising data for tasks. Small step adjustment and continuous feedback could gradually take shape of integrating capability under resource constraint. Advancement of the integration pathway should focus on coverage scope and operating frequency of data closed loop; the tighter the closed loop is to core tasks, the more obvious the supportive role of integrating capability in resource orchestration.

3.3 Construction Pathways of Reconfiguring Capability Oriented toward Organizational Resilience

The foundation of reconfiguring capability relies on organizational resilience. Though SME has a short decision chain and fast adjustment speed but lack resources for stock, so there can't have any frequent large-scale change happened in reconfiguration. The pathways design focuses on process modularization and reversible resource allocation that enables replacement/suspension/combination of some capability modules. Resilience in organization reflects its personnel role and boundary between tasks: Cross-position collaboration, temporary task group and interface with external partners could extend adjustment space without significant fixed cost. Trigger rules about reconfiguration should include trigger conditions and fallback mechanism to prevent losing operational stability when adjusting. Setting up trigger condition needs to link to resource stocks and relationship status; if too loose then frequent adjustment happens while too tight delays the timing of reconfiguration.

Another thread along the reconfiguration pathway: Relationship portfolio adjustment. SME reduces the lock-in risk relying on one relationship through multi-platform connections, replacing partner portfolio, or switch external services. Platform connections provide resources/data under rule constraints; there is a balance between connection efficiency and autonomy while reconfiguring capabilities. The design of pathway has moderate redundancy and slack resources allowing us to adjust unexpectedly. Replacing capability modules, orchestrating relationships, revising rules are the operational content for reconfiguring capability. Feedback brings back the outcome of reconfiguration to sensing and integrating stage as a cycle across these three pathways. What does it mean to reconfigure? No tear down and start over but keep an adjustable, replaceable, and recoverable capability portfolio at key nodes. Whether we can find feedback signals timely transforming them into adjustment actions decide the effectiveness of this reconfiguration pathway – the shorter the feedback chain, the timeliness of reconfiguration response, the easier to maintain our organization's resilience in a dynamic environment.

Conclusion

Clarify the formation logic of dynamic capabilities of SMEs in its digital transformation at three levels: theoretical boundaries and dimensional structure, evolutionary mechanisms and construction pathways. Embeddedness of digital technology makes capability structures more open, sensing, integrating, and reconfiguring form feedback loops, and resource constraints determines capability heterogeneity and boundaries. Construction pathways are digital opportunity sensing, data collaborative integration and organizational resilience reconfiguration highlighting capability modularization, reversible resource allocation and the tension between connection efficiency and autonomous space. Distinguish the difference of pathway among industries, different digital connectivity position and different resource combination in the future; follow up the long-term feedback of capability evolution; measure the method for sensing, integrating, and reconfiguring; explore the applicable condition of pathway combination; analyze the influence of changing platform rules and relationship reconfiguration on capability stability. This will bring our research about dynamic capability construction closer to the SME context as well as give a testable direction for further theoretical advancement.

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