Using Twitter as a public communication strategy

Can '@NMBS' improve the relationship between citizens and the National Railway Company of Belgium?

Steven F. De Vadder

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Contact:
steven.devadder@uantwerpen.be | steven_de_vadder@hotmail.com

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Steven F. De Vadder

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Prof. dr. Wouter Van Dooren
Prof. dr. Jan Wynen

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Members of the doctoral committee

Prof. dr. Peter Van Aelst (Universiteit Antwerpen)
Prof. dr. Jan Boon (UHasselt)
Prof. dr. Peter M. Kruyen (Radboud Universiteit | Nederlandse Arbeidsinspectie)

Members of the doctoral jury

Prof. dr. Sandra Jacobs (Universiteit van Amsterdam)
Prof. dr. Shirley Kempeneer (Tilburg University)

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"You can never know everything, and part of what you know is always wrong. Perhaps even the most important part. A portion of wisdom lies in knowing that. A portion of courage lies in going on anyway"
Robert Jordan (Wheel of Time – Winter's Heart)

Wisdom comes at a cost, as evidenced by numerous tales: Odin sacrificing an eye to obtain wisdom at the well of Mímir, Prometheus enduring daily torment for sharing the knowledge of fire, Adam and Eve's banishment from paradise for eating the forbidden fruit from the tree of knowledge (of good and evil), and Plato's allegory where escapees can never go back to living in the cave and might face death for it. While such tales of divine or transformative knowledge are reserved for legends, this dissertation stands as my own heroic feat. The price? The loss of hair and a few extra pounds can hardly be considered a noteworthy sacrifice. Mentally, these past years have been challenging; in essence, a PhD is a battle against oneself and one's limitations. However, I maintain that I am just as sane as before, which admittedly may not be saying much. I believe the true cost was borne by those closest to me. They not only had to exercise a lot of patience when I put work before private affairs, but they also had to tolerate my interest in research (in Public Administration, for heaven's sake). Something my brother eloquently described as wasting "his" taxes. I am deeply grateful to have been surrounded by amazing individuals, to whom I dedicate this acknowledgment.

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Introduction

1

Setting the stage

Many public organizations have started using social media to engage with digitally empowered citizens (Alon-Barkat, 2020; Mergel, 2016; van Dijk *et al.*, 2015; Wong *et al.*, 2021). By doing so, public agencies hope to improve public relations and customer service (Moss *et al.*, 2015). Similarly, scholars have argued that public communication is crucial in building reputation, legitimacy, satisfaction, trust, etc. (Canel & Luoma-aho, 2019). Yet, only a few studies have tried to measure the impact of a social media strategy by a public sector organization (Medaglia & Zheng, 2017). This dissertation focuses on the Twitter activity surrounding the Belgian Railway Company (NMBS). The effect of social media activity by the NMBS on the sentiment of citizens' tweets was measured with two papers. A third paper explored whether the satisfaction of train travelers improved after interactions with the NMBS through Twitter. This research contributes to the growing literature on social media as a tool to bridge the gap between public sector organizations and citizens.

Public sector organizations have long been associated with negative traits, including bureaucracy, slowness, unreliability, and inefficiency (Wæraas & Byrkjeflot, 2012). Paradoxically, most citizens are overwhelmingly satisfied with individual experiences with public services (Goodsell, 2004; Wilson, 1989). In Goodsell's classic "The [new] Case for Bureaucracy", several myths about the public sector in the United States are disproven by a significant amount of research (Goodsell, 2004, 2014; Wallace, 2010). He shows that government agencies are not inflexible, discriminative, or inefficient when compared to private businesses. Hence, the public sector faces a persistent image problem, which results in poor relationships between citizens and the public sector. Mettler (2018) notes that the current disconnect between government and citizens in the US is remarkable considering Americans more than ever depend on the government for economic security, health care, and educational opportunities. Yet, the US government is regarded with more disdain than ever.

In multiple countries, efforts to better the public sector mainly focused on savings and efficiency, have not improved this relationship (Bouckaert *et al.*, 2001; Carmeli & Tishler, 2005; Van de Walle & Bouckaert, 2003). For example, several studies (notably Ho & Cho, 2017) have concluded that actual improvements in public services did not result in higher customer satisfaction with these services. One of the reasons reforms fail to alter perceptions is the absence of strategic and planned communication (Canel & Luoma-aho, 2019). Additionally, traditional means of communication through radio, television, and print media did not seem to be able to change the public's image of the public sector. In the last decade, however, the media landscape changed drastically with the rise of social media (Ortiz-Ospina & Roser, 2023). Social media allow for faster and more personalized communication, and therefore, could help align the image of the public sector with the satisfaction of services.

Lorzenz-Spreen *et al.* (2023) conducted a review of studies related to digital media use by citizens and political variables. They concluded that social media was overwhelmingly detrimental to a functioning democracy as trust in political institutions eroded and hate, populism, and polarization increased. However, the results also suggested that social media can increase political participation, political knowledge, and exposure to diverse viewpoints in news. These studies measure the effect of social media platforms on citizen's perceptions *an sich*. They did not investigate how social media strategies of public organizations can influence these detrimental and beneficial democratic consequences. Thijs and Staes (2008, p. 8) wrote that public sector organizations should be "more responsive to society's needs and demands." Yet, society is more complex than ever (Thomas, 2013). Public managers and employees face a far more complex public because of four recent evolutions: increased citizens' demands and expectations, individualization of communication practices, expanded citizens' diversity, and new citizen roles.

To begin, over the past decades, citizens' needs evolved due to private sector standards of service (Thijs & Staes, 2008). A private service or good can be received almost instantly, which raises the expectations of public service providers. Citizens expect a similar level of service delivery from public sector organizations. Previous research suggests that citizen expectations are formed based on a combination of prior experiences, personal needs, word of mouth, and the implicit and explicit communication emanating from the public service (Thijs & Staes, 2008). Hence, a more significant emphasis on communication is essential to stay responsive to increased society's demands. Independent of the rising private sector standards, many citizens have gotten familiar with social media, which has increased and matured expectations towards public agencies in terms of responsiveness, information delivery, and service provision (Medaglia & Zheng, 2017).

A second evolution, social networks partly replacing mass communication (Castells, 2009), alters citizen engagement. Digital self-communication empowers individual customers to voice their opinions, experiences, or even critiques in real time to mass audiences. In turn, this content may be used by traditional media, making citizens co-producers of news (Bruns & Highfield, 2012). The gatekeeping function of traditional journalism, including rigorous fact-checking, is circumvented by technologically empowered citizens (Castells, 2009; Rosen, 2006). The spread of either true or false information cannot be controlled by public sector organizations (Luoma-aho & Vos, 2010). Additionally, reaching individual citizens becomes more challenging as they live in (digital) bubbles (Sloterdijk, 2011) that only let communication through that citizens actively choose themselves. Public organizations should find ways to deal with this plurality of isolated spheres and shift from a "culture of controls" to a citizen-centered engagement (Bourgon, 2011; Canel & Luoma-aho, 2019).

Thirdly, citizens today are not a homogenous group; "super-diversity" is becoming the norm (Vertovec, 2007). This term encompasses various factors, such as citizen identities, locations, histories, trajectories, and expectations (Canel & Luoma-aho, 2019). As a result, messages need to be tailored to individual citizens as much as possible.

Finally, new roles for citizens, fueled initially by New Public Management, have emerged (Canel & Luoma-aho, 2019). One role is that of customer or client, which emphasizes a demand for quality: if money is paid (also indirectly through taxes), the quality of service should be higher (Thijs & Staes, 2008). Moreover, citizens become producers and cocreators of public sector services instead of merely taxpayers and contributors. Instead of passive citizens, governments expect citizens to be "an active part of a common solution to social problems, bringing experiential expertise and local knowledge" (Durose *et al.*, 2015, p. 139). This requires increased attention to the nature of engagement and interaction between citizens and organizations (Bowden *et al.*, 2016). In conclusion, there is an increasing need for public managers "to know how to interact with the public" (Thomas, 2013, p. 786). Terry Cooper (1984, p. 143) noted that public administrators need to "seek 'power with' rather than 'power over' the citizenry".

An additional obstruction for the public sector to solve the citizen-state disconnect is the change in the traditional values of public organizations (Pollitt & Bouckaert, 2011).

For example, Kuipers *et al.* (2014) discuss that the legitimacy of public organizations, meaning the license to exist, shifts from "equity" to the "efficiency of services" and that the value of "fairness" is replaced by "transparency." Indeed, public organizations have started to become more responsive. For instance, Koop and Lodge (2020) established increased attention for communication, outward-oriented activities, and a widening of stakeholder engagement and accountability by interviewing British economic regulators.

Regardless, public sector organizations have not adapted fully to the changing society or values. Predominantly, they are still guided by the scientific management paradigm's principles of efficiency and structure, resulting in bureaucratic procedures instead of flexibility (Canel & Luoma-aho, 2019). In an age of globalization and technological advancements (Johnson *et al.*, 2009), this traditional mode of managerial authority is perceived as obsolete and slow (Canel & Luoma-aho, 2019). However, these procedures often have a logical justification. For example, public health officials might be unable to see medical records when a citizen moves to a new city because of personal data protection. Adhering to procedures, even for simple requests, might frustrate citizens if they don't understand the justification for the slowness of the process (Thijs & Staes, 2008).

Another obstacle to the relationship between citizens and organizations is their different points of view (Canel & Luoma-aho, 2019). Citizens with particular questions often face difficulties finding answers or understanding the technical descriptions from the authorities. An undesirable consequence is that people may resort to alternative outlets with clearer but not necessarily accurate outlets, such as online discussions (Tirkkonen & Luoma-aho, 2011, 2014). An illustration of this can be found in the opposition to vaccinations during the COVID-19 pandemic, whereby falsehoods on social media encouraged mistrust in health authorities (Bonnevie *et al.*, 2021). Statistical probabilities and medical jargon published by health organizations don't provide as clear an answer as the strong opinions of other concerned individuals active on online discussion forums. The different points of view go beyond linguistic differences. When a public organization deals with a problem or complaint, it is often considered a one-off event in an otherwise successful operation (Canel & Luoma-aho, 2019). On the other hand, because negative reports are viewed as more credible than positive ones (Chen & Lurie, 2013), citizens have the impression of recurrent failures. They are more likely to remember public sector failures and develop a narrative of ongoing problems, which strengthens the negative attitude toward the public sector. However, studies also suggest that citizens may still, despite general negative attitudes about the public sector, have an appreciation for individual organizations (Thijs & Staes, 2008).

A fundamental democratic obligation of the public sector is to report decisions and actions to the public (Liu *et al.*, 2010). True accountability means seeking out dialogue with citizens. Canel and Sanders (2012, 2013) argue that most democratic countries are being submitted to higher requirements for transparency, which encourages the adoption of innovative ways of establishing relations with citizens. Many public organizations still rely on conveying one-way communication through their agency websites, and press releases to traditional media, or advertising/campaigns to communicate information, but these channels do not match citizens' media use habits anymore, especially if citizens need specific information (Brainard & Edlins, 2015; Canel & Luoma-aho, 2019; Norris & Reddick, 2012; Sanders & Canel, 2013). Many governmental organizations focus on sending general information or forwarding people to other websites or platforms if citizens have queries. However, public organizations should interact with citizens, where citizens prefer to be.

Incorporating social media can be considered an extension of a long wave of digitization efforts by governments (Bretschneider & Mergel, 2010). The e-government literature, which studies the use of government agencies of information technologies (such as the Internet), has long been interested in how better information access can stimulate relationship-building (Hung *et al.*, 2020). The nature of social media that allows for two-way dialogs serves as an important key to attain higher stages in Palvia and Sharma's (2007) five stages of e-government implementations (emerging, enhanced presence, interactive presence, transactional presence, and networked presence). A unidirectional interaction on social media at best falls in the first two stages. Good quality of communication, social interaction, and responsiveness are vital elements for the higher stages that emphasize collaboration and engagement (Hung *et al.*, 2020; Lee & Kwak, 2012). Utilizing existing social media platforms allows for a low-cost alternative to creating government-owned initiatives (Hung *et al.*, 2020). Furthermore, the relative ease of use of Twitter, Facebook, or others appeals to a wide range of citizens with varying levels of technical skills.

Interestingly, there is a steady trend of public organizations adopting individual citizen-centered approaches to public sector communication (Alon-Barkat, 2020; Bourgon, 2009; Canel & Sanders, 2015; Luoma-aho & Canel, 2016; Wæraas, 2014). Different programs, for example, the Open Government Directive in the USA, seek to use the Internet to improve relationships between citizens and the state (Lee, 2021). Similarly, the European Union has put digital transformation high on the agenda. Ursula von der Leyen, president of the European Commission, said "We must now make this Europe's Digital Decade so that all citizens and businesses can access the very best the digital world can offer." (European Commission, 2021a). The Digital Europe Programme with 7.5 billion euros or the Digital Compass framework are aimed at empowering people and businesses in a human-centered and sustainable way (European Commission, 2021a, 2023).

The topicality of the digital transformation is also reflected in initiatives from Member States of the European Union. For example, the different governments in Belgium have also established several programs that should improve the way citizens engage with the Government. The list includes, but is not limited to, 'Flanders Radically Digital 2' (Digitaal Vlaanderen, n.d.a; Van der Linden *et al.*, 2022), Sandbox Flanders prototyping platform (Digitaal Vlaanderen, n.d.b), Contract of Administration' of Wallonia (Wallonie service public SPW, n.d.), Walloon Digital Agency (Digital Wallonia, 2021; European Commission, 2021b), The Brussels Capital region's 'Easy Way' (easy.brussels, n.d.a), IRISbox virtual counter, (easy.brussels, n.d.b), the federal 'Digital Wallet' (FOD Kanselarij van de eerste minister, 2023) and the Digital Open-network (European Commission, 2021b; FOD BOSA, 2023). As a result, 88% of Belgians aged 16-74 used the Internet for interactions with public authorities on websites or mobile applications in 2022 (European Commission, n.d.). This is an increase of 22 percentage points compared to 2020.

Many government organizations have, on top of general e-government initiatives, also invested in an active presence on social media (Alon-Barkat, 2020; Mergel, 2016; van Dijk *et al.*, 2015; Wong *et al.*, 2021). As of 2012, more than 90% of state and local government organizations in the United States are using at least one social media tool (Mergel, 2015). Mabillard and Zumofen (2022) studied if Belgian municipalities with over 10 000 inhabitants used Facebook, Twitter, or Instagram. While 97.5% of studied municipalities were registered on Facebook, only 62.1% were present on Twitter.

Moreover, the difference is especially outspoken if you consider active accounts. Facebook is actively used by 97.3% of the municipalities. However, just 24.2% of the municipalities had an active account on Twitter. Instagram, with 61.3% registered users and 50.3% active users falls in between both platforms. Although this study does not discuss the strategy used (top-down centered one-way communication or bidirectional communication), it does show that, at least for municipalities, only a small part of the potential powers of social media are being used. Although a start, true bidirectional interactions by more public organizations may prove desirable to address some of the obstacles between the public sector and citizens. Increased communication efforts have tremendous potential to succeed where other reforms have failed to bridge the gap between the state and individuals.

With the challenges and opportunities for communication between public organizations and citizens established, the following section starts with defining public sector communication and subsequently discusses the current state of the literature. Public communication plays a vital role in several intangible assets of public organizations, such as satisfaction, trust, reputation, legitimacy, social or intellectual capital, and citizen engagement. However, we focus only on satisfaction and reputation. Communication offers a great opportunity to build on intangible assets that benefit both citizens and public organizations, potentially improving the relationship between citizens and the public sector. Following a short review of the literature on the two intangible assets studied in this dissertation, we discuss the research questions and theoretical frameworks. The introduction ends with the selection of a suitable social media platform and a public sector organization.

State of the art

Defining Public Sector Communication

Despite the huge potential for improving the relationship between citizens and the public sector, research on public communication remains limited (Canel & Luoma-aho, 2019). However, this does not mean it is a new academic interest; McCamy already published a book chapter on external communications by public administrators in 1939 (McCamy, 1939). Different scholars have referred to our central concept, or aspects of the concept, in inconsistent wordings, for example "Administrative communication" (Garnett & Kouzmin, 1997), "Public sector branding" (Wæraas, 2008), "Public agency communication" (Avery *et al.*, 2009), "Public relations in public administration" (McCamy, 1939), "Government information management/provision" (Gelders, 2005), … [1] In this dissertation, we use the expression "public sector communication" (or the shorter "public communication"), which was first coined by Graber in 1992 (Graber, 1992).

Unfortunately, Graber did not provide a definition of public sector communication. Instead, she discusses the public sector and communication separately. For communication, she draws on the classic communication model established by Lasswell and subsequent scholars with sources, messages, channels, receivers, effects, and feedback). Canel and Luoma-aho (2019) recently established a definition by studying a wide range of academic sources (including those using different terminology) and professional practices (for example, a contribution from the New Zealand government). They understand public sector communication as:

> *"Goal-oriented communication inside organizations and between organizations and their stakeholders that enables public sector functions within their specific cultural and/or political settings, with the purpose of building and maintaining the public good and trust between citizens and authorities." (Canel & Luoma-aho, 2019, p. 33)*

This definition does not limit what a public organization is. It could refer to organizations owned/controlled by the state or organizations involved in the provision

[1] For a full overview of used nomenclature, see Canel & Luoma-aho (2019).

of public services with more autonomy (such as Quango's[2]). Furthermore, it intrinsically links communication to the creation of values. The authors explicitly mention building and maintaining trust between citizens and authorities as a purpose. However, scholars have theorized and proven the benefits of communication to several other assets besides trust (for example reputation, satisfaction, citizen engagement, etc.) (Canel & Luamoa-aho, 2019). Hence, in this work, public communication is seen as intentional communication (usually about service delivery) between organizations and citizens, with the aim of improving the relationship between the public sector and citizens by fostering intangible assets. Public communication is conscious and strategic and is especially relevant for service customers. Yet, in this dissertation we shy away from regarding citizens as mere consumers, as this implies a disconnect from the state. Instead, communication from public organizations can be relevant for all citizens, not only those who choose or are forced to make use of a public service.

Satisfaction and reputation as intangible assets

The dissertation focuses on two intangible assets. Intangible assets refer to nonphysical realities (as opposed to buildings, machinery, land, …) that provide nonmonetary value (Canel & Luoma-aho, 2019). These assets produce not only competitive advantages, but their impact is also social (enhanced public participation, empowering citizens, increased engagement, …). Well-established intangible assets will spill over to economic benefits, maintaining and attracting more business. However, intangibility is especially relevant for public organizations for different reasons. In contrast to the private sector's main objective of profitability and value for shareholders, public organizations predominantly have nonmonetary aims (Cinca *et al.*, 2003). Furthermore, the public sector predominantly works with intangible resources. Instead of capital, raw materials, or machines, they require knowledge and human resources. Also, these assets enable organizations to become known for particular strengths, which will ultimately be to their benefit (Canel & Luoma-aho, 2019). More importantly, intangible assets increase flexibility and generate goodwill that can be carried into uncertain times (Longstaff &

[2] The acronym quango stands for quasi nongovernmental organization and usually alludes to agencies that have their own separate legal identity and operates with a high degree of autonomy and low control by political principals (e.g. a parent ministry) (Van Thiel, 2001).

Yang, 2008; Luoma-aho, 2005). When public organizations themselves face turbulence, intangible assets are one of the few available sources to ensure survival (Canel & Luoma-aho, 2019). Turbulence can arise or be amplified from interconnected individuals that share (true or false) information or experiences. Unpredictable changes pose less of a threat if relationships with citizens become stronger. An organization with established citizen engagement, trust, legitimacy, … will be better equipped to weather storms. These organizations are better able to respond to citizen needs (through a previously built relationship). Additionally, the advantages of solid intangible assets aren't just to ensure the survival of public organizations. There can also be benefits for citizens when confronted with external crises. Longstaff and Yang (2008) for example studied how society bounced back from a crisis such as natural disaster or terrorist attacks. A local population that had immediate access to a trusted source of information adapted more confidently and bounced back quickly from challenges. An organization that had built trust, ensured effective coordination and a quicker response to an emergency. Hence, investments by public organizations in intangible assets, such as trust, can produce societal resilience for the population, as well as organizational resilience for the organization itself.

Intangible assets depend on the perceptions held by both citizens and the organization itself (Canel & Luoma-aho, 2019; Meynhardt, 2009). Communication is crucial, not just in the generation of intangible assets but also in the mutual acknowledgment of perceptions. Open and transparent communication can help establish a common ground and understanding of each other's points of view (Canel & Luoma-aho, 2019). Operating under the illusion that the public sector's operating environment is predictable, that changes allow control, and that ad hoc adaptations suffice, will result in fragile public sector organizations (Bourgon, 2009). Ensuring thriving public organizations in the new era of networked, empowered public and real-time media requires antifragile communication (Luoma-aho, 2013). Canel and Luoma-aho (2019) identified five changes in public sector organizations to ensure this. The first change takes place inside the organization and puts a larger emphasis on employee engagement instead of "humans as resources". Only engaged public servants can authentically engage with others (Imandin *et al.*, 2014). Secondly, organizations should move from (individual) strategies to cultivating a strong internal culture which can guide actions to save time spent on dealing with specific procedures (Schein, 1985). The following three changes include outside stakeholders in listening, interaction, and expectation management. The third change concerns a shift from messages to listening. Public organizations rarely listen to citizens, and attempts are often limited to surveying citizens and stakeholders according to organizational needs (Macnamara, 2015, 2016). Listening (about for example the needs of citizens) is important in ensuring authentic interaction with citizens. The fourth change highlights the importance of going beyond attention. Attention alone isn't enough to guarantee that citizens share their views. Today, most public sector organizations still rely on a campaign that creates attention (Canel & Sanders, 2015). Authentic interaction requires ongoing collaboration and meeting needs (Tirkkonen & Luoma-aho, 2014). The final change deals with expectation management instead of reputation management. Public sector organizations should be able to anticipate citizens' expectations through ongoing interaction and monitoring (Luoma-aho & Olkkonen, 2016).

The dissertation is limited to two intangible assets: satisfaction and reputation. Citizen satisfaction, by far the most studied asset, is volatile and is built on expectations and experiences (Canel & Luoma-aho, 2019; Van Ryzin, 2006). It refers to citizens' pleasure levels (Oludele *et al.*, 2012). Basically, it is the extent to which citizens feel fulfilled, indicating whether their experience is pleasant or unpleasant. This asset is measured frequently by public sector organizations as it is easy to ask citizens to quantify a service (Holzer & Yang, 2004). Satisfaction has been linked with several benefits for society, organizations, and individual citizens (Canel & Luoma-aho, 2019). It contributes to better democracy, better life outcomes, social tranquility, productivity, positive word of mouth, increased employee efficiency, lower costs for public administrations because of fewer complaints, improved organizational operations, increased trust, more willingness to collaborate/contribute, and makes citizen's demands more flexible (Choy *et al.*, 2012; James, 2011; James & Moseley, 2014; Morgeson, 2014; Oliver, 2010; Putnam, 1993; Thijs & Staes, 2008). Dissatisfaction, an extremely negative feeling, is often a less passive state than satisfaction and has been linked with certain behaviors such as voicing complaints or attempting to terminate the relationship (Hirschman, 1970).

A lack of accessibility to public services is often listed as a source of dissatisfaction with public services[3]. Yet, the importance of communication in shaping citizen satisfaction is

[3] See for example the 2022 annual report by the Belgian federal ombudsman (Baele & Aass, 2022)

well-established (Riley *et al.*, 2015). Research demonstrates that publishing (absolute or relative) performance measures influence satisfaction (James & Moseley, 2014). As expected, good performance evaluations improve satisfaction, while bad performance indicators increase dissatisfaction. Furthermore, public communication can manage expectations, which is, besides the actual performance, a basis for satisfaction (Luoma-aho & Olkkonen, 2016; Olkkonen & Luoma-aho, 2015). Setting the right expectations about service deliveries is crucial for satisfaction over time. Moreover, communication enables organizations to highlight the most important factors for citizens to pay attention to while evaluating services (Sanders & Canel, 2013). Bidirectional interactions could even take into account the heterogeneity of individual preferences (which decide if someone is satisfied or dissatisfied). In addition, citizens are more satisfied with services closer to their reach relative to those further away or less concrete (Thijs & Staes, 2008). If information is lacking, satisfaction judgments are made based on impressions. Making an organization more tangible through communication about available services can ensure a higher degree of satisfaction.

Reputation, the second intangible asset studied in this dissertation, is defined as "a set of beliefs about an organization's capacities, intentions, history, and mission that are embedded in a network of multiple audiences." (Carpenter, 2010a, p. 33). Reputation is the aggregate of the perceptions of stakeholders (Wæraas & Maor, 2015). It is embedded in a social network of individuals and groups that assess organizations in a collective estimate (Carroll, 2016b; Nahapiet & Ghoshal, 1998). A good reputation is valued as it can be "used to generate public support, to achieve delegated autonomy and discretion from politicians, to protect the agency from political attack, and to recruit and retain valued employees" (Carpenter, 2002, p. 491). Additionally, some sector organizations can turn a better reputation into a financial advantage: it permits higher prices, ensures greater customer loyalty, boosts word-of-mouth recommendations, and can increase the budget (Canel & Luoma-aho, 2019; Carpenter & Krause, 2012; Fombrun & van Riel, 2004; Sataøen & Wæraas, 2016). Moreover, it leads to higher trust, more legitimacy, stronger citizen commitment, and overall satisfaction with an organization and its products or services.

As citizens constantly balance their own experiences and (conflicting) information about an organization, communication from the public organization might influence reputation (Canel & Luoma-aho, 2019). Information can be provided by media reports or other citizens, but also by the organization itself. However, information is often substituted by impressions. Masum and Tovey (2012) described our society as a "reputation society", where technology-enabled networks provide us with impressions about organizations. The different online networks, where people share, compare, and rank experiences with organizations, increase the importance of impressions (Canel & Luoma-aho, 2019). This puts more pressure on the reputation management of the public sector (Edelman & Singer, 2015). Public organizations must step into the digital networks to counterbalance (incorrect) impressions. The fundamental issue is often that citizens are unable to read and understand public sector organizations' choices. Picci (2012, p. 142) wrote that "the situation generally imposes a heavy cognitive load on citizens and opens the door for strategies of obfuscation of various types – unwarranted attribution of credit or blame, spin, bureaucratic delays, and downright propaganda. The necessary information may be available – indeed, thanks to the Internet, lots of information is available – but making sense of it is challenging." Public communication, as in engaging with citizens, can help citizens find and make sense of information.

Satisfaction and Reputation are not the only intangible assets that can be linked to communication. Canel and Luamoa-aho (2019) review the role of communication for six other assets: legitimacy, organizational culture, intellectual capital, social capital, engagement, and trust. *Legitimacy*, a judgment according to cultural norms and standards of an audience (Bitektine, 2011), is generated and maintained (as sense-making) through communication (Gordon *et al.*, 2009; Suchman, 1995). Furthermore, public sector organizations with greater visibility in the media have a stronger legitimacy (Davis, 2013; Fredriksson & Pallas, 2016). The *organizational culture* – the principles that encompass memories, values, assumptions, and expectations that make an organization (Cameron & Quinn, 2011) – is shaped by communication (to those outside), which, in turn, is dictated by the culture (Canel & Luoma-aho, 2019; Parker & Bradley, 2000). The intangible assets *intellectual capital* refers to knowledge and information that can be put to use to create value (Dumay, 2016). Vagnoni and Oppi (2015) documented the impact of communication in acknowledging the intellectual capital, which influences strategic management and ultimately the success of the organization. *Social capital* deals with "making connections among people, establishing bonds of trust and understanding, building community" (Putnam *et al.*, 2003, p. 9). As relationships are formed through interaction, communication is central for the social capital of an organization (Coleman, 1990; Henttonen, 2009; Luoma-aho, 2013; Van

Emmerik & Brenninkmeijer, 2009). *Engagement*, meaning the involvement of citizens, is studied extensively in public administration literature (for example, Heikkila & Isett, 2007; Yang & Callahan, 2005, 2007; Yang & Pandey, 2011). As with other assets, communication is a prerequisite for citizen engagement (Canel & Luoma-aho, 2019). Lastly, communication also helps in building *trust* in the public sector (Dervitsiotis, 2003; Hung *et al.*, 2004). Rawlins (2008) demonstrated that trust can be created by increased transparency (for example through the provision of information). *Trust* can be seen as the "willingness, within the context of uncertainty, to grant discretion to the other party (an organization, a leader, a citizen, and so forth) in the use of public resources for the provision of public services, from which a certain compliance, or at least a reduction in the desire to control, emerges." (Canel & Luoma-aho, 2019, p. 278). We decided not to focus on the abovementioned assets in this dissertation because we believe social media content will relate most to satisfaction or reputation. These are clearly linked to the performance of a specific public service. They refer to outcomes in society. Engagement, intellectual capital, and organizational culture are more a means to a different end. Satisfaction and reputation are also most clearly linked to a specific public service. Trust, social capital, and legitimacy go beyond the confines of a single public organization's performance. We know citizens mostly use social media to complain or express concerns about a specific public service delivery (see for example Méndez *et al.*, 2019 or Schweitzer, 2014).

Research

Research questions

Although the research in public sector communication has significantly expanded since the birth of Web 2.0, there remain large gaps in our knowledge as few studies have quantitatively measured the impact of (online) public communication in a natural, real-world setting. Previous studies overwhelmingly focus on how the government uses social media (Medaglia & Zheng, 2017). These studies look at the devised strategies, and the presence of public agencies or do a content analysis of the posts generated by public entities. The research in public administration literature on the effects of social media usage on citizens is underdeveloped and focuses only on limited types of effects (such as political activism, citizen empowerment, and trust in government). Future research should, according to Medaglia & Zheng (2017) and Schmidthuber & Hilgers (2017), dive into the complexity of social media user behavior and outcomes that go beyond counting the number of likes and comments on social media accounts. Although some (such as Das & Zubaidi, 2023 or Ho & Cho, 2017)[4] have since increased complexity, there remain plenty of untouched research questions and methodologies.

This dissertation set out to do just that by investigating the effects of public communication on social media with an innovative methodology. We will study a public organization that makes optimal use of social media as a way of interacting with citizens. Bidirectional communication is the terminology often used in the literature (see for example Hosseini *et al.*, 2018 or Lovari & Parisi, 2012) to distinguish it from traditional one-way communication, meaning communication from the public sector to citizens with little interest in establishing a reciprocal dialog. The novelty of social media is that it enables two-way interactions, transforming the role of citizens from passive consumers of government services to active co-creators (Bertot *et al.*, 2012).

The following overarching question informs this dissertation:

Does bidirectional public sector communication through social media improve the relationship between citizens and public organizations?

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[4] A discussion of these articles and more can be found in the literature section of chapter 3-5.

As noted in the first sections of the introduction, the poor relationship between citizens and the public sector might be partly attributed to the absence of strategic and planned communication. Technological advances, such as social media, allow for a more citizen-centered approach which could improve several intangible assets of public organizations. To help answer this general question, we devised three research (sub)questions. Each question is addressed separately in a chapter and utilizes its own data and statistical method.

The first research question set out to examine the direct effect of commencing with extensive online communication on social media sentiment about that public organization. In other words, can we observe a difference in social media messages posted by citizens before and after a public sector organization becomes an active social media communicator? Chapter 3 presents a regression discontinuity analysis to compare social media sentiment prior and post-public sector communication. Social media sentiment is determined by automated text analysis.

R1: What is the immediate effect of commencing with a bidirectional online public communication on social media satisfaction?

The second question goes beyond this by introducing time-series analyses (more specifically, VAR-models). While the previous research question looked at one moment in time (before and after the intervention), the next question looks at the interplay of several variables over a longer period of time with an attempt to predict future online sentiment. The first variable captures the intensity of public communication. We want to know whether more/less online public communication by an organization influences future social media sentiment (again measured with supervised machine learning) regarding the organization. Furthermore, as changes in social media perceptions can be influenced by variables other than public communication, this study adds traditional media (news articles) and an objective performance indicator (punctuality data) to the study. Again, automated text analysis was used to obtain the sentiment of newspaper articles. The objective performance indicator refers to a crucial quality characteristic of public service delivery.

R2: What is the effect of more or less online public communication on social media reputation when including traditional media and a performance indicator?

Lastly, we want to step away from social media sentiment and study general customers' perceptions. We address two connected questions. First, how important is communication for satisfaction with public sector performance? The previous research questions studied how social media sentiment is influenced by online communication. The last question is broader because it studies all customers, not just the Twitterers. The aim is to establish which variable (of which communication is one) increases/decreases satisfaction. Second, are customers who interacted with social media communicators from the organization more satisfied compared to customers with no social media exchange? This last part is the capstone to answer the overarching question. For this part, we surveyed 300 customers of the public organization every month for two years[5].

R3: Does (online) public communication significantly influence customers' satisfaction with public services?

[5] Some respondents were recontacted every 6 months, resulting in a panel structure. See the Methodology of Chapter 5 for a more detailed explanation.

Selection social media platform and public organization

Twitter

Social media are Web 2.0 applications that can be defined as "a group of Internet-based technologies that allows users to easily create, edit, evaluate and/or link to content or other creators of content" (Kaplan & Haenlein, 2010, p. 61). Social network sites were originally developed to connect with friends, but they have evolved into powerful tools for communication between friends, colleagues, retailers, service providers, customers, and others (Bonini & Sellas, 2014). This dissertation studies bidirectional public communication on one social media platform, namely Twitter. Twitter, a microblogging site launched in 2006, allows users to upload short updates, called tweets, on any topic on the sender's profile page (Cottrill *et al.*, 2017). Although the number of maximum characters in a tweet increased in 2017 from 140 to 280 characters, Twitter remained a place for brief thoughts. Only 12% of tweets were longer than 140 characters with 1% hitting the 280-character limit (Perez, 2018). These short tweets are shared with a network of followers who automatically receive the content on their homepage. Other users can like the post, reply to it, or share the tweet by retweeting. A tweet can contain images, and links to other content, but can also mention other users using the '@' symbol, followed by the specific username. Words preceded by a '#' symbol are known as hashtags and are used to assign a tweet to a specific topic (Chang, 2010). By clicking on these hashtags, users can track all the tweets posted about a specific topic. This makes trending topics possible. Another feature on Twitter is that users can also message each other freely in private.

Twitter has been growing significantly over the years. In 2022, there were almost 370 million monthly active users, sending 500 million tweets per day (Enberg & Konstantinovic, 2022). Twitter is an ideal forum to study our research questions because it allows interaction with large audiences and offers the possibility of live updates on services. Furthermore, sentiment analysis on entities (e.g., products, organizations, people, etc.) in tweets has become a rapid and effective way of gauging public perceptions for business marketing or social studies (Anastasia & Budi, 2016; Kanavos *et al.*, 2017; Méndez *et al.*, 2019; Permana *et al.*, 2017; Sahayak *et al.*, 2015; Schivinski & Dabrowski, 2016; Shukri *et al.*, 2015). This is partly because of the relative ease of access to Twitter data for analyses (Cottrill *et al.*, 2017). Also, within politics, numerous studies have tried to forecast, with varying degrees of success, election results based on Twitter sentiment (see Gayo-Avello, 2013 for a meta-analysis). O'Connor *et al.* (2010) for example demonstrated that Twitter sentiment towards politicians and political parties proves to be a leading indicator for important public opinion polls such as Gallup. Not surprisingly, many private sector companies already routinely and proactively use social media communication strategies to influence customer perceptions, such as satisfaction (James, 2011).

Although Twitter users are not a good representation of the general population, it is still particularly interesting for sentiment research. The younger, higher educated, and urban people that populate Twitter and other social media have a disproportionate impact on general public opinions towards public services, as their group includes relatively more opinion leaders and influencers (Karlsen, 2015; O'connor, *et al.*, 2010)[6]. Additionally, Twitter comments are public and accumulate into a searchable short-term text archive that even individuals without a Twitter account can search and access (Schweitzer, 2014). Moreover, it is a platform that brings together different kinds of audiences; journalists, politicians, service customers, and citizens all read, like, post, and react to each other through tweets. Especially journalists are very active on Twitter, which means Twitter content may exert a disproportionate influence on other, traditional media (Canter, 2015; Schweitzer, 2014).

Elon Musk acquired Twitter in April 2022 and rebranded Twitter as X (Conger, 2023; Conger & Hirsch, 2022). The launch of a new name and logo was met with criticism (Espada, 2023). The Twitter name and iconic blue bird logo have been used since 2006 and were embedded in popular culture (Conger, 2023). Consumers even referred to activities on the platform with a bird-related lexicon (like tweets and retweets). This dissertation will keep utilizing the old terminology (Twitter instead of X) for three reasons. Firstly, the studied timeframe (and hence the research data) was before the takeover by Elon Musk. Secondly, since October 2022, several changes have taken place (paid blue checkmarks, 4000 characters for subscribers, reinstating banned accounts, less censorship, different rules for academic research to acquire posts on the platform, an initial decline in active users, …). More changes, considering the aim of rebranding to an "everything app", are likely to occur (Conger, 2023). By referring to Twitter, it is less ambiguous what the policies were at the time the research was conducted. Thirdly, the

[6] See Discussion from chapter 3 on page 46 for a more extensive discussion on opinion leaders.

name Twitter is unlikely to disappear completely as some users insist they will stick to it (and the derivative terms such as (re)tweeting). Even more, for now, media outlets also call the company and its social media platform "X, formerly known as Twitter." (Conger, 2023).

Belgian Railway Company

To study the effects of public communication, this research focused on one public organization, the Belgian Railway Company (NMBS). We looked for an organization that fulfilled five criteria. To begin, the organization should be charged with a public service delivery. In contrast to organizations responsible for policy implementation or regulation, citizens come into direct contact with public service delivery regularly. There should be a need for engagement between citizens and the studied organization. The NMBS is a prime example of a public service provider. It is charged with passenger train transportation. The next two criteria are identifiability and evaluability. In order to properly assess the perceptions about public service delivery, service customers should be able to identify the organization responsible for good or bad performance and should be able to evaluate the service delivery (Bertelli 2016). NMBS fulfills the conditions of identifiability and evaluability[7]. It holds a monopoly regarding passenger train traffic and has a well-known name generally used by media and other actors. Moreover, its task is understandable, observable, and assessable in terms of quality for customers.

We also looked for an organization that does not operate in a highly politicized sector or country. An organization with a divisive *raison d'être* (for example, immigration) or a country where everything is a political issue complicates how people form perceptions and what role communication plays. Ideally, the organization should be evaluable on somewhat objective performances instead of political stances. We argue that the Belgian Railway Company does not function in a highly politized context, meaning customers typically assess performance based on quality characteristics (especially punctuality, see

[7] As discussed in the next chapter, the situation is more complex with the separation between the infrastructure management and the operator. While train passenger is still the responsibility of the NMBS, the infrastructure is managed by Infrabel. Hence, not all performance issues with passenger train traffic can be attributed to the NMBS. While citizens might be familiar with both companies, it is debatable whether they make a distinction between both if they asses their satisfaction with a train service.

NMBS, 2013, 2017) instead of ideological positions. Lastly, public communication should be a core strategy, and the organization should have an established social media presence. This last criterion is essential to measure the effects of online communication. This final criterion, being active on social media, is also fulfilled as the NMBS started with intensive public communication through Twitter in 2013 (NMBS, 2013). The large amount of Twitter activity[8] regarding the services of the NMBS by citizens and the NMBS itself further strengthens this claim.

There are two reasons the NMBS is well-placed in terms of generalizability. Research demonstrated that comparing semi-autonomous agencies between countries is complicated by differences in institutional contexts and differences in the translation of the agency idea (Moynihan, 2006; Pollitt *et al.,* 2001; Smullen 2010). Specific characteristics of public organizations differ between countries, and similar tasks are charged to different types of agencies (Verhoest *et al.*, 2021). However, Van Thiel (2012) categorized public-sector organizations of 21, mostly Western, countries into three types of agencies based on their formal legal features. She revealed that the railways, the national airport, the national broadcasting company, and to a lesser extent road maintenance and national museums have been corporatized (or privatized) in almost all studied countries. They are usually type 3 organizations, meaning they have their own legal identity separate from the state or their parent ministry (typically a private law corporation, company, or foundation) but are predominantly controlled by the government and are at least partially involved in executing public tasks. Secondly, the NMBS can be considered a critical case (Yin, 2009) for other public-sector organizations. If public communication does not affect customer citizens' perceptions in the case of the NMBS, being an easily identifiable and evaluable public organization with clear and well-known tasks and a lot of Twitter activity, then we may expect that the theory will also not hold for public organizations which do not have these characteristics. Hence, this organization is optimally fit to test our theory and hypotheses. If, however, an effect is found, this does not necessarily mean other public organizations will see positive effects of public communication.

[8] See Twitter on page 11 for more information.

Conceptual framework: Twitter Sentiment

This dissertation focuses on both satisfaction and reputation to measure the impact of public communication. The first article of the dissertation (see Chapter 3) adopts the literature on satisfaction. Consequently, the article treats the sentiment about a public organization on social media as a satisfaction measurement. The second article (chapter 4) utilizes reputation literature and treats Twitter sentiment as a proxy for reputation. This requires a more extensive explanation or even justification. How can Twitter sentiment be both satisfaction and reputation? In this subsection, we start with a small summary of the theoretical framework of each chapter. After that, we provide definitions of both concepts and highlight similarities and differences. Finally, we argue in favor of using Twitter sentiment as both satisfaction and reputation in this dissertation.

Chapter 3 is embedded in the literature on the performance-satisfaction gap. In recent decades, the implicit assumption of many public sector reforms has been that better performance will result in higher public satisfaction. Yet, this is not necessarily the case (Van de Walle & Bouckaert, 2007). There are two mechanisms that explain the performance-satisfaction gap. Firstly, there are several biases that shape satisfaction (Olsen, 2015). When citizens form their opinions about their satisfaction with public services, objective performance metrics play a limited role. The rational decision would be to be more satisfied when performance increases. Yet, in reality, our capacity for rational decision-making is bounded by psychological and cognitive limitations (Andersen & Hjortskov, 2015; Barrows *et al.*, 2016; Bellé *et al.*, 2017; Olsen, 2017; Simon, 1982). Common biases are negativity bias (propensity to overemphasize negative performance- see James, 2011), inadequate information processing (inability to find and process available information – see Sutcliffe & Weick, 2008), the use of information shortcuts (use of overall sentiment of peers towards the involved organization rather than actual performance data) and motivated reasoning (tendency to look for confirmation of one's beliefs – see James & Van Ryzin, 2017). Citizens might also hold anti-public sector biases that negatively skew the perceived quality of services (Marvel, 2015; Olsen, 2015; Van de Walle, 2018). Additionally, perceptions toward organizations are fragile as negative information is considered more credible and more reported in media than positive information (Chen & Lurie, 2013). Secondly, marketing research has further explored satisfaction and argues that it arises from citizens' comparison between their expectations and their actual or perceived experiences of the service (Oliver, 1981, 2010). The Expectancy-Disconfirmation Model (EDM) states that a performance exceeding expectation will lead to satisfaction (positive disconfirmation), while a performance that falls short will result in dissatisfaction (negative disconfirmation) (Oliver, 1981; Spreng *et al.*, 1996; Van Ryzin, 2006). Hence, citizens' expectations of services may significantly hinder accurate assessments of service quality. Communication plays a central role in both mechanisms responsible for low satisfaction. Many of the biases explaining the performance-satisfaction gap are related to information use/processing, and authority communication sets the expectations that guide satisfaction (Luoma-aho & Olkkonen, 2016). Research has demonstrated that communication (such as publishing absolute and relative performance measures) plays a central role in shaping citizen satisfaction (James & Moseley, 2014; Riley *et al.*, 2015). Furthermore, satisfaction with services close by citizens is often higher than satisfaction with public services further away or less concrete (Thijs & Staes, 2008). This means satisfaction can be improved by making public services more tangible.

Chapter 4 ties in with the public administration literature on reputation. The reputation of the public sector has been established over time and remains relatively stable (Luoma-aho, 2008). The public sector is associated with negative characteristics such as (excess) bureaucracy, slowness, unreliability, inflexibility, non-transparency, and inefficiency (Wæraas & Byrkjeflot, 2012). These negative reputational stereotypes persist, despite successful renewals and practices. Research indicates that even significant improvements and reforms (like mergers) may not have a noticeable impact on the organizational reputation (Luoma-aho & Makikangas, 2014), as public perception tends to overshadow even the sincerest efforts to improve. Evaluating the actual performance of the public sector is challenging for individual citizens, particularly when the service process is complex, as it becomes increasingly difficult to assess (Thijs, 2011). As a result, citizens rely on the associations (as listed above) with the whole public sector instead of judging every individual public organization separately (Luoma-aho, 2008). The crucial question for practitioners and scholars is how public organizations can improve their relationships with different audiences to achieve a positive reputation (Bustos, 2021). This dissertation suggests public communication strategies can help enhance reputation. Communication of an organization can limit the spill of negative overtones from the general public sector reputation (Canel & Luoma-aho, 2019). Communication can also aid in providing and sense-making of information, which is one of the core hindrances for citizens (Picci, 2012). Additionally, the current practices adopted by public organizations often prioritize communicating more urgent issues rather than their development and achievements, thereby exacerbating the difference in perception (Canel & Luoma-aho, 2019; Thijs, 2011). Personal experiences, emotions, and perceptions take precedence over performance reports. As argued in the State of the Art, reputation management in the form of extensive communication is required to balance, or at least engage with, impressions spread through online networks.

Both chapters examine the evolution of social media sentiment. The first article treats the sentiment about a public organization on Twitter as a measurement of satisfaction, while the second articles treat it as an assessment of reputation. It is important to note that these two conceptual frameworks are not opposites or irreconcilable alternative ways of thinking. Perceptions of citizens lie at the heart of both satisfaction and reputation. Research has demonstrated that intangible assets are interconnected[9]. For example, a good reputation provides legitimacy for an organization (Wæraas & Byrkjeflot, 2012) and builds citizens trust commitment, and satisfaction, which contributes to higher citizen engagement (Carroll, 2016a; Fombrun & van Riel, 2004). Increased citizens' trust also results in a higher reputation (Luoma-aho, 2007). Inversely, a negative reputation decreases trust, commitment, and engagement (Rothstein & Stolle, 2008). The next paragraph takes a closer look at the connection between satisfaction and reputation, which can help us build a conceptual model.

Citizen satisfaction refers to "happiness or contentment with an experience or experiences with the services (or goods, or process, or programs) provided by government bureaucracies and administrative institutions" (Morgeson, 2014, p. 7). Literature sometimes utilizes two types of satisfaction: service-specific and cumulative (Oliver, 2010). The first type of satisfaction is related to a specific service delivery. However, research addressing citizen satisfaction mostly refers to some overall collection of emotional experiences, not an individual experience. In contrast to reputation, satisfaction, especially the service-specific type, is a volatile sentiment. It can vary between citizens of the same area, and it can change over time (even for the same individual) (Thijs & Staes, 2008). Even with one service, citizens may be satisfied with certain aspects and dissatisfied with other aspects at the same time. Organizational reputation is a set of beliefs embedded in multiple audiences about an organization's

[9] For a full discussion on the relationship between intangible assets see Canel & Luoma-aho (2019), chapter 4.6.2., chapter 12.5 and chapter 12.6.

capacities, intentions, history, and mission (Carpenter, 2010). Hence, it is a multifaceted concept. Carpenter has highlighted four critical dimensions of an agency's reputation (Carpenter, 2010). The performative reputation asks whether the agency can do the job. It looks at the competence to execute its responsibility. The moral reputation looks at the agency's compassion, flexibility, and honesty. Does the agency protect the interests of its clients? The third, procedural reputation, questions if the agency follows normally accepted rules and norms, however good or bad its decisions. Technical reputation is the last dimension and asks if the agency has the capacity and skill required for dealing in complex environments, separate from its actual performance. Reputation, as described by Wæraas and Maor (2015), is stable and enduring.

Figure 1 visualizes a conceptual model that includes both types of satisfaction and the dimensions of reputation. It also proposes a hierarchical relationship between both concepts. The most volatile is the satisfaction specific to an experienced service. This is closely related to the perceived quality of the performance. These individual satisfactions cumulate in a more general satisfaction. In turn, we believe that these influence organizational reputation. In the long term, distinguishing between cumulative satisfaction and reputation is tough as both refer to an accumulated, overarching sentiment. Wæraas and Maor (2015) summarized that reputation is the aggregate perception of all stakeholders. High reputation, combined with low general satisfaction or *vice versa*, feels counterintuitive. Theoretically, it could occur if a citizen holds a reputation due to assigning more importance to a specific dimension of reputation (for example, moral dimension) while judging satisfaction on completely other elements. We argue that in practice, a difference would only occur if asked about particular events.

The figure utilized three different arrows. The full lines depict the most direct relationships. Based on the literature, we argue that service satisfaction feeds into an accumulated satisfaction. Furthermore, we postulate that satisfaction, especially with a service provider, mostly affects the performative reputation. Citizens are better able to judge performances of key responsibilities based on personal experiences/accumulated satisfaction than for example the technical capacities. If satisfaction improves, it will also seep into a more positive image of the organization's functioning. Although less common, it is not impossible for citizens to evaluate the moral, technical, and procedural reputation. Multiple experiences (for example also with customer services) can provide insights into the identity of an organization, which helps in formulating a more nuanced reputational judgment, taking into account all facets of reputation. This is shown by dotted lines in the figure. The last type, the striped arrow, indicates feedback loops. Although these effects are less outspoken, people might be more/less satisfied with a service if the organization has a certain reputation. If an organization has a bad reputation, even a slight hiccup in the service might be exaggerated and framed into a narrative of constant failures. On the other hand, reputation systems can also make expectations more realistic (Canel & Luoma-aho, 2019), which helps individuals to better deal with their experience, resulting in higher satisfaction. Previous research, as discussed in the state of the art in this chapter, has demonstrated that reputation will influence satisfaction with an organization and its products or services.

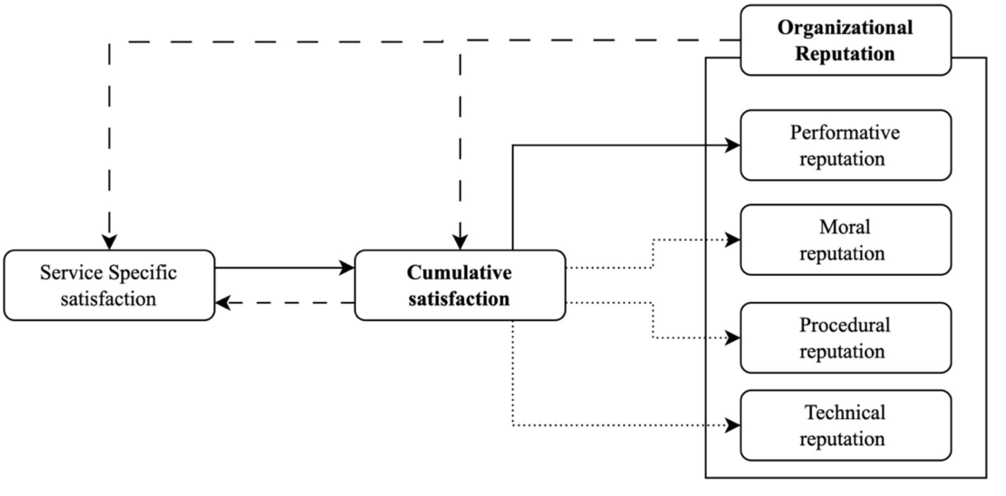

Figure 1 – Conceptual model of the interconnectivity of Satisfaction and Reputation.

In the previous paragraphs, we argued that both concepts heavily influence each other. They are interconnected. This is not surprising if you compare the antecedents of satisfaction and reputation. They share common elements. Canel and Luoma-aho (2019, p. 156) define public sector reputation as "a collective assessment of the organization by both the mediated and personal experiences of stakeholders that results from the stakeholders' expectations (…)". Hence, despite the stability of reputation, it originates from something volatile, namely expectations. Similarly, expectations and experiences form a crucial determinative factor for satisfaction (Canel & Luoma-aho, 2019; Van Ryzin, 2006). Our conceptual model did not include all variables (such as expectations, traditional media coverage, …) that have been proven to influence reputation or satisfaction, nor does it include the variable studied in this dissertation, public communication. The figure only shows how we, on a theoretical level, see the interconnectivity of the two concepts.

On a methodological level, both concepts are often measured by asking stakeholders direct questions through surveys or focus groups (Canel & Luoma-aho, 2019). Satisfaction scores usually refer to the percentage of citizens who declare to be satisfied with a service. Alternatively, when employing a scale, it can reflect citizens who have reported at least a certain point of satisfaction. It can be operationalized with a general evaluation or with multidimensional questions (Cappelli *et al.*, 2010). Reputation usually doesn't focus on all citizens (as citizens don't interact with all organizations), but on the stakeholders who are able to assess its performance, hence, the group the organization actually serves. Studies measuring reputation often employ various measurable factors or dimensions, such as Carpenter's (2010) four dimensions. However, the reputation literature lacks agreements on how to precisely measure reputation and its dimension (Boon *et al.*, 2021). This study deviates from the traditional methods of grasping satisfaction or reputation (except in the third paper) as we observe citizens' behavior online. Although uncommon, it is not unprecedented. Several reputation scholars (mostly from the private sector) have demonstrated how tweets can be monitored to grasp the reputation of an organization (Carrillo-de-Albornoz *et al.*, 2014; Grover & Kar, 2017; Milán, 2022; Rust *et al.*, 2021; Vidya *et al.*, 2015). Similarly, sentiment analyses on digital texts (Twitter, blogs, reviews,…) have been used, mainly by computer scientists, to measure satisfaction (Al-Otaibi *et al.*, 2018; Al-Sahar *et al.*, 2023; Anastasia & Budi, 2016; Chamorro-Atalaya *et al.*, 2022; Das & Zubaidi, 2023; Hopper & Urivo, 2015; Méndez *et al.*, 2019; Ng *et al.*, 2021; Rasool, 2019; Tusar & Islam, 2021).

A last justification, besides interconnectivity and methodological precedence, is more about pragmatism. The goal of this dissertation is not to determine the true nature of Twitter sentiment. A qualitative study might shed more light on this. However, the wide variety of content posted in tweets, let alone the plethora of different organizations active on Twitter, makes it difficult (if not impossible) to settle a debate between reputation and satisfaction. To further complicate matters, Twitter sentiment can also say something about citizens' trust in organizations, citizen engagement, social capital, or the legitimacy of public sector organizations. This research aggregates individual tweets and studies evolutions of perceptions over time. Aggregating individual perceptions isn't uncommon as reputation is defined as a shared understanding of an audience (Maor, 2022) and satisfaction scores typically refer to a percentage of citizens (Canel & Luoma-aho, 2019). We use the two theoretical frameworks as points of departure. Ultimately, Twitter sentiment is probably not completely reputation nor outright satisfaction. Nevertheless, we can still use the insights from these mature streams of literature to consider Twitter sentiment (calculated based on combining individuals' perceptions shared as tweets) as a potential proxy to study satisfaction or reputation. More relevant is the fact that public communication about available services contributes to citizens' perceptions. When information is lacking, judgment (either about satisfaction or reputation) is based on impressions, whereby the public sector always has a disadvantage. If nothing else, it can spark discussions about how we should approach social media data in both research fields.

Outline of the dissertation

The dissertation is structured as follows. Chapter 2 provides more background about the Belgian Railway Company. It addresses the history, the current situation, and problems. Moreover, this chapter details the public communication strategy of the Belgian Railway Company and ends with an insight into the content of tweets posted by citizens to the NMBS and how often/quickly they respond. Chapter 3 is the first academic paper and is devoted to the first research question. It studies the immediate effect of starting with online public communication on Twitter sentiment. This chapter considers tweets an expression of satisfaction regarding the public organization. By employing a regression discontinuity analysis, the study compares a satisfaction index before and after the NMBS became an active Twitter user. This is expended upon in Chapter 4 as more advanced time-series analyses search for daily and monthly dynamics between the intensity of public communication, the traditional media covering the NMBS, and the punctuality performance of the NMBS. This paper, centered around the second research question, builds upon the reputation literature and views Twitter sentiment as an articulation of a collective reputational judgment. The next chapter substituted Twitter sentiment for customer satisfaction to answer the final research question. Regression analyses demonstrate the importance of communication (both off- and online) for customer satisfaction. Finally, Chapter 6 concludes the dissertation by summarizing the main findings. It also provides an extensive reflection on the contributions of the articles, the limitations, and opportunities for future research.

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2

The case of the NMBS

History

The first railway line in Belgium, connecting Brussels and Mechlin, commenced operations in 1835 (Train World, n.d.). By 1843, the state-owned railway network had expanded to encompass over 500 km of tracks. Private companies also started investing in railways around 1840, resulting in a total of more than 2,000 km of tracks by 1870, with the state holding slightly over a third of the ownership. To gain control over concessions for political and economic reasons, the state-owned network had reached nearly 5,000 km of tracks by the onset of the First World War. However, the war inflicted substantial damage, rendering over 1,000 km of tracks unusable or completely destroyed.

Following necessary repairs, the National Railway Company of Belgium (NMBS) was established in 1926 as an autonomous government entity (Train World, n.d.). Despite operating autonomously and introducing shares to the market, the government maintained control by retaining a portion of the shares. The process of acquiring concessions, which had commenced in the nineteenth century, continued until the complete nationalization of the railway network in 1958. Additionally, the Second World War inflicted significant destruction, with more than half of the railway network being devastated by bombings. Post-war reconstruction efforts were undertaken, and a few years later, modernization plans were implemented.

The structure remained unchanged until the company split into three separate entities in 2005 (NMBS, 2013a, 2013b): the NMBS-Holding, which assumed responsibility for major stations, personnel management, and coordination among the new companies, the NMBS, tasked with organizing train services and maintaining train units, and Infrabel, which took on the roles of traffic control and infrastructure management. This new corporate structure aligned with the European Directive 91/440/EEC, which mandated the separation between infrastructure management and operator. In 2014, the structure underwent revision as the NMBS-Holding ceased to exist (NMBS, 2013b, 2014). All matters concerning train passengers became the responsibility of NMBS, including station management and customer communication. Infrabel retained its role as the infrastructure manager and took on the responsibility of communicating with train operators. HR Rail was established as the official employer of personnel for both Infrabel and NMBS.

International freight traffic was liberalized in 2003, and the liberalization of national freight connections followed in 2007 (NMBS, 2013b). Until 2011, the NMBS operated its own freight division known as B-Cargo. In 2011, it was transformed into NMBS Logistics, a private subsidiary of NMBS. Subsequently, in 2015, the company underwent further privatization, with a private investment company acquiring 69% of the shares (Meeussen, 2017). The company's name was changed to B Logistics, which was eventually rebranded as Lineas in 2017. NMBS still holds shares in the company but does not have a controlling stake in rail freight transport.

Current situation

Except for a few tracks on private property, all railway infrastructure is state-owned by Infrabel (NMBS, 2013). The national passenger transportation sector has not yet been liberalized, granting NMBS a monopoly in rail passenger services. On the other hand, rail freight transport has been fully liberalized since 2007, and nine private companies are currently operating in this sector (Federale Overheidsdienst Mobiliteit en vervoer, 2023). NMBS holds a minority stake in Lineas. The Railway company (in Dutch “Nationale Maatschappij der Belgische Spoorwegen (NMBS)” and in French “Société Nationale des Chemins de fer belges (SNCB)”, is a limited liability company under public law. It is one of Belgium's largest public sector companies, employing more than 16 500 (Full-Time Equivalent) people and realizing a revenue of 2192 million euros (NMBS, 2022). Furthermore, with 227.4 million domestic train travelers in 2022, it is an important aspect of transportation in Belgium. Although the company operates with autonomy, the federal government, as the main shareholder, appoints the members of the Board of Directors (NMBS, n.d.). The Board of Directors, in turn, forms an executive committee responsible for the company's day-to-day management. The responsibilities of the executive committee are defined in management contracts established between the Belgian government and the NMBS group (De Boeck & Peeters, 2018). The current management contract, in effect from 2023, focuses on more comfort (i.e. accessibility), better punctuality, and more trains to increase the number of travelers by 30% over ten years (NMBS, 2023).

Problems facing the NMBS

The NMBS has been grappling with service provision, labor agreements, and financial difficulties for several decades. The following text discusses the four main challenges for the Belgian Railway company, starting with the financial situation. In 2015, a benchmark study was conducted by McKinsey to identify problems and inefficiencies (De Smet, 2015). The study revealed that comparable companies have ticket revenues per passenger kilometer that are 52% higher than those of NMBS. Conversely, NMBS incurs costs that are 9% higher (NMBS, 2015). If the Belgian railway company were to match the efficiency levels of its European counterparts in maintenance, train personnel, and administrative burden, potential savings of around 110 million euros could be achieved. However, investments for improvements are hampered by the financial situation (NMBS, 2022). NMBS has a debt of 2275 million euros and ended with a deficit of 142.6 million euros in 2022 due to energy prices and personnel costs.

A second problem is the managerial culture of the NMBS. The Railway company is often described as a very unwieldy and dilapidated organization with a military hierarchy (De Boeck & Peeters, 2018). With almost 700 directors, the company is regarded as a bureaucratic monstrosity (Terrière, 2023). Sophie Dutordoir, the current CEO of NMBS, said at her appointment that the NMBS should be "run like a normal company". Despite (theoretical) autonomy, high political interference impedes fluent working. For decades, political appointments were commonplace. Additionally, governments didn't want to hand over responsibility (which is very apparent in building projects), meaning almost all decisions passed the federal government. This can also be explained by the fact that the previous contract between the government and NMBS wasn't renewed since 2008 because the government parties couldn't agree on several chapters (for example the prices). The new management contract might improve the situation as it details the goals and tasks for the next ten years (NMBS, 2023). Another persistent managerial challenge is the rivalry between NMBS and Infrabel (De Boeck & Peeters, 2018). Both organizations have their own budget and stakes, resulting in malfunctioning collaboration.

Punctuality, or lack thereof, is a third challenge for the NMBS. Belgian trains often experience delays. The official data indicates that in 2022 89.2% of trains arrived on time (NMBS, 2022). However, these official punctuality figures do not provide a comprehensive view for several reasons. Firstly, the punctuality of domestic train services is measured at the final destination and if the train passes through the Brussels North-South connection, at the first station of that connection (Infrabel, n.d.a). Delays that are resolved during the journey and delays between Brussels North and Brussels South are not considered in the calculations. Secondly, according to the NMBS and Infrabel, a train is considered on time if it has a delay of less than 6 minutes. Considering only trains with less than one minute of delay (thus truly 'on time') presents a different perspective (Delbeke & Poppelmonde, 2020). In 2019, slightly over half of the trains (53.7%) arrived at their final destination without delay. Thirdly, the percentage does not consider the passenger load. During the morning and evening rush hours, punctuality drops to approximately 45%, meaning less than half of the busiest train rides occur without delays. The Platform of Rail Infrastructure Managers in Europe (PRIME) regularly conducts performance benchmarks (PRIME, 2022). Based on data from 2016 to 2020 for 19 European countries, they demonstrated that the punctuality of the Belgian passenger trains is second to last after Italy. The lack of punctuality is caused by a wide array of incidents: technical malfunctions, weather conditions, suspicious packages or bomb threats, derailments, copper theft, strikes, accidents, strikes, construction works, … (Infrabel, n.d. b). The NMBS is only responsible for around 36.6% of delays. So-called third parties (39.1%) and Infrabel (19.8%) are the other main perpetrators of delays or cancellations (Arnoudt, 2024; Infrabel, n.d.c).

Finally, the NMBS faces persistent low customer satisfaction. During the COVID-19 pandemic in 2020 and 2021, there was an unprecedented increase in satisfaction levels (Michiels, 2023), with only around 25% of respondents expressing dissatisfaction. However, a survey conducted in 2022 revealed that 31% of customers were dissatisfied, which, although an improvement compared to the 40% dissatisfaction rate in 2018, indicates there is still room for further enhancement. However, this trend is likely to continue. In 2023, Ombudsrail, the ombudsman service for rail passengers, already reported an increase of 22% in general complaints and 34% in complaints about delays and cancellations (Muylaert, 2023). Passengers are generally most satisfied with the NMBS personnel and the purchase of the ticket. On the contrary, punctuality, ticket prices, and information-sharing are rated the worst (De Boeck, 2018). Most relevant for this study is the low satisfaction (52% in 2018) with the provision of information (European Commission, 2018). This means there is still ample enhancement possible concerning communication. Low satisfaction with rail services is not only a challenge for

Belgium; most public sector railway companies in the EU don't satisfy customers. In a Eurobarometer of 2018, Belgium scored 25.9 on an overall satisfaction index (between 0 and 30), which is only a bit higher than the EU average of 25.4 (European Commission, 2018). Improving customer satisfaction and decreasing punctuality are two explicit goals in the new management contract, which introduced a system allowing financial penalizations or rewards (Michiels, 2023; NMBS, 2023). If the NMBS fails to meet certain performance indicators, it can lose up to 5 million euros in funding, but if it does achieve them, there is a bonus of 5 million euros.

Twitter strategy

Many public transit providers have moved to social media, with Twitter as the most popular platform, to maintain active lines of communication with riders (Bregman, 2012; Chan & Schofer, 2014; Collins *et al.*, 2013; Liu *et al.*, 2016). Some cities (such as Go Transit in Toronto) even have a Twitter account for each major route (El-Diraby *et al.*, 2019). A presence on social media is particularly interesting during disruptions (such as delays). These situations generate a lot of social media activity as travelers demand real-time relevant information to cope with the uncertainty and frustration (Cheng, 2010; Diaz *et al.*, 2021; Harazeen, 2011; Pender *et al.*, 2014; Transport Focus, 2015). During unplanned disruptions, riders have three informational needs: an accurate prediction of the length of delay, the reason for the delay, and alternative travel options (Cottrill *et al.*, 2017; Pender *et al.*, 2014; Transport Focus, 2011; Yates & Paquette, 2011). Transit agencies use different styles of communication. Some use an "interactive" style that entails two-way communication with individual commenters (Schweitzer, 2014). By contrast, one-way communication, or blast communication, is the dissemination of information directed from the agency outwards with little individual interaction.

Due to the NMBS frequently facing strong and negative public opinions, the organization is trying to enhance the customer experience. Since 2013, one of the key strategies employed to achieve this objective has been intensive public communication through Twitter, which continues to be a central approach (NMBS, 2013a, 2018). Twitter, a social networking platform, offers various avenues for organizations to engage with the public. Firstly, the organization can post tweets, which are messages published on Twitter that may include photos, videos, links, and text. These tweets appear on the home timeline of their followers, who have chosen to subscribe to their Twitter updates. Secondly, Twitter users can send direct messages, which are private messages exchanged between two Twitter accounts and are not visible to the public. Lastly, an organization can respond to other tweets, whether they are public messages or not, without requiring mutual followership.

In 2012, before the NMBS became a Twitter user, 91 400 (meaning around 250 each day) tweets were posted that mentioned the company (De Vos, 2013). This prompted the NMBS to create a team of ten people to provide information on the platform from the 24th of October 2013 onwards (Tlb, 2013; Van Damme, 2013). Currently, the Dutch-spoken Twitter account of the NMBS has almost 65 000 followers, while the Francophone account has around 50 000 followers. You can contact them on Twitter by adding "@NMBS" or "@SNCB" respectively, in a tweet. Their active presence is demonstrated by the large amounts of tweets posted by the organization; in total more than 275 000 Dutch tweets have been posted since starting public communication. In 2018, they published 3721 original tweets with general announcements, usually about delays and their reason (construction work, accidents, copper theft, people walking on tracks, technical difficulties, ...). In the same year, they also wrote 3 916 replies to other tweets. These tweets address a more comprehensive range of issues. The railway company also has two substantially smaller accounts focused on international travel, NMBS_Int and SNCB_Int.

1000 random Dutch-spoken tweets posted between 2014 and 2019 aimed at the NMBS were coded to provide more insight into the tweets. We listed the topics of the original tweets, the response rate by the NMBS, the response time, and whether the reply was helpful. Figure 2 provides an overview of the topics. Almost 52% of tweets with "@NMBS" were questions. Most questions were about the schedule of the trains and delays or cancellations. Complaints, mostly about delays/cancellations or general service, were the second largest group of tweets (34%). It is common for people to use social media as a medium to express their anger, frustrations, and negative sentiments (Das & Zubaidi, 2023; Schweitzer, 2014; Méndez *et al.*, 2019). 7% of tweets were compliments about personnel, the trains, the schedule, or general service. The remaining tweets belong to general announcements and a residual category. General announcements included tweets from people who wrote about buying a ticket or taking the train for an event. It also includes tweets addressing fellow travelers, for example, warning them about pickpockets. Finally, the residual category consisted of tweets wishing the railway company a good morning or a happy holiday. It also contains humoristic tweets, often funny anecdotes about the NMBS and (political) debates. This last subcategory is so limited because news articles and discussions are not directed at the Twitter profile of the NMBS. Instead, they often employ the hashtag, used on Twitter to index keywords or topics, #NMBS.

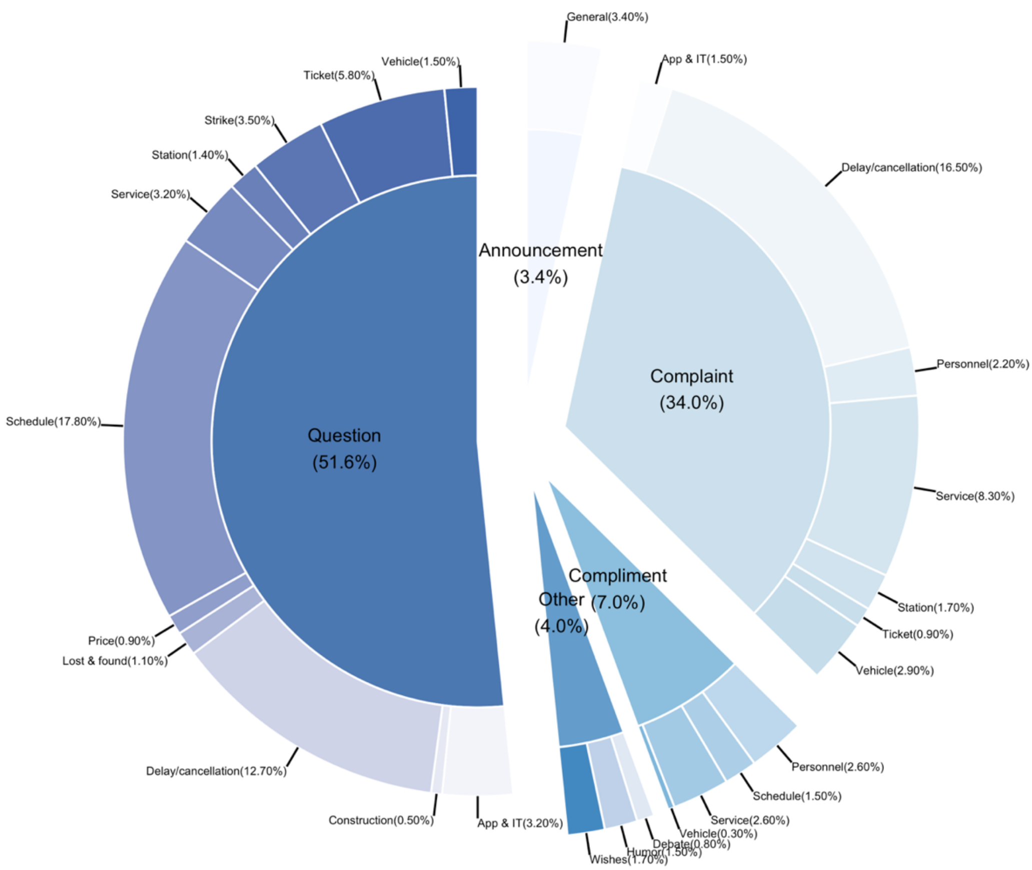

Figure 2 – The topics of 1000 random Tweets posted with "@NMBS"

	Response (%)
All topics	68.8
Question	94.4
Complaint	44.7
Compliment	34.8
Other	26.9
Announcement	36.4

Table 1 – Response rate to tweets according to the topic.

The Belgian Railway Company does not respond to all tweets. Of the 1000 random tweets, they replied to approximately 69%. This general percentage conceals much variation depending on the topic. Table 1 illustrates that the focus of the social media team of the Railway Company lies in answering questions. Complaints, which are often formulated in a rude manner, only got a reply in about 45%. Compliments, announcements, and the residual category only sometimes get a reply, which makes sense as these tweets do not require a reaction. Considering the importance of answering questions, we coded whether the NMBS was able to assist, merely gave a referral, or wrote something besides the question. We deemed approximately 79% of the replies helpful. Finally, the speed of responses was considered as well. As shown in Figure 3, if the NMBS comments on a tweet, they do it remarkably fast. About half of the replies were posted instantly (maximum five minutes after the original tweet) and nearly 80% of responses followed before 15 minutes. Answers that took more than five hours were partly due to original posts tweeted late in the evening or at night.

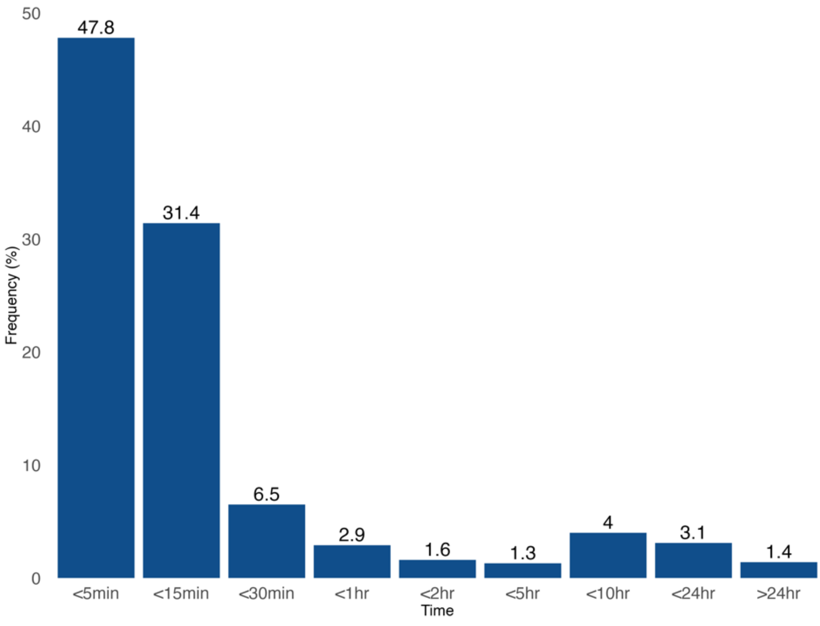

Figure 3 – Response time by the NMBS to tweets.

This chapter demonstrated that studying the effects of the Belgian Railway Company's public communication is appropriate. This large and well-known public service provider has an extensive Twitter strategy to interact online with passengers. Although some challenges, such as financial, managerial, and punctuality issues, currently faced by the NMBS cannot be solved with public communication, other shortcomings can be partly remedied with online accessibility. The persistent low customer satisfaction can be tackled by better (online) communication. As information-sharing is one of the lowest-rated characteristics of the railway company, an extensive communication strategy has the potential to improve overall satisfaction. Since 2013, four official accounts have amassed quite a lot of followers through which they assist travelers. Most tweets addressed to the NMBS can be categorized as questions and complaints about the schedule, delays, tickets, staff, … Overall, the NMBS replies to almost 70% of tweets. They are especially active in answering questions (approximately 95% response rate). Furthermore, the NMBS speedily provides answers, usually within minutes of the original tweet. Hence, the Belgian Railway Company has successfully enacted a Twitter strategy that allows for reciprocal interaction with citizens.

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Closing the performance-satisfaction gap with public communication. A pretest-posttest study of the Belgian railway company's Twitter account.

Steven F. De Vadder, Jan Wynen, Koen Verhoest & Wouter Van Dooren
This chapter is currently under review.

3

Abstract and keywords

Better performance does not always lead to higher citizen satisfaction. Academics have argued that this so-called performance-satisfaction gap is often due to a lack of accurate information. Introducing social media offers opportunities for public sector organizations to communicate information to users directly. Especially Twitter has become an essential medium for public organizations to inform and interact directly with service users. In this study, we hypothesize that when controlling for actual performance, starting with online public communication on Twitter will positively affect satisfaction (measured as Twitter sentiment). Using the case of the Belgian railway company, we implement a quasi-experimental pretest-posttest design from 2010 to 2018. A significant reduction in negative tweets could be observed after 2013 when the railway company started communicating directly on Twitter. This research brings new insights into the effectiveness of public communication through social media while controlling for an objective performance indication. Furthermore, this study employs a novel method with supervised machine learning-based classification of tweets.

Keywords
Expectancy-Disconfirmation Model, public communication, citizen satisfaction, railway services, Twitter, regression-discontinuity design.

Introduction

Paradoxically, improving public services does not always result in higher citizen satisfaction with these services. Several studies have identified a performance-satisfaction gap (Ho & Cho, 2017; Kelly, 2003; Kelly & Swindell, 2002; Swindell & Kelly, 2000; Van de Walle & Bouckaert, 2007; Van Ryzin, 2013). For example, Kelly (2003) found no relationship between aggregate measures of fire and police service performance and citizen satisfaction with those services. More recently, Ho and Cho (2017) established that a crime reduction did not lead to increased satisfaction with police services. Fellesson and Friman (2012) demonstrated that many countries have invested substantially in public transportation to make it a viable alternative to private cars. However, increased investments aimed at improved service delivery did not lead to a corresponding increase in demand or satisfaction. Research on the mechanisms that drive the performance-satisfaction gap remains scarce. This article reports on a study of how better information (i.e., public communication on Twitter) influences satisfaction (i.e., Twitter sentiment).

A better understanding of how perceptions of public services are shaped is essential in the context of the rising distrust or disconnect of citizens in the public sector (Ho & Cho, 2017; Lee, 2021; Mettler, 2018; Stipak, 1979). More direct communication by public organizations to their service customers and the wider public can be a remedy against a worsening relationship between the state and citizens (Alon-Barkat, 2020). The hope is that more significant investments in direct government communication to citizens will mitigate the tendency of many citizens to have implicit negative attitudes towards the public sector. Similarly, Swindell and Kelly (2000) have argued that citizens' lack of satisfaction is often due to a lack of accurate information. Hence, public communication could mitigate the performance-satisfaction gap.

The Internet offers a wide range of public communication strategies. Online communication can be a means to foster more interaction, solicit citizen participation, and facilitate a more diffuse consumption of information, all at a lower cost to citizens and the government (Lee, 2021). The online interaction between state and citizens can take many shapes, from a unidirectional flow of information from the government to users or citizens to complex schemes of interaction between citizens and between citizens and the government (Chadwick & May, 2003). Interaction between public organizations and citizens has several advantages. Public organizations tend to be more aligned with users' interests when they act upon user feedback, which may result in better staff-user relations and even higher job satisfaction on the part of frontline workers (Kowalski *et al.*, 2017).

In this study, we focus on the role of public communication, meaning communication by public organizations to their service customers and the wider public about their service delivery. The underlying assumption is that information influences behavior and attitudes/dispositions (Im *et al.,* 2014). Changes in the media environment, especially the introduction of social media, have reshaped citizen-state relations. The traditional forms of mass media are supplemented by tools of direct communication with the public. Social media (and public communication through it) holds challenges and opportunities for government agencies (Im *et al.,* 2014; Lee, 2021). Research on environmental public services in China demonstrated that consuming new media as a primary source of information, contrary to traditional media, negatively impacted public service satisfaction (Hu *et al.*, 2019). Interestingly, Im *et al.* (2014) found similar results but added an important nuance. The adverse effects can be moderated through citizens' increased use of e-government. As such, adapting methods of coordinating information flows and involving citizens in governmental processes through the Internet becomes an important point of interest for Public Administration practitioners.

While a substantial body of research acknowledges the effect of general public communication on citizens' attitudes toward government (Alon-Barkat & Gilad, 2017), few studies have empirically measured the impact of *direct or bidirectional* public communication through social media (Yang & Anwar, 2016). We investigate what happens to Twitter sentiment when a public service starts with a public communication strategy on Twitter, focused on reaching and interacting with individual citizens. We report on a case study of the Belgian railway company's Twitter sentiment before and after the start of intensive public communication on Twitter in 2013. We analyse the sentiment of tweets about the Belgian railway company with a quasi-experimental pretest-posttest research design while controlling for changes in the actual performance with data on the punctuality of passenger trains. With the pretest-posttest design, we can isolate the effect of the public communication campaign to suggest a causal claim. Furthermore, this study employs a novel method with supervised machine learning-based classification of tweets.

In the paper, we first examine a theoretical framework, the Expectancy-Disconfirmation Model, which provides a better understanding of citizen satisfaction with public services by taking account of citizens' prior expectations. Next, we discuss the empirical evidence for the Expectancy-Disconfirmation Model and identify existing research on public communication, satisfaction, and the use of social media by public organizations. We also review public transportation literature that has already studied social media data. After that, we report on the methodology of our study, including some more information about the case study, the Belgian Railway Company and an explanation of the machine learning used. Finally, we present and discuss our findings.

Literature

Citizen satisfaction: the Expectancy-Disconfirmation model

The Expectancy-Disconfirmation Model (EDM) has become the primary framework for explaining citizen satisfaction with public services (Zhang *et al.*, 2021). It originated from research on customer satisfaction with private sector goods and services and introduced insights from psychology (such as the cognitive dissonance theory) in the field of public administration (Harmon-Jones & Mills, 2019; Zhang *et al.*, 2021). While prior work investigated external determinants of satisfaction, such as service characteristics or demographic variables, EDM shifted the focus to citizens' expectations about the given product or service (Van Ryzin, 2006). Satisfaction, in the EDM, is defined as a citizen's summarised judgment about a product or service. This judgment depends on their frame of reference and the perceived performance of that product or service (Oliver, 1980). This frame of reference can be viewed as a standard against which comparisons are made. Expectations, what individuals think either will or should happen, are generally responsible for this referent (Oliver, 2010). The discrepancy between the anticipated quality of the good or service and the quality experienced can be positive or negative. A performance exceeding expectations will lead to satisfaction (positive disconfirmation), while a performance that falls short will result in dissatisfaction (negative disconfirmation) (Oliver, 1980; Spreng *et al.*,1996; Van Ryzin, 2006).

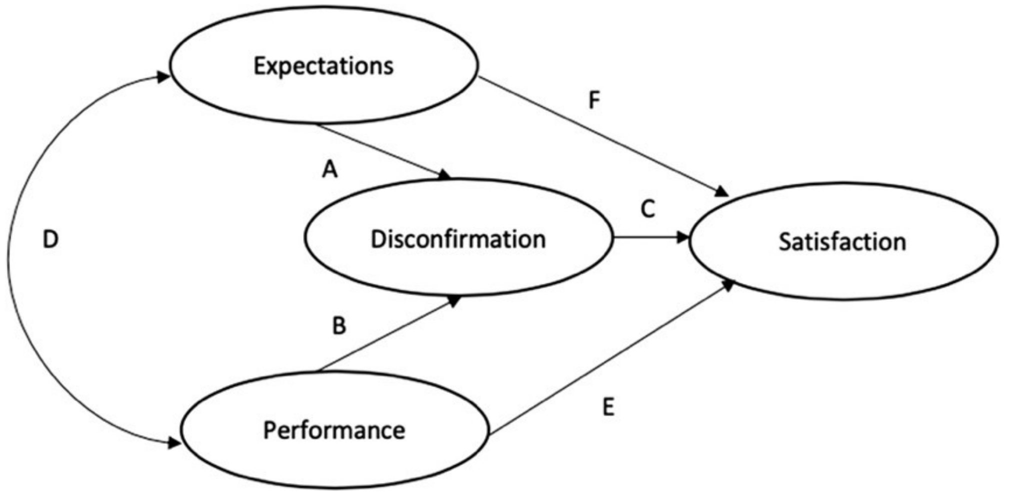

Figure 4 – The Expectancy-Disconfirmation Model by Van Ryzin (2004)

Figure 4 illustrates the complete Expectancy-Disconfirmation Model (Grimmelikhuijsen & Porumbescu, 2017; Van Ryzin, 2004, 2013). Both expectations and performance determine disconfirmation (links A and B). All else equal, a higher performance is hypothesized to increase the chance of positive disconfirmation, whereas higher expectations are hypothesized to increase the likelihood of negative disconfirmation. The core of EDM entails that this disconfirmation is positively related to satisfaction (link C). In other words, high performance is more likely to exceed expectations, leading to high satisfaction. Higher expectations can lead to negative disconfirmation and less satisfaction because the expectation is less likely to be exceeded, even if the performance is high. This model assumes that expectations and performance are correlated (link D). Performance can also directly and positively affect satisfaction (link E), implying that performance matters in some absolute sense. Finally, expectations influence satisfaction (link F) when citizens cannot judge the performance or base their satisfaction on previously held expectations for reasons of reduction of dissonance or ego defensiveness (Oliver, 2010; Oliver & DeSarbo, 1988). For example, citizens' political orientations may influence satisfaction judgment regardless of other links in the model (Stipak, 1977). Subsequently, the direct effect of expectations can be positive or negative.

Marketing research has extensively tested the EDM model with different private-sector products and services (Oliver, 2010; Szymanski & Henard, 2001). Van Ryzin (2004) was the first to provide evidence for the public sector supporting the model for citizen satisfaction with New York City government services. Subsequent research further confirmed the expectancy-disconfirmation theory. Citizens judge public services not only on experienced service quality but also on an implicit comparison with prior expectations (James, 2009; Morgeson, 2012; Poister & Thomas, 2011; Roch & Poister, 2006). Most of the evidence in public administration relies on surveys in which expectations and performance may be endogenous for satisfaction judgments (Van Ryzin, 2013). Recent randomized experiments confirm some of the causal claims of the relationships in the model (Grimmelikhuijsen & Porumbescu, 2017; James, 2011; Porumbescu, 2017; Van Ryzin, 2013). Zhang *et al.* (2021) published a meta-analysis of seventeen empirical studies of EDM in public administration literature. The authors found that the EDM model is generally supported, with variation in the strength of relationships depending on the research design and the public service examined.

Some scholars have challenged the assumptions of the EDM model. They question the ability of citizens to reflect on government performance and expectations deliberately and rationally (Andersen & Hjortskov, 2016), arguing that most thinking is intuitive and fast (Tversky & Kahneman, 1974). A new theoretical model, the anchoring effect, might better explain conflicting results in experimental studies. Once an anchor is set, subsequent judgments tend to bias around that anchor (Grimmelikhuijsen & Porumbescu, 2017). This anchoring would require less intensive cognitive processes to form a judgment. However, expectations can still provide an initial point of reference (or anchor) from which citizens can determine future satisfaction. The essential insight from both the EDM model and the anchoring framework is the necessity to understand the standard against which citizens assess public service performance and the factors that influence the standard (expectations or anchors).

Despite the recent empirical advancements, the research still faces several challenges. Zhang and co-workers (2021) point out several shortcomings of the current research. Firstly, most studies testing the EDM model were conducted in the United States, a customer- and market-centered society. Secondly, the scope of public services examined is limited. Future research should include specific services instead of focusing on the government as a whole. Thirdly, and most importantly, the authors argue that studying the determinants of expectations is necessary. While many studies have focused primarily on the relationship between the concept of EDM (such as Grimmelikhuijsen

& Porumbescu, 2017; James, 2011; Porumbescu, 2017; Van Ryzin, 2013), identifying antecedents for them remains underexposed. Authors, such as Hung *et al.* (2020) or Lowry *et al.* (2009), have extended the precursors of Expectation-confirmation processes and proved that communication indirectly (through expectations and confirmation) influenced satisfaction. Still, as argued by Medaglia and Zheng (2017) and Hung *et al.* (2020), more research on citizen's interactions with government communication on social media is warranted.

Although our study is rooted in the EDM-literature, we do not attempt to extend the EDM. Instead, we focus on one exogenous variable of EDM, the provision of information. We look at how public communication on social media can be a driver for satisfaction. Our study is set in Belgium, a continental welfare state with a strong role for the state. The public service in our study is the public railway company, a single public organization responsible for a single task. In the following subsection, we first discuss literature on social media use by the public sector in general before discussing constructing the general hypotheses. After that, we devote attention to the transportation literature that has studied social media data.

Managing expectations with public communication

Over the past decade, developed democratic countries have increased government advertising and presence on social media and e-government platforms (Alon-Barkat, 2020). Federal government agencies in the United States spend approximately 1.5 billion dollars annually on public relations and advertising. To improve citizens' attitudes toward the public sector, many countries have adopted the Internet to keep citizens better informed of what their government is doing. Different programs, for example, the Open Government Directive in the USA, sought to use the Internet to improve relationships between citizens and the state (Lee, 2021). Research on the value-added benefit of public communication is limited (Ho & Cho, 2017). Still, emerging research, both survey and experimental, has recently demonstrated that communication and the publication of performance information can indeed shape citizens' perception of public services (Barrows *et al.*, 2016; Grimmelikhuijsen & Meijer, 2015; Ho & Cho, 2016; Im *et al.*, 2014; Marvel, 2015; Porumbescu, 2016; Van Ryzin & Lavena, 2013).

The rise of social media has made a broader range of communication strategies available for public services. Although one-way communication is still the most common form of messaging adopted by public sector organizations on social media (Brainard & Edlins, 2015), more attempts to develop interaction between organizations and customers are being made (Meijer & Torenvlied, 2016). Many public sector organizations are incorporating social media into their planning, marketing, and communication strategies. Many agencies report performance measures on their websites and social media platforms (Caillier, 2018). Social media is valued because it allows public organizations to communicate directly with service customers, reach out to potential users, develop stronger connections with local communities, recruit new employees, and improve the agency's image (Manetti *et al.*, 2017). The advantage of interacting directly with service customers is that public services not only can manage expectations but also provide accurate information about the service performance and what is being done to ensure improvements in the future. Customers will be more likely to evaluate the organization and its services positively because they are less likely to overgeneralize anecdotic experiences (Berman, 1997). Offering more precise and real-time information on social media to service customers and the wider public will influence expectations and perceived performance.

Previous research has shown that perceptions can be influenced. Managing expectations and perceived performance through public statements or social marketing can be an effective strategy to maximize citizen satisfaction (James, 2009; Van Ryzin, 2004). James (2011), for instance, showed that exposure to credible government performance information could influence positive expectations (what performance will be). Normative expectations (what performance should be) appeared more ingrained and less adjustable. Im *et al.* (2014) similarly supported managing citizen expectations with e-government through transmitting a great deal of information at a low cost. Citizens can then better understand their government's capacity and limitations and why specific courses of action were taken, reducing the feeling of being alienated from the governmental processes. Hence, public information can shape public expectations and perceptions of government performance (Ho & Cho, 2017).

For public communication to work effectively, people need to accept and believe the (performance) information that public services release. This is not a given in the current context of distrust in the public sector (Van Ryzin & Lavena, 2013). Van Ryzin and Lavena (2013) showed with a survey experiment that US citizens generally find basic performance information credible, even when a (local) government is reporting on itself.

Most participants in the experiment were prepared to believe what the local government said about how well it delivers public services. Several other studies have confirmed the influence of public communication on the performance–perception link. Barrows *et al.* (2016) reported that showing high rankings of public schools is sufficient to shape citizens' evaluations of local school service quality. Caillier (2018) proved that negative cues have the reverse effect. Citizens receiving signals of corruption and bureaucracy-bashing had a lower perception of performance. Alon-Barkat & Gilad (2017) and Alon-Barkat (2020) found that the strategic use of symbolic elements in Israeli public communications (e.g., logos, images, and celebrities) increased citizens' trust, even when citizens recently experienced poor services.

Furthermore, Ho and Cho (2017) also examined how perceived communication effectiveness and public communication strategies relate to public satisfaction by analyzing crime trends and satisfaction data from Kansas City. They confirmed that effective communication, not just improvements in actual policing outcomes, contributes directly to public satisfaction with police protection and crime prevention. Moreover, public communication also mitigated the negative impact of a crime rate increase. They concluded that, while the public expects the police to solve crimes alone, reducing crime rates is insufficient to satisfy citizens. Still, officials can manage public perception through effective engagement and communication with the public. Similarly, a survey of Dutch citizens suggested that social media use can increase perceived police legitimacy by enhancing transparency and participation, albeit to a limited extent (Grimmelikhuijsen & Meijer, 2015). Another study also found a small effect as objective performance information can mitigate but does not entirely override an anti-public sector bias (Marvel, 2015).

Not all authors agree that public information about government services leads citizens to view public services more positively. A recent study by Lee (2021) reported that South Korean citizens tend to use online sources that align with their prior opinions, which results in little substantive change to citizens' levels of satisfaction with government information provision. The high degree of interactivity of a conventional offline medium might evoke a higher impact on citizens' satisfaction, which could explain the different findings from other established studies. Additionally, Porumbescu (2016) offered preliminary evidence from Seoul suggesting that how and where information is being presented matters for the effectiveness of public communication. Exposure to information-rich communication platforms, such as e-government websites, is less effective at fostering positive evaluations of the public sector when compared to less information-rich communication platforms, such as social media.

Although a range of studies has been focusing on the organizational benefits of social media (Yang & Anwar, 2016), little is known about how public communication through social media affects satisfaction with the organization on social media (Schivinski & Dabrowski, 2016).
In this article, we empirically evaluate the effect of public communication through social media on the satisfaction of people on Twitter, while controlling for objective performance. Controlling for an objective performance measure is crucial as improved satisfaction may simply reflect better public performance. The central tenet in private sector management has always been that consumer satisfaction is primarily driven by the quality of goods or services (Collins *et al.*, 2019). As demonstrated by several scholars (see for example Brown, 2007; Roch & Poister, 2006; Van Ryzin, 2004, 2013) it also appears to be a causal driver of satisfaction in the public sector. Hence, if we want to establish the effect of public communication, we cannot disregard a key determinant of citizen satisfaction.

Building on the past findings, we constructed the following hypothesis:

A public organization that starts with public communication through Twitter will directly and positively affect satisfaction with that public organization on Twitter when controlling for actual performance.

Transit sector

The transit sector is especially interesting to test our hypothesis as the nature of communication between public transport service providers and their customers has changed dramatically with social networking (Cottrill *et al.*, 2017). Instead of static time-table information, providers have embraced real-time updates through a variety of digital methods (Tang & Thakuriah, 2012). Additionally, complaints are no longer addressed privately in a one-to-one manner (Cottrill *et al.*, 2017; Ye & Wu, 2010). Complaints are now posted on public fora which created a heightened need for agencies to modify their communication procedures. As public posts can spread far beyond, the tone and content of customer interactions are carefully monitored. A 2012 report from the Transit Cooperative Research Program (TCRP) identified five uses of social media: timely updates, public information, citizen engagement, employee recognition, and entertainment (Bregman, 2012). Social media platforms, and especially Twitter, are commonly used by public transport agencies to communicate relevant, reliable, personalized, and timely information to passengers in a cost-effective way (Bregman, 2012; Camacho *et al.*, 2013; Cottrill *et al.*, 2017; Liu *et al.*, 2016; Papangelis *et al.*, 2016). A recent study of the top 40 transit agencies in the U.S. for example showed that all agencies were using Twitter to communicate with riders (Zhang *et al.*, 2023). This is not surprising considering research has highlighted the potential of transit agencies to reach a lot of people through Twitter. During the 2014 Commonwealth Games in Glasgow, the @GamesTravel2014 Twitter account generated a maximum reach of almost 3 million people (Cottrill *et al.*, 2017; Legacy2014, 2014).

To better understand the social media posts about different transportation agencies, multiple studies have applied sentiment analyses or content analyses on data from social media. Collins *et al.* (2013) first applied sentiment analysis to determine transit riders' satisfaction and opinions about the Chicago Transit Authority (CTA) from Tweets. They showed that transit riders express more negative sentiments than positive sentiments. Schweitzer (2014) even found that transit systems in the United States and Canada receive more negative comments than other public or private services. Similarly, Méndez *et al.* (2019) showed, by a manual sentiment analysis, that 75% of tweets from Santiago Bus users expressed a negative sentiment (about the frequency of buses, the app, a lack of information, …). The remaining tweets had a neutral sentiment; the number of positive tweets was negligible. Hence, several studies showed that public transport users mainly use Twitter to complain or express concern about the service.

Some studies went beyond a traditional sentiment analysis and performed a topic analysis on Twitter data. These studies show that the content of complaints highly depends on the location or agency involved. Haghighi *et al.* (2018) established the underlying reasons for riders' dissatisfaction in the Salt Lake region (US). Most of the negative tweets were related to the performance of transit routes with high ridership. El-Diraby *et al.* (2019) found that for Vancouver, the highest negative sentiment was related to information availability. People go to Twitter to get information and if they do not find it, this will contribute to any negative sentiment they may already have. In Colombia, most tweets highlighted concerns with safety, problems with the system's infrastructure, and behavioral issues of fellow passengers (Casas & Delmelle, 2017). Safety and security also turned out to be a top interest in the study by Hosseini *et al.* (2018) about three Canadian transit agencies. For the metro in Madrid, the main issues tweeted were punctuality and breakdowns (Osorio-Arjona *et al.*, 2021). Most recently, Das and Zubaidi (2023) analysed transit-related Twitter data from New York City and San Francisco. They established that the words associated with negative sentiments widely differed between the two locations. For example, the tweets showed a growing concern about homeless people in public transportation in San Francisco, while the tweets in New York mentioned "maintenance", "dirty", "sick", …

While the number and depth of analyses on Social Media information about public transit is expanding, some gaps remain. The literature review reveals that several studies explored the potential of examining customer feedback, opinions, and sentiments about transit experiences. The focus of previous studies is usually the added value of social media data for the service provider. Some, such as Haghighi *et al.* (2018) and El-Driaby *et al.* (2019), explicitly construct a framework for agencies to identify key concerns that better inform the agency or policymakers. Only one study, by Schweitzer (2014), has tried to systematically understand how interactive communication can foster more positive messages about public transit services by comparing 10 agencies spread across the United States and Canada with different communication styles. She constructed a dialog score (D-score) by sampling all the Twitter feeds that came directly from the agencies for 60 random days and calculating the ratio of conversation moments (in which an agency representative tweets back and forth with another commenter) to the agency's total content broadcast via Twitter. She showed, by hand coding 5000 randomly selected tweets, that agencies in the high-interaction group have statistically more favorable opinions expressed by other social media users. Additionally, agencies with the most two-way communication have fewer slurs in Tweets about class, race, gender, and size directed at other passengers.

Methodology

This research uses the Belgian railway company (SNCB - NMBS) as a single case. This railway company is one of the largest public sector companies in Belgium, employing more than 16 500 (FTE) people and realizing a revenue of nearly 2.2 billion euros (NMBS, 2022). Yet, the organization and its services are often the subject of intense and negative public opinions. Consequently, the organization is trying to improve services and customer experience. Starting intensive public communication through Twitter in 2013 was, and still is, a core strategy to achieve this goal (NMBS, 2013, 2018). This timing makes the company an interesting case for examining the impact of public communication on social media. The intense Twitter activity concerning the services of the NMBS further strengthens this claim. For instance, in 2018, 95 266 Dutch tweets or replies were posted by both NMBS and Twitter users referring to services provided by the NMBS. The NMBS has a monopoly of passenger rail services in Belgium and has a well-known name, as 'NMBS' has been used since 1926. Moreover, its task (providing rail transport for passengers) is easy to understand, observable, and assessable regarding customer quality.

We acquired all tweets mentioning the Belgian railway company from January 2011 until December 2018 from the Twitter API v2 for academic research. This timeframe was chosen due to the data availability of the performance indicator (see below). It contained 34 months before and 62 months after the NMBS became an active communicator on Twitter (first tweet on the 24th of October 2013). We subsequently applied several filters. Firstly, we only kept tweets in Dutch and deleted all other languages. This selection was necessary for coding the tweets with classifiers. For similar reasons, we also deleted tweets that contained pictures. Secondly, tweets from the railway company, other public organizations, or news media were omitted as we are only interested in citizen satisfaction. Lastly, we filtered for original tweets, meaning replies, retweets, and quotes were removed. In total, 197 869 unique tweets remained.

In our study, the measure of satisfaction is the Twitter sentiment regarding the Belgian railway company. Satisfaction and sentiment are closely related concepts. Analyzing tweets is a popular and effective way of measuring satisfaction in the private sector (Anastasia & Budi, 2016; Kanavos *et al.*, 2017; Méndez *et al.*, 2019; Permana *et al.*, 2017; Sahayak *et al.*, 2015; Schivinski & Dabrowski, 2016; Shukri *et al.*, 2015). Not surprisingly, many private sector companies already routinely and proactively use social media communication strategies to influence customer satisfaction (James, 2011). Political science has also studied the potential of predicting election results based on Twitter sentiment (Gayo-Avello, 2013). O'Connor *et al.* (2010) showed that Twitter sentiment towards politicians and political parties could be an indicator for public opinion polls such as Gallup. However, as detailed in a meta-analysis by Gayo-Avello (2013), not all studies were able to establish such an effect. Using sentiment analyses on tweets (or other posts on different fora), although rare, as a proxy for satisfaction is not unheard-of. Sentiment analysis is the computational study of people's emotions, attitudes, and opinions expressed in text (Medhat *et al.*, 2014). Numerous studies, mainly by computer scientists, have utilized this method to study customer satisfaction (Al-Otaibi *et al.*, 2018; Al-Sahar *et al.*, 2023; Anastasia & Budi, 2016; Chamorro-Atalaya *et al.*, 2022; Hopper & Urivo, 2015; Ng *et al.*, 2021; Rasool, 2019; Tusar & Islam, 2021). Also, several transit studies (see for example Méndez *et al.*, 2019) have used Twitter sentiment to capture the satisfaction of a large mass of users of public transport as they could bypass limitations of traditional surveying (such as high costs, proper spatial coverage, timely capturing of current problems, …).

The sheer number precluded any individual from classifying every tweet. Instead, we deployed Natural language processing (NLP), namely supervised machine learning-based classification. Automated text analysis offers the potential to code and analyse large amounts of texts at levels of precision and reliability that nowadays match or surpass manual coding (Anastasopoulos & Whitford, 2019; Belder-bos *et al.*, 2017; He *et al.*, 2020). We manually classified a sample of 500 tweets into two categories: negative and non-negative. The non-negative category is a combination of positive and neutral tweets. Having a multi-class classification proved highly imprecise. We could not distinguish between the two sentiments (partly due to the high imbalance of classes). With the binary classified sample, we trained an algorithm that could predict the sentiment of the remaining tweets.

Table 2 shows the quality of our classification model. There are different metrics that reflect different aspects of model quality (Evidently AI, n.d.; Powers, 2020). As no single metric is perfect, it is important to look at all metrics simultaneously and consciously choose the one more suitable for our data. The top-performing model, a finetuned Bidirectional Encoder Representations from Transformers (BERT) for Dutch Sentiment

Analysis, gave an overall accuracy over 75 percent. This metric measures how often a machine learning (ML) model correctly predicts the outcome. It is a simple division of the number of correct predictions by the total number of predictions. The downside of this metric is that it treats all classes as equally important. Because wrong predictions might be more prevalent in a category with less frequent occurrences, we calculated the precision and recall to evaluate the True Positive predictions for each category. Precision measures how often a model correctly predicts the target class by dividing the number of correct positive predictions (True Positives) by the total number of instances the model predicted as positive (both True and False positives). The precision for the non-negative is lower than for the negative category. However, 0.72 still indicates that the model makes relatively few false positive predictions. It is more likely to be correct whenever it predicts a positive outcome. The disadvantage of precision is that it does not consider False Negatives (cases when we miss our target event). The recall measurement shows whether an ML model can find all objects of the target class. It is calculated by dividing the number of true positives by the number of positive instances (the actual positive samples in the dataset). The downside of this model is the opposite of the accuracy. You can flag every single object as positive (a 100% recall score as you detect all objects of the target class), but the model would be useless. The recall score for the negative tweets is, with 0.57, the lowest quality assessment. As a rule of thumb, precision is a more suitable metric when you care about "being right" when assigning the positive class (Evidently AI, n.d.). The recall metric is vital when you care about "detecting them all." As there isn't a high cost of False Negatives (or at least not as high as False Positives), we place more importance on precision. Additionally, the F1 score combines the precision and recall scores (using their harmonic mean), leading to its widespread use in recent literature (Kundu, 2022). The macro-average is just a simple average of the class-wise F1 scores obtained. The sample-weighted F1 score is ideal for class-imbalanced data distribution. The weights are determined by the number of samples available in each class. In our model, the results for the macro and the weighted scores are very similar (meaning we don't have drastic class imbalances). In conclusion, our model can, based on most quality measurements, be considered a good predictor.

With the assigned classification for each tweet, we subsequently constructed a weighted negativity index for each month by dividing the number of negative tweets by the total number of tweets. It is a weighted index because we assigned weights according to the number of likes and retweets. A higher number of likes or retweets means more people agree with a certain tweet, resulting in a higher circulation on Twitter.

	Precision	Recall	F1-score
Negative	0.93	0.57	0.7
Non-negative	0.72	0.96	0.83
Accuracy		0.78	
Macro average		0.76	
Weighted average		0.78	

Table 2 – The quality of our supervised machine learning binary classification for Twitter sentiment.

In the analysis, we control for the actual performance of the NMBS. In order to avoid confusion between different quality aspects and to maximize data availability on actual performance, we focus specifically on one crucial quality characteristic of the NMBS service delivery, the punctuality of train services. Reliability in terms of the punctuality of train services is a core element in customer satisfaction (NMBS, 2013). Data on the punctuality of its services were made available by Infrabel (the infrastructure manager of the railways in Belgium). It consists of a monthly percentage from January 2011 onwards of trains that are on time or with a delay of fewer than six minutes (train cancellations included). Six minutes is the official norm of a permitted delay from the management agreement with the government.

Our data allows for a quasi-experimental pretest-posttest research design. We can compare Twitter sentiment about the NMBS before, and after the moment the NMBS started public communication through Twitter. We use a regression discontinuity (RD) analysis, which offers insight into the effect of publicly communicating on Twitter sentiment regarding the organization through Twitter. The RD design is widely used in applied work as it is one of the most credible quasi-experimental research designs for the identification, estimation, and inference of treatment effects (Calonico *et al.*, 2017). We apply a sharp RD design as we can identify a discrete cut-off point because the NMBS launched with an entire team of ten people in October 2013 and immediately interacted fully with citizens (Tlb, 2013).

Results

Table 3 presents the descriptive statistics. The punctuality of the trains has mainly remained the same across both periods. A Wilcoxon rank-sum test shows that the average punctuality does not differ significantly between the period before being active on Twitter and afterward ($z = -1.379$ with a p-value of 0.1679). However, the share of negative tweets significantly differs ($z = 8.074$ with a p-value of 0.000). Figure 5 confirms that punctuality rises and drops again over time, while the percentage of negative tweets drastically reduces starting from October 2013. The fitted values are indicated by a dash-line, while the entire line represents a locally weighted regression (lowess).

Variable	Overall sample (02/2011 - 12/2018) 96 months		Before 10/2013 34 months		After 09/2013 62 months	
	Mean	SD	Mean	SD	Mean	SD
Punctuality (monthly basis)	0.872	0.035	0.868	0.026	0.874	0.039
% of negative tweets (monthly basis)	0.651	0.126	0.803	0.028	0.568	0.066

Table 3 – Descriptive statistics (Mean and SD) of the monthly Punctuality and Twitter sentiment.

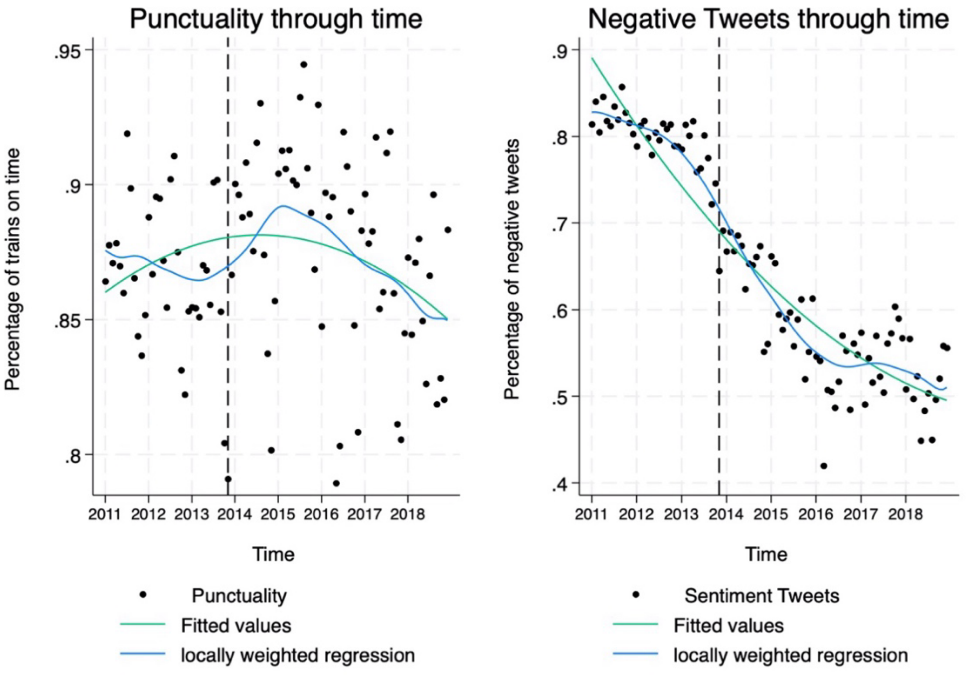

Figure 5 – Visual representation of punctuality and negative tweets through time.

In order to test if being active as an organization on Twitter causes improved sentiment on Twitter, we run a discontinuity regression. Table 4 presents the result from a first-order to a fourth-order polynomial (columns 1-4). This is done to test whether the estimate of being active on Twitter is sensitive to the different specifications of the control function. The results are satisfactory and support the finding that the Twitter presence of the NMBS (since 10/2013) has drastically reduced the percentage of negative Tweets (see also Figure 6). Becoming active on social media decreased the monthly index of negative tweets by 0.06 to 0.1 standard deviation, which is a reduction significantly different from zero. Based on these results, we confirm our hypothesis that public communication through Twitter directly and positively affects satisfaction.

Variables	Percentage of negative tweets			
	1	2	3	4
Twitter presence	-0.060***	-0.062**	-0.083***	-0.100**
	(0.020)	(0.025)	(0.032)	(0.040)
Punctuality	Included	Included	Included	Included
Polynomial	First	Second	Third	Fourth

Table 4 – Results of the regression-discontinuity approach.
N=96, with 34 before treatment & 62 after treatment. Standard errors clustered by month within parentheses. All regressions included punctuality.
** significant at 10%; ** significant at 5%, *** significant at 1%.*

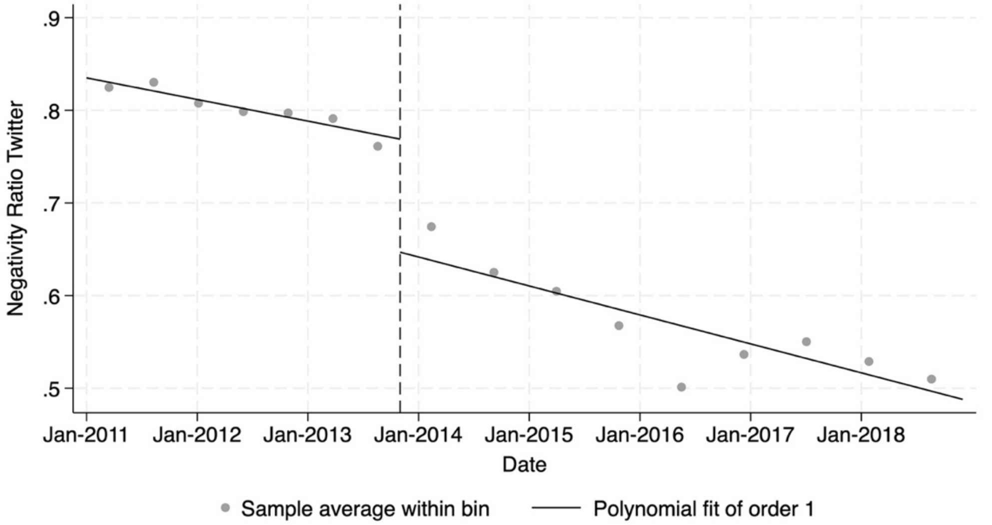

Figure 6 – Regression-discontinuity plot
The impact of public communication on Twitter sentiment.

Discussion

Interpreting a discrete cut-off point is only valid if there are no other unaccounted treatments present that could cause the effect. Therefore, we controlled for punctuality, a crucial element in customer satisfaction. We consulted the annual report from 2013 and no other potential variables, such as changes in investments, management, service provisions, information campaigns, or political incumbents, could be identified in or in the months preceding October 2013 (NMBS, 2013). This observation strengthens our claim that the observed decrease can only be allocated to public communication. Surprisingly, there was already a declining trend before the cut-off point. As demonstrated by Figure 5, this does not originate from a strong performative improvement. Hence, we can't explain the dynamic before the online presence of the NMBS. One possible explanation, which is speculation, is the efforts of the Twitter user @StationchefBMO. He was an anonymous stationmaster (active on Twitter since October 2011) who unofficially already helped or reacted to tweets on Twitter (Van Damme, 2013).

Some limitations of the automated text analysis should be considered when analyzing the results. Although there is no gold standard for the overall accuracy, the average accuracy of 78% is good, but not perfect. Fortunately, there is no reason to suspect the accuracy differs before and after the cut-off point. The inaccuracies in the coding can be seen as noise in the data unrelated to the analysis. We could not train an algorithm capable of distinguishing between positive and neutral tweets or train an algorithm capable of recognizing sarcasm or irony. Yet again, especially with sarcasm, it is not likely to differ before and after October 2013.

Other unresolved questions should be given future attention. Beginning with expanding the scope to other social media platforms. Engaging with citizens is not limited to one medium, and other platforms might have different audiences, influencing the potential effect of public communication. Secondly, various service provisions should be examined. The Belgian Railway Company was easily identifiable and evaluable. Citizens might not experience services or goods provided by smaller organizations. Whether these other public organizations might benefit from public communication remains uncertain. Thirdly, as utilizing public communication becomes more widespread, we should try to distinguish different types of public communication and study the differences between strategies. Fourthly, traditional and social media interactions should be examined in depth. Whether public communication is successful in the long-term when controlling for standard media coverage and more specific media storms remains uncertain.

An important blind spot is the mechanism through which Twitter presence improves Twitter sentiment. We started with the Expectancy-Disconfirmation Model to explain why performance and citizen satisfaction don't have a one-to-one relationship. According to EDM, the expectation of citizens (and the disconfirmation with the performance) is the missing link. We postulated that offering more precise and real-time information on social media to service customers and the wider public could influence both the expectations and perceived performance. On the one hand, communication (customer-friendliness, accuracy, speed, efficiency, …) is one of the dimensions on which a performance is judged. On the other, communication about (delays on) certain routes can manage expectations. This paper is not able to pinpoint if sentiment improves through expectation management or better-perceived performances.

Additionally, we are not able to prove that the improved sentiment is a direct consequence of an improved flow of information. There are two alternative explanations. Firstly, the fact that the Belgian Railway company answered questions might have shifted the narrative of the tweets from complaints to questions, for example, about train timetables. Improvement in Twitter sentiment could be the result of a sudden increase in tweets with questions about rail services, which are phrased in a less negative manner. However, the total number of tweets did not increase dramatically initially and even declined over time. Secondly, despite the substantial Twitter activity by the NMBS[10], Twitter users might just have adapted their language because somebody is likely to respond. Before October 2013, saying something extremely negative about the NMBS was uncomplicated as it could not get challenged or be criticized for the used language. Although there is substantial antisocial behavior on Twitter (see for example Guberman *et al.*, 2016 or Saveski *et al.*, 2021), the reduced level of anonymity because the NMBS is present might reduce negative tweets. As Schweitzer (2014) suggested, interactions with an agency might remind people that they are communicating in a highly public forum in which anybody might read what they write. Regardless of the cause, a sudden increase in

[10] As demonstrated in chapter 2.

questions or less anonymity, a decline in negative tweets is a good thing for a public organization. Even if the language adaptation isn't due to increased satisfaction, other people will still read more positive tweets about the service provider. Followers or even random citizens who go from reading negative tweets to more neutral (or even positive) tweets might start to view the organization in a more positive light.

A final unanswered question related to the effect on the general public. While the sentiment on Twitter might have improved, it is unclear if it seeps through to the general public opinion and customer satisfaction. The reasoning might be that the younger, higher educated, and urban people that populate Twitter and other social media include relatively more opinion leaders and influencers (Blank, 2017; Duggan & Brenner, 2013). The construct of opinion leadership originates from Katz and Lazarsfeld (1955) and includes a two-step flow system. Ideas flow (from the mass media) to opinion leaders and then to the general public. Opinion leaders are more interested in issues and better informed (Park, 2013). Because they are better exposed to information, process information more efficiently, are more likely to be interconnected, and have a somewhat higher socioeconomic status, they have a larger impact on public opinion. Research has established that opinion leaders are early adopters of innovation (Rogers, 2003; Weinmann, 1994). This, combined with the tendency to view themselves as intelligent and independent enough to form a judgment about public issues that they can share with others (Chan & Misra, 1990), makes it more likely they are active on Twitter compared to opinion followers. Studies (like Karlsen, 2015 and Park, 2013) support this by highlighting the importance of opinion leaders, active on social media. Karlsen (2015) concluded that social media users have a significant impact by diffusing (political) information to their (online and offline) networks. Also, journalists are very active, both regarding newsgathering and sharing information, on Twitter, which could flow to traditional media reportings (Canter, 2015). Regardless, it is not clear-cut that this holds for messages about the Belgian Railway Company. Additionally, opinion leaders influencing other citizens is likely something that takes time. This explains why there isn't a similar drop compared to social media sentiment in satisfaction measurements with NMBS customers. Further studies should evaluate the impact of public communication efforts through social media on the perceptions of public organizations held by the broader public beyond social media users.

Conclusion

Public services are reshaping the citizen-state relationship amid rising distrust and low satisfaction with public performance. Digitalization has caused fundamental transformations, not only for making public services more efficient. Digitalization also allowed more direct interaction with citizens through channels other than the traditional media. This direct relationship can provide better insight into citizens' preferences for public services. For citizens, direct interaction with public services could provide more accurate information about public services and public performances.

Providing information through direct public communication is regarded as a solution to dissatisfaction precisely because research has demonstrated that improvements in public services do not automatically result in higher customer satisfaction. The Expectancy-Disconfirmation Model (EDM) uses not only performance but also expectations and the interaction between performance and expectations to explain satisfaction with public services. Arguably, accurate information about the organization and direct interaction with the organization could significantly impact the concepts in the conventional EDM through managing expectations and perceived performance.

Many public organizations, also transit agencies, have recently invested in social media to engage in public communication, attempting to increase satisfaction. This study empirically tested the effect of that social media presence. We focused on one of the largest public sector organizations in Belgium, the Belgian Railway Company (SNCB – NMBS), which became active on Twitter, the dominant medium for public communication, in 2013 to improve negative public opinions. Our study examined whether engaging with citizens directly and positively influenced the sentiment of tweets regarding that organization. The Flemish tweets mentioning the railway company were analysed by machine learning-based classification. They were aggregated to construct a monthly negativity index, weighted according to the number of likes and retweets. The regression discontinuity design uncovered a significant reduction in negative tweets after the railway company became active on Twitter.

Advancing our understanding of what determines customer satisfaction has theoretical implications. The study by Hu *et al.* (2019) demonstrated that consuming new media as a primary source of information negatively impacted public service satisfaction. Our findings add an important refinement, similar to the nuance brought by Im *et al.* (2014), who concluded that negative effects could be moderated through citizens' increased use of e-government. In parallel, our paper highlighted the importance of adapting methods of coordinating information flows and interacting with users and citizens through the Internet. Our findings align with the research showing that public organizations' communication can shape citizens' perceptions of government organizations. Our specific contribution to the literature is twofold. Firstly, we empirically establish the effect of a public organization becoming active on social media on social media sentiment, which differs from previous studies. They focused either on the impact of general information on the citizens' perception or on comparing different agencies. Secondly, with a quasi-experimental research setup and novel automated text analyses, we utilize a different methodology than prior research.

The practical implication is that well-known organizations should invest in public communication to tackle an unmerited lack of satisfaction. However, poorly performing organizations should not resort to managing expectations or strategic propaganda to manipulate citizens' views. Studies from EDM (in particular James, 2011 and Van Ryzin, 2013) have made the same objection about lowering expectations to achieve more satisfaction. These policies might have detrimental consequences on the perceived competency of the organization, its (political) incumbents, and the whole public sector. Instead, public sector service providers should invest in transferring accurate information or engaging directly with citizens. Brewer *et al.* (2006) already constructed different stages of e-governance in 2006, from providing information on static Web pages to direct (transactional) interaction between citizens and government agencies. They argued that a digital-oriented government is (perceived as) more efficient, accessible, transparent, accountable, agile, and responsive. Similarly, incorporating IT systems can promote democratic processes, as Dahl's (1989) first criterion for democracy is effective participation. Internet communication can facilitate citizen participation and involvement with public organizations.

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Can Twitter reputation of a public sector organization be predicted based on performance, traditional media, and public communication?

Steven F. De Vadder, Koen Verhoest, Jan Wynen & Wouter Van Dooren
This chapter is currently under review.

4

Abstract and keywords

With digitalization came new modes of communication. Social media in particular allows different stakeholders of public organizations to interact with each other and with the public organization itself. In this research, we tried to forecast the Twitter reputation of the Belgian Railway company based on changes in performance, media reputation, and public communication strategies. An increased performance, traditional media coverage, or more interactive public communication were expected to improve future Twitter sentiment. With automated text analyses, a daily and monthly reputation index was constructed and based on a vector autoregressive model (VAR) we showed that only performance had a causal effect on Twitter reputation. If the punctuality of the railway company improved, so did the sentiment of tweets posted about them in the subsequent days. If we analysed the evolution over different months, nothing has a clear significant effect. Only public communication was significant in one of the models. That media reputation (measured as both the sentiments of the articles and media storms) nor public communication impacted daily (and to a certain extent monthly) Twitter sentiment was surprising. However, as VAR allows for probing bidirectional relationships, this paper is able to reflect on the different causal mechanisms of the different variables. Regardless, this research demonstrates that predicting the future Twitter reputation is challenging as social media sentiment is by nature unpredictable.

Keywords
Twitter reputation, media reputation, performance, public communication, Twitter sentiment, railway services, Social Media, Vector Autoregression Modelling.

Introduction

Digitalization has become a reality in every area of our lives. People are demanding more digital solutions not only in their private lives but also when interacting with public sector organizations. Many public organizations are transforming themselves digitally to accommodate these new demands (Danielsen, 2021). Additionally, public officials hope to take advantage of the many benefits associated with a digital transition. It is especially praised as a potential tool to improve citizens' perceptions of public sector organizations. There is a deep-rooted public hostility and widespread political and media bashing towards public bureaus and their employees (Del Pino *et al.*, 2016; Goodsell, 2004; Hvidman & Andersen, 2016; Marvel, 2015, 2016). Public organizations are perceived as being too big, wasteful, slow, unreliable, not sufficiently transparent, and inefficient (du Gay, 2000; Goodsell, 2004). Public servants are portrayed as 'Ill-spirited bureaucrats, constantly trying to figure out how to increase regulation of citizens while extending their own "malign influence"' (du Gay, 2000, p. 2) or lazy, procrastinating, and indifferent bureaucrats with no customer or service orientation (Osborne & Gaebler, 1992). Even citizens with high-performing public government organizations, such as in Norway, view public organizations as difficult to deal with, excessively bureaucratic, and not service-minded (United Nations, 2020; Christensen *et al.*, 2014).

With digitalization came a new mode of communication: social media. These web-based applications allow users to interact with one another (Das *et al.*, 2022). There is a plethora of different platforms, focusing on certain aspects. There are social networking sites (like Twitter, Facebook, Telegram,..), media-sharing sites (Instagram, TikTok, YouTube, Twitch, …), and professional networking sites (e.g., LinkedIn). Social media sites in particular can build connections based on similar interests, shared experiences, information-searching, … It allows everybody with a platform to reach many people at once with little time and effort. With increased access to the Internet, the use of social media platforms by the general public surged. Many public sector organizations have followed since and incorporated social media in one way or another in their daily functioning (Alon-Barkat, 2020).

In this research, we study one of the biggest social media platforms, namely Twitter. Sentiment analysis on entities (e.g., products, organizations, people, etc.) in tweets has become a rapid and effective way of gauging public perceptions for business marketing or social studies (Kanavos *et al.*, 2017). Although not a good representation of the general population, the Twitter population is of particular interest for sentiment research. The younger, higher educated, and urban people on social media have a disproportionate impact on public opinion and customer satisfaction towards public services, as their group includes relatively more opinion leaders and influencers, impacting upon opinions of larger groups (O'Connor, *et al.*, 2010; Rogers, 2003; Schivinski & Dabrowski, 2016). Twitter is also interesting as different stakeholders or audiences populate it, ranging from journalists, politicians, service customers, to citizens who all read, like, post, and react to (re)tweets. However, we still don't fully understand how perceptions on Twitter take form. What real-life or online events shape social media posts?

This article treats the aggregation of tweets about a public sector organization as its Twitter reputation. This social media-based reputation probably does not develop in a vacuum. We identify and empirically test (with longitudinal analyses) three variables that could affect the Twitter reputation of a public organization over time. The first is the performance of the organization. If service delivery improves or deteriorates, we expect it to show in Twitter reputation. Traditional media is the second variable as there is considerable diffusion from traditional media articles to Twitter content (Wu *et al.*, 2011). We expect changes in traditional media reputation to seep through into the reputation on Twitter. Lastly, various levels and types of institutions in several OECD countries take matters into their own hands and try to improve the negative impressions of the public sector (Wæraas & Byrkjeflot, 2012). We believe that these new public communication strategies employed by an organization can potentially affect its reputation on that forum, namely Twitter.

The next section starts with a discussion of the general literature on reputation. Furthermore, it established three potential variables (performance, traditional media reputation, and public communication) that could affect Twitter reputation. The research question and hypotheses are detailed before diving into the methodology of this research. The studied case (the Belgian Railway Company), the data, and the method of analysis are outlined. Next, the results are presented and discussed. Finally, a conclusion summarizes the findings and provides some reflection.

Literature

Reputation and social media

Reputation is defined as "a set of beliefs about an organization's capacities, intentions, history, and mission that are embedded in a network of multiple audiences." (Carpenter, 2010a, p. 33). Individuals' perceptions about a specific government agency aggregate into a shared understanding among members of a particular audience or multiple ones (Maor, 2022). Government agencies, tasked with both making and administering public policies, operate in a richly textured political environment composed of diverse audiences, including elected officials, clientele groups, the media, policy experts, and ordinary citizens (Carpenter & Krause, 2012). Public managers, by necessity and training, are especially aware that audiences monitor them. However, some audiences are being watched more explicitly (and even implicitly) by public administrators to gauge expectations regarding external demands placed on the organization accurately.

An organization's reputation is vital for a public administrator's capacity when handling administrative and societal challenges. Reputation is a valuable asset for two reasons. Firstly, it serves as a competitive advantage. Research has demonstrated that a strong reputation increases sales, profits, identification, and performance (Rhee & Valdez, 2009). It also aids in recruiting and retaining valued employees (Carpenter, 2002). Secondly, and more importantly, it is a political asset and strategic resource. Reputation impacts organizations' discretion and bureaucratic autonomy (Carpenter, 2002, 2010a; Verhoest *et al.*, 2014). It can also be used to generate public support for an organization. Additionally, reputation can offer a protective shield against opposition from hostile external audiences (Carpenter & Krause, 2012). Hence, reputation strengthens bureaucratic power and autonomy and reduces threats to its legitimacy (Bustos, 2021).

The challenge for organizations is that perceptions about the agency's performance, the expertise of its staff, its values, and the legality of its actions are shaped by uncertainty and ambiguity (Carpenter, 2010a). "Complex public organizations are seen 'through a glass but dimly' by their manifold audiences" (Carpenter & Krause, 2012, p. 27). What audiences see and experience is not an agency's perfectly tuned or visible reality; audiences simplify the aggregated functions and behaviors of the public agencies they observe (Carpenter & Krause, 2012; Maor, 2022). However, this also presents opportunities for public organizations to strategically market themselves. Another challenge facing organizations is that audiences' expectations of different agencies may differ over time (Maor, 2016). Identical behavior for one agency may produce different reputational consequences for different agencies. In addition, audiences may hold conflicting or complementary expectations for some agencies, and some expectations may be more prominent/consequential than others.

A social media presence has the potential to benefit or harm the reputation of a public sector organization. On one hand, it can make expectations more realistic, which enables individuals to better deal with their experiences (Canel & Luoma-aho, 2019). Additionally, by providing support, they can mediate and facilitate the information used for value judgments (Masum & Tovey, 2012). On the other hand, if organizations bring about more transparency, citizens could become less tolerant of the service (Canel & Luoma-aho, 2019). A negative experience would resemble a breach of a brand promise that organizations are expected to live up to. Furthermore, reviews of the organization may be produced by entities that might not be who they seem to be. Individuals post questions prompted by conspiracy theories, fake news, or unfounded allegations regarding the conduct of authorities that could damage organizations' reputations (Luoma-aho, 2015).

Carpenter and Krause (2012) wrote that it is tempting to believe the significance of "reputation" relative to "facts" will be diminished by modern information technology. The notion suggests that as organizations become more transparent, as more details are made public, and as information and search costs decrease, reputation will lose its relevance because everyone will have access to the true state of the world. Carpenter and Krause argue this is a false hypothesis and that the impact of reputation will not fade away as information becomes more accurate and transparent. Their skepticism arises from the belief that the surge of information due to technological progress and transparency measures will lead citizens to an information overload. Faced with the dilemma of abundant information and inherent cognitive limitations, individuals will continue to resort to heuristics or information shortcuts. In a similar vein, Hunt (2009) has described the future importance of organizational reputation with the concept of "whuffie". This term, borrowed from Cory Doctorow's Down and Out in the Magic Kingdom, is the organization's reputation among its social networks and will determine which public services citizens will choose to interact with. The whuffie is based on the organization's perceived niceness, the noteworthiness of its actions, and its position of value among social networks. Especially niceness continues to be a challenge for public organizations (Canel & Luoma-aho, 2019).

Research question and hypotheses

The abovementioned literature establishes why public organizations should, and do, care about their online perceptions. The crucial question for practitioners and scholars is always how public organizations can improve their relationships with their different audiences to achieve a positive reputation (Bustos, 2021). Hence, this paper studies what can influence the reputation of a public organization on social media. For this, we must first highlight potential antecedents of organizational reputation in public administration. Previous research has focused on both antecedents aimed at internal (bureaucrats, legislators, political and judicial authorities that have formal responsibilities in service delivery, formulating policies, and scrutinizing agencies) and external audiences (citizens, civic associations, academic and professional experts, or media that evaluate the results of organizations) (Boon *et al.*, 2020; Capelos *et al.*, 2016). Bustos (2021) published a systemic literature review in which he identified which areas of research were the most analysed for each group. Within the external audience studies, the focus of this article, efficacy or performance assessments (e.g., Luoma-aho, 2007), media influence (e.g., Thorbjørnsrud, 2015), and strategic communication (e.g., Gilad *et al.*, 2016) received the most attention.

These three, (performance assessments, media influence, and strategic communication) will form the three variables of interest for this paper. Other variables established in the literature could not be included in this study because of restrictions with the available data or the chosen case study. For example, Lee and Van Ryzin (2020) looked at what individual or contextual factors influence citizens' beliefs about specific US government agencies. Citizens' general level of trust in government, political ideology, and demographic, socioeconomic, and regional differences shape reputational judgments. Another study assessed the effect of organizational resources: administrative, human, financial, political, etc. (Lee & Whitford, 2013). Unfortunately, micro-level data or data on organizational resources were not available or relevant to our study.

This paper studies the causal relationships between performance, traditional media, public communication, and Twitter reputation. As demonstrated in the Analyses of the methodology, our research design allows the study of all causal inferences between all the variables. Yet, the aim is to predict social media sentiment based on the past values of the three variables. Thus, we work with the following research question:

Can performance, (traditional) media reputation, and social media public communication predict Twitter reputation?

The following three sections provide a brief overview of the literature on the independent variables in our research question. This will provide us with three hypotheses.

Performance

The systemic literature review of Bustus (2021) showed that the facets associated with the efficacy of organizations are the dominant focus in reputation literature. Research has studied performance both as an antecedent and outcome of organizational reputation. The potential for (perceived) performance to build or maintain a positive reputation (e.g., Doering *et al.*, 2019) is an example of an antecedent of organizational reputation. Studies focused on the outcomes have studied reputation as a means to enhance organizational performance (e.g. Krause & Douglas, 2005).

Many scholars assume that performance and reputation move in tandem. Some do not even distinguish the two concepts, saying that "well-functioning functioning is defined here in the sense of having a reputation for being competent" (Lodge, 2014, p. 65). Other research explicitly distinguishes between performance and reputation, but still (implicitly) assumes that an agency that performs better will become more reputable (like in Carpenter, 2002; Krause & Corder, 2007; Krause & Douglas, 2005; Maor & Sulitzeanu-Kenan, 2016). This assumption is not farfetched if audiences are users of the public organizations' service delivery. They will experience the performative outcome firsthand, which will influence the perception of that agency. However, forming the reputation of an organization is much more complicated if you are not using the services. In that case, citizens will rely on cues from other audiences or fora (see later). The public sector's actual performance is something individual citizens can seldom evaluate for themselves, and the more complex the service process, the more difficult its evaluation becomes (Thijs, 2011).

Considering the abovementioned, we derive the following hypothesis:

H1: Improvements in a public organization's performance will result in a better reputation on Twitter.

However, the "seeing through a glass, but dimly lit"-metaphor is highly appropriate as there are inconsistencies between performance and reputation. The latter is an intersubjective concept. Contrary, performance can be measured more or less objectively and belongs to 'the world of facts' (Bovens & t' Hart, 2016). This difference can result in overstated or underrated reputational judgments based on the performance of an organization. Research has illustrated (for example, Gilad, 2015) that performance and reputation do not always match. Inconsistencies between the two can move in both directions. An organization can have a reputation that overstates or underrates its performance. There are several potential reasons for these inconsistencies. For example, audiences might have trouble interpreting performances due to cognitive biases (Baekgaard & Serritzlew, 2016; James & Van Ryzin 2017) or the organization could employ strategic miscommunication of performances. Media logic, see our next variable, can also induce inconsistencies (Rindova & Martins, 2012).

Media reputation

Reputation does not only emerge from everyday interactions between public agencies and their policy audiences, but it also reflects media coverage and tone (Arnold, 2004; Carpenter, 2002; 2010a; Carpenter & Sin, 2007; Grosso & Van Ryzin, 2011; Peci, 2021; Project for Excellence in Journalism, 2010). According to some, mass media are even "by far the most important" source of information about public agencies (Arnold, 2004; Project for Excellence in Journalism, 2010). Mass media has often been described as a fourth branch of government with extensive liberties to examine and even scrutinize the activities of public organizations and their representatives (Fredriksson & Pallas, 2020). The media assists citizens in uncovering policy failures, corruption, inefficiencies, and other forms of malfunctions. Citizens cannot experience and evaluate all public service deliveries, let alone hold them accountable for their actions. Hence, audiences rely on news media if their performance information is incomplete (Einwiller *et al.*, 2010). Media operates as a watchdog and encourages the formation of an informed public opinion (Coglianese & Howard, 1998; Maggetti, 2012).

Communication research has long examined what influence media content has on altering people's behaviors, emotions, attitudes, and beliefs (Scheufele, 1999; Ball-Rokeach & DeFleur, 1976; Drew & Weaver, 1990). According to Potter (2012), more than 10 000 articles on media effects show mixed results, ranging from substantial to negligible effects. This depends on context, message, media format, and audience. Especially the agenda-setting literature is relevant to this research and shows that, by framing in particular ways, news media can influence the salience of (specific attributes of) an organization on the public agenda (Carroll & McCombs, 2003; Deephouse, 2000; McCombs, 2007, 2014). Under the right conditions, media does influence what people think about and, in turn, how they evaluate the things media brings to their attention (Gunther, 1991; McCombs, 2007).

The media has a dual character as both an audience of public agencies and an institutional intermediary used by other audiences that make sense of agencies' reputations (Boon *et al.*, 2019; Rindova & Martins, 2012). Media signals important aspects of agencies, such as their moral, technical, or procedural reputation (Carpenter, 2010a; Carpenter & Krause, 2012). Reputational beliefs are primed by salient issues covered by the media which scrutinizes public agencies' agendas (Busuioc & Lodge, 2016). Additionally, it has the capacity, as an intermediary, to synthesize reputational beliefs that are held by a broader public. The media acts as a mirror of organizations' actions and as an active agent shaping information for the public (Fombrun & Shanley, 1990; Zhang, 2016).

News media is more than just a conduit (Peci, 2021). It operates with its own values and strategic objectives; it acts according to its own distinctive media logic. This logic determines if and how public organizations appear in the news (Altheide, 2015; Altheide & Snow, 1979; Boon *et al.,* 2019a, 2019b). Newsworthiness depends on criteria such as timeliness, proximity, surprise, negativity, elite involvement, conflict, and personalization, all of which might cause biases in what is reported and how this is done (Soroka, 2016; Strömbäck & Esser, 2014; Van Aelst *et al.,* 2012). Media can also be considered an arbiter of reputations (Thorbjørnsrud, 2015). It can exclude accurate or neutral information on an organization's performance based on media logic.

News media not only has the potential to influence offline reputational judgments. Wu *et al.* (2011) studied the production, flow, and consumption of information on Twitter extensively and found considerable support for the two-step flow of information. Almost half of the information originating from media passes indirectly to the online masses through an intermediate layer of opinion leaders. These opinion leaders are Twitter users who are more exposed to the media than their followers. Although media articles are shared numerously, media-originated URLs are disproportionately represented among short-lived URLs, contrary to, for example URLs from bloggers. This is consistent with the news logic that involves a fast rhythm (Thorbjørnsrud, 2015).

In conclusion, audiences' perceptions of an organization's performance are filtered through the selection and framing of news intermediaries. Some studies have even relied on the coverage of agencies in newspapers as a proxy to measure reputation, assuming it dictates or reflects the views of the public and other audiences (Lee & Van Ryzin, 2020). Hence, media reputation, defined as the overall evaluation of a public agency presented in the media (Peci, 2021), could not be missing in this study.

H2: An improved media reputation will result in a better reputation on Twitter.

Public communication

Communication by public organizations to their service customers and the wider public about their service delivery, labeled public communication, is a way to actively influence attitudes/dispositions (Im *et al.,* 2014). Public communication can be a form of reputation management whereby you share the organization's intentions, mission, and capacities, … with audiences. This can be achieved in a reactive way, by answering questions or complaints, or in a proactive role, by spreading information. Reputation management is something that many public sector organizations attempt (Wæraas & Byrkjeflot, 2012) and involves creating and defending positive public perceptions (Gibson *et al.*, 2006). The introduction of social media has opened a lot of possibilities for agencies to take control of the narrative and interact directly with different audiences.

Implementing reputation management is not a straightforward endeavor for most public organizations. Wæraas and Byrkjeflot (2012) categorize five problems hampering a successful reputational initiative. The first, called the politics problem, refers to the limited control agencies have over their mission as they operate within a (limited) political mandate. Furthermore, election dynamics provide incentives for politicians to criticize organizations. The consistency problem is the second issue and deals with multiple identities because they perform varied tasks and employ various professionals and experts. The next problem is related to public organizations' lack of charisma. Brunsson (1989) has argued that public organizations are chronically depressive because they deal with insoluble problems. The fourth problem is that public organizations are usually not recognized as ones with a unique identity; public organizations probably seem more similar than unique, given their common characteristics as political, hierarchical, and rule-oriented entities. The final problem is called the excellence problem. Many agencies must make unpopular decisions at times. When disappointments or spurring negative media attention occurs, an organization with an excellent reputation may struggle for years trying to recover. A neutral reputation is often preferable (Luoma-aho, 2007).

Some of the problems mentioned above with public sector reputational management can be remedied with social media (Anastasopoulos & Whitford, 2019). Social media has made a broader range of communication strategies available for public services to manage their reputation. Most notable is perhaps the potential to tackle the uniqueness and charisma problem. In addition, more direct communication can also minimize the electoral dynamic as it allows speaking out against politicians making harmful claims. Regardless of the specific problems facing public organizations, social media is generally valued because it allows organizations to communicate directly with different audiences for many purposes: contact service customers, reach out to potential users, develop stronger connections with local communities, recruit new employees, etc. (Manetti *et al.*, 2017). The underlying assumption is that people will be more likely to evaluate the organization and its services positively because they are less likely to overgeneralize anecdotic experiences (Berman, 1997). In addition, mass media communication has been partly replaced by social networks that operate with a new logic of citizen engagement (Castells, 2009). Hence, more accurate information and engagement about the service performance and what is being done to ensure improvements in the future could improve the reputation of public organizations.

Several studies have looked at the mechanisms and benefits of public communication. Especially strategic communication (risk and crisis communication) when exposed to reputational threats has received much attention in the literature (Frandsen & Johansen, 2020). Other studies established positive effects of online public communication on public satisfaction (Ho & Cho, 2017), legitimacy (Grimmelikhuijsen & Meijer, 2015), anti-sector biases (Marvel, 2015), alienation (Im *et al.*, 2014), etc. However, some scholars challenge the benefits of (strategic) communication (Maor, 2020). They argue that communication only provides short-term, symbolic solutions to emerging threats (Grunig 1993; Picci, 2014; Schanin, 2014). They believe an agency's communication is overemphasized and that the ability to accomplish organizational goals should be the focus. Regardless, little is known if or how organizations strategically shape their reputation through social media (Anastasopoulos & Whitford, 2019). In this study, we want to establish whether public communication through social media (as a form of reputation management) can cultivate the reputation on social media of public organizations. Hence, the third and final hypothesis is:

H3: More public communication will result in a better reputation on Twitter.

The three hypotheses together are visualized in the following figure:

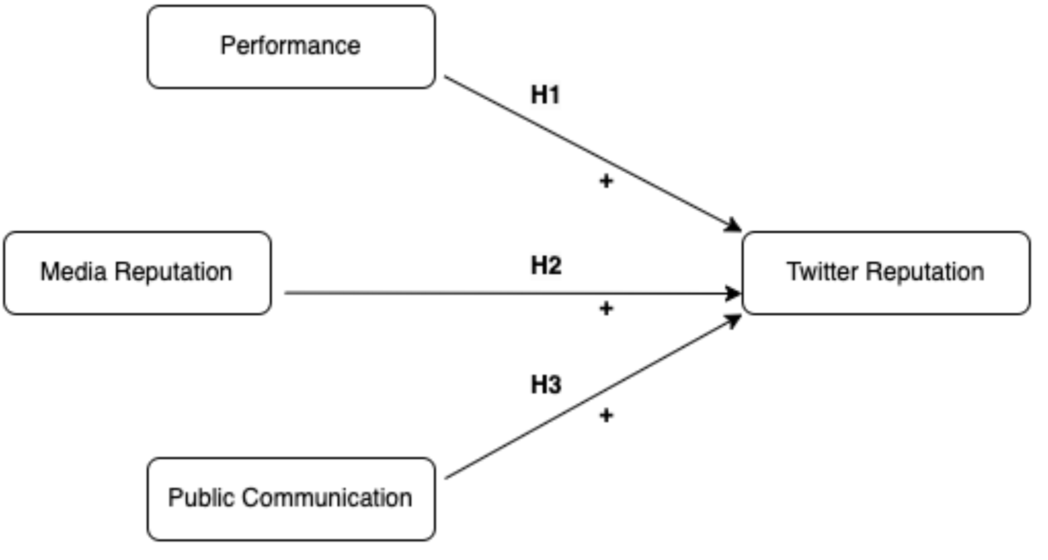

Figure 7 – The three hypotheses of this study.
All are predicted to have a positive effect on Twitter Reputation.

Methodology

Case

Many transit agencies have begun to use social networking tools (Das *et al.*, 2022). They typically use it for five categories. Firstly, to provide the public with timely updates and crisis information. Secondly, to educate citizens by sharing information about services, fares, updates on ongoing and future projects, and special service-related information. Thirdly, to encourage public engagement based on their feedback. Fourthly, to promote transport services and increase ridership. Finally, to support organizational goals. The Belgian Railway Company (NMBS) is one such transit agency with a very active social media presence. The following paragraph will provide a brief summary of the public organization[11].

The Belgian railway company (NMBS) employs more than 16 500 people and realizes a revenue of nearly 2.2 billion euros, making it one of the largest public sector companies in Belgium (NMBS, 2022). Nevertheless, the organization struggles with persistent negative public perceptions (Michiels, 2023). Consequently, the organization started with an intensive public communication strategy through Twitter in 2013 to improve customer experience and, by extension, improve its public perception (NMBS, 2013, 2018). The organization offers an interesting case for examining how different variables can influence Twitter reputation. The NMBS has a monopoly on passenger rail services in Belgium and is well-known. Its task is easily understood, observable, and assessable. Additionally, there is extensive Twitter activity concerning the services of the NMBS. For instance, in 2018, 95 266 Dutch tweets or replies were posted by both NMBS and Twitter users referring to services provided by the NMBS. There is also, with 4 481 Dutch articles in 2018, a lot of traditional media coverage. Furthermore, Infrabel published punctuality data, which enables us to include a measure of objective performance in the analyses.

Data

As mentioned previously, the analyses look at both daily and monthly data. This ensures we make optimal use of our data. On the one hand, we have the lowest possible unit of time (days) potentially giving us insight into small changes over time. On the other hand,

[11] A full discussion of the case can be found in Chapter 2.

we allow for a more accumulating effect of reputation by using a more aggregated period (months).

Twitter reputation

We gathered all tweets mentioning the Belgian railway company from January 2014 through December 2018 from the Twitter API v2 for academic research. We subsequently applied two filters. Firstly, we deleted all non-Dutch tweets. This selection was necessary for coding the tweets with classifiers. For similar reasons, we also deleted tweets that contained pictures. Secondly, tweets from the railway company and other related public organizations were omitted. In total, 322 755 tweets remained. Classifying all these tweets manually would have been extremely time-consuming. Instead, we deployed a supervised machine learning-based classification. Automated text analysis can code large amounts of text at levels of precision and reliability that nowadays could match (or even surpass) manual coding (Anastasopoulos & Whitford, 2019; Belderbos *et al.*, 2017; He *et al.*, 2020). We trained an algorithm based on a random sample of 500 manually coded tweets. Initially, we classified the sample tweets into three categories: negative, neutral, and positive. However, the automated text analysis was not able to distinguish between neutral and positive tweets, resulting in low accuracy. As a result, we combined the neutral and positive tweets in a non-negative group. This binary division (negative versus non-negative) predicted the sentiment with more than 75 percent overall accuracy (see Table 5).[12]

	Precision	Recall	F1-score
Negative	0.93	0.57	0.7
Non-negative	0.72	0.96	0.83
Accuracy		0.78	
Macro average		0.76	
Weighted average		0.78	

Table 5 – The quality of our supervised machine learning binary classification for Twitter sentiment.

[12] A full discussion on the different measurements of quality can be found in the Methodology of the previous chapter.

With the assigned sentiment for each posted tweet, we subsequently constructed a daily and monthly negativity index by dividing the number of negative tweets by the total number of tweets that day or month respectively. These indexes are weighted because we incorporated the number of likes. A higher number of likes means more people agree with a particular tweet, resulting in a higher circulation on Twitter.

Recent publications (for example Lee & Van Ryzin, 2019 or Overman *et al.*, 2020) have developed validated questionnaires for the Bureaucratic Reputation Theory. Due to the nature of our data, tweets instead of surveys, and how we process it, automated text analyses, we could not utilize these detailed measurements with different questions related to the dimensions of reputation. However, our sentiment analysis reflects the general, more affective aspect of reputation (Lee & Van Ryzin, 2019). Existing work on bureaucratic reputation has similarly looked at reputation as a singular, positive, or negative phenomenon (Capelos *et al.*, 2016). Furthermore, using machine-learning techniques to analyse tweets is not unheard of in bureaucratic reputation studies. Anastasopoulos and Whitford (2019) used supervised machine learning to classify tweets according to the different dimensions of reputation. Several, mostly private sector studies have also demonstrated how tweets can be monitored to grasp the reputation of an organization (Carrillo-de-Albornoz *et al.*, 2014; Grover & Kar, 2017; Milán *et al.*, 2022; Rust *et al.*, 2021; Vidya *et al.*, 2015).

Performance

As Das and Zubaidi (2023) pointed out, there is a need for a data-driven analysis of daily experience with the quality and performance of transportation services on social media reactions. For the actual performance of the Belgian railway company, we focus on a crucial quality characteristic of the service delivery, the punctuality of train services. Reliability in terms of the punctuality of train services is crucial for customer satisfaction (NMBS, 2013). Infrabel (the infrastructure manager of the Belgian railways) publishes data on the punctuality of trains. It consists of monthly percentages of trains without a delay of over six minutes (the limit according to the management agreement between the NMBS and the Belgian government). We use the monthly index that takes the number of passengers on board into account. Hence, a delay (or cancellation) of a train during rush hour weighs heavier in this percentage. In this paper, we analyse both the monthly and daily evolutions. However, the same monthly index from Infrabel is not available for each day. In these analyses we work with the raw data, detailing the delays (both at arrival and departure) of every train at every station in seconds. From this data, we calculated the total number of delays (in hours) at arrival for every day. We decided to focus on arrival-delay instead of departure-delay because we assume travelers care more about when they reach their destination. A train that departed on time but encountered troubles on its way is probably more detrimental to people's perception than a train that left too late but was able to catch up along the way. This daily sum of all delays is not adjusted for the number of passengers on the trains.

Media reputation

Belga.press (formally GoPress) collects articles published by Belgian journals and magazines in an online database. Access to this database is free for academic research. With the permission of Belga.press we scraped all 30 863 news articles about the NMBS between 2014 and 2019 from their website. All major Flemish journals (including regional branches) were included in the search: De Morgen, De Standaard, De Tijd, De Zondag, Gazet van Antwerpen, Het Belang Van Limburg, Het Laatste Nieuws, Het Nieuwsblad, Krant van West-Vlaanderen en Metro NL. Like with Twitter reputation, we utilized supervised machine learning to process the sheer number of articles. We started by splitting the articles into sentences with three tokenizers: SpaCy, Stanza, and NLTK. As SpaCy proved the best match, we used it to identify and cut the sentences that included "NMBS". We coded yet again a random selection of 500 sentences and divided it into a train- and test-dataset. After cross-validation, we obtained a very good predictor (see Table 6). With the lowest metric of 0.85, the model can be considered high-quality. This algorithm is a better predictor across the board than the Twitter classifier, probably because news articles are written in a more standardized lexicon than the 140 or 280 characters of tweets. Classifying the sentences in every article enabled us to label each article as negative or non-negative. In our analyses, we utilize the percentage of negative articles in a day or month as an indication of media reputation.

Although the method to process news articles differs from our sentiment analysis with the tweets for Twitter reputation, the result is similar. We use the sentiment (negative or not) as a proxy for media reputation. Other studies, most notably Maor & Sulitzeanu-Kenan (2016) and Gilad *et al.* (2015) have similarly used a, albeit with manual content analyses, sentiment-based approach to media coverage to track bureaucratic reputation.

	Precision	Recall	F1-score
Negative	0.858	0.842	0.850
Non-negative	0.921	0.929	0.925
Accuracy		0.900	
Macro average		0.887	
Weighted average		0.900	

Table 6 – The quality of our supervised machine learning binary classification for Media Reputation.

Alternatively, not necessarily the frequency of negative articles is influential for Twitter sentiment. It might be the number of negative articles on a day/month that has a real impact. One negative article on a particular day with only one published article about the NMBS (a 100% negativity index) might be insignificant if other days have hundreds of negative articles. We test the effect of a media storm with a dummy for days with more than 25 articles or more than 600 articles per month. Maor and Sulitzeanu-Kenan (2013) for example found that media salience, meaning periods in which press coverage is relatively intense, had an impact on how quickly the Food and Drug Administration's Center for Drug Evaluation and Research took action.

Public communication

The Belgian railway company became active on Twitter on the 24th of October 2013 (Tlb, 2013; Van Damme, 2013). Since the first tweet, the NMBS has interacted heavily with Twitter users. They listen to complaints, explain delays (for example, unauthorized track walkers), aid customers in optimizing routes, send tickets if the app or website is malfunctioning, etc. We acquired all tweets posted by the NMBS before 2019. Contrary to the variable Twitter reputation, we did not classify the tweets. There isn't a difference in sentiment between the tweets of the NMBS; they are all formulated in a neutral way. Instead, we calculated the intensity of public communication for each day or month. We divided the number of tweets and replies of the NMBS by the total number of tweets mentioning the NMBS that day or month. Like Twitter sentiment, we weighted according to the number of likes.

Analyses

We opted for a vector autoregressive (VAR) model in this study to examine the causal relationships among the variables of interest. The VAR model is a statistical technique for analyzing the behavior of two or more time series variables that influence each other (Stock & Watson, 2001). It is called an autoregressive model because each variable (also called time series) is modeled as a function of the past values. The predictors are the time-delayed values (lags) of the series. Ultimately, the goal is to use the past values of the series to forecast the current and future values. The benefit of a VAR from other autoregressive models (like AR, ARMA, or ARIMA) is that the relationship between the time series involved is bi-directional (Hashimzade, & Thornton, 2015). A typical model autoregressive equation looks like this:

$$Y_t = \alpha_t + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \cdots + \beta_p Y_{t-p} + \epsilon_t$$

α is the intercept and β_1, β_2 till β_p are the coefficients of the lags of Y till order p. The ε_t is the error.

In the VAR model, each variable is modeled separately as a linear combination of past values of itself and past values of other variables. Hence, you obtain one equation per variable. Suppose you have two variables Y_1 and Y_2 and you want to forecast the values of the variables at time (t). VAR will use the past values of both Y_1 and Y_2 to calculate $Y_{1(t)}$. Likewise, to compute $Y_{2(t)}$, it will use its own past values and the past values of Y_2. The equations if we include only one lag (VAR(1) model) would be:

$$Y_{1,t} = \alpha_1 + \beta_{11,1} Y_{1,t-1} + \beta_{12,1} Y_{2,t-1} + \epsilon_{1,t}$$
$$Y_{2,t} = \alpha_2 + \beta_{21,1} Y_{1,t-1} + \beta_{22,1} Y_{2,t-1} + \epsilon_{2,t}$$

Hence, VAR models enable researchers to capture rich dynamics in multiple time series. In our research, we have four variables: Twitter sentiment (TS), accuracy trains (acc), negativity news articles (news), and public communication (pc). As mentioned in the literature, we are mainly interested in forecasting Twitter sentiment based on the three other variables (and the past values of Twitter sentiment). The number of lags (L) will be determined later based on testing the data. Hence, the mathematical equation of the main focus (Twitter reputation as dependent variable) in this article can be found below. The other three equations can be constructed by applying the same logic.

$$Y_t^{TS} = \alpha + \sum_{l=1}^{L} \beta_{TS,l}^{TS} Y_{t-l}^{TS} + \sum_{l=1}^{L} \beta_l^{acc} Y_{TS,t-l}^{acc} + \sum_{l=1}^{L} \beta_l^{news} Y_{TS,t-l}^{news} + \sum_{l=1}^{L} \beta_l^{pc} Y_{TS,t-l}^{pc} + \epsilon_t^{TS}$$

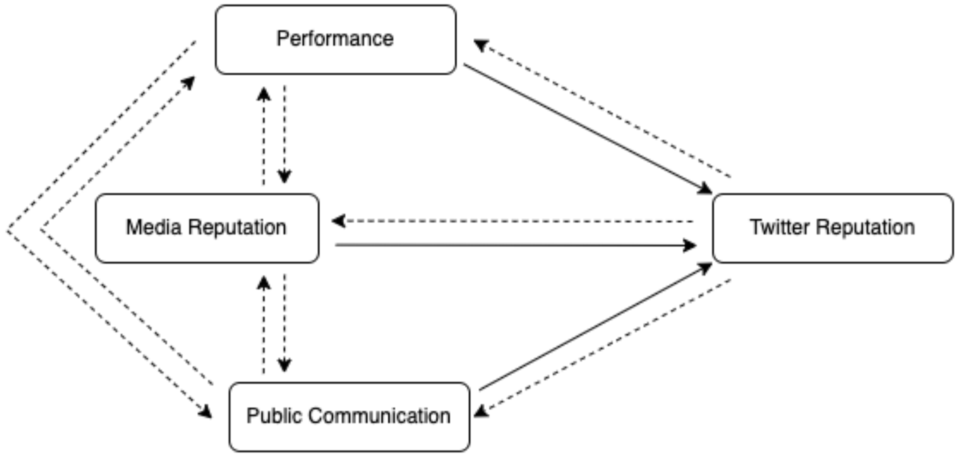

Figure 8 – The different relations tested with the VAR-model.

Figure 8 is an adaptation of the figure with the three hypotheses (bold lines). As VAR looks at all the regressions between the different variables (bi-directional), we updated the figure to include all the studied relationships. However, the focus remains on the three bold arrows.

In the following section, we construct a VAR model for the daily and monthly variables. For this, we follow the standard procedure (see Lütkepohl, 2005 and Sims, 1980) of selecting the lag order (mostly based on minimizing the SBIC and HQIC) and testing the stability condition, residual autocorrelation (with Lagrange-multiplier test), and normality (with the Jarque-Bera test). With a Granger causality test, we test for the presence of causal relationships among the variables. Granger causality concerns in-sample fitting; it tells nothing about out-of-sample forecasting. However, it is a great way to establish whether the lagged values of certain variables explain another variable, and *vice versa*. Finally, we also use the VAR model to estimate the impulse response function and forecast future values of the variables.

Results

Daily data

The descriptive statistics of our variables are reported in Table 7. The daily dataset contains 1826 observations. The variable of interest, Twitter reputation, has a mean (and median) of 0.44. On average, 44% of tweets (weighted for likes) on a day have a negative sentiment. The distribution of these different observations is almost symmetrical (0.01) and thin-tailed (3.96). The mean delay was 2546 hours a day, which seems impossible. However, this variable accumulated all the delays of every train at every station. The distribution of the delays is highly skewed. The distribution has a long right tail, suggesting a prevalence of higher delays. Public communication, calculated as the number of tweets by the NMBS divided by the total number of tweets mentioning the NMBS, has a mean value of 0.13 but is also a bit positively skewed. On an average day, 25% of the articles about the NMBS had a negative sentiment. Again, the distribution is skewed towards more negative articles, which isn't surprising as the maximum value is 1. Some days, especially days with one or a few articles, had a 100% frequency of negative articles. Lastly, the table shows the descriptives of the dummy for media storms, the second measurement of traditional media. Almost one in four days had a media storm, meaning 25 articles or more a day.

Variable	Obs.	Mean	Median	Min.	Max.	Std. Dev.	Skewness	Kurtosis
Twitter Reputation	1 826	0.440	0.441	0.043	0.950	0.115	0.013	3.965
Performance (hours)	1 826	2546.35	2462.19	460.95	10052.96	1176.40	1.029	5.562
Public Communication	1 826	0.127	0.122	0	0.517	0.084	0.666	3.759
Frequency Neg. Articles	1 826	0.253	0.250	0	1	0.217	0.626	3.188
Dummy Media Storm	1 826	0.234	0	0	1	0.423	1.258	2.582

Table 7 – Descriptive statistics of the daily data.

Figure 9 visualizes the four daily time series. The only variable with a clear pattern over time is punctuality performance. The daily hours of delay decrease over time. No noticeable pattern can be found in the other time series. The large differences between days are present for all variables.

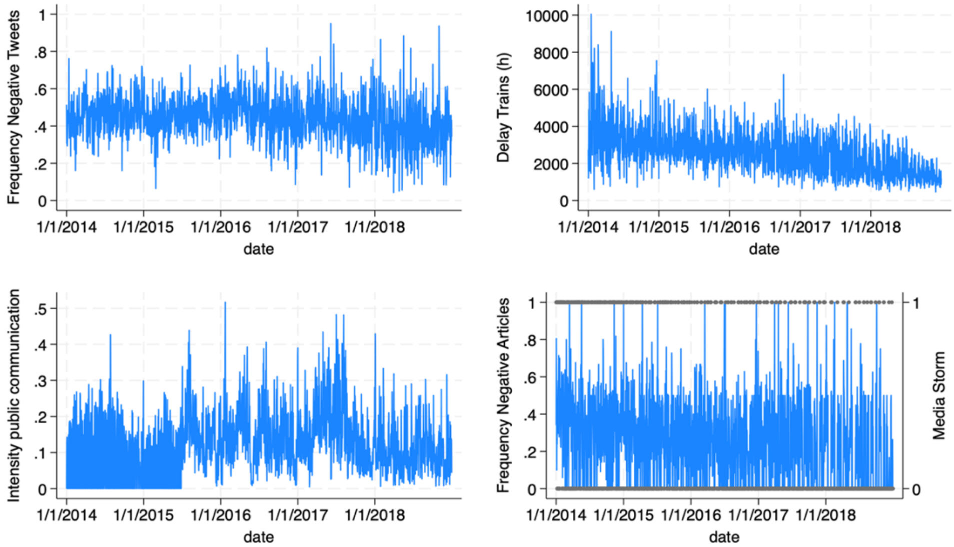

Figure 9 – Visualization of the four variables over time with daily observations.

Subsequently, we determined the number of lagged values to include in our equation by using the AIC, HQIC, and SBIC selection criteria (see Lütkepohl, 1993). These criteria disagreed about the optimal lags. SBIC advised the inclusion of 3 lags, HQIC put 7 lags forward and finally, AIC proposed 14 lags. However, all the models with the proposed lags suffered from serial correlations according to the Lagrange-multiplier test. This means the residuals aren't just white noise. This autocorrelation in the residuals should be fixed before performing a Granger causality Wald test. A way to correct serial correlation is to modify the regression equation. This can be achieved by adding a lag term. Only after including 23 lags were all assumptions satisfied. Next, we modeled the autoregression models. These results can be found in the appendix at the end of the article. For this study, the autoregressive coefficient of a certain lag is less relevant (certainly not of 23 lags of every variable). Instead, we focus on the Granger Causality test and the impulse response.

Before the Granger Causality test, we also ran the Johansen test for cointegration to investigate whether Twitter sentiment, punctuality, public communication, and news articles have a long-run statistically significant relationship. The test indicates there is no long-run association between our time series.

Maximum rank	Params	LL	Eigenvalue	Trace statistics	5% critical value
0	356	-10831.799		202.7142	47.21
1	363	-10776.397	0.05961	91.9101	29.68
2	368	-10745.094	0.03413	29.3031	15.41
3	371	-10733.573	0.01270	6.2627	3.76
4	372	-10730.442	0.00347		

Table 8 – Johansen tests for cointegration with daily observations.

In Table 9, we report the Granger causality, which is an econometric test used to verify the usefulness of one variable to forecast another. The table has two models, for each measurement of traditional media. As mentioned before, the frequency of negative articles (model A) might be the wrong variable. One negative article on a particular day could be insignificant if other days have hundreds of negative articles. Hence, we created a dummy that represents a media storm on a particular day (Model B). The first dependent variable is Twitter reputation and is the variable of interest in this paper. In both models, only the lags of punctuality are a significant predictor of Twitter reputation. We cannot reject the null hypothesis that media reputation or public communication fails to Granger-cause Twitter reputation. These two variables are not helpful for forecasting as they don't reduce the forecasting error. These findings fail to confirm two out of three of our hypotheses.

The Granger test for the other variables shows some interesting findings. Apparently, media reputation causes performance (more trains without delay). Likewise, the lag in performance granger-cause media reputation. This effect makes sense as a worse performance could lead to more negative articles (focused on bad punctuality). This establishes a bidirectional Granger causality between media reputation and performance. The same results appear when switching to a model with a different measurement for media reputation. Finally, the performance helps to predict future public communication. If the NMBS encounters more delays, the NMBS Twitter account will presumably try to respond to more tweets. Lagged values of Twitter reputation (the percentage of negative tweets) do not cause public communication at a 5% level of significance, (only at 10%). However, both the performance and Twitter reputation Granger-cause public communication in the second model. The significance of Twitter reputation on public communication is the only difference between the two different variables capturing media attention.

Dependent variable	Excluded	df	chi² (Prob > chi²) Model A (*Freq. Negative Articles)	Model B (*Dummy Media Storm)
Twitter Reputation	Performance (hours)	23	37.473 * (0.029)	43.123 ** (0.007)
	Traditional Media*	23	25.277 (0.336)	26.7 (0.269)
	Public Communication	23	26.938 (0.259)	24.603 (0.371)
	All	69	90.074 * (0.045)	91.546 * (0.036)
Performance (hours)	Twitter Reputation	23	27.969 (0.217)	29.899 (0.152)
	Traditional Media*	23	37.486 * (0.029)	52.204 *** (0.000)
	Public Communication	23	18.318 (0.740)	18.511 (0.729)
	All	69	80.852 (0.156)	95.916 * (0.018)
Traditional Media*	Twitter Reputation	23	25.888 (0.306)	21.923 (0.525)
	Performance (hours)	23	79.603 *** (0.000)	60.935 *** (0.000)
	Public Communication	23	19.665 (0.662)	17.427 (0.788)
	All	69	144.65 *** (0.000)	111.04 ** (0.001)
Public Communication	Twitter Reputation	23	33.891 (0.067)	35.853 * (0.043)
	Performance (hours)	23	48.725 ** (0.001)	46.531 ** (0.003)
	Traditional Media*	23	13.38 (0.943)	26.822 (0.264)
	All	69	95.464 * (0.019)	109.51 ** (0.001)

Table 9 – The Granger-Causality Tests for Daily observations.
*Significance levels are: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Next, we construct Impulse Response Functions, which are used to trace the dynamic impact to a system of a "shock" or change to an input. We specifically make use of the Forecast error variance decomposition (FEVD) that "decomposes" the variance of the forecast error into the contributions from specific exogenous shocks. It can also show how the importance of shocks changes over time; some impulses may not be responsible for variations in the short run but may cause longer-term fluctuations. Table 10 demonstrates that shocks are not at all important in explaining variations of the variable in the model (1%). Thus, although we established a causal impact of performance on Twitter reputation, the explained variation is extremely limited.

	(1)	(2)	(3)
0	0	0	0
1	0	0	0
2	0.000	0.001	0.003
3	0.000	0.001	0.003
4	0.000	0.002	0.004
5	0.001	0.002	0.005
6	0.002	0.003	0.005
7	0.002	0.003	0.007
8	0.003	0.003	0.007
9	0.008	0.003	0.007
10	0.009	0.003	0.007
11	0.009	0.003	0.007
12	0.009	0.003	0.008
13	0.010	0.004	0.008
14	0.010	0.008	0.008
15	0.011	0.008	0.008
16	0.011	0.009	0.009
17	0.011	0.009	0.009
18	0.011	0.009	0.010
19	0.012	0.010	0.010
20	0.012	0.010	0.012
21	0.012	0.011	0.012
22	0.014	0.011	0.012
23	0.015	0.012	0.012

Table 10 – The FEVD table for daily observations.

1) impulse = Performance (hours), and response = Twitter Reputation.

2) impulse = Media reputation (frequency), and response = Twitter Reputation.

3) impulse = Public communication, and response = Twitter Reputation.

The same uncertainty in explaining variation is demonstrated by the graph (Figure 10). The figure tries to forecast the future evolution of Twitter reputation for 100 additional days, based on the lags of Performance, media reputation, and public communication. The confidence interval (yellow and green line) is so wide that we can't consider it a successful forecasting.

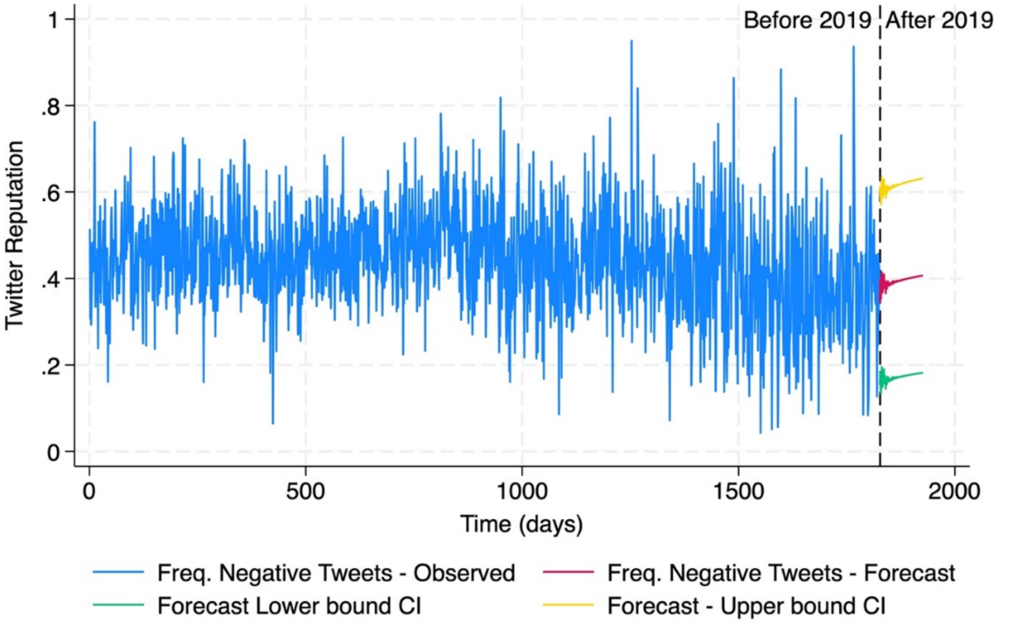

Figure 10 – 100-day forecasting of Twitter Reputation.

Monthly data

Table 11 reports the descriptive statistics of the monthly dataset with 60 observations. Twitter reputation has a mean (and median) of 0.64 which is higher than the daily average of 0.44. Almost 64% of tweets (weighted for likes) in a month have a negative sentiment. The measurement for monthly performance differs, as stated in the methodology, because it uses an official index that takes the number of passengers on board into account. On average, 87% of trains in a month arrive without delays. The distribution of the different months is negatively skewed, meaning that a lot of observations are spread on a larger left-side tail (less punctual). Public communication, calculated as the number of tweets by the NMBS divided by the total number of tweets mentioning the NMBS, has an identical mean value as the daily data, 0.13. The mean frequency of negative articles was 0.33, which is very symmetrically distributed. The monthly data is not as susceptible to outliers as the daily frequency. Days with very few articles (and hence very high or low frequencies) are leveled out by looking at full months. Although correcting for this with a dummy for media storms is not as relevant, we still included this variable in the regressions. 28% of months had a media storm of at least 600 published articles.

Variable	Obs.	Mean	Median	Min.	Max.	Std. Dev.	Skewness	Kurtosis
Twitter Reputation	60	0.638	0.636	0.499	0.808	0.060	0.363	3.172
Performance (index)	60	0.868	0.874	0.786	0.936	0.036	-0.498	2.706
Public Communication	60	0.133	0.130	0.056	0.215	0.040	0.307	2.127
Frequency Neg. articles	60	0.326	0.331	0.195	0.464	0.076	0.025	1.802
Dummy Media Storm	60	0.283	0	0	1	0.454	0.962	1.924

Table 11 – Descriptive statistics of the monthly data.

Recognizing patterns is, similar to the daily data, not possible. Not even the performance indicator (punctuality) has a clear downward trend. Again, it should be noted that this is a different measurement than in the previous section where we used hours of the delay. Infrabel publishes a monthly percentage calculated based on how many trains railed without delay while taking the number of passengers into account.

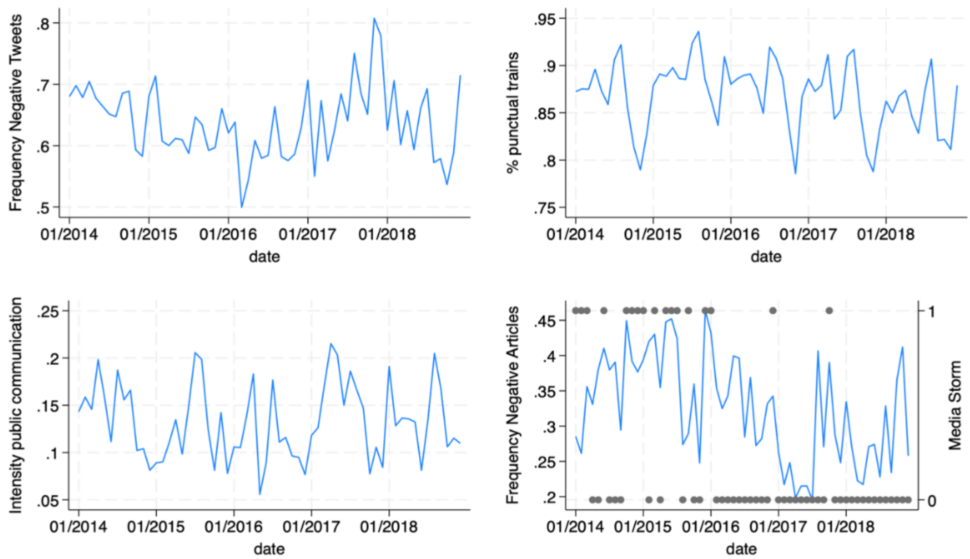

Figure 11 – Visualization of the four variables over time with monthly observations.

For the monthly data, we work with seven lags. In this model, there is no problem with serial correlation (or stationarity or normality). As before, the results of the regressions are detailed in the appendix. The Johansen test for cointegration shows that at maximum rank one, the trace statistic (24.7244) does not exceed the critical values (29.68). Therefore, we accept the null hypothesis that there is a cointegration of one equation. If time series are cointegrated, there must exist Granger causality (either uni- or bi-directional).

Maximum rank	Params	LL	Eigenvalue	Trace statistics	5% critical value
0	100	406.19821		75.2938	47.21
1	107	431.48289	0.61486	24.7244*	29.68
2	112	438.00543	0.21818	11.6793	15.41
3	115	442.63168	0.16019	2.4268	3.76
4	116	443.8451	0.04476		

Table 12 – Johansen tests for cointegration with monthly observations.

Indeed, as suggested by the Johansen test, there is some Granger-causality. However, this causal effect is not situated at the variable of interest, Twitter reputation in the first model. No variable, not even performance, is significant when Twitter reputation is the dependent variable with monthly data. The causality for the first model can be found with Performance and public communication. All three time series (either Twitter reputation, media reputation, and public communication for performance and Twitter reputation, media reputation, and performance for public communication) have a significant causal effect. For public communication, these findings could be expected. The proportion of negative tweets posted about the NMBS, the actual performance, or media attention could all reasonably influence public communication efforts. This is less so for forecasting performance (with Twitter reputation, media reputation, and public communication). For media reputation, only public communication has a Granger-causal effect. Granger tests with a dummy for media attention (instead of percentage negative tweets), gave different results. Only the findings for the dependent variable performance are identical. For Twitter reputation, public communication has a causal effect, which is unlike previous models. Media storm is significantly influenced by all other time series. Finally, Twitter reputation and performance (not media storms) have a causal relationship to public communication.

Dependent variable	Excluded	df	chi^2 (Prob > chi^2)	
			Model A (*Freq. Negative Articles)	Model B (*Dummy Media Storm)
Twitter Reputation	Performance (index)	7	4.562 (0.713)	4.868 (0.676)
	Traditional Media*	7	2.991 (0.886)	7.387 (0.390)
	Public Communication	7	12.233 (0.093)	20.254 ** (0.005)
	All	21	31.773 (0.062)	38.43 * (0.011)
Performance (index)	Twitter Reputation	7	16.243 * (0.023)	46.601 *** (0.000)
	Traditional Media*	7	17.164 * (0.016)	55.724 *** (0.000)
	Public Communication	7	47.215 *** (0.000)	70.883 *** (0.000)
	All	21	94.252 *** (0.000)	175.18 *** (0.000)
Traditional Media*	Twitter Reputation	7	13.069 (0.070)	19.867 ** (0.006)
	Performance (index)	7	11.213 (0.130)	31.266 *** (0.000)
	Public Communication	7	20.055 ** (0.005)	19.901 ** (0.006)
	All	21	31.016 (0.073)	53.4 *** (0.000)
Public Communication	Twitter Reputation	7	29.263 *** (0.000)	23.894 ** (0.001)
	Performance (index)	7	19.812 ** (0.006)	16.204 * (0.023)
	Traditional Media*	7	16.211 * (0.023)	9.999 (0.189)
	All	21	62.853 *** (0.000)	52.455 *** (0.000)

Table 13 – The Granger-Causality Tests for Monthly observations.
*Significance levels are: *p < 0.05, ** p < 0.01, *** p < 0.001.*

As the Granger test did not reveal significant effects (except for public communication when media storms were included), the Forecast error variance decomposition similarly showed no notable effects (maximum 14%). Forecasting future evolutions of Twitter reputation based on monthly data is equally unsuccessful (see Figure 12).

	(1)	(2)	(3)
0	0	0	0
1	0	0	0
2	0.000	0.004	0.018
3	0.010	0.006	0.018
4	0.019	0.009	0.038
5	0.021	0.009	0.089
6	0.023	0.051	0.123
7	0.048	0.048	0.139

Table 14 – The FEVD table for monthly observations.

(1) impulse = Performance (index), and response = Twitter Reputation.
(2) impulse = Media reputation (frequency), and response = Twitter Reputation.
(3) impulse = Public communication, and response = Twitter Reputation.

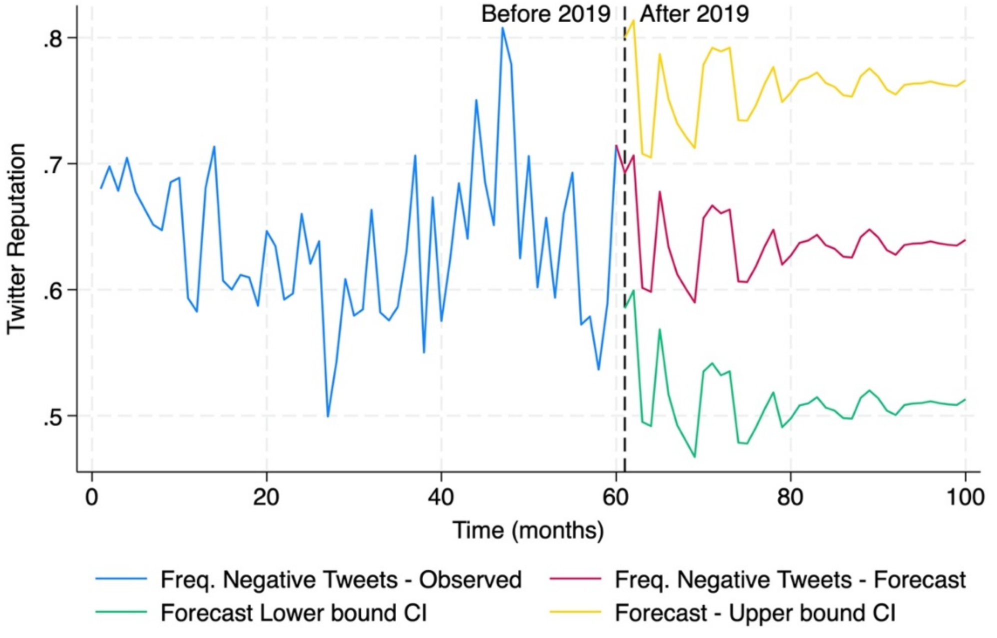

Figure 12 – 40-month forecasting of Twitter Reputation.

Discussion

Based on the literature review we identified three potential variables that could influence Twitter sentiment. The performance, media reputation, and public communication have all proven to impact an organization's reputation. The idea was that the same variables would also cause changes in Twitter reputation. To test this, we looked at both daily and monthly data concerning the NMBS. The daily optimizes the available data by looking at the smallest unit of time available. The monthly data has the benefit that it allows for the accumulation of reputation over a longer period. For the daily analyses, only the performance proved to have a causal effect on Twitter reputation. If performance improves, so does the sentiment on Twitter a couple of days later. Media reputation (both measured as a sentiment index and media storm), and the intensity of public communication had no significant effect on the future values of Twitter reputation.

The monthly data showed different results. At first, no variable had a significant impact. A potential reason performance is not significant anymore is that the effect occurs within a month, not over different months. Improved punctuality improves perceptions for a few days, but the effect does not linger for weeks. Furthermore, working with monthly data means there could be considerable variations within that aren't captured by the index. A monthly average of punctuality could mean a service customer had some terrible and great days/weeks which cancel each other out on a monthly basis. Also theoretically, for a performance to influence the Twitter reputation for several months afterward it would have to be exceptionally memorable, which is harder to statistically establish. In the second VAR-model, with a dummy for media storm, public communication is the only significant effect. The intensity of public communication in one month caused changes in the negativity of tweets in the subsequent months. As this effect is only noticeable when including a dummy for media storms, there must be some interplay between public communication and media coverage that makes public communication a significant causal influence on Twitter reputation. It is important to keep in mind that comparing daily, and monthly results is hampered by the fact that the measurement of punctuality differs. This might be one reason why the differences between the two time series differ substantially.

As a result of the limited findings of causal effects for Twitter reputation, we were unable to reliably predict the future values of Twitter reputation. There are several explanations as to why the findings didn't establish many significant causal effects, unlike the expectations from the literature. The first reason has already been touched upon when explaining the difference between daily and monthly findings. The same arguments, for example that the effect occurs within a month, hold for the other variables. Even in the daily data, the effect could be (more) instantly. For example, public communication about delays during morning rush hour could influence tweets posted the following hours. It is less likely for the influence to only occur with huge delays. Hence, using the lags of our three variables to explain later Twitter reputation might be the wrong approach. A second explanation is about the operationalization of our variables. The lack of effects can be a result of our measurements. Besides averaging the data to days or months, classifying tweets or media coverages into two categories is also a very crude operationalization that does not include a lot of details (concerning for example the topics of tweets, and media articles). For tweets, we did include weights according to the reach (number of likes), but for media articles, we could not adjust according to the number of readers. Some articles might have more impact on public perceptions than others. A third and final explanation concerns other variables for which we don't control. Presumably, social media dynamics are too complex to be reduced to changes of three variables. Even more so, because of the nature of social media where everybody can post something, there will always remain a high level of unpredictability.

The benefit of a VAR is that the studied relationship between the time series is bi-directional. So, although the focus was predicting future Twitter reputation, we also found interesting causal mechanisms related to other variables. In the daily data, we established a bidirectional causality between media reputation and performance. Improvements (or deteriorations) in punctuality lead to better (or worse) media coverage. Similarly, the performance is also a subject of media reputation. However, this last effect might just be the result of a naturally occurring improvement after some bad performances. A few days of really bad performance might be followed by some media coverage (the first causal effect). An improvement thereafter is not necessarily the result of media attention, but perhaps due to technical solutions that took a few days to implement. Also, the performance helps to predict future public communication. Hence, punctuality (or lack thereof) influences the future intensity of Twitter activity by the NMBS Twitter account. Additionally, previous Twitter reputation impacted public communication in one model at $p<0.05$ (with media storm) and $p<0.1$ in the other model (with media sentiment). Surprisingly, we could not establish a relationship between traditional media and Twitter reputation; the sentiment or the number of media articles had no impact on the sentiment on Twitter and *vice versa*. Intermedia agenda-setting research, meaning the study of content transfers between different media, has suggested that traditional media and social media can function as inspiration or source material for each other (*Harder et al.*,2017).

The monthly data showed some different effects but was highly inconsistent between the two models. As the monthly results are very sensitive according to the operationalization of the media variable (media reputation or media storm), it is difficult to interpret these findings. However, there is one causal relation from the monthly data worth discussing. In the literature section, we discussed how media logic can influence people's perceptions. As such, media logic provides challenges for public organizations and has affected organizational activities, routines, decisions, resource allocation, and communication (Fredriksson & Pallas, 2020). This process, called mediatization, means that public organizations adopt new strategies to cope with media pressure (Thorbjørnsrud, 2015). Traditional public service ethos (neutrality, impartiality, transparency, etc.) are challenged as civil servants try to prevent, anticipate, and defend against critical news stories through the steering information output. Nuancing or countering the often sensationalist and negative news is not always successful, which might lead a public organization to adopt a proactive strategy that actively promotes 'positive' news. Regardless of negativity or selectivity bias (Boon *et al.*, 2019b) present in the media coverage, research indicates that reputationally conscious public agencies could invest in agency strategizing to defend or promote their reputation (Busuioc & Lodge, 2016; Carpenter, 2001, 2010a; Gilad *et al.*, 2015; Maor, 2011, 2014; Maor *et al.*, 2012; Rimkutė, 2019). Hence, public communication from strategical public organizations might influence media coverage, which in turn could influence people's perceptions. We only see a significant effect of online public communication on media reputation in the monthly analyses. Future research should keep in mind that the relationships between performance, public communication (both offline and online), media reputation, and public perceptions are more complex than characterized in this research.

Conclusion

In this research, we tried to forecast the Twitter reputation of the Belgian Railway company based on changes in performance, media reputation, and public communication strategies. With automated text analyses, we constructed a daily and monthly negativity index by dividing the number of negative tweets by the total number of tweets mentioning the NMBS that day or month respectively. We worked with two variables measuring media reputation. The first used the percentage of negative articles (again constructed with automated text analyses) on a day or month. The second media variable is a dummy, indicating whether a high number of articles were posted on a day or month. Punctuality data was used as a proxy for the actual performance of the NMBS.

For the monthly data, we relied on an index published by Infrabel that measures the percentage of trains without delay. This index is weighted according to how many people experienced the delay. The daily data, due to the unavailability of the index, was calculated by adding all delays (in hours) at the arrival at a train station for each train. Finally, public communication was obtained by dividing the number of tweets and replies of the NMBS by the total amount of tweets mentioning the NMBS that day or month. Again, we weighted according to the number of likes. This provided us with a measurement of the intensity of public communication.

Based on insights from the literature, we expected the three variables to have a causal effect on Twitter reputation. To test the causal relationships among the different variables, we deployed a vector autoregressive (VAR) model. This statistical technique can analyse the behavior of two or more time series that influence each other (Stock & Watson, 2001). It does this by modeling each variable as a function of the past values. With the daily data, only the performance proved to have a causal effect on Twitter reputation. With the monthly data, only public communication had a significant effect in one of the two models. The lack of significant findings could be the result of our operationalization and the chosen analyses. Not being able to see the interplay of the dynamics within the time unit is a severe limitation. Daily and monthly data aggregate everything that happens within. People do not wait a day to tweet about a delay, making the effect of the different variables immediate. Although, as demonstrated in this paper, there might be something that continues to resonate in the days or months afterwards. People who experience a delay (or not) still carry that feeling with them for a couple of days, making them more (or less) prone to tweet negatively about the NMBS. Regardless, this paper showed that predicting Twitter reputation isn't a straightforward endeavor. Because anyone can share something about anything, social media sentiment is and will always be to some degree unpredictable.

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Appendix: Results Vector autoregression

Daily results

Model A

Sample: 24 thru 1826	Number of obs = 1803
Log likelihood = -10730.44	AIC = 12.31552
FPE = 2.623158	HQIC = 12.73416
DET (Sigma_ml) = 1.735624	SBIC = 13.44972

Equation	Parms	RMSE	R-sq	chi2	P>chi2
Twitter Reputation	93	.109685	0.1402	293.9217	0.0000
Performance (hours)	93	951.707	0.3521	979.7155	0.0000
Traditional Media (Frequency)	93	.202373	0.1667	360.6265	0.0000
Public Communication	93	.069915	0.3445	947.3643	0.0000

	Coefficient	Std. err.	z	P>z	[95% conf. interval]	
Twitter Reputation						
Twitter Reputation						
L1.	0.159	0.024	6.740	0.000	0.113	0.206
L2.	0.067	0.024	2.800	0.005	0.020	0.114
L3.	0.036	0.024	1.520	0.129	-0.011	0.083
L4.	-0.012	0.024	-0.510	0.614	-0.059	0.035
L5.	-0.037	0.024	-1.530	0.125	-0.084	0.010
L6.	0.016	0.024	0.680	0.499	-0.031	0.063
L7.	0.010	0.024	0.430	0.665	-0.037	0.057
L8.	0.004	0.024	0.170	0.863	-0.043	0.051
L9.	0.044	0.024	1.810	0.070	-0.004	0.091
L10.	0.046	0.024	1.930	0.054	-0.001	0.093
L11.	0.029	0.024	1.190	0.235	-0.019	0.076
L12.	-0.015	0.024	-0.620	0.532	-0.062	0.032
L13.	0.003	0.024	0.110	0.915	-0.045	0.050
L14.	0.062	0.024	2.590	0.009	0.015	0.109
L15.	-0.028	0.024	-1.150	0.249	-0.075	0.019
L16.	0.016	0.024	0.690	0.493	-0.031	0.064
L17.	0.011	0.024	0.460	0.642	-0.036	0.058
L18.	0.013	0.024	0.530	0.595	-0.034	0.060
L19.	0.001	0.024	0.020	0.983	-0.047	0.048
L20.	0.024	0.024	0.980	0.326	-0.024	0.071
L21.	-0.008	0.024	-0.340	0.735	-0.055	0.039
L22.	-0.015	0.024	-0.620	0.534	-0.062	0.032
L23.	0.029	0.024	1.230	0.217	-0.017	0.076

Performance (hours)						
L1.	-0.000	0.000	-0.540	0.588	-0.000	0.000
L2.	0.000	0.000	0.180	0.859	-0.000	0.000
L3.	-0.000	0.000	-0.380	0.706	-0.000	0.000
L4.	0.000	0.000	1.150	0.250	-0.000	0.000
L5.	0.000	0.000	1.210	0.227	-0.000	0.000
L6.	-0.000	0.000	-0.280	0.778	-0.000	0.000
L7.	0.000	0.000	1.750	0.079	-0.000	0.000
L8.	0.000	0.000	2.740	0.006	0.000	0.000
L9.	0.000	0.000	0.250	0.805	-0.000	0.000
L10.	-0.000	0.000	-0.700	0.484	-0.000	0.000
L11.	-0.000	0.000	-0.170	0.864	-0.000	0.000
L12.	0.000	0.000	1.430	0.152	-0.000	0.000
L13.	-0.000	0.000	-0.090	0.932	-0.000	0.000
L14.	0.000	0.000	0.910	0.365	-0.000	0.000
L15.	-0.000	0.000	-0.370	0.713	-0.000	0.000
L16.	-0.000	0.000	-1.010	0.315	-0.000	0.000
L17.	-0.000	0.000	-0.850	0.397	-0.000	0.000
L18.	0.000	0.000	0.750	0.454	-0.000	0.000
L19.	0.000	0.000	0.650	0.514	-0.000	0.000
L20.	0.000	0.000	0.830	0.405	-0.000	0.000
L21.	0.000	0.000	1.120	0.264	-0.000	0.000
L22.	0.000	0.000	0.060	0.952	-0.000	0.000
L23.	0.000	0.000	1.470	0.141	-0.000	0.000
Traditional Media (Frequency)						
L1.	0.012	0.013	0.970	0.331	-0.013	0.038
L2.	0.003	0.013	0.260	0.795	-0.022	0.029
L3.	-0.027	0.013	-2.100	0.036	-0.053	-0.002
L4.	0.003	0.013	0.190	0.845	-0.023	0.028
L5.	-0.005	0.013	-0.350	0.727	-0.030	0.021
L6.	-0.008	0.013	-0.620	0.535	-0.034	0.017
L7.	0.013	0.013	1.010	0.313	-0.012	0.039
L8.	-0.002	0.013	-0.160	0.875	-0.028	0.024
L9.	-0.011	0.013	-0.830	0.408	-0.036	0.015
L10.	-0.010	0.013	-0.750	0.454	-0.035	0.016
L11.	-0.002	0.013	-0.140	0.887	-0.028	0.024
L12.	-0.006	0.013	-0.450	0.652	-0.032	0.020
L13.	-0.035	0.013	-2.670	0.008	-0.060	-0.009
L14.	0.000	0.013	0.030	0.980	-0.025	0.026
L15.	0.014	0.013	1.100	0.272	-0.011	0.040
L16.	-0.003	0.013	-0.270	0.789	-0.029	0.022

L17.	-0.012	0.013	-0.930	0.352	-0.038	0.013
L18.	-0.017	0.013	-1.280	0.201	-0.042	0.009
L19.	0.004	0.013	0.300	0.762	-0.022	0.029
L20.	0.023	0.013	1.780	0.075	-0.002	0.049
L21.	-0.006	0.013	-0.500	0.619	-0.032	0.019
L22.	0.001	0.013	0.090	0.927	-0.024	0.027
L23.	-0.012	0.013	-0.920	0.359	-0.037	0.013
Public Communication						
L1.	0.081	0.037	2.190	0.029	0.009	0.154
L2.	-0.004	0.038	-0.100	0.919	-0.079	0.071
L3.	0.048	0.038	1.260	0.207	-0.026	0.122
L4.	-0.006	0.038	-0.160	0.871	-0.081	0.068
L5.	-0.020	0.038	-0.520	0.602	-0.094	0.055
L6.	0.066	0.038	1.740	0.082	-0.008	0.140
L7.	-0.016	0.038	-0.410	0.680	-0.090	0.059
L8.	-0.014	0.038	-0.350	0.724	-0.089	0.062
L9.	-0.025	0.038	-0.640	0.522	-0.100	0.051
L10.	-0.002	0.038	-0.050	0.957	-0.076	0.072
L11.	-0.058	0.038	-1.530	0.126	-0.132	0.016
L12.	0.017	0.038	0.450	0.655	-0.057	0.091
L13.	0.021	0.038	0.570	0.572	-0.053	0.095
L14.	-0.034	0.038	-0.910	0.363	-0.108	0.040
L15.	0.034	0.038	0.890	0.373	-0.041	0.109
L16.	-0.034	0.038	-0.880	0.379	-0.108	0.041
L17.	0.036	0.038	0.950	0.343	-0.038	0.110
L18.	0.037	0.038	0.980	0.327	-0.037	0.110
L19.	-0.086	0.038	-2.300	0.021	-0.160	-0.013
L20.	-0.015	0.038	-0.400	0.690	-0.089	0.059
L21.	0.042	0.038	1.120	0.262	-0.031	0.116
L22.	0.002	0.038	0.040	0.967	-0.073	0.076
L23.	0.019	0.037	0.520	0.601	-0.053	0.091
_cons	0.179	0.027	6.640	0.000	0.126	0.231
Performance (hours)						
Twitter Reputation						
L1.	-118.137	205.185	-0.580	0.565	-520.293	284.019
L2.	-54.699	207.739	-0.260	0.792	-461.861	352.462
L3.	301.843	208.131	1.450	0.147	-106.086	709.772
L4.	-72.168	207.900	-0.350	0.728	-479.645	335.308
L5.	106.192	207.806	0.510	0.609	-301.101	513.484
L6.	-40.856	208.010	-0.200	0.844	-448.548	366.835

L7.	-33.701	208.236	-0.160	0.871	-441.837	374.435
L8.	666.098	208.571	3.190	0.001	257.306	1074.889
L9.	-208.528	209.033	-1.000	0.318	-618.225	201.169
L10.	314.915	208.660	1.510	0.131	-94.052	723.881
L11.	-44.679	208.619	-0.210	0.830	-453.564	364.206
L12.	-293.413	208.478	-1.410	0.159	-702.022	115.197
L13.	231.812	208.529	1.110	0.266	-176.897	640.521
L14.	258.759	208.513	1.240	0.215	-149.919	667.437
L15.	2.427	208.788	0.010	0.991	-406.790	411.644
L16.	-5.077	208.551	-0.020	0.981	-413.830	403.676
L17.	8.666	208.425	0.040	0.967	-399.840	417.173
L18.	-146.045	209.082	-0.700	0.485	-555.839	263.749
L19.	-261.893	208.928	-1.250	0.210	-671.384	147.598
L20.	166.714	209.177	0.800	0.425	-243.266	576.694
L21.	411.142	209.190	1.970	0.049	1.137	821.147
L22.	-35.124	208.939	-0.170	0.867	-444.635	374.388
L23.	80.881	206.298	0.390	0.695	-323.456	485.218
Performance (hours)						
L1.	0.067	0.024	2.840	0.005	0.021	0.113
L2.	0.049	0.024	2.060	0.039	0.002	0.095
L3.	0.077	0.024	3.280	0.001	0.031	0.124
L4.	0.068	0.024	2.880	0.004	0.022	0.114
L5.	-0.020	0.024	-0.850	0.397	-0.066	0.026
L6.	0.034	0.024	1.430	0.152	-0.012	0.080
L7.	0.015	0.024	0.630	0.530	-0.031	0.061
L8.	0.060	0.023	2.560	0.010	0.014	0.106
L9.	0.049	0.023	2.090	0.036	0.003	0.095
L10.	0.063	0.023	2.700	0.007	0.017	0.109
L11.	0.009	0.023	0.400	0.692	-0.037	0.055
L12.	-0.043	0.023	-1.820	0.068	-0.089	0.003
L13.	0.046	0.023	1.960	0.050	-0.000	0.092
L14.	-0.010	0.023	-0.440	0.662	-0.056	0.036
L15.	0.021	0.023	0.880	0.380	-0.025	0.066
L16.	0.016	0.023	0.690	0.493	-0.030	0.062
L17.	0.013	0.023	0.540	0.588	-0.033	0.058
L18.	0.040	0.023	1.730	0.083	-0.005	0.086
L19.	0.034	0.023	1.470	0.142	-0.011	0.080
L20.	0.082	0.023	3.540	0.000	0.037	0.128
L21.	0.081	0.023	3.470	0.001	0.035	0.126
L22.	0.020	0.023	0.860	0.391	-0.026	0.066
L23.	0.040	0.023	1.720	0.085	-0.005	0.085

Traditional Media (Frequency)						
L1.	294.130	110.962	2.650	0.008	76.649	511.611
L2.	194.944	112.638	1.730	0.084	-25.823	415.711
L3.	12.149	113.056	0.110	0.914	-209.437	233.736
L4.	187.236	113.265	1.650	0.098	-34.758	409.231
L5.	-87.604	113.072	-0.770	0.438	-309.222	134.013
L6.	119.787	113.144	1.060	0.290	-101.971	341.544
L7.	102.546	113.330	0.900	0.366	-119.577	324.668
L8.	0.140	113.333	0.000	0.999	-221.989	222.269
L9.	-3.299	113.391	-0.030	0.977	-225.540	218.942
L10.	-196.471	113.407	-1.730	0.083	-418.745	25.803
L11.	-105.846	113.644	-0.930	0.352	-328.585	116.893
L12.	-111.216	113.432	-0.980	0.327	-333.538	111.107
L13.	187.416	113.298	1.650	0.098	-34.645	409.476
L14.	186.134	113.413	1.640	0.101	-36.152	408.419
L15.	93.688	113.386	0.830	0.409	-128.545	315.921
L16.	-26.392	113.242	-0.230	0.816	-248.341	195.558
L17.	-84.476	113.095	-0.750	0.455	-306.138	137.187
L18.	-56.744	112.979	-0.500	0.615	-278.179	164.691
L19.	94.835	113.041	0.840	0.402	-126.722	316.393
L20.	-104.996	113.017	-0.930	0.353	-326.505	116.513
L21.	-85.123	112.920	-0.750	0.451	-306.442	136.195
L22.	-17.276	112.356	-0.150	0.878	-237.490	202.938
L23.	171.301	110.568	1.550	0.121	-45.408	388.010
Public Communication						
L1.	-100.649	322.667	-0.310	0.755	-733.064	531.766
L2.	-104.389	331.112	-0.320	0.753	-753.358	544.579
L3.	-306.200	328.950	-0.930	0.352	-950.930	338.529
L4.	-226.771	329.603	-0.690	0.491	-872.780	419.239
L5.	465.389	329.159	1.410	0.157	-179.752	1110.529
L6.	-224.437	329.139	-0.680	0.495	-869.538	420.663
L7.	155.882	328.960	0.470	0.636	-488.868	800.633
L8.	-322.118	332.180	-0.970	0.332	-973.178	328.942
L9.	-1.485	332.817	0.000	0.996	-653.795	650.825
L10.	76.769	328.678	0.230	0.815	-567.427	720.966
L11.	-136.574	328.525	-0.420	0.678	-780.471	507.322
L12.	195.059	328.245	0.590	0.552	-448.290	838.408
L13.	-439.274	327.505	-1.340	0.180	-1081.172	202.624
L14.	-3.919	327.584	-0.010	0.990	-645.971	638.134
L15.	25.721	331.502	0.080	0.938	-624.012	675.454
L16.	173.625	331.212	0.520	0.600	-475.538	822.787
L17.	586.001	326.661	1.790	0.073	-54.243	1226.246

L18.	213.071	325.995	0.650	0.513	-425.867	852.009
L19.	-28.776	325.637	-0.090	0.930	-667.014	609.462
L20.	-384.600	326.111	-1.180	0.238	-1023.764	254.565
L21.	-397.783	325.755	-1.220	0.222	-1036.250	240.685
L22.	359.561	327.852	1.100	0.273	-283.018	1002.140
L23.	-140.051	319.182	-0.440	0.661	-765.636	485.534
_cons	-200.490	233.412	-0.860	0.390	-657.969	256.989

Traditional Media (Frequency)						
Twitter Reputation						
L1.	-0.002	0.044	-0.040	0.967	-0.087	0.084
L2.	0.030	0.044	0.690	0.491	-0.056	0.117
L3.	0.033	0.044	0.740	0.458	-0.054	0.120
L4.	-0.026	0.044	-0.580	0.560	-0.112	0.061
L5.	0.035	0.044	0.780	0.433	-0.052	0.121
L6.	0.010	0.044	0.230	0.817	-0.076	0.097
L7.	-0.129	0.044	-2.920	0.004	-0.216	-0.042
L8.	-0.003	0.044	-0.060	0.949	-0.090	0.084
L9.	0.015	0.044	0.350	0.727	-0.072	0.103
L10.	0.025	0.044	0.560	0.578	-0.062	0.112
L11.	0.097	0.044	2.180	0.029	0.010	0.184
L12.	0.015	0.044	0.340	0.733	-0.072	0.102
L13.	0.003	0.044	0.070	0.948	-0.084	0.090
L14.	-0.030	0.044	-0.680	0.498	-0.117	0.057
L15.	-0.010	0.044	-0.220	0.824	-0.097	0.077
L16.	0.016	0.044	0.370	0.710	-0.070	0.103
L17.	-0.027	0.044	-0.600	0.546	-0.114	0.060
L18.	0.003	0.044	0.070	0.942	-0.084	0.090
L19.	0.102	0.044	2.300	0.021	0.015	0.189
L20.	-0.003	0.044	-0.070	0.945	-0.090	0.084
L21.	0.016	0.044	0.370	0.715	-0.071	0.103
L22.	-0.035	0.044	-0.790	0.432	-0.122	0.052
L23.	-0.031	0.044	-0.700	0.483	-0.117	0.055
Performance (hours)						
L1.	0.000	0.000	3.810	0.000	0.000	0.000
L2.	0.000	0.000	0.920	0.356	-0.000	0.000
L3.	0.000	0.000	1.830	0.067	-0.000	0.000
L4.	-0.000	0.000	-0.180	0.857	-0.000	0.000
L5.	0.000	0.000	1.180	0.238	-0.000	0.000
L6.	0.000	0.000	0.210	0.831	-0.000	0.000
L7.	0.000	0.000	0.980	0.329	-0.000	0.000

L8.	0.000	0.000	0.870	0.382	-0.000	0.000
L9.	0.000	0.000	0.010	0.995	-0.000	0.000
L10.	0.000	0.000	1.880	0.060	-0.000	0.000
L11.	-0.000	0.000	-0.710	0.481	-0.000	0.000
L12.	0.000	0.000	2.840	0.005	0.000	0.000
L13.	-0.000	0.000	-0.710	0.476	-0.000	0.000
L14.	0.000	0.000	1.230	0.218	-0.000	0.000
L15.	0.000	0.000	0.030	0.980	-0.000	0.000
L16.	-0.000	0.000	-0.790	0.430	-0.000	0.000
L17.	0.000	0.000	1.090	0.274	-0.000	0.000
L18.	0.000	0.000	0.200	0.840	-0.000	0.000
L19.	-0.000	0.000	-0.770	0.441	-0.000	0.000
L20.	-0.000	0.000	-0.130	0.894	-0.000	0.000
L21.	0.000	0.000	0.630	0.532	-0.000	0.000
L22.	0.000	0.000	1.260	0.206	-0.000	0.000
L23.	0.000	0.000	0.760	0.446	-0.000	0.000
Traditional Media (Frequency)						
L1.	0.163	0.024	6.900	0.000	0.116	0.209
L2.	0.076	0.024	3.160	0.002	0.029	0.123
L3.	0.036	0.024	1.490	0.137	-0.011	0.083
L4.	0.000	0.024	0.000	0.996	-0.047	0.047
L5.	0.021	0.024	0.860	0.389	-0.026	0.068
L6.	-0.063	0.024	-2.610	0.009	-0.110	-0.016
L7.	-0.040	0.024	-1.670	0.096	-0.087	0.007
L8.	-0.047	0.024	-1.950	0.051	-0.094	0.000
L9.	0.015	0.024	0.630	0.530	-0.032	0.062
L10.	-0.035	0.024	-1.460	0.144	-0.082	0.012
L11.	-0.050	0.024	-2.090	0.037	-0.098	-0.003
L12.	-0.046	0.024	-1.900	0.057	-0.093	0.001
L13.	-0.001	0.024	-0.040	0.965	-0.048	0.046
L14.	-0.015	0.024	-0.620	0.538	-0.062	0.032
L15.	0.019	0.024	0.790	0.430	-0.028	0.066
L16.	-0.045	0.024	-1.890	0.059	-0.093	0.002
L17.	-0.024	0.024	-0.990	0.324	-0.071	0.023
L18.	-0.004	0.024	-0.150	0.878	-0.051	0.043
L19.	-0.001	0.024	-0.030	0.977	-0.048	0.046
L20.	-0.013	0.024	-0.540	0.591	-0.060	0.034
L21.	0.019	0.024	0.800	0.426	-0.028	0.066
L22.	0.018	0.024	0.760	0.449	-0.029	0.065
L23.	-0.033	0.024	-1.400	0.162	-0.079	0.013
Public Communication						

L1.	-0.043	0.069	-0.630	0.531	-0.177	0.092
L2.	-0.018	0.070	-0.260	0.797	-0.156	0.120
L3.	0.074	0.070	1.050	0.292	-0.063	0.211
L4.	-0.019	0.070	-0.270	0.787	-0.156	0.118
L5.	0.073	0.070	1.040	0.296	-0.064	0.210
L6.	-0.060	0.070	-0.860	0.389	-0.197	0.077
L7.	0.034	0.070	0.490	0.622	-0.103	0.172
L8.	0.172	0.071	2.440	0.015	0.034	0.311
L9.	-0.086	0.071	-1.210	0.226	-0.224	0.053
L10.	-0.068	0.070	-0.970	0.333	-0.205	0.069
L11.	0.009	0.070	0.130	0.893	-0.128	0.146
L12.	0.021	0.070	0.300	0.760	-0.116	0.158
L13.	-0.005	0.070	-0.070	0.944	-0.141	0.132
L14.	0.032	0.070	0.470	0.642	-0.104	0.169
L15.	-0.024	0.070	-0.340	0.735	-0.162	0.114
L16.	0.065	0.070	0.920	0.355	-0.073	0.203
L17.	-0.033	0.069	-0.470	0.638	-0.169	0.103
L18.	0.060	0.069	0.870	0.384	-0.076	0.196
L19.	-0.126	0.069	-1.820	0.069	-0.261	0.010
L20.	-0.010	0.069	-0.140	0.890	-0.146	0.126
L21.	-0.011	0.069	-0.160	0.869	-0.147	0.124
L22.	-0.095	0.070	-1.370	0.171	-0.232	0.041
L23.	-0.051	0.068	-0.750	0.451	-0.184	0.082
_cons	0.022	0.050	0.440	0.657	-0.075	0.119
Public Communication						
Twitter Reputation						
L1.	0.015	0.015	0.980	0.326	-0.015	0.044
L2.	0.018	0.015	1.150	0.251	-0.012	0.047
L3.	0.013	0.015	0.850	0.394	-0.017	0.043
L4.	0.010	0.015	0.640	0.523	-0.020	0.040
L5.	0.019	0.015	1.260	0.207	-0.011	0.049
L6.	-0.002	0.015	-0.160	0.871	-0.032	0.027
L7.	0.006	0.015	0.380	0.705	-0.024	0.036
L8.	-0.010	0.015	-0.680	0.496	-0.040	0.020
L9.	0.016	0.015	1.030	0.305	-0.014	0.046
L10.	0.004	0.015	0.280	0.780	-0.026	0.034
L11.	0.012	0.015	0.800	0.425	-0.018	0.042
L12.	-0.026	0.015	-1.720	0.085	-0.056	0.004
L13.	0.025	0.015	1.620	0.106	-0.005	0.055
L14.	0.009	0.015	0.590	0.552	-0.021	0.039
L15.	0.018	0.015	1.140	0.253	-0.013	0.048

L16.	0.019	0.015	1.220	0.221	-0.011	0.049
L17.	-0.053	0.015	-3.450	0.001	-0.083	-0.023
L18.	0.026	0.015	1.700	0.089	-0.004	0.056
L19.	0.007	0.015	0.450	0.656	-0.023	0.037
L20.	0.008	0.015	0.540	0.586	-0.022	0.038
L21.	-0.013	0.015	-0.850	0.395	-0.043	0.017
L22.	-0.003	0.015	-0.220	0.829	-0.033	0.027
L23.	0.010	0.015	0.670	0.502	-0.020	0.040
Performance (hours)						
L1.	-0.000	0.000	-0.900	0.367	-0.000	0.000
L2.	-0.000	0.000	-1.610	0.108	-0.000	0.000
L3.	-0.000	0.000	-1.290	0.198	-0.000	0.000
L4.	0.000	0.000	1.600	0.109	-0.000	0.000
L5.	-0.000	0.000	-0.830	0.405	-0.000	0.000
L6.	-0.000	0.000	-0.950	0.340	-0.000	0.000
L7.	-0.000	0.000	-2.010	0.044	-0.000	-0.000
L8.	-0.000	0.000	-2.300	0.021	-0.000	-0.000
L9.	0.000	0.000	1.000	0.317	-0.000	0.000
L10.	0.000	0.000	0.100	0.917	-0.000	0.000
L11.	0.000	0.000	3.070	0.002	0.000	0.000
L12.	0.000	0.000	1.260	0.209	-0.000	0.000
L13.	-0.000	0.000	-0.590	0.558	-0.000	0.000
L14.	-0.000	0.000	-1.510	0.131	-0.000	0.000
L15.	-0.000	0.000	-1.390	0.165	-0.000	0.000
L16.	0.000	0.000	2.280	0.023	0.000	0.000
L17.	0.000	0.000	0.000	0.998	-0.000	0.000
L18.	0.000	0.000	0.320	0.750	-0.000	0.000
L19.	0.000	0.000	2.440	0.015	0.000	0.000
L20.	-0.000	0.000	-0.780	0.436	-0.000	0.000
L21.	-0.000	0.000	-1.430	0.153	-0.000	0.000
L22.	-0.000	0.000	-0.550	0.583	-0.000	0.000
L23.	0.000	0.000	0.770	0.441	-0.000	0.000
Traditional Media (Frequency)						
L1.	0.009	0.008	1.080	0.282	-0.007	0.025
L2.	0.008	0.008	0.920	0.355	-0.009	0.024
L3.	0.006	0.008	0.750	0.454	-0.010	0.023
L4.	-0.009	0.008	-1.110	0.268	-0.026	0.007
L5.	0.006	0.008	0.670	0.504	-0.011	0.022
L6.	-0.006	0.008	-0.690	0.490	-0.022	0.011
L7.	-0.001	0.008	-0.160	0.876	-0.018	0.015
L8.	0.005	0.008	0.550	0.579	-0.012	0.021

L9.	0.003	0.008	0.340	0.735	-0.014	0.019
L10.	0.005	0.008	0.640	0.524	-0.011	0.022
L11.	-0.003	0.008	-0.380	0.701	-0.020	0.013
L12.	-0.001	0.008	-0.160	0.877	-0.018	0.015
L13.	-0.002	0.008	-0.240	0.811	-0.018	0.014
L14.	-0.007	0.008	-0.860	0.389	-0.024	0.009
L15.	0.006	0.008	0.760	0.450	-0.010	0.023
L16.	0.008	0.008	0.910	0.363	-0.009	0.024
L17.	0.010	0.008	1.220	0.222	-0.006	0.026
L18.	-0.014	0.008	-1.680	0.094	-0.030	0.002
L19.	0.006	0.008	0.750	0.454	-0.010	0.022
L20.	-0.005	0.008	-0.570	0.568	-0.021	0.012
L21.	-0.004	0.008	-0.460	0.648	-0.020	0.012
L22.	0.007	0.008	0.830	0.407	-0.009	0.023
L23.	-0.001	0.008	-0.080	0.939	-0.017	0.015
Public Communication						
L1.	0.230	0.024	9.700	0.000	0.184	0.276
L2.	0.050	0.024	2.060	0.039	0.002	0.098
L3.	0.085	0.024	3.500	0.000	0.037	0.132
L4.	0.021	0.024	0.850	0.393	-0.027	0.068
L5.	-0.002	0.024	-0.090	0.931	-0.049	0.045
L6.	0.081	0.024	3.350	0.001	0.034	0.128
L7.	0.160	0.024	6.640	0.000	0.113	0.208
L8.	0.038	0.024	1.550	0.121	-0.010	0.086
L9.	-0.044	0.024	-1.820	0.069	-0.092	0.003
L10.	-0.021	0.024	-0.850	0.393	-0.068	0.027
L11.	-0.016	0.024	-0.670	0.500	-0.064	0.031
L12.	-0.002	0.024	-0.100	0.918	-0.050	0.045
L13.	-0.007	0.024	-0.290	0.771	-0.054	0.040
L14.	0.163	0.024	6.780	0.000	0.116	0.210
L15.	-0.034	0.024	-1.400	0.163	-0.082	0.014
L16.	-0.045	0.024	-1.860	0.063	-0.093	0.002
L17.	-0.010	0.024	-0.440	0.663	-0.058	0.037
L18.	-0.011	0.024	-0.440	0.658	-0.058	0.036
L19.	-0.033	0.024	-1.380	0.169	-0.080	0.014
L20.	0.054	0.024	2.240	0.025	0.007	0.101
L21.	0.126	0.024	5.270	0.000	0.079	0.173
L22.	-0.003	0.024	-0.130	0.897	-0.050	0.044
L23.	-0.005	0.023	-0.220	0.823	-0.051	0.041
_cons	-0.018	0.017	-1.050	0.293	-0.052	0.016

Model B

Sample: 24 thru 1826	Number of obs = 1803
Log likelihood = -11668.98	AIC = 13.35661
FPE = 7.429538	HQIC = 13.77525
DET (Sigma_ml) = 4.915786	SBIC = 14.4908

Equation	Parms	RMSE	R-sq	chi2	P>chi2
Twitter Reputation	93	.109642	0.1408	295.5529	0.0000
Performance (hours)	93	947.924	0.3572	1001.968	0.0000
Traditional Media (Dummy)	93	.3429	0.3674	1047.314	0.0000
Public Communication	93	.069657	0.3493	967.718	0.0000

	Coefficient	Std. err.	z	P>z	[95% conf. interval]	
Twitter Reputation						
Twitter Reputation						
L1.	0.158	0.024	6.670	0.000	0.111	0.204
L2.	0.065	0.024	2.710	0.007	0.018	0.112
L3.	0.032	0.024	1.320	0.187	-0.015	0.079
L4.	-0.012	0.024	-0.500	0.620	-0.059	0.035
L5.	-0.030	0.024	-1.230	0.218	-0.076	0.017
L6.	0.016	0.024	0.660	0.508	-0.031	0.063
L7.	0.006	0.024	0.260	0.795	-0.041	0.053
L8.	0.005	0.024	0.190	0.850	-0.042	0.052
L9.	0.047	0.024	1.950	0.052	-0.000	0.094
L10.	0.051	0.024	2.130	0.033	0.004	0.098
L11.	0.027	0.024	1.110	0.268	-0.020	0.074
L12.	-0.012	0.024	-0.490	0.623	-0.059	0.035
L13.	0.005	0.024	0.200	0.840	-0.042	0.052
L14.	0.060	0.024	2.490	0.013	0.013	0.107
L15.	-0.023	0.024	-0.970	0.332	-0.070	0.024
L16.	0.016	0.024	0.680	0.497	-0.031	0.063
L17.	0.007	0.024	0.280	0.779	-0.040	0.054
L18.	0.016	0.024	0.670	0.500	-0.031	0.063
L19.	-0.001	0.024	-0.020	0.982	-0.048	0.047
L20.	0.024	0.024	1.010	0.310	-0.023	0.072
L21.	-0.009	0.024	-0.380	0.701	-0.056	0.038
L22.	-0.019	0.024	-0.800	0.421	-0.066	0.028
L23.	0.026	0.024	1.080	0.279	-0.021	0.072
Performance (hours)						
L1.	-0.000	0.000	-0.440	0.662	-0.000	0.000
L2.	0.000	0.000	0.030	0.975	-0.000	0.000

L3.	-0.000	0.000	-0.270	0.788	-0.000	0.000
L4.	0.000	0.000	1.140	0.252	-0.000	0.000
L5.	0.000	0.000	1.290	0.197	-0.000	0.000
L6.	-0.000	0.000	-0.070	0.945	-0.000	0.000
L7.	0.000	0.000	2.020	0.043	0.000	0.000
L8.	0.000	0.000	2.930	0.003	0.000	0.000
L9.	0.000	0.000	0.400	0.688	-0.000	0.000
L10.	-0.000	0.000	-0.710	0.476	-0.000	0.000
L11.	-0.000	0.000	-0.060	0.951	-0.000	0.000
L12.	0.000	0.000	1.490	0.137	-0.000	0.000
L13.	0.000	0.000	0.090	0.930	-0.000	0.000
L14.	0.000	0.000	0.770	0.441	-0.000	0.000
L15.	-0.000	0.000	-0.550	0.584	-0.000	0.000
L16.	-0.000	0.000	-1.190	0.234	-0.000	0.000
L17.	-0.000	0.000	-1.160	0.246	-0.000	0.000
L18.	0.000	0.000	0.860	0.387	-0.000	0.000
L19.	0.000	0.000	0.710	0.478	-0.000	0.000
L20.	0.000	0.000	0.320	0.751	-0.000	0.000
L21.	0.000	0.000	1.160	0.246	-0.000	0.000
L22.	0.000	0.000	0.170	0.866	-0.000	0.000
L23.	0.000	0.000	1.390	0.165	-0.000	0.000
Traditional Media (Dummy)						
L1.	0.007	0.008	0.980	0.325	-0.007	0.022
L2.	-0.006	0.009	-0.750	0.456	-0.023	0.010
L3.	-0.009	0.009	-1.050	0.295	-0.026	0.008
L4.	0.018	0.009	2.050	0.040	0.001	0.034
L5.	-0.005	0.009	-0.540	0.588	-0.021	0.012
L6.	-0.009	0.009	-1.060	0.289	-0.026	0.008
L7.	0.010	0.009	1.120	0.261	-0.007	0.027
L8.	0.001	0.009	0.160	0.872	-0.015	0.018
L9.	0.003	0.009	0.330	0.742	-0.014	0.020
L10.	-0.007	0.009	-0.780	0.436	-0.024	0.010
L11.	0.006	0.009	0.660	0.509	-0.011	0.022
L12.	-0.009	0.009	-1.090	0.277	-0.026	0.007
L13.	-0.016	0.009	-1.910	0.056	-0.033	0.000
L14.	0.000	0.009	0.020	0.988	-0.017	0.017
L15.	0.002	0.009	0.290	0.774	-0.014	0.019
L16.	-0.010	0.009	-1.200	0.229	-0.027	0.006
L17.	-0.005	0.009	-0.620	0.534	-0.022	0.011
L18.	0.004	0.009	0.490	0.625	-0.013	0.021
L19.	-0.007	0.009	-0.860	0.392	-0.024	0.009
L20.	-0.012	0.009	-1.400	0.162	-0.029	0.005

L21.	0.012	0.009	1.350	0.176	-0.005	0.028
L22.	-0.003	0.009	-0.320	0.752	-0.020	0.014
L23.	-0.006	0.008	-0.770	0.440	-0.021	0.009
Public Communication						
L1.	0.073	0.037	1.970	0.049	0.000	0.146
L2.	-0.014	0.038	-0.360	0.722	-0.089	0.061
L3.	0.042	0.038	1.110	0.267	-0.032	0.117
L4.	0.000	0.038	0.010	0.993	-0.074	0.075
L5.	-0.025	0.038	-0.660	0.509	-0.100	0.049
L6.	0.061	0.038	1.610	0.108	-0.013	0.136
L7.	-0.009	0.038	-0.250	0.804	-0.084	0.065
L8.	-0.019	0.038	-0.490	0.624	-0.094	0.056
L9.	-0.022	0.038	-0.590	0.558	-0.098	0.053
L10.	0.002	0.038	0.040	0.966	-0.073	0.076
L11.	-0.065	0.038	-1.720	0.085	-0.139	0.009
L12.	0.016	0.038	0.420	0.676	-0.058	0.090
L13.	0.023	0.038	0.620	0.535	-0.051	0.097
L14.	-0.030	0.038	-0.780	0.434	-0.104	0.045
L15.	0.038	0.038	1.010	0.314	-0.036	0.113
L16.	-0.035	0.038	-0.920	0.357	-0.110	0.040
L17.	0.036	0.038	0.960	0.338	-0.038	0.110
L18.	0.035	0.038	0.930	0.354	-0.039	0.109
L19.	-0.082	0.038	-2.180	0.029	-0.155	-0.008
L20.	-0.010	0.038	-0.270	0.789	-0.084	0.064
L21.	0.031	0.038	0.830	0.409	-0.043	0.105
L22.	0.007	0.038	0.180	0.858	-0.067	0.081
L23.	0.022	0.037	0.590	0.553	-0.050	0.094
_cons	0.170	0.027	6.340	0.000	0.117	0.222
Performance (hours)						
Twitter Reputation						
L1.	-149.836	204.393	-0.730	0.464	-550.439	250.766
L2.	-63.786	206.884	-0.310	0.758	-469.272	341.700
L3.	361.235	207.168	1.740	0.081	-44.808	767.278
L4.	-68.979	207.092	-0.330	0.739	-474.872	336.913
L5.	50.924	206.946	0.250	0.806	-354.682	456.530
L6.	-27.757	207.235	-0.130	0.893	-433.930	378.417
L7.	-15.403	207.529	-0.070	0.941	-422.152	391.347
L8.	645.678	207.286	3.110	0.002	239.405	1051.952
L9.	-246.173	207.854	-1.180	0.236	-653.559	161.212
L10.	296.683	207.606	1.430	0.153	-110.217	703.583

L11.	-46.901	207.785	-0.230	0.821	-454.152	360.351
L12.	-223.795	207.187	-1.080	0.280	-629.874	182.283
L13.	253.678	207.306	1.220	0.221	-152.634	659.990
L14.	299.421	207.370	1.440	0.149	-107.016	705.858
L15.	-5.253	207.725	-0.030	0.980	-412.387	401.880
L16.	21.449	207.644	0.100	0.918	-385.526	428.423
L17.	34.457	207.444	0.170	0.868	-372.126	441.040
L18.	-108.365	208.278	-0.520	0.603	-516.583	299.853
L19.	-242.342	208.160	-1.160	0.244	-650.328	165.644
L20.	176.184	207.982	0.850	0.397	-231.454	583.821
L21.	419.764	208.173	2.020	0.044	11.751	827.776
L22.	-9.148	207.911	-0.040	0.965	-416.647	398.351
L23.	146.056	205.304	0.710	0.477	-256.332	548.445
Performance (hours)						
L1.	0.059	0.024	2.500	0.012	0.013	0.105
L2.	0.039	0.024	1.630	0.102	-0.008	0.085
L3.	0.072	0.023	3.090	0.002	0.026	0.118
L4.	0.066	0.023	2.830	0.005	0.020	0.112
L5.	-0.014	0.024	-0.610	0.540	-0.060	0.032
L6.	0.033	0.024	1.410	0.157	-0.013	0.079
L7.	0.014	0.023	0.610	0.545	-0.032	0.060
L8.	0.058	0.023	2.520	0.012	0.013	0.104
L9.	0.052	0.023	2.230	0.026	0.006	0.098
L10.	0.061	0.023	2.640	0.008	0.016	0.107
L11.	0.008	0.023	0.340	0.733	-0.038	0.053
L12.	-0.041	0.023	-1.780	0.075	-0.087	0.004
L13.	0.041	0.023	1.760	0.078	-0.005	0.087
L14.	-0.012	0.023	-0.530	0.598	-0.058	0.033
L15.	0.011	0.023	0.490	0.621	-0.034	0.057
L16.	0.016	0.023	0.700	0.483	-0.029	0.061
L17.	0.008	0.023	0.350	0.727	-0.037	0.053
L18.	0.034	0.023	1.460	0.145	-0.012	0.079
L19.	0.026	0.023	1.110	0.266	-0.019	0.071
L20.	0.076	0.023	3.330	0.001	0.031	0.122
L21.	0.075	0.023	3.270	0.001	0.030	0.120
L22.	0.014	0.023	0.600	0.546	-0.031	0.059
L23.	0.028	0.023	1.220	0.222	-0.017	0.073
Traditional Media (Dummy)						
L1.	114.319	65.120	1.760	0.079	-13.315	241.952
L2.	-34.550	74.246	-0.470	0.642	-180.070	110.971
L3.	109.850	74.218	1.480	0.139	-35.615	255.315

L4.	84.881	74.143	1.140	0.252	-60.435	230.198
L5.	34.168	74.085	0.460	0.645	-111.035	179.372
L6.	178.890	74.042	2.420	0.016	33.770	324.009
L7.	33.060	74.377	0.440	0.657	-112.716	178.836
L8.	56.651	74.337	0.760	0.446	-89.047	202.350
L9.	121.484	74.277	1.640	0.102	-24.096	267.064
L10.	-111.999	74.299	-1.510	0.132	-257.622	33.625
L11.	36.702	74.246	0.490	0.621	-108.816	182.221
L12.	-62.102	74.073	-0.840	0.402	-207.282	83.078
L13.	156.209	73.995	2.110	0.035	11.182	301.236
L14.	12.307	74.129	0.170	0.868	-132.983	157.597
L15.	1.623	74.098	0.020	0.983	-143.607	146.852
L16.	122.027	74.067	1.650	0.099	-23.141	267.196
L17.	-13.264	74.112	-0.180	0.858	-158.520	131.993
L18.	-47.155	74.004	-0.640	0.524	-192.200	97.890
L19.	37.022	74.060	0.500	0.617	-108.133	182.178
L20.	20.884	73.969	0.280	0.778	-124.092	165.861
L21.	-82.793	73.984	-1.120	0.263	-227.799	62.213
L22.	120.906	74.188	1.630	0.103	-24.499	266.311
L23.	-52.909	65.277	-0.810	0.418	-180.850	75.032
Public Communication						
L1.	-32.618	322.279	-0.100	0.919	-664.274	599.039
L2.	-55.555	330.924	-0.170	0.867	-704.155	593.044
L3.	-368.920	329.138	-1.120	0.262	-1014.018	276.178
L4.	-236.207	329.505	-0.720	0.473	-882.024	409.611
L5.	495.747	329.191	1.510	0.132	-149.456	1140.950
L6.	-194.133	329.169	-0.590	0.555	-839.292	451.026
L7.	133.779	328.492	0.410	0.684	-510.053	777.611
L8.	-363.135	331.342	-1.100	0.273	-1012.555	286.284
L9.	-22.368	331.525	-0.070	0.946	-672.144	627.409
L10.	31.360	327.452	0.100	0.924	-610.434	673.153
L11.	-156.856	327.231	-0.480	0.632	-798.217	484.505
L12.	217.498	327.050	0.670	0.506	-423.509	858.505
L13.	-455.140	326.235	-1.400	0.163	-1094.548	184.268
L14.	72.141	326.659	0.220	0.825	-568.099	712.380
L15.	35.112	330.246	0.110	0.915	-612.158	682.381
L16.	110.858	330.114	0.340	0.737	-536.153	757.869
L17.	652.666	325.629	2.000	0.045	14.446	1290.887
L18.	219.508	325.070	0.680	0.500	-417.617	856.633
L19.	3.509	324.682	0.010	0.991	-632.855	639.874
L20.	-334.545	324.896	-1.030	0.303	-971.329	302.239
L21.	-391.061	324.478	-1.210	0.228	-1027.025	244.904

L22.	397.377	326.094	1.220	0.223	-241.755	1036.509
L23.	-172.913	317.154	-0.550	0.586	-794.524	448.698
_cons	-117.545	231.618	-0.510	0.612	-571.508	336.418
Traditional Media (Dummy)						
Twitter Reputation						
L1.	0.016	0.074	0.210	0.834	-0.129	0.160
L2.	0.052	0.075	0.700	0.484	-0.094	0.199
L3.	0.032	0.075	0.420	0.672	-0.115	0.179
L4.	0.098	0.075	1.300	0.192	-0.049	0.245
L5.	-0.116	0.075	-1.550	0.121	-0.263	0.030
L6.	-0.027	0.075	-0.360	0.717	-0.174	0.120
L7.	-0.104	0.075	-1.380	0.167	-0.251	0.043
L8.	0.067	0.075	0.890	0.373	-0.080	0.214
L9.	0.051	0.075	0.680	0.497	-0.096	0.198
L10.	-0.032	0.075	-0.420	0.674	-0.179	0.116
L11.	-0.072	0.075	-0.950	0.340	-0.219	0.076
L12.	0.132	0.075	1.770	0.077	-0.014	0.279
L13.	0.037	0.075	0.490	0.624	-0.110	0.184
L14.	-0.077	0.075	-1.030	0.304	-0.224	0.070
L15.	-0.124	0.075	-1.660	0.098	-0.272	0.023
L16.	0.042	0.075	0.560	0.577	-0.105	0.189
L17.	-0.104	0.075	-1.390	0.164	-0.252	0.043
L18.	0.076	0.075	1.010	0.313	-0.072	0.224
L19.	-0.051	0.075	-0.680	0.494	-0.199	0.096
L20.	-0.045	0.075	-0.600	0.545	-0.193	0.102
L21.	-0.047	0.075	-0.630	0.529	-0.195	0.100
L22.	0.020	0.075	0.260	0.793	-0.128	0.167
L23.	-0.047	0.074	-0.630	0.527	-0.193	0.099
Performance (hours)						
L1.	0.000	0.000	1.220	0.222	-0.000	0.000
L2.	-0.000	0.000	-0.220	0.824	-0.000	0.000
L3.	-0.000	0.000	-0.520	0.601	-0.000	0.000
L4.	-0.000	0.000	-1.080	0.280	-0.000	0.000
L5.	0.000	0.000	0.520	0.601	-0.000	0.000
L6.	0.000	0.000	0.130	0.894	-0.000	0.000
L7.	0.000	0.000	0.530	0.598	-0.000	0.000
L8.	-0.000	0.000	-0.480	0.633	-0.000	0.000
L9.	0.000	0.000	0.780	0.433	-0.000	0.000
L10.	0.000	0.000	1.480	0.138	-0.000	0.000
L11.	-0.000	0.000	-0.740	0.461	-0.000	0.000

L12.	0.000	0.000	2.070	0.038	0.000	0.000
L13.	0.000	0.000	0.350	0.727	-0.000	0.000
L14.	0.000	0.000	1.200	0.231	-0.000	0.000
L15.	-0.000	0.000	-0.290	0.774	-0.000	0.000
L16.	0.000	0.000	1.720	0.086	-0.000	0.000
L17.	0.000	0.000	0.540	0.592	-0.000	0.000
L18.	0.000	0.000	0.010	0.994	-0.000	0.000
L19.	0.000	0.000	0.930	0.353	-0.000	0.000
L20.	-0.000	0.000	-0.870	0.384	-0.000	0.000
L21.	0.000	0.000	2.730	0.006	0.000	0.000
L22.	0.000	0.000	2.320	0.020	0.000	0.000
L23.	0.000	0.000	1.210	0.226	-0.000	0.000
Traditional Media (Dummy)						
L1.	0.546	0.024	23.200	0.000	0.500	0.593
L2.	-0.045	0.027	-1.680	0.093	-0.098	0.008
L3.	-0.034	0.027	-1.250	0.212	-0.086	0.019
L4.	-0.002	0.027	-0.060	0.954	-0.054	0.051
L5.	-0.022	0.027	-0.810	0.421	-0.074	0.031
L6.	-0.054	0.027	-2.020	0.044	-0.107	-0.002
L7.	-0.011	0.027	-0.410	0.683	-0.064	0.042
L8.	-0.054	0.027	-2.020	0.043	-0.107	-0.002
L9.	0.037	0.027	1.370	0.171	-0.016	0.089
L10.	-0.002	0.027	-0.080	0.939	-0.055	0.051
L11.	-0.010	0.027	-0.350	0.723	-0.062	0.043
L12.	0.015	0.027	0.560	0.573	-0.037	0.068
L13.	-0.027	0.027	-1.020	0.308	-0.080	0.025
L14.	-0.034	0.027	-1.260	0.209	-0.086	0.019
L15.	0.017	0.027	0.640	0.521	-0.035	0.070
L16.	0.030	0.027	1.140	0.255	-0.022	0.083
L17.	-0.033	0.027	-1.220	0.221	-0.085	0.020
L18.	0.050	0.027	1.860	0.063	-0.003	0.102
L19.	-0.030	0.027	-1.120	0.261	-0.083	0.022
L20.	0.020	0.027	0.750	0.452	-0.032	0.073
L21.	-0.018	0.027	-0.670	0.500	-0.071	0.034
L22.	-0.000	0.027	-0.010	0.995	-0.053	0.052
L23.	0.012	0.024	0.520	0.602	-0.034	0.059
Public Communication						
L1.	-0.085	0.117	-0.730	0.466	-0.313	0.144
L2.	0.123	0.120	1.030	0.304	-0.112	0.358
L3.	0.036	0.119	0.300	0.764	-0.198	0.269
L4.	-0.109	0.119	-0.920	0.360	-0.343	0.125

	L5.	0.016	0.119	0.140	0.890	-0.217	0.250
	L6.	0.005	0.119	0.040	0.968	-0.229	0.238
	L7.	-0.017	0.119	-0.140	0.886	-0.250	0.216
	L8.	0.142	0.120	1.190	0.236	-0.093	0.377
	L9.	-0.112	0.120	-0.930	0.352	-0.347	0.123
	L10.	0.017	0.118	0.140	0.887	-0.215	0.249
	L11.	0.020	0.118	0.170	0.863	-0.212	0.252
	L12.	-0.104	0.118	-0.880	0.380	-0.336	0.128
	L13.	-0.191	0.118	-1.620	0.106	-0.422	0.040
	L14.	-0.074	0.118	-0.630	0.530	-0.306	0.157
	L15.	0.123	0.119	1.030	0.302	-0.111	0.358
	L16.	-0.165	0.119	-1.380	0.167	-0.399	0.069
	L17.	0.087	0.118	0.740	0.460	-0.144	0.318
	L18.	0.061	0.118	0.520	0.601	-0.169	0.292
	L19.	0.099	0.117	0.850	0.398	-0.131	0.330
	L20.	-0.090	0.118	-0.760	0.444	-0.320	0.140
	L21.	0.060	0.117	0.510	0.610	-0.170	0.290
	L22.	-0.143	0.118	-1.210	0.225	-0.374	0.088
	L23.	0.179	0.115	1.560	0.119	-0.046	0.404
_cons		-0.027	0.084	-0.330	0.744	-0.192	0.137
Public Communication							
Twitter Reputation							
	L1.	0.014	0.015	0.900	0.367	-0.016	0.043
	L2.	0.014	0.015	0.940	0.349	-0.016	0.044
	L3.	0.014	0.015	0.910	0.361	-0.016	0.044
	L4.	0.010	0.015	0.620	0.532	-0.020	0.039
	L5.	0.016	0.015	1.050	0.294	-0.014	0.046
	L6.	-0.001	0.015	-0.080	0.936	-0.031	0.029
	L7.	0.006	0.015	0.410	0.680	-0.024	0.036
	L8.	-0.011	0.015	-0.750	0.452	-0.041	0.018
	L9.	0.011	0.015	0.740	0.457	-0.019	0.041
	L10.	0.006	0.015	0.400	0.692	-0.024	0.036
	L11.	0.015	0.015	1.010	0.312	-0.015	0.045
	L12.	-0.027	0.015	-1.790	0.074	-0.057	0.003
	L13.	0.028	0.015	1.830	0.068	-0.002	0.058
	L14.	0.009	0.015	0.560	0.575	-0.021	0.038
	L15.	0.021	0.015	1.380	0.168	-0.009	0.051
	L16.	0.019	0.015	1.220	0.224	-0.011	0.048
	L17.	-0.056	0.015	-3.700	0.000	-0.086	-0.027
	L18.	0.027	0.015	1.750	0.080	-0.003	0.057
	L19.	0.007	0.015	0.490	0.624	-0.022	0.037

L20.	0.010	0.015	0.650	0.517	-0.020	0.040
L21.	-0.010	0.015	-0.650	0.514	-0.040	0.020
L22.	-0.007	0.015	-0.480	0.629	-0.037	0.023
L23.	0.010	0.015	0.690	0.493	-0.019	0.040
Performance (hours)						
L1.	-0.000	0.000	-0.630	0.529	-0.000	0.000
L2.	-0.000	0.000	-1.420	0.157	-0.000	0.000
L3.	-0.000	0.000	-1.270	0.204	-0.000	0.000
L4.	0.000	0.000	2.160	0.031	0.000	0.000
L5.	-0.000	0.000	-1.040	0.298	-0.000	0.000
L6.	-0.000	0.000	-0.450	0.656	-0.000	0.000
L7.	-0.000	0.000	-1.910	0.056	-0.000	0.000
L8.	-0.000	0.000	-1.880	0.060	-0.000	0.000
L9.	0.000	0.000	1.510	0.130	-0.000	0.000
L10.	0.000	0.000	0.140	0.892	-0.000	0.000
L11.	0.000	0.000	3.230	0.001	0.000	0.000
L12.	0.000	0.000	1.220	0.221	-0.000	0.000
L13.	-0.000	0.000	-0.100	0.923	-0.000	0.000
L14.	-0.000	0.000	-1.360	0.173	-0.000	0.000
L15.	-0.000	0.000	-1.400	0.161	-0.000	0.000
L16.	0.000	0.000	2.490	0.013	0.000	0.000
L17.	-0.000	0.000	-0.210	0.836	-0.000	0.000
L18.	0.000	0.000	0.620	0.533	-0.000	0.000
L19.	0.000	0.000	2.190	0.028	0.000	0.000
L20.	-0.000	0.000	-0.520	0.606	-0.000	0.000
L21.	-0.000	0.000	-1.550	0.122	-0.000	0.000
L22.	-0.000	0.000	-0.690	0.493	-0.000	0.000
L23.	0.000	0.000	0.830	0.406	-0.000	0.000
Traditional Media (Dummy)						
L1.	0.003	0.005	0.620	0.535	-0.006	0.012
L2.	-0.004	0.005	-0.680	0.499	-0.014	0.007
L3.	-0.001	0.005	-0.230	0.815	-0.012	0.009
L4.	0.006	0.005	1.120	0.261	-0.005	0.017
L5.	-0.002	0.005	-0.410	0.682	-0.013	0.008
L6.	0.004	0.005	0.800	0.425	-0.006	0.015
L7.	-0.005	0.005	-0.830	0.404	-0.015	0.006
L8.	-0.005	0.005	-0.860	0.387	-0.015	0.006
L9.	0.010	0.005	1.900	0.057	-0.000	0.021
L10.	-0.003	0.005	-0.500	0.614	-0.013	0.008
L11.	-0.009	0.005	-1.670	0.096	-0.020	0.002
L12.	0.000	0.005	0.050	0.961	-0.010	0.011

L13.	0.004	0.005	0.680	0.494	-0.007	0.014
L14.	-0.007	0.005	-1.260	0.208	-0.018	0.004
L15.	-0.009	0.005	-1.580	0.115	-0.019	0.002
L16.	0.013	0.005	2.430	0.015	0.003	0.024
L17.	-0.014	0.005	-2.660	0.008	-0.025	-0.004
L18.	0.006	0.005	1.170	0.244	-0.004	0.017
L19.	-0.003	0.005	-0.480	0.635	-0.013	0.008
L20.	-0.003	0.005	-0.630	0.530	-0.014	0.007
L21.	0.000	0.005	0.020	0.983	-0.011	0.011
L22.	-0.005	0.005	-0.860	0.387	-0.015	0.006
L23.	0.001	0.005	0.240	0.806	-0.008	0.011
Public Communication						
L1.	0.233	0.024	9.850	0.000	0.187	0.280
L2.	0.052	0.024	2.140	0.033	0.004	0.100
L3.	0.077	0.024	3.180	0.001	0.029	0.124
L4.	0.017	0.024	0.710	0.476	-0.030	0.065
L5.	0.002	0.024	0.060	0.949	-0.046	0.049
L6.	0.080	0.024	3.310	0.001	0.033	0.127
L7.	0.160	0.024	6.620	0.000	0.113	0.207
L8.	0.042	0.024	1.730	0.084	-0.006	0.090
L9.	-0.048	0.024	-1.960	0.051	-0.095	0.000
L10.	-0.017	0.024	-0.690	0.492	-0.064	0.031
L11.	-0.015	0.024	-0.620	0.534	-0.062	0.032
L12.	-0.009	0.024	-0.380	0.704	-0.056	0.038
L13.	-0.003	0.024	-0.110	0.916	-0.050	0.044
L14.	0.165	0.024	6.880	0.000	0.118	0.212
L15.	-0.033	0.024	-1.380	0.168	-0.081	0.014
L16.	-0.047	0.024	-1.930	0.054	-0.094	0.001
L17.	-0.004	0.024	-0.170	0.862	-0.051	0.043
L18.	-0.015	0.024	-0.610	0.541	-0.061	0.032
L19.	-0.033	0.024	-1.370	0.171	-0.079	0.014
L20.	0.055	0.024	2.300	0.021	0.008	0.102
L21.	0.118	0.024	4.950	0.000	0.071	0.165
L22.	-0.002	0.024	-0.070	0.942	-0.049	0.045
L23.	-0.008	0.023	-0.330	0.742	-0.053	0.038
_cons	-0.020	0.017	-1.160	0.245	-0.053	0.014

Monthly results

Model A

Sample: 8 thru 60	Number of obs = 53
Log likelihood = 443.8451	AIC = -12.37151
FPE = 8.52e-11	HQIC = -10.7132
DET (Sigma_ml) = 6.25e-13	SBIC = -8.059176

Equation	Parms	RMSE	R-sq	chi2	P>chi2
Twitter Reputation	29	.065439	0.4716	47.30289	0.0127
Performance (index)	29	.026654	0.7645	172.0536	0.0000
Traditional Media (Frequency)	29	.075469	0.5706	70.4227	0.0000
Public Communication	29	.035924	0.6359	92.55062	0.0000

	Coefficient	Std.err.	z	P>z	[95% conf. interval]	
Twitter Reputation						
Twitter Reputation						
L1.	0.065	0.143	0.450	0.651	-0.216	0.345
L2.	-0.063	0.149	-0.430	0.670	-0.355	0.228
L3.	0.061	0.166	0.360	0.715	-0.265	0.386
L4.	-0.071	0.168	-0.420	0.671	-0.400	0.258
L5.	0.124	0.164	0.760	0.449	-0.197	0.445
L6.	-0.153	0.159	-0.960	0.338	-0.465	0.160
L7.	-0.085	0.152	-0.560	0.577	-0.382	0.213
Performance (index)						
L1.	-0.123	0.314	-0.390	0.696	-0.738	0.493
L2.	-0.345	0.377	-0.920	0.360	-1.084	0.393
L3.	-0.224	0.379	-0.590	0.554	-0.967	0.518
L4.	-0.130	0.388	-0.340	0.737	-0.892	0.631
L5.	-0.338	0.375	-0.900	0.368	-1.074	0.397
L6.	0.033	0.321	0.100	0.918	-0.596	0.662
L7.	-0.418	0.294	-1.420	0.155	-0.995	0.158
Traditional Media (Frequency)						
L1.	-0.013	0.120	-0.110	0.912	-0.248	0.222
L2.	0.034	0.125	0.270	0.788	-0.211	0.279
L3.	0.112	0.128	0.880	0.381	-0.138	0.362
L4.	0.086	0.125	0.690	0.490	-0.159	0.332
L5.	-0.140	0.126	-1.100	0.269	-0.387	0.108
L6.	0.064	0.131	0.490	0.627	-0.194	0.321
L7.	0.018	0.123	0.140	0.886	-0.224	0.260

Public Communication						
L1.	0.292	0.284	1.030	0.304	-0.264	0.848
L2.	0.001	0.280	0.000	0.999	-0.547	0.548
L3.	0.258	0.276	0.930	0.351	-0.284	0.800
L4.	0.409	0.281	1.460	0.145	-0.141	0.960
L5.	0.438	0.299	1.460	0.144	-0.149	1.025
L6.	0.442	0.280	1.580	0.115	-0.107	0.992
L7.	-0.065	0.296	-0.220	0.826	-0.645	0.516
_cons	1.769	0.782	2.260	0.024	0.236	3.303
Performance (index)						
Twitter Reputation						
L1.	0.190	0.058	3.260	0.001	0.075	0.304
L2.	-0.081	0.061	-1.340	0.180	-0.200	0.038
L3.	0.075	0.068	1.110	0.269	-0.058	0.207
L4.	0.028	0.068	0.420	0.678	-0.106	0.162
L5.	-0.004	0.067	-0.060	0.949	-0.135	0.126
L6.	0.022	0.065	0.340	0.737	-0.105	0.149
L7.	-0.002	0.062	-0.030	0.976	-0.123	0.119
Performance (index)						
L1.	0.577	0.128	4.510	0.000	0.326	0.827
L2.	-0.310	0.153	-2.020	0.043	-0.611	-0.009
L3.	-0.046	0.154	-0.300	0.764	-0.349	0.256
L4.	0.089	0.158	0.560	0.574	-0.221	0.399
L5.	-0.183	0.153	-1.200	0.230	-0.483	0.116
L6.	0.179	0.131	1.370	0.171	-0.077	0.435
L7.	0.234	0.120	1.960	0.050	-0.000	0.469
Traditional Media (Frequency)						
L1.	0.056	0.049	1.150	0.248	-0.039	0.152
L2.	0.125	0.051	2.450	0.014	0.025	0.224
L3.	0.030	0.052	0.590	0.558	-0.071	0.132
L4.	-0.136	0.051	-2.660	0.008	-0.235	-0.036
L5.	0.019	0.051	0.370	0.715	-0.082	0.120
L6.	-0.070	0.054	-1.320	0.188	-0.175	0.034
L7.	0.066	0.050	1.310	0.189	-0.033	0.165
Public Communication						
L1.	0.026	0.116	0.230	0.821	-0.200	0.253
L2.	-0.329	0.114	-2.890	0.004	-0.553	-0.106
L3.	0.222	0.113	1.980	0.048	0.002	0.443

	L4.	-0.220	0.114	-1.920	0.055	-0.444	0.004
	L5.	0.098	0.122	0.800	0.423	-0.141	0.337
	L6.	-0.320	0.114	-2.800	0.005	-0.543	-0.096
	L7.	-0.556	0.121	-4.610	0.000	-0.793	-0.320
_cons		0.368	0.319	1.150	0.248	-0.257	0.992
Traditional Media (Frequency)							
Twitter Reputation							
	L1.	-0.256	0.165	-1.550	0.120	-0.579	0.067
	L2.	-0.203	0.172	-1.180	0.237	-0.540	0.133
	L3.	-0.377	0.192	-1.970	0.049	-0.753	-0.002
	L4.	0.241	0.194	1.240	0.214	-0.139	0.620
	L5.	-0.020	0.189	-0.110	0.916	-0.390	0.350
	L6.	-0.173	0.184	-0.940	0.346	-0.533	0.187
	L7.	-0.133	0.175	-0.760	0.446	-0.476	0.210
Performance (index)							
	L1.	-0.406	0.362	-1.120	0.262	-1.115	0.304
	L2.	0.271	0.435	0.620	0.533	-0.581	1.123
	L3.	0.020	0.437	0.050	0.963	-0.836	0.877
	L4.	-0.168	0.448	-0.380	0.708	-1.046	0.710
	L5.	-0.768	0.433	-1.770	0.076	-1.616	0.081
	L6.	0.243	0.370	0.660	0.511	-0.482	0.969
	L7.	-0.892	0.339	-2.630	0.009	-1.558	-0.227
Traditional Media (Frequency)							
	L1.	0.188	0.138	1.360	0.175	-0.084	0.459
	L2.	0.015	0.144	0.100	0.917	-0.268	0.298
	L3.	0.343	0.147	2.330	0.020	0.055	0.631
	L4.	-0.010	0.144	-0.070	0.946	-0.293	0.273
	L5.	0.323	0.146	2.220	0.026	0.038	0.609
	L6.	-0.070	0.152	-0.460	0.643	-0.367	0.227
	L7.	0.257	0.142	1.810	0.071	-0.022	0.536
Public Communication							
	L1.	0.532	0.327	1.630	0.104	-0.109	1.173
	L2.	-0.452	0.322	-1.400	0.161	-1.084	0.180
	L3.	0.063	0.319	0.200	0.844	-0.562	0.687
	L4.	0.452	0.324	1.390	0.163	-0.183	1.087
	L5.	0.679	0.345	1.970	0.049	0.003	1.356
	L6.	0.734	0.323	2.270	0.023	0.100	1.368
	L7.	0.494	0.342	1.450	0.148	-0.175	1.164

_cons		1.715	0.902	1.900	0.057	-0.053	3.483
Public Communication							
Twitter Reputation							
	L1.	0.231	0.079	2.940	0.003	0.077	0.385
	L2.	0.278	0.082	3.400	0.001	0.118	0.438
	L3.	0.057	0.091	0.630	0.531	-0.122	0.236
	L4.	0.018	0.092	0.200	0.845	-0.163	0.199
	L5.	0.135	0.090	1.510	0.132	-0.041	0.311
	L6.	0.061	0.087	0.700	0.484	-0.110	0.232
	L7.	-0.036	0.083	-0.440	0.663	-0.200	0.127
Performance (index)							
	L1.	0.442	0.172	2.570	0.010	0.104	0.780
	L2.	-0.238	0.207	-1.150	0.250	-0.644	0.167
	L3.	0.199	0.208	0.960	0.339	-0.209	0.606
	L4.	0.392	0.213	1.840	0.066	-0.026	0.810
	L5.	-0.180	0.206	-0.870	0.383	-0.583	0.224
	L6.	0.320	0.176	1.810	0.070	-0.026	0.665
	L7.	0.324	0.162	2.010	0.045	0.008	0.641
Traditional Media (Frequency)							
	L1.	0.106	0.066	1.600	0.109	-0.023	0.235
	L2.	0.004	0.069	0.050	0.958	-0.131	0.138
	L3.	-0.022	0.070	-0.320	0.752	-0.159	0.115
	L4.	-0.144	0.069	-2.100	0.036	-0.279	-0.010
	L5.	-0.103	0.069	-1.490	0.136	-0.239	0.033
	L6.	-0.063	0.072	-0.880	0.380	-0.205	0.078
	L7.	-0.059	0.068	-0.870	0.383	-0.192	0.074
Public Communication							
	L1.	0.121	0.156	0.770	0.438	-0.185	0.426
	L2.	-0.033	0.153	-0.210	0.830	-0.334	0.268
	L3.	-0.138	0.152	-0.910	0.365	-0.435	0.160
	L4.	-0.209	0.154	-1.350	0.176	-0.511	0.093
	L5.	-0.257	0.164	-1.570	0.118	-0.579	0.065
	L6.	-0.518	0.154	-3.370	0.001	-0.820	-0.217
	L7.	-0.533	0.163	-3.280	0.001	-0.851	-0.214
_cons		-1.137	0.429	-2.650	0.008	-1.978	-0.295

Model B

Sample: 8 thru 60	Number of obs = 53
Log likelihood = 363.809	AIC = -9.351284
FPE = 1.75e-09	HQIC = -7.692968
DET (Sigma_ml) = 1.28e-11	SBIC = -5.038947

Equation	Parms	RMSE	R-sq	chi2	P>chi2
Twitter Reputation	29	.063012	0.5101	55.17879	0.0016
Performance (index)	29	.021412	0.8480	295.7373	0.0000
Traditional Media (Dummy)	29	.400969	0.6067	81.76262	0.0000
Public Communication	29	.037653	0.6000	79.48795	0.0000

	Coefficient	Std. err.	z	P>z	[95% conf.	interval]
Twitter Reputation						
Twitter Reputation						
L1.	0.129	0.142	0.910	0.360	-0.148	0.407
L2.	-0.267	0.157	-1.700	0.089	-0.574	0.041
L3.	0.348	0.195	1.790	0.074	-0.033	0.730
L4.	-0.250	0.226	-1.100	0.269	-0.694	0.194
L5.	0.322	0.189	1.700	0.088	-0.048	0.693
L6.	-0.208	0.181	-1.150	0.250	-0.563	0.146
L7.	-0.020	0.143	-0.140	0.892	-0.300	0.261
Performance (index)						
L1.	0.411	0.348	1.180	0.237	-0.271	1.093
L2.	-0.772	0.483	-1.600	0.110	-1.718	0.174
L3.	0.442	0.492	0.900	0.369	-0.522	1.405
L4.	-0.491	0.500	-0.980	0.325	-1.470	0.488
L5.	0.059	0.408	0.140	0.885	-0.740	0.858
L6.	-0.057	0.319	-0.180	0.858	-0.683	0.568
L7.	-0.382	0.276	-1.390	0.166	-0.922	0.158
Traditional Media (Dummy)						
L1.	0.014	0.020	0.680	0.494	-0.026	0.054
L2.	-0.002	0.019	-0.120	0.902	-0.040	0.035
L3.	0.020	0.018	1.090	0.277	-0.016	0.055
L4.	-0.020	0.020	-1.010	0.310	-0.058	0.019
L5.	0.030	0.023	1.270	0.203	-0.016	0.076
L6.	-0.044	0.024	-1.810	0.070	-0.091	0.003
L7.	0.003	0.024	0.130	0.894	-0.044	0.050
Public Communication						
L1.	0.222	0.248	0.890	0.372	-0.265	0.709

L2.	-0.259	0.273	-0.950	0.343	-0.795	0.277
L3.	0.624	0.294	2.130	0.034	0.049	1.200
L4.	-0.102	0.344	-0.300	0.767	-0.775	0.572
L5.	0.950	0.374	2.540	0.011	0.216	1.684
L6.	-0.089	0.361	-0.250	0.804	-0.796	0.618
L7.	0.173	0.326	0.530	0.596	-0.466	0.811
_cons	1.086	0.791	1.370	0.170	-0.465	2.637
Performance (index)						
Twitter Reputation						
L1.	0.267	0.048	5.550	0.000	0.172	0.361
L2.	-0.219	0.053	-4.110	0.000	-0.323	-0.114
L3.	0.062	0.066	0.940	0.349	-0.068	0.192
L4.	-0.170	0.077	-2.210	0.027	-0.321	-0.019
L5.	-0.010	0.064	-0.150	0.877	-0.136	0.116
L6.	-0.077	0.062	-1.250	0.210	-0.198	0.043
L7.	0.036	0.049	0.750	0.456	-0.059	0.132
Performance (index)						
L1.	0.470	0.118	3.970	0.000	0.238	0.702
L2.	-0.658	0.164	-4.010	0.000	-0.979	-0.337
L3.	0.122	0.167	0.730	0.465	-0.205	0.449
L4.	-0.238	0.170	-1.400	0.160	-0.571	0.094
L5.	-0.160	0.139	-1.160	0.248	-0.432	0.111
L6.	0.039	0.108	0.360	0.719	-0.174	0.252
L7.	0.196	0.094	2.090	0.036	0.012	0.379
Traditional Media (Dummy)						
L1.	0.004	0.007	0.650	0.515	-0.009	0.018
L2.	-0.004	0.006	-0.620	0.538	-0.017	0.009
L3.	0.019	0.006	3.010	0.003	0.007	0.031
L4.	-0.020	0.007	-2.970	0.003	-0.033	-0.007
L5.	0.024	0.008	3.070	0.002	0.009	0.040
L6.	0.010	0.008	1.280	0.199	-0.006	0.026
L7.	0.023	0.008	2.820	0.005	0.007	0.039
Public Communication						
L1.	0.235	0.084	2.780	0.005	0.070	0.401
L2.	-0.365	0.093	-3.930	0.000	-0.547	-0.183
L3.	0.326	0.100	3.270	0.001	0.131	0.522
L4.	-0.347	0.117	-2.970	0.003	-0.575	-0.118
L5.	0.241	0.127	1.900	0.058	-0.008	0.491

L6.	-0.248	0.123	-2.020	0.043	-0.488	-0.008
L7.	-0.300	0.111	-2.710	0.007	-0.517	-0.084
_cons	1.183	0.269	4.400	0.000	0.656	1.710
Traditional Media (Dummy)						
Twitter Reputation						
L1.	0.310	0.901	0.340	0.731	-1.456	2.076
L2.	2.025	0.998	2.030	0.043	0.068	3.982
L3.	-4.610	1.239	-3.720	0.000	-7.038	-2.181
L4.	3.615	1.441	2.510	0.012	0.791	6.439
L5.	-1.491	1.203	-1.240	0.215	-3.848	0.866
L6.	-0.643	1.152	-0.560	0.577	-2.900	1.614
L7.	0.256	0.911	0.280	0.779	-1.530	2.042
Performance (index)						
L1.	-11.067	2.215	-5.000	0.000	-15.407	-6.726
L2.	8.805	3.071	2.870	0.004	2.785	14.825
L3.	-4.603	3.128	-1.470	0.141	-10.733	1.528
L4.	3.678	3.179	1.160	0.247	-2.552	9.909
L5.	-2.863	2.594	-1.100	0.270	-7.948	2.222
L6.	-0.848	2.031	-0.420	0.676	-4.829	3.133
L7.	1.108	1.753	0.630	0.527	-2.328	4.545
Traditional Media (Dummy)						
L1.	0.346	0.129	2.680	0.007	0.093	0.599
L2.	0.194	0.121	1.600	0.110	-0.044	0.431
L3.	-0.145	0.116	-1.250	0.210	-0.372	0.082
L4.	0.450	0.125	3.610	0.000	0.206	0.695
L5.	-0.310	0.149	-2.090	0.037	-0.602	-0.019
L6.	0.543	0.153	3.560	0.000	0.244	0.842
L7.	0.013	0.152	0.090	0.931	-0.284	0.310
Public Communication						
L1.	3.065	1.581	1.940	0.053	-0.034	6.164
L2.	0.332	1.740	0.190	0.849	-3.078	3.741
L3.	-7.076	1.869	-3.790	0.000	-10.739	-3.412
L4.	5.554	2.186	2.540	0.011	1.269	9.839
L5.	-2.789	2.382	-1.170	0.242	-7.458	1.881
L6.	6.363	2.295	2.770	0.006	1.865	10.861
L7.	-4.993	2.073	-2.410	0.016	-9.055	-0.931
_cons	5.257	5.035	1.040	0.296	-4.611	15.125

Public Communication						
Twitter Reputation						
L1.	0.254	0.085	3.000	0.003	0.088	0.420
L2.	0.226	0.094	2.410	0.016	0.042	0.410
L3.	0.036	0.116	0.310	0.757	-0.192	0.264
L4.	-0.200	0.135	-1.480	0.140	-0.465	0.066
L5.	0.133	0.113	1.180	0.240	-0.089	0.354
L6.	-0.020	0.108	-0.180	0.856	-0.232	0.192
L7.	-0.100	0.086	-1.170	0.241	-0.268	0.067
Performance (index)						
L1.	0.435	0.208	2.090	0.037	0.027	0.842
L2.	-0.668	0.288	-2.320	0.020	-1.234	-0.103
L3.	0.289	0.294	0.980	0.325	-0.286	0.865
L4.	0.109	0.299	0.370	0.714	-0.476	0.694
L5.	-0.330	0.244	-1.350	0.176	-0.807	0.148
L6.	0.047	0.191	0.250	0.806	-0.327	0.421
L7.	0.167	0.165	1.010	0.312	-0.156	0.489
Traditional Media (Dummy)						
L1.	-0.006	0.012	-0.470	0.639	-0.029	0.018
L2.	0.001	0.011	0.080	0.933	-0.021	0.023
L3.	0.009	0.011	0.790	0.429	-0.013	0.030
L4.	-0.022	0.012	-1.890	0.058	-0.045	0.001
L5.	-0.006	0.014	-0.400	0.690	-0.033	0.022
L6.	-0.001	0.014	-0.040	0.967	-0.029	0.027
L7.	0.022	0.014	1.580	0.115	-0.005	0.050
Public Communication						
L1.	0.249	0.148	1.670	0.094	-0.042	0.540
L2.	0.177	0.163	1.090	0.277	-0.143	0.498
L3.	-0.015	0.176	-0.090	0.930	-0.360	0.329
L4.	-0.294	0.205	-1.430	0.153	-0.696	0.109
L5.	0.015	0.224	0.070	0.947	-0.424	0.453
L6.	-0.410	0.216	-1.900	0.057	-0.832	0.012
L7.	-0.171	0.195	-0.880	0.380	-0.552	0.210
_cons	-0.061	0.473	-0.130	0.898	-0.987	0.866

Keeping Satisfaction on Track: Exploring the Role of Twitter Communication in Passenger Satisfaction.

Steven F. De Vadder

This chapter is currently under review.

5

Abstract and Keywords

Public transportation is crucial to achieve a Modal shift. However, railway services are not a popular means of transportation as it is plagued by low satisfaction with riders. This paper set out to measure the impact of communication on satisfaction with the Belgian Railway Company. This public sector organization has become very active on Twitter, where it interacts with customers. We surveyed 7200 train travelers spread over 24 months (300 respondents each month). Our findings show two important insights. Firstly, communication, besides actual performance and expectations, is a significant factor in traveler satisfaction. Secondly, a Twitter interaction with the NMBS also increased satisfaction significantly. This effect can be attributed to the NMBS explaining to people why a certain delay occurred. Twitter users seem to blame the NMBS for an experienced delay to a lesser extent than non-Twitter users. Offering accurate and real-time information to individual citizens offers the potential to improve satisfaction with transit services, and by extension might increase ridership.

Keywords
Public communication, Twitter, Satisfaction, railway services, performance, expectation.

Introduction

Public transportation infrastructure is vital for transporting goods and passengers and can bring substantial environmental and health benefits (Kwan & Hashim, 2016). It could reduce air pollution, greenhouse gas emissions, traffic injuries, noise, congestion, and physical inactivity. Trains are often proposed as an alternative to road transport, which is responsible for nearly three-quarters of energy-related CO_2 emissions (Graham-Rowe *et al.,* 2011; IEA, 2013; Thies *et al.*, 2016). Despite technological developments (such as electric cars), emissions related to transport are even expected to increase due to the rising global vehicle fleet and more freight transportation (partly through aviation) (Bleviss, 2021; Jochem *et al.*, 2016; Kwan & Hashim, 2016; OECD, 2010). In a *Modal shift* referring to a shift from cars to lower CO_2 modes of travel, public transport is a crucial link. Trains are able to move people collectively (reducing the use of cars) and cut emissions by around 80% compared to cars and approximately 86% compared to domestic flights (Ritchie, 2023). However, transit agencies are, besides pedestrian alternatives such as walking and bicycling, in direct competition with automobile services. Commuters are likely choosing modes that maximize their utility and provide the most satisfaction (Andreassen, 1995).

In 2018, the European Union conducted a flash Eurobarometer about passenger rail services in Member States (European Commission, 2018). Overall, only one in ten respondents used trains for suburban trips at least once per week and one in twenty used trains weekly or more for national or regional trips (beyond suburban trains). Approximately, 60% of respondents indicated they only took the train once a year or never. International rail travel is even less popular. Almost 80% of the 25 537 respondents never traveled by train for an international trip. Hence, there is still a huge potential of attracting more rail passengers. If we want citizens to move away from traveling by car or airplane, the alternative should be satisfactory. The flash Eurobarometer calculated an overall satisfaction index (between 0 and 30) with rail services for all Member States. The average of 25.4 conceals the large difference between countries. Respondents living in some central, northern, and western European countries were most satisfied with railway transport (maximum of 29.6 for Austria). Bulgaria (with 20.8) had the lowest satisfaction index. Belgium scored close to the EU average with an overall score of 25.9.

A myriad of factors can affect satisfaction with rail services. However, as communication is a crucial aspect of any service, this study studies the impact of (both offline and online) communication on satisfaction. Effective communication between service providers and customers could help manage expectations, build trust, and resolve issues promptly, resulting in higher customer satisfaction (Canel & Luoma-aho, 2019). Yet, train travelers are not particularly satisfied with the accessibility of travel information at the station and on-board trains (European Commission, 2018). On average, only 52% of train travelers are satisfied with the provision of information. However, disseminating information isn't limited to stations and on-board anymore. The Internet, and more specifically social media, offer new opportunities for service providers to share information, create awareness, engage the public and build long-term customer relationships (Canel & Luoma-aho, 2019; Luoma-aho, 2013; Luoma-aho & Olkkonen, 2016; Olkkonen & Luoma-aho, 2015).

One way in which online communication can improve satisfaction with a service is through increased convenience and accessibility. Online communication allows customers to interact with service providers at any time, from any location, without face-to-face interaction or phone calls. This can be especially beneficial for customers with busy schedules or who prefer not to interact with service providers in person. Another way in which online communication can improve satisfaction with a service is through increased speed and efficiency (Canel & Luoma-aho, 2019). Online communication could ensure a faster response from service providers to customer inquiries and issues, which can lead to increased satisfaction with the service. A final advantage of social media interaction is increased personalization and customization (Sanders & Canel, 2013). More tailored responses or individualized recommendations can improve the overall service experience.

The NMBS is the public company responsible for passenger transport services in Belgium and carried more than 220 million domestic travelers in 2022 (NMBS, 2022). It incorporated social media in its communication strategy from 2013 onwards (NMBS, 2013, 2018). This allows us to study two research questions. The first question deals with the effect of general communication on satisfaction when controlling for other variables. The research question here is:
RQ1: "Does communication influence satisfaction with the Belgian railway company?"

The second question asks if social media interaction (more specifically, Twitter contact) with the Belgian railway company influences satisfaction with their service provision. This question will establish if having contact with the NMBS through Twitter resulted in more satisfaction:

RQ2: "Does Twitter interaction influence satisfaction with the Belgian railway company?"

Both research questions are studied with a survey spread over 24 months. In total 7200 observations were collected. A part of these observations is panel data, which allows us to study variation over time. Profiling rider views and a better understanding of what drives satisfaction is important for a modal shift, which requires changes in behavior (Waisman *et al.*, 2013).

This paper starts with a literature review that first defines the key concepts of our research (communication and satisfaction). Subsequently, we discuss the literature relating to how communication affects satisfaction, mainly from the perspective of public service. In addition, we review existing studies relating to the influence of online communication on satisfaction. Lastly, we highlight some insights from previous studies on satisfaction with public transportation. After discussing the current literature, a methodology section details our dataset. This is followed by the results and discussion. Finally, we close with a conclusion.

Literature

The first concept in our paper is satisfaction. Kotler and Keller (2016) described satisfaction as a feeling of liking or disliking a service or product based on comparing its actual performance with the expected performance. Similarly, Bahrudin and Zuhro (2016) define it as a state that is the result of a comparison of performance evaluation between the expected and actual performance. In that regard, customer satisfaction can be described as an evaluation of the expected performance and the actual experience after using the service or product (Hermawati, 2022; Oludele *et al.*, 2012). Satisfaction is a popular intangible asset to measure (particularly for public sector organizations), as it is easy to quantify and mold into questions citizens can understand (Holzer & Yang, 2004). It has also been linked to numerous advantages: better democracy, better life outcomes, social tranquility, positive word of mouth, increased employee efficiency, improved organizational operations, … (Choy *et al.*, 2012; James, 2011; James & Moseley, 2014; Morgeson, 2014; Oliver, 2010; Thijs & Staes, 2008). It also has the potential to save costs for organizations as they face fewer complaints. However, the core argument in favor of greater citizen satisfaction is that it contributes to trust within society through an increased willingness to collaborate and contribute (Putnam, 1933).

The second concept studied in our research is communication. In its simplest form, Hermawati (2022) describes communication as exchanging information, emotions, ideas, and attitudes through non-verbal or verbal means between two or more individuals. Curado *et al.* (2022) pointed out that communication can be defined in the context of the environment or settings. For instance, in the organizational context, the authors defined communication as exchanging or sharing information among employees to build relationships and absorb organizational values. However, this research interests the relationship between an organization and its customers. In that regard, communication with customers involves the flow of information or messages from the organization to the customers, mainly concerning products (or services) (Wagenheim & Rood, 2010). We focus specifically on public sector communication, which provides information about public sector services. At the same time, public communication builds and maintains reputation, legitimacy, organizational culture, intellectual capital, social capital, engagement, and ultimately citizen's trust (Canel & Luoma-aho, 2019).

General communication

Communication is crucial in influencing satisfaction levels in public service provisions (Riley *et al.*, 2015). Accurate and timely information ensures that users can have a seamless (or more seamless) experience with the services, increasing their satisfaction with such services. Rivai *et al.* (2022) investigated how civil servants' communication skills affect community satisfaction. By analyzing 104 civil servants, they determined that civil servants' communication skills influence the community's satisfaction with public service. The authors argue that civil servants who are skilled in communication could provide clear, sufficient, and accurate information concerning where, when, and what the government is doing, making the public more satisfied with the service. The argument that communication moderates the relationship between public service and satisfaction because it helps convey government projects and strategies to the public is also present in a paper by Matraeva *et al.* (2020). While developing a conceptual framework for measuring public service quality and satisfaction, they identified public communication as a significant factor in determining satisfaction levels among citizens as it helps illuminate or explain government services.

Ho and Cho (2017) used multiple large datasets from Kansas City between 2009 and 2014 to evaluate the effectiveness of communication on police performance. The result of the study demonstrated that the perceived effectiveness of public communication significantly influences general satisfaction with the level of crime prevention and police protection. In other words, the study argues that public communication moderates the adverse effects associated with high crime rates because there is clear communication on various policy platforms outlining strategies for fighting and preventing crime, thereby bringing better understanding among the public. James and Moseley (2014) conducted two field experiments. The first was situated in a local government area with low performance in household waste recycling services. The second field experiment was conducted in a local government area with high performance. This research demonstrated that publishing performance information (either absolute or relative) influenced satisfaction. Simply put, good performance evaluations improve satisfaction, while bad performance indicators increase dissatisfaction. Thus, public organizations that communicate positive performance information could influence satisfaction.

Since these studies adopted different methods and were conducted in other geographical locations but still arrived at the same conclusion, it is apparent that effective public communication positively influences public satisfaction with public services. This is even established in public transportation studies. Dong *et al.* (2021) sought to understand satisfaction in the context of public transport in the post-Covid-19 pandemic. They adopted a cross-sectional survey in eight Chinese cities. Statistical analysis demonstrated that communication about safety measures improved the level of service satisfaction. Hence, the first hypothesis is as follows:

H1: Communication from the NMBS will positively influence the satisfaction of train passengers.

Digital communication

Already in 2002, McIvor *et al.* showed the potential of Internet technologies to facilitate the achievement of transparency from public sector organizations (McIvor *et al.*, 2002). Based on interviews, they conclude that connectivity resulting from the Internet will have a major impact on the way in which the public sector interacts with users of their services. It offers an immense opportunity to make public sector organizations more responsive to the needs of citizens. Given the huge surge in the use of social media networks like Twitter, many (government) organizations have resorted to adopting these channels for communications. Lee (2021) demonstrated that online communication could be a means to foster more interaction, solicit citizen participation, and facilitate a more diffuse consumption of information, all at a lower cost to citizens and the government.

Some researchers have focused on exploring the influence of online communications on satisfaction. Welch *et al.* (2005) linked citizen satisfaction with E-government and trust in government. They found that electronic government strategies are important factors that directly affect e-government satisfaction and indirectly affect trust. Ho and Cho (2017) noted that the government's online engagement through digital communication contributed to public satisfaction with government services. In particular, the authors showed that besides traditional communication channels, the government's use of online magazines and websites enhanced public satisfaction since people can get frequent updates about government projects that affect their welfare.

Not all studies demonstrate such a clear positive effect. For instance, Krøtel (2019) established that adopting digital communication of information from government agencies to the public had only a little effect on citizens' satisfaction and trust. The author argues that, considering the internal benefits for the public administrations in terms of reduced cost and ease of functioning, this is a positive story as digitization of communication can be introduced without lowering citizens' perception. However, the same study indicated that citizens view digital information as less important compared to traditional posts. Receiving something digitally had a small negative effect on the perceived importance of the information.

While the abovementioned studies look at a whole range of digital communication (government websites, TV advertising, e-platforms, digital newsletters, …), this research studies the impact of online public communication through a social media platform, namely Twitter. Twitter allows organizations to engage in real-time with large audiences. The study by Welch *et al.* (2005) demonstrated the dissatisfaction of citizens with the transaction and interactivity of websites. More interactivity can be achieved through the use of social media. Grimmelikhuijsen and Meijer (2015) studied whether Twitter interactions with Dutch police forces increased legitimacy by enabling transparency and participation. Although the negligible number of citizens that engaged with the police through Twitter revealed no impact of participation, Twitter did increase perceived police legitimacy through enhanced transparency. This suggests that a direct communication channel between citizens and public organizations can improve perceptions. Thus, we hypothesize the following:

H2: Twitter interaction with the NMBS will positively influence the satisfaction of train passengers.

However, theoretically, there is an alternative hypothesis possible. We don't know why some citizens have contact with an organization through Twitter, while others don't. Even people with a Twitter account may not contact the service provider without a cause. Customers may only use Twitter after experiencing problems (for example, in our case delays or cancellations). Users who interact through social media may have lower satisfaction ratings based on the severity of encountered issues, even if their Twitter contact improved an otherwise negative experience. Better information may not necessarily offset the negative incident. Moreover, if people purposefully turn to Twitter seeking information, only to find nothing, it might even exacerbate any preexisting negative sentiment they harbor (El-Diraby *et al.*, 2019).

Satisfaction with public transportation

Public transport services are a very specific type of service that is an integral factor in connecting communities and enhancing accessibility to jobs, education services, facilities, and other essential social amenities. Therefore, it is necessary to understand what influences satisfaction with public transportation in order to add transport-specific variables to our models.

Cantwell *et al.* (2009) conducted an extensive study to examine the various factors that affect the public's overall satisfaction concerning transport commuting in Dublin. In the study, the researchers considered factors like the frequency of the services, which they defined as the number of trips the vehicle made within a specified timeframe, and reliability of the transport system, the ability to maintain consistent and timely schedules, the time of travel which they defined as the overall duration of the trip from the origin to the final destination, the quality of service in terms of how clean the vehicles are and the overall behavior of the personnel. This study established that the factors mentioned above play a significant role in influencing the aggregate satisfaction of customers. Of these factors, the reliability of the transport was the most critical factor that influenced how satisfied the public was with a service.

A prior study by Eboli and Mazzulla (2007), focused on how service quality attributes affect satisfaction for bus transit with university students in Italy. The study established that factors such as punctuality, the provision of timely and accurate information, and the courtesy of the bus transit service sector staff are key factors affecting users' satisfaction with such services. When staff demonstrates the virtues of politeness, helpfulness, and professionalism in dealing with customers, the aggregate customer experience is enhanced, increasing users' satisfaction levels with the services provided. Interestingly for our research, providing timely and accurate information on available routes, schedules, and fares charged also significantly influenced users' satisfaction. More recently, Pawlasova (2015) identified key factors that affect public transport satisfaction in the Czech Republic. In Pawlasova's study, information similarly proved to be an important element, besides punctuality, frequency, vehicle cleanliness, station proximity, and overall service quality.

The abovementioned factors influencing general satisfaction (punctuality, vehicle cleanliness, helpfulness staff, etc.) are also included in every customer satisfaction survey of the Belgian Railway Company (NMBS, 2019). According to these studies (and our own survey, see later), punctuality – or rather the lack thereof – is a core element for the current customer (dis)satisfaction. Considering the importance of punctuality, both in prior academic research and reports from the NMBS, we decided to study satisfaction with punctuality instead of a general satisfaction judgment. Additionally, the active need for fast and reliable information (through communication) is especially prevalent if passengers encounter problems with the service, such as delays or cancellations.

This research tests several possible variables, besides communication or Twitter interaction, that might influence satisfaction with punctuality. The frequency of rail use can differ a lot between people (Eurobarometer, 2018), some take the train daily for commuting to work, while others never make a rail trip. Secondly, people who voluntarily choose to travel by train (despite having good alternatives), might be less unsatisfied with punctuality. These travelers' motivations may differ (for example, more ecologically driven), resulting in a different satisfaction judgment. Thirdly, having a very recent bad experience with the NMBS might result in a lower satisfaction assessment. A recent memory of a delay might steer respondents more than a delay that occurred farther away from when the survey was conducted. Fourthly, driven by the Expectancy Disconfirmation Model (see Van Ryzin, 2006), expectations are known to impact contentment with services and goods greatly. Higher expectations might lead to less satisfaction and *vice versa*. Fifthly, the quality of the service itself (how many times a respondent was confronted with a punctuality issue) should also have a direct relationship with satisfaction. A better performance, meaning less experienced delays, will result in higher satisfaction. Sixthly, not all delays are equal, some might only take a few minutes while others (especially with cancellations) could be longer than an hour. Presumably, longer delays will more severely impact satisfaction with punctuality negatively. Lastly, the NMBS is not responsible for every issue with punctuality. Intrusions on the tracks, suicide attempts, exceptional weather conditions, copper theft, and bomb threats are all examples of reasons for delays that are beyond the control of the railway company (Infrabel, n.d.b). The NMBS is only responsible for about a third of delays (Arnoudt, 2024, Infrabel, n.d.c). Travelers who hold the NMBS more responsible for problems with punctuality might be more dissatisfied with the services of the NMBS.

Methodology

Surveys have been used for decades by transit agencies to measure the levels of customer satisfaction. They usually contain questions about the socio-economic characteristics of the users, trip features, the importance of different service attributes, and levels of satisfaction with these attributes (Hosseini *et al.*, 2018). Surveys typically ask customers about their overall satisfaction over a period of 30 days. We surveyed 300 representative Dutch-speaking train passengers for 24 months between November 2020 and July 2023. During all 24 waves, we questioned travelers about their experiences in the past month with the NMBS. For example, the survey of January 2023 asked about train experiences during December 2022. Each survey wave took place in the first week of the month.

The representativeness was ensured by surveying a larger group each month to learn who traveled by train. Afterwards, we contacted train passengers who had taken the train at least twice in the past month until we obtained 300 observations that were representative of the sex, education, and age of train passengers. After every six months, we re-contacted the same 300 respondents as before. Hence, we have six panels with four observations. To account for dropout, we added respondents until we gathered 300 respondents for each wave. Figure 13 graphically depicts these connections between survey waves. The original intent was to let the survey continually run for two years. However, another Belgian lockdown combatting the COVID-19 pandemic halted the survey after just one wave. We waited until September 2021, after a vaccination campaign and relaxation of measures, to relaunch the survey.

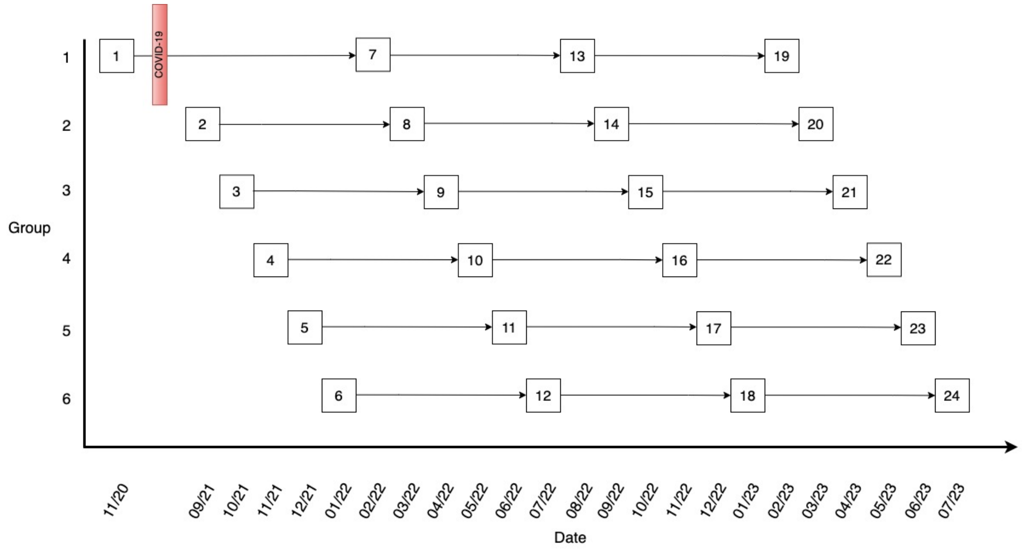

Figure 13 – Design of the Survey with 24 waves spread over 6 groups.

Table 15 details the questions of the survey that are used in the analyses. At first, there is a measurement of satisfaction. This study uses satisfaction with punctuality as the dependent variable. The literature review on satisfaction with public transport demonstrated the importance of this aspect to general satisfaction. In Appendix 1, we ran our own analyses proving that punctuality, cleanliness, staff, and prices have significant effects. However, the largest impact on general satisfaction is the ability to provide train services without delays or cancellations. We obtained the following control variables: age, sex, education, and anti-public sector bias. The last variable refers to negative attitudes towards the public sector, even when confronted with evidence of satisfactory performance (Van Ryzin, 2013). This bias has been documented in previous studies. Among others, Marvel (2015, 2016) showed that citizens automatically and unconsciously associate public sector organizations with inefficiency, inflexibility, and other pejoratives that color their assessments of public sector performances. Lastly, various variables (see previous section) deal with how respondents experienced and felt about the punctuality of the Belgian railway company in the past month. The two independent variables of interest for this study are how people rated communication and whether they interacted with the NMBS through Twitter.

	Name of variable	Question in Survey (translated from Dutch)	Scale
Dependent variable	Satisfaction Punctuality	In the past month, how satisfied were you with the punctuality of the trains?	0 (completely unsatisfied) to 10 (completely satisfied)
Control Variables	Age	What is your age (in years)	/
	D_Female	What gender do you identify with?	0 = Male 1 = Female
	D_High_Education	Have you completed a degree at a University College or University?	0 = No 1 = Yes
	Anti-public sector bias	Do you consider the NMBS to be a public or private company?	0 = Private company or don't know 1 = Public sector company
	D_No_Alternative	In the past month, did you have access to a good alternative method of transportation for your travels by train?	0 = Respondent had an alternative 1 = Respondent had no alternative
	D_Recent_Delay	When was the last time you had a delay with the NMBS?	0 = Two days ago or more 1 = Today or yesterday
Independent Variables	Frequence	In the past month, how many times did you take the train on average?	1 = Less than once a week 2 = once a week 3 = two or three times a week 4 = four times a week or more
	Duration	In the past month, how long was the average experienced delay?	1 = ... less than 5 min 2 = ... less than 15 min 3 = ... less than 30 min 4 = ... between 30 min and an hour 5 = ... more than an hour
	Responsible	In the past month, how responsible do you think the NMBS is for the experienced delay(s)?	1 = Completely unresponsible 2 = Somewhat unresponsible 3 = Unresponsible nor responsible 4 = Somewhat responsible 5 = Completely responsible
	Expectations	In the past month, what were your expectations about the punctuality of your trains? I expected that trains would ...	1 = ... never depart on time 2 = ... depart on time now and then 3 = ... depart on time half of the times 4 = ... depart on time most of the times 5 = ... always depart on time
	Performance	In the past month, how many times did you experience a delay with your trains?	1 = Always 2 = More than half the times 3 = Less than half the times 4 = Never
	Communication	In the past month, how satisfied were you with the communication regarding your delay? *Only asked to people who experienced a delay	0 (completely unsatisfied) to 10 (completely satisfied)
	D_Twitter_user	Do you have an active Twitter account?	0 = No 1 = Yes
	D_Twitter_Contact	In the past month, have you had contact with the official NMBS Twitter account regarding delays?	0 = No 1 = Yes

Table 15 – Explanation of the different variables included in the analyses.
In grey the main variables of interest for this study. D = Dummy.

Self-reported data collected through the same questionnaire during the same time frame might make the results sensitive to common method bias (CMB). In order to reduce the likelihood of CMB we avoided complex, ambiguous, or abstract items (Jakobsen & Jensen, 2015; Meier & O'Toole, 2012; Podsakoff *et al.*, 2012). The questions measure our different variables with focused items on specific experiences. Additionally, we consciously placed different sets of questions in different locations of the survey. These questions appeared as separate web pages, not in consecutive order. Separation in the survey between independent and dependent variables measures has been suggested as a way to reduce common method bias (Jakobsen & Jensen, 2015, p. 17; Podsakoff, *et al.*, 2012). Furthermore, we regularly switched the response formats (Linear numeric scales, Semantic Differential Scales, sliders, dichotomous scales, …) (Kothandapani, 1971; Podsakoff *et al.*, 2012). Although it can never be completely ruled out, we believe the risk of CMB to be limited considering the abovementioned precautions.

The following section details the regression analyses for the panel data (332 respondents who participated four times). To reduce confusion, we decided not to include the results of all (7200) observations in the text. However, all these analyses can be consulted in the appendices of this chapter. Also included in the analyses is a comparison of socio-demographic variables between the full and panel data (Appendix 2), to show that they differ very little, at least on these characteristics. In the result section we will just refer to similarities or discrepancies between the panel and full results. These complete analyses are relevant as they are representative for all train travelers. In the panel data, the considerable number of drop-outs means we can't claim similar representativity. However, as analyses on the full dataset have respondents who participated multiple times, we mainly focus on the panel dataset. With the observations from respondents who participated in multiple waves, we study the effect of (Twitter) communication on satisfaction with punctuality in two parts. In the first part, we use Fixed effects analyses (based on the Hausman specification test) to study the influence of communication (besides other variables) on satisfaction. The Fixed effects allow us to control for any individual-specific attributes that do not vary across time. For the analyses, we used the variables described in Table 15, except for the socio-demographics (as they do not change between survey waves) and two variables related to Twitter. We also added an interaction term between communication and performance, as a lousy performance and bad communication might reinforce each other, meaning even lower levels of satisfaction. In the second part, studying the effect of Twitter interaction, we also employ t-tests to look for significant differences between Twitter and non-Twitter users. As the limited number of observations unabled Fixed Effects regressions, we deployed pooled OLS regressions of all panel observations. This regression shows whether people who had contact with the NMBS Twitter account in the past month were more satisfied.

Results

Does communication matter?

Descriptives

To start, Table 16 shows the descriptive summaries of our variables relevant for the first research question. As previously mentioned, this section only highlights the descriptives and analyses of the panel data with four complete participations. Of the 7200 respondents, only 332 respondents participated in all four contacts, resulting in 1328 observations. However, not all respondents encountered delays or cancellations. Hence, not all 332 respondents were asked to rate the NMBS communication about delays four times. Similarly, the "Duration", measuring the length of the delays, and "responsibility", measuring how responsible the respondents deem the railway company for the experienced delay, were also only asked if respondents experienced delays in the past month. The table below shows the descriptives of two subsamples. The first sample includes all the panel members who encountered one or more delays in the past month. Some only experienced a delay prior to one survey, while others had delays before two, three, or even four surveys. The second sample is limited to the respondents who reported delays in every single survey. In Appendix 3, the two other subsamples (with two to four and three to four delays) are discussed. The results will only highlight the two extremes, ranging from at least one delay to constant delays.

	N=938		N=600		All	
	Mean	SD	Mean	SD	Min	Max
Satisfaction punctuality	5.55	2.32	5.17	2.42	0	10
Age	47.94	15.69	45.79	15.28	18	81
Dummy_Female	0.39	0.49	0.38	0.49	0	1
Dummy_High_Education	0.50	0.50	0.52	0.50	0	1
Anti-public sector bias	0.88	0.32	0.89	0.32	0	1
Dummy_No_Alternative	0.26	0.44	0.27	0.45	0	1
Dummy_Recent_Delay	0.15	0.36	0.18	0.38	0	1
Frequence	2.22	1	2.38	1.01	1	4
Duration	2.17	0.84	2.19	0.81	1	5
Responsible	3.59	0.98	3.72	0.98	1	5
Expectations	3.85	0.93	3.75	0.98	1	5
Performance	2.58	0.65	2.52	0.66	1	3
Communication	5.53	2.21	5.17	2.23	0	10

Table 16 – The descriptive statistics of samples 1-4T and 4T for general communication.

The mean of the dependent variable, satisfaction with punctuality, is 5.55 and 5.17 for the two samples. Figure 14 shows the left-skewed distributions of satisfaction. However, this is not a problem as the assumption of a normal distribution of residuals is never violated in the subsequent regressions. The mean satisfaction with communication, the main independent variables, was almost equal (with 5.53 and 5.17) to satisfaction with punctuality. Appendix 4 provides the descriptives for each wave separately for the entire panel. Moreover, it also contains a correlation table of the different variables.

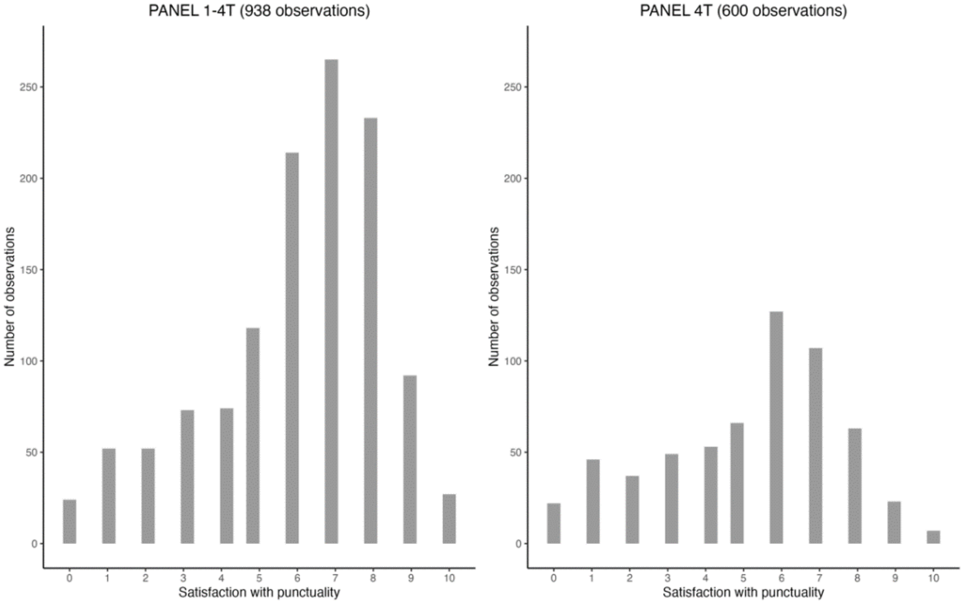

Figure 14 – Histograms showing the distribution of satisfaction for 1-4T and 4T.

Analyses

The first research question set out to study the potential benefit of communication about delays/cancellations on satisfaction. Based on the existing literature, we hypothesized that satisfaction with communication has a positive effect on satisfaction with punctuality. We test this by looking at two models. The number of respondents (and thus observations) differs for each model. As mentioned previously, the first model included every panelist who reported at least one delay over the four survey waves. The second model is a balanced model with the people who dealt with a delay every time. A third and fourth regression model with a minimum of, respectively, two and three delays, can be viewed in Appendix 3. These results are completely identical to the first model (with 938 observations). The final models, as presented in

Table 17 does not include an interaction between performance and communication was not included in the final models. This interaction term was consistently insignificant and didn't add explanatory power to the models.

Communication has a significant positive effect in both models. When train travelers are more satisfied with the received communication, they are also more content with punctuality. As expected, effective punctuality (how many times the train rode without delay) is similarly significant in both models. It also has a large coefficient, meaning the impact of a performance improvement heavily impacts satisfaction. Expectation, another fundamental variable according to EDM, is significant in the unbalanced panel. The strictest analysis (with the fewest observations) did not find a significant effect (at $p<0.05$). Surprisingly, it has a positive effect, meaning higher expectations lead to more satisfaction and *vice versa*. You would expect, based on prior research, that higher (lower) expectations lead to less (more) satisfaction. The last significant variable is the duration of delays. As expected, longer delays result in less satisfaction. How often you take the train, how recent the last delay was, the availability of alternative transportation who is deemed responsible for the delays had no significant effect in the models. The explained variability of the models ranges between 25% and 20%.

	FE-MODEL 1	FE-MODEL 2
	Unbalanced	Balanced
	Minimum 1 Delay in 4 survey waves (T1-4)	4 Delay in 4 survey waves (T4)
Constant	2.763***	2.862**
	(0.742)	(0.887)
Dummy_No_Alternative	-0.135	-0.349
	(0.181)	(0.230)
Dummy_Recent_Delay	-0.105	-0.102
	(0.150)	(0.172)
Frequence	-0.0877	-0.0832
	(0.0791)	(0.0901)
Duration	-0.310***	-0.261**
	(0.0775)	(0.0927)
Responsible	-0.139	-0.139
	(0.0844)	(0.0944)
Expectations	0.187*	0.185
	(0.0879)	(0.0958)
Performance	0.917***	0.857***
	(0.126)	(0.162)
Communication	0.203***	0.165**
	(0.0429)	(0.0554)
Observations	938	600
Number of respondents	306	150
F	21.80***	13.20***
Hausman test	59.21***	51.11***
R^2 (within model)	0.255	0.217
R^2 Adjusted	0.249	0.206

*Table 17 – Results of two extreme models (T1-4 and T4) of general communication on satisfaction. Robust standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Does online interaction matter?

Descriptives

So far, we have established the influence of general communication on satisfaction with punctuality. This second part of the analysis aims to study how online communication/interaction impacts satisfaction. The analyses in this section use all the observations of the panel data (N=1328). Table 18 shows the descriptives of this data. The mean of satisfaction with punctuality is 6.17, which is higher than the mean in the previous part (see Table 16). This is to be expected as the previous sample only looked at people who experienced a delay. This sample also includes some people who never encountered issues with punctuality. The distribution of satisfaction (see Figure 15) is also a bit left-skewed. However, the regressions always had a normal distribution of residuals. Only a subset of the rider pool uses social media. A small 25% of our respondents actively use Twitter and only a very few participants (4%) had interactions in the past month with the official NMBS Twitter account. This does not seem a lot, but it means about 20% of Twitter users communicated online with the Belgian railway company in the month before the survey. See Appendix 4 for an overview of the descriptives for each wave separately and a correlation table.

	N	Mean	SD	Min	Max
Satisfaction punctuality	1328	6.17	2.3	0	10
Age	1328	50.47	15.96	18	82
Dummy_Female	1328	0.4	0.49	0	1
Dummy_High_Education	1328	0.48	0.5	0	1
Anti-public sector bias	1328	0.88	0.33	0	1
Dummy_No_Alternative	1328	0.23	0.42	0	1
Dummy_Recent_Delay	1328	0.11	0.31	0	1
Frequence	1328	2.02	1	1	4
Duration	938	2.17	0.84	1	5
Responsible	938	3.59	0.98	1	5
Expectations	1328	4	0.88	1	5
Performance	1328	2.99	0.85	1	4
Twitter users	1328	0.23	0.42	0	1
Twitter interaction	1328	0.04	0.19	0	1

Table 18 – The descriptive statistics of the sample for online communication.

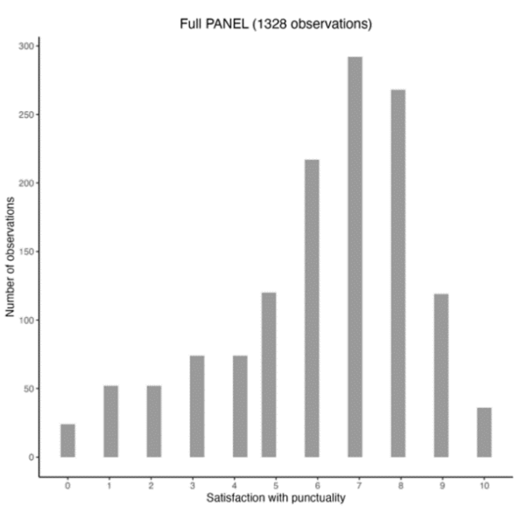

Figure 15 – Histogram showing the distribution of satisfaction with 1328 observations.

Analyses

Table 19 shows two t-tests comparing the mean satisfaction with punctuality between different groups. Despite the potentially biased demographics of Twitter users (Blank 2017), the first t-test shows that Twitter users, at least for satisfaction with punctuality, are not a significantly different group from people who don't use Twitter. This insignificant difference can also be found in the full dataset (see Appendix 5). The second t-test compares the group that had contact via Twitter with the NMBS to those without. There isn't a significant difference between the group that interacted with the NMBS Twitter account in the month prior to the survey, and the Twitter users without contact with the NMBS Twitter account. This is different if you look at all observations, where there is a significant difference in satisfaction between those with an interaction on the social media platform and those without interaction. A possible explanation can be found in the fact that the number of observations with a contact in the panel data is limited. Although an indication, the t-test does not conclusively prove the absence of an effect of Twitter Contact on satisfaction.

	N	Mean 1	Mean 2	t	df	p-value
non-Twitter users vs Twitter users	1328	6.163	6.198	-0.227	480.65	0.820
no contact NMBS vs Contact NMBS	1328	6.156	6.346	-0.806	121.09	0.422

Table 19 – Two t-tests comparing the satisfaction with punctuality for different groups.

For this, we subsequently regressed the same variables as in Table 17. However, communication is now replaced with a dummy indicating whether the respondent had a Twitter interaction with the NMBS in the past month. We could not employ a Fixed Effects model because the number of panel members who engaged with NMBS through Twitter was too limited. From the 332 respondents, only 26 had a Twitter contact in one wave or more. In a Fixed Effects regression, 5 additional respondents would have been eliminated as they had contact in all survey waves; we need variation over time. With only 21 people to study how a change in interaction through social media (either from no-contact to contact or *vice versa*), no significant effect could be found. This small number of contacts forced us to resort to a pooled OLS. In this regression model we look at all panel observations, regardless of identical respondents. This regression, with 1328 observations in total (four observations for each of the 332 panel members), can show us if people who had contact with the NMBS Twitter account in the month before a survey were more satisfied because we have a bit more observations (51 to be exact) of Twitter interactions.

The pooled regression, depicted in Table 20, showcases a small but significant ($p < 0.05$) effect of Twitter interaction, the variable of interest. This significance is noteworthy, especially because of the small number of Twitter interactions (51 out of 1328 observations). Age, being female, higher education, and perceiving the railway company as a public sector organization negatively affected satisfaction. A recent delay or the number of train rides did not affect satisfaction. Having no alternative mode of transportation also, unlike the fixed effects model in the first part, significantly decreases satisfaction. This finding shows that traveling with trains by choice improved satisfaction with punctuality. Having access to alternative means of transportation and still opting for rails probably reflect other priorities (for example ecological motives). Expectations, again contrary to predictions, and actual performance have a positive effect. The model explains a bit over 40% of the variability. The results with all observations (regardless of recontacts) have small deviations (see Appendix 5 Table 33). Regardless, having a Twitter contact has again a positive effect on satisfaction. The higher significance level ($p < 0.001$) of this variable is probably a result of more interactions (335 observations of a Twitter contact).

	OLS
Intercept	1.264 (0.395) **
Age	-0.009 (0.003) **
Dummy_Female	-0.214 (0.100) *
Dummy_High_Education	-0.245 (0.100) *
Anti-public sector bias	-0.519 (0.150) ***
Dummy_No_Alternative	-0.409 (0.125) **
Dummy_Recent_Delay	-0.265 (0.175)
Frequence	0.083 (0.052)
Expectations	0.314 (0.066) ***
Performance	1.573 (0.068) ***
Dummy_Twitter_Contact	0.621 (0.270) *
n	1328
R^2	0.419
R^2 Adj.	0.415

Table 20 – Results Twitter communication on satisfaction.
*Robust standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

However, we should still interpret the findings above with caution. As the group with a Twitter contact is still relatively small (51 observations), a few extreme findings in the group can weigh heavily on the results. The significant finding might be the result of a few positive outliers in the dummy group. Figure 16 identifies outliers for the group with (1) and without (0) a Twitter contact. The figure suggests that the significant positive effect of a Twitter contact isn't due to a few positive outliers. The opposite is true, there are outliers with a low satisfaction score. These observations impede rather than enforce the effect.

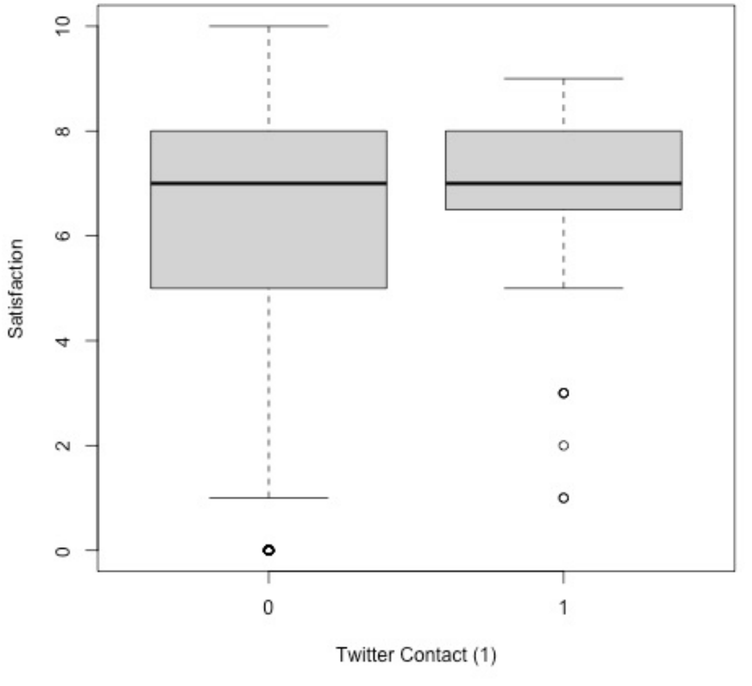

Figure 16 – Boxplots showing the outliers of satisfaction by dummy Twitter contact.

As proposed in the literature review, more satisfaction in punctuality after Twitter interaction could be attributed to knowing the Railway Company isn't always responsible for delays. Because the NMBS tries to explain why a delay occurs, it is reasonable to suspect that these travelers are better informed about the reasons for delays. A t-test (Table 21) compares respondents who encountered delays with and without a Twitter interaction. The group that engaged with the NMBS in the past month held the company significantly less responsible for the experienced delays than Twitter users with no contact and non-Twitter users. The same can be observed in the t-test for the full dataset (see Appendix 5 Table 34).

	N	Average Mean 1	Average Mean 2	t	df	p-value
Contact NMBS vs no contact NMBS	938	3.000	3.621	4.429	52.541	0.000

Table 21 – t-test comparing the allocated Responsibility to the NMBS by Twitter interaction.

Discussion

The first hypothesis said that satisfaction with communication significantly improved satisfaction with punctuality. This was proven in all analyses. The time series analysis showed that a unit increase in satisfaction with communication between survey waves increased satisfaction with punctuality by 0.21 or 0.16 depending on the model. We could not find a significant effect of the interaction between communication and performance. This means there is no reinforcing effect of both variables on the level of satisfaction. Regardless, these findings demonstrate the importance of good communication. Public organizations that invest in better communication should be able to achieve more satisfaction.

The second hypothesis expected Twitter interaction to have a positive effect on travelers' satisfaction with punctuality. The regression indicated that people who had contact with the NMBS Twitter account in the past month had an increased satisfaction with 0.05 (or 0.07 for all observations) standard deviations. Although significant (with 5% significance and 0.1% significance for panel and full data respectively), it is a rather limited effect compared to a variable such as the perceived performance. With these findings, we can reject the alternative hypothesis that people with interactions on Twitter have lower satisfaction. The reason behind this alternative hypothesis was that travelers would only resort to Twitter if they encountered serious punctuality issues. These frustrations might not be remedied with an additional interaction. However, this was disproven as a Twitter interaction significantly improved satisfaction.

This research proposes that the effect of communication influences satisfaction, at least partly, through the perceived responsibility. The NMBS communicates several things on Twitter. It helps people map out a route, answers questions about tickets and prices, gives updates on constructions, apologizes to people for unsatisfactory services, … It also tries to explain why a particular delay occurred. Some delays are not the result of a failing service but force majeure (unforeseeable circumstances). If travelers are aware of the reason they experience a less punctual service, especially if the NMBS is not responsible, this might reflect in more satisfaction. Another strength (mentioned by the literature) of Twitter communication is the possibility to customize responses to individual users, highlight particular service elements, and manage expectations. The possibility for direct communication can be seen as customer-friendly and makes the organization more tangible.

Throughout all the different regression models (Fixed effects and OLS), the results (or lack thereof) of some additional variables are surprising. The frequency of rail use has never had a significant effect on satisfaction with punctuality. This is probably partly the result of including the duration of the experienced delays in some models, which always had a significantly negative effect on satisfaction with punctuality. Longer delays (in minutes) decrease satisfaction with punctuality. Similarly, expectations (with one exception) and the actual performance are always significant. A better performance or higher expectations leads to higher satisfaction. The latter is very remarkable as it contrasts theory and previous research. However, it might be explained by socialization. Because of frequent experiences, train travelers might be able to estimate how much delay they will encounter. Low expectations and low satisfaction, or the opposite, might be tied together because of a general impression built on years of piling train experiences. Additionally, expectations should preferably be asked before a particular service. Asking people to rate their expectations after an experience might be challenging cognitively as respondents might be influenced by the actual performance.

Conclusion

This paper explored the impact of communication (both in general and online communication) on satisfaction with the Belgian Railway Company. We conducted a survey, spread out over 24 months with 7200 observations (including a panel of 332 respondents with four contacts). The analyses focused specifically on satisfaction with punctuality, which is – both according to the literature and our analysis – crucial for general satisfaction. The results show that an improvement in the experienced communication significantly increased satisfaction with the punctuality of trains. This finding is consistent with the current literature and proves that increased efforts to better communication between the public sector and citizens are advantageous. Citizens expect, especially when experiencing problems, clear and accurate information.

Novel in this research is the inclusion of social media interaction. We examined the effect of the Twitter communication strategy of the NMBS. This organization, and many others, became an active Twitter user and shares information about delays or cancellations, assists with alternative routes, conveys apologies, details future plans to prevent current issues, helps if the app isn't working, … This allows for more direct interaction with service users, which helps build better long-term relationships with customers. In order to have a successful social media strategy to impact people's satisfaction, people need to be aware of your social media presence. Based on the number of respondents with Twitter who interacted with the NMBS, we can conclude that the NMBS Twitter account has managed to become a successful channel for providing information. About 1 in 5 Twitter users had an experience with the account in the month before the survey. As we can assume not all Twitter users require assistance or information every month (only when encountering troubles or tweeting something extraordinary), this can be considered a high percentage of interaction for a public organization.

The social media strategy of the Belgian Railway Company may be quite effective in reaching a Twitter audience, but that does not automatically mean it is successful in improving satisfaction. We don't know why some users had contact via Twitter and not others. Respondents may only use Twitter after experiencing severe problems, meaning users who communicate through Twitter may have lower satisfaction ratings, even if their Twitter contact actually improved an otherwise negative experience. However, this reasoning was not supported by our analyses. Having an exchange with the NMBS Twitter account significantly increased the respondent's satisfaction.

This study has several limitations. The complex survey structure is, with different groups of panels, not straightforward. Furthermore, a limited number of observations of Twitter interactions meant we did not fully utilize our whole dataset. The pooled regressions of the whole representative dataset are documented in the appendix but arrived at similar conclusions. A second downside of this study is that communication in the first part is measured in a very broad/generic way. We did not look at the underlying dimensions of communication (such as transparency, speed, completeness, and accuracy of information, …). This paper was restricted to studying how communication (including social media communication) and performance relate to each other. Studying the communication design (and the different facets) could and should be another paper.

A third limitation is that we don't know what is discussed in the interactions respondents had through Twitter. We know the general content of tweets from chapter two of this dissertation. However, a linkage with the exact tweets studied in this paper is missing. More insight (through qualitative research) into the content of the contacts would shed light on the mechanisms at play. We also don't know how much interaction took place in the studied month; was it a one-time question or a series of questions/complaints? Another limitation is the decision to ignore other social media platforms. Engaging with citizens is not limited to one medium, and other platforms might have different audiences, influencing the potential effect of public communication. Furthermore, extrapolating our results to other, less identifiable or lesser-known organizations remains uncertain. A last limitation is the fact that we don't know if the online efforts seep through to general customers. Not all citizens have a Twitter account, which limits online strategies' potential impact. These unresolved questions should be given future attention. As the public sector increasingly incorporates modern technology or social media platforms in their day-to-day operations, numerous avenues for research are wide open.

In conclusion, our findings suggest that establishing effective communication helps improve the satisfaction of customers. This is relevant as studies have demonstrated that better performances do not automatically result in more satisfaction (Van de Walle & Bouckaert, 2007). Communication can play a vital role in shaping citizen satisfaction.

The effect, although limited, of increased approachability through social media is especially noteworthy. However, it only reaches a small group of digitally empowered citizens.

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Appendices

Appendix 1: General satisfaction

	Name of variable	Question in Survey	Scale
Satisfaction	General	In the past month, how satisfied were you with the general services of the NMBS?	0 (completely unsatisfied) to 10 (completely satisfied)
	Punctuality	In the past month, how satisfied were you with the punctuality of the trains?	0 (completely unsatisfied) to 10 (completely satisfied)
	Cleanliness	In the past month, how satisfied were you with the cleanliness of the trains?	0 (completely unsatisfied) to 10 (completely satisfied)
	Staff	In the past month, how satisfied were you with the staff of the NMBS?	0 (completely unsatisfied) to 10 (completely satisfied)
	Prices	In the past month, how satisfied were you with the prices of the NMBS?	0 (completely unsatisfied) to 10 (completely satisfied)

Table 22 – Different types of satisfaction measured in the survey.

In this appendix, we demonstrate why it is relevant to study only one aspect of satisfaction, namely punctuality. A quick statistical analysis, similar to previously mentioned studies, shows significant effects of cleanliness, staff, and prices on general satisfaction with NMBS in a pooled OLS. However, the most important effect is the ability to provide train services without delays or cancellations. The dependent variable had a slight skewedness, and the distribution of the residuals was non-normal. We tested several transformations, that all yielded the same results, but were not able to fix the non-normality completely. To account for the panel structure in our dataset, we also ran a Fixed Effects regression with the four contacts of every group. Only 332 respondents participated in all four iterations (making it 1328 observations). This regression is almost identical to the pooled OLS. Moreover, (change in) satisfaction regarding punctuality has again the largest effect on (changes in) general satisfaction.

	Full dataset	Panel (T4)
	OLS Full	
Intercept	0.923 (0.085)***	2.380 (0.331)***
Age	0.003 (0.001)***	
Dummy_Female	0.174 (0.028)***	
Dummy_High_Education	0.004 (0.029)	
Anti-public sector bias	0.123 (0.037)**	
Punctuality	0.468 (0.010)***	0.401 (0.030)***
Cleanliness	0.138 (0.012)***	0.093 (0.038)*
Staff	0.189 (0.013)***	0.128 (0.032)***
Prices	0.066 (0.009)***	0.067 (0.027)***
n	7200	1328
groups	/	332
F	/	70.31***
Hausman test	/	52.94***
R^2	0.640	0.384
R^2 Adj.	0.639	0.382

Table 23 – Results different subtypes of satisfaction on general satisfaction.
*Robust standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

Appendix 2: Difference Full dataset and panel

The table below highlights the descriptive statistics of the four socio-demographic variables in our survey. It shows both the full dataset (with 7200 representative observations) and the panel dataset (with 332 observations). The difference, at least concerning the control variables, is very limited. The mean age is a bit higher for the panel dataset. Additionally, the number of females is a bit lower in the panel.

	7200		332	
	Mean	SD	Mean	SD
Age	43.86	17.0	50.47	15.96
Dummy_Female	0.47	0.5	0.4	0.49
Dummy_High_Education	0.48	0.5	0.48	0.5
Anti-public sector bias	0.79	0.41	0.88	0.33

Table 24 – The descriptive statistics of the full sample and the panel sample.

Appendix 3: T2-4 and T3-4

Descriptives

The following table and figure show the two samples with either two or three (out of four) months with a delay. The mean of the variables and the distribution of satisfaction is always between the two extreme samples, shown in Table 16 and Figure 14.

	N =898		N =798		ALL	
	Mean	SD	Mean	SD	Min	Max
Satisfaction punctuality	5.5	2.33	5.42	2.37	0	10
Age	47.46	15.59	46.54	15.49	18	81
Dummy_Female	0.38	0.49	0.38	0.49	0	1
Dummy_High_Education	0.51	0.5	0.5	0.5	0	1
Anti-public sector bias	0.88	0.32	0.88	0.33	0	1
Dummy_No_Alternative	0.26	0.44	0.28	0.45	0	1
Dummy_Recent_Delay	0.16	0.37	0.16	0.37	0	1
Frequence	2.24	1	2.29	1	1	4
Duration	2.17	0.84	2.19	0.81	1	5
Responsible	3.6	0.98	3.63	0.98	1	5
Expectations	3.84	0.93	3.78	0.94	1	5
Performance	2.57	0.65	2.56	0.65	1	3
Communication	5.49	2.22	5.39	2.23	0	10

Table 25 – The descriptive statistics of samples T2-4 and T3-4 for general communication.

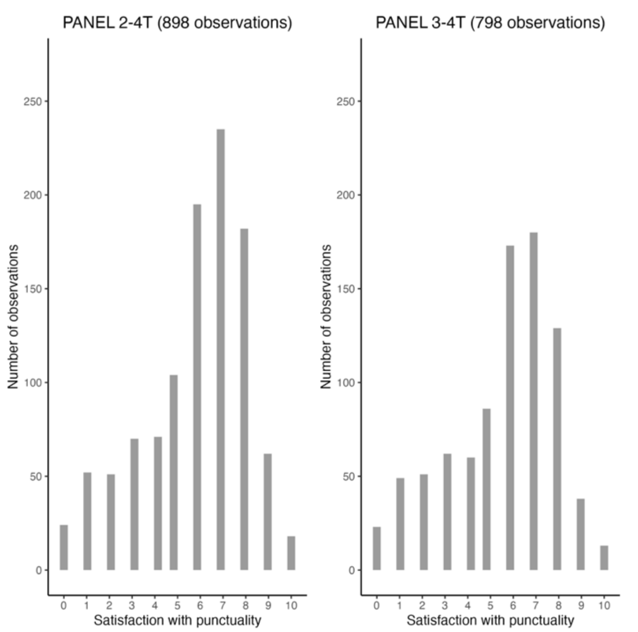

Figure 17 – Histograms showing the distribution of satisfaction for T2-4 and T3-4.

Analyses

The following regression models do not differ from the sample with at least one delay (T1-4) from Table 17.

	FE-MODEL A	FE-MODEL B
	Unbalanced	Unbalanced
	Minimum 2 Delays in 4 survey waves (T2-4)	Minimum 3 Delays in 4 survey waves (T3-4)
Constant	2.733***	2.647***
	(0.741)	(0.778)
Dummy_No_Alternative	-0.135	-0.229
	(0.181)	(0.191)
Dummy_Recent_Delay	-0.105	-0.0533
	(0.150)	(0.154)
Frequence	-0.0877	-0.0843
	(0.0792)	(0.0828)
Duration	-0.310***	-0.249**
	(0.0775)	(0.0822)
Responsible	-0.139	-0.167
	(0.0844)	(0.0867)
Expectations	0.187*	0.206*
	(0.0879)	(0.0899)
Performance	0.917***	0.892***
	(0.126)	(0.133)
Communication	0.203***	0.210***
	(0.0429)	(0.0467)
Observations	898	798
Number of respondents	266	216
F	21.78***	18.19***
Hausman test	58.07***	63.16***
R^2 (within model)	0.255	0.246
R^2 Adjusted	0.249	0.239

*Table 26 – Results of two middle models (T2-4 and T3-4) of general communication on satisfaction. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.*

Appendix 4: Descriptives full panel

The following tables detail the descriptives of all observations of the panel members and every wave separately. The control variables (age, sex, education, and anti-public sector bias) did not change over time. This is, especially in the case of age, incorrect over 24 months. However, we only possess the age at the first survey and don't know the exact birthday of each respondent.

	Full panel (332 with T4)				
	N	Mean	SD	Min	Max
Satisfaction punctuality	1328	6.17	2.3	0	10
Age	1328	50.47	15.96	18	82
Dummy_Female	1328	0.4	0.49	0	1
Dummy_High_Education	1328	0.48	0.5	0	1
Anti-public sector bias	1328	0.88	0.33	0	1
Dummy_No_Alternative	1328	0.23	0.42	0	1
Dummy_Recent_Delay	1328	0.11	0.31	0	1
Frequence	1328	2.02	1	1	4
Duration	938	2.17	0.84	1	5
Responsible	938	3.59	0.98	1	5
Expectations	1328	4	0.88	1	5
Performance	1328	2.99	0.85	1	4
Communication	938	5.53	2.21	0	10

Table 27 – The descriptive statistics for the full panel (with T4).

	Contact 1			Contact 2			Contact 3			Contact 4		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Satisfaction punctuality	332	6.47	2.31	332	6.45	2.18	332	5.99	2.35	332	5.77	2.31
Dummy_No_Alternative	332	0.22	0.41	332	0.21	0.41	332	0.22	0.41	332	0.25	0.43
Dummy_Recent_Delay	332	0.08	0.28	332	0.09	0.29	332	0.12	0.33	332	0.14	0.35
Frequence	332	1.93	1.01	332	1.97	1.01	332	2.12	0.99	332	2.07	1.01
Duration	214	2.12	0.9	232	2.09	0.77	247	2.2	0.85	245	2.25	0.83
Responsible	214	3.55	1	232	3.66	0.94	247	3.55	1.01	245	3.6	0.98
Expectations	332	4.13	0.79	332	4.03	0.85	332	3.92	0.94	332	3.92	0.93
Performance	332	3.12	0.82	332	3.03	0.83	332	2.93	0.85	332	2.89	0.87
Communication	214	5.45	2.26	232	5.59	2.09	247	5.49	2.14	245	5.57	2.34
Twitter users	332	0.22	0.41	332	0.24	0.43	332	0.25	0.43	332	0.22	0.41
Twitter interaction	332	0.03	0.18	332	0.04	0.19	332	0.05	0.22	332	0.03	0.18

Table 28 – The descriptive statistics for the four waves of the panel data.

The final table shows the correlation between the variables used in the different regressions. We did not have a high correlation (or multicollinearity) between different variables in our models.

	Age	Female	High Education	Anti-public sector bias	No Alternative	Recent Delay	Frequence	Duration	Responsible	Expectations	Performance	Communi-cation	Twitter	Contact Twitter
Age	1													
Female	-0.157	1												
High_ Education	-0.171	-0.072	1											
Anti-public sector bias	0.169	-0.040	0.000	1										
No Alternative	-0.079	0.035	0.014	-0.018	1									
Recent Delay	-0.109	-0.068	0.046	-0.081	0.044	1								
Frequence	-0.171	0.017	-0.038	-0.062	0.074	0.289	1							
Duration	-0.001	-0.001	-0.017	-0.029	0.088	0.023	0.031	1						
Responsible	0.039	-0.171	0.098	0.206	0.160	0.002	-0.038	0.189	1					
Expectations	0.158	-0.075	-0.084	0.081	-0.070	0.001	-0.015	-0.112	-0.111	1				
Performance	0.061	-0.005	-0.011	-0.046	-0.121	-0.052	0.091	-0.215	-0.287	0.230	1			
Communi-cation	-0.026	0.050	-0.020	-0.123	-0.171	-0.013	0.036	-0.196	-0.386	0.170	0.330	1		
Twitter	-0.256	-0.084	-0.010	-0.221	0.001	0.078	0.129	0.045	-0.045	-0.130	-0.007	0.064	1	
Twitter interaction	-0.153	-0.046	-0.031	-0.349	-0.093	0.222	0.157	0.057	-0.139	-0.057	0.040	0.107	0.401	1

Table 29 – Correlation matrix for the full panel.

Appendix 5: Full dataset

This final appendix lists the descriptives and results with the full dataset of 7200 observations. Table 30 is a summary of the descriptive values. Table 31 shows the pooled OLS results of the first part of the study. Communication has again a significant influence on satisfaction. Table 32 does the same as Table 19. Table 33 proves the effect of a Twitter interaction on satisfaction with the full dataset. Finally, Table 34 tests if the group that engaged with the NMBS in the past month held the company less responsible for the experienced delays.

	All waves				
	N	Mean	SD	Min	Max
Satisfaction punctuality	7200	6.06	2.35	0	10
Age	7200	43.86	17.0	16	86
Dummy_Female	7200	0.47	0.5	0	1
Dummy_High_Education	7200	0.48	0.5	0	1
Anti-public sector bias	7200	0.79	0.41	0	1
Dummy_No_Alternative	7200	0.2	0.4	0	1
Dummy_Recent_Delay	7200	0.09	0.28	0	1
Frequence	7200	1.89	1.02	1	4
Duration	7200	2.21	0.89	1	5
Responsible	7200	3.55	0.98	1	5
Expectations	7200	3.94	0.94	1	5
Performance	7200	3.01	0.89	1	4
Communication	4849	5.52	2.2	0	10
Twitter users	7200	0.24	0.43	0	1
Twitter interaction	7200	0.05	0.21	0	1

Table 30 – The descriptive statistics of the full dataset.

The following pooled OLS on the full dataset (4849 observations with delays out of the 7200) has similar findings as the Fixed Effects regressions. The result for the main variable of interest, communication, is identical. Performance, expectations, and the duration of delays are also significant. The result for age, education, and anti-public sector bias (not included in the panel regressions) is non-significant. Being female is the only socio-demographic with a significant effect; females have less satisfaction. The two variables that are different compared to the fixed effects are "Dummy_Recent_delay" and "Responsible". Both are statistically significant. Hence, if respondents blame the NMBS, they are less satisfied with their services. If respondents attribute the delay to others, they are more satisfied with the punctuality of the railway company. Having a very recent delay also significantly reduced satisfaction a bit in the full model.

	OLS
Intercept	1.636 (0.228)***
Age	0.001 (0.001)
Dummy_Female	-0.222 (0.050) ***
Dummy_High_Education	-0.002 (0.049)
Anti-public sector bias	-0.089 (0.060)
Dummy_No_Alternative	-0.046 (0.060)
Dummy_Recent_Delay	-0.153 (0.074) *
Frequence	0.038 (0.025)
Duration	-0.173 (0.030) ***
Responsible	-0.412 (0.029) ***
Expectations	0.212 (0.027) ***
Performance	1.073 (0.046)***
Communication	0.393 (0.015) ***
n	4849
R^2	0.494
R^2 Adj.	0.492

Table 31 – Results of general communication on satisfaction (full dataset).
*Robust standard errors in parentheses. + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

Concerning the second research question, the following table starts again by comparing the mean satisfaction with punctuality between different groups. Twitter users are again not significantly different from people who don't have a Twitter account. However, the second comparison differs from Table 19. There is a significant difference between those with an interaction on the social media platform and those without interaction. The group with an interaction had a significantly higher satisfaction.

	N	Mean 1	Mean 2	t	df	p-value
non-Twitter users vs Twitter users	4 849	6.034	6.136	-1.565	2940	0.118
no contact NMBS vs Contact NMBS	4 849	6.027	6.719	-6.091	380.35	0.000

Table 32 – t-tests comparing the satisfaction with punctuality for different groups (full dataset).

A regression similar to Table 20, showed that having a Twitter interaction was not significant in the full dataset.

	OLS
Intercept	3.890 (0.242)***
Age	0.001 (0.002)
Dummy_Female	-0.155 (0.055) **
Dummy_High_Education	0.002 (0.055)
Anti-public sector bias	-0.065 (0.068)
Dummy_No_Alternative	-0.136 (0.066) *
Dummy_Recent_Delay	-0.261 (0.084) **
Frequence	0.025 (0.027)
Duration	-0.295 (0.033) ***
Responsible	-0.633 (0.031) ***
Expectations	0.290 (0.030) ***
Performance	1.323 (0.048) ***
Dummy_Twitter_Contact	0.752 (0.131) ***
n	4849
R^2	0.395
R^2 Adj.	0.393

Table 33 – Results of Twitter communication on satisfaction (full dataset).
*Robust standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$*

The last table shows that the group with an interaction via Twitter blamed the NMBS significantly less compared to the travelers without Twitter.

	N	Average Mean 1	Average Mean 2	t	df	p-value
Contact NMBS vs no contact NMBS	7200	2.909	3.586	11.756	310.55	0.000

Table 34 – t-test comparing the allocated Responsibility to the NMBS (full dataset).

6

Conclusion

Introduction

This dissertation studied whether public sector communication on social media can bridge the gap between public sector organizations and citizens. Public sector communication is defined as goal-oriented, intentional communication between a public organization and their service customers or to the wider public about their service delivery with the purpose of building and maintaining intangible assets (values such as trust, legitimacy, satisfaction, citizen engagement, satisfaction, …). Many government organizations have invested in an active government presence on social media, which allows for a fast and more personalized form of communication (Canel & Luoma-aho, 2019; Mergel, 2015, 2016; van Dijk *et al.*, 2015; Wong *et al.*, 2021).

Incorporating social media is imperative to remain responsive to heightened citizens' demands and expectations, influenced by elevated service standards in the private sector (Thijs & Staes, 2008). Moreover, placing a stronger emphasis on social media communication is crucial for reaching technologically empowered individuals expressing real-time opinions to mass audiences (Castells, 2009). Citizens, expected to actively engage with public organizations to address social problems by bringing experiential expertise and local knowledge, can benefit heavily from the facilitation of such interactions through social media (Bowden *et al.*, 2016; Durose *et al.*, 2015). Additionally, social media enables the public sector to tailor messages to the diverse citizens in our society who differ on perceived identities, locations, histories, expectations, education levels, … (Canel & Luoma-aho, 2019; Vertovec, 2007).

As communication is considered a potential remedy for the bad relationship between the state and citizens, this dissertation set out to examine if citizen-centered communication through social media can influence perceptions (i.e., citizens' satisfaction or reputation). This dissertation had three research questions, each corresponding to an empirical chapter. The first research question asked if we could observe a difference in social media messages posted by citizens before and after a public sector organization becomes an active social media communicator. The second question inquired if evolutions in social media sentiment can be predicted by public communication, traditional media, and an objective performance indicator. The third and final question stepped away from social media sentiment and wanted to know if communication (both in general and through social media) can influence customer satisfaction.

RQ1: What is the immediate effect of commencing with a bidirectional online public communication on social media sentiment?

RQ2: What is the effect of more or less online public communication on social media sentiment when including traditional media and a performance indicator?

RQ3: Does (online) public communication significantly influence customers' satisfaction with public services?

To answer these questions, the public communication strategy of the Belgian Railway Company (NMBS) on Twitter was utilized. Twitter is a social media that allows interaction with large audiences and offers the possibility of live updates on services. It is a platform that brings together different kinds of audiences; journalists, politicians, service customers, and citizens all read, like, post, and react to each other through tweets. These Tweets have also frequently been used as a way of gauging public perceptions (Anastasia & Budi, 2016; Gayo-Avello, 2013; Kanavos *et al.*, 2017; Méndez *et al.*, 2019; O'Conner *et al.*, 2010; Permana *et al.*, 2017; Sahayak *et al.*, 2015; Schivinski & Dabrowski, 2016; Shukri *et al.*, 2015). The studied case, a public service provider solely responsible for passenger train transportation, is one of Belgium's largest public sector companies and faces persistent negative public opinions. Since 2013, the organization has been trying to enhance the customer experience by intensive public communication through Twitter (NMBS, 2013a, 2018).

This final chapter addressed the key insights derived from the three empirical chapters, providing answers to the research questions outlined in Chapter 1. After a thorough examination and discussion of the primary results, we explore the contributions of these findings. The focus lies on the theoretical, empirical, and practical relevance of the dissertation. In this section, we also contemplate the future of public communication for the NMBS, specifically within the context of increased competition on text-based social media platforms. Although this section is not based on findings from our study, it is a relevant addition as practitioners will be confronted with new challenges when constructing or adapting a social media strategy. Subsequently, the study's limitations are discussed and potential avenues for future research connected to the dissertation are explored. To conclude, this chapter offers a normative reflection that extends beyond the empirical chapters, aiming to enrich the discourse on the necessity of a well-thought-out communication strategy.

Findings and contributions

We started the dissertation with a small analysis of how the NMBS uses Twitter. As many other transit providers, the company uses it for timely updates, public information, and citizen engagement. Although they post original content on Twitter, the major focus lies on citizen engagement. As previously established by different scholars (Cheng, 2010; Cottrill *et al.*, 2017; Diaz *et al.*, 2021; Harazeen, 2011; Pender *et al.*, 2014; Transport Focus, 2011, 2015; Yates & Paquette, 2011), disruptions generate a lot of uncertainty and frustrations. People demand an estimated time of delay, the reason for the problem, and some alternative routes. Questions (about half of the tweets from citizens) almost always receive a prompt and helpful reply from the NMBS. However, complaints (a third of all tweets) are more likely to go unanswered. The strong language in some of these tweets might explain why the NMBS decide not to enter such a discussion. Nevertheless, the NMBS is an exemplary model of bidirectional and citizen-centered use of social media. This is relevant to interpret the findings of our empirical chapters. An organization that only relies on, as Schweitzer phrased it, blasting information from the agency outwards, will probably not achieve similar results.

The third chapter of this dissertation investigated what happened to the Twitter sentiment of the NMBS when they started a public communication strategy on Twitter. By comparing the sentiment of tweets before and after the railway company became active on Twitter in 2013, the study was able to assess the effect of NMBS's Twitter presence. All tweets (almost 200 000 tweets) mentioning the NMBS from January 2011 to December 2018 were classified based on machine learning-based automated text analysis and were weighted according to the number of likes and retweets. The hypothesis that commencing with public communication positively affected satisfaction was confirmed with a regression discontinuity design. Results indicated a significant reduction in the percentage of negative tweets. This decrease in negativity was not attributed to changes in the performance (i.e., punctuality) of train services.

Although the presence on social media initially had a significant effect on Twitter sentiment at the start of the public communication strategy, the findings didn't delve into the potential effect of public communication intensity; do more interactions for example lead to a better sentiment? In chapter four, we introduced time-series analyses to study the effect of multiple variables on Twitter sentiment over longer periods of time. Hence, the first research question employed a static pretest-posttest analysis, while the second is a dynamic approach examining the evolution of sentiment of tweets due to changes in three other variables. Ideally, a good understanding of how previous values of online and real-life events affect social media sentiment can enable us to predict future values of Twitter sentiment.

Tweets on social media do not develop in a complete vacuum. This research hypothesized, based on existing literature, that the performance of the organization impacts future sentiment. If service delivery improves or deteriorates, we expect it to show over time in tweets. Similarly, changes in traditional media reputation (also constructed with automated text analyses) or media storms were expected to seep through in Twitter conversations; an improved media reputation could improve the language of tweets about that organization. Lastly, most attention is put on the hypothesis that more intensive public communication enhances Twitter sentiment. Both daily and monthly data from January 2014 through December 2018 were analysed with a vector autoregressive model to examine causal relationships among the variables of interest.

In the daily dataset, our findings revealed that only delays in the preceding days significantly influenced Twitter sentiment. Improved performance translated into enhanced sentiment on Twitter a few days later. Interestingly, neither media reputation, measured as a sentiment index nor as media storm occurrences, nor the intensity of public communication, showed a significant impact on future tweets. However, when analyzing the monthly data, we found that public communication had a notable causal effect when media storms were considered in the model. Interestingly, this significance diminished when media sentiment replaced media storms. Attempting to forecast Twitter sentiment based on these findings proved challenging, highlighting the unpredictable nature of social media. Anyone can tweet about an experience (either good or bad), which may or may not gain traction.

The previous two studies have demonstrated the (non-)impact of public communication on social media sentiment. While the mere presence had an effect, the level of responsiveness did not show a clear positive effect. These two findings should be viewed together as they complement each other. People might adopt their language when they know somebody will reply, suggesting a sudden and relatively permanent effect. The sentiment of current tweets may not reflect the agencies' recent activity but rather its overall established presence. Therefore, seeing or experiencing even one interaction would be enough to know the organization is approachable and tries to help customers, which could change the way people tweet about the organization. The fact that we didn't find a causal relationship between the daily intensity of interaction and future sentiment can also be reassuring: if an organization is less active for a few days, this will not nullify the previously achieved effect. Tweets don't immediately increase in negativity. However, a more permanent decline in Twitter activity (as our monthly result was partly significant) could still decay the reputation built over time.

The final study shifted focus from social media sentiment to general customer perceptions. This chapter addressed the importance of communication and interaction via social media for satisfaction with public sector performance. Conducting a survey spread over 24 months with 7,200 observations, including a panel of 332 respondents with four contacts, our results revealed that an improvement in experienced communication significantly increased satisfaction. The findings also demonstrated that an exchange with the NMBS Twitter account significantly increased the respondents' satisfaction. This is probably the result of the NMBS being blamed significantly less by Twitter users. As Twitter is ideally suited to explain why a certain disruption occurred, these riders might be better informed which in turn improves satisfaction. Twitter interactions having a positive effect is interesting because an interaction without relevant information might just make the dissatisfaction bigger. El-Diraby et al. (2019) found that for Vancouver, the highest negative sentiment was related to information availability. People go to Twitter to get information and if they do not find it, this will contribute to any negative sentiment they may already have. We did not find evidence of such an effect.

The overarching question guiding this dissertation was as follows:

Does bidirectional public sector communication through social media improve the relationship between citizens and public organizations?

Our answer, which is divided into two segments covering the impact on online discourse and service satisfaction, suggests that a social media strategy is able to improve this relationship. In doing so, we have made several noteworthy contributions to the existing academic field. Firstly, as stated by other scholars (such as Medaglia & Zheng, 2017 and Schmidthuber & Hilgers, 2017) research on the effects of social media usage by public sector organizations is scarce. We expanded the scope of the studied effects. Secondly, our findings offer valuable insights that were previously absent from the current literature. The first article arrived at similar conclusions as Schweitzer (2014) who compared agencies with different levels of citizen engagement. She found, based on a hand-coded limited sample, that tweets were less negative depending on agencies with more interactions. However, our paper is able to establish an effect for a single organization, which ensures differences can't be explained by the unique characteristics of the compared agencies. Additionally, we delved into the dynamics over time, while incorporating traditional media and performance. Combining public communication, performance, and traditional media is something original. Although individual relationships have been tested before, we have never encountered a study that tries to paint a more complete picture by incorporating all. Thirdly, this research is situated in a growing wave of Public Administration studies that employ some kind of machine learning techniques, particularly Natural Language Processing, to process large quantities of text over extended periods (Anastasopoulos & Whitford, 2019; Belder-bos *et al.*, 2017; He *et al.*, 2020). Fourthly, while machine learning aided in processing process some data, we employed robust econometric models to derive our results. The first article used a regression discontinuity design which is one of the most credible quasi-experimental research designs for the identification, estimation, and inference of treatment effects (Calonico *et al.*, 2017). The second paper opted for a vector autoregressive model which is a great tool to model past values of different variables on future values. Additionally, this model modeled bi-directional, meaning all the relationships were studied (Hashimzade, & Thornton, 2015). Twitter sentiment has been used in VARs in fields such as finance (for example Behrendt & Schmidt, 2018; Hamraoui & Boubaker, 2022; Katsafados *et al.*, 2023). However, to the best of our knowledge, a VAR with Twitter sentiment has never been used in Public Administration or Transport literature to study how public communication can impact Twitter sentiment. Lastly, most transit studies about public communication predominantly centered on the US or Canada. Not a lot of studies have focused on European countries. Moreover, if you only consider the studies with automated machine learning, non-English speaking countries were severely neglected.

Practical implications

Future public communication by NMBS

The practical implication of our research suggests the importance NMBS should keep investing in their public communication. As demonstrated, Twitter is a possible forum to effectively reach a subset of your customers. It's important to note that while a heightened focus on Twitter communication is beneficial, other aspects of service delivery should not be neglected. As discussed in Chapter Two, the lack of punctuality is a persistent issue for the Belgian Railway Company (NMBS, 2022). James (2011) and Van Ryzin (2013) have warned that public communication should not be used to manipulate citizens' views to disregard or misinterpret performance indicators. Public communication is never a substitute for investments/improvements in the basic service provision.

Given the empirical evidence highlighting the significance of public communication demonstrated in this dissertation, coupled with the normative considerations discussed in the next section, it becomes imperative to scrutinize the suitability of Twitter as the optimal medium for public communication. Is Twitter the best social media platform to bridge the gap between citizens and public sector organizations? There are two considerations to make here. The first is about the representation on social media. The advantages of posting live updates on services and interacting with a large audience are hindered by the lack of a good representation of the general population. Although opinion leaders may act as mediators between social media initiatives and citizens, this process takes time, and the success rate depends on elements out of the control of public organizations. The second reason why choosing Twitter might be questioned is due to ownership. Social media platforms are usually designed, managed, and maintained by commercial third parties, which are outside of the control of public agencies (Mergel, 2013).

This is a very topical concern at the moment. Since Elon Musk paid 44 billion dollars to become the owner on October 27, 2022, Twitter has undergone significant transformations (Conger & Hirsch, 2022). Elon Musk's acquisition prompted a rebranding, transforming Twitter into X (an app by X Corp.) (Conger, 2023). According to Linda Yaccarino, the company's chief executive, the goal is an "everything app" with "unlimited interactivity - centered in audio, video, messaging, payments/banking -

creating a global marketplace for ideas, goods, services, and opportunities." However, the disappearance of the Twitter name and the iconic bird logo was met with criticism and even mockery by users (Conger, 2023; Espada, 2023). The change may be especially hard considering it is extremely rare for consumers to develop a lexicon around a brand. No major social media app has undergone such a drastic name change before. Analysts and brand agencies suggest that the move away from one of the most recognizable social media brands decreased the company's value between 4 and 20 billion dollars (Counts & Levine, 2023). The company was already experiencing a decline in value, with advertising revenues down more than 50% since October as advertisers expressed concerns about Musk's controversial opinions and policies.

As a result of the acquisition, a plethora of alternative text-based social apps have emerged, such as Mastodon, Cohost, Post News, Plurk, Spill, Pebble Minds, Bluesky, and Threads (He *et al.*, 2023; Henshall, 2023). While X remains the dominant player, it now faces a growing field of competitors. Mastodon announced that over a million users had registered in the two weeks after the acquisition (He *et al.*, 2023). The future evolution of microblogging in general, and specifically the rebranding of X, remains uncertain. People have already noticed an increase in hate speech, fake news, and online intimidation, due to a reduction in content moderation (Frenkel & Conger, 2022; Ray & Anyanwu, 2022). At the very least, the barriers for (public sector) organizations to initiate a social media strategy have increased. Even more, organizations might feel prompted to consider a cross-media presence for reaching diverse audiences.

As an alternative, public organizations such as the NMBS might be incentivized to enhance their own existing mobile applications. For instance, the NMBS app could improve by better integrating live updates and explanations, especially for delays, and by incorporating a feature to chat with customer service directly within the app. Enhancing the mobile app offers the advantage of providing personalized assistance to a broader spectrum of train travelers. With over 1 million downloads, the app holds significant potential to meet the varying needs of travelers for accurate, swift, and personalized information (especially when encountering problems with the service) compared to Twitter/X. According to the Flash Eurobarometer survey on European's satisfaction with passenger rail services, more than nine in ten respondents emphasized the importance of quality information (regarding timetables and platforms) (European Commission, 2018). Despite this, a slight majority (52% for EU26 and 57% for

Belgium) express satisfaction with the accessibility of travel information both at stations and on-board trains. This challenge extends beyond the NMBS, as the inadequacy of information accessibility remains a common source of dissatisfaction for numerous public sector organizations (Baele & Aass, 2022).

There are several drawbacks to expanding the app as a substitute for an extensive social media presence. First, the organization would lose the finger on the pulse. The organization would be unable to follow and reply to general social media discussions about ongoing events (news articles, reports, scandals, political debates, …) or debunk circulating fake news. Second, without a presence on general social media platforms, the organizations would lack a channel to share generic information such as annual results, new investments, and job vacancies, which is pertinent to all citizens, not just those already using the NMBS services through the mobile app. Thirdly, social media platforms are low-cost compared to government-owned initiatives (Hung *et al.*, 2020), making them a more economical option. Moreover, a Twitter strategy can be managed by a few employees, handling a chat through an app with a considerably larger user base could pose an additional challenge. Expanding the communication team might not suffice. AI could mitigate some of these concerns. Recent technological advancements enable the preselection of messages requiring a response, including the identification and filtering of hate speech (Gollatz *et al.*, 2018). Many businesses, such as airlines, have successfully implemented chatbots to provide instant feedback to millions of customers, eliminating the need for direct intervention from staff members (Bilan, 2024; Chhibber, 2023). With the abundance of train data available, including information from Infrabel, and the wealth of questions and answers generated over the years, an intelligent system could be developed to operate even faster than the current social media team. However, this would mean considerable additional hurdles. Lastly, the dynamics between an application and social media are very different. Discussions on Twitter take place in the public realm. Hence, the balance of power differs substantially. In an NMBS app, a complaint can be addressed privately in a one-to-one manner between the customer and the operator. Complaints on social media often address other users to warn them (Albert, 2016; Vasquez, 2011). They only mention the organization in the third person. As other users, including journalists and politicians, can read, like, reply, or retweet the original post on social media, it underscores the need for the operator to evaluate the tone and content of their interactions (Cottrill *et al.*, 2017). Hence, social media empowers citizens in their relationship with the public sector a lot more than an app.

Interactive media, despite a dynamic environment, are likely here to stay. The challenge for (transit) organizations is to adapt accordingly.

Generalizability other public sector organizations

Mabillard and Zumofen (2022) demonstrated that Belgian municipalities haven't all adopted Twitter. If this is the case for the public sector, a lot of potential is up for grabs. However, only if our results from the railway company can be generalized. In the introduction, we asserted that the NMBS is well-positioned in terms of generalizability. Our findings can readily be translated to railway companies of other developed countries considering the service provided is similar and they share formal legal features (Van Thiel, 2012). However, extrapolating towards other public service providers or public organizations is more challenging. We considered the NMBS a critical case (Yin, 2009) for other public-sector organizations. Our rationale was that if public communication did not affect customer citizens' perceptions in the case of the NMBS, being an easily identifiable and evaluable public organization with clear and well-known tasks and a lot of Twitter activity, then we expected it would not affect the perceptions of other public organizations. However, that an effect is found does not automatically imply other organizations will experience similar positive effects of public communication.

Investing in public communication is particularly pertinent for organizations charged with a public service delivery. Organizations responsible for policy implementation or regulation seldom come into direct contact with citizens. While public communication can still be beneficial to enhance trust, legitimacy, reputation, etc., for these lesser-known organizations, there isn't an active need for online interactions with citizens. Contrary to the NMBS, not all public service providers operate with a monopoly. These public companies have even more reason to pursue social media engagement. Their goal is multifaceted and goes beyond the typical societal goals. These organizations, for example through a better reputation, hope to increase financial return or market share, stimulate customer loyalty, foster word-of-mouth recommendations, etc. (Canel & Luoma-aho, 2019; Carpenter & Krause, 2012; Fombrun & van Riel, 2004; Sataøen & Wæraas, 2016). Additionally, social media campaigns might simply be a necessity to match the rising private sector's increasing (online) standards of service (Thijs & Staes, 2008).

The question of whether other organizations, which are less identifiable or evaluable than the NMBS, should invest in public communication, remains open for debate. In reality, the public sector's performance is something individual citizens can seldom evaluate for themselves, and the more complex the service process, the more difficult its evaluation becomes (Thijs, 2011). On one hand, public communication could potentially yield even more pronounced effects as perceptions aren't as influenced by personal experiences, media appearances, or the views of others. On the other hand, public communication efforts might not reach citizens as they have a limited number of followers and, consequently, a limited circulation.

Limitations and research agenda

Some limitations need to be addressed. First, the dissertation should be approached as a compilation of three articles with commonalities but also clear differences. Each empirical chapter was written as an independent article with the ambition to contribute to the literature of a specific research field. This resulted in internal coherence of each chapter but meant a lack of consistency in the complete dissertation. Notably, the treatment of Twitter sentiment varies across chapters. In chapter two, the sentiment of tweets is regarded as a measurement of satisfaction, whereas in chapter three, it serves as a proxy for the organizational reputation. The introduction attempted to justify this approach by offering both theoretical and pragmatic reasons. While research has demonstrated the interconnectedness of intangible assets (see Canel & Luoma-aho, 2019 for an overview), to our knowledge no prior work has conceptually linked them with regards to Twitter Sentiment. The crucial difference between both concepts in our model was the volatility; we saw satisfaction as something fluid, something closely related to an experience. Reputation is regarded as something robust. However, considering this distinction, it is remarkable that we also used a daily sentiment index in the paper framed from the reputation literature. This was done to make maximum use of the available data. Future studies should probably keep in mind, according to us, that smaller timeframes better represent satisfaction, while accumulation over a longer period establishes a reputational judgment of a public sector organization.

Regardless, the distinction will never be straightforward due to diverse Twitter user purposes. Different audiences use Twitter differently. Journalists use it to gather and promote news stories, politicians use it as a campaign tool, companies use it to market products, citizens use it to talk about experiences or to express opinions, etc. Classifying the content on Twitter, regardless of the studied timeframe, would be highly dependent on the specific source and intent behind a tweet. The discussion about the nature of social media data with different audiences is difficult but warranted. Government social media research has studied several types of different effects: Citizen engagement (Sandoval-Almazán & Gil-Garcia, 2014; Sumra & Bing, 2016), Politician empowerment (Hong, 2013; Hong & Nadler, 2012), Citizen empowerment (Ling et al., 2015), Trust in government (Feeney & Welch, 2016; Grimmelikhuijsen & Meijer, 2015; Kim *et al.*, 2015; Porumbescu, 2016a, 2016b; Valle-Cruza *et al.*, 2016), etc. All intangible assets mentioned in the introduction of this dissertation could be linked to social media data.

Tweets might also express a judgment of trust or legitimacy, besides satisfaction and reputation. Future studies should conceptualize social media data and unite scattered and unidimensional findings.

Second, certain important theoretical questions remain unaddressed in this dissertation. The existence of opinion leadership has been used to underscore the relevance of studying social media. The assumption is that sentiment on Twitter seeps through to the general public opinions as opinion leaders disseminate their views to their networks. While there is some evidence of this mechanism (for example: Karlsen, 2015), it is not explicitly tested in the case of the dissertation. There are uncertainties regarding whether opinion leaders will share their views about a specific service (for example, the NMBS), what they will say, and how others will interpret it considering their own experiences or conflicting perceptions. The timeframe for changing citizens' perceptions indirectly through opinion leaders is also highly uncertain. Similarly, these uncertainties apply to journalists active on Twitter. We can't be sure public communication efforts change traditional media reporting, which in turn could influence the general public. Future studies should evaluate the indirect impact of public communication through social media on the broader public with opinion leaders or journalists as intermediaries.

Another theoretical caveat relates to the underlying mechanism. We established that the public communication on Twitter of the NMBS reduced the negativity of Tweets and improved the satisfaction of customers who interacted with the NMBS account, yet the reason for this effect remains unclear. The Expectancy-Disconfirmation Model is an example of a theory that tries to explain how (dis)satisfaction arises (Van Ryzin, 2004). Communication could influence both the expectations and perceived performance of this model. Do customers view communication as part of the performance? Can it balance other performative dimensions? Or is communication solely an antecedent of expectations? Although we alluded to a potential cause – Twitter users blaming the NMBS less for a delay - this dissertation does not empirically test a mechanism. Hence, whether the sentiment improves through expectation management or better-perceived performances is still up for debate. EDM is an established and valuable model with a lot of empirical research focusing on the relationships between the four concepts (Grimmelikhuijsen & Porumbescu, 2017; James, 2011; Porumbescu, 2017; Van Ryzin, 2013). However, the model should be expanded so more studies can establish how certain antecedents (such as public communication, but also traditional media, (e)Word-of-Mouth, societal context, etc.) influence satisfaction.

A more fundamental critique is that we don't know if the actual perceptions of people changed and by extension their behavior (for example, increased ridership). We implicitly assume fewer negative tweets correspond to improved perceptions. However, the diminished anonymity due to NMBS's presence and ability to respond might be the driving factor behind fewer negative tweets. It has been proposed that Twitter offers greater user anonymity than other social media platforms, like Facebook, which may mean that Twitter provokes more "toxic" behavior (Hughes *et al.*, 2012; Lapidot-Lefler & Barak, 2012). If the sentiment of tweets is explained by the level of anonymity, the type or intensity of public communication becomes irrelevant; the mere presence on social media suffices to improve Twitter sentiment. An alteration in language does not necessarily indicate a shift in people's perceptions. Nonetheless, the change in how people discuss NMBS on Twitter can still be beneficial, as other users will encounter less negative content. This shift in discourse might cast the organization in a more positive light, although its effectiveness in overcoming negativity bias or anti-public sector bias remains to be determined.

The dissertation also faces limitations at the level of the research design and the methodologies. We advocate for later studies to augment social media data with a survey or interviews. Although, the number of observations (tweets) would be severely reduced, the added depth would enrich the literature. It would improve the operationalization of the variables greatly. Our binary classification of tweets - positive and neutral sentiment were bundled together as our machine learning algorithm couldn't distinguish them - was not based on validated measurements (of satisfaction or reputation). Additionally, Das & Zubaidi (2023) have argued that a binary sentiment analysis is not always adequate in analyzing transit tweets as different emotions play a role. Moreover, some studies (most notably Haghighi *et al.*, 2018 and El-Diraby *et al.*, 2019) have combined content analyses with a sentiment analysis. Hence, they were able to see which kind of tweets (for example those related to specific performances of a transit route with high ridership) were mostly associated with negative sentiment. Das and Zubaidi (2023) have similarly shown that the words associated with negative sentiment differed widely between locations.

By supplementing social media data with other data sources, you could employ validated measurements and add more information by delving into the topic of the tweets, the intended meaning by the author, the motive, the follow-up, the emotions, etc. For our first two articles, incorporating a survey could have added micro-level data such as political ideology, trust in government, socioeconomic status, address, education, and more. It would also have enabled us to use real experienced punctuality by the user (or other quality dimensions) instead of a monthly aggregate for the whole country. For our last article, it could have ensured more observations of Twitter interactions. In our survey of customers, only a small percentage had contact with the NMBS account in the past month. Conducting surveys or interviews specifically with this subset of customers, rather than general customers, would ensure an adequate number of observations for robust statistical analysis. Additionally, linking the content of these interactions with survey responses could provide a richer understanding of the dynamics at play.

Finally, the generalizability to broader settings is constrained. Our decision to focus exclusively on Twitter as the medium for public communication introduces a limitation. Engaging with citizens occurs across diverse social media platforms, each with its unique user demographics and interaction dynamics. Ignoring other platforms may overlook valuable nuances in the public's response to communication efforts; the efficacy of public communication could vary significantly. The extrapolating of our results is also hampered by the limited scope of public service examined in our study. As mentioned when discussing the practical relevance of the dissertation, the NMBS is a very tangible and easily evaluable case. Other, less well-known public organizations might be confronted with different challenges and opportunities in their engagement strategies. To ensure the robustness of our conclusions, future research should encompass public communication benefits for various public services. Additionally, as the utilization of public communication becomes increasingly prevalent, there is a need to further distinguish between different types of communication strategies. Our study acknowledges the significance of public communication but does not delve deeply into the nuances of various communication approaches. Recognizing, categorizing, and testing different strategies can provide a better understanding of the impact of public communication. As the public sector increasingly incorporates modern technology or social media platforms into their day-to-day operations and communication, numerous avenues for research are wide open. We encourage future research in more diverse and comprehensive settings to systematically validate, refine, and expand our findings.

Concluding normative reflections

This dissertation offered some findings highlighting the advantages of public communication on social media for customers' satisfaction or social media sentiment. Other studies have empirically demonstrated similar or additional benefits of public communication. Communication is highly valued as it can improve the intangible assets of organizations, which in turn leads to various advantages for society, organizations, and individual citizens (Canel & Luoma-aho, 2019). These advantages include increased employee efficiency, lower costs for public administrations because of fewer complaints, improved organizational operations, heightened trust, greater willingness to collaborate and contribute, increased flexibility of citizen's demands, enhanced autonomy and discretion from politicians, improved recruitment of employees, greater legitimacy – meaning the license to exist, etc. (Carpenter, 2002; Choy *et al.*, 2012; Gordon *et al.*, 2009; James, 2011; James & Moseley, 2014; Morgeson, 2014; Oliver, 2010; Putnam, 1993; Thijs & Staes, 2008).

Regardless of this selection of measurable advantages, there are also more normative arguments to consider when advocating for increased public communication. Public sector organizations should be responsive to society's needs and demands (Thijs & Staes, 2008). An increasing number of citizens use the Internet on a daily basis. The Internet penetration rate, the percentage of the total population that uses the Internet, in Belgium, was 96% at the start of 2022 (Kemp, 2022). About 82% of the total population uses one form or another of social media. One could argue that the government should be where the people are or where the people want them to be. Between 2020 and 2022, there was a 22-percentage point increase in Belgians who used the Internet for interactions with public authorities on websites or mobile applications (European Commission, n.d.). This meant that in 2022, 88% of Belgians aged 16-74 had an online interaction with or about governmental services.

Scholars have argued that most democratic countries are being submitted to higher requirements for transparency (Canel & Sanders, 2012, 2013). According to some, the traditional values are shifting from "fairness" to transparency (Kuipers *et al.*, 2014; Pollitt & Bouckaert, 2011). This entails increased responsiveness, active communication, outward-oriented activities, widening of stakeholder engagement, increasing the level of accountability, … However, it is always a fundamental democratic obligation of the public sector to report decisions and actions to the public (Liu *et al.*, 2010). As true accountability means seeking out dialogue with citizens, communication is an intrinsic value for the public sector in obtaining their (social) goals.

Transparency is not just desirable; it has become a necessity in this digital era. Social networks have, in part, taken the place of mass communication (Castells, 2009). Traditional journalism's gatekeeping role, which involves meticulous fact-checking, is now bypassed by technologically empowered citizens who express their opinions, share experiences, and provide critiques to large audiences in real-time. The spread of either true or false information cannot be controlled by public sector organizations (Luoma-aho & Vos, 2010). The prevalence of fake news, as seen during the COVID-19 pandemic, particularly regarding vaccinations (Bonnevie *et al.*, 2021), underscores the urgent need for credible public communication by relevant authorities. The ability to respond promptly and effectively to external crises relies heavily on the trust established by an organization. Moreover, connecting with individual citizens poses increasing challenges as they live in (digital) bubbles (Sloterdijk, 2011), allowing only the communication through which citizens actively choose themselves. Public organizations must navigate this array of isolated spheres and shift from a "culture of controls" to a citizen-centered engagement (Bourgon, 2011; Canel & Luoma-aho, 2019).

The advantages of public communication extend beyond citizen interests; they also contribute to organizational resilience in the face of turbulence. Building flexibility and goodwill creates a foundation that can be carried into uncertain times (Canel & Luoma-aho, 2019; Longstaff & Yang, 2008; Luoma-aho, 2005). Strengthening relationships with citizens offers a shield against unpredictable changes, mitigating potential threats. An organization that has cultivated citizen engagement, trust, and legitimacy possesses enhanced capabilities to navigate challenges and respond to citizen needs. Operating under the assumption of a predictable public sector environment and relying on ad hoc adaptations risks fostering fragility within public sector organizations (Bourgon, 2009). To ensure resilience in the contemporary era of networked, empowered citizens and real-time media, adopting antifragile communication strategies is imperative (Luoma-aho, 2013). We know social media is detrimental to citizens' trust in political institutions if left alone (Lorzenz-Spreen *et al.*, 2023). However, this trust is the "glue that keeps democracies together" (Dodsworth, & Cheeseman, 2020).

Society isn't static, and neither are the needs of citizens. In the face of societal evolution, public sector organizations are compelled to revolutionize their communication strategies. The individualization of communication practices as discussed above, is not the only trend making society more complex (Thomas, 2013). The private sector standards of service have increased substantially, raising the expectations of public sector providers (Thijs & Staes, 2008). Many companies have transformed how they communicate and are now closer to audiences than ever before (Chaffey & Ellis-Chadwick, 2019). They even regularly employ artificial intelligence to help manage the flow of interactions with customer services. Another evolution is the "super-diversity" of our society (Canel & Luoma-aho, 2019; Vertovec, 2007). Messages need to be tailored to individual citizens as much as possible to deal with this diversity in varying identities, locations, histories, trajectories, and expectations. A final evolution is the changing role of citizens (Canel & Luoma-aho, 2019). Governments expect citizens to be "an active part of a common solution to social problems, bringing experiential expertise and local knowledge" (Durose *et al.*, 2015, p. 139). Citizens are expected to become producers and cocreators of public services instead of merely passive taxpayers and contributors. This requires increased attention to the nature of engagement and interaction between citizens and organizations (Bowden *et al.*, 2016). Public managers need to "seek 'power with' rather than 'power over' the citizenry (Cooper, 1984, p. 143) for which they need "to know how to interact with the public" (Thomas, 2013, p. 786).

That the incorporation of social media, or more significant emphasis on communication in general, is imperative to stay responsive to societal demands and to ensure these do not fall on deaf ears. One of the most beneficial usages of social media is to improve the understanding of customers and by extension all citizens. The content of tweets can inform and help guide future planning and operations processes which ultimately improves the services delivered (Collins et al., 2013; Das & Zubaidi, 2023; Koushki *et al.*, 2003). As a result, misaligned reforms with misallocated scarce resources, based on performance metrics that are irrelevant to customers, can be prevented.

There is undoubtedly an emerging trend of public organizations adopting individual citizen-centered approaches to public sector communication on social media, e-government platforms, websites, online databases, etc. (Alon-Barkat, 2020; Bourgon, 2009; Canel & Sanders, 2015; Luoma-aho & Canel, 2016; Mergel, 2016; van Dijk *et al.*, 2015; Wæraas, 2014; Wong *et al.*, 2021). The digital transformation of communication has also been put on the political agenda (European Commission, 2021). Numerous initiatives are altering the way citizens engage with the government. However, there remains a lot of untapped potential. These attempts to better reach citizens are often still top-down centered and recycle already-existing content from an agency's website. Many governmental organizations still rely on conveying one-way communication focused on sending general information and forwarding people to other websites or platforms if citizens have queries (Brainard & Edlins, 2015; Canel & Luoma-aho, 2019; Sanders & Canel, 2013). Ultimately, online public communication strategies have tremendous potential to serve and connect with audiences which might change the persistent image problem of the public sector (Goodsell, 2014) and succeed where other reforms have failed to bridge the gap between the state and individuals.

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Author contributions
Summary (EN)
Summary (NL)

Author contributions

General project	
Research project conception:	K. Verhoest, J. Wynen & W. Van Dooren
Project conceptualization, discussion of research ideas and article proposals:	**S. F. De Vadder**, K. Verhoest, J. Wynen & W. Van Dooren
Chapter 1: Introduction	
Single authored:	**S. F. De Vadder**
Chapter 2: The case of the NMBS	
Single authored:	**S. F. De Vadder**
Chapter 3: Closing the performance-satisfaction gap with public communication. A pretest-posttest study of the Belgian railway company's Twitter account	
Co-authored:	**S. F. De Vadder**, J. Wynen, K. Verhoest & W. Van Dooren
	S. F. De Vadder: Data gathering, Data cleaning and Machine Learning, Literature review, writing of all sections of the paper. J. Wynen: Data analysis and Feedback K. Verhoest: Theoretical framework and structuring, reviewing and editing drafts. W. Van Dooren: Theoretic framework, reviewing and editing drafts
Chapter 4: Can Twitter reputation of a public sector organization be predicted based on performance, traditional media and public communication	
Co-authored:	**S. F. De Vadder**, K. Verhoest, J. Wynen & W. Van Dooren
	S. F. De Vadder: Data gathering, Data cleaning and Machine Learning, Data analyses, Literature review, writing of all sections of the paper K. Verhoest: Theoretical framework and Feedback J. Wynen: Data analyses and Feedback W. Van Dooren: Operationalization and Feedback
Chapter 5: Keeping Satisfaction on Track: Exploring the Role of Twitter Communication in Passenger Satisfaction	
Single authored	**S. F. De Vadder***
Chapter 6: Conclusion	
Single authored:	**S. F. De Vadder**

*K. Verhoest, J. Wynen & W. Van Dooren did provide initial feedback when designing the survey and aided in negotiating a contract with iVOX. They also commented on the final chapter (especially on the analyses).

Summary (EN)

The public sector faces a persistent problem with its image. Efforts to enhance the public sector's performance through cost-saving measures and efficiency initiatives have not resulted in improved citizen relations. Scholars argue that these reforms have failed to alter perceptions due to the absence of strategic communication that could counteract cognitive biases and address misaligned expectations. Communication is deemed crucial in building reputation, legitimacy, satisfaction, trust, citizen participation, … Overall, such communication efforts are expected to contribute to a better democracy. The birth of Web 2.0 brought new ways for public organizations to engage with citizens. Many government organizations have, on top of general e-government initiatives, invested in an active social media presence.

The novelty of social media lies in its facilitation of two-way interactions, transforming citizens from passive consumers of government services into active co-creators. Twitter is generally a preferred platform for this as it allows for interactions with large audiences (among them journalists and opinion leaders). It also offers the possibility of real-time updates on services (and disruptions). While there are numerous reasons for adopting a social media strategy (such as: countering fake news, bypassing traditional media, gauging public opinion, enhancing transparency, protecting from political attacks, and recruiting employees), most organizations aim to improve relations and customer services. Although social media generally undermines citizens' trust in political institutions and fosters hate, populism, and polarization, a citizen-centered engagement might succeed where other reforms have failed to bridge the gap between the state and citizens.

Despite the vast potential, very few studies have tried to measure the real-life impact of such a social media presence. Previous research predominantly focused on the public agencies (the content posted, the devised strategy, the number of followers, etc.), not the citizens. This dissertation set out to contribute to this growing literature by applying innovative methods to study if a social media presence can enhance citizen's perception of an organization. We focus on a public organization that makes optimal use of social media as a way of interacting with citizens. While many organizations still favor one-way communication, the Belgian Railway Company (NMBS) has established bidirectional

dialogs on Twitter since 2013. Our own analyses of the Twitter activity of the NMBS confirmed that a lot of tweets are directed at the NMBS. These tweets were usually questions or complaints about services. Almost all the questions (and some of the complaints) received a fast and helpful reply from the NMBS-account.

Supervised machine learning was used to study both the immediate and long-term effects of the NMBS social media presence. By training an algorithm that could determine the sentiment of tweets, we could classify all tweets mentioning the NMBS. This enabled the first paper to compare the tweets posted by citizens before and after the NMBS became an active social media communicator using a regression discontinuity analysis. There was a significant decline in the percentage of negative tweets when the NMBS-account started that could not be attributed to changes in a performance indicator. Although presence on social media had an immediate effect, the findings didn't delve into the potential effect of public communication intensity; do more daily or monthly interactions lead to a better sentiment?

The second research paper introduced time-series analyses (more specifically, VAR-models) to study the interplay of the intensity of public communication with traditional media coverage and the punctuality of trains in predicting future Twitter sentiment. Only punctuality turned out to be a significant predictor of daily Twitter sentiment. If the performance improved, so did the sentiment on Twitter a couple of days later. Public communication did have a significant effect in one of the regressions looking at monthly fluctuations, but media reputation (measured as a sentiment index based on machine learning and a dummy to indicate media storms) was never significant.

These findings established that it is the mere presence on social media that is beneficial to improving how people talk about the organization. The level of responsiveness did not show such a clear positive effect. Hence, the sentiment of tweets does not appear to be very volatile according to the responsiveness of the public organization; A few days with less responsiveness does not automatically result in lower perceptions (and *vice versa*). A third, and final, study, stepped away from social media sentiment and focused on general customers' perceptions instead. A survey spread out over 24 months with 7 200 observations, including a panel of 332 respondents, demonstrated the importance of communication, both offline and online. Improvement in the experienced communication significantly increased passenger's satisfaction. Additionally, the passengers who experienced an interaction with the NMBS Twitter account were also significantly more satisfied. Twitter users blame the NMBS less for an experienced delay, probably because they are better informed about the reason (and what is being done about it).

In conclusion, this dissertation argues, based on our findings and some normative reflections, that public organizations should actively engage with citizens on social media to bridge the gap between the state and citizens.

Summary (NL)

De publieke sector kampt met een aanhoudend imagoprobleem. Inspanningen om de efficiëntie van de publieke sector te verbeteren hebben niet geleid tot een verbeterde relatie met burgers. Academici wijten dit toe aan het ontbreken van strategische communicatie wat cognitieve processen kan beïnvloeden of misplaatste verwachtingen van burgers kan bijsturen. Communicatie wordt cruciaal geacht bij het opbouwen van reputatie, legitimiteit, tevredenheid, vertrouwen, burgerparticipatie, en draagt zo bij aan een betere democratie. De digitale revolutie, en met name Web 2.0, bracht nieuwe manieren voor publieke organisaties om in contact te komen met burgers. Veel overheidsorganisaties hebben, naast een algemene uitbreiding van e-government, geïnvesteerd in een actieve aanwezigheid op sociale media.

De unieke eigenschap van sociale media is dat ze tweerichtingsinteracties faciliteren waarbij de burgers worden getransformeerd van passieve consumenten van overheidsdiensten tot actieve coproducenten. Twitter is over het algemeen hiervoor een voorkeursplatform, omdat het interacties met een groot publiek (waaronder journalisten en opinieleiders) mogelijk maakt. Het biedt ook de mogelijkheid om in *real-time* updates over diensten (en storingen) te geven. Hoewel er tal van redenen zijn om een sociale-mediastrategie aan te nemen (zoals: het tegengaan van *fake news*, het omzeilen van traditionele media, het peilen van de publieke opinie, het vergroten van transparantie, het beschermen tegen politieke aanvallen, en het werven van werknemers), streven de meeste organisaties naar het verbeteren van hun klantenservice. Hoewel sociale media over het algemeen het vertrouwen van burgers in politieke instellingen ondermijnen en haat, populisme en polarisatie bevorderen, zou een online communicatiestijl waar burgers centraal staan kunnen helpen om de kloof tussen de staat en burgers te overbruggen.

Ondanks het aanzienlijke potentieel zijn er slechts een beperkt aantal studies die getracht hebben om de impact van een dergelijke aanwezigheid op sociale media te meten. Eerdere onderzoeken hebben zich voornamelijk gericht op de overheidsinstanties (o.a. de berichten die zij uitsturen, de gebruikte strategie en het aantal volgers), niet op de burgers. Deze dissertatie beoogde bij te dragen aan deze groeiende literatuur door middel van innovatieve methoden. Het onderzoek had als doel om te achterhalen of een aanwezigheid op sociale media de perceptie van burgers kan verbeteren. We hebben

daarbij gefocust op een overheidsorganisatie die optimaal gebruik maakt van sociale media. Terwijl veel organisaties nog steeds de voorkeur geven aan eenrichtingscommunicatie, zet de Belgische spoorwegmaatschappij (NMBS) sinds 2013 in op interacties via Twitter. Onze eigen analyses van de Twitteractiviteit van de NMBS bevestigden dan ook dat er veel tweets aan de NMBS worden gericht. Deze tweets waren voornamelijk vragen of klachten over hun dienstverlening. Vrijwel alle vragen (en een deel van de klachten) kregen een snelle en behulpzame reactie terug van de NMBS-account.

Supervised machine learning werd gebruikt om zowel het onmiddellijke als het langetermijneffect van de aanwezigheid van de NMBS op sociale media te bestuderen. Door een algoritme te trainen dat het sentiment van tweets kon bepalen, konden we alle tweets die de NMBS vermelden classificeren. Dit maakte een eerste artikel mogelijk om, met behulp van een regressie-discontinuïteitsanalyse, de tweets van burgers vóór en na het moment dat een overheidsinstantie een actieve gebruiker werd van sociale media, te vergelijken. Er werd een significante daling in het percentage negatieve tweets vastgesteld bij de start van het NMBS-account, die niet kon worden toegeschreven aan veranderingen in punctualiteit. Hoewel aanwezigheid op sociale media dus een onmiddellijk significant effect heeft, gingen de bevindingen niet in op het potentiële effect van de intensiteit van openbare communicatie; leiden meer dagelijkse of maandelijkse interacties tot een beter sentiment?

Het tweede onderzoek introduceerde vervolgens tijdreeksanalyses (meer specifiek, VAR-modellen) om de wisselwerking tussen de intensiteit van openbare communicatie met traditionele media en de punctualiteit van treinen te bestuderen bij het voorspellen van Twitter-sentiment. Alleen punctualiteit bleek een significante voorspeller te zijn van het dagelijkse Twitter-sentiment. Als de prestaties verbeterden, verbeterde ook het sentiment op Twitter de daaropvolgende dagen. Openbare communicatie had wel een significant effect in een van de regressies die keken naar maandelijkse schommelingen, maar mediareputatie (gemeten als een sentimentindex op basis van *machine learning* en een dummy om mediastormen aan te geven) was nooit significant.

Deze bevindingen stellen vast dat het louter aanwezig zijn op sociale media gunstig is om te verbeteren hoe mensen over de organisatie tweeten. Het niveau van responsiviteit vertoonde geen een duidelijk positief effect. Daarom lijkt het sentiment van tweets niet erg onderhevig te zijn aan de responsiviteit van de overheidsorganisatie; een paar dagen met minder responsiviteit leidt niet automatisch tot lagere percepties (en *vice versa*). Een derde en laatste studie stapte af van het sentiment op Twitter en richtte zich in plaats daarvan op klanttevredenheid. Een enquête verspreid over 24 maanden met 7.200 observaties, inclusief een panel van 332 respondenten, toonde het belang aan van communicatie, zowel offline als online. Verbeteringen in de ervaren communicatie verhoogde significant de tevredenheid van passagiers. Bovendien waren de passagiers die een interactie hadden met de NMBS Twitter-account ook significant meer tevreden. Twitter-gebruikers achtten de NMBS minder verantwoordelijk voor een ervaren vertraging, waarschijnlijk omdat ze beter geïnformeerd zijn over de reden (en wat eraan wordt gedaan).

Concluderend betoogt deze dissertatie, gebaseerd op onze bevindingen en enkele normatieve overwegingen, dat overheidsorganisaties actief met burgers moeten communiceren via sociale media om de kloof tussen beiden te dichten.