Assessing the Impact of COVID-19 on Website Technology Penetration on Businesses in Rural Towns

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Abstract

Rural small and medium-sized businesses (SMEs) represent a significant proportion of SMEs, are typically micro-enterprises (MSMEs), and face different challenges to their urban peers yet are typically under-represented in research. The COVID-19 pandemic accelerated enterprise internet adoption and use however extant reports primarily focus on large enterprises and SMEs, as a whole. This paper examines web technology (WT) adoption by 849 businesses in five rural towns prior to and during the COVID-19 pandemic. Longitudinal data is analysed by town, technology, and economic activity. We find that COVID-19 resulted in significant growth in the adoption of online advertising, cloud computing, and e-commerce by rural businesses. Rural businesses located in commuter towns adopted more WTs than those in other rural towns. Highly digitalised sectors increased their WT adoption more than those reliant on physical products or human interaction. Similarly, those who already had high levels of WTs in place adopted more sophisticated technologies.

1. Introduction

In most OECD countries, small and medium-sized enterprises (SMEs) account for the overwhelming majority of businesses, existing and new jobs, and up to 60% of value added [1]. In rural areas, not only are the vast majority of firms SMEs, they are highly skewed towards micro-enterprises (MSMEs), firms with less than ten employees [2]. Compared to SMEs located in urban areas, rural SMEs are particularly reliant on access to external markets due to constraints on local market size, and face additional operational costs due to distance from customers and markets [2, 3].

Information and communication technologies

(ICTs), and specifically the Internet, present rural SMEs with the opportunity to overcome the limitations of their location. The positive commercial impact of ICTs including websites, e-commerce, digital advertising, and social media on SME marketing, sales, customer service, and operations is well-documented [4, 5, 6, 7, 8, 9, 10]. Notwithstanding these benefits, recent research suggests that a digital divide remains between urban SMEs and rural SMEs in relation to their adoption of website technologies (WTs), online marketing, and e-commerce practices [11]. In Europe, rural businesses may be under-represented in official statistics to inform digital policy as major studies, e.g. the European Union Digital Economy and Society Index (DESI) [12], exclude SMEs with less than ten employees.

The acceleration of digital technology adoption by both consumers and enterprises due to the COVID-19 pandemic has been reported both in commercial [13, 14], and increasingly academic contexts [15, 16]. However, these studies do not typically focus on the rural SME context and are limited by their use of cross-sectional surveys. This paper examines the adoption and use of website technologies (WT) by 849 rural businesses located in five rural Irish towns before and during the COVID-19 pandemic. Specifically, we explore four questions:

1. To what extent do rural businesses adopt website technologies?
2. Did rural businesses increase their adoption and use of website technologies since the emergence of COVID-19?
3. Is website technology adoption and use by rural businesses uniform across different types of rural towns?
4. Is website technology adoption and use by rural

businesses uniform across different types of sectors?

A combination of manual coding and a commercial website profiler were used to extract WT information, where a business had a website or social media presence. A Web Intensity Index (WII) was developed to measure firm-level use of eight WT categories across two periods, September 2019 and June 2020. Analysis was performed by town, technology, and sector. The contribution of this study is twofold. Firstly, it applies a novel methodology to perform a longitudinal study on the use of WTs by an under-represented cohort in the literature i.e. rural businesses including MSMEs. Secondly, it provides insights in to the response of rural businesses to an unprecedented extreme societal disruption, COVID-19.

2. Literature Review

Website technologies (WT) include a wide range of internet-based technologies including the website itself, paid advertising, social media, email marketing, mobile commerce and e-commerce, and analytics, amongst others. More recently, the emergence of cloud computing has enabled SMEs outsource their ICT infrastructure to support their web operations and provide greater reliability and scalability [17, 18]. Similarly, the availability of easy to use no-code/low-code digital advertising platforms and content management systems (CMS) with support for mobile responsive themes, has resulted in websites that support both desktop and mobile marketing and commerce. WTs can support multiple commercial objectives including search engine optimisation, information dissemination and exchange [10, 19], demand generation [9, 11], sales [9, 10, 20], customer relationship management [7, 11], and network building [10].

The potential benefits of WTs to SMEs are well-established. They include reductions in distance-related barriers [4], cost and time savings [4, 6, 18], and improvements to ICT resilience and scalability [17, 18], access to new markets [4, 6], marketing effectiveness [9], customer service and engagement [7], and market and customer intelligence [8], amongst others. From a strategic perspective, WTs can provide relative advantages when compared to more traditional methods [5] while also enabling SMEs compete with larger firms [5, 11]. Despite these benefits, SMEs continue to lag their larger counterparts in adopting WTs, and particularly more sophisticated technologies, for a variety of reasons [21]. Those most often cited include access to skills and skilled resources,

and perceived risk associated with greater investment to adopt and support more advanced and transactional technology use [22]. For some discrete technologies, for example cloud computing, concerns about data security are significant barriers [17, 18].

The urban-rural digital divide has been a focus of research for over two decades [21, 23, 24]. Despite this, there is a relative dearth of research on exploring this divide in the context of rural SMEs, and specifically MSMEs. As recent as a decade ago, studies reported relatively low broadband access, website and social media use by rural SMEs in developed countries [25, 26]. More recently, a study of SMEs in North Carolina found that while there has been a closing in the gap between urban and rural SMEs with regards to broadband access, rural SMEs still lagged urban SMEs in online marketing practices in terms of website sophistication, e-commerce, and social media [11].

Since January 2020, the COVID-19 pandemic has resulted in significant non-pharmaceutical interventions that disrupted the normal operations of businesses worldwide including the closure of non-essential retail outlets. SMEs are disproportionately impacted by such measures as they are over-represented in sectors impacted by lockdowns [27], have lower productivity and weaker supply chain capabilities [27], are more financially fragile with limited cash reserves [27, 28, 29], and lack the managerial capabilities to navigate through the evolving challenges presented by COVID-19 [27]. In addition, SMEs lag larger companies in their adoption and use of digital tools [21]. While governments have invested in substantial initiatives for digitalisation, innovation and technology development, upskilling and reskilling, and finding new alternative markets [27], a significant number of SMEs report that they have made significant layoffs during the COVID-19 pandemic, and expect that it could take up to two years to recover to pre-pandemic levels [28, 29]. Some forecasts suggest that between 20% and 36% of SMEs could close down permanently [30]. Rural SMEs are likely to be more adversely affected due to their less diversified economic activity, disproportionate reliance on local markets, disruption to national and international supply chains, and as discussed earlier, their lower adoption, use and sophistication of WTs both in general and compared to urban SMEs [11, 31]. Recognising this, governments worldwide have put in place specific initiatives for rural SMEs [30, 31].

Against the backdrop of COVID-19, the acceleration of digital initiatives has been reported in scholarly and commercial contexts [13, 14, 15, 16]. For some commentators, the disruption to the market and changes in consumer behaviour represent an opportunity [32].

It is unclear, however, whether rural businesses are adequately reflected in this research.

3. Empirical Context

Ireland has a population of 4.9 million people; 37.3% of the population live in rural areas [33]. 22.5% of Ireland's population and 44% of Ireland's total urban population live in Dublin, the capital city [33]. Ireland has one of the most globalised and open economies in the OECD [34]. Foreign multinational corporations account for a higher share of value added in Ireland than in any other economy in the EU [34]. Despite this prominence of foreign direct investment in Ireland, SMEs account for 99.8% of private business enterprises in Ireland accounting for approximately 68% of private business employment [35, 36]. The majority of Irish SMEs are MSMEs; 92.3% employ less than 10 people [35, 36]. Approximately 37% of SMEs are located in rural counties. The rural-urban divide is acute in Ireland, with 80% of all private enterprises that closed between 2006 and 2010 located in rural areas [35]. Reported challenges that Irish rural SMEs face include distance from larger markets, relatively poor transport and broadband infrastructure, declining populations, difficulties in attracting talent (particularly managers and skilled technical people), lack of skills and access to training, and lack of networking opportunities [35]. In the most recent DESI country-level benchmarks for integration of digital technologies in business, Ireland was the leading country in the EU[37]. It ranked fifth for business digitisation and first for e-commerce [38]. However, as mentioned earlier, DESI does not include SMEs with less than ten employees thus it is unrepresentative of the rural economy which comprises predominantly MSMEs [12].

The first case of COVID-19 was reported in Ireland on February 2020 [39]. In March 2020, the Irish government implemented a stay-at-home order banning all non-essential travel and limiting physical contact [40]. The adverse impacts of the pandemic measures disproportionately and adversely impacted SMEs [41]. Furthermore, it was forecasted that the impact on coastal and rural Irish towns would be significant due to their reliance on businesses requiring human interaction that cannot be operated remotely [42].

4. Methodology

Specific criteria were set to filter and select suitable towns to participate in the study. The criteria included (i) an upper limit of 10,000 in population to ensure no town selected was designated a gateway or hub urban centre

in the Irish National Spatial Strategy (2002)[43] or the Project Ireland 2040 National Planning Framework [44], and (ii) no towns located in the Greater Dublin Area or towns denoted as core electoral divisions by the Irish Central Statistics Office as pertaining to an Irish city. This left 112 towns that were then further assessed by size (small, medium, and large) and whether they experienced (a) negative population growth, (b) positive but below (national) average population growth, and (c) positive and above average population growth for the period 2002-2016. To provide a more complete geographical picture, we selected a sample of rural, commuter, coastal, and border towns that met the selection criteria i.e. Gorey (Wexford), Kilrush (Clare), Edgeworthstown (Longford), Boyle (Roscommon), and Buncrana (Donegal).

Table 1: Overview of Selected Towns

Town	Type	Population (2016 Census [33])	Population Trend	No. of Businesses Examined
Gorey	Commuter Town	9,822	Positive (Below Average)	352
Kilrush	Coastal Town	2,719	Negative	142
Edgeworthstown	Midlands Town	2,072	Positive (Above Average)	37
Boyle	Western Town	2,568	Positive (Below Average)	139
Buncrana	Border Town	6,785	Negative	179
Total				849

An authoritative list of active businesses in September 2019 located within a two kilometre radius of each town centre was sourced from GeoDirectory, a joint venture between An Post, the Irish National postal service, and Ordnance Survey Ireland. The data was cleaned to remove duplicates, inactive businesses, and non-commercial operations e.g. public service or civil society. Table 1 summarises the characteristics of the focal towns (n=5) and the final number of businesses (n=849) analysed by town. To allow for the impact of broadband access, an analysis of both fixed and mobile broadband coverage was undertaken for the focal areas using data from the Irish Department of the Environment, Climate and Communications [45] and the Irish Commission for Communications Regulation [46]. In all cases, coverage was considered high and therefore broadband access was not considered a barrier to digitisation.

Based on common indicators used by intergovernmental and international organisations, a Web Intensity Index (WII) was developed to measure firm-level availability of seven different WTs. A further item, the presence of a mobile responsive website or mobile app, was added to reflect the high penetration of mobile broadband and use in Europe - DESI [37] reports 100.2 active mobile broadband SIM cards per 100 people in the EU. The items included in the WII are:

Table 2: Selected DESI Indicators for the EU (2019 & 2020)[37, 38] and Ireland (2020) [53]

Web Technologies	DESI 2019 (EU)		DESI 2020 (EU)		DESI 2019 (IRELAND)
	Large Enterprises	SMEs	Large Enterprises	SMEs	
Website	94%	77%	-	-	-
Website with sophisticated functions	74%	57%	-	-	-
Social Media	63%	37%	78%	52%	36%
Cloud Computing	39%	17%	56%	25%	30%
Selling Online	38%	26%	39%	18%	33%

1. A website or web page [37, 47, 48, 49, 50]
2. A website with sophisticated functions e.g. analytics, tracking, chat, encrypted website, etc. [37, 47, 49]
3. Mobile responsive website or mobile app
4. Social media [37, 47, 49]
5. Paying to advertise on Internet [49]
6. Sophisticated use of online advertising e.g. remarketing, contextual advertising, personalisation etc.[49]
7. Using cloud computing services [37, 47, 49, 51]
8. Selling on the Internet from their website [37, 47, 49, 50, 51, 52]

The value for the index ranged from 0 to 8 where 0 (non-existent), 1-2 (very low), 3-4 (low), 5-6 (high) and 7-8 (very high). Digital technology take-up was measured by the percentage of firms adopting the different technologies in the WII, excluding one item: “selling on the internet from their website”. The E-commerce take-up was measured by the percentage of firms selling on the internet from their website. Each business was also manually classified by economic activity based on UK SIC 2-digit industry codes. To assess the impact of COVID-19, measurements were taken in September 2019 (T1) prior to the COVID-19 pandemic and in June 2020 (T2) following the implementation of pandemic restrictions.

5. Results

5.1. To what extent do rural businesses adopt website technologies?

Table 3 provides a summary of the WII results for T1 and T2 by town; Table 4 provides a breakdown of technologies by town for the same periods. As can be seen, even before the pandemic the overwhelming majority of businesses in the sample had some form of online presence (88%). This compares favourably

to the most recent (pre-pandemic) EU figures (77%) on this dimension as reported in DESI 2019 [38]. Similarly, rural businesses in our sample are active on social media (69%), significantly higher than the EU average for SMEs reported in DESI 2020 [37] (52%) and the Irish average (36%) reported in DESI 2019 [53]. Indeed for the rural businesses in our sample, 19% only had a social media presence, typically Facebook. Notwithstanding website and social media penetration, over 62% of the rural businesses examined had relatively low web intensity scores. These results can be explained by a number of factors. Other than Gorey (72%), the majority of businesses did not have mobile responsive websites or a mobile app. Similarly, there was relatively low evidence of use of online advertising, cloud computing, and e-commerce. While no DESI benchmark data is available for online advertising, Eurostat ([49]) report that in 2018 26% of EU businesses used internet advertising. The 34% of rural businesses using internet advertising in our sample in T1 thus compares favourably. While cloud computing penetration was higher than the EU average for SMEs reported in DESI 2019 (17%) and DESI 2020 (25%); it was below the Irish average (30%) however the DESI 2019 figure reported in Table 2 only includes both large enterprises and SMEs. Finally, 32% of the rural businesses in our sample were selling online in T1. Again this was higher than the EU average for SMEs reported in DESI 2019 (17%) and DESI 2020 (18%) and is only 1% below the Irish overall average reported in DESI 2019. Mere presence of WTs does not infer successful online trading or marketing. It is also worth noting that the statistics that policymakers across the EU use for policymaking, namely DESI and its source data (Eurostat), may not only be under-representing rural SMEs but under-reporting SME digital readiness, both in general and in advance of going into lockdown.

5.2. Did rural businesses increase their adoption and use of website technologies since the emergence of COVID-19?

As can be seen in Table 3 and Table 4, while 62% of the rural businesses continue to have low WII scores, there is a notable shift in the upper end with those businesses rated as very high increasing from 23% in 32% in T2. Firstly, the use of responsive web design increased as whole although this metric decreased for Gorey (from 72% to 69%) albeit significantly above the average in the sample. The number of websites using support for online advertising as a whole increased significantly from T1 to T2. While there was a decrease in basic online advertising support,

Table 3: Summary of Web Intensity Index by town for T1 and T2

WII Levels	Gorey		Kilrush		Edgeworthstown		Boyle		Buncrana		Total	
T1	#	%	#	%	#	%	#	%	#	%	#	%
Non-existent (0)	15	4%	37	26%	7	19%	30	22%	14	8%	103	12%
Very low (1-2)	73	21%	56	39%	17	46%	59	42%	93	52%	298	35%
Low (3-4)	83	24%	11	8%	5	14%	18	13%	8	4%	125	15%
High (5-6)	74	21%	10	7%	4	11%	28	20%	15	8%	131	15%
Very High (7-8)	107	30%	28	20%	4	11%	4	3%	49	27%	192	23%
Total	352	100%	142	100%	37	100%	139	100%	179	100%	849	100%
T2	#	%	#	%	#	%	#	%	#	%	#	%
Non-existent (0)	14	4%	21	15%	5	14%	30	22%	26	15%	96	11%
Very low (1-2)	66	19%	60	42%	17	46%	53	38%	80	45%	276	33%
Low (3-4)	48	14%	14	10%	5	14%	4	3%	8	4%	79	9%
High (5-6)	67	19%	13	9%	3	8%	17	12%	24	13%	124	15%
Very High (7-8)	157	45%	34	24%	7	19%	35	25%	41	23%	274	32%
Total	352	100%	142	100%	37	100%	139	100%	179	100%	849	100%

Note: Text in green/red denotes a positive/negative variation from T1 to T2. Text in yellow denotes no change from T1 to T2.

support for sophisticated online advertising technology increased from 34% to 49%, most likely reflecting increased consumer behaviour online. There was similar significant shifts in support and use of cloud computing from T1 (28%) to T2 (44%); again this is significantly higher than the DESI 2020 figures for SMEs (25%) and the DESI 2019 Irish overall average (30%). Finally, the number of rural businesses selling online increased from 32% to 41%. Firstly, the T1 figures were similar to those reported as the Irish overall average in DESI 2019 (30%) and significantly higher than the EU average for SMEs of 18% reported in DESI 2020. It should be noted that despite being relatively strong compared to EU counterparts, the average number of SMEs selling online in non-EU countries was far higher at 43.6 % although it should be noted different source date was used [47]. Notwithstanding the levels of web intensity, there is significant room for improvement. The evidence suggests that as a whole rural businesses increased the number of WT used during the pandemic, particularly those who had already started digitising their business.

5.3. Is website technology adoption and use by rural businesses uniform across different types of rural towns?

A comparison across towns suggests that the impact of the COVID-19 pandemic on increased digitisation is not uniform. Firstly, the results suggest that the SMEs in the border town in our sample, Buncrana, did not progress to the same extent as other towns. As discussed earlier, the Three Regions Assembly [42] suggested that towns that relied on tourism would be disproportionately effected by the COVID-19 pandemic. This would

seem to be the case here where a number of business websites were no longer online by T2. However, it is also likely that Buncrana suffered from its proximity to Northern Ireland (and associated UK COVID-19 interventions) and Brexit which may have impacted the overall economic activity of the town and wider environs [54]. Secondly, Gorey, the largest town in the sample and a commuter town for Dublin had significant shifts in WII scores moving from 30% of rural businesses rated very high to 45% in T2. This reflects its size and more diversified economy. Kilrush, the coastal town in our sample, saw a more gradual upward shift in the level of sophistication with a decrease in the number of businesses rate non-existent and a general increase of the number of businesses across all other other levels.

5.4. Is website technology adoption and use by rural businesses uniform across different types of sectors?

Table 5 illustrates the presents the percentage of firms by economic activity and by WII level. These are consistent with EU studies [38] that suggest that relatively small percentages of firms in the construction, transport, and storage industries have high or very high WII scores, while ICT, media and financial services businesses tended to be the more highly digitized sectors in the economy. Given that the COVID-19 restrictions directly impacted travel, tourism, hospitality, arts, entertainment and recreation, and transport related businesses, it is unsurprising that these businesses experienced some of the least increases in WT adoption from T1 to T2. Similarly, the low changes in the waste sector is to be expected. While travel, tourism and

Table 4: Web Technology Adoption by Town for T1 and T2

Technologies	Gorey		Kilrush		Edgeworthstown		Boyle		Buncrana		Total	
T1	#	%	#	%	#	%	#	%	#	%	#	%
Website	336	95%	85	60%	19	51%	56	40%	76	42%	572	67%
Sophisticated website	243	69%	37	26%	12	32%	44	32%	60	34%	396	47%
Mobile Responsive	255	72%	37	26%	12	32%	2	1%	62	35%	368	43%
Social Media	268	76%	75	53%	19	51%	74	53%	150	84%	586	69%
Online Advertising	134	38%	38	27%	6	16%	44	32%	64	36%	286	34%
Sophisticated Online Adv.	139	39%	36	25%	11	30%	44	32%	62	35%	292	34%
Cloud	120	34%	38	27%	7	19%	21	15%	49	27%	235	28%
Selling online	147	42%	36	25%	6	16%	24	17%	57	32%	270	32%
T2	#	%	#	%	#	%	#	%	#	%	#	%
Website	334	95%	116	82%	32	86%	109	78%	152	85%	743	88%
Sophisticated website	226	64%	46	32%	13	35%	51	37%	61	34%	397	47%
Mobile Responsive	244	69%	54	38%	13	35%	54	39%	69	39%	434	51%
Social Media	269	76%	73	51%	21	57%	90	65%	147	82%	600	71%
Online Advertising	145	41%	36	25%	8	22%	37	27%	41	23%	267	31%
Sophisticated Online Adv.	236	67%	49	35%	13	35%	54	39%	64	36%	416	49%
Cloud	212	60%	47	33%	9	24%	52	37%	57	32%	377	44%
Selling online	200	57%	47	33%	9	24%	42	30%	60	34%	358	42%

Note: Text in green/red denotes a positive/negative variation from T1 to T2. Text in yellow denotes no change from T1 to T2.

property businesses would be expected to make high use of WTs, extreme disruptions such as COVID-19 cannot be addressed using such technologies. The relatively low increases in web intensity for human health and social work activities is noteworthy given the nature of the COVID-19 disruption. However, despite Ireland's high DESI ranking in the integration of digital technologies in business, Ireland has not performed well with regards to e-health. Indeed, in DESI 2019, Ireland was ranked as one of the lowest performing countries in the EU for general practitioner use of electronic networks to transfer prescriptions to pharmacists [38].

6. Discussion and Conclusion

There is evidence to suggest that rural SMEs may be under-represented in international composite indices and academic research on digital adoption and use due to reliance on firm-level data from sources, such as Eurostat, that only collect data on enterprises with greater than ten employees. For example, the G20 Toolkit for Measuring the Digital Economy [51], and the Digital Ecosystem development Index [52], DESI [12] and I-DESI [47] all feature indicators that exclude MSMEs based on this criteria. This paper helps address the knowledge gap on rural SMEs by exploring (i) to what extent rural businesses adopt WTs, and (ii) whether rural businesses increased their adoption and use of WTs since the emergence of COVID-19. In their study of online marketing tools by rural SMEs in North Carolina,

Richmond et al.[11] found that the urban-rural digital divide with regards to high-speed broadband access is largely closed and suggested that it has been replaced by a divide in the adoption and use digital business practices. Similarly, our findings suggest that while the majority of rural businesses have an online presence, the intensity and sophistication of WTs lag best practice. In particular, while the percentage of rural businesses in our sample with some form of online presence is reaching saturation, a significant proportion of these are Facebook pages. This, in itself, is not a sufficient base upon to which to advance further integration of digital technologies into a business and limits economic activity, in particular, e-commerce.

Unsurprisingly, we find evidence to support the reported digital acceleration driven by the COVID-19 pandemic across all categories. However, increased adoption and use of WTs was not uniform. Those rural businesses that had already commenced using more sophisticated WTs before the COVID-19 pandemic, continued to invest in digitisation and increase their WT intensity. While our findings suggest the rural businesses in our sample compare well against their European counterparts, over 50% of rural businesses analysed are not selling online, not advertising online, or not leveraging cloud computing infrastructure for their marketing and sales. Our research also explored whether pandemic effects varied by geographic location and sector. We find that location matters. The rural town located closer to a large urban area, Gorey, had

Table 5: WII Level by Economic Activity

Industry	Non-existent (0)		Very low (1-2)		Low (3-4)		High (5-6)		Very High (7-8)	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Accommodation and Food Services Activities	14%	11%	42%	43%	12%	8%	12%	15%	20%	23%
Administrative and Support Service Activities	9%	9%	18%	9%	18%	18%	27%	9%	27%	55%
Agriculture, Forestry and Fishing	25%	0%	25%	25%	0%	25%	25%	0%	25%	50%
Arts, Entertainment and Recreation	0%	0%	32%	32%	16%	8%	16%	24%	36%	36%
Business Services	10%	10%	25%	20%	15%	5%	30%	25%	20%	40%
Construction	17%	28%	50%	17%	28%	22%	0%	17%	6%	17%
Education	13%	6%	50%	38%	13%	19%	19%	19%	6%	19%
Financial and Insurance Activities	0%	0%	5%	5%	5%	0%	14%	14%	77%	82%
Human Health and Social Work Activities	13%	16%	35%	32%	19%	9%	15%	19%	18%	24%
Information and Communication	0%	0%	0%	10%	20%	10%	30%	10%	50%	70%
Legal and accounting activities	12%	35%	50%	23%	8%	8%	15%	19%	15%	15%
Manufacturing	3%	6%	28%	19%	31%	16%	25%	34%	13%	25%
Other Service Activities	20%	14%	48%	53%	11%	7%	8%	6%	13%	20%
Professional, Scientific and Technical Activities	3%	0%	21%	24%	34%	21%	24%	17%	17%	38%
Publishing activities	0%	0%	25%	25%	0%	0%	25%	0%	50%	75%
Real Estate Activities	7%	13%	27%	7%	20%	13%	27%	27%	20%	40%
Telecommunications	0%	0%	0%	0%	0%	0%	100%	0%	0%	100%
Transportation and Storage	25%	31%	38%	19%	19%	13%	0%	19%	19%	19%
Veterinary activities	0%	33%	100%	67%	0%	0%	0%	0%	0%	0%
Water Supply, Sewerage, Waste Management etc	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%
Wholesale and Retail Trade	13%	7%	32%	33%	12%	8%	16%	11%	27%	41%

Note: Text in **green/red** denotes a positive/negative variation from T1 to T2. Text in **yellow** denotes no change from T1 to T2.

higher WT adoption and use. In both cases, the effects were non-uniform. Rural businesses in the border town did not present the same increase in adoption as those in other towns. Similarly, the more highly digitalised sectors increased their digital technology adoption and used more WTs than those reliant on physical products or human interaction, and cannot be operated remotely.

Historically, SMEs cited relatively high infrastructure and technology costs, staff skills and experience, and previous bad experiences, liquidity constraints, and uncertain return on investment (ROI) for not adopting WTs and online marketing [22, 55, 56, 57]. WTs are increasingly low-code/no-code on-demand cloud-based technologies, and for most rural SMEs, given their size, these are also low-cost/no-cost. Indeed, many service providers have specific initiatives for SMEs to onboard them and accelerate their use including free training, consulting, and credit. Unfortunately, rural SMEs, due to a lack of knowledge and skills, may outsource this work to local agencies rather than upskill or hire specialist staff. In some instances, including in Ireland, government initiatives may encourage SMEs to do so. Unfortunately, having outsourced to a third party, they may not have the skills to maintain and develop the website internally and are locked into an unproductive or unprofitable commercial relationship, and potentially underwhelmed if not negatively disposed to their website. This may explain the preponderance of rural SMEs using Facebook as their commercial web page. It is easy to use, inexpensive, with less third party dependencies for maintenance. At the same time, this may be a lost opportunity for many due to the functional limitations of Facebook as an e-commerce platform compared to dedicated e-commerce websites. Given the additional liquidity constraints arising from lockdown, prioritising digital investments may be challenging for rural SMEs.

In practical terms, this study is particularly relevant to policymakers in Ireland and beyond, especially given efforts to support increased integration of digital technologies in all aspects of society, and both rural and SME economic post-pandemic recovery. It highlights the need to capture more accurate data on the integration of digital technologies at a much more granular level, and specifically for MSMEs. It can help inform and guide policymakers, rural development and sectoral development agencies on specific investments in digital skills and technologies to increase the adoption and sophistication of rural business use of WTs. It can help identify laggards, high potential businesses, and high performance businesses so that interventions are appropriate for particular levels. Similarly, owners and managers of rural business websites can use the findings

to benchmark their own readiness and performance against peers, and inform their online efforts. Indeed, little effort would be needed to generate firm-level reports to guide their website decisions. Research suggests that SMEs are less likely to participate in formal courses and are more likely to commit to and find success through collaboration with local peers who have themselves found success online [58]. The barriers to digital adoption and use by rural businesses may not be capable of being addressed by government intervention alone, requiring a multi-stakeholder approach and support for local bottom up initiatives including local digital champions.

From a methodological perspective, the use of automated website profilers allows data to be collected on scale, rapidly and more regularly. However, many rural SMEs use social network pages such as Facebook as their *de facto* web page which poses problems for automated extraction. Automated website profilers typically only recognise third party code on websites and cannot crawl Facebook effectively. Thus some degree of manual data collection is required. More significantly, the extracted data is merely an indicator of adoption and, potentially limited use; it does not provide insights into digital effectiveness. Furthermore, for more comparative analysis against extant digital readiness studies, e.g. DESI and I-DESI, and to allow for stay-at-home scenarios, other ICTs and business models, and not just WTs, would need to be examined e.g. web conferencing, advanced cloud computing, cross-border e-commerce, enterprise resource planning (ERP), customer relationship management (CRM), Big Data analytics etc.. Based on the business mix in rural areas, one would anticipate that the use of such advanced technologies to be significantly lower than urban SMEs and businesses as a whole. Again, this would require manual data collection. At the same time, website crawling technology can provide additional insights on a much wider range of WTs and the evolution of adoption over time; this could provide valuable insights in to popular practice. This may be augmented by web content analysis of websites at very large scales based on frameworks such as the Extended model of Internet Commerce Adoption (eMICA)[59]. Advances in natural language processing and machine learning (and specifically deep learning) may prove fruitful for automating and scaling up large scale web content analysis for this purpose.

This study explored the adoption and use of a specific set of businesses in rural Irish towns over two periods, prior to COVID-19 (September 2019) and during the first lockdown (June 2020). Firstly, in June 2020, it is possible businesses did not think the

lockdowns would continue for another year and thus additional investment in digitalisation was postponed. Secondly, businesses closed as the lockdowns persisted, both temporarily and permanently, while their websites remained live. At the same time, new businesses may have been created that are not captured in our dataset. These are all limitations. A further study in June 2021 as Ireland came out of lockdown, with a refreshed set of active businesses, might produce interesting insights into the impact of COVID-19 as a whole and the evolution of digitisation over that period.

The adoption and use of WTs by businesses in only five rural towns in Ireland are examined in this study. Firstly, businesses are not the only commercial entities in towns and a more complete picture of the digital readiness of a town may provide important insights to policymakers and rural development agencies at local, regional and national levels. Research in digital towns is still at a nascent level and the same methodology could be applied to other institutions and social actors in towns including voluntary, social, and community organisations, educational institutions, and public services [60]. Given the scalability of a methodology using an automated website profiler, there are opportunities to research scale up and out. Depending on one's definition of a rural town, there are between 33 and 112 towns in Ireland alone; this paper looks at a very small sample. While a complete census might seem daunting, website domain name registration in Ireland is structured in such a way to potentially reduce the research burden - it has both nationality and residency requirements. As such, the .ie domain name is effectively an Irish domain for Irish websites. Consequently, the vast majority of Irish firms use the .ie domain name representing a significant opportunity to scale up the research. Other countries have similar registration requirements e.g. Australia, Canada, Finland, France, and Hungary, amongst others. This would allow research to be scaled out and enable detailed international comparisons of WT adoption and use. More granular analysis at different settlement sizes (cities and functional urban areas, towns and semi-dense areas, and rural areas) could be undertaken rapidly with cooperation from the domain registration agencies in each country.

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