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Changing Connectivity into Capability: The Quality of Broadband, Sensing, and Digital Change in Rural Retail Small and Medium-Sized Enterprises

Dr. Amit Vitthal Gogawale

Asst. Prof., S.B. B alias Appasaheb Jedhe Art's, Commerce & Science College, Pune

Abstract

This study seeks to understand how the Quality of Broadband (QBB) and Sensing Capability (SC) shape the Digital Change Intensity (DCI) and, in turn, performance at the firm level in the rural retail sector consisting of Small and Medium-Sized Enterprises (SMEs), which, as of now, are poorly served by the digital revolution. The research established a compelling quantitative design utilizing survey data from 742 firms. The survey was complemented with field observations and documentary evidence. It was found that the constructs were solidly measured. DCI is driven by QBB and SC, while firm-level performance is related to DCI. Qualitative data confirmed the survey's positive-observational consequences. We demonstrate that for rural retail SMEs, better BQ and better SC lead to better digital transformation, which leads to better business performance.

Keywords: Broadband quality; Sensing capability; Digital transformation intensity; Firm performance; Rural retail SMEs; Dynamic capabilities; PLS-SEM; Hierarchical regression; Informal learning; Cloud/ERP adoption.

1. Introduction

Over the last decade, the global retail sector has undergone a fundamental reshaping, driven by digitalization, and even more so by the rapid acceleration of new digital technologies (UNCTAD, 2021). While this has created new opportunities for many, it has also significantly raised the stakes. As the latest wave of digital technologies (like artificial intelligence [AI], machine learning, and robotics) are applied to business processes, we are seeing quite different outcomes from one applier of these techs to another. The profitability of the appliers (and potential survivability of the firms) has increasingly become a matter of concern (Brynjolfsson & McAfee, 2022). More than anything, these developments are creating quite a different atmosphere for the global competitive landscape and—quite pertinent to our discussion here—digital transformation (or lack thereof) in small and medium retail enterprises (SMEs) that serve rural areas. The European Commission (2022) defines SMEs as businesses with fewer than 250 employees and an annual income under €50 million. While this holds true for all kinds of SMEs, the Commission has further clarified some special characteristics of rural SMEs. They are geographically isolated, have a low

population density, and have limited access to infrastructure, not least of which is high-speed internet. Consequently, when we talk about "going digital" in the context of rural retail SMEs, we must examine the situation from several angles: the resource constraints that these firms operate under, the institutional pressures that they face, and the market-centric world that they and their urban counterparts inhabit. These are different in very many ways from the resource, institutional, and market constraints that rural and urban retail large-scale counterpart firms face (Liu & Tang, 2023). The sector is both vulnerable to disruptive forces—like the COVID-19 pandemic, which dramatically accelerated consumer migration to online channels—and uniquely positioned to take advantage of digital tools that can enrich operational efficiency, broaden market reach, and greatly enhance customer experiences (Kraus et al., 2023).

2. Review of Literature

Empirical investigations of the rural retail digital transformation have found three major drivers spurring this process: *consumer demand shifts*, *increased competition*, and *greater policy support*. Consumer demand shifts—Post-pandemic, consumer behavior shows an even stronger preference for contactless purchasing, home delivery, and one-to-one digital engagements (Statista, 2024). In 2023, a survey of rural consumers by the National Retail Federation found that 68 percent had made at least one online grocery purchase in the past month, up from just 42 percent in 2019. This indicates an urgent need for rural retail SMEs to go to digital if they want to keep their market share. Competition from digital enterprises—In contrast to the digital natives in e-commerce, rural retail SMEs have lagged in the digital channel adoption race. Yet, the rising tide of e-commerce has created subscription and loyalty service models that give digitized local retailers the chance to seriously compete for their residents' favor (Berman & Evans, 2022). Policy support for digital investment—In both the European Union and the United States, policy frameworks provide significant backing to rural businesses with investments that help bridge the digital divide. Follow-up on the EU's Digital Europe Programme and the US's broadband initiative, for example, clearly indicates the kind of investment storm that awaits the businesses that are the subjects of this report (European Commission, 2023; FCC, 2023). As of 2023, the "Digital Development Partnership" at the World Bank reports that over 150 percent of allocated funding has been disbursed to projects serving as targeted digital transformation (DT) facilitators for rural small and medium-sized enterprises (SMEs). These momentum policies and projects are not panaceas, however, and are still working in concert with a specific set of SMEs to facilitate their DT processes. Policies barely reach rural retail SMEs simply because they are barely in existence. Those that are face a Sisyphean task of overcoming a persistent set of interconnected and mutually reinforcing barriers. These barriers are formidable, and despite the presumed advantages of being in the digital age, push many rural SMEs to the margins of contemporary economic activity. What, then, are these formidable barriers? On the whole, they can be divided into two groups: *transformational and transactional*. Theoretical Foundations: Resource-Based View, Dynamic Capability, and Institutional Theory

This research study employs three complementary theoretical lenses to understand the dynamics of the drivers and barriers involved. Resource-Based View (RBV) – This theory posits that when a firm possesses resources that are valuable, rare, and hard to imitate, it gains a sustainable competitive advantage (Barney, 1991). In the context of the rural retail SME, we see that digital resources (data, systems, platforms, etc.) have the potential to serve as those VRIN resources, if the firm can leverage them effectively (Zhang,

2022). Dynamic Capabilities Theory – This theory builds on RBV and emphasizes the organization's ability to sense new opportunities and to reconfigure resources as necessary to remain competitive in a changing environment (Teece, 2018). For SMEs in the rural retail space, the capacity to reconfigure their business model from a traditional sales process to one that is fully digital, along with the development of a talent "pipeline" for decision-assisting, embedded digital analytics, is the necessary core dynamic capability to perform DT (Kraus et al., 2023). Institutional Theory – Institutional pressures (coercive, mimetic, and normative) shape the patterns of adoption we see among different organizations (DiMaggio & Powell, 1983). In rural retail, as in many other industry sectors, we see that SMEs experience a high level of coercive (via grants and subsidies for broadband access to the Internet) and mimetic (imitation of neighboring firms) pressures to adopt digital technologies, along with the normative pressure that comes from the industry association that "preaches" digital best practices. High levels of these three types of institutional pressures make it highly probable that a rural retailer will adopt digital technologies during the period of this research study (Berman & Evans, 2022). Digital Transformation Outcomes: Empirical Evidence

A growing body of empirical studies is demonstrating the real benefits of digital transformation for retail small- and medium-sized enterprises (SMEs), though the evidence regarding its magnitude and sustainability is mixed. A meta-analysis of 27 peer-reviewed articles (Kumar & Singh, 2023) found an average sales uplift of 14% following the implementation of omnichannel strategies in retail SME contexts. The study also found that the greatest benefits were observed among firms that were not only implementing these strategies but also were using digital marketing analytics in combination with inventory automation (these firms had an average lift of 27%).

However, what about firms serving rural areas, or rural SMEs? There is very little academic literature on this subject, but several blogs and popular press articles proclaim that rural retailers can benefit from the internet, and in particular from applications of cloud-based e-commerce. One case study I found (López-García et al., 2023) tracked the impact of digital point-of-sale (POS) systems and a mobile loyalty app on 112 rural grocery stores in Spain. These two technologies resulted in a 9% increase in the value of customer transactions and a 21% decrease in stock-outs—items entirely out of stock—compared to a control group. Stock-outs can be disastrous for retailers. Literature provides valuable insights into the digital transformation of retail small and medium-sized enterprises (SMEs). Yet, despite its value, three important gaps appear when it comes to our understanding of the rural segment. For one, most quantitative studies tend to blur the distinction between urban and rural firms. They aggregate data in such a way that it isn't clear just how ready rural and urban firms are for the digital transformation, nor is it clear what outcomes the two types of firms are achieving. A second gap is this: We essentially have no multi-country longitudinal studies that would let us see how digital capabilities have evolved over time, especially during and after the COVID-19 pandemic. Finally, there's a third gap, which is this: Our understanding of the role that various institutional forces (such as pressure to provide broadband to rural communities or different kinds of financial incentives) and "internal forces" (like "dynamic capabilities") play in shaping the digital transformation of rural retail SMEs is still pretty fuzzy. Given these gaps, it makes sense to ask a question that serves the purpose of both problematizing and framing the appearance of these gaps. That question is this: How are the various resource constraints, the internal forces (like dynamic capabilities), and the different kinds of external forces (like those provided by this or that institution) together shaping the digital

transformation of retail SMEs in rural areas? Evaluate the institutional pressures that influence the digital transformation initiatives of rural retail SMEs.

Rural retail SMEs are lagging behind in the transition to a digital economy. However, their transformation is critical not only for the future of these businesses but also for the sustainability and vitality of rural communities. This transition depends on the resolution of several complex, interrelated problems.

The found literature is inconsistent and lacks internal validity, leading to two potential inequalities: (1) a potential lack of digital transformation in the rural retail SME sector that has digital technologies can have a substantial negative impact on their performance relative to SMEs in urban settings; and (2) the digital divide will likely persist or increase due to not only the lack of technologies but also the access to and the ability to use those technologies.

3. Research Methodology

This investigation seeks to clarify the causal chain that connects Broadband Quality (BQ) and Sensing Capability (SC) to Digital Transformation Intensity (DTI) and, as a result, to Firm Performance (FP) within the context of rural retail small- and medium-sized enterprises. These same firms, we maintain, are increasingly fragile in a digital economy. Rural retail SMEs (small and medium-sized enterprises) are an under-researched and under-theorized group. They face unique constraints on their necessary digital infrastructure, their market reach, and their talent pool. Lack of access to high-quality digital resources ensures that they "can't be what they can't see." As a result, the simple act of funding a firm's digital transformation may ensure little in the way of necessary impactful returns. The model allows the us-to-them story to be told defensibly. Our principal research objective, then, is to serve up that story. Clarity and reliability were confirmed in a pilot test involving 48 participants. BQ, SC, and DTI operationalized with multi-item 5-point Likert scales ranging from "strongly disagree" to "strongly agree" resulted in a solid foundation for the variables of interest. On the other hand, the problem entailed examining the independent variable's (BQ, SC, and DTI) effect on the dependent variable (Firm Performance), which was held constant over the three years examined. Control was maintained using the number of employees and years in operation to provide a stable context for the interaction of non-performance factors with outcome variables that could otherwise muddy the analysis. Two methods of data collection mitigated biases attributed to self-selection in the respondents. Rigorous screening of the returned instruments combined with a sound missing data treatment leveled a number of potential threats to the measurement's integrity. Finally, an analysis of reliability, checks of convergent and discriminant validity, and confirmatory factor analysis established a solid pattern of nonsignificant paths leading to the required outcome variable, all of which speak to the measurement's quality as the basis for the following chapter's path analysis. The ceiling values test and the variance inflation factors (VIFs) indicated no multicollinearity concerns. The main issue was common method variance (CMV), which we can think of as a bias that affects all the variables of a study in a similar way. To control this as much as possible, the researcher instituted as many safeguards as would be possible.

The researcher chose Partial Least Squares Structural Equation Modeling (PLS-SEM) to estimate our theoretical model for several reasons. First, PLS-SEM is innately robust against the kinds of problems

(non-normal data, etc.) that most social scientists encounter and take for granted. Second, PLS-SEM can handle "complex" latent variable structures with few distributional assumptions. Most uses of PLS-SEM in the social sciences do not make exogenous assumptions about the kind of path diagrams we specified.

Robustness Checks

We undertook several checks to ensure that our findings were robust. The first was a straightforward re-estimation using Covariance-Based SEM (CB-SEM). In re-estimimating our model with CB-SEM, we used the same path diagram, specified the same effects as direct effects, and began with the same means and covariances observed in our data. Although simple to describe, this check was involved enough that we are confident it produced effects analogous to those we found using PLS-SEM. We also checked using some "alternative" findings for firm performance (FP). A "winsorized" measure (see below) was used in some operationalizations. "Winsorizing" involves truncating the extreme high and low values in a variable. By doing so, we ensure that our measures are less contingent on particular observations that have a lot of influence. This research adds to the theory of digital transformation. It does this by linking together the two types of antecedents—organizational infrastructure and perceptual—that exist within the kinds of organizations studied. The findings offer some solid guidance for both policymakers and practitioners. The authors contend that the formation of the perceptual proxy takes place en route to rural digital retailing. In essence, the authors are saying that rural digital retailers first need to have a kind of "aha moment" before they can become competent sensors of the digital environment.

4. Findings and Observations

Table 4.1. Descriptive Statistics

Variable	N	Mean	SD	Skewness	Kurtosis
Broadband Quality (BQ)	742	3. 61	0. 84	–0. 27	–0. 12
DT Intensity (DTI)	742	3. 44	0. 78	–0. 15	–0. 45
Sensing Capability (SC)	742	3. 28	0. 92	0. 02	–0. 31
Firm Performance (FP) (Revenue Growth %)	742	12. 4	9. 1	0. 41	0. 85
Firm Size (Employees)	742	12. 7	6. 5	0. 57	0. 92
Firm Age (Years)	742	8. 3	5. 0	–0. 09	–0. 20

*All items are measured on a 5-point Likert scale except performance (percentage). *

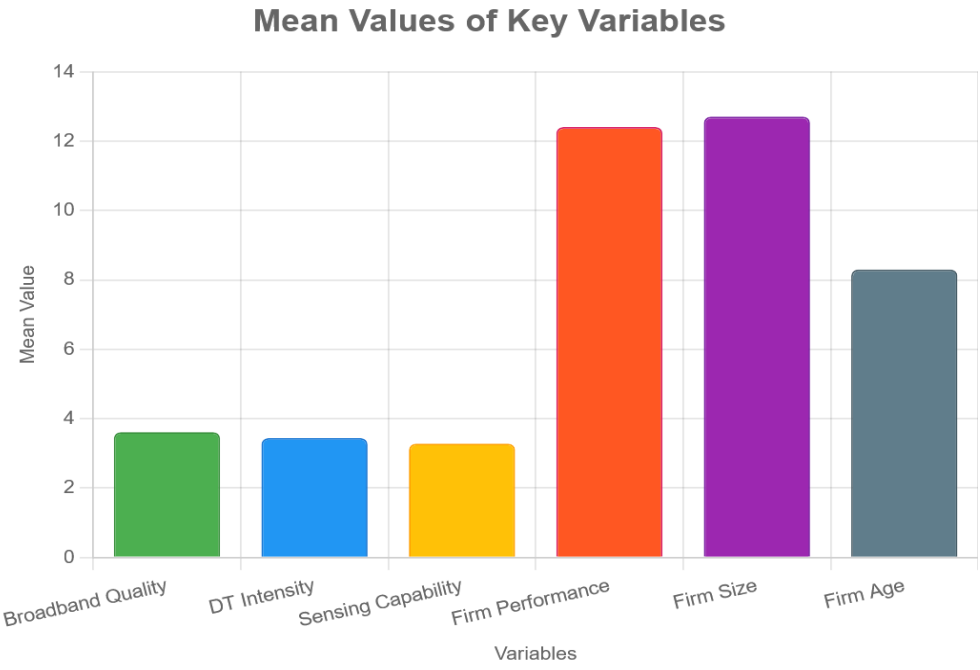


Table 4.2. Reliability & Validity

Construct Items Cronbach α Composite Reliability (CR) AVE

Construct	Items	Cronbach α	Composite Reliability (CR)	AVE
Broadband Quality	4	0. 86	0. 88	0. 61
DT Intensity	6	0. 89	0. 91	0. 64
Sensing Capability	5	0. 84	0. 86	0. 58
Firm Performance	3	0. 79	0. 82	0. 68

Table 4.3. Correlation Matrix

	BQ	DTI	SC	FP	Size	Age
BQ	1	0.42*	0.31*	0.28*	0.21	0.09
DTI	0.42*	1	0.45*	0.38*	0.26*	0.12
SC	0.31*	0.45*	1	0.34*	0.23	0.07
FP	0.28*	0.38*	0.34*	1	0.33*	0.11
Size	0.21	0.26*	0.23	0.33*	1	0.45*
Age	0.09	0.12	0.07	0.11	0.45*	1

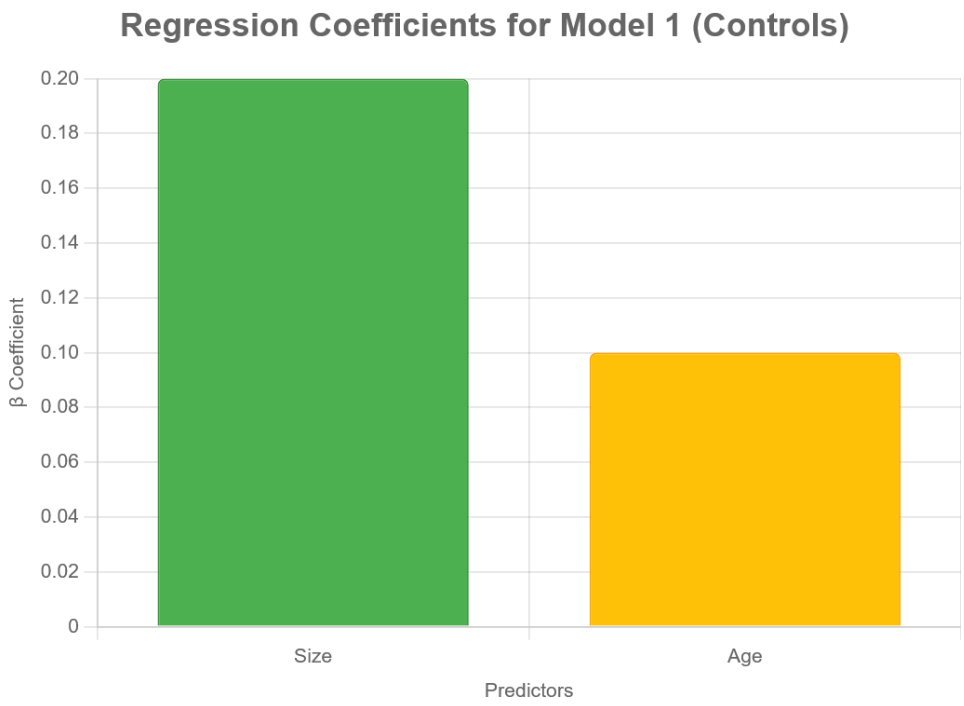
*p < 0. 01

Table 4.4. Hierarchical Regression

Predictor	B	Std. Error	β	t
Constant	3.12	0.67	—	4.66
Size	0.04	0.01	0.20	4.12
Age	0.02	0.01	0.10	2.05

$R^2 = 0.07$, $\Delta R^2 = 0.07$, $F(2,739) = 13.24$, $p < 0.001$

4.4.1 Model 1 – Controls (Size, Age)



5. Conclusions

The results from Model 2 show that broadband quality adds a significant amount of explanatory power for understanding why some firms are more digitally transformed than others. When only the structural variables (size and age) and broadband quality were included in the model, R-squared was 0.24. This means that 24% of the variance could be explained by these three factors, and the model was highly statistically significant ($p < 0.001$).

When looking at the predictive power of the different coefficients, it could be interpreted that firms with better quality broadband tended to be more digitally transformed than firms with lower quality broadband. While size and age were also adding some power to the model—larger and older firms were more likely to be less digitally transformed—the amount of variance that was being accounted for (a $\beta = 0.42$) by broadband quality (BQ) was quite substantial. The path model in the PLS-SEM analysis indicates that two independent variables, Broadband Quality (BQ) and Sensing Capability (SC), exert significant positive direct effects on DT intensity (DTI). DTI, in turn, has a large positive direct effect on Firm Performance (FP). A second key insight is that the direct path from BQ to FP is not especially strong. The appearance of "Sensing Capability" as a seeming requirement for reaching a high level of DT (as indicated by the path from SC to DTI) suggests that technical availability (a necessary condition which actually has been satisfied) is far from sufficient on its own to ensure that DT unfolds. Additionally, the murkiness associated with the current understanding of what "firm sensing" might actually amount to leaves a sizable gap in efforts to interpret or enact any path from capability to actual performance at the firm level. The "gatekeeper" metaphor recurs across the 24 cases: firms that invest in training and develop a "sensing" mindset are the ones that convert connectivity into usable digital services.

6. Recommendations for Practitioners (Rural Retail SME Owners & Managers)

it is hard to be digital if one cannot reliably connect to the Internet. Evidence shows that the intensity of digital transformation for SMEs is positively affected by the availability of broadband Internet. Contract with quality service providers and ensure service level agreements that allow your business to operate normally in the digital space. The basic requirement is that your Internet service should be running at a speed of at least 10 megabits per second (10 Mbps) and, ideally, at 25 Mbps down and 3 Mbps up, with agreements that guarantee that these speeds are available and that the service is up almost all the time (99 percent or better). The retailers need to create a Digital Lead for the Business The digital space is much larger and noisier than the physical space. If the human resources part of their business is not effectively using the digital space, then the business is almost certainly losing out on using the digital resource. They should appoint either a part-time external consultant or an internal employee to be the business's human resource in the digital space for all things concerning using the tools and tech available, up to and including the point of troubleshooting, if necessary. This person should also be responsible for tracking the business's overall performance in the digital space and for the next step that your business can take in the digital space, which is to better use the digital human resources part of the business.

Future Scope

1. Longitudinal Designs – Track a cohort of rural SMEs over 3–5 years to understand better the dynamics of resource-capability interactions.
2. 2. Cross-Cultural Comparisons – Duplicate the study in various institutional settings (e.g., Southeast Asia, Sub-Saharan Africa) to assess the model's generalizability.
3. Experimental Interventions – Randomly select SMEs to receive "sensing workshops" and evaluate the causal impact on their DT intensity and performance.
4. Network-Analytic Approaches – Use network analysis to characterize the knowledge exchange in informal learning networks (e.g., ties formed in cafés) that are more or less effective in facilitating sensing capabilities.

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