



Digitalization, External Knowledge Sourcing, and Service Innovation in SMEs

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3 **1. Introduction**
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6 The emergence of the 'service economy' (Sirilli and Evangelista, 1998) reflects rising global living
7 standards, including higher life expectancy and household income (OECD, 2020). As production
8 declines, the service sector increasingly influences GDP across countries (Massimiliano *et al.*,
9 2008). The transition to a service logic, known as 'servitization' (Vandermerwe and Rada, 1988)
10 or 'service infusion' (Brax, 2005), shifts firms to integrated product-service offerings (Barrett *et*
11 *al.*, 2015), elevating service innovation. This change is being exacerbated by the recent
12 digitalization¹ of business. New digital technologies challenge firms to make service innovation a
13 key performance outcome, even for those focused on product innovation (Frank *et al.*, 2019; Kraus
14 *et al.*, 2019; Favoretto *et al.*, 2022).
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28 This accelerating shift toward digital-enabled service innovation has significant
29 implications not only for large, established firms but also, and perhaps more critically, for small
30 and medium-sized enterprises (SMEs). While large firms often have the resources to implement
31 broad digital strategies, SMEs play a distinct and increasingly vital role in this evolving landscape.
32 Their flexibility, proximity to customers, and often more agile decision-making processes position
33 SMEs uniquely to harness digital technologies in ways that drive innovative service development
34 and unlock competitive advantage (Mennens *et al.*, 2018). Indeed, scholarly studies reveal half of
35 SMEs are now pursuing service innovations (Sirilli and Evangelista, 1998; Mennens *et al.*, 2018).
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¹ While often used interchangeably, this study distinguishes between related concepts as follows: “digitalization” refers to the adoption and integration of digital technologies into business functions to create or enhance value (Svahn *et al.*, 2017); “digital transformation” encompasses a broader organizational shift involving changes to strategy, culture, and processes driven by digital technologies (Vial, 2019); and “digital servitization” is the process by which firms use digital tools to transition from product-based to service-based offerings (Kohtamäki *et al.*, 2019; Shen *et al.*, 2023). For the purposes of this study, we primarily use the term digitalization, aligned with the operationalization of digital breadth across business functions.

performance (Baldwin and Gellatly, 2003; Mansury and Love, 2008; Roper *et al.*, 2002; de la Calle *et al.*, 2025) with innovators consistently more profitable than non-innovators (Love *et al.*, 2009).

However, the dynamics favouring service innovation in the SME context remain relatively understudied as compared to their larger counterparts (Gronum *et al.*, 2012). Indeed, research investigating how SMEs might engage in service innovation are relatively scarce (Kowalkowski *et al.*, 2013; Lopez *et al.*, 2024; Mennens *et al.*, 2018; Prajogo and McDermott, 2014; Van de Vrande *et al.*, 2009), and this is especially true in this digital age, where the innovative implications of digitalization seem to be of interest mostly for large firms (Eller *et al.*, 2020; Costa *et al.*, 2024). The bias towards physical products (Beimans and Griffin, 2018) persists, with studies tending to focus on large industrial manufacturing contexts (Valtakoski, 2017; Kowalkowski *et al.*, 2023; Shen *et al.*, 2023). Such firms enjoy resource advantages over smaller firms and are, hence, more able to exploit the potential advantages of digitalization in entering the service economy (Coreynen *et al.*, 2017), while smaller firms are deemed to possess an internal R&D disadvantage (Choi and Lee, 2018) and fail to engage in a digital transformation to innovate (Eller *et al.*, 2020). This study confronts this approach, delving into the influence of digitalization, being the combination and recombination of digital technologies to create and harvest value in new ways (Svahn *et al.*, 2017), on the likelihood of SMEs to introduce service innovations.

Still, it is also important to recognize that, due to the liability of smallness, SMEs often rely on external knowledge resources to drive innovation (Brunswicker and Vanhaverbeke, 2015; Usman *et al.*, 2023). This reliance can help offset the challenges of engaging in digitalization through value co-creation (Randerson and Estrada-Robles, 2023) or even serve as a substitute for digitalization in terms of enhancing innovation performance (Lorenz *et al.*, 2020; Ricci *et al.*, 2021). Adopting an open innovation approach can further support value co-creation, integrating

stakeholders beyond typical business relationships (Cappa et al., 2022; Randerson and Estrada-Robles 2023). Open innovation refers to purposive inflows and outflows of knowledge across organizational boundaries to speed up internal innovation and leverage external ideas (Huizingh, 2011). In our context, we capture this logic through “external search breadth,” i.e., the number of heterogeneous knowledge sources SMEs use to support innovation processes (Laursen and Salter, 2006). More specifically, whether and how an SMEs’ tendency to engage with a wide range of external knowledge sources, such as customers, suppliers, universities, research institutions, competitors, and informal networks, to support innovation processes (Laursen and Salter, 2006; West and Bogers, 2014), commonly referred to as ‘external search breadth’ (Laursen and Salter, 2006; Aliasghar *et al.*, 2023), affects the digitalization-service innovation relationship, may be worthy of investigation and represents a line of inquiry that has been neglected by previous studies. Relatedly, understanding on knowledge search, too, tends to be limited to a manufacturing context (Rosenkopf and Nerkar, 2001; Katila and Ahuja, 2002; Laursen and Salter, 2006; Leiponen and Helfat, 2010; Love *et al.*, 2014), requiring to broaden scholarly endeavours to study SMEs in service contexts (Van de Vrande *et al.*, 2009).

Following the foregoing discussion, this study addresses two core research questions: 1) Does digitalization affect service innovation in SMEs? And, 2) Does external search breadth moderate the relationship between digitalization and service innovation in SMEs? In so doing, the authors develop hypotheses and test them based on a sample of 489 North American SMEs. Results reveal that external search breadth holds a curvilinear (inverted U-shaped) relationship with service innovation. Yet, the curve changes shape in such a way that it flips from an inverted U-shape to a U-shape when external knowledge sourcing is taken into account. That is, digitalization has an inverted U-shaped effect on service innovation when external search breadth is low, but a

U-shaped effect when external search breadth is high, a phenomenon called shape-flip (Haans *et al.*, 2016).

Overall, the findings address an important gap in the literature by examining whether resource-constrained smaller firms leverage digitalization to drive service innovation, and by exploring the potential complementary or substitutive relationship between digitalization and broad-based external knowledge sourcing. Theoretically, this study contributes to the intersection of research on digitalization, service innovation, and SME innovation strategies. From a managerial perspective, the results offer actionable guidance for SME leaders, highlighting the importance of adopting digital technologies strategically and maintaining an appropriate balance between digitalization initiatives and efforts to source external knowledge. These insights also carry implications for policymakers, who are encouraged to design support mechanisms that facilitate both digital transformation and external knowledge acquisition among SMEs.

2. Literature Review

2.1 Digitalization and the service economy

Digitalization transforms how products and services are developed, creating new value pathways and innovation processes that reshape industries (Boudreau and Lakhani 2013; OECD 2016; Porter and Heppelmann 2014, 2015; Shen *et al.*, 2023; Collevocchio *et al.*, 2024). Specifically, over the last decade, there has been an increasing focus on service across socioeconomic sectors coupled with transformational developments in digital technologies and firms adopting them.

Together, these developments are engendering dramatic new opportunities for service innovation. These opportunities challenge conventional views of service and require reconsideration of service innovation development. This is especially pertinent considering that

service innovation is emergent, interactive, and dynamic, as well as knowledge and information intensive as communication flows between providers and customers (Miles, 2008).

Service delivery depends increasingly on digital technologies, which amplify the flow and analysis of information (Cenamor *et al.*, 2017; Shen *et al.*, 2023).. The focus shifts to “the transformation in processes, capabilities, and offerings within firms and their associate ecosystems to progressively create, deliver, and capture increased service value arising from a broad range of enabling digital technologies” (Sjödina *et al.*, 2020; 478). Digitalization helps firms change research processes, develop new services, launch new business model innovations, enhance customization, and optimise processes (OECD, 2019; Favoretto *et al.*, 2022).

In sum, the link between firm digitalization and servitization has been widely theorised (Ardolino *et al.*, 2018; Barrett *et al.*, 2015). However, so far, empirical evidence about the actual influence of digitalization on service innovation in SMEs is under researched.

2.2 Digitalization and Service Innovation in SMEs

Today, digital technologies enable process automation and reduce the need for human involvement (Lerch and Gotsch, 2015). SMEs can adopt digital technologies to transform their existing services and develop new offerings that meet future customer expectations (Bouncken *et al.*, 2019; Davis *et al.*, 2015; Eller *et al.*, 2020; Nguyen, 2009), while simultaneously improving service quality, reducing operational expenditures (Kindström and Kowalkowski, 2014; Porter and Heppelman, 2014), and expanding their service reach across international markets (Kolagar *et al.*, 2021). Digitalization, therefore, serves as a key enabler of service innovation by allowing SMEs to manage interactions more efficiently across external networks (Story *et al.*, 2017; Mennes *et al.*, 2020; OECD, 2019). Additionally, Krause *et al.* (2018) highlight that digital ecosystems offer

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4 design, deliver, and refine services through interconnected platforms.
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8 To take full advantage of digitalization, SMEs must invest intentionally in service
9 innovation, placing customer experience at the core of digital improvements and simplifying
10 service delivery mechanisms (D'Emidio et al., 2015). For instance, developing mobile-compatible
11 customer service portals, as Costa et al. (2023) suggest, enables SMEs to centralize sales and after-
12 sales operations, directly improving service accessibility, responsiveness, and perceived value;
13 factors that are essential to service innovation.
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23 As SMEs adopt a service-based strategy, they increasingly digitize functional areas that
24 support service delivery (Cenamor et al., 2017). The adoption of digital technologies is therefore
25 expected to foster service innovation by enhancing competitiveness, responsiveness, and service
26 performance in entrepreneurial contexts (Eller et al., 2020; Papadopoulos et al., 2020). Moreover,
27 the integration of digital platforms within broader ecosystems can support continuous service
28 innovation through data-driven insights, modular service architectures, and agile delivery models
29 (Krause et al., 2018). In this way, digitalization empowers SMEs to deliver more effective and
30 differentiated services (Abed, 2020; Chau et al., 2020; Prause, 2019).
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42 However, recent studies suggest that the relationship between digitalization and service
43 innovation is not linear. The increasing complexity involved in integrating diverse technologies,
44 ranging from software applications to hardware infrastructure and network connectivity, can
45 overwhelm SMEs (Bosman et al., 2019; Culot et al., 2020). As digital investments escalate, the
46 associated costs, operational challenges, and required capabilities may begin to offset the
47 innovation benefits. SMEs with limited financial and human resources may struggle to keep pace
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with technological advancements, which may hinder rather than support service innovation (Costa et al., 2023). Consequently, many SMEs opt to adopt individual digital solutions rather than fully integrated systems (Mise, 2017; Martinelli et al., 2019), a strategy that may limit the overall innovation potential of their service offerings. Moreover, without clear strategic planning, the rapid adoption of digital tools can lead to fragmented or misaligned initiatives that dilute the intended service innovation outcomes (Mennes et al., 2018).

Therefore, while initial levels of digitalization enhance SMEs' service innovation capabilities, excessive or poorly coordinated digital adoption can result in diminishing returns. More formally:

H1: Digitalization will have a curvilinear (inverted u-shape) relationship with service innovation in SMEs.

2.3 The Moderating Role of External Search Breadth

As previously discussed, the relationship between digitalization and service innovation is curvilinear, following an inverted U-shape: the adoption of digital technologies initially enhances service innovation, but beyond a certain point, due to integration complexity, coordination costs, and limited absorptive capacity, additional digital investment yields diminishing or even negative returns (Bosman et al., 2019; Haans et al., 2016; Pierce and Aguinis, 2011). We contend that this relationship changes significantly when external search breadth is taken into account.

The underlying idea is that diverse sources of knowledge provide access to non-redundant information, increasing the firm's ability to generate novel service concepts, improve service delivery mechanisms, and respond to emerging customer needs (Katila and Ahuja, 2002; Leiponen and Helfat, 2011). In the context of service innovation, external search breadth is particularly

valuable because services often emerge from interactive, iterative processes that benefit from co-creation and external insights (Randerson and Estrada-Robles, 2023).

Considering SMEs, external search breadth plays a crucial role in enabling service innovation. Unlike larger firms with internal R&D departments and structured innovation units, SMEs often face significant resource constraints, including limited financial capital, technological infrastructure, and specialized personnel (Brunswicker and Vanhaverbeke, 2015). These limitations shape their innovation strategies by increasing reliance on open innovation (Mawson and Brown, 2017; Huber et al., 2020; Crupi et al., 2020), especially in terms of knowledge that can be accessed through external means. To compensate for their internal limitations, SMEs actively engage with both formal and informal knowledge sources. Formal collaborations with suppliers, customers, universities, and public research institutions remain valuable and are shown to enhance innovation outcomes in small firms (Spithoven et al., 2013; Aliasghar et al., 2023).

These structured relationships can support more systematic forms of service innovation, particularly when SMEs are able to absorb and apply technical or market-specific expertise from their partners (Ferrerias-Méndez et al., 2015). At the same time, SMEs frequently turn to informal and nonpecuniary sources of knowledge, such as peer networks, professional associations, family, and social contacts, to drive more flexible and adaptive forms of service innovation (MacPherson and Holt, 2007; Randerson and Estrada-Robles, 2023). These informal channels often offer cost-effective and context-specific insights that are especially valuable for service development, which tends to be user-driven and experience-based. Such sources help SMEs stay close to evolving customer needs, identify niche opportunities, and respond rapidly to feedback, all without the overhead of formal R&D processes.

However, expanding the breadth of external search introduces coordination and assimilation challenges, especially for resource-constrained firms (Van de Vrande et al., 2009; Ardito and Petruzzelli, 2017). The more diverse the sources, the greater the cognitive and managerial burden involved in integrating fragmented insights into coherent service offerings. This complexity may strain the already limited absorptive capacity of SMEs (Cohen and Levinthal, 1990), and if not managed effectively, may dilute the focus of innovation efforts. That said, when external search breadth is low to moderate, the inverted U-shaped relationship between digitalization and service innovation remains largely intact. With limited external knowledge inputs, SMEs rely primarily on their internal structures and, hence, their digitalization efforts to generate and implement service innovations. Digitalization, in this case, plays a central role in offsetting resource constraints and enhancing (service) innovation over external knowledge sources (Eller et al., 2020). Yet, as digital investment grows, firms face the familiar challenges of over-digitalization that eventually suppress service innovation gains as already discussed.

Instead, as firms begin to shift from low-medium to medium-high levels of external search breadth, the dynamics of the digitalization–service innovation relationship change. Access to a broader and more diverse set of knowledge sources provides SMEs with alternative pathways to innovate (Spithoven et al., 2013; Ferreras-Méndez et al., 2015; MacPherson and Holt, 2007; Randerson and Estrada-Robles, 2023). In this context, external search breadth begins to act as a partial substitute for digitalization, especially at lower levels of digitalization. Indeed, the diverse range of ideas, practices, and expertise accessed through broad external knowledge sourcing may reduce the immediate dependency on digital technologies to drive service innovation. For SMEs with limited financial and managerial resources, leveraging external sources can provide valuable inputs into service innovation without requiring heavy digital investment at the same time,

highlighting the delicate balance SMEs may strike between digital investments and knowledge acquisition strategies.

However, as external search breadth reaches high levels, the coordination and integration of this distributed knowledge becomes increasingly complex. Informal sources may yield fragmented insights, while formal collaborations require structured processes for effective knowledge absorption (Cohen and Levinthal, 1990; Scuotto et al., 2017). Here, digitalization regains strategic importance, not as a driver of innovation *per se*, but as support to external search breadth. It helps SMEs structure information flows, improve internal-external knowledge alignment, and reduce the noise associated with managing multiple knowledge inputs (Laursen and Salter, 2006; Aliasghar et al., 2023), whereby the downsides of heavy digitalization are outweighed by the benefits of allowing SMEs to benefit from external search breadth.

In sum, external search breadth shapes how digitalization contributes to service innovation, leading to an inverse relationship as its level grows. More formally:

H2: External search breadth performs a moderating role on the relationship between digitalization and service innovation; this moderation effect leads to a flip from inverted U-shape to a U-shape as the reliance on external knowledge increases.

Figure 1 depicts our conceptual model.

INSERT FIGURE 1 ABOUT HERE

3. Sample and Measures

3.1 Sample and Data

Data was obtained from a large-scale survey of Canadian SMEs exploring firm-level performance factors. The survey was distributed in 2016, and closed in 2017. This study focuses on Canadian SMEs due to project funding and the limited academic attention they have received compared to U.S. firms. Notably, Canadian companies often prioritise the United States as their preferred location for internationalisation efforts, highlighting their proficiency in adhering to U.S. regulations and standards (Government of Canada, 2019). This study focuses on SMEs, which make up 98 percent of businesses in both the U.S. and Canada, driving wealth, employment, and innovation (OECD, 2015). In Canada, approximately 78.9 percent of small and micro businesses operate within the service sector, underscoring the importance of understanding service innovation in this national context (ISED, 2024). Canada offers a compelling environment for examining the interplay between digitalization and service innovation due to its proactive governmental strategies, diverse economic landscape, and emphasis on user-centric service delivery.

The Government of Canada's "Digital Ambition 2023–24" outlines a comprehensive approach to modernizing public services, focusing on leveraging emerging technologies to enhance digital services for Canadians . This initiative emphasizes the adoption of artificial intelligence, cloud services, and the development of digital standards to improve service delivery². Furthermore, Canada's commitment to digitalization is evident in its efforts to create a seamless, user-centric digital experience for citizens. The government's strategy aims to integrate services across platforms, simplifying interactions with various government services online. This approach

² See “Canada’s Digital Ambition 2023-24”, Available from <https://www.canada.ca/>

not only enhances accessibility but also fosters a culture of innovation within public services³. Additionally, Canada's diverse economic sectors and regional variations provide a rich environment to study how digitalization impacts service innovation across different contexts. The country's emphasis on inclusive and accessible digital services ensures that innovations cater to a broad spectrum of the population, making it an ideal case for examining the broader implications of digitalization.

The design of the questions in this study adhered to the established practices of previous researchers, such as Laursen and Salter (2006), Leiponen and Helfat (2009), and Spithoven *et al.* (2013), who utilised the widely recognized Community Innovation Survey (CIS) for their investigations into innovation, a survey well-regarded in both academic circles and policy research. The comprehensive questionnaire encompassed inquiries related to innovation performance, digital technologies, and strategies for sourcing knowledge. To ensure that the questionnaire was consistently understood and that the language used was uniform, a preliminary version was administered to a panel of ten business owners before the full-scale survey release, as recommended by Collins (2003). Additionally, a follow-up survey was conducted with respondents identified as innovators to enhance the overall survey consistency, as suggested by Arundel and Smith (2013).

The survey targeted a stratified random sample of 4000 SMEs, ensuring anonymity to mitigate common method bias (Podsakoff *et al.*, 2003). The questionnaire was sent to the owner-manager. In total, the study received responses from 509 SME leaders/owners, representing an initial response rate of 12.7 percent. A data cleansing process was undertaken, removing missing

³ See "Canada's Digital Transformation: Strategies, Goals and Emerging Technologies", Available from <https://cocoflo.com>

data and respondents who did not align with the North American SME⁴ definition. This left us with 489 valid responses, resulting in a final response rate of 12.2 percent, which is consistent with the norms in similar research endeavours (Klassen and Jacobs, 2001; Brinkerink and Bammens, 2018).

To evaluate the sample's representativeness and potential non-response bias, the authors conducted a comparison between responding and non-responding firms, including early and late respondents, with regards to industry and sales. The results of all tests demonstrated no statistically significant differences at the 0.05 significance level, confirming that non-response bias did not substantially influence the outcomes of this research, in accordance with Armstrong and Overton (1977). Table 1 describes the sample characteristics. As can be seen, responses provide a good representation of industrial sectors. With the majority of respondents (73.0 percent) being SME owner-managers or holding a senior management role (For example, CEO, President), respondents were considered reliable information sources. The remaining respondents (25.8 percent) held general management positions (For example, operation, quality, finance, sales and marketing), with a minority (1.2 percent) holding lower administration responsibilities (For example, personal assistant, company secretary).

3.2 Variables

3.2.1 Dependent Variables

The dependent variable of the study (*Service Innovation*) is a dummy variable taking the value of one if a SME has declared to have introduced at least one service innovation in the three years prior to the questionnaire. This approach follows previous innovation studies that have

⁴ Small enterprises between 5-49 employees, Medium enterprises between 50-499 employees.

operationalized innovation performance as the likelihood that, in a certain time period, a firm was able to introduce an innovation (Freel, 2003; Erumban and Timmer, 2012; Giannopoulou, *et al.*, 2019).

3.2.2. Independent and Moderating Variables

Digitalization in the present study is measured through the operationalization of digital orientation, a composite index of different types of firm-level functions that can be enabled by technology. The construct is essentially a measure of digitalization breadth (Ardito *et al.*, 2021), being indicative of the number of functions into which SMEs digitalize. Functions included: advertising/marketing, selling, purchasing, producing, distributing, human resources, IT, finance, strategic thinking, management information. The reliability of the measure was measured through Cronbach's Alpha, which resulted in 0.81.

INSERT TABLE 1 ABOUT HERE

Similar to Classen *et al.* (2012) and Hewitt-Dundas and Roper (2017), the authors follow Laursen and Salter (2006), who conceptualise search breadth as the number of external sources from which a firm has sought knowledge (*External Search Breadth*). The considered external knowledge sources are: Advisory, Conciliation and Arbitration Service, Central Government Department, Local government department or agency, management consultants, external lawyers/solicitors, external accountants, trade/employers' associations, citizen advice bureau (or equivalent), other professional bodies, family/friends, other business owners, bank manager, university, other learning providers, head office, employment/recruitment agency, unions, other. . These binary variables take a value of one if the SME has sought knowledge from the specific

source and zero otherwise. Search breadth then equals the sum of these binary variables (Cronbach's Alpha equal to 0.70).

3.2.3 Control Variables

Control variables were added to improve model reliability. First, the degree of exports (percentage of internationalisation), a known driver of digitalization and service innovation, was included (*Internationalisation*). For example, digital technologies can support autonomous services and delivery across boundaries (Lerch and Gotsch, 2015). Second, the authors considered whether the firm perceives the environment as highly competitive (*Competitive Intensity*), thus leading to a dummy variable taking the value of one in this case, zero otherwise (Prajogo and McDermott, 2014). Third, the authors considered the relative focus on a cost strategy over a diversification/quality strategy (*CostStrategy*) (Leitner and Guldenberg. 2010). Fourth, the authors included a dummy variable taking the value of one if the SME has established collaborations (Collaboration) (Colombo *et al.*, 2012). Fifth, the authors controlled for the firm age (*Firm Age*) and the firm size (*Firm Size*), measured as the number of employees, since age size can influence the resources available to the firm and attitude to innovation (MacPherson and Holt, 2007; Rhee *et al.*, 2010). Finally, the authors included a set of dummy variables reflecting the diverse industry sectors of sample firms.

3.3 Model Specification

The dependent variables were dichotomous binary measures, so logit and probit regression models best test the hypotheses (Hoetker, 2007; Wiersema and Bowen, 2009). The choice between logit and probit models was made by estimating respective values of the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) (Akaike, 1974; Kass and Raftery, 1995). Both

values were found to be lower for the probit model, hence suggesting the best fit (Akaike, 1974; Kass and Raftery, 1995). Therefore, the probit model was adopted.

4. Results

Table 2 displays descriptive statistics of the selected variables, while Table 3 shows pairwise correlations, with all values below the 0.70, thus suggesting the multicollinearity issues are not a concern (Cohen *et al.*, 2013).

INSERT TABLE 2 ABOUT HERE

INSERT TABLE 3 ABOUT HERE

Table 4 shows that collaborations positively influence service innovation ($\beta=0.429$, $p<0.05$), while market internationalization has a minor negative effect ($\beta=-0.001$, $p<0.10$). Model 2 adds the linear term of Digitalization, and Model 3 also includes its squared term. In Model 2, the linear term of Digitalization is positive and significant. In Model 3, the linear term of Digitalization remains positive and significant ($\beta=0.429$, $p<0.05$), while the squared term is negative and significant ($\beta=0.429$, $p<0.05$), confirming the curvilinear effect.

INSERT TABLE 4 ABOUT HERE

For robustness, the digitalization level where negative returns to service innovation arise was checked to fall within data limits. This is supported as the data range is between zero and 11 and the tipping point occurs at a value of seven. The authors also computed the Fieller (1954) confidence interval (Haans *et al.*, 2016), and this also is contained within the data range. Second, the authors confirmed that the slope steepness at the low end is positive and at the high end is negative, as expected. Results of the U-test confirms all the required assumptions (SteepnessLowEnd=0.20, $p<0.01$; SteepnessHighEnd=-0.12, $p<0.01$). Finally, the overall test of

presence of an Inverse U-shape is significant at the 0.01 level. Eventually, the authors can consider H1 as fully supported.

Model 4 adds *External Search Breadth* and the interaction terms *Digitalization X External Search Breadth* and *Digitalization Squared X External Search Breadth*. Both are significant, with the first negative ($\beta=-0.185$, $p<0.01$) and the second positive ($\beta=0.015$, $p<0.01$). This supports H2, confirmed by plotting the relationship between Digitalization and Service Innovation at different External Search Breadth levels. Figure 2 shows these relationships considering three levels of *External Search Breadth*, namely high (one standard deviation above the mean), low (one standard deviation below the mean), and mean. The figure shows that the depicted relationship between *Digitalization* and *Service Innovation* changes from an inverted U to a U as the level of *External Search Breadth* goes from low to high, confirming H2.

To unpack the moderation, we probed the conditional effect of Digitalization at contrasting levels of External Search Breadth. When breadth is low, Digitalization exhibits an inverted U-shaped effect on Service Innovation; benefits taper as integration costs and capability demands rise. In contrast, when breadth is high, the curve flips to a U-shape: at low levels of Digitalization, broad external search offers alternative innovation pathways, partially substituting for digital investments. However, at very high breadth levels, firms require robust digital infrastructures to coordinate, integrate, and absorb diverse knowledge inflows; consequently, Digitalization again exerts a positive effect on Service Innovation. This “shape-flip” aligns with theorization on non-linear relationships (Haans et al., 2016) and emphasizes that the interplay of internal (digital) and external (knowledge) resources is contingent and dynamic.

INSERT FIGURE 2 ABOUT HERE

5. Discussion

This study reinforces the digitalization-service innovation relationship in SMEs, using a sample of 489 North American firms to provide evidence of this link. The study confirms a curvilinear relationship between digitalization and service innovation in SMEs, resembling an inverted U-shape. That is, digitalization positively affects service innovation but only to a certain threshold, after which costs of digitalization arise. Subsequent to this, this study provides a new perspective by analysing the role of external knowledge sourcing on the relationship between digitalization and service innovation in SMEs. Results reveal that as external search breadth increases, the main relationship presents a shape-flip. This shape-flip highlights that external knowledge breadth can initially substitute for digital investments but eventually necessitates stronger digital infrastructures to absorb and coordinate diverse inputs—reinforcing the contingent complementarities between digitalization and openness (see Figure 1 and our post-Table 4 probing of conditional effects). These findings offer theoretical and managerial implications.

5.1 Implications for Theory

This study makes several contributions to the literature at the intersection of digitalization, service innovation, and SME innovation strategies.

First, it advances the understanding of the relationship between digitalization and service innovation, particularly in the context of SMEs. While service innovation has garnered increasing scholarly interest in recent years, especially as a result of the digitalization phenomenon (Lerch & Gotsch, 2015; Vendrell-Herrero et al., 2016; Favoretto et al., 2022; Shen et al., 2023), empirical research examining how digitalization influences service innovation outcomes in SMEs remains limited. Our findings demonstrate that this relationship is non-linear, following an inverted U-

shape, suggesting that beyond a certain threshold, additional digitalization may hinder rather than support service innovation. This nuanced understanding contributes to ongoing debates about the strategic implications of digitalization for innovation.

Second, this study addresses a significant gap in the literature by focusing on SMEs; organizations that have distinct structural, strategic, and resource characteristics compared to large firms. Prior research on digital-enabled service innovation has predominantly focused on large corporations (Eller et al., 2020; Kowalkowski, 2023), leaving a limited understanding of how smaller firms manage the digitalization of their service offerings. By examining SMEs specifically, this study provides insights into the conditions under which digitalization contributes to or constrains service innovation in resource-constrained environments, thereby extending SME innovation research (Costa et al., 2024).

Third, the study contributes to the literature on digitalization within the open innovation framework. We adopt an open innovation perspective centered on external search breadth. Our results reveal that external search breadth moderates the digitalization–service innovation relationship by altering its shape. This underscores that the digitalization–openness interplay is non-linear and context dependent, with breadth-driven substitution effects at low digitalization levels and complementarity at high ones. This finding offers new insights into the boundary conditions of digitalization in SMEs and suggests a dynamic interplay between digital technology adoption and sourcing strategies.

5.2 Managerial and Policy Implications

The findings suggest that while digitalization can significantly enhance service innovation in SMEs, its benefits are not limitless. As digital investments increase, the positive impact on service

innovation begins to decline, indicating that excessive digitalization may strain resources or lead to diminishing strategic focus. For SME managers, this underscores the importance of adopting a balanced and deliberate approach to digitalization. Rather than pursuing comprehensive digitalization efforts indiscriminately, managers should prioritize technologies that align with specific innovation goals and are feasible within the firm's current operational and financial capacity. For example, digital tools that improve customer interaction, enhance data collection, or streamline service delivery may yield more immediate and impactful results than enterprise-wide system overhauls. Managers should consider piloting new digital initiatives on a small scale, assessing their contribution to innovation outcomes, and expanding only those that demonstrate clear value. This iterative approach can help avoid overinvestment and enable learning along the way.

Moreover, the role of external search breadth adds important nuance to this relationship. When firms operate with low to moderate levels of digitalization, expanding the breadth of external knowledge sourcing, such as engaging with customers, suppliers, or peer organizations, can act as a substitutive resource. This suggests that managers with limited capacity for digital investment may still enhance service innovation by actively cultivating diverse external connections. However, the findings also reveal that when external search breadth is pursued at high levels, high levels of digitalization may become beneficial again, despite the usual drawbacks associated with extensive digital investments. In such cases, digitalization may serve a critical role in managing, integrating, and making sense of the wide array of external knowledge inputs. Digital tools can facilitate coordination, data sharing, and knowledge assimilation, which are essential when engaging with a diverse set of partners and information sources. Managers should therefore consider extending their digitalization efforts when they are actively supporting a broad and

diverse external search strategy, as the technological infrastructure can enhance their ability to absorb and utilize external inputs effectively.

In sum, managers should be cautious about simultaneously focusing on digitalization and external knowledge sourcing for the sake of service innovation, as doing so without clear strategic alignment may lead to resource strain and complexity that outweigh the benefits. Instead, rather than advancing both dimensions simultaneously at high intensity, managers should first assess their firm’s current capabilities, strategic priorities, and resource constraints. Moreover, they should approach these strategies as interdependent and context-sensitive, scaling digitalization when it complements external knowledge efforts, and avoiding concurrent intensification when internal capacities or integration mechanisms are lacking. By recognizing the dynamic interaction between these two levers, managers can make more informed decisions that sustain innovation without triggering diminishing returns.

From a policy perspective, our findings emphasize the need for nuanced support strategies that go beyond encouraging digital adoption alone. While policy measures in most countries have increasingly focused on fostering SME digitalization, the evidence suggests that unqualified promotion of digital investment may not always yield optimal innovation outcomes. Instead, policy frameworks should take into account the contingent nature of digitalization benefits and the importance of how firms combine internal and external knowledge sources to innovate. In turn, governments and industry associations can play a key role by supporting SMEs in developing the absorptive capacity needed to integrate digital tools with external knowledge effectively. This includes providing guidance on how to tailor digital adoption to firm-specific contexts and encouraging experimentation with innovation models that balance digital capabilities with open search practices. Support initiatives that help SMEs identify when and how to adjust their mix of

internal and external innovation activities, rather than merely increasing their intensity, could be particularly valuable. In doing so, policymakers would help SMEs avoid the pitfalls of overextension and unlock more sustainable paths to service innovation.

5.3 Limitation and Future Research Directions

The study was conducted within the Canadian context, and although certain policy measures implemented to encourage digitalization in SMEs may bear resemblances to those in other developed economies, it is valuable to acknowledge that Canada has implemented its own unique policy responses. Additionally, the composition of businesses and the policy environment can impose limitations on the generalizability of the findings beyond the Canadian context.

This research employed a quantitative survey-based research methodology to investigate the digitalization, external search breadth and service innovation in SMEs. However, this approach primarily addresses the “what” aspect of the subject matter and lacks an in-depth exploration of the “why” and firms internal processes to gain advantage of digitalization. Consequently, it creates an opportunity for future research to comprehensively explore these actions by employing qualitative research methods.

While a significant association is observed between a change in digitalization, external knowledge sourcing and service innovation, it is essential to emphasise that these findings establish a correlation and do not fully imply causation. Establishing causal relationships typically requires the utilisation of additional experimental or quasi-experimental research designs. Moreover, the study's cross-sectional design limits its capacity to examine changes and developments over time, making it challenging to establish trends or causality. This presents a

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significant avenue for future research endeavours that adopt a longitudinal approach to the study of these effects.

Finally, from a methodological perspective, the authors recognize the measure of service innovation is captured by a binary variable, while more details on innovation performance (innovativeness) could have added value to the study. Moreover, the authors were unable to capture several additional factors that could have provided a more comprehensive understanding of the phenomenon under investigation. These include the varying contributions of different functions (e.g., advertising, HR, finance) to service innovation, as well as the relative importance of different external knowledge sources and digital technologies. In particular, future research could examine not only the breadth but also the depth of digitalization and knowledge sourcing, to better understand how the intensity and quality of both digital technologies and external inputs interact to influence service innovation.

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Table 1.
Survey Response by NAICS Classification.

NAICS	Industries	Representative sample (percent)*	Actual response (percent)
11	Agriculture, forestry, fishing, and hunting	2.0	1.6
21	Mining, quarrying and oil and gas extraction	3.2	2.9
22	Utilities	0.3	0.0
23	Construction	12.2	9.0
31–33	Manufacturing	4.9	15.3
41	Wholesale trade	6.9	6.7
44–45	Retail trade	16.5	5.1
48–49	Transportation and warehousing	4.3	1.2
51	Information and cultural industries	1.1	1.2
52	Finance & insurance	3.7	4.1
53	Real estate, rental, and leasing	3.0	3.3
54	Professional, scientific and technical services	6.8	29.7
55	Management of companies and enterprises	1.1	0.4
56	Administrative and support, waste management and remediation services	5.1	5.3
61	Educational services	1.1	3.5
62	Health care and social assistance	7.6	3.3
71	Arts, entertainment, and recreation	1.4	1.6
72	Accommodation and food services	10.4	3.1
81	Other services	8.4	2.6

* Statistics Canada, Canadian business patterns database, December 2014

Table 2.
Descriptive Statistics

Variable	Mean	Dev. Std.	Min	Max
ServiceInnovation	.587	.492	0	1
Digitalization	3.937	2.947	0	11
ExtSearchBreadth	3.618	2.920	0	12
MrktInternationalization	11.127	26.194	0	100
CompetitiveIntensity	.507	.500	0	1
CostStrategy	17.530	24.826	0	100
Collaboration	.531	.499	0	1
FirmAge	19.164	18.053	0	120
FirmSize	26.442	44.126	0	250

Table 3.
Pairwise Correlations

	1	2	3	4	5	6	7	8	9
1-ServiceInnovation	1								
2-Digitalization	0.438*	1							
3-ExtSearchBreadth	0.333*	0.554*	1						
4-MrktInternationalization	-0.010	0.143*	0.054	1					
5-CompetitiveIntensity	0.010	0.025	0.019	-0.172*	1				
6-CostStrategy	0.026	0.080	0.034	-0.100*	0.087*	1			
7-Collaboration	0.174*	0.234*	0.218*	0.101*	0.008	0.066	1		
8-FirmAge	-0.092*	0.012	0.034	-0.106*	0.084	0.063	-0.098*	1	
9-FirmSize	-0.044	0.131*	0.095*	0.035	0.064	0.104*	0.126*	0.263*	1

Table 4.
Probit Regression Model

	Model 1	s.e.	Model 2	s.e.	Model 3	s.e.	Model 4	s.e.
Digitalization			0.242***	0.026	0.633***	0.068	0.965***	0.110
Digitalization ²					-0.045***	0.007	-0.073***	0.013
Digitalization X ExtSearchBreadth							-0.185***	0.029
Digitalization ² X ExtSearchBreadth							0.015***	0.003
ExtSearchBreadth							0.448***	0.071
MrktInternationalization	-0.000	0.002	-0.005**	0.003	-0.002*	0.002	-0.006**	0.003
CompetitiveIntensity	0.012	0.122	-0.051	0.129	-0.139	0.135	-0.196	0.142
CostStrategy	0.001	0.002	0.000	0.003	0.000	0.003	-0.001	0.003
Collaboration	0.429***	0.122	0.227*	0.131	0.239*	0.133	0.273*	0.139
FirmAge	-0.003	0.004	-0.004	0.004	-0.004	0.004	-0.005	0.004
FirmSize	-0.001	0.002	-0.003	0.002	-0.002	0.001	-0.001	0.001
dummySector	Yes		Yes		Yes		Yes	
Constant	-0.286	0.404	-0.666***	0.371	-1.006***	0.351	-1.540***	0.405
WaldChi(2)	37.22*		112.73***		154.31***		199.83***	
LogPseudolikelihood	-311.94		-260.37		-243.94		-230.86	

N=489; *p<0.1; **p<.05; ***p<.01

Figure 1.
Conceptual Model

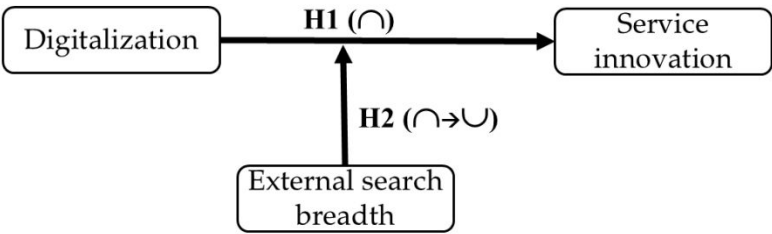


Figure 2.
The Relationship between Digitalization and Service Innovation at different levels of External Search Breadth

