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Electronic governance with an infrastructure reporting platform: The case of Züri wie neu.

GEO 511 Master's Thesis

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Abstract

This master thesis researches how the interaction between the administration of the city of Zurich and users of the infrastructure reporting platform Züri wie neu (ZWN) is mediated. The thesis is a case study of an internet and communication solution adopted in state-led digitized governance structures often understood under the moniker of e-governance in so-called smart cities. Like characterizations found in literature on smart cities, literature on comparable infrastructure reporting platforms and ZWN specifically sees those platforms as a bottom-up tool to increase participation while fostering more accountability of governments, govern more transparently and efficiently. With the help of a heuristic platform walkthrough, semi-structured interviews with officials of the city of Zurich involved in the management and maintenance of ZWN and a spatial analysis of the openly available data this thesis questions some of the fundamental promises of digitized governance such as increased efficiency and accountability, foster active participation and provide improved services.

The interaction through ZWN is mediated in ways that protect the administration from stirring up wrong expectations by creating distance between the administration and users through a standardized, nudged, and one-sided communication, allowing them to deal better with time consuming users, 'naggers' and prevent political discussion the administration is unable to deal with due to a structural problem. Further, ZWN appears as an isolated tool within the organization of the city of Zurich with limited benefits for the efficiency of the administration in providing infrastructure maintenance services which is already extensively managed apart from the usage of the platform. Simultaneously, the platform serves as an image caretaker showcasing the performance of the administration. Lastly, compared to other studies on infrastructure reporting platforms from the US, UK and Belgium no apparent differences over space in report contribution to the platform have been found.

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1. Introduction

In the focus of this thesis lie increasingly digitized governments that use internet and communication technology (ICT) to improve the management, operation and development of cities (Li, Batty and Goodchild, 2020). The broader context where ICTs are used to govern cities is often summarized under the buzzword 'smart city' promising to improve city life by enhancing service provision and management through interconnected, automated and 'smart' digital technologies (Kitchin, Cardullo and Di Feliciantonio, 2019; Neumann *et al.*, 2019). While the smartness of cities through digital technologies is debated and thoroughly questionable (Zook, 2017: 2-7; Shelton and Lodato, 2019: 35-40) the exploitation of technology and information arguably brings up a range of new possibilities in administrating (digital) governance and interacting with citizens (Kitchin, Lauriault and McArdle, 2015; Matthews *et al.*, 2018; Li, Batty and Goodchild, 2020). Infrastructure reporting platforms such as Züri wie neu (ZWN) and Fix-My-Street (FMS) from the UK are part of these increasingly digitized governance structures of cities using ICTs. The digitization of governance referred to as e-governance uses ICTs to interact with and govern citizens and shifted from the use of top-down technocratic and centralized operation systems to seemingly more bottom-up, citizen-centric approaches (da Cruz, Rode and McQuarrie, 2019; Barns, 2020; Sharma, Kar and Gupta, 2021). Citizen centric approaches are characterized by open data government paradigms with a focus on transparency as well as accountability and participatory governance (da Cruz, Rode and McQuarrie, 2019; Barns, 2020; Sharma, Kar and Gupta, 2021). City governments seek to govern more participatory with the help of ICTs while simultaneously e-governance attempts to contribute to an efficient and effective management of cities (Barns, 2020; Cardullo, 2020; Cahlikova, 2021). Authors from the realm of public management and policy studies see ICT solutions as enabling an efficient and transparent participation of citizens ensuring more accountability by governments (Abu-Tayeh, Portmann and Stürmer, 2017; Stürmer, Neumann and Loosli, 2017; Saikia, 2019). More critical scholars on participatory ICT solutions point out to biased report contributions in participation disadvantaging less privileged minorities. Another reoccurring topic is the one-sided and individualized nature of participation resembling a provider-consumer relationship questioning the bottom-up nature of ICT solutions such as FMS or ZWN (Harris and Weiner, 1998; Baykurt, 2011; Elwood, 2011; Cardullo and Kitchin, 2019). While the role of citizens in

smart cities and e-governance has been researched by various scholars (Baykurt, 2011; Albino, Berardi and Dangelico, 2015; Shelton and Clark, 2015; Zook, 2017; Cardullo and Kitchin, 2019), case studies on the interaction between governments and citizens through specific e-governance tools are rather scarce. This thesis adopts three different methods, a platform walkthrough, semi-structured interviews with officials from the administration of the city of Zurich and a spatial analysis of the openly available data on ZWN. By adopting methods from three different scientific backgrounds this thesis approaches the research question 'how is the government-user interaction mediated through the platform Züri wie neu?'.

1.1. Motivation

As infrastructure reporting platforms such as FMS and ZWN are part of newly adopted ICT tools in the management of cities (Kitchin, Lauriault and McArdle, 2015), they play an important role in mediating the interaction between government and the public. Researching and gaining a better and more detailed understanding of this interaction mediated through such platforms is crucial as it shapes how cities are governed and will be governed in the future forming the relationship between city governments and citizens.

As infrastructure reporting platforms are web-based GIS applications, it is viable to look at the interaction between governments and users from a GIS and a societal perspective. Addressing socio-political issues and raising questions on the influences of GIS in our society is an intriguing field of research. Especially in the recent decade with the ever-increasing importance of spatial data in many societal and academic fields and the emergence of more awareness towards the role of (spatial) data in our society, research on the interplay of GIS and society is crucial (Ricker *et al.*, 2020). The ubiquity of spatially referenced data brings chances and challenges to researchers as a lot of knowledge on societal phenomena can be gained when understanding the spatial configurations of data correctly, but also many false conclusions can be drawn, 'quicker than ever' (Matthews *et al.*, 2018; Gahegan, 2020).

1.2. Structure

The thesis follows the classical background-methods-results-discussion-conclusion structure. In the chapter Background infrastructure reporting platforms and ZWN specifically are

introduced, the term e-governance and its relation to infrastructure reporting platforms and citizens briefly defined and afterwards notable interaction characteristics of infrastructure reporting platforms and ZWN from the literature are introduced such as participation and infrastructure reporting platforms, geographies of difference and accountability, transparency and controllability. The chapter Methods introduces the research gaps and the research questions of this thesis before outlining the three employed methods. In the following chapter Results the results of the three methods are presented and interpreted and in the end the results for each method are separately summarized and related to the corresponding research question. Further, in the chapter Methods the triangulation of methods and limitations are discussed. Subsequently in the chapter Discussion the results are jointly discussed with reference to the literature. In the last chapter Conclusion the overall research question is addressed by summing up the findings and an outlook on future research directions and practical implications are given.

2. Background

2.1. Infrastructure reporting platforms

The topic of this thesis revolves around the platform ZWN and how it mediates the interaction between the city of Zurich and its users. Before discussing how the various forms of mediation of this interaction are described in literature it is necessary to understand the basic principles of ZWN. As ZWN is based on the British platform FixMyStreet (FMS) and research specifically on ZWN is rather rare, the focus does not lie solely on the platform ZWN itself, but research on other platforms related to infrastructure reporting in cities are presented as well.

Infrastructure reporting platforms are a specific form of internet and communication technologies (ICT) used to digitize governance structures of cities. The idea behind all of them is to enable people to report damages or impurities of city infrastructure via an openly available and free of charge online platform (King and Brown, 2007; Abu-Tayeh, Portmann and Stürmer, 2017) or in the case of 311 and 12345 via telephone (Minkoff, 2016; Wichowsky, Shah and Heideman, 2021; Peng *et al.*, 2022). Besides FMS and ZWN several other platforms to report infrastructure problems exist around the globe. In the US, Puerto Rico and Canada there is a platform called 311 where people can report issues either via phone or online (Minkoff, 2016; Wichowsky, Shah and Heideman, 2021). A similar hotline exists in China called 12345 (Peng *et al.*, 2022). SchauAufLinz is the equivalent in Austria with similar

conceptualization of the platform to FMS (Schmidthuber and Hilgers, 2018). Further, the platform FMS is also used under the same name in Brussel (Pak, Chua and Vande Moere, 2017). Each platforms configuration, the exact functionalities as well as the ownership and the data handling is different from platform to platform visible in Table 1.

	ZüriWieNeu (Gees, 2013)	FixMyStreet (King and Brown, 2007; Pak, Chua and Vande Moere, 2017)	SchauAufLinz (Schmidthuber and Hilgers, 2018)	311 (Kundra, 2010; Ganapati and Gina, 2015; Minkoff, 2016)	SeeClickFix (Mergel, 2012)	12345 (Peng *et al.*, 2022)
Start Date	2013	2007	2013	1996/2010	2008	2014
Location	Zürich	UK, Brussels	Linz	USA, Canada, Puerto Rico (Ashlock, 2015)	USA	China
Type of entry	Infrastructure service requests	Infrastructure service requests	Infrastructure service requests	Infrastructure service requests	Infrastructure service requests	Infrastructure service requests
Owner	City of Zurich (hosted by mySociety)	mySociety	City of Linz	City/API enabling independent development	Civic Plus (*Civic Plus*, 2021)	General Office of the State Council (Wei, 2021)
Government answer possibility	Yes	No	Yes	No	-	No
Open Data	Yes	Yes	No	Depending on government	No	Yes

Table 1: Characteristics of different infrastructure reporting platforms.

Table 1 does not offer an exhaustive list of all available infrastructure reporting platform but helps to grasp the context of the platforms appearing in this thesis.

2.1.1. FixMyStreet and Züri wie neu

The most prominent platform is FMS which was developed by the non-profit organization mySociety in the UK with the self-inscribed goal to develop software that augments citizen engagement with governments (Baack, 2018: 47-48). FMS exists since 2007 and has received more than 1 million entries until 2018 in the UK alone. MySociety monitors the incoming reports through FMS and makes them accessible to the public via the platform. The platform can be seen as an openly accessible database allowing people to add entries, revisit older entries and providing local government with the information sent by users (Baack, 2018: 51). The problems reported on the platform are transferred to the corresponding local government via e-mail. The platform also offers the possibility for users to update the status of the reported issue and tick a box whether the reported problem persists or has been fixed (mySociety, no date; King and Brown, 2007)

ZWN is a special adaptation of FMS by the city of Zurich and comparing the two platforms reveals some important characteristics of ZWN. The source code is based on FMS, the basic operation for users works equally and most of the functionalities are similar. The look of the platform ZWN has been adjusted to match the corporate identity of the city of Zurich and the underlying maps also stem from the city of Zurich (Gees, 2013: 323). Although the application is hosted by mySociety and thus all data runs through their servers (Gees, 2013: 323), the integration into the administration of and the moderation of the platform by the city of Zurich is the most evident difference between the original mode of operation of FMS and the adapted version of ZWN. Whereas in cities where FMS is deployed, the government can only see the reports, is informed via mail and is not capable of moderating the platform whereas the administration of the city of Zurich manages and moderates the platform itself. The administration moderates the platform in the sense that they can decide whether a report is in accordance with the guidelines or if it violates them. Consequently, the administration of the city of Zurich can decide whether they want to publish or hide a report which happens within one day (Gees, 2013: 323). A report is then answered within 5 days and an assignment is delegated. In Zurich, every report category called service code in ZWN is managed by a corresponding service department of the city (Gees, 2013: 323) including Entsorgung &

Recycling (ERZ) for service code 'Abfall/Sammelstellen', Tiefbaumamt (TAZ) for 'Strasse/Trottoir/Platz', Grün Stadt Zürich (GSZ) for 'Grünflächen/Spielplätze', Dienstabteilung Verkehr (DAV) for 'Signalisation/Lichtsignale', Immobilien Stadt Zürich (IMMO) for 'Graffiti', Eektrizitätswerk (ewz) for 'Beleuchtung/Uhren', Wasserversorgung (WVZ) for 'Hydranten/Brunnen', Verkehrsbetriebe (VBZ) for 'VBZ/ÖV' and Stadtpolizeit (Stapo) for miscellaneous called 'Allgemein'. Further the security of information is ensure by the Organisation und Informatik (OIZ), the data security is taken care of by the Datenschutzbauftragter (DSB), the communication by the Stadtkanzlei Internetdienste and lastly the project management and maintainance by Geomatik und Vermessung (GeoZ) (Gees, 2022).

The different level of moderation of the platform further manifests itself in the level of interaction between the administration of the city of Zurich and the users. Whereas there is no possibility for governments to interact with users via the platform FMS (mySociety, no date; King and Brown, 2007: 74), ZWN lets the administration answer the reports publicly (Gees, 2013: 323). On the other hand, while FMS offers users the possibilities to update on reports and mark them as fixed, ZWN does not offer this functionality (Gees, 2013). Although the platforms are very similar, modifications of ZWN lead to the fact that the platform mediates the interaction between the administration and platforms users in a different way which this thesis researches in more detail.

2.2. Electronic governance

Before delving into literature specifically on the interaction mediated by infrastructure reporting platforms like FMS or ZWN, the 'interaction' itself needs some contextualization by introducing the idea of e-governance. E-governance has been differently defined throughout literature, the definitions range from stressing the important role of ICTs (Palvia and Sharma, 2007; Saikia, 2019: 4025), over emphasizing possibilities for policy making and regulations (Finger and Pécoud, 2003: 1-4; Rossel and Finger, 2007: 399), to highlighting the transformative character of e-governance in relation to public services and thus the relationship between the public, the private and the people (Sandoval-Almazan and Gil-Garcia, 2012: 572-573; Tomczak, Andermatt and Schedler, 2020: 203; Loukis, Macadar and Meyerhoff Nielsen, 2021: v). Whereas the role of ICTs in e-governance is undisputed, studies

on e-governance are increasingly interdisciplinary and highlight the importance of not only considering technological progress or possibilities through a technological lens, but also addressing socio-political implications and challenges for various actors in society with increasingly digitalized governments (Janowski and Pardo, 2007: iii; Meijer and Bolívar, 2016: 403-404).

In this thesis e-governance is understood as the abbreviation of 'electronic governance' and describes the organization of governance with and around ICTs thereby focusing on the interactions between government and non-government stakeholders such as people, NGOs and business partners. This approach to define e-governance is a conglomerate between the various definitions on e-governance which differ in their emphasize but all include a reference to the role of ICTs and the focus on the relationship between governments and a variety of stakeholders.

2.3. Citizens in electronic governance

The previous definition of e-governance highlights the focus of e-governance on the relationship between various stakeholders. In the context of smart city literature an important stakeholder is 'the citizen' (Cardullo, 2020). Citizen is an often-encountered term in literature on e-governance and infrastructure reporting platforms and framed and conceptualized in various ways. Baykurt (2011) and Cardullo and Kitchin (2019) and Cardullo (2020) offer an extensive and critical discussion around the various roles citizens play in the context of e-governance. Whereas it is not within the scope of this thesis to discuss the role of citizens in-depth the key points of Baykurt (2011), Cardullo and Kitchin (2019) and Cardullo (2020) are subsequently presented. Cardullo and Kitchin (2019) point out to the delegation of power over decisions between governments and citizens via e-governance tools and developed a categorization system called the scaffold of smart city participation derived from Arnstein (1969) enabling to entangle the different levels of power over decisions citizens have depending on the e-governance tool. different levels of power over decisions range from passive receivers of information to active shaping of the political process and making decisions which is a rare role citizens play. Cardullo and Kitchin (2019: 11) clearly state that most roles are embedded in a paternalistic and market-driven participation contrary to an understanding of citizens as holders of rights and entitlements. The shift from rights towards

market is also described in Cardullo's (2020) book about the new roles citizens take up in e-governance structures. The book finds that e-governance is rooted in neoliberalism leading to a shift in citizenship away from rights and the common good towards citizens as individual consumers, data points or residents and “a conception rooted in individual autonomy and freedom of ‘choice’ and personal responsibilities and obligations” (Cardullo, 2020: 42) through nudging and normalising behaviour and forms of social control (Cardullo, 2020: 54). A similar argument is found in Baykurt's (2011: 10) article on FMS which highlights how infrastructure reporting platforms render citizens to consumers consuming a service delivered by the city more in the way of a costumer complaint service instead of a becoming a way to involve people.

In this thesis preference was given to the term ‘user’ and not ‘citizen’. Citizen is an intricate term which was discussed in-depth by other researchers (Baykurt, 2011; Cardullo and Kitchin, 2019; Cardullo, 2020). Further, The Britannica Dictionary (2022) defines citizen as either “a person who legally belongs to a country and has the rights and protection of that country” or as “a person who lives in a particular place”. Both definitions do not accurately describe the people able to interact with the city of Zurich via ZWN as the platform can be accessed by everyone regardless of its legal status and place of residency (Gees, 2013). Instead of opening up this broad theoretical discussion once more and adding another nuance to the definition of citizens in the context of e-governance, the term ‘user’ for this thesis is more accurate and straightforward when researching the interaction mediated through the platform. Although the term ‘user’ in the context of e-governance and smart cities might appear in line with neoliberal visions of governments as providers of services fulfilling needs of citizens as consumers (Baykurt, 2011; Cardullo, 2020), the author of this thesis would like to emphasize the pragmatic reasoning to work with this term. The usage of the term ‘user’ should by no means be understood as positioning the following work within neoliberal strains of thought on governments and the relationship between citizens and the state.

2.4. Electronic governance with infrastructure reporting platforms

Already touched upon in the previous section, ICT solutions in the context of e-governance are the mediator between the stakeholders and the government. ICTs are said to be able to “attract human capital and to mobilize this capital in collaborations between the various

organized and individual actors through the use of ICTs " (Edelenbos *et al.*, 2018: 40). An example for an ICT solution that is said to mediate interaction possibilities between governments and stakeholders are infrastructure reporting platforms such as FMS, Open 311, SchauAufLinz or ZWN.

The interaction mediated by infrastructure reporting platforms are similarly described by the literature than the interaction characteristics of e-governance in general. The focus of research on e-governance often lies on improved participation of stakeholders by providing accessible, efficient, and transparent interaction possibilities (Loukis, Macadar and Meyerhoff Nielsen, 2021: v; Sharma, Kar and Gupta, 2021). Whereas some scholars see a positive relationship between the adoption of e-governance tools and more transparent government services capable of ensuring enhanced accountability which involves people better than traditional government services (Tomor *et al.*, 2019: 9-11; Sharma, Kar and Gupta, 2021), others critique the adoption of e-governance tools as having top-down technocratic tendencies able to nudge and control people rather than providing 'easy access' (Kitchin, Lauriault and McArdle, 2015: 14-17; Schwarz, 2017: 374-380).

The literature on infrastructure reporting platforms follows similar dichotomies where some authors associate such platforms with participation and increased efficiency, transparency and accountability (Schmidthuber and Hilgers, 2018; Peng *et al.*, 2022: 2), others critique them for being of questionable participatory quality (King and Brown, 2007; Baykurt, 2011). Positively connoted interaction characteristics such as efficiency, transparency and accountability are mainly uttered by scholars with backgrounds in economic science, informatics or public management and administration who see infrastructure reporting platforms as means to ensure a more bottom-up mode of governance (Schmidthuber and Hilgers, 2018: 276-278; Peng *et al.*, 2022: 2). On the contrary, more critical voices see the interaction mediated by infrastructure reporting platforms as one-sided, individualized form of interaction with questionable improvements on the participation of citizens (Baykurt, 2011). The various perspectives on the interaction mediated by infrastructure reporting platforms will be discussed in the following sections based on overarching topics describing key aspects of the interaction found in the literature namely participation, unequal report contributions over space, accountability, transparency and controllability and in the end efficiency. More precisely, the following chapters will firstly discuss how participation through infrastructure reporting can be characterized, who participates through infrastructure

reporting platforms and spatial inequalities result, how an oversimplified understanding of transparency is associated with such platforms, in how far infrastructure reporting platforms can be expected to foster accountability and controllability and how efficiency gains through the adoption of infrastructure reporting platforms are described in literature.

2.5. Participation and infrastructure reporting platforms

An often-encountered argument in literature on infrastructure reporting platforms is that such platforms foster participation. The term 'participation' in the context of infrastructure reporting platforms is often used without considering the depth of the word, although authors like Harris and Weiner (1998: 75) termed 'participation' a 'buzzword' already in the late 90's when researching the participatory potentials of GIS. A basic definition of the word delivers The Britannica Dictionary (2022b) which defines the verb to participate as "to be involved with others in doing something" or as "to take part in an activity or event with others". The interesting aspect in this definition is the involvement which is mentioned. Involvement in the context of participation through e-governance tools is a complex topic because the modes how people are involved can vary significantly depending on the tool or the platform and its configurations. A characterization of participation through e-governance tools is delivered by Cardullo and Kitchin (2019) in their adapted ladder of participation by Arnstein (1969). The classification called 'the scaffold of smart citizen participation' considers the role of participants, the political discourse and framing and the modality of the participation leading to four forms of participation. The forms of participation range from non-participation which they do not see as an actual form of participation over consumerism and tokenism to citizen power which is the most empowering form of participation (Cardullo and Kitchin, 2019: 5-10). Whereas the study from Abu-Tayeh, Portmann and Stürmer (2017) simply frames ZWN as a tool for citizen participation without further specification of their understanding of participation, Cardullo and Kitchin (2019) highlight the intricate nature of participation and thus enable a more detailed look on how participation is mediated by platforms like ZWN.

Central in the discussion about how participation through infrastructure reporting platforms is mediated, is the delegation of power over decisions between government or administration and its participants. This delegation of power manifest itself in how far participants of

infrastructure reporting platforms can make decisions and shape the outcome of their contribution (Cardullo and Kitchin, 2019: 9). The discussion around the delegation of power over decisions in participatory e-governance tools in general and infrastructure reporting platforms more specifically culminates on terms such as 'bottom-up' or 'top-down', which are often quite differently conceived. For example Peng *et al.* (2022: 1-2) frame the infrastructure hotline 12345 adopted by local governments in China as 'bottom-up tool' better suited to handle urban problems than tools with a 'top-down design'. Urban problems are tackled by social sensing which takes citizens as sensors who report infrastructure problems in cities 'from the bottom up' (Peng *et al.*, 2022: 2). In essence, Peng *et al.* (2022) in their characterization of 12345 as 'bottom-up' simply describe the mere collection of data which happens from the bottom up and fail to acknowledge that referring to an e-governance tool as 'bottom-up' requires more than the simple collection of data by citizens. Various scholars noted how the bottom-up framing of e-governance tools is often not more than a (corporate) discursive strategy to meet fears of technocratic control which is for example pushed forward by the likes of IBM to popularize the idea of digitized governments (Söderström, Paasche and Klauser, 2014; Barns, 2020: 65-69). Exemplarily, in their scaffold of smart citizen participation Cardullo and Kitchin (2019: 5-9) place Fix-Your-Street, the Dublin equivalent of FMS, in the category 'tokenistic' characterized by a top-down modality as although citizen are able to suggest alternatives and additions they do not have the power to make decisions nor have the power to influence how a proposed alternative or addition is realized. What one can derive from the scaffold of smart citizen participation by Cardullo and Kitchin (2019) is that framing a participatory e-governance tool as bottom-up needs a certain delegation of power over decisions to the participants.

As of now, infrastructure reporting platforms such as FMS as well as ZWN delegate little power over decisions to its users as users can only detect damages, cannot decide on the modes of exchange, and are not able to influence decisions made by the administration. An interesting perspective on how little power (infrastructure reporting) platforms delegate to their users delivers Schwarz (2017). Schwarz (2017: 381-382) highlights that not only the platform surface is controlled by the deployer but also the exchange happening over the platform is controlled by the owner of the latter. Although Schwarz's (2017) argument relates to platforms such as Facebook the same power imbalance can be translated to the likes of ZWN or other infrastructure reporting platforms. In the case of ZWN, users can only

contribute through reports, the surface of the platform and the mode of interaction and exchange is controlled by the city of Zürich. Whereas it is not within the scope of this thesis to precisely examine Cardullo and Kitchin's (2019: 9) categorization of Dublin's Fix-Your-Street as a tokenistic platform where users can 'suggest alternatives and additions', it can be said that ZWN does not enable user to suggest alternatives nor additions. Users can only detect damages or impurities and report them to the city (Gees, 2013: 323; Abu-Tayeh, Portmann and Stürmer, 2017: 535-537). The user of ZWN is therefore in the role of simply suggesting repairs rather than proposing alternatives or additions let alone ameliorations. All decisions based on a reported issue on the platform are exclusively made by the administration of Zurich. For example, users cannot influence the decision if a report is publicly visible which is decided solely by the administration. User can further not influence how a reported issue is fixed. Baykurt (2011) characterizes the usage of the website as fleeting, fast and problem focused and derives that the delegation of power over the platform resembles a costumer complaint service where governments are the complaint service and users the consumers.

Concluding on the delegation of power in the participation on ZWN, it can be said that framing ZWN as a platform for participation oversimplifies the relationship between the city and the users of the platform. When Stürmer and Ritz (2014: 130) talk about ZWN as a form of involving the public and frames ZWN as a platform for participation this needs to be considered carefully and one needs to ask the question: how precisely is the public included? Participation via ZWN needs to take the delegation of power over decision in the participation process over the platform into account which makes visible that the city of Zurich is in the position to decide which reports are publicly visible, how the interaction possibilities are configured and first and foremost what can be contributed. The data of ZWN might be gathered from 'the bottom up' but the design and all the decisions are made by the city of Zurich.

2.6. Geographies of difference and infrastructure reporting platforms

Whereas the last section posed the question 'how' people are involved, this section could be framed as questioning 'who' exactly is involved through infrastructure reporting platforms. Infrastructure reporting platforms seem to be prone to similar spatial inequalities found in countless studies on participation with GIS finding that it tends to reproduce existing (spatial)

inequalities as data acquired by participatory GIS practice is prone to “exclusion and under-representation of information from and about marginalized people and places in existing data records and is linked to the ensuing exclusion of their needs and priorities from policy and decision-making processes.” (Elwood, 2008: 178). Thereby, the unequal contribution on online participatory GIS reflects wider societal inequalities with respect to people’s economic means, ethnicity and gender (Elwood, 2011: 7-8; Brown and Kyttä, 2014: 133-134). Same has been found for infrastructure reporting platforms where people with less economic means, ethnic minorities and women report less (Minkoff, 2016; Pak, Chua and Vande Moere, 2017; Matthews *et al.*, 2018; Rae and Nyanzu, 2021). These inequalities in contribution manifest themselves in space which is referred to as geographies of difference in this thesis: areas with higher reporting rates are areas with higher socioeconomic status and less deprivation, and areas with higher proportion of people of ethnic minorities are underrepresented (Minkoff, 2016; Pak, Chua and Vande Moere, 2017; Rae and Nyanzu, 2021).

Regarding geographies of difference with respect to economic means, there is limited comparability between the studies on different platforms of different countries as the available data and thus variables used to assess economic means or wealth differ. A general tendency is visible that areas where people with less economic means reside are underrepresented in infrastructure reporting platforms, meaning there are less reports from these areas. Minkoff (2016) researches the “spatial variations in contacting volume” for the complaint categories graffiti, noise and government-provided goods, an umbrella term created by Minkoff (2016: 217) under which he clumps “streets, trees, sidewalks, garbage, water, and lighting, and other problems that can be generally classified as being associated with the condition and upkeep of government-provided goods in a specific place.” (Minkoff, 2016: 217). He finds inter alia that areas with higher home-ownership rates show higher reporting rates for the category government-provided goods meaning that low-ownership areas are most probably underreported in the category government goods (Minkoff, 2016: 229-238). Slightly positive and significantly correlated with increased contacting in the categories government goods and noise is also the median income. Minkoff's (2016: 236-238) overall conclusion is that higher socioeconomic status is tied to a higher contacting volume, although weakly. For reporting via FMS in the UK, Matthews *et al.*, (2018) and Rae and Nyanzu (2021) find similar patterns when comparing the deprivation index on the level of census Super Output Areas for Northern Ireland, Wales and England and Data Zones for Scotland

with contacting volume on the same aggregation level. The deprivation index is an index for neighbourhood deprivation (Rae and Nyanzu, 2021: 210). Rae and Nyanzu (2021: 211) grouped the deprivation index into 10 deciles and then counted the reports for each decile finding that the lowest decile with most deprivation shows lowest report counts. The second and third most deprived decile also show lower report counts, the highest report counts are found in the 7th decile which Rae and Nyanzu (2021: 211) term middle-class. Low report counts does not mean high-quality infrastructure as although reporting is related to the state of infrastructure it depends on the expectations of the people towards the infrastructure (Rae and Nyanzu, 2021: 215). Rae and Nyanzu (2021: 215-217) rise some intriguing questions on report distribution by stating that most probably areas with for example more road surface will have more reports in road related categories or that areas with more daytime population probably generate higher report counts than accounting for resident population alone. Besides concluding that more deprived areas report less, Rae and Nyanzu (2021: 215-217) conclude that report counts might follow fabric of urban infrastructure and what people expect from it. For the case of FMS in Brussel, Pak, Chua and Vande Moere (2017) find very similar results for the average taxable income aggregated on district level, districts with low average income show lower numbers of reports but districts with highest incomes do not necessarily show highest reporting. Overall, it can be concluded that socioeconomic measures are positively associated with contacting frequency especially that areas where people with lower economic means reside show lower report counts.

Contributions to infrastructure reporting platforms further show bias with respect to ethnic backgrounds with ethnic minorities reporting less frequently. Researching FMS in Brussels Pak, Chua and Vande Moere (2017: 69-84) find that ethnic minorities are underrepresented with respect to report counts except for people with a Turkish background. Ethnicity was computed as an index based on the distribution of language used in geo-tagged tweets via Twitter and official statistics from the Brussels official statistics dataset on ethnicity. The study finds that people with Sub-Saharan and North African background are underrepresented but people with a Turkish background use FMS more actively (Pak, Chua and Vande Moere, 2017: 82). A non-spatial study by Gibson, Cantijoch and Galandini (2014: 11) came to similar conclusion whereas in the UK – where 13% of all population have a non-white background – only 4% of their subsample of FMS where contributions by people with a non-white background. Summing up, in general ethnic minorities seem to contribute less to

infrastructure reporting platforms and areas with a higher proportion of people with ethnic minority backgrounds are underrepresented.

For ZWN only one study researching the contribution and its user base was found. The study by Stürmer and Kölliker (2016) was able to send a questionnaire to 2613 users of ZWN with the help of the city of Zurich and finds gendered imbalance and a tendency towards higher educational levels in the user base of ZWN. The study did not explicitly mention how many users returned the questionnaire but counting the values in the histogram of the age distribution lead the author of this thesis to 933 participants. According to the study over 90% are German native speakers, 73.3% are male, the most common age is between 25 and 44 and the education level is either high school (In Switzerland either university or university of applied science) or vocational training. The findings are especially striking with regards to the gendered imbalance of users, where only 23.7% women make up the user base of ZWN (Stürmer and Kölliker, 2016). What the study does not consider is how the number of reports per users relates to their demographic analysis of the users. This has been investigated by the study from Neumann and Schott (2021) finding that women also contribute 25% less than men.

Whereas all the cited studies on geographies of difference focused on the distribution of reports contributed by users, Wichowsky, Shah and Heideman (2021) looked at the distribution of responsiveness of the government and their respective response time for the case of 311 in Milwaukee. The study of Wichowsky, Shah and Heideman (2021) highlights that not only reporting behaviour of users varies over space but moreover the answering behaviour of governments is different depending on location. They find lower response rates by government for requests from areas with higher shares of African American and Latino residents as well as higher poverty rates. On the other hand, looking at specific report categories, reports on private neglect are timelier answered in areas with higher poverty rates which according to the authors could mean that the city prioritizes more distressed neighbourhoods with respect to private neglect. Nevertheless, the authors conclude that “concerns about racial inequality persist when we examine response times, with minoritized and more distressed neighbourhoods receiving less timely responses to their complaints, all else equal.” (Wichowsky, Shah and Heideman, 2021: 12).

2.7. Accountability, transparency, and controllability

The interaction mediated by infrastructure reporting platforms is associated with fostering more accountability of administrations (Walravens, 2013; Abu-Tayeh, Portmann and Stürmer, 2017; Stürmer, Neumann and Loosli, 2017; Granero Moya, Phan and Gatica-Perez, 2021). Whereas some studies such as one by Granero Moya, Phan and Gatica-Perez (2021) simply utter that infrastructure reporting platforms such as ZWN "improve the efficiency and accountability for damage in local infrastructures with citizen-driven technologies" without further backing up the claims, the research conducted by Abu-Tayeh, Portmann and Stürmer (2017) is of questionable quality and the study by Walravens (2013) as well lacks explanations how accountability through infrastructure reporting platforms is ensured. Abu-Tayeh, Portmann and Stürmer (2017) find that ZWN helps to build trust in the city government as users see ZWN as serving the interest of the public, being reliable and serves its purpose to improve city infrastructure. The study has a major methodological limitation as only users of the platform meaning people who have already participated have been questionned and the results are afterwards extrapolated for the whole population saying that "eine ganzheitliche Evaluation dieser Maßnahme zeigt sehr deutlich, dass die Bevölkerung Online-Partizipation als wertvoll empfindet, und sie gibt Aufschluss darüber, dass ihr Nutzen vor allem darin liegt, das Vertrauen in die Stadt Zürich zu erhöhen." (Abu-Tayeh, Portmann and Stürmer, 2017: 539). Although the authors shortly address this limitation, the bias in the sampling strategy is fundamental and the author of this thesis rejects the falsely generalized and extrapolated findings that the population's trust in government is increased by ZWN. For the UK and FMS Walravens (2013) questionned in his study the assistant director of communication of Barnnet, one of the first cities in the UK to adopt FMS who finds that the platform can ensure more accountability as well as transparency and mobilizes citizens to participate more actively. Although Walravens (2013) adds that in the case of FMS, the accountability depends on the extent of involvement of citizens and the reaction speed, if and how FMS ensures accountability is not further elaborated. Whereas the first study has a biased sampling strategy, the second study derived its argument for more accountability through infrastructure reporting platforms from one interview with a state official working with FMS which results in limited explanatory power.

Accountability through infrastructure reporting platforms can be described as a result from transparency which is given through the visibility of the reports and the availability of data

resulting in controlability of the administration's work holding them accountable for their actions. The study by Sharma, Kar and Gupta (2021) attempts to operationalize accountability in e-governance services with a best-worst method determining the relative importance of constituent factors for accountability and finds that transparency and controllability are the most important constituents of accountability. Sharma, Kar and Gupta (2021) place transparency as the originator for controllability because transparency makes it possible that "citizens can use public data to judge the service provider for performance" meaning that transparency makes it possible for users to have means of control to hold the service provider accountable for their performance. Similarly, Cahlikova (2019) sees transparency as a precondition to accountability because increased transparency of public administration allows citizens to evaluate capacities of public authorities and thus better evaluate what they can expect from them which ultimately leads to increased trust in public authorities.

A central aspect of Infrastructure reporting platforms in fostering accountability is the transparency based on the visibility of reports. Schmidthuber and Hilgers (2018: 277) find that SchaufAufLinz ensures a more transparent communication between the public and the government of Linz as it shows users the stage of case handling of a report and the government can comment on reports and explain procedures or possible non-handling of a report (Schmidthuber and Hilgers, 2018: 277). Baykurt (2011, 8) for the case of FMS shows that "local councils, also, do not disclose any information about the process of dealing with complaints" and users are not able to find information on how the website works at the first place, how long they have to wait until their report is resolved or how they should follow up if a report is not taken care of. Opposing Schmidthuber and Hilgers' (2018: 277) and Baykurt's (2011, 8) take on the visibility of reports shows two things: firstly the configuration of SchauAufLinz and FMS seem to be slightly different whereas Baykurt (2011, 8) says there are no means to see the state of a report, Schmidthuber and Hilgers (2018: 277) mention the stage of case handling of a report. Secondly, the assessment of transparency based on the visibility of reports is different, whereas Schmidthuber and Hilgers (2018: 277) seem to frame the visibility of reports in SchauAufLinz as transparent, Baykurt (2011, 8) shows that the transparency on FMS is limited. What one can derive from above studies for the case of ZWN is that the accountability depends on what exactly can be inferred from the openly visible reports and how exactly the administration communicates because this impacts how users are able to "evaluate realistically the capacities of their government and assign accountability

directly to responsible actors" (Cahlikova, 2019). The mere visibility of reports alone does not ensure accountability, but accountability depends on how transparently information is disclosed and how much details about the handling of a report are revealed.

The accountability of infrastructure reporting platforms not only grounds on the visibility of reports but also on the availability of data generated through the platforms. Abu-Tayeh, Portmann and Stürmer (2017) and Stürmer and Ritz (2014) both strongly link ZWN to open government data, a concept dating back to the Obama administration characterized by the open availability of principally every document or dataset of the administration as long as the information does not affect the security of the country or the privacy of individuals (Stürmer and Ritz, 2014: 127-128). Openly available data is said to increase the transparency of the interaction between governments and the public (Schmidthuber and Hilgers, 2018: 270) and thus enables the people to assess or control the performance of governments or administrations (Stürmer and Ritz, 2014; Sharma, Kar and Gupta, 2021). Besides the fact that this perspective on open government data suffers an epistemological fallacy which assumes that 'the people' as individuals are able to simply "seek information about a system, to interpret that information, determine its significance" (Ananny and Crawford, 2018) from raw data, the degree to which an assessment of the performance of the administration is possible depends on the available data source, how thoroughly the data is stored and made available and how understandable the variables are.

Ultimately, when referring to the accountability resulting from the transparency of the interaction between government and users mediated by infrastructure reporting platforms be it through the visibility of reports or the availability of data, it is necessary to not only consider what is visible but how transparency-opacity is managed and how this impacts the accountability through the platform. Transparency is best understood as a range between fully opaque and totally open as there is no such thing as fully transparent or fully opaque (Birchall, 2011; Ananny and Crawford, 2018). The paradox of transparency can be illustrated by thinking about a situation where literally everything is openly visible and available online. The paradox lies therein that due to the immense volume of data much of it remains unseen and unprocessed, full blown transparency thus creates opacity (Birchall, 2011). Platforms such as infrastructure reporting platforms can be understood as networks of human and non-human actors creating and managing visibility (Ananny and Crawford, 2018). As transparency and secrecy or opacity coexist, framing infrastructure reporting platforms as transparent

(Stürmer and Ritz, 2014; Abu-Tayeh, Portmann and Stürmer, 2017; Schmidthuber and Hilgers, 2018) fails to acknowledge the complexity of transparency and hinders to draw attention to how infrastructure reporting platforms and involved actors actively manage transparency influencing the resulting accountability.

Lastly, the controllability which infrastructure reporting platforms enable is not only based on the visibility of report and availability of data but depends on the configuration of the platform and which possibilities are made available to express (dis-)content about the performance of the administration. Baykurt (2011, 8) shows that the controllability of FMS is based on controlling whether a damage has been fixed or not. Baykurt (2011, 8) utters "citizens, who want to use this service, do not have clear information about …, how they should follow up if their issues are not taken into consideration or what they should do if they are not satisfied with the response they get. (...). As for accountability, local councils can be controlled only about whether they fix problems or not. How they choose which problems to deal with over others or what kind of measures they take to reach a certain end are not shared on the website.". Baykurt (2011) for the specific case of FMS describes the controlling possibilities offered by FMS as limited to whether a problem has been fixed or not and raises an intriguing topic: The controllability able to hold administrations accountable depends on the possibilities to express judgments about the performance which are managed through infrastructure reporting platforms.

2.8. Efficiency

The efficiency of infrastructure reporting platforms is one of the key aspects associated with these platforms. The importance of efficiency for infrastructure reporting platforms is best understood by briefly considering the broader discussion around efficiency in the uptake of e-governance tools and ICTs. One of the main objectives of the uptake of ICTs in the public sector was increased efficiency which also the case for Switzerland (Cahlikova, 2021: 19). The efficiency gains through the adoption of ICTs are seen as results due to automatization of services associated with enhanced transfers and exchange of data and increasing interconnection of services (Li, Batty and Goodchild, 2020) said to allow the public sector to save costs (Cahlikova, 2021: 90-91) and deliver services in times of austerity through the use of cheap ICTs (Kitchin, Cardullo and Di Feliciantonio, 2019: 1-3). But not only operational

efficiency is a goal of the adoption of ICTs but also facilitating access for citizens, letting them participate more efficiently (Cahlikova, 2021: 91).

In the specific case of infrastructure reporting platforms efficiency for users seems to be guaranteed by gain of time (Abu-Tayeh, Portmann and Stürmer, 2017). Whereas the author of this thesis rejected the extrapolated findings of Abu-Tayeh, Portmann and Stürmer (2017) earlier, the biased sampling strategy is not an issue concerning their findings that users of ZWN appreciate the gain of time by using the platform. The platform seems to offer a quicker way to interact with the administration then traditional forms of communication (Abu-Tayeh, Portmann and Stürmer, 2017: 537).

On the other hand, operating infrastructure reporting platforms is associated with limited efficiency gains due to the organization of administrations. Peng et al., (2022: 3) find that the 12345-hotline shows “an unoptimized problem-handling responsibility designation among the municipal departments which inflicts inefficiency in problem-handling.”. Peng et al., (2022: 12-13) show an example highlighting how reports concerning several service departments pose an existential problem for infrastructure reporting platforms which require a rigid classification of the reports into only one category (Gees, 2013). Cahlikova (2021: 117-118) highlights similar problems regarding efficiency of e-governance tools in general for the specific case of Switzerland. The increasing digitization of governments is less a technological issue but “a process of organisational learning and should be undertaken only after careful planning in accordance with precise objectives, predefined strategies and roadmaps outlining their achievement." (Cahlikova, 2021: 117). Besides ZWN enabling users a quicker way to interact with the administration of the city of Zurich, deriving from the study of Peng et al., (2022) and Cahlikova (2021), the efficiency in operating and managing the interaction through ZWN is of questionable efficiency and needs closer examination.

3. Methods

3.1. Research gaps

The preceding section Background shows that the research gaps surrounding ZWN are manifold. There have been several scholars researching geographies of difference underlying the reporting on other infrastructure reporting platforms but no geospatial analysis of the data of ZWN has been conducted and nothing is known about the distribution of reports and potential geographies of difference in Zurich. Further, only one study has been found that

approached the data by looking at the response times of the administration (Wichowsky, Shah and Heideman, 2021), which shows a lack of studies concerned with how the administration side uses infrastructure reporting platforms to interact with users of the platform and is thus not only in the case of ZWN barely researched.

Although touched upon by several studies (Stürmer and Ritz, 2014; Abu-Tayeh, Portmann and Stürmer, 2017) the interaction between users of ZWN and the administration has not been researched in adequate depth with respect to how the platform ensures accountability, transparency, and efficiency. As the preceding sections show in the context of infrastructure reporting platforms in general, the conceptualizations of those terms strongly attached to the interaction mediated by infrastructure reporting platforms lack theoretical context and analytical focus. Studies by Cardullo and Kitchin (2019) and Baykurt (2011) critically examined the roles of citizens in the context of Fix-Your-Street in Dublin and FMS respectively offering some insights into the interaction mediated by infrastructure reporting platforms. But firstly, their studies focused on the roles of citizens and less on the governance and interaction through those platforms and secondly as ZWN and its connection to the administration of the city of Zurich shows some notable differences to FMS and other infrastructure reporting platforms the interaction between administration and users mediated by ZWN remains largely unresearched.

3.2. Research questions

The methodology is based on a triangulation of three methods namely a platform walkthrough, semi-structured interviews with officials of the city of Zurich involved in the implementation and maintenance of ZWN and a spatial analysis of the openly available data from ZWN. The three different methods enable three different perspectives on the platform ZWN and approach the overall research question ‘how is the government-user interaction mediated through ZWN?’ by answering three research questions. The platform analysis generates data to answer the first research question ‘What form of usage does ZWN enable?’. The interview with city officials provides data foundation for the second research question ‘How do city officials interact with users via ZWN?’. The spatial analysis of the data from ZWN serves to answer the third research question ‘What characteristics of interaction can be inferred from the data of ZWN?’. To answer the last research question findings of the

interview where sporadically considered to better understand certain variables, therefore the dotted line in Figure 1. Subsequently, each of the three methods will be discussed separately and in more detail.

3.3. Platform walkthrough

The platform walkthrough is based on the walkthrough method by Light, Burgess and Duguay

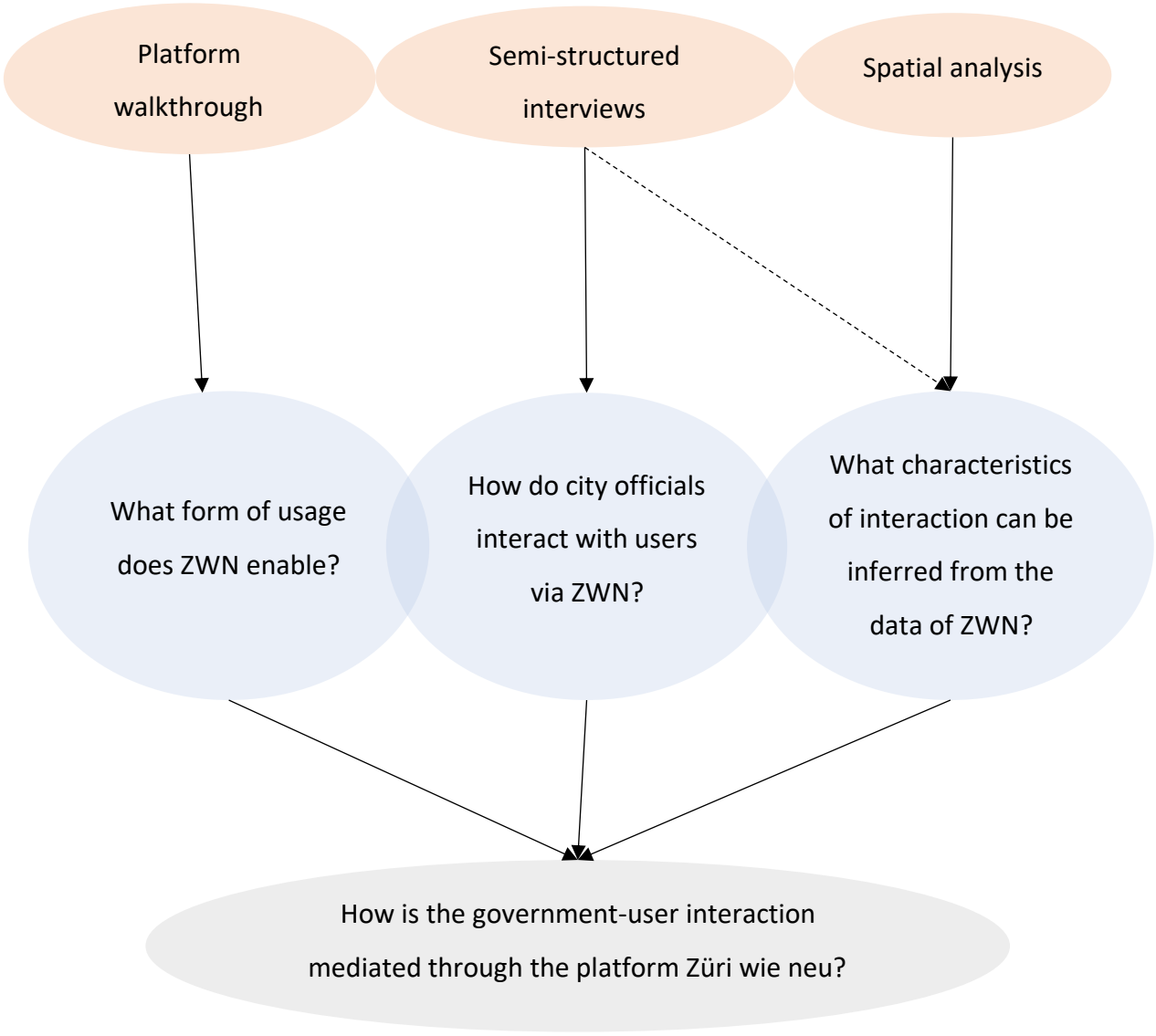


Figure 1: Methods and connection to research questions.

(2018) which describes a heuristic tool to analyse online platforms such as webpages and apps and grounds on both technology and cultural studies thus it considers not only the technological architecture moreover embedded cultural values and socioeconomic aspects of a platform. The walkthrough by Light, Burgess and Duguay (2018: 891) gathers data by the so

called technical walkthrough which requires researchers to place themselves in the perspective of the user and systematically step through all the stages of using a webpage or a mobile application. This process is documented with labelled screenshots including descriptions and thoughts of the researcher. The technical walkthrough is comprised of going through all the stages of using a webpage or a mobile application including four central categories called user interface arrangement, functions and features, textual content and tone, as well as the symbolic representation. The focus thereby lies not only on the mere materiality of a webpage or an app but also on the affordances the platform and its architecture requires, offered guidance and possible constraints (Light, Burgess and Duguay, 2018). Apart from the technical walkthrough, the overarching goal of the platform walkthrough is to establish the environment of expected use. The idea to place the researcher in the perspective of the user is central to the idea of a platform walkthrough as it helps to entangle the environment of expected use by identifying three core aspects: the vision, the operating model, and governance. The environment of expected use indicates how the platform provider represents the app or webpage, how it is consumed by users, how it is regulated and what social and cultural identities are associated (Light, Burgess and Duguay, 2018).

3.3.1. Technical walkthrough

3.3.1.1. User interface arrangement

The user interface arrangement describes how the app channels users through the possibilities of the platform with the placement and arrangement of buttons, menus or other navigation functions, and entry options. Of importance are not only the placement of above-mentioned aspects but also their relation to other elements of the platform in form of size and orientation which in- or decreases the importance of elements (Light, Burgess and Duguay, 2018: 891).

3.3.1.2. Functions and features

Under the title functions and features Light, Burgess and Duguay (2018: 891) understand the “groups of arrangements that mandate or enable an activity”. More practically formulated the functions and features of a platform are described by the different pages and the whole

range of possibilities for the user including data entry fields, pop-up windows, compulsory fields or request requiring action by users (Light, Burgess and Duguay, 2018: 891).

3.3.1.3. Textual content and tone

In the description of the platform walkthrough Light, Burgess and Duguay (2018: 891-892) describe textual content and tone only shortly as comprising "written instructions, available categories, and the discursive power to shape use". The technical walkthrough of this thesis considers textual content and tone of a platform as everything in written form further including the help sections and its mode of presentation as well as considerations about the overall amount of text.

3.3.1.4. Symbolic representation

The symbolic representation of a platform considers the look and feel of a platform which includes observations about the colours used, the symbols and possible connotations as well as font choices. The symbolic representation shapes how users view an app and is closely related to values and cultural norms (Light, Burgess and Duguay, 2018: 892).

3.3.2. Environment of expected use

3.3.2.1. Vision

The vision in the sense of Light, Burgess and Duguay (2018: 889): "involves it's purpose, target user base and scenarios of use. (…). An app's vision tells users what it is supposed to do and, by extension, implies how it can be used and by whom.".

3.3.2.2. Operating model

The operating model focuses on the business strategy and potential sources of income which at the same time indicate underlying political and economic interests of a platform. Light, Burgess and Duguay (2018: 890) also point out to governmental platforms which have little commercial interest but nonetheless receive support, knowledge and information through webpages and apps.

3.3.2.3. Governance

The third aspect is the governance of a platform resolving around how a platform manages and regulates user activity reflected in the guidelines and rules established in a platform. The governance does not simply nudge user behaviour it may also favour certain values and norms. The governance sustains the operating model and tries to fulfil the vision of the platform (Light, Burgess and Duguay, 2018: 890-891).

3.3.3. Procedure

The platform walkthrough conducted for this thesis closely followed the above outlined framework by Light, Burgess and Duguay (2018). Regarding the technical walkthrough, the procedure for this thesis directly followed the approach of Light, Burgess and Duguay (2018). The functions and features proposed by Light, Burgess and Duguay (2018) was approached via the documentation of all the pages with screenshots and text boxes with comments. Besides the elements proposed by Light, Burgess and Duguay (2018) such as the report function, compulsory fields and requests, the maps from the platform were also considered. The technical walkthrough and documentation were made for both the web version and the mobile app of ZWN but only the results for the web version are presented in the section Results. The analysis of the mobile version can be found in the appendix.

The technical walkthrough and the establishment of the environment of use was approached iteratively. The first step was a simple navigation through all the pages and functions of the webpage which was documented by the screenshots of the main windows of the platform. Besides, first notes on the environment of expected use were made, including considerations in the categories vision, operating model and governance. Successively, more detailed aspects of the technical layout of the platform were documented and described and the environment of expected use was refined.

3.4. Semi-structured interviews

For this thesis semi-structured interviews have been conducted following Mattissek, Pfaffenbach and Reuber (2013). Semi-structured interviews are a qualitative method to acquire data and are characterised by a mixture between guided, directed questions and an open, flexible flow of the interview adapting to possibly interesting and fruitful pathways

brought up during the interview. Semi-structured interviews make it possible for the interviewed person to talk more freely and allows narrative sequences (Mattissek, Pfaffenbach and Reuber, 2013).

The semi-structured interviews for this thesis can further be considered expert interviews as all the interviewees are situated in a structural position allowing them to have a specific prior knowledge on the subject making them somehow experts of their field. Expert interviews require a more advanced preparation for the interviewing person and more in-depth knowledge of the subject (Mattissek, Pfaffenbach and Reuber, 2013).

The interviews were accompanied by pre- and post-scripts reflecting on the mood of the author before the interview, the interview setting and non-verbal interactions in the sense of Kaspar (2016) who argues for integrating the interview situation, feelings about the interview and verbal as well as non-verbal interaction during the interview into the analysis but also a personal reflection about one's position with respect to the interviewed person and one's research question.

3.4.1. Guiding questions

Due to the expert position of the interviewees the guiding questions for the interviews were structured into three parts and formulated and written out instead of a bullet point like notation which is a common form found in semi-structured interviews according to Mattissek, Pfaffenbach and Reuber (2013). The basic guiding questions were structured into three parts containing a more introductory part about the integration into the city organization, a middle part about the workflow and the final part specifically about interaction possibilities offered by ZWN. The focus lied on the interviewees interaction via the platform meaning the individual experience of each interviewee was at the centre of all formulated questions. Prior to each interview, the guiding questions were slightly adjusted depending on the position of the interviewee in the city. If asked for, the guiding questions were sent to the interviewees in advance which was only demanded twice. The guiding questions for all interviews can be found in the appendix.

3.4.2. Interviewees

For the interviews officials of the city directly related or working with ZWN were approached. The first contact was via the responsible person indicated on the platform ZWN who was kind enough to give me email addresses of people working with ZWN. Other contacts were found on the website of the city of Zurich. The interviewees include the responsible person from different service departments. Four interviews were held via video chat and two in persona at the office of the interviewee.

3.4.3. Transcription and coding

All interviews were recorded and later transcribed with the help of happyscribe.com. The platform is one of the few transcription programs detecting Swiss German. Nevertheless, the resulting transcript needed revision as the technology is not precise thus all the interview transcripts were manually revisited and corrected. After the transcription, the text bodies were imported into MaxQDA for coding purposes. In the beginning, the coding of the text bodies was approached by an open coding procedure with the help of the so called W-questions by Flick (2004). Open coding is said to work well with semi-structured interviews with potentially longer narrative sequences (Mattissek, Pfaffenbach and Reuber, 2013). The codes were established inductively and were iteratively refined and summarized into fewer more generalized codes. The coding scheme can be found in the appendix. Due to the anonymization of the interview, the transcripts are not included in the appendix. A table of all the interviews conducted and corresponding dates is available in the appendix.

3.4.4. Ethics

The interviewees were contacted via mail with a description of the aims of the thesis, the purpose of the interview, the institutional context of the thesis at the institute for geography and contact details of the author including the phone number. Many of the contacted persons called the author prior to the interview where arising question have been clarified and a date for the interview has been set. Before the interview started all participants were asked if they agreed with recording of the conversation which upon all participants agreed. The option to proofread the later transcript was offered to all participants. After the interview, a declaration of consent was sent to all interviewees again clarifying the topic of the thesis, the purpose of

the interview, the context of the thesis, a guarantee that the material will be used anonymized and the information that the interview transcripts will only be on the authors personal computer and will not be shared with third persons. Further it was clarified that the participation in the research for this thesis can be withdrawn at any point in time and all the interview material will be deleted if desired.

3.5. Spatial analysis

The third method used for this thesis is a spatial analysis of the openly available platform data from ZWN. The analysis is inspired by Rae and Nyanzu's (2021) analysis of the data from the British FixMyStreet. Rae and Nyanzu (2021: 205) conduct a spatial analysis of the platform data which leads them to argue that analysing "geospatial datasets are a potential goldmine of social science knowledge, but only if they are treated with the requisite caution and the methodological minefield is carefully navigated". Conducting a spatial analysis of crowd sourced open data needs a careful consideration about what one can infer from this kind of analysis. Whereas Rae and Nyanzu (2021) were trying to infer knowledge from FMS data about the patterns on neighbourhood infrastructure conditions with the help of a deprivation index, this thesis tries to infer knowledge about the interaction between city administration and users mediated by the platform ZWN by answering the question: what characteristics of interaction can be inferred from the data of ZWN?

After briefly discussing the used software and its packages, the following sections will be guided by the flowchart in Figure 2 starting with the analysis based on report counts discussing the district and grid aggregation levels, the report counting for the two aggregation levels, the normalization with population data and the hotspot analysis with the Getis Ord. The rest of the chapter treats the correlation measures visualized in Figure 3 as well as the report status, the zonal statistics of the response time and the natural language processing following the flowchart in Figure 4.

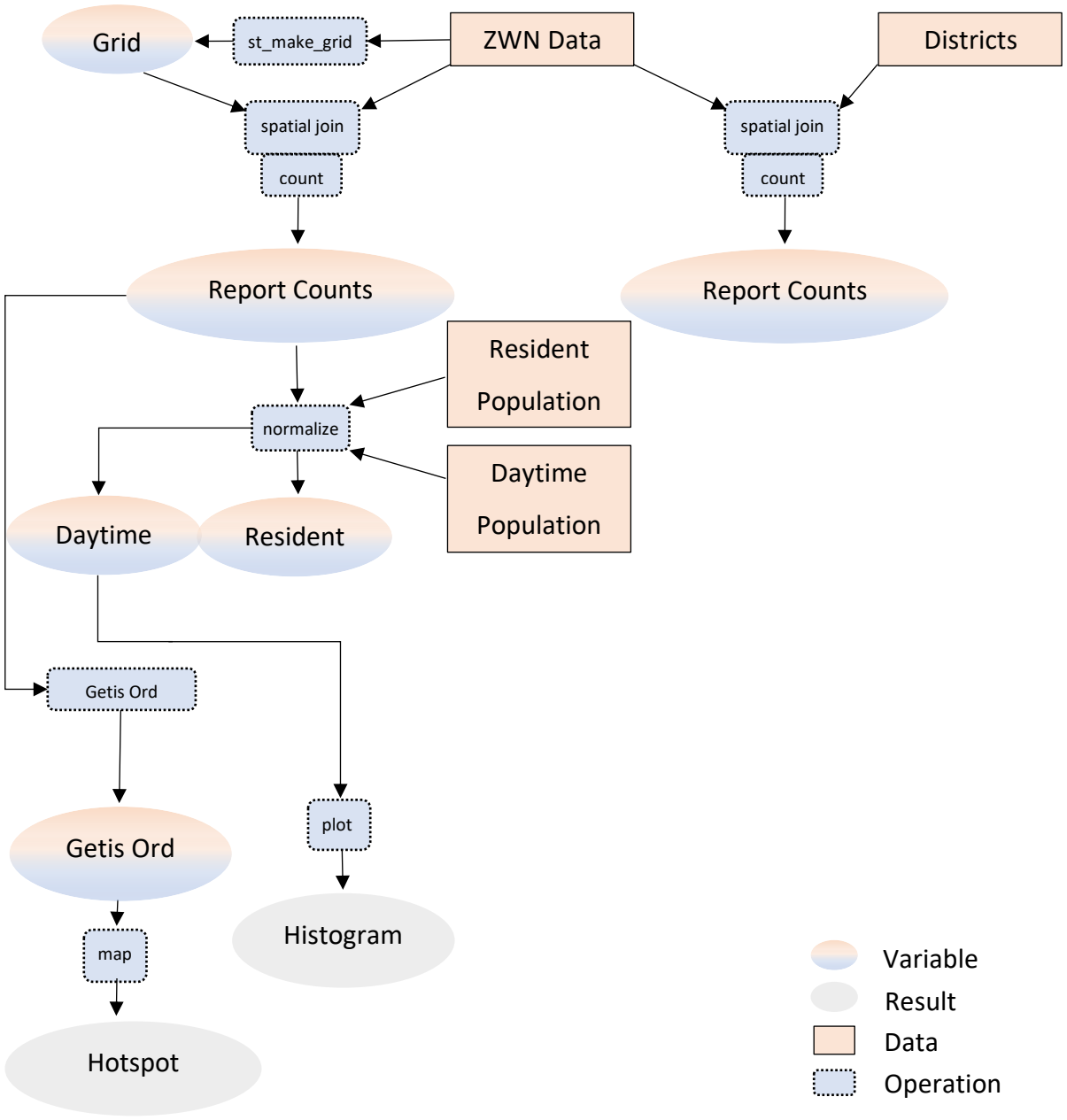


Figure 2: Flowchart of the first part of the spatial analysis based on report counts.

3.5.1. Software

The spatial analysis was done with open-source software R which offers useful libraries for data handling and spatial analysis. Used libraries include 'tidyverse' for data handling which includes crucial libraries such as 'dplyr' (Wickham *et al.*, 2019), 'spdep' for spatial autocorrelation (Bivand and Wong, 2018), 'sf' for simple feature handling (Pebesma, 2018), 'tmap' for visualization (Tennekes, 2018), 'lubridate' for manipulating time data (Grolemund and Wickham, 2011), 'rgeoda' for spatial statistics (Anselin and Li, 2022), 'quanteda' for

natural language processing (Benoit *et al.*, 2018), 'wordcloud' for word cloud visualization (Fellows, 2018) and 'seededlda' for topic modelling (Watanabe and Phan, 2022).

3.5.2. Data

The data from the platform is openly available via the open government data portal of the city of Zurich. The dataset consists of spatial points with attributes and was downloaded on the 21.2.2022 containing 32368 entries over the extent of the city of Zurich. Each row represents a unique report consisting of 18 columns where only 9 were of interest for this thesis including the unique identifier, latitude, longitude, the report text, the service code (jurisdiction within the city, each service code belongs to a corresponding service department), report status, the answer text from the government, the report date and time and the date and time the city administration answered back. The latitude and longitude were transformed into a geometry column when loading the data into R with the 'sf' package (Pebesma, 2018). The other variables are discussed in the following sections separately.

Further data that was used were two population data sets. The first population dataset was obtained from the open government data portal of the canton of Zurich and contains resident population data as points with a resolution of 1 hectare last updated on the 2.10.2020. The second population data set was obtained from Swisscom daytime population estimates from the 27.1.2020 which is based on an interpolation of Swisscom mobile phone data with a resolution of 100 x 100m.

For the district information, the district dataset consisting of the 34 districts from the city of Zurich as polygons was downloaded from the open government portal of the city of Zurich last changed on the 27.2.2020. The district polygons were checked for validity and fixed with 'st_make_valid' from the 'sf' package (Pebesma, 2018). The district polygons were the first of two aggregation levels the other being a self-made grid with a resolution of 200 x 200m. The grid was computed with the function 'st_make_grid' from the 'sf 'package by Pebesma (2018) based on hexagon polygons provided with unique IDs cropped to the extent of Zurich. The resolution of 200 x 200m was chosen as it is coarse enough to detect patterns and fine enough to avoid generalizations about areas of the city.

The median taxable income for the districts of the city of Zurich was downloaded from the open government data portal of the city of Zurich. The data lists taxable income of natural persona who pay their primary tax in the city of Zurich on three percentiles 25%, 50% and

75%. The taxable income is further distinguished into three tax categories basic tax, tax for married persons and one parent family tax. The data was only available on district aggregation level. The only comparable data source to the deprivation index used in Rae and Nyanzu (2021) that was found for the city of Zurich was the median taxable income. Rae and Nyanzu (2021) used the deprivation index to investigate spatial contribution inequality and its correlation with socioeconomic (dis-)advantages of regions.

3.5.3. Report count analysis

To get an overview over the distribution of the reports they were counted on two different aggregation levels the first based on the districts of the city of Zurich the second on the self-made grid. The individual reports were intersected with both aggregation levels separately and then summarized for each spatial aggregation unit resulting in count values. The results for both aggregation levels were plotted with 'tmap' for spatial representation of the count values (Tennekes, 2018).

Two different population counts were used to normalize the report counts. The points from the resident population dataset of the city of Zurich were intersected with the grid geometries and counted. The geometries were plotted as maps with the population data counts as colour value with the 'tmap' package. The 'tmap' package allows plotting in 'view' mode which enables interactive display of the map with various background maps (Tennekes, 2018). The daytime population data was downloaded from the Swisscom Digital Marketplace, whereof the free plan was used, and the data was downloaded via the API and a phyton script. The obtained daytime population data had peculiar geometry information namely the left lower corner and the upper right corner of a polygon. To obtain a meaningful sf representation for each row the centroid of each grid was calculated by adding half of the distance between lower left and upper right corner to the lower left corner. The resulting centroids were intersected with the grid. Again, the geometries were plotted as maps with the population data counts as graduated symbols with 'tmap' (Tennekes, 2018).

The count values were normalized with both the resident and the daytime population counts to better take eventual shortcomings of the population data into account. The normalization was used to minimize the effect of population density on the report values proposed by Rae and Nyanzu (2021). The underlying logic is that in areas where more people live or visit, more reports are to be expected thus minimizing this effect shows areas with unexpectedly high

counts indicating something ‘unusual’ and thus interesting for further analysis. The normalization was done by dividing the report counts by the population counts and saving the obtained value in a new column. The normalized values were plotted with ‘tmap’ (Tennekes, 2018) as maps with quantile breaks and the normalization with the daytime population was additionally plotted as a histogram to get a better overview over the distribution of the values. As the distribution of normalized report count values were heavily skewed, the visualization of the quantile breaks of the ‘tmap’ package did not work properly namely displaying 0 several times. The problem is also discussed on the github page of ‘tmap’: https://github.com/r-tmap/tmap/issues/258. A workaround was found by manually setting the breaks according to the values obtained by the quantile break function of ‘tmap’.

The report counts were further used to conduct a hotspot analysis with the goal to find meaningful distribution patterns and districts with potential hotspots where many reports in a specific service code were issued. The first step was the calculation of the Getis Ord which is a local measure for spatial clustering or dispersion analysing features in the context of user-defined neighbourhoods (Getis and Ord, 1992). All the functions for the calculation of the Getis Ord were taken from the ‘spdep’ package (Bivand and Wong, 2018).

The calculation of the Getis Ord requires a neighbourhood list which was built with the neighbourhood list function for polygons. Afterwards a weights list was computed based on the neighbourhood list and a binary coding scheme which either lists polygons as neighbours or it does not. The binary coding scheme is the default setting and was chosen to only include the directly neighbouring grid cells into account. As one grid cell is 200 x 200m a binary coding scheme results in weighted neighbourhoods with a diameter of 600m in each direction which was thought to be a reasonably large spatial extent for examining the usage of ZWN in space. 600m is easily manageable by foot also for older people thus making it a realistic window of analysis. The Getis Ord value was attached to each grid polygon and plotted as map in ‘view’ mode to obtain an interactive map representation.

With the help of the Getis Ord value, areas with high Getis Ord values were looked at in more detail by plotting the unprocessed reports as points on top of the polygon grid with the Getis Ord values. This made it possible to inspect individual reports in hotspot areas manually and to look at the answers from the administration on each report potentially identifying exceptional interaction patterns between the city administration and users.

Whereas the above procedure took all reports into account the hotspot analysis was also approached for each service code respectively. The goal of the hotspot analysis for reports of each service code was to get a more detailed insight into the distribution of the reports and identify hotspots for specific service codes. The first step in examining the distribution of reports based on the service code was a histogram grouped by district and service code resulting in a histogram for every district with coloured bars indicating the count per service code. The procedure for the hotspot analysis based on the service codes was the same as for all the reports except that the data was filtered based on the service code. Afterwards, the unprocessed points were plotted on top of the polygon grid with the Getis Ord values and examined by hand in 'view' mode of the 'tmap' package (Tennekes, 2018).

3.5.4. Report status

The report status was examined to find out more about the state of the reports by counting the report status for every attribute category including 'external', 'jurisidiction unk', 'fixed – council', 'not contactable', 'wish' and 'confirmed'. The count values were plotted in a histogram, a spatial representation and analysis for this attribute was not considered fruitful.

3.5.5. Zonal statistics of the response time

The zonal statistics of the response time were used to investigate whether the response time from the government differs over space and to identify potentially interesting outliers and notable patterns.

For calculating the response time, the available time data from the ZWN data set first needed to be converted into a meaningful date and time representation with the 'lubridate' package (Grolemund and Wickham, 2011). The ZWN data contained the time information on when a report has been issued, when the report has been sent to the administration and when the last update from the city administration was made on that specific report. The difference between the issuing of the report and the last update from the city administration was treated as the response time which was saved in a new column.

The zonal statistics required the aggregation of the response time into zones. For that the grid was used again, the points including the response time values where intersected with the grid

and for each grid a different ID was given. The response time values were grouped by the grid ID and the mean and standard deviation for each grid cell was computed.

The resulting mean response time and the standard deviation were plotted into two separate plots with 'tmap' (Tennekes, 2018) with the report count layer on top of them. Further outliers with response times above 10 days were removed for a second map to better visualize the distribution of the values.

3.5.6. Bivariate LISA and Spearman's rank correlation

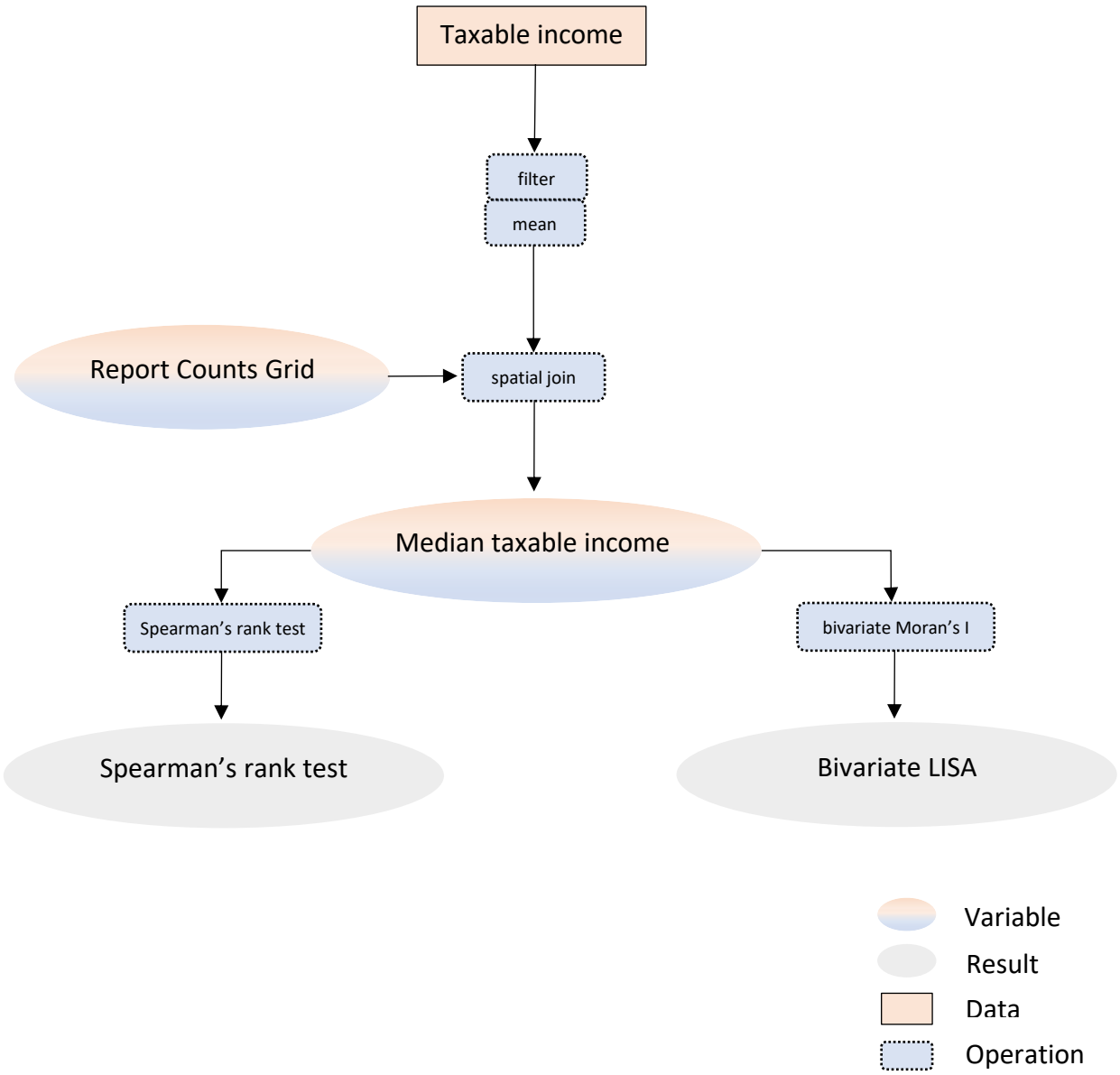


Figure 3: Flowchart of the bivariate LISA and Spearman's rank correlation tests.

The bivariate LISA and the Spearman's rank test were used to determine if the report contribution shows spatial differences based on wealth.

For the bivariate LISA and Spearman's rank correlation the taxable income data had to be refined. First, only the 50% percentile of the data, equal to the median, was used. The data was filtered for the most recent year available which was 2019. The mean of the three tax categories mentioned in the section Data was computed for every district respectively. The taxable income dataset was then joined with the report count dataset which includes both the counts and the grid cells to obtain spatial representation on grid level. Although the grid level aggregation was artificially constructed, it was a necessary step to conduct the bivariate LISA and Spearman's rank for the report count on grid level. If higher resolution data on the taxable income was available, the above step would not have been necessary.

For the bivariate LISA queen's weights have been chosen, as all eight surrounding polygons are valid neighbours. Afterwards the local bivariate Moran's I was calculated with the function 'local_bimoran' from the 'rgeoda' package with 999 permutations and alpha = 0.05 (Anselin and Li, 2022). The results were plotted with the R built-in plot function.

The Spearman's rank is a non-parametric test, suitable for variables not meeting the normality criterion and is thus well suited for various variables. The null hypothesis was that the values of income and report count are randomly distributed, the alternative hypothesis of interest is that income and report count are correlated. The Spearman's rank test was conducted with the function 'corr.test' from the 'stats' package built into R with a significance level of 0.05.

3.5.7. Natural language processing

The natural language processing was conducted only on the answer texts from the city administration back to the user and the overall workflow is visible in Figure 4. This was approached with four measurements including the response length, cosine similarity, topic modelling and word clouds. The response length, cosine similarity and the topic modelling were all done for each service code respectively.

The response length was calculated with the basic 'length' function of R for the answers texts of the administration and was plotted as boxplots for every service code displaying the mean length and the variance. The mean response length and variance in length serves as a first proxy for textual diversity in the answer from the administration.

The second measure of textual diversity within one service code was approached by calculating the cosine similarity. Beforehand, the texts were tokenized, upper- and lowercase removed, german stopwords were removed, page breaks and the words from the standardized greeting from the city removed ('br', 'dass', 'freundliche', 'freundlich', 'gruss', 'grüsse', 'stadt', 'zürich', 'zurich', 'besten', 'dank', 'meldung'), punctuation, symbols, numbers,

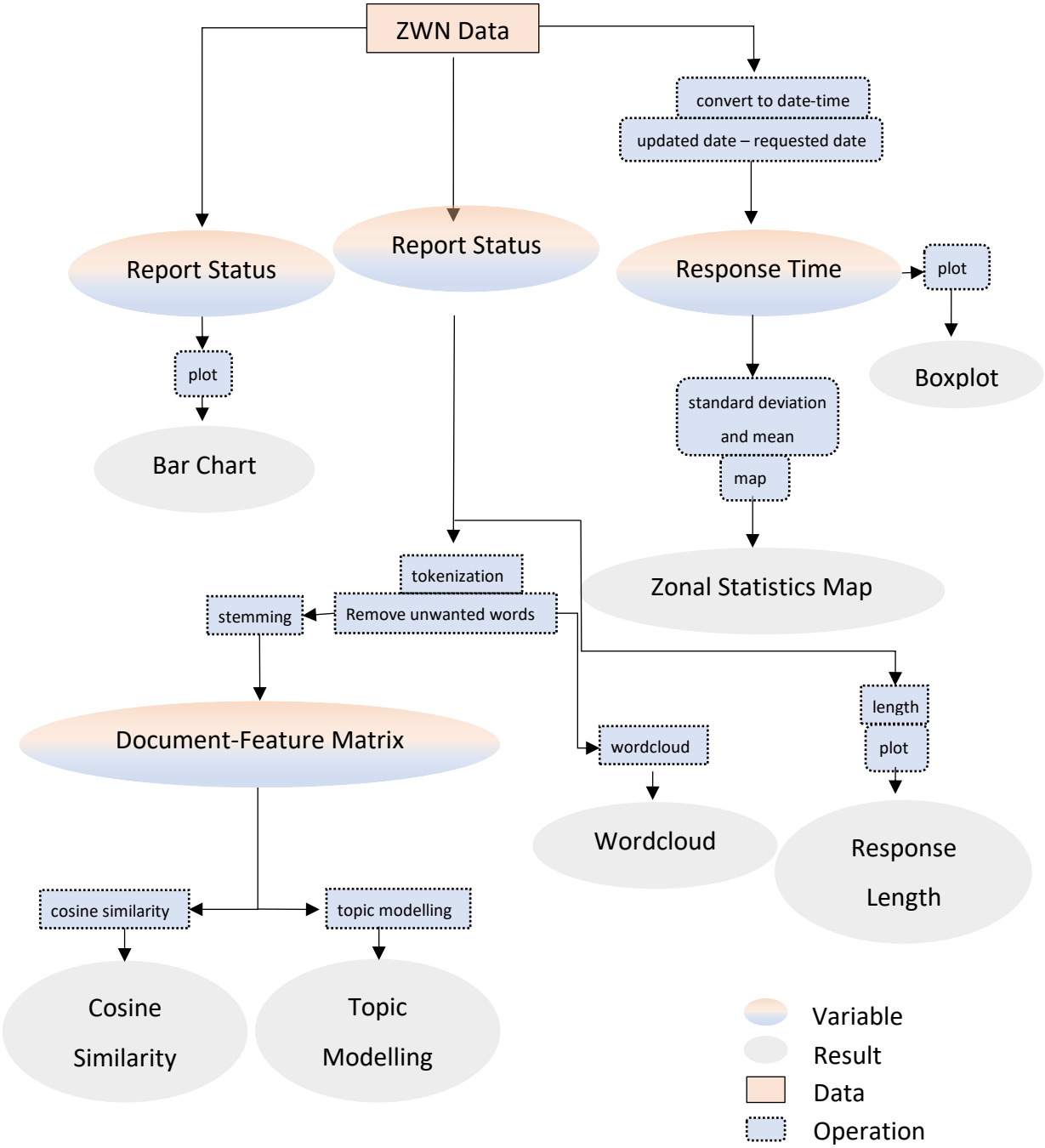


Figure 4: Flowchart of the natural language processing part of the spatial analysis.

url's and separators removed. Further only German wordstems were used. The process of tokenization and stemming was done in R with 'quanteda' which offers a wordstem function

based on an algorithm of Martin Porter and a C libstemmer library (Benoit *et al.*, 2018, no date).

After the pre-processing of the text bodies, the cosine similarity was obtained by transforming the tokens into a document-feature matrix and subsequently running the function 'textstat_simil' with the method cosine from 'quanteda' (Benoit *et al.*, 2018). The rounded mean value of the cosine values was computed with a precision of 3 digits for better readability. Knowing the textual diversity helps to understand the interaction between city administration and users better in so far as it indicates how individualized or standardized the city responses.

The topic modelling was approached on each service code and was conducted with the 'seededlda' package (Watanabe and Phan, 2022). The 'textmodel_lda' function from the 'seededlda' package is a semi-supervised topic modelling for which the document-feature matrix needed to be trimmed thus the minimum term frequency was set to the 80 percentiles. The number of words per topic was set to 5 and the number of topics was set to 3.

The word cloud was computed three times, once with all the text bodies from all the reports irrespective of the service code, once for the service code 'Allgemein' showing least textual diversity and once for the service code 'Schädlinge' showing amidst the highest textual diversity. The function 'wordcloud' was used from the 'wordcloud' package (Fellows, 2018). The word cloud and the topic modelling were used to get an overview over the terms of the city administration answer text which form the textual basis of the interaction between administration and users. In general, the natural language processing tried to find out more about the nature of the response text overall and for each service code as the answer text directly shapes the interaction between city administration and users.

4. Results

4.1. Platform walkthrough

The results for the platform walkthrough in the following section will be structured equally to the methodology part and according to the analysis categories from Light, Burgess and Duguay (2018). ZWN exists both as web and mobile version but as the two interfaces are similar in their functionality only the results for the web version are outlined. The descriptions of the walkthrough are followed by the labelled screenshots of the respective section.

4.1.1. Technical walkthrough

4.1.1.1. Functions and features

4.1.1.1.1. Pages

The landing page of the web version offers three directly accessible pages: „eine Meldung erfassen“, „Alle Meldungen“, „Hilfe“. On the landing page users can see minimal statistics about how many reports have been reported in the last week and month as well as the most recent reports. The landing page has an address field and an automatic geolocation button which leads to the first page of the report procedure discussed in section

Reports. The “Alle Meldungen” tab leads to the page on Figure 13, which allows filtering earlier reports on behave of the report category, the report status and a basic sorting based on date of update and date of reply and most frequent comments (which is bizarre as the comment function original found in FMS had been removed from ZWN). It is further possible to access already issued reports via the location markers on the map, which leads to the window shown in Figure 6 where the individual report, text from the user and answer from the government are displayed on the left-hand side of the web page. Each report has a status update in the header with colours indicating the status. The location marker on the map is coloured equally and is bigger than the surrounding ones indicating that this specific report is selected, and corresponding information is displayed. Moving back to previous pages is only possible with the browser intern back and forth arrows, the pages do not offer such a function. When clicking on the logo of Zurich one is directed to the landing page of the city of Zurich not to the landing page of the specific application ZWN, which is the case in many other web pages. Thus, the navigation between pages is rather diffuse and makes it difficult to discover the webpage. But as the use of the webpage is simply to report an issue the streamlined procedure does make sense in a way. The last page of the three main pages is the help page providing minimal background information and clarifying the rules and guidelines of issuing a report.

4.1.1.1.2. Reports

The most important part of the website is the report window as it enables the user to report infrastructure issues which is the main function of ZWN. The access to the reporting function is not direct but a submenu of “Eine Meldung erfassen”. Users first must enter an address, then go to the “Schaden lokalisieren” page via the big blue rectangle with an arrow with the message “Schaden lokalisieren” visible in Figure 7. The purpose of this page in between is a

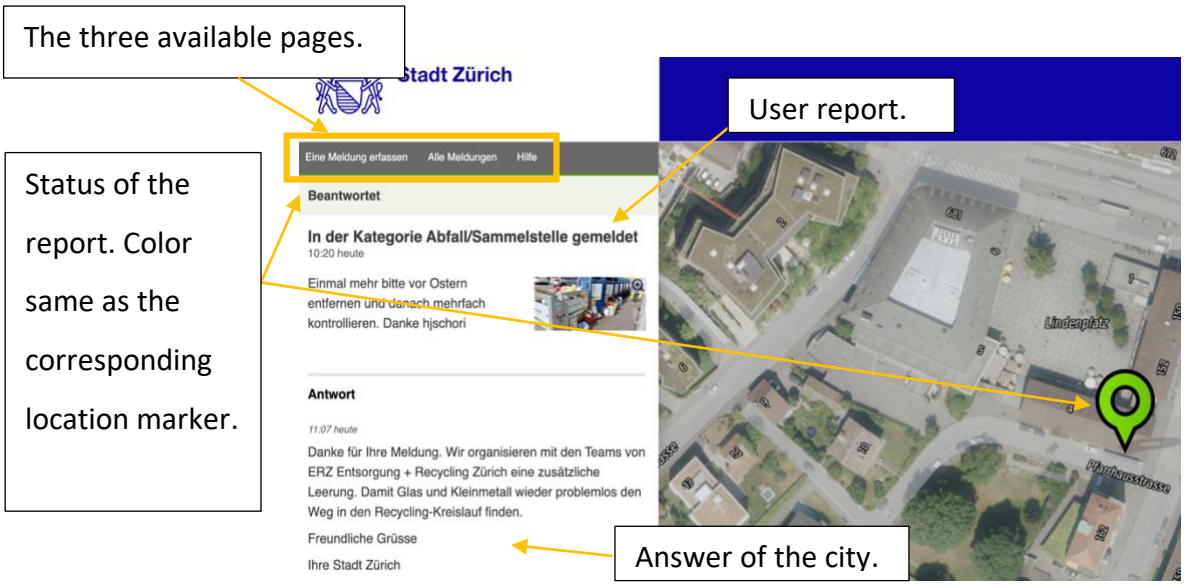


Figure 6: ‘Alle Meldungen’ page after clicking on a location marker.

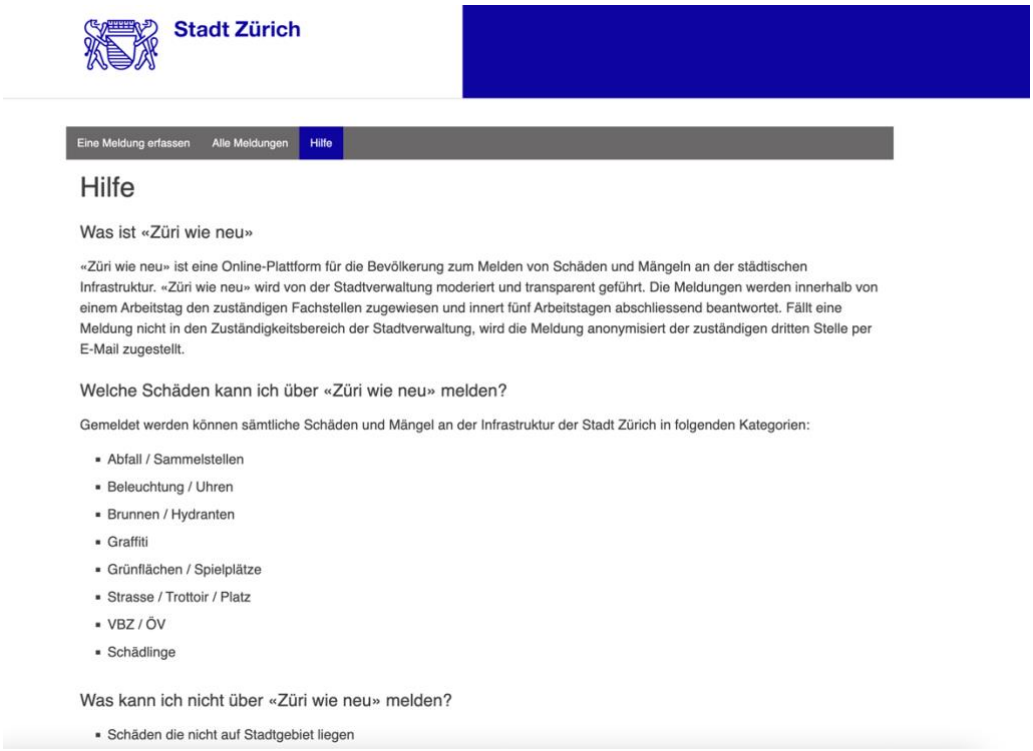


Figure 5: The help page, providing information on the platform.

bit unclear as it has no real function. Most probably the idea of this page in-between is to show users other reports near the entered or GPS tracked address to ensure that the same issue is not reported twice. Another confusing element is that this page looks almost identical to the “Alle Meldungen” page visible in Figure 13 only differing due to the lack of the blue “Schaden lokalisieren” button. After clicking on the map or the “Schaden lokalisieren” the user enters the actual report entry menu. The report menu is clearly structured although the window is, again, similarly designed as the “Alle Meldungen” page with all the info to the left and the map to the right. The map window allows users to refine the geolocation by moving the marker via drag and drop. The info on the left of the page is the report entry field with several consecutive data entry steps and a text body in green and red indicating does and don’ts. The page allows to enter a description of the damage. The categories that can be entered when reporting damages are limited to 10 categories such as Allgemein, Abfall/Sammelstellen, Beleuchtung/Uhren, Brunnen/Hydranten, Graffiti, Grünflächen/Spielplätze, Schädlinge, Signalisation/Lichtsignal, Strasse/Trottoir/Platz, VBZ/ÖV. The whole report procedure is illustrated in Figure 7: Report procedure web version.

Figure 7: Report procedure web version.

4.1.1.1.3. Maps

The map is a prominent feature and has several functions: locating ones report precisely, looking at other reports in similar areas or areas of interest. The location marker indicates the status of a report meaning whether a report has been fixed, is in process or untreated. Within the "Alle Meldungen" page the map allows to navigate all the reports ever made. When

selecting a specific location marker, it gets slightly bigger and information on the report is depicted to the left. The map also allows users to choose different visualizations either satellite or the standard road map of the city of Zurich. Both maps have a high resolution and are zoomable via trackpad or +/- buttons on the top right corner.

The map is also used to issue a report and allows users to geolocate the damage (already described in section Pages). A neat function is that after entering an address on the starting page the extent of the map is already zoomed into the respective address. This makes it easy to check whether a similar report has already been issued, whether the entered address really located the damage and if need be, to adjust the location of the marker by drag and drop.

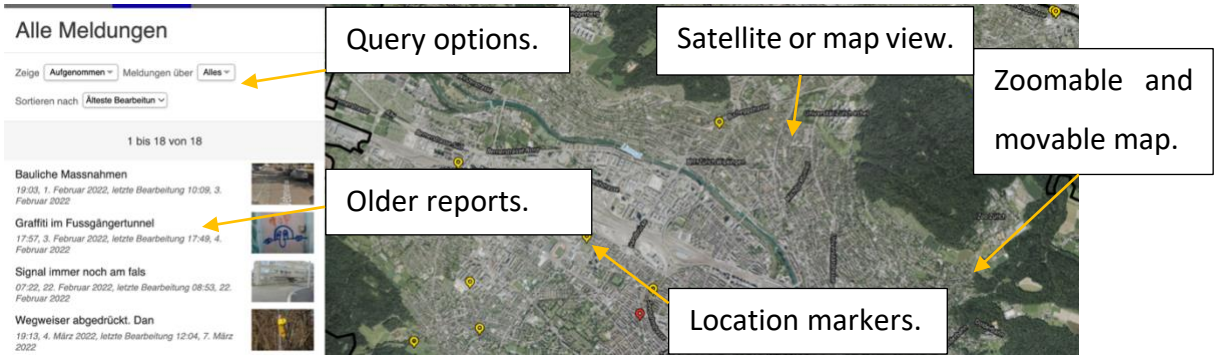


Figure 8: Example for the prominence of the map, web version.

4.1.1.1.4. Compulsory fields and requests

The only compulsory fields appear when making a report and users must enter a phone number, e-mail address, the address of the report, check if the location marker on the map is at the correct location, upload a photo as well as a description of the damage and further need to classify the report into one of 10 categories where it is only possible to choose one at a time. A username on the other hand is optional.

Regarding requests, ZWN does not pose any but if the GPS tracking is not enabled for the browser the automatic tracking does not work and an address needs to be entered manually.

4.1.1.2. Textual content

The tone of the platform is formal and pragmatic without special formulations or adjectives indicating feelings. Text in general is seldomly present and is often used to guide the user, explain procedures, and indicate do's and don'ts. Further the text is often presented in bullet points making it easy to read and understand. The only page with more text is the "Hilfe" page which is presented in a question and answer style again mostly explaining how the platform works namely that a responsible department finishes a report within 5 days. Further, the "Hilfe" page indicates what can be submitted and includes minimal background information on the platform by indicating a contact person and the original developer of the website mySociety.

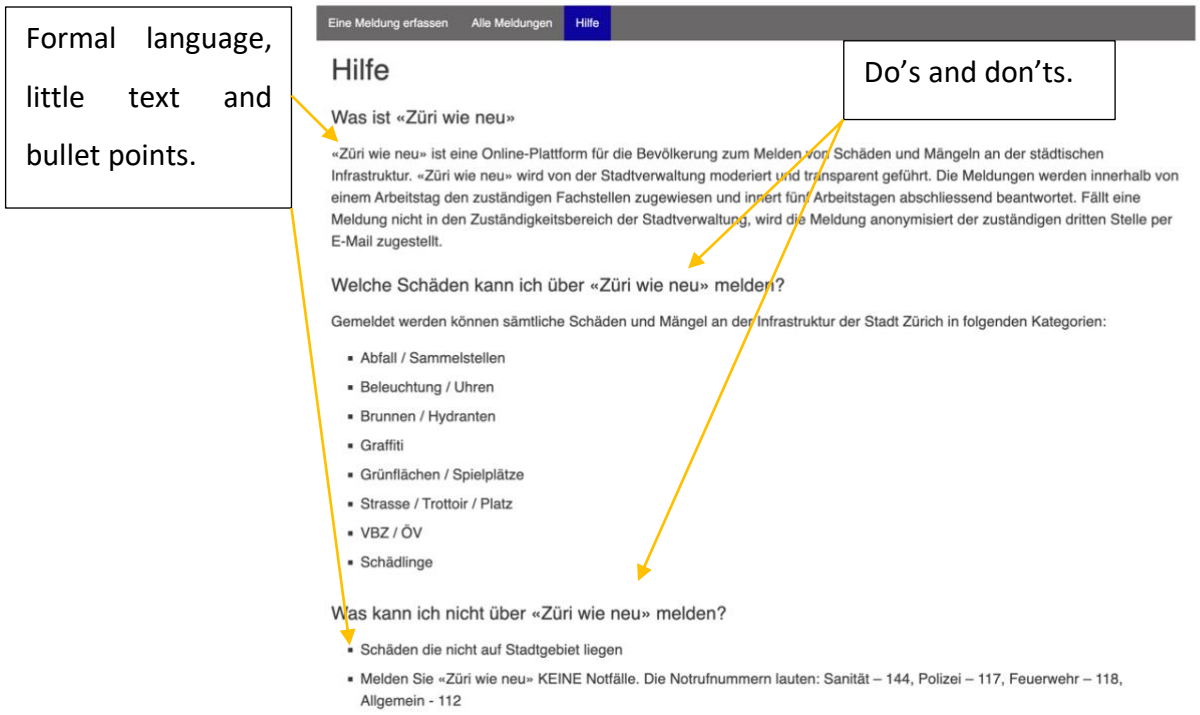


Figure 9: Example of the textual tone on ZWN.

4.1.1.3. User interface arrangement

The user interface arrangement revolves around four main goals namely the geolocation, ad hoc and spontaneous use, ease of use by a focus on functionality.

That the geolocation is of vital importance is visible in the centred position of the address entry field and the map being even the background of the starting page and else being always in the focus of the pages. The geolocating is facilitated by the omnipresence of the map which makes geolocation a visual thus easy to perform task. The possibility to use the map to

geolocate a report makes it superfluous to search for the exact address as users can identify their location based on features of the street or buildings where the damage is situated. Further, ZWN is designed to be used ad hoc and spontaneously. This is visible in the fact that the geolocation can be automated, that the map enables a quick adjustment of the position in a graphic and tangible way and that photos of the damage are highly encouraged making tedious descriptions less important. Reporting an issue takes up very little time and is instantly accessible.

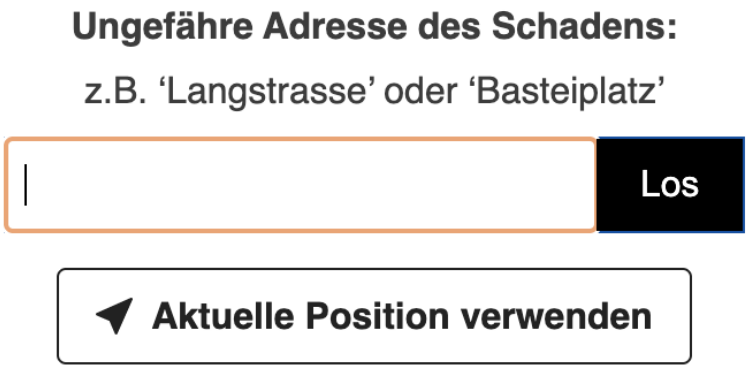


Figure 10: Example for the geolocation via address or automated geolocation, enabling a spontaneous use of Züri wie neu.

The ease of use appears to be important. ZWN is set up minimalistic, the focus lies on the entry field and the immediate begin suggested by the big and blacked out 'Los' button visible in Figure 10. The automatic GPS tracking is in immediate focus of the starting page enabling users to easily geolocate their report which is a key step in filing a report. The other two eye catching elements are numbered descriptions on how the tool works and two count measures - namely the count of the reports in the last week and the completed reports within the last month. On the right are examples of recently reported damages visible in the topmost screenshot of Figure 7. The descriptions, the count measures and the recently reported damages can be seen as encouraging users to contribute because the affordances are clearly described and simultaneously examples are delivered. Lastly, text bodies are minimal and most of the text bodies describe the affordances and the procedure to report thus making it even easier to get a report done.

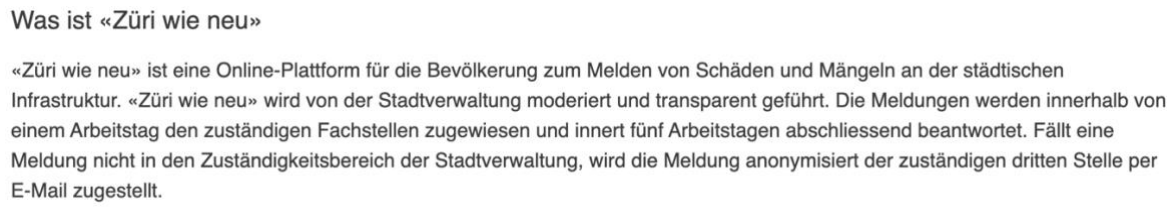
The design choice of all the buttons, the entry fields and the maps are basic and do not try to impress users but rather focus on mere functionality. This is visible in the minimalistic colouring, simple use of shapes and the simplicity of the maps as well. Although the guidance through the menus is slightly confusing the affordances to issue a report are little and the purpose of the website is clear. The simplistic design supports the ease of use by focusing on functionality over design.

4.1.2. Environment of expected use

4.1.2.1. Vision

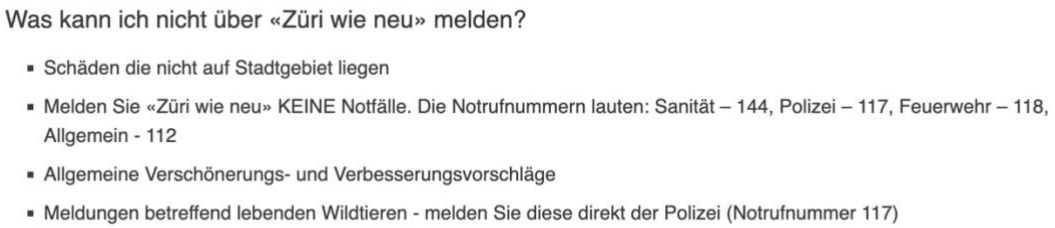
4.1.2.1.1. Purpose

The purpose of ZWN is straightforward: enable reporting infrastructure damages to the city administration of 9 service departments. By doing so, ZWN enables people to voice things about broken infrastructure they are bothered by. The purpose can further be derived by what ZWN is not about which is clearly stated on the “Hilfe” page: Improvements or beautifications are not welcome, ZWN is about fixing and maintaining existing infrastructure.


Was ist «Züri wie neu»

«Züri wie neu» ist eine Online-Plattform für die Bevölkerung zum Melden von Schäden und Mängeln an der städtischen Infrastruktur. «Züri wie neu» wird von der Stadtverwaltung moderiert und transparent geführt. Die Meldungen werden innerhalb von einem Arbeitstag den zuständigen Fachstellen zugewiesen und innert fünf Arbeitstagen abschliessend beantwortet. Fällt eine Meldung nicht in den Zuständigkeitsbereich der Stadtverwaltung, wird die Meldung anonymisiert der zuständigen dritten Stelle per E-Mail zugestellt.

Figure 11: Explanation of the purpose on the "Hilfe" page.


Was kann ich nicht über «Züri wie neu» melden?

- Schäden die nicht auf Stadtgebiet liegen
- Melden Sie «Züri wie neu» KEINE Notfälle. Die Notrufnummern lauten: Sanität – 144, Polizei – 117, Feuerwehr – 118, Allgemein - 112
- Allgemeine Verschönerungs- und Verbesserungsvorschläge
- Meldungen betreffend lebenden Wildtieren - melden Sie diese direkt der Polizei (Notrufnummer 117)

Figure 12: What can be reported on ZWN.

4.1.2.1.2. Target user base

The target user base is not clearly defined. On ZWN the target user base is characterized as population but is not further specified. As reports can only be made for the extent of Zurich the website is addressing people located in Zurich encompassing all people living in, working,

or visiting Zurich. There are no further restrictions to use the platform except for the basic needs to enter an email address, phone number and having access to the internet.

4.1.2.1.3. Scenarios of use

The scenarios of use are partially touched upon in the section User interface arrangement and revolves around the ad hoc and spontaneous use. ZWN is clearly designed to be used on the way an in the very moment a damage has been encountered. The whole report process offers an immediate possibility to file a report. The web version, when used on a computer, is probably thought to be used at home requiring thinking ahead, taking the photo and noting the address or keeping the location in mind. Therefore, the scenario of use can be distinguished between ad hoc, spontaneous and at the computer at home.

4.1.2.1.4. Symbolic representation

The colours are minimal, mainly white, black, grey but also blue. Blue and white representing the colours of the city of Zurich establishing a close relationship to the latter via the colours. The logo of the city of Zurich is also prominent on all pages of the website and the app. Maps are always around and are thus important features of the app highlighting the geographic importance of issuing a report. In general, there are limited number of symbols and styles and if they occur symbols and style are rather basic. The styling of the app appears simple, neutral, and practically oriented leading to a website and an app less about appearance and more about functionality. An example is delivered by the ‘Alle Meldungen’ page visible in Figure 13 from the web version where the map is the most prominent feature, including limited features to enable navigation, the logo of the city and else only the brief overview over the latest reports.

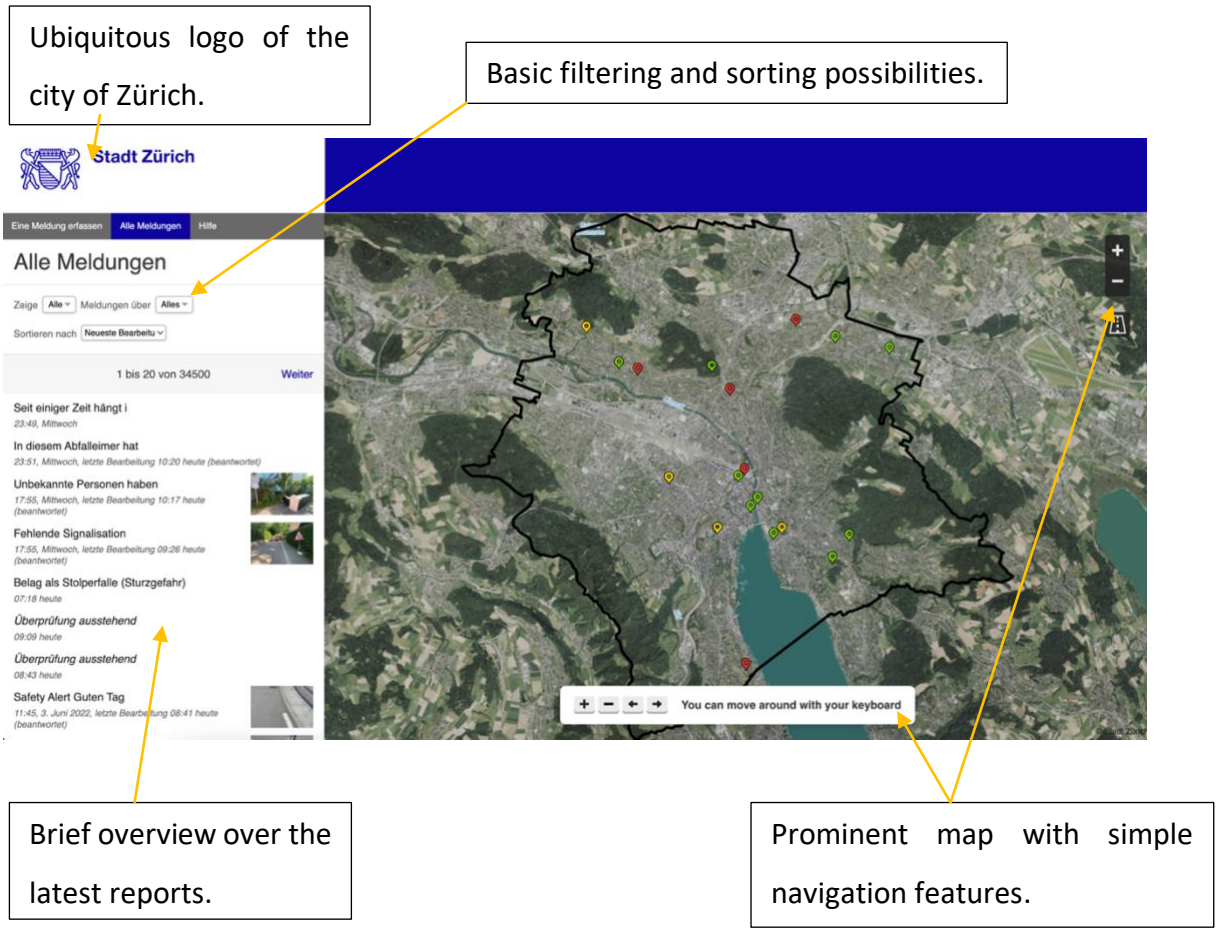


Figure 13: "Alle Meldungen" page used to illustrate the symbolic representation.

4.1.2.2. Operating model

4.1.2.2.1. Revenue generation

By using the app, users provide information about city infrastructure meaning that the users do infrastructure assessment which is a duty of the city apparatus. The workload needed for checking the city infrastructure on that scale with such regularity costs a lot of workforce and thus money. One could argue that users generate revenue for the city in the sense that they help in assessing the state of the infrastructure. Else there is no direct revenue for the city through this platform.

4.1.2.2.2. Business strategy

The platform is part of eZurich by the canton originally initiated by the city of Zurich, trying to foster more cooperation between various actors involved in the use and production of ICTs. Overall, ZWN can be seen as a measurement to augment the attractiveness of the IT location

Zurich by highlighting competences and youth development (see Kanton Zürich, 2022 under "Bereits realisierte Projekte: Züri wie neu"). The tool was further part of the initiative “smart city Zürich”, referring to it as a tool to augment an active citizen participation (Stadt Zürich, 2022)

On the platform itself, ZWN is advertised as a tool specifically for citizens enabling them to notify the city about defects and damages. Financially the app is backed up by the government, but the development was done by an external developer.

4.1.2.3. Governance

The governance at first hand is characterized by the fact that no regulations are in place except for the need of an email address and a telephone which are required to report. On the other hand, the “rules” of writing a report are indicated twice: on the help page in detail and when entering a report on the right between map and report entry infrastructure. The rules are detailed and include the following bullet points translated to English:

- Users should make as clear descriptions as possible
- No suggestions or improvement wishes
- Only one damage per report
- Avoid submitting pictures indicating personal information of others
- No emergencies

The procedure on how to file a report are indicated three times: on the front page, the help page and when entering a report. The procedure is presented as a numbered sequence. Compared to the little text overall, rules and guidelines make up a big part of the text bodies. Summing up, the governance of the platform is focused on enabling an easy and understandable access to issue a report by clarifying the procedure on almost every page. At the same time the rules described twice indicate that the governance model tries to make very clear how a correct report looks like. Further a correct report in the sense of the platform follows a rather narrow definition, suggestions for improvement or creative inputs are clearly not welcome and only broken or misplaced things are to be reported, emergencies should be directed to the police. All in all, the governance model indicates that the platform is a tool to maintain momentary order and opinions as well as wishes are not welcomed.

4.2. Semi-structured interviews

The following results for the semi-structured interviews are presented in seven topics exemplified with citations from the interviews. The results encompass the strategic integration of ZWN, the depoliticization of the platform by the administration and the one-sided nature of the communication through ZWN. Further they show how working bodies from the administration see accountability through ZWN and how the city of Zurich wants to speak through the platform with one voice as 'the city'. The results further discuss how efficient the administration perceives the interaction via ZWN and in how far ZWN helps to improve the infrastructure service provision in Zurich.

4.2.1. Strategy

ZWN is barely integrated into any overarching strategy on the interaction between administration and users. The management and planning of the platform and thus also its interaction with the users is limited to the project team consisting of GeoZ as the leading unit. The project team consists of employees from the different service departments involved in managing user report as well as people from communications giving advice on communication strategies. Decisions and discussions are normally communicated or elaborated in annual training sessions but are neither discussed or planned at higher political levels nor involved in political decision-making processes. One interviewee formulates that a strategy does not exist, the meetings are there to discuss issues and questions once a year if something comes up. *"Eine Strategie in dem Sinn wäre mir nicht bekannt, dass es das gibt. Was allerdings gemacht wird, sind regelmässige Erfahrungsaustausch Erfa-Sitzungen nennen wir das. Ich weiss gar nicht... die sind, glaube ich, jährlich. (...) Ja es [ZWN] läuft wirklich einfach so nebenbei oder ja diese Erfa-Gruppe diese gibt es, oder, dann, wenn jemand etwas hat."* (20220624_Interview_A6, Pos. 62).

While there is no clear strategy on how to proceed with ZWN, the most common assessment of the interaction between administration and users of ZWN was positive. It is based on a quantitative measure, the constant number of people using ZWN and the steady flow of new users joining ZWN. The number of reports per week is also the only statistic displayed on the platform itself as discussed in the section Pages under Technical walkthrough. An interviewee formulates it as follows: *"Ja, wir selber haben schon intern manchmal gewisse Analysen*

*machen wir einmal pro Jahr, für das interne CAB, bei der wir ein bisschen Sachen anschauen auch wie viele neue User äh meldende Personen haben wir oder wie viel kommen regelmässig darauf. Aber mehr machen wir jeweils nicht." (*20220602_Transkript_A3, pos. 220). The interaction between the administration and its users is judged on a quantitative level. It is irrespective of other criteria forming the interaction and let alone formulating a perspective to shape the interaction in the future. In the context of the quantitative judgment of the interaction via ZWN the usage of the data from ZWN is paradigmatic. One answer of an interviewee succinctly describes the problem by explaining that although the service department GeoZ is responsible for the data of ZWN, they only prepare the data for the city. What the data is ultimately being used for afterwards, they do not know. An interviewee formulates: *"Das wissen wir nicht wirklich, wie die Leute das [die Daten] brauchen oder das ist jeweils ein bisschen unser Problem (...)" (*20220602_Transkript_A3, Pos. 32). Nevertheless, some interviewees formulated perspectives for the future saying that the current design of ZWN does not allow a dialog. Opening up the platform towards more dialog could be possible but it is questionable if ZWN is the right vessel for this. (see 20220516_Interview_Transkript_A1, pos. 140).

4.2.2. Depoliticization

The platform ZWN serves to depoliticize the interactions with users which is said to ground on the one hand on a structural necessity of Zurich's political system but on the other hand on the understanding of certain people from the administration that users are not interested in a more open, potentially political dialog.

The structural necessity urges the administration to depoliticize the interaction via ZWN since the administration can only pursue purely operational goals and cannot handle reports that would have to be part of a political process. In the words of one interviewee: *"Wir haben es 'learn it the hard way' oder würde ich mal sagen, A4 könnte über das jetzt natürlich noch mehr erzählen. Bei ihnen in der Dienstabteilung sind dann diese Sachen hineingekommen. Diese Vorschläge oder, gopf wieso kann ich da nicht rechts abbiegen an den Rotlichtern zum Beispiel. (…) . Ja aber dann ist A4 irgendwie da gesessen und hat gesagt, ich kann nichts machen, das ist falsch bei mir, das muss in einen politischen Prozess, den ich hier nicht leisten kann oder." (*20220624_Interview_A6: 210).

The formulation shows how the administration is rapidly unable to act, since a political process would be necessary for answering certain inquiries satisfyingly. The obstacles to initiating a political process are considerable for the administration as the political system of the city of Zurich in which ZWN is embedded is divided into operational and political functions. To start a political process people from the administration would need to hand the issue to the parliament via a certain political party. These systemic obstacles are described by one interviewee as follows: "*Unser politisches System sagt ja wenn du etwas ändern willst, dann musst du... Also kann es angestossen werden von der Verwaltung oder es kann angestossen werden vom Parlament oder durch eine Einzelinitiative, wie auch immer. Aber es muss in den parlamentarischen Betrieb eingespiesen werden. Und das ist natürlich wirklich nicht unsere Aufgabe. Ich meine, wir sind nicht einmal dazu befugt, da irgendwie Sachen zu sammeln und/oder wir müssen so wie einer Partei dann geben und sagen, wenn euch das interessiert, könnt ihr daraus ein Postulat machen oder. Ja das wäre der Weg, oder also. Ich habe auch schon Leuten, die mir geschrieben haben, einfach gesagt: schauen sie ich sehe was sie möchten, sie können das aber nicht bei mir deponieren, sondern das muss auf den parlamentarischen Weg, also suchen sie sich ihre Gemeinderatsvertretung des Vertrauens und speisen sie es so ein. Geht nicht anders." (*20220624_Interview_A6: 218). The depoliticization of the platform is thus firmly linked to the political system and context in which ZWN is embedded. Since the administration must pursue operative goals, it does not seem profitable to conduct political discussions on ZWN. Discussions with political potential cause unnecessary additional effort.

On the other hand, depoliticization is legitimized by the conviction that many users reporting issues reveal a certain irrelevance towards their own reports and are not interested in a political dialogue in the first place. This irrelevance is characterized by the fact that users simply want to make a report and then they are said to be no longer interested. The mere act of reporting is described as sufficient for the reporters as this citation highlights: "*Sie haben das einmal erhoben und dort ist glaube ich eben herausgekommen, dass sie eigentlich froh sind, wenn sie es melden können und mehr wollen sie einfach dann nicht mehr wissen. Es ist einfach, ich habe es jetzt gemacht, guet tschüss und machs guet." (*20220520_Interviewtranskript_A2, Pos. 304). The platform thus becomes more a tool for pacification of the users and does not involve the population. Thus the platform is not merely

about the interaction with users, but primarily about creating a vessel through which people can simply offload things that concern them.

At this point, an ambivalent perception of the users by the administration is revealed: on the one hand people are characterized as being irrelevant to their report, and on the other hand, people are described as overzealous and overly willing to engage in dialogues as visible in the following interview passage: *"Es hat Nörgler, die einfach eben... Ich weiss nicht wie ich Ihnen das sagen sollen. Nie zufrieden sind. Egal was man sagt, wie man es sagt, wie man es macht. Die wollen einfach diskutieren. Und das ist per se ja nichts schlechtes, aber es ist einfach die falsche Plattform." (*20220520_Interviewtranskript_A2, Pos. 64). The people that overzealously engage in dialogues are characterized as rather annoying and using the wrong platform representing the opposite group to the helpful users. This is accompanied by the fact that the latter clearly represents the desired and legitimate target group of the city through ZWN.

4.2.3. One-sided communication

The communication via ZWN is said to be deliberately designed in a one-sided way meaning there is one report and one corresponding answer and then the procedure is considered complete. The design of the original platform would permit a dialog, but it was decided to omit this feature as one interviewee formulates: *"Oder also prinzipiell würde die Plattform auch einen Dialog zu lassen (...) Das lassen wir nicht zu, machen wir nicht. Also dort haben wir schon eine, eine Einschränkung. Das ist quasi wie einmal hin einmal zurück Kommunikation und fertig."* (20220602_Transkript_A3, pos. 164). The reasoning offered by interviewees for the one-sided communication is two folded. Firstly, it is said that the one-sided communication is sufficient for the normal user and secondly that ZWN is a so called 'quick and dirty' not a dialog platform. The argument that the user is satisfied with a one-sided communication is already touched upon in the section Depoliticization where the mere act of reporting is described as satisfactory for most users. According to the administration, users do not necessarily want to write back and forth as one interviewee utters exemplarily: "*Man ist davon ausgegangen, dass die Leute hauptsächlich eine Meldung absetzen wollen und das mitteilen wollen und das hat sich dann auch bei der Evaluationen eben nach einem Jahr, als wir die Leute befragt haben, hat sich das bestätigt, dass das den Leuten eigentlich im Normalfall reicht, dass man nicht hin und her mailen muss." (*20220602_Transkript_A3, pos.

168). The citation further points towards the evaluation of Stürmer and Kölliker (2016) confirming that users do not want to write back and forth.

The second reasoning based on the perspective on ZWN as a 'quick and dirty' platform is undermined by the understanding that a dialog platform requires more moderation and thus more work. Implementing more dialog possibilities is considered being connected with an increased need to moderate the platform thus leading to an increased workload: *"Und umgekehrt die Dialogsysteme, diese sind natürlich noch aufwendiger in der Moderation. Das muss man schon sehen." (*20220516_Interview_Transkript_A1, pos. 140). The citation above highlights the need of increased workload to moderate a platform offering dialog. Several interviewees utter that the reporting via ZWN should work quickly and easily and in essence the platform has to fulfil a 'quick and dirty' way to issue a report but also to manage user requests (see 20220601_Transkript_A4, pos. 34 and 20220602_Transkript_A3, pos 212).

4.2.4. Accountability

The platform ZWN is said to ensure accountability through the open visibility of all reports and their respective answers. Due to the public visibility of all the reports and all the responses one interviewee argues that the platform can ensure that the administration is held accountable for their performance as everyone can trace what happened to a report. *"Das ist auf einer Plattform, ein Problem, für alle einsichtbar und das geht dann vielleicht schon ein bisschen an den Berufsstolz von unseren Mitarbeitern und ist einem bewusst hoppala da sehen die Leute, was man gut macht, oder eben, dass man das Problem löst. Ich glaube, da ist schon ein Bewusstsein geschärft worden, was das heisst in der Verwaltung zu arbeiten und, dass man letztlich im Dienste aller, im Dienste der Bevölkerung angestellt ist. Also dass man da sicher mehr machen muss wie früher, als einfach ein Brief geschrieben haben und der dann per Zufall nicht angekommen ist, wenn er unliebsam war, oder im Schredder gelandet ist. Das ist natürlich schon ein hoher Druck, der sicher auch ein Gegendruck in Form von einer Handlung auslöst."* (20220601_Transkript_A4: 138).

On the other hand, the administration is cautious with providing too much information and thus meets certain reports with standardized and template-like responses. The standardization of the responses is said to serve the purpose to hide details and thus protect the city from stirring up wrong expectations. One interviewee formulates it that way: *"Das ist von Anfang an Diskussion gewesen und dann hat man sich geeinigt, ... dass man inhaltsmässig*

ungefähr die gleichen Antworten geben wird ... Aber so Grosso Modo, diese Vorlagen, die wir haben, wahrscheinlich 8 von 10 entsprechen den gleichen von den anderen Dienstabteilungen. So haben wir das jetzt eigentlich recht gut handeln können, dass einfach keine falschen Erwartungen geschürt werden, auch wirklich wir nicht Sachen in den Raum stellen, wo nachher eben einer findet ja ich habe da bei Züri wie neu gelesen, die haben gesagt, die machen ein Projekt oder so und nachher gehört dass der der und der und dann haben wir plötzlich irgendeine politische Anfrage im Haus wegen einer Antwort, welche wir jetzt vielleicht verkehrt formuliert haben oder und wir haben noch gar nichts. Wir haben vielleicht im Gang draussen von einem Projekt geschwätzt oder passiert ist aber noch nichts." (20220520_Interviewtranskript_A2, Pos. 56). The interaction between the administration and the users is maintained in a way that limits accountability although simultaneously some interviewees see accountability as an important part of the platform which is ensured by public visibility.

4.2.5. Speaking with one voice

Whereas the standardized response text serves the purpose to somehow protect the city from fomenting false expectations they further serve the purpose to interact with users as a unified voice namely as the city of Zurich. To achieve a unified response scheme not only template answers as mentioned in the section Accountability but also text blocks are saved in ZWN that can be copied into a response text. The text blocks are used for the greeting part at the end of the answers in the form of 'Freundliche Grüsse Ihre Stadt Zürich' or the welcoming statement 'Besten Dank für Ihre Meldung auf "Züri wie neu"'. The reasoning for speaking as one voice is rather vague. One interviewee said the communications unit decided it is not important which service department answers a report but to speak as the city of Zurich almost like a 'brand': *"Ob das intern jetzt VBZ oder die Wasserversorgung oder so ist, haben wir als nicht wichtig befunden, weil offensichtlich auch die Kommunikationstellen gefunden haben hey, das ist die Stadt Zürich, die euch diese Dienstleistung bietet und nicht das Tiefbauamt. Ja, das war einfach eine Entscheidung auch von oben herunter wo gesagt hat, das ist die Stadt Zürich. Als Brand quasi oder." (*20220602_Transkript_A3, pos. 188). As the citation shows, the decision to appear as the city of Zurich and not as the responsible service departments individually is further said to be made in a top-down manner and was simply decided.

Thoughts and decisions about the interaction mediated by ZWN that came up during the interviews were often about delegating work via ZWN making the interaction with users more efficient. ZWN is said to make the delegation of incoming requests much easier compared to communication via e-mail, telephone or letters as the ZWN enables to send the complete report to other e-mail addresses with only a few clicks. This means there is no need to copy-paste information or to attach the image of the report as this is all sent at once.

Nevertheless, the organization around ZWN is not harmonized in total as some administrative units are not part of the platform requiring officials working with ZWN to delegate reports manually outside of the platform. If a service department is not involved in ZWN, the delegation of the report is a classic copy-paste job, and the reported issue is delegated via mail (see 20220516_Interview_Transkript_A1, pos. 84). Additionally, the working bodies from the administration still must know which department or person from the city is responsible for the reported issue which is described as a difficult task requiring some time. One interviewee formulated both the issue of external service departments and the difficulty to determine responsibilities neatly: *"... wenn man intern noch suchen muss, wo ist es überhaupt zu platzieren, weil auf Züri wie neu kommt dann ein EWZ-Schachdeckel hinein, wo ich nicht genau weiss in welchem Gebiet wer zuständig ist, dann muss ich dort die Verantwortlichkeit abfragen und dann das so weiterleiten. Weil diese dann auch kein Login haben, muss ich dann noch ein Snip [Screenshot] machen oder einfach irgendwie ihm zu stellen um was es genau geht, wo und so weiter. Weil sonst bekommt er nur den Text und, wenn es hat, ein Bild ... Eben ohne Admin einfach auf dem Link von Züri wie neu, dann hat er zu wenig Angaben und kann nichts damit anfangen." (*20220603_Transkript_A5, pos. 132). The two above mentioned issues in the citation by the interviewee are said to make ZWN as time intensive as conventional communication technologies.

The same ambivalence towards the efficiency of the platform is visible in voices from interviewees about the geolocation feature of ZWN. Whereas the geolocation makes the interaction clearer and faster by knowing where a reported issue is situated, it depends on the accuracy with which it is delivered by the user. All interviewees see the geolocation as a benefit compared to conventional communication media saying that the geolocation helps to identify the reported problem and can make the interaction clearer and thus allowing a quicker response (see 20220601_Transkript_A4, pos. 70). Exemplarily for voices from the

interviews that criticize the lacking location accuracy stands the following citation: *"Das ist ein bisschen der Nachteil, dass diese nicht eindeutig platziert werden in Züri wie neu, sondern einfach irgendwelche Fotos und die Strassennamen, wenn sie es überhaupt eintragen oder dann während dem laufen, dann sind sie über den Hausecken herumgelaufen, abgesendet und dann ist der Standort völlig nicht mehr dort, wo eigentlich die Lampen nicht funktioniert." (*20220603_Transkript_A5, pos. 60). To mitigate unclear location specifications, city officials either contact the user to clarify the location or compare the location with thematic maps where the reported issue could potentially be located. These procedures relativize the efficiency of the interaction via ZWN as they can take up some time depending on the case.

When asked how long it takes to answer a report, answers from the interviewees differ. Whereas some say it might be slightly quicker than conventional communication media others say it might even take some minutes longer as the subsequent citation highlights: "*Es ist eigentlich genau gleich hoch also ein bisschen mehr ist es, weil sie ja im System drin ein paar Parameter auswählen müssen, also ein akzeptieren, rückmelden auf ausstehend setzen und so weitermachen. Gewisse Klicks müssen sie noch machen. Also von dem her ist es ein Mü, sage ich jetzt mal, wenn sie schnell sind, ist es 2 Minuten mehr Aufwand." (*20220601_Transkript_A4, pos. 66). The extra time needed is explained by platform specific affordances described as 'clicks' whereas the rest of the task is said to be equal to conventional communication media.

4.2.6. Improving service provision

On the question whether ZWN leads to a cleaner or safer city, an interviewee said it can not be measured as there is no index (see 20220516_Interview_Transkript_A1, pos. 114-116). According to a personal estimation of another interviewee ZWN might slightly accelerate the service provision of the city with respect to fixing the infrastructure yet the city regularly checks for infrastructure damage anyways: *"Ich gehe jetzt mal davon aus, dass so in Einzelfällen, dass es halt schneller in Angriff genommen werden kann. (…). Also es ist nicht so, dass man dann gewisse Schäden nicht sehen würde, wir würden sie vielleicht einfach in einem anderen Zeitrahmen sehen oder. Wir sind so aufgestellt, dass man Schäden an der Strasse sowieso regelmässig suchen oder ablaufen gehen muss. Jeder Gebietsmanager, der für 3 Quartiere … zuständig ist, der muss in 3 Jahren sein gesamtes Quartier abgelaufen sein mit einem Belagsexperten … . Man stört sich dann einfach auf einem hohen Niveau, dass jetzt hier*

*eine Delle drin ist. (…). Aber eben sauberer, glaube ich nicht. Einfach einzelne Spots sind schneller vielleicht aufgeräumt oder eben bei uns einmal ein Flick schneller gemacht als üblich. Aber es ist nicht so, dass sie sonst nicht machen würden." (*20220520_Interviewtranskript_A2, Pos. 132). On the one hand the citation makes visible that the city in the case of the service department 'Verkehr' where the interviewed person works, the whole infrastructure of the city is checked by a regional manager within 3 years. ZWN might accelerate certain repairs by detecting a damage a bit faster, but the city handles infrastructure repairs regularly anyways. On the other hand, the administration wants to show users of the platform its function within the city as each department is a provider of services. One interviewee formulates that in the end ZWN also works as a visiting card towards the public. An interview passage highlights the rationale from above exemplarily: "*… und auf die andere Seite quasi als Rückkopplung auch eine Image Pflege. Es geht darum, dass wir auch als Verwaltung wahrgenommen werden, als Dienstleister oder so effektiv, das wir gute Dienstleistungen erbringen, weil das ist ja auch das Ziel.*" *(*20220624_Interview_A6: 110). This passage shows that the administration is interested in providing good services and to display that ZWN enables the administration to combine both provision of services and image care.

4.3. Spatial analysis

The results for the spatial analysis will be structured similarly to the section Spatial analysis in the chapter

Methods. Firstly, the results for the report counts will be outlined for different aggregation levels and the normalized counts, followed by the hotspot analysis and the report status. Afterwards, the results for the zonal statistics of the response times will be inspected as well as the bivariate LISA and the Spearman's rank correlation. Lastly, the findings from the natural language processing will be presented.

4.3.1. Report counts

The report counts were analysed to get an overview over the distribution of the reports and thus a first spatial perspective on the interaction between the city administration and users. The reports were counted for the district aggregation level and for a 200 x 200 grid. The overall report count for the district aggregation level shows highest values in Sihlfeld and

Langstrasse district and higher values in Wipkingen, Unterstrasse, Höngg and Altstetten. Comparing the counts on the two aggregation levels shows that the district level aggregation is prone to the modifiable are unit problem (Openshaw and Taylor, 1981). This is visible for

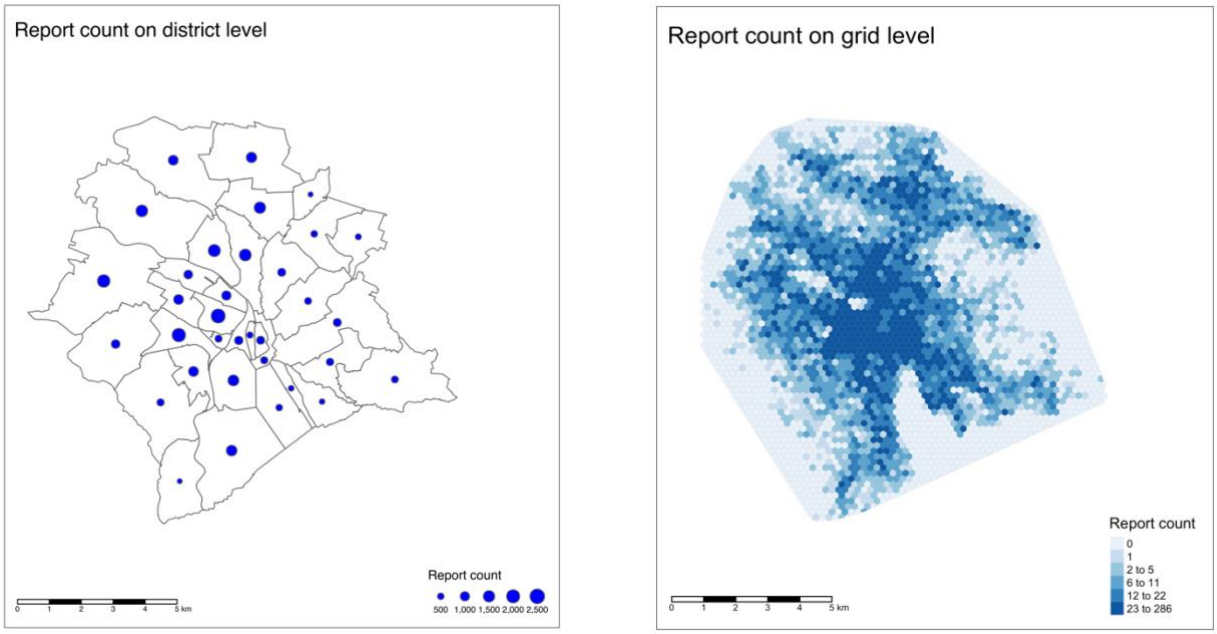


Figure 14: Report count for district (left) and grid level (right).

example in the district of Altstetten that showed rather high overall report counts in the district level aggregation, but no notably high report counts can be found in the grid level aggregation. The high count is simply due to the large area the district spans. On the other hand, the high report count values in Niederdorf are not detectable on the district level aggregation map as the district is one of the smallest in Zurich. Thus, for analysing the spatial distribution of the reports the grid level aggregation is more suitable.

The map with grid level aggregation shows, besides the region around the Langstrasse district, high count values around the districts Wipkingen as well as Unterstrass and the region around the Niederdorf with districts Rathaus and Lindenhof.

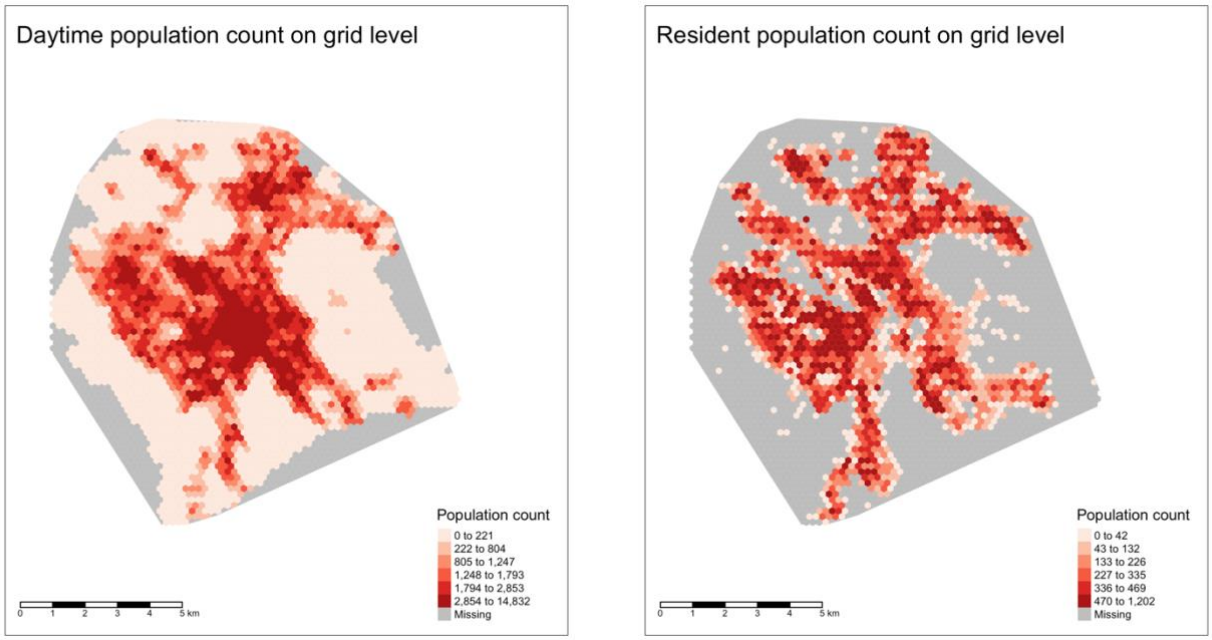


Figure 15: Population counts for daytime (left) and residents (right).

As all three districts are populated districts, higher report counts might simply occur due to potentially more people able to report issues thus report count being an effect of population size. Whereas Wipkingen is more of a living area, region Niederdorf is more frequented by tourists and for leisure and Langstrasse is both living area and highly frequented for leisure. This gets evident in the population data maps in Figure 15 where the left map showing daytime population and the right map the resident population. The difference in population distribution is most evident in the region of the Niederdorf and region around the Bellevue where little people reside but many people go to work or visit for leisure. To better understand the distribution of report counts and minimize effects of population size the counts were normalized with those two population data sets leading to the maps in Figure 15.

The normalized report counts maps must be interpreted with care: areas with high values are not necessarily areas with high report counts. When looking at grid cells with high normalized values individually it gets evident that the high values are only due to very low population numbers within a given grid cell. Those very low numbers most probably do not show an actual effect of the real-life distribution of people but arose due to the timing of the data acquisition in the case of the daytime population and areas where no people are registered

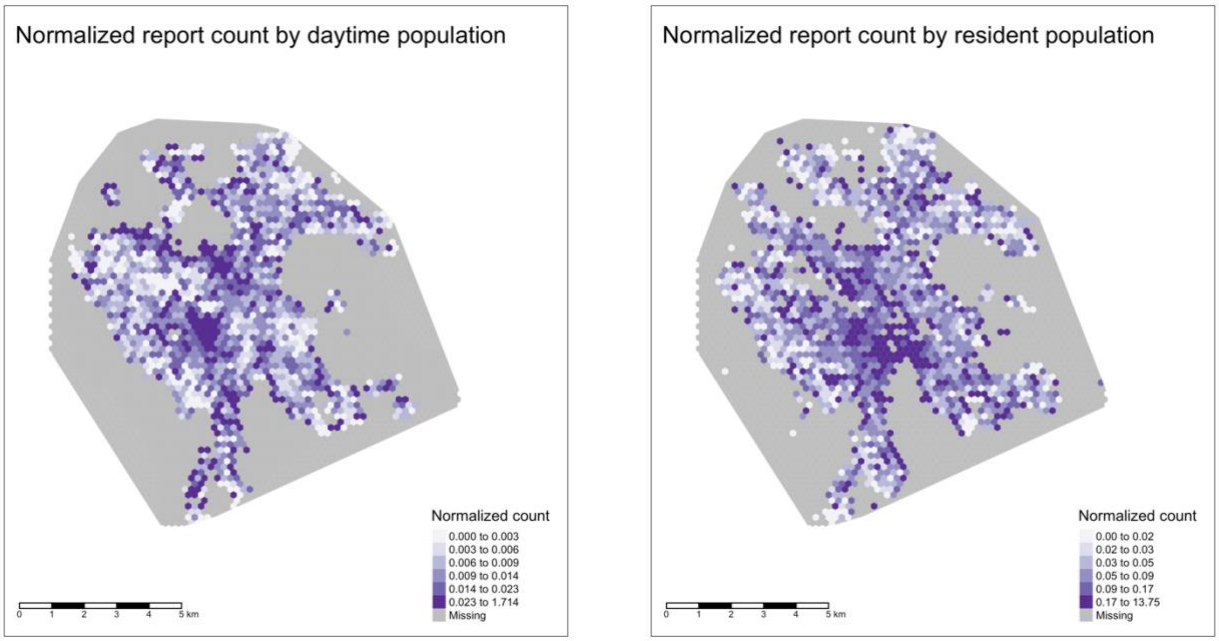


Figure 16: : Normalized report counts with resident (left) and daytime (right) population.

in the case of the resident population best visible in the map to the left in the region between the Bellevue and the Central where simply very little people reside. Besides the few hotspots due to the population data, the normalization maps show a relatively even distribution of values except for a slight accentuation of the area around the Langstrasse district. Most grid cells in the resident population map show values between 0 and 2 with very few with values between 2 and 4. In the daytime population map almost all values lie between 0 and 0.3. The histogram in Figure 17 allows a closer look at the normalization values obtained by normalizing with the daytime population data set. The high value outliers due to low population counts are well visible. Further it is evident that overall, the rest of the normalized values are low and only deviate within 0 and ≈0.3 from each other.

As both the population data of the daytime population and that of the resident population do not depict a precise picture of the distribution of people in Zurich conclusions have to be treated with care. Nevertheless, the results hint that the report distribution of ZWN entries

in Zurich are relatively evenly distributed with no area showing remarkable over- or underrepresentation and the distribution of reports follows the population density of the city.

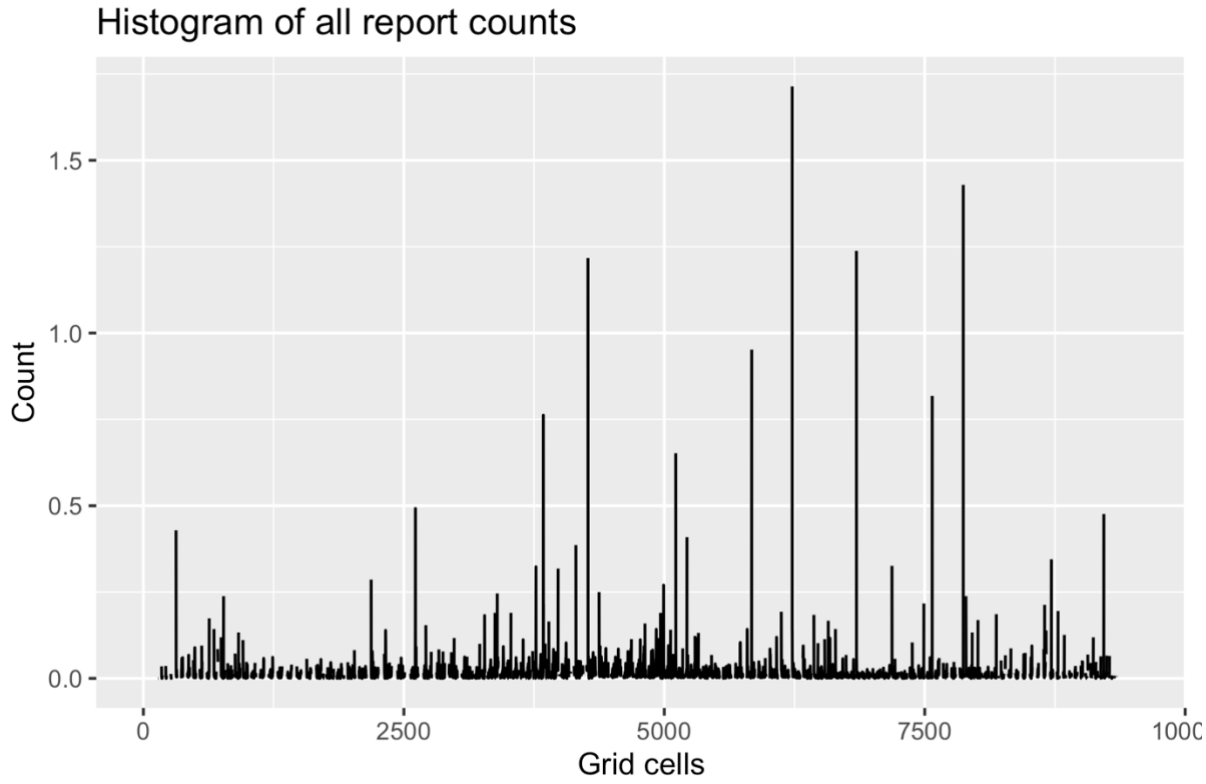


Figure 17: Histogram of all normalized values for daytime population data set.

4.3.2. Hotspot analysis with Getis Ord

The hotspot map in Figure 18 to the left shows clustering mainly around the Langstrasse and Sihlfehld district. Less pronounced hotspots can be found in Wipkingen and around the Bucheggplatz as well as in the region around the Niederdorf. The outer parts of the city show dispersion which comes as no surprise as they are simply less frequented visible in the population count maps in Figure 15.

Manually looking through the report answers by the administration at the main hotspot around the Langstrasse and Sihlfeld districts it gets evident that most answers respond to reports on trash disposed on the street. This also well visible in the hotspot map specifically on trash in Figure 18 to the right. A rather high density of reports related to trash are also found in the other hotspot clusters around the Niederdorf region, in Wipkingen and around the Bucheggplatz. An exemplary answer on reports on trash is the following which can be found in all hotspot areas equally: "*ERZ Entsorgung + Recycling Zürich holt den gemeldeten Abfall bis spätestens am 10. Juni ab. Besten Dank für Ihren Beitrag für ein sauberes Zürich. Freundliche Grüsse Ihre Stadt Zürich.*". The answer to the report is equal for all hotspots and answers and only the date is adjusted from report to report.

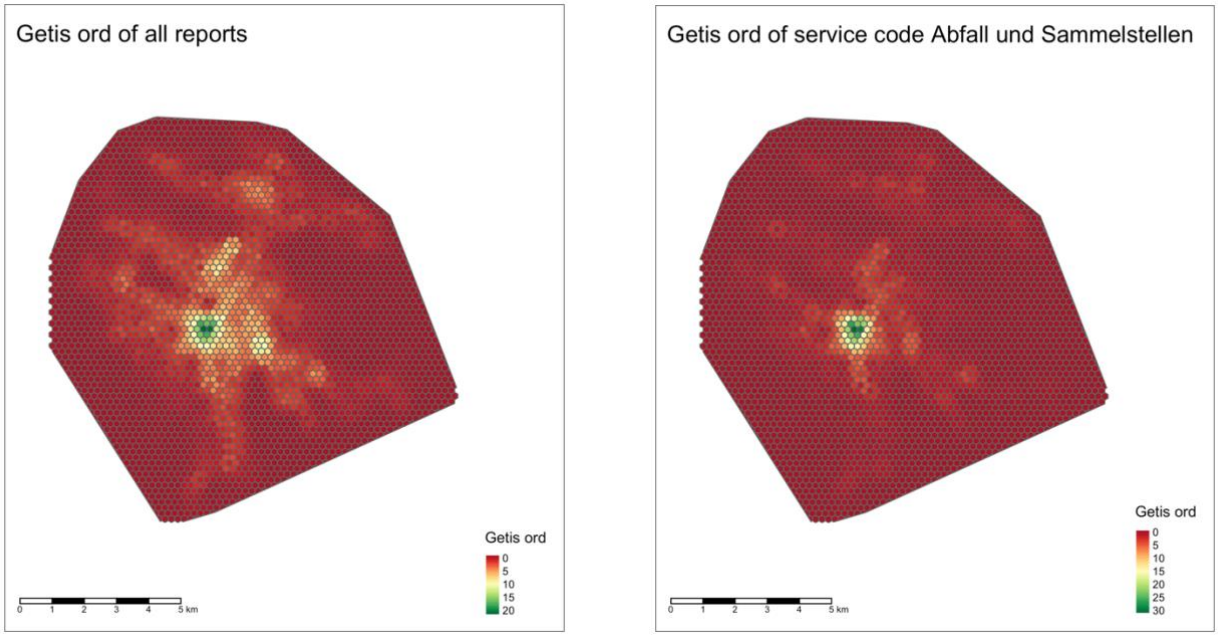


Figure 18: Getis ord of all report (left) and Getis ord of service code 'Abfall und Sammelstellen' (right).

When zooming in on the area of Langstrasse the highest cluster is between Seebahnstrasse and Kernstrasse between Kalkbreite and Bäckeranlage, the points in Figure 19 represent single reports. The clustering around the Kanzlei-, Pflanzschul- and Anwandstrasse are evident. Interesting is the comparison to the Langstrasse where the clustering is less pronounced although this is the most frequented street in that area featuring late night shops, restaurants, bars, and a diverse range of other night life venues. From the difference in report counts between said streets, the interpretation comes to mind that the high number of reports around Kanzlei-, Pflanzschul- and Anwandstrasse are due to residents reporting issues around their home location which they are directly concerned by. It might also be due

to different expectations towards the infrastructure, whereas the Langstrasse can be quite dirty from time to time (most often during night before the cleaning in the morning), the surrounding areas are calmer living areas with less trash. A third explanation could be that the Langstrasse gets cleaned much more regularly, thus the trash is removed before it can be reported.

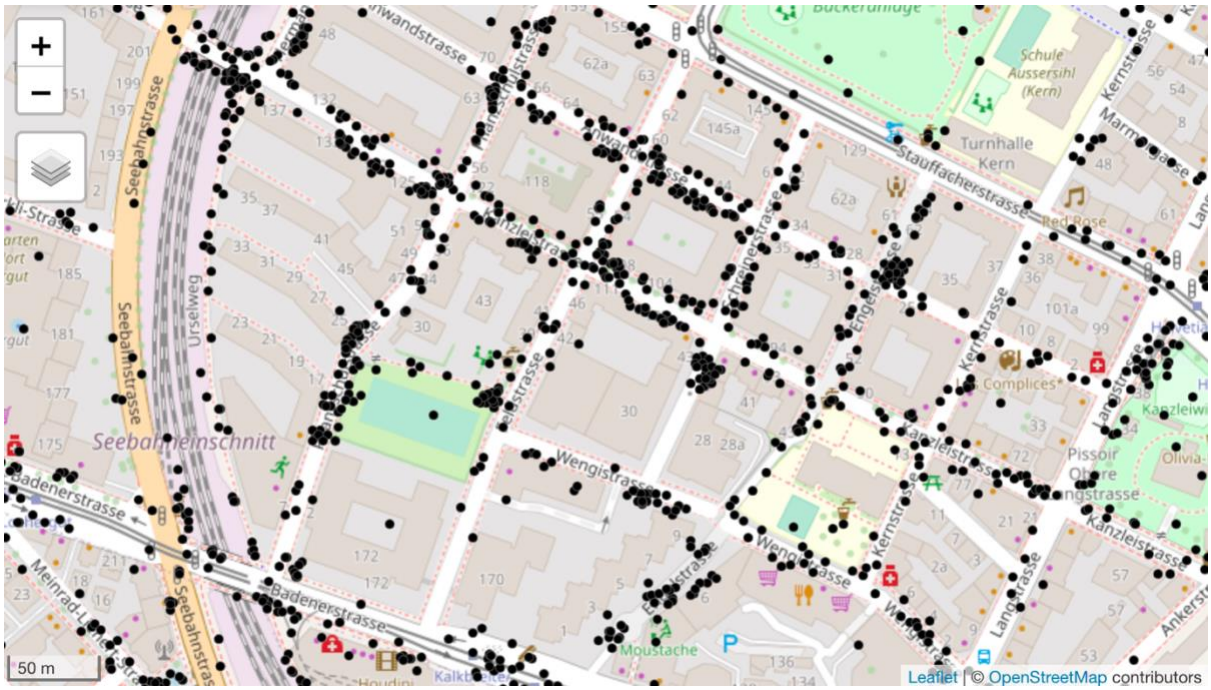


Figure 19: Reports as points in the region Langstrasse

To illustrate those arguments further, it is fruitful to take a step back again and zoom out on district level again. The histogram in Figure 20 shows the report counts on each service code per district. The histogram highlights that depending on the region different service codes are more or less frequently reported. Although this finding sounds trivial, it could show an interesting aspect about the interaction between the administration and users of ZWN.

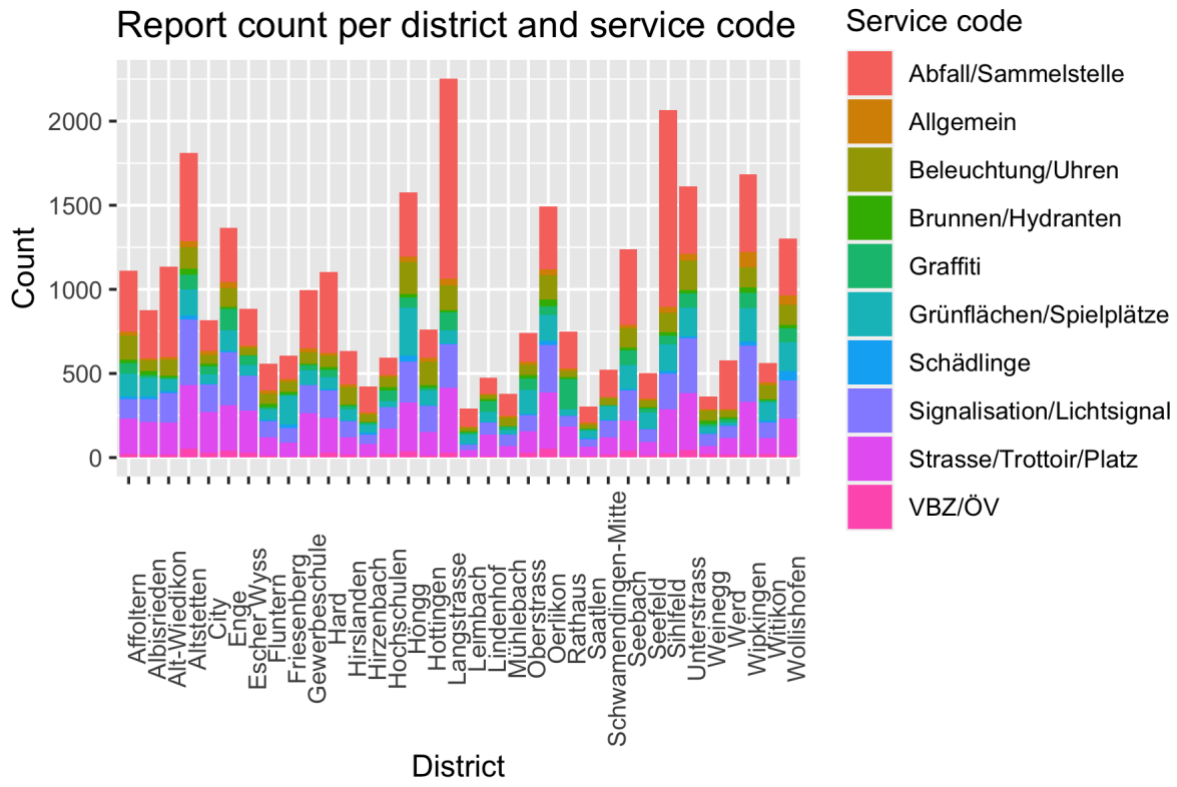


Figure 20: Histogram of report count for district and service code.

The differences between regions can, to some degree, be understood by the underlying fabric of urban space in Zurich already touched upon in the example of the area next to the Langstrasse in Figure 19. It comes as no big surprise that trash reports are most frequent in the region around the busy night life area Langstrasse, it is further not astonishing that reports on greenspaces are most common in the region Unterstrasse, Wipkingen and Höngg where notable forest areas and meadows for recreation are situated. An example for the distribution that can be understood by the underlying fabric of urban space delivers the hotspot map of 'Strasse, Trottoir, Platz' in Figure 21.

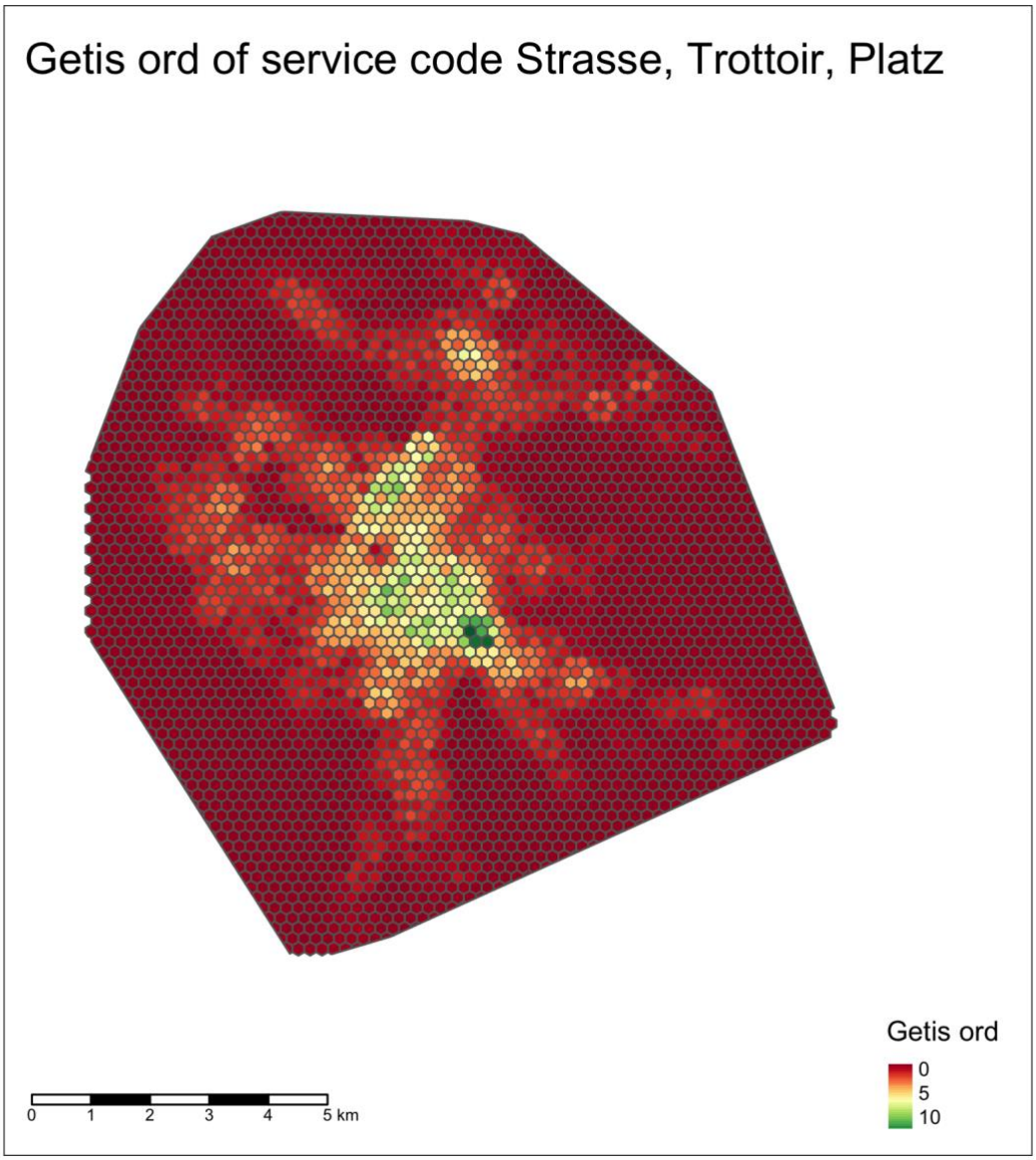


Figure 21: Getis ord of service code 'Strasse, Trottoir, Platz'.

The map shows a concentration of reports in the city center especially along the Hardbrücke and the Niederdorf. For the Hardbrücke, the higher density of reports can be explained by the fact that it is an important traffic route connecting the left and right side of the train tracks and the river Limmat. It is a central traffic route and thus a highly frequented route for cars, bikes and pedestrians alike. The high density of reports in the Niederdorf on the other hand could be explained by very high pedestrian numbers and the small-scaled alignment of streets and places lending itself to dense reporting. The Niederdorf is also the old town where infrastructure such as streets are still made of older materials for example cobblestone which is potentially prone to frequent repair needs.

The difference in report distributions can further be understood by what people expect from urban space. This is best illustrated based on the hotspot map of the category Graffiti. Whereas for living areas low graffiti reports could be explained by less frequent tagging or graffiti spraying, the lower numbers of Graffiti reports around the Langstrasse district cannot be explained by low graffiti spraying or tagging as it is an area with a rather high density of Graffitis. The reasoning could be that residents are used to Graffitis and therefore see it as a normal part of their environment not worth reporting to ZWN. On the other hand, the report density in Niederdorf is high although the area is much less sprayed or tagged then the Langstrasse. The reverse logic applies as before, residents in Niederdorf might experience Graffitis as something unusual and unwanted thus worth reporting. This assessment is only based on personal observation, living and working in the city of Zurich for over a decade, no datasets were found for those topics.

On the other side, the administration of the city seems to treat different regions of the city equally through ZWN. The findings that the reports reflect urban space and what people expect from it to some degree contrasts with the uniform answering of reports. The answer texts are standardized, and template-like for every service code and do not vary over space and are thus independent of local characteristics of urban space and what people expect from it.

4.3.3. Report status

Overall, most of the reports are marked as ‘fixed’ and a lower proportion are reports within the category “external”. The one confirmed report is due to the timing of the data download which was not yet treated by the city thus marked as ‘confirmed’. On the other hand, the low numbers of the report status categories ‘unknown jurisdiction’, ‘not contactable’ or ‘wish’ indicates that either the people use the platform according to the guidelines or the city officials simply classify issues into either ‘fixed’ or ‘external’ without considering other possible categorizations.

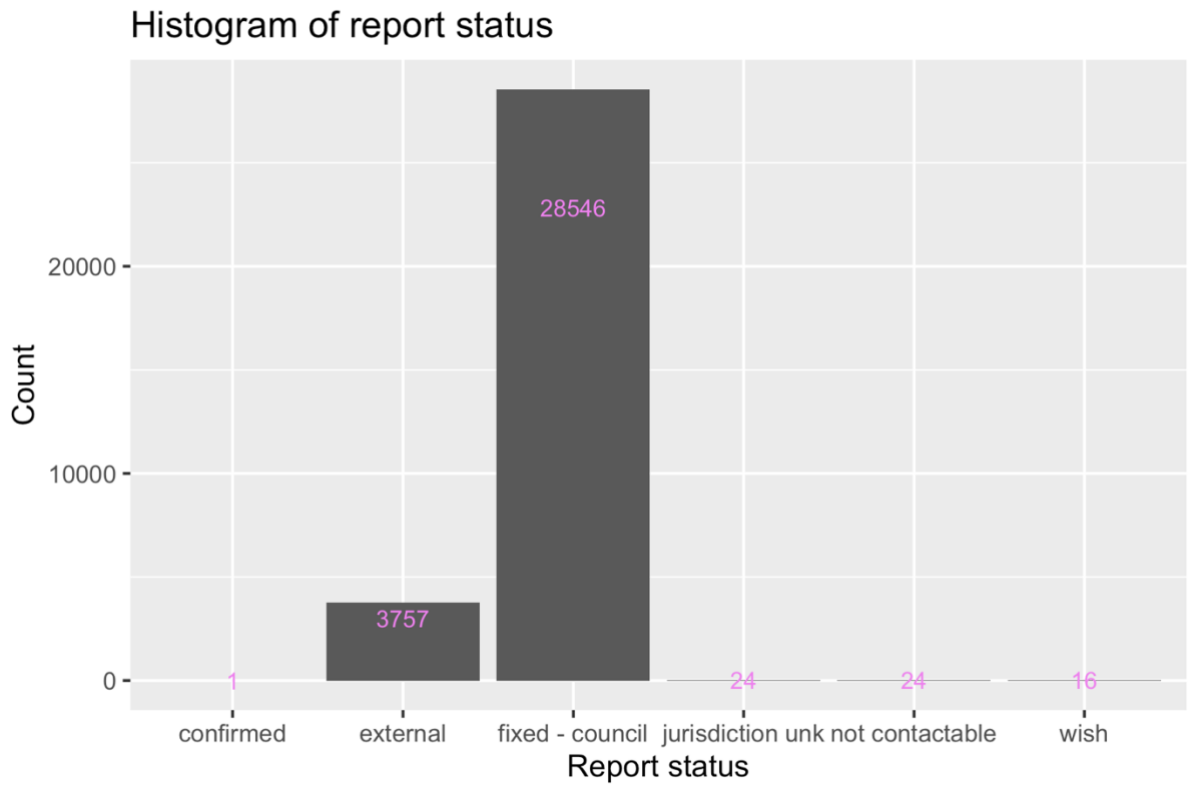


Figure 22: Histogram of report status.

The most interesting finding from the report status plot is not due to what one can derive from the data but what one cannot derive. The category 'fixed' suggest that the reported damage has been fixed. The clarification of what the category 'fixed' means can neither be found anywhere on the webpage or the app nor in the metadata. The author had to clarify the meaning of said status in an interview where one interviewee specifies: *"(...) innerhalb von 5 Tagen, glaube ich sind es, soll eine Meldung auf Züri wie neu abgeschlossen sein, ohne, dass tatsächlich der Schaden schon behoben ist." (*20220602_Transkript_A3: 86-88). This means 'fixed' does not signify that a report is brought to a solution but that for the city the report procedure is closed thus fixed.

The second most common label 'external' is again rather misleading as the wording suggests that the reported issue is external to the jurisdiction of the city. The information on what exactly this category means can again neither be found anywhere on the webpage or the app nor in the metadata. One interviewee specified the category external as everything external to ZWN, not the city itself, consisting of a potpourri of service departments not involved in ZWN, departments of the federal government, semi-state-owned companies like the SBB or notable private companies. Private persons are not considered. The idea behind the category

'external' is that the city officials can save addresses under the category 'external' and delegate the reported issues to responsible third parties via the platform: *"(...) eben wenn wir es melden, dann werden diese Adressen diese für uns externe oder die werden ergänzt (...) oder wenn ich wiederkehrende habe, ... dann kann ich mir das ersparen sie jedes Mal raussuchen. (...), dann kann ich es auch über meine Plattform laufen lassen."* (20220520_Interviewtranskript_A2, pos. 253).

4.3.4. Zonal statistics of response time

The plots from the zonal statistics of the response time show at first glance a uniform distribution over space with a few cells with exceptionally high values in both mean and standard deviation. When looking closer at the high value cells it gets evident that the mean response time is higher in grid cells with higher standard deviation indicating that the mean response time values are due to some outliers within that cell and not a local tendency or pattern. Further some cells with high mean values show count number of 1, the mean values are thus actually just one value. In those cases, the administration just took exceptionally long for this one report in that cell also not indicating a more general pattern.

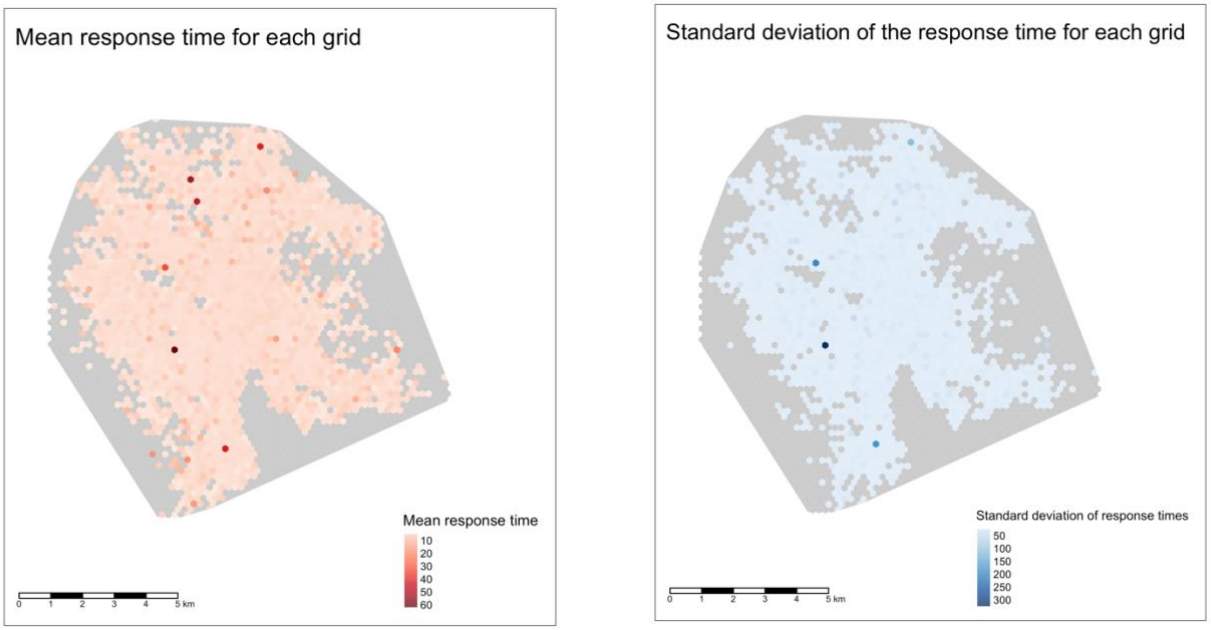


Figure 23: Zonal statistics for response time.

After removing all grid cells with values above 10 days, the distribution looks different on the first glance with the regions around the main station of Zurich showing shorter response times than regions further away from the centre. The distribution of grid cells with lower response

times matches the distribution of the report counts, areas with higher counts showing lower response time. When examining the grid cells with high mean response times in more detail, they again show either low report counts, one report with high response time influencing the overall mean more then in grid cells with high report counts, or high variance. The pattern is thus most probably not due to regional differences in response times.

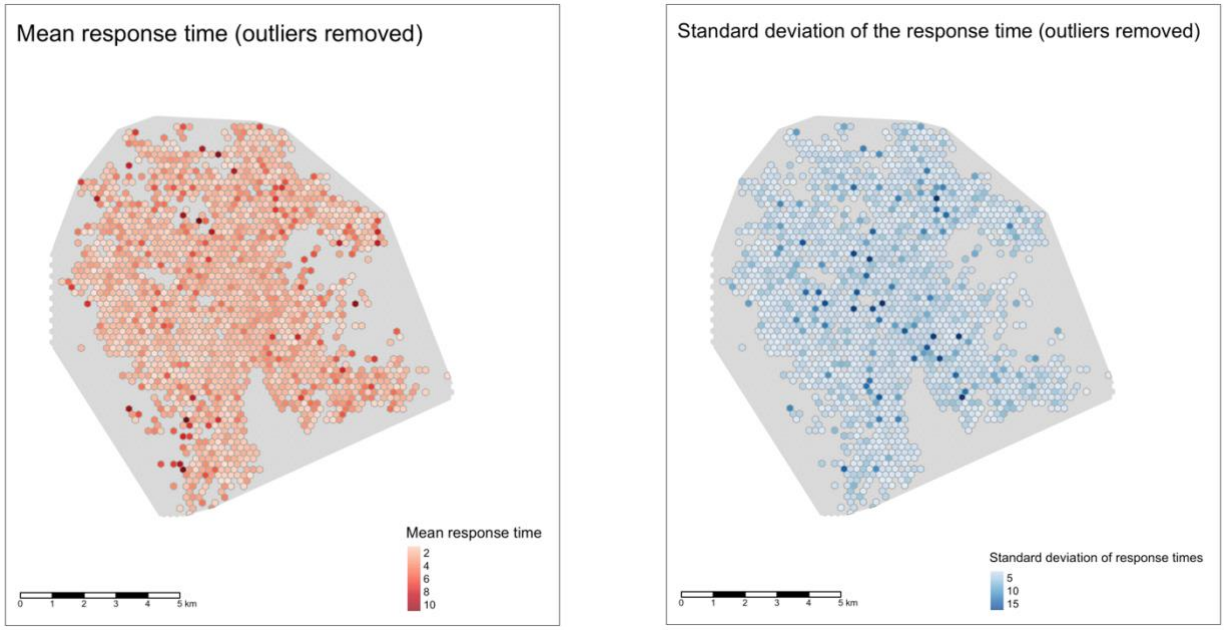


Figure 24: Zonal statistics for response time with outliers removed.

4.3.5. Bivariate LISA and Spearman's rank correlation

The bivariate LISA visible in Figure 25 shows areas where the report counts, and the median taxable income respectively show high or low values. In areas where report counts are high and median taxable income is high, there is a significant positive spatial correlation between the two variables. On the other hand, in areas where report counts are low and median taxable income is high there is a significant negative spatial correlation between the two variables. Grey areas are not significantly correlated.

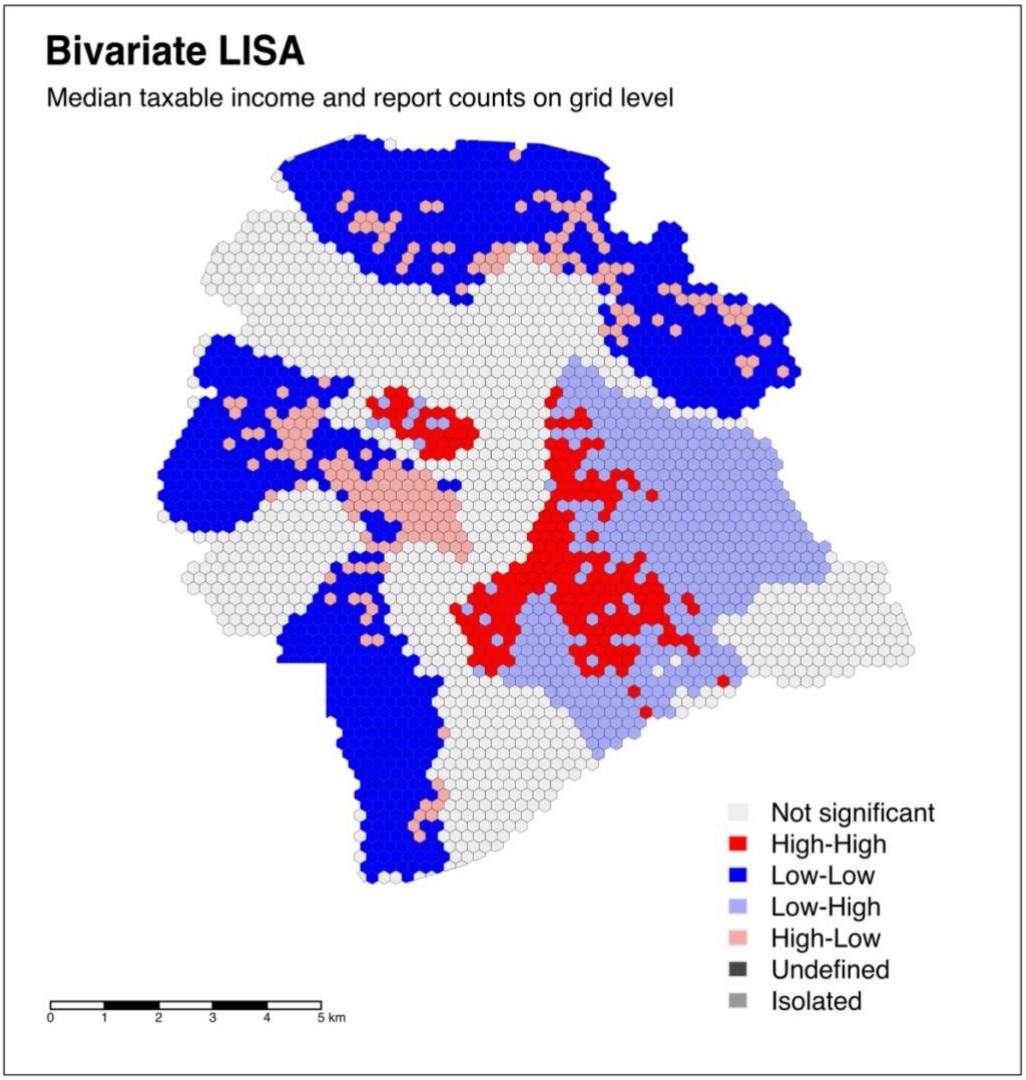


Figure 25: Bivariate LISA for median taxable income and report counts on grid level.

As the underlying data on the taxable income is only available on district level, conclusion on the correlation between median taxable income and report counts must be considered carefully. The author's conclusion is that although some areas show significant positive and negative spatial correlation, the median taxable income has a too coarse resolution to be able to infer something about the correlation between report counts and taxable income. The variation within a district gets obfuscated by the districts level aggregation. If one looks at Zurich's districts it gets quite evident that within one district the taxable income can differ heavily for example in the district 5 where still some people with lower income live in housing cooperatives but also people with increasingly higher incomes inhabit newly build flats.

The results from the Spearman's rank correlation show that although the effect is significant with a P-value of 0.0006 taxable income explains very little about the report count distribution

with rho = 0.057. Thus, the null hypothesis that the values of income and report count are randomly distributed cannot be rejected.

Overall, the bivariate LISA and the Spearman's rank cannot answer the question whether the data from ZWN shows spatial inequalities based on health as the resolution of the taxable income is too coarse.

4.3.6. Natural language processing

4.3.6.1. Response length

The boxplot of the response length and the spread between the 25 and 75 quantiles in particular helps as a measure to understand the textual diversity from the answers by the city administration for each service code. Textual diversity offers a first glimpse whether the answers to the reports are more template like (little textual difference between answers meaning low spread) or whether answers to reports are individually tailored depending on the report (higher textual difference between answers meaning high spread).

Visible in Figure 26 the median response length ranges from about 100 to over 500 words depending on the service code. The service code 'Schädlinge' shows by far the highest response length with a median response length of around 550 characters.

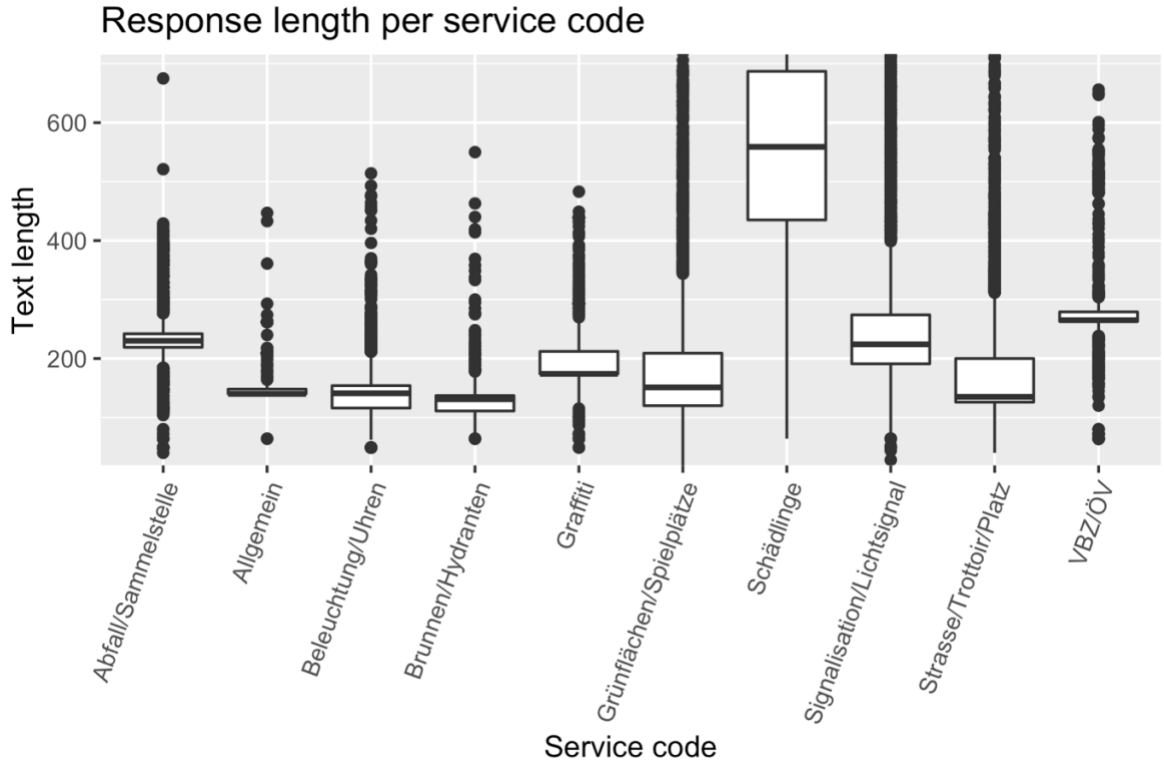


Figure 26: Boxplots of response length of administration answers for each service code.

Further the spread of the response length indicated by the box of the boxplots gives a first feeling for textual diversity of the answers by the city administration within a service code. The boxplots in Figure 26 suggest low spread of response length in general, indicating little textual diversity between answer of one category to another of the same category. The category 'Allgemein' shows almost no spread in response length, which hints towards very similar answers in this category. The category 'Schädlinge' has not only the highest median value but also the highest spread suggesting that answers are more individually tailored to user reports. The service code 'Schädlinge' is a newer category on ZWN since 2019, when manually looking through the answers to the reports it gets evident that the dominating topic is the tiger mosquito. Responses to reports on tiger mosquitos are mostly met with rather long but standardized answers stating that the displayed animal is not a tiger mosquito or that the quality of the picture is too bad and does not allow a species identification. For reports on less frequent animals the responses are most often isolated cases with an individually tailored response This explains the bigger spread and the higher mean of the boxplot compared to other service codes.

Although many categories show similar values of response length and spread, each service code shows unique answering characteristics with respect to the length of the text and the spread in response length over all answers. The case of the category 'Schädlinge' is slightly different, and the answers show less standardization although there are several template answers.

4.3.6.2. Cosine similarity

The cosine similarity values for each service code in Figure 27 show a similar picture then the spread from the boxplots for the response length. Service codes such as 'Allgemein' and 'Abfall und Sammelstellen' show high values of similarity between the response texts whereas the service codes 'Schädlinge' or 'Grünflächen und Spielplätze' show the lowest values of similarity between response texts. Compared to the results from the boxplots on response length where the service code 'Schädlinge' shows the highest spread indicating the highest textual diversity, the service code 'Grünfläche und Spielplätze' has the lowest mean cosine similarity value. One explanation for that is that the cosine similarity does not only take the words of a sentence into account but also the sequence of words. The mean cosine similarity value thus refines the picture of textual diversity. Nevertheless, the tendencies indicated by

the spread of the boxplots are equal, with the service code ‘Allgemein’ showing the least textual diversity thus highest standardization of answers and service codes ‘Schädlinge’ and ‘Grünflächen und Spielplätze’ the highest textual diversity thus lower standardization of answers.

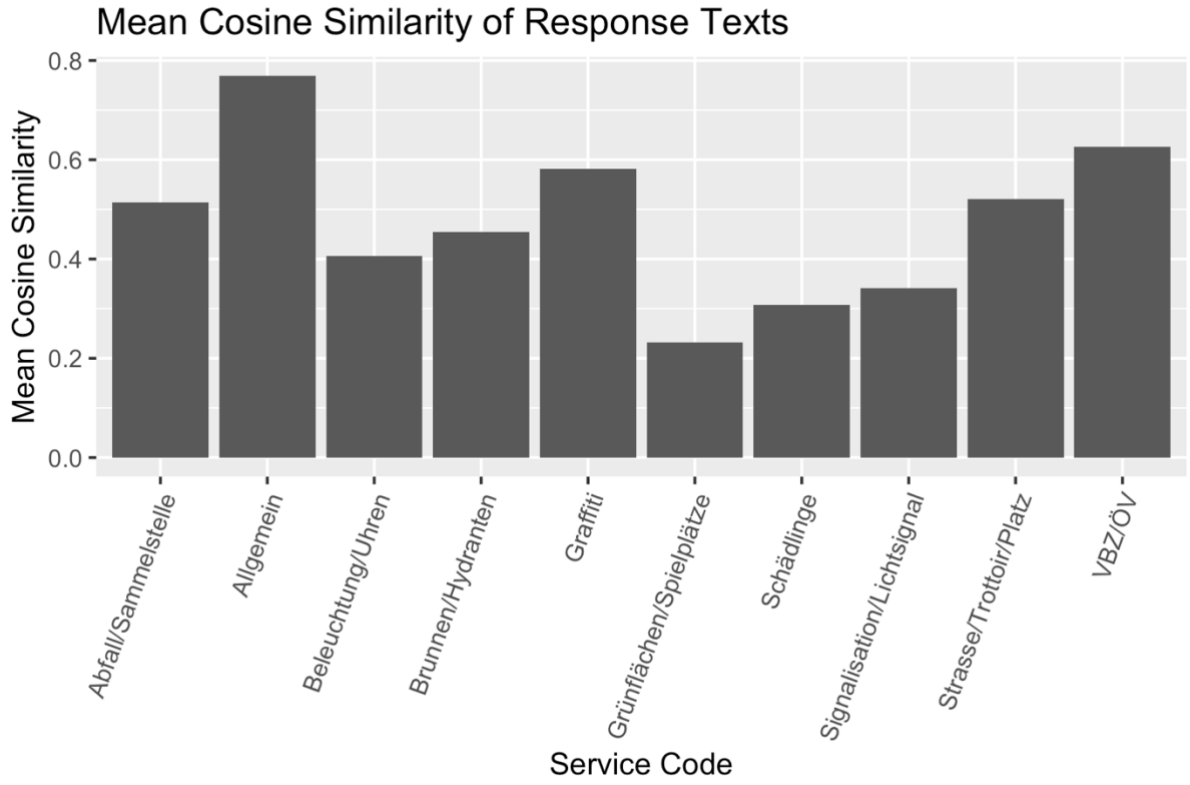


Figure 27: Mean cosine similarity for each service code.

4.3.6.3. Topic modelling

As visible in Figure 28 it is evident that the topics of the responses differ for each service code showing words specific to the topic of the service code. The service code ‘Abfall und Sammelstellen’ for example shows topic specific words such as recycling, trash or ERZ (service department responsible for trash collection and recycling). The topics of three service codes namely ‘Graffiti’, ‘Grünflächen und Spielplätze’ and ‘Strasse, Trottoir, Platz’ show relatively unspecific words compared to the example of the service code for ‘Abfall und Sammelstellen’. Words such as reparation, or damage appear and neither a service department nor the words defining the service code such as for example graffiti, greenspace or street appear. Whereas for the service code ‘Graffiti’ and ‘Strasse, Trottoir, Platz’. When checking the reports from the administration of those service codes manually, more specific wording can be detected.

This result might thus be due to the algorithm of the topic modelling or the setting of the parameters but does not show an underlying pattern.

On the other hand, certain words reappear in several topics of different service codes although the words for the greeting and welcoming part which is obviously standardized were already removed (see section Natural language processing). For example, the word ‘forwarded’ appears in the topic of the service codes ‘Allgemein’, ’Beleuchtung und Uhren’, ’Grünflächen und Spieltplätze’, ’Strasse, Trottoir, Platz’ and ‘VBZ/ÖV’.

The answers from the administration for the different service codes are thus topic related but do share certain commonalities. This might be due to the usage of standardized text blocks and template answers across service departments.

Topic Modelling for each Service Code
Three Topics with the five most likely words per topic

Topic 1	Topic 2	Topic 3
Allgemein		
stell	zustand	fur
weitergeleitet	weitergeleitet	verantwort
zustand	fur	informiert
fur	stell	notig
stadtpolizei	wend	massnahm
Abfall/Sammelstellen		
fur	fur	erz
saub	gemeldet	entsorgung
beitrag	holt	recycling
anlieg	abfall	geniess
erz	ab	konn
Beleuchtung/Uhren		
ewz	fur	wurd
zustand	zuri	defekt
weitergeleitet	neu	ersetzt
stell	gemeldet	lamp
werd	wurd	heut

Topic Modelling for each Service Code
Three Topics with the five most likely words per topic

Topic 1	Topic 2	Topic 3
Brunnen/Hydranten		
fur	brunn	wasserversorg
hinweis	wasserversorg	sach
dank	neu	annehm
behebt	wurd	nimmt
merci	stellt	augenschein
Graffiti		
fur	entfernt	schad
werd	schmiererei	fur
zuri	neu	neu
neu	moglich	zuri
reinig	zuri	gemeldet
Grünflächen/Spielplätze		
fur	fur	fur
werd	zustand	werd
hinweis	stell	baum
dank	weitergeleitet	dank
mitteil	neu	wurd

Topic Modelling for each Service Code
Three Topics with the five most likely words per topic

Topic 1	Topic 2	Topic 3
Strasse		
werd	fur	ausgefuhrt
wurd	neu	reparatur
fur	zuri	kommend
schad	anlieg	woch
rahm	weitergeleitet	tag
Signalisation		
werd	werd	verkehr
reinig	fur	dienstabteil
period	wurd	gemeldet
gebietsweis	fussgangerstreif	registriert
situation	moglich	wurd
Schädlinge		
fur	tigermuck	fur
walchestrass	buschmuck	muck
konnt	weiss	ugz
tier	find	leid
leid	hinterbein	foto
VBZ/ÖV		
fur	hinweis	fur
vbz	annehm	uhr
gruezi	wichtig	gruezi
weitergeleitet	sachverhalt	hinweis
verantwort	bedau	kundendien

Figure 28: Topic modelling of the response texts for each service code.

4.3.6.4. Wordcloud

The wordcloud in Figure 30 of all the words from all the response texts from ZWN shows that the platform is mostly used to report trash as the most common word in the responses of the government is entsorgung, sauberes, recycling and ERZ. All those terms stem from the response texts of the service code 'Abfall und Sammelstellen' as visible in the topic modelling in Figure 28. As already touched upon in the sections Response length and Cosine similarity the response texts from the service code 'Schädlinge' have amidst the highest values of textual diversity proxied by the response length and the mean cosine similarity value. This is well visible when comparing the wordcloud of the service code 'Schädlinge' Figure 31 to the wordcloud of the service code 'Allgemein' in Figure 29. The wordcloud of the service code 'Schädlinge' shows much more words although many related to the dominant topic of the tiger mosquito already discussed in section Response length. On the other hand, the wordcloud for the service code 'Allgemein' shows only formal words without thematic context. This comes as no surprise as the findings on the mean cosine similarity and the response length already hinted towards high standardization of answers and very little textual diversity.

Figure 29: Wordcloud of response texts from service code 'Allgemein'.

Figure 31: Wordcloud of all response texts.

Figure 30: Wordcloud of response texts for service code 'Schädlinge'.

4.4. Summarizing the results

Before delving into the discussion of the results a short summary is needed to bundle the results from the three methods and relate them back to their corresponding research question.

4.4.1. What form of usage does the platform enable?

The results from the platform walkthrough answer the question ‘what form of usage does the platform enable?’. The used method followed the idea of the platform walkthrough by Light, Burgess and Duguay (2018) and showed that the platform is focused on enabling ease of use and spontaneous usage. The platform’s symbols and colours focus on functionality over

design. Further, the geolocating possibility is of central importance to submit a report easily and spontaneously. A report in the sense of the platform follows a narrow definition and leads to rather nudged reporting possibilities leaving little freedom to the user to report by offering simplistic tools such as geolocation and upload of photos. The information displayed on the pages is mostly about do's and don'ts trying to make clear how a report should look like whilst offering little details on the background of the platform and the integration into the administration of the city of Zurich. The way reports are publicly visible and processed for viewers makes it difficult to get an overview over the contributions to the website apart from the most basic quantitative measure on how many reports were closed in the last month and how many reports were issued this week.

4.4.2. How do city officials interact with users via ZWN?

The interviews with officials working with ZWN showed that the administration interacts with users with standardized answers and text blocks through the platform and speaks as one city, the city of Zurich through ZWN. The interaction is further designed to be one-sided; a report is met with one answer and the case is closed. The interaction in that sense is contrary to a dialog which is also stated by officials that supporting dialog is not the purpose of the website. Apart from not supporting dialog, the interaction is strictly about operational aspects and is depoliticized partially by a structural necessity and the understanding that users are satisfied with trivial 'unpolitical' reporting. Working bodies of the administration depict users as either naggers using the wrong platform leading to unnecessary extra effort or as being irrelevant towards their report and are happy with simply offloading their report.

4.4.3. What characteristics of interaction can be inferred from the data of ZWN?

The spatial analysis showed some aspects of the spatial distribution of the interaction of ZWN and allows to infer several but cautious interaction characteristics. The report counts seem to follow the population density, thus there are no over- or underrepresented areas with respect to the quantity of interaction. The method and result section showed how a smaller grid resolution is more suitable than the district aggregation to investigate report counts. Further, the administration writes back to users in a similar manner over the extent of Zurich showing no different treatment depending on the region. Nevertheless, the topics brought up by users

differ from region to region and might be shaped by the fabric of urban space and people's expectation towards city infrastructure. This finding was obtained by looking closely at hotspots, manually investigating the report texts and by knowing the city and its infrastructure through living and working in Zurich. The most common topics dominating the overall interaction of ZWN is trash which is also the most frequently reported category. Furthermore, the answers from the administration indicate a high degree of standardization, depending on the service department to a different degree. The response time of the administration is overall quite fast with some exceptions and seems to be uniformly distributed over space where no area receives less timely answers. The available data to check for spatial autocorrelation with a socioeconomic measure was too coarse to infer results of value. This exemplifies a general problem underlying the spatial analysis namely the availability of meaningful high-resolution data. Finding meaningful dataset on population densities was rather difficult, a more detailed and accurate population dataset might have lead to a different conclusion on the spatial distribution of the report counts. The spatial analysis of ZWN conducted in this thesis showed that some characteristics of interaction can be inferred from the platform's data and offered paths for future analysis which can and should be elaborated further.

4.5. Method Triangulation and limitations

This thesis showed how the triangulation of three methods of different scientific disciplines allows to entangle how the interaction is mediated through a platform in an interdisciplinary way using qualitative and quantitative methods. The platform walkthrough approached the platform's technical design and functions with a perspective grounded in technology and cultural studies (Light, Burgess and Duguay, 2018), the spatial analysis researched the platform based on the generated data and is a classical GIS research method while the semi-structured interviews provided a qualitative view behind the platform focusing on the people working with ZWN daily. The triangulation of the methods resulted in similar findings while adding nuances and complementing each other. The results on the standardized answers based solely on quantitative data would not have allowed to understand the underlying reasonings brought up by the qualitative interviews. For other aspects the triangulation simply helped to grasp more diverse aspects of the interaction. Namely, only the platform

walkthrough was able to highlight the simplistic and nudged reporting by drawing attention to the business strategy, governance and purpose of the website.

Clearly, all the three methods have their shortcomings and limitations. Difficulties with the walkthrough are mostly to balance out subjective reasoning. Subjective reasoning is explicitly part of the analysis but quickly leads to an overtly biased perspective only serving to prove oneself right. This bias cannot be averted and must be kept in mind. The difficulty in the interviews were the guiding questions which required a reasonable balance between openness and focus. The author sometimes found it a challenge to find the right formulations for spontaneous questions without posing them suggestively possibly influencing the results. Further a limitation of the interviews is that the interviewees of the city were not only experts on the topic but also involved in the process that was researched for this thesis. They were the information source and the research subject at the same time leading to questionable openness about failures, problems, and future perspectives of the platform.

For the spatial analysis, a notable methodological limitation has been addressed throughout the thesis namely the lack of open availability of meaningful data on population and high-resolution data on a socioeconomic measure for privilege or, in reverse, for deprivation. The population data provided by the city is of limited use as it only displays information on residents and not on actual whereabouts of people. The only alternative is data from Swisscom taken on only one date, otherwise data must be purchased. The data was raised in winter thus a different distribution can be expected during warmer times in the year. An idea for future research could be to combine the resident and daytime population data and to spend some money and buy the data from Swisscom for the course of a year. Further the method used to analyse the distribution of the report counts is based on a simple normalization and histograms and therefore does not allow a statistical analysis which could be interesting for future research, for example working with the chi-squared test of goodness of fit to determine whether there is a significant difference between expected and observed report counts (Snedecor and Cochran, 1989). The taxable income is only available on district level which is a rather coarse resolution and inhibits the problem of the modifiable area unit problem already addressed in the section Report counts. Further taxable income was the only data source to assess socioeconomic privilege or deprivation. Taxable income is a rather weak signifier for privilege or deprivation which would be crucial to assess spatial inequalities in a more holistic way such as the study by Rae and Nyanzu (2021).

5. Discussion

Some of the core ideas of e-governance and smart cities brought up in the sections Electronic governance and Electronic governance with infrastructure reporting platforms are that the digitization of governance allows a more bottom-up and inclusionary form of governance (Cardullo and Kitchin, 2019; Kitchin, Cardullo and Di Feliciantonio, 2019; Li, Batty and Goodchild, 2020; Peng *et al.*, 2022). It increases the efficiency of the interaction between governments and citizens (Kitchin, Cardullo and Di Feliciantonio, 2019: 1-3; Cahlikova, 2021: 10) and ultimately holds governments accountable for their actions by enhancing transparency and controllability through ICTs (Saikia, 2019; Sharma, Kar and Gupta, 2021). Further, not only the general idea of smart cities is strongly attached to notions of improving city life by enhanced service provision through efficient management and operation and increased accountability of responsible actors of the government (Li, Batty and Goodchild, 2020) but also infrastructure reporting platforms in particular are seen as a tool fostering an interaction which then results in more accountability of governments (Abu-Tayeh, Portmann and Stürmer, 2017; Stürmer, Neumann and Loosli, 2017), enhancing transparency of the administration (Walravens, 2013; Stürmer and Ritz, 2014) and is strongly linked to an efficient management of the interaction between users of the platform and governments (Abu-Tayeh, Portmann and Stürmer, 2017).

Firstly, the results of this thesis provide an alternative view on the interaction between the users of ZWN and the administration by questioning if the platform is about interacting with users in the first place. The results suggest that ZWN acts as a platform to manage distance and proximity of users by delegating them little power over decision to them and by countering the visibility of reports with standardized answer and removing possibilities to interact that limit in how far administration can be held accountable.

Secondly, the results question whether ZWN improves the service provision of the administration as the work with the platform is associated with limited efficiency gains and is only an addition to the extensive infrastructure management of the city of Zurich. Findings suggest that the work required to answer requests has simply shifted to other tasks and no apparent strategy to work with ZWN in the future is visible. At least, no apparent spatial

inequalities in contribution have been found thus no area is under- or overrepresented and the response times of the administration do not vary over the extent of the city.

5.1. Distance and proximity

The following chapter will discuss the mechanisms that allow the city of Zurich to balance the distance and proximity of users to the administration through ZWN. The mechanisms rely on delegating little power over decisions to users of the platform and by meeting the visibility of the reports with standardized answers that hide internal responsibilities and ultimately limit in how far they can be held accountable. This chapter synthesizes in the section Protection through distance where the idea of distance and proximity of users to the administration through ZWN is taken up and it is argued that the distance the platform creates between users and the administration helps the latter to protect themselves from having to deal with overtly engaged users, stirring up wrong expectations and having to engage in political discussion.

5.1.1. Delegation of power

The delegation of power over decision was introduced in the context of participation through infrastructure reporting platforms which are commonly framed as a bottom-up tool for participation (Abu-Tayeh, Portmann and Stürmer, 2017; Peng *et al.*, 2022) as a good example of an e-governance application that shook of its top-down, technocratic configurations associated with adoptions of ICTs in governance (da Cruz, Rode and McQuarrie, 2019; Barns, 2020). Looking at the delegation of power over decisions enables to observe to what degree participants of infrastructure reporting platforms can make decisions and shape the outcome of their contribution (Cardullo and Kitchin, 2019: 9) or shape the interaction over the platform in the first place (Schwarz, 2017). The delegation of power over decision manifesting itself in the participation of users through ZWN is reflected in findings from the platform walkthrough namely the Business strategy, Governance and Purpose of the website as well as in findings from the interviews namely the One-sided communication through ZWN.

The walkthrough shows that the business strategy of ZWN is to foster an active participation of citizens as stated in the initiative ‘smart city Zürich’ which ZWN is a part of. The governance of the platform is tailored to make it clear how and what to report by clarifying rules and

guidelines various times and detailed. The governance is designed to keep the purpose of the website and thus of a report clear. The rules and guidelines make the purpose clear but also narrow the definition of the purpose significantly. Issuing a report is the main purpose of the website, maintaining the current state of infrastructure the sole purpose of a report. Further, the interface to report is confined in its functionalities and nudges users into simplistic tasks such as geolocating, ticking the right service department, and uploading a photo. The only unconfined aspect is the user's text else the possibilities are limited to simplistic tasks. The findings enhance the notion brought up by Baykurt (2011) characterizing FMS as resembling a costumer-complaint service. By showing the confined paths and possibilities the website nudges users into following a clear but narrow approach to a report resulting in a simplistic interaction.

The interviews give insights into the logic behind narrowing down the possibilities and the purpose of a report. Interviewees state that the dialog function offered by other FMS derivatives has been omitted as the platform ZWN is described to be a quick and dirty platform not a platform for dialog. This view on ZWN is undermined by an understanding that users do not really want to engage in a dialog in the first place. This finding is based on a study by Stürmer and Kölliker (2016). When considering the literature, there is an ambivalence between ZWN which, compared to FMS, enables the administration to answer reports publicly but disabled dialog possibilities for users (mySociety, no date; King and Brown, 2007: 74; Gees, 2013: 323). This means that the communication possibilities for the administration are expanded yet the response possibilities for users are disabled. The purpose of the website was changed by the city of Zurich towards less dialog and more 'quick and dirtiness' and is seen as fulfilling users' needs assessed by only one study. The result is a one-sided communication pretty much opposed to dialog, leaving users only the report function to involve themselves through ZWN.

Summing up, the simplistic reporting and the one-sided communication through ZWN have implications on the interaction as they delegate the power over decision to the city of Zurich away from users. The design of the webpage and the reporting interface is clear but narrowed down thus not allowing dialog in any way. Considering Schwarz's (2017) argument that the platform surface and design is controlled by the deployer, the city of Zurich defines the ways of interaction offered by ZWN and thus shapes the interaction. The administration sees ZWN as a 'quick and dirty' platform not suited for dialog thus the interaction is limited down to a

nudged and one-sided interaction similarly to how Baykurt (2011) describes the interaction over FMS.

Within the discussion on top-down or bottom-up exemplified by Cardullo and Kitchin (2019) with their descriptions of the ladder on smart citizen participation, ZWN falls within the realms of a top-down tool leaving users with little to no power over decisions and give them no options to shape the outcome of their contribution. Whereas the Stadt Zürich (2022) sees ZWN as part of their smart city initiative to foster an active participation of citizen and Stürmer, Neumann and Loosli (2017) term ZWN as a tool to involve the public, the above findings refine the nature of this involvement of users through ZWN by showing an overall lack of delegation of power over decisions to users through a one-sided communication and nudged and simplistic reporting possibilities.

5.1.2. Managing accountability

Increasing the accountability of governments is a key promise of e-governance tools (Tomor *et al.*, 2019; Sharma, Kar and Gupta, 2021). Accountability is also attributed to infrastructure reporting platforms (Walravens, 2013) and ZWN specifically (Abu-Tayeh, Portmann and Stürmer, 2017). Yet in both cases the exact mechanisms that ensure accountability are not further elaborated. Schmidthuber and Hilgers (2018) base the accountability through infrastructure reporting platforms on transparency, more precisely on the mere visibility of reports and the availability of data. This perspective fails to acknowledge what information the platforms hide (Ananny and Crawford, 2018), that transparency can create opacity (Birchall, 2011) and that the controllability through the availability of data depends on the available data source, how thoroughly the data is stored and made available and how understandable the variables are. The controllability further depends on the given possibilities for users to assign judgment through the platform.

The discussion in this chapter is based on findings from the section Textual content and Pages from the platform walkthrough as well as on results from the interview sections Accountability and Speaking with one voice, the Natural language processing and on results from investigating the Report status from the spatial analysis.

Although, the interviews showed that certain members of the administration see the public visibility of the interaction on ZWN as means to hold themselves more accountable, the administration meets the visibility of reports with standardized answers hiding internal details

about responsibilities, not communicating the clear procedure what happens to a reported damage whic in the end protects the city from stirring up wrong expectations (20220520_Interviewtranskript_A2, pos. 56). Whereas the open visibility of reports is, compared to traditional interactions via e-mail, more difficult to simply ignore and sweep under the carpet as one interviewee formulated already shown in the interview section Accountability (20220601_Transkript_A4, pos. 146), it also led the administration to answer reports with predefined standardized answer texts and text blocks. The natural language processing part of the spatial analysis specifically the response length and cosine similarity data indicated that answers from the administration are simply standardized, depending on the service code to a more or lesser degree. The spread of the response lengths was overall very low and the cosine similarity of documents within the same service code was high for all service codes. The topic modelling showed that certain words were equal between different service codes although the standardized greeting was removed thus the text blocks are also shared amongst the service departments. This finding is also reflected in the interviews. All the interviewed person from the different service departments follow the same communication strategy using standardized answers and template text to answer reports (20220516_Interview_Transkript_A1, pos. 32; 20220624_Interview_A6, pos. 30).

Whereas increased accountability through transparency is a central claim of e-governance (Tomor *et al.*, 2019; Sharma, Kar and Gupta, 2021) this relationship is not as straightforward. Equating the visibility of reports with increased transparency and thus increased accountability of the administration, follows the same logic as Schmidthuber and Hilgers (2018) for whom accountability resulted from the mere visibility of the interaction. But in the case of ZWN the visibility of reports leads to a more controlled and a less open communication style. The relationship between visibility of information, transparency and accountability is a more intricate issue than a simple equation. Due to the visibility of reports, the administration answers through standardized answers and text blocks ultimately communicating less transparently with less information displayed and a more controlled flow of information. The less open communication style can be illustrated through the standardized answers and greetings used in every answer from the administration. According to findings from the interview section Speaking with one voice, the city aims to speak through ZWN with ‘one voice’ as ‘the city of Zurich’. This decision was decided in a top-down manner by higher entities of the city as highlighted by one interviewee (20220624_Interview_A6, pos. 42). Such

kind of communication style elegantly hides internal delegation of tasks and the responsibilities within the administration by simplifying the administration into 'one city'. The user is not informed about who took charge of the reported damage neither does the user know which department is assigned to fixing the damage.

The piece-meal wise manner to deliver information via the platform is not only apparent in the answers to reports but is also visible in the information on the platform itself. The section Textual content of the platform walkthrough shows that the main text and information on the platform are about the reporting procedure, how it is done and what can be reported. Information about the background of ZWN is partially displayed on the "Hilfe" page in a question and answer style where also a contact person, the duration of handling a report and that it is sent to the 'responsible department' which finishes the report within 5 days are mentioned. Information is displayed piece-meal wise, where although the platform indicates a contact person and makes sure people understand the procedure how a report is issued, which departments is responsible for handling the report and what it means that a report is considered 'fixed' remains hidden. These findings enhance the notion of ZWN being 'transparent' (Stürmer and Ritz, 2014; Abu-Tayeh, Portmann and Stürmer, 2017; Schmidthuber and Hilgers, 2018). The results show how the information displayed on ZWN is managed to hide crucial information such as responsibilities while at the same time revealing banal information about report procedures and a contact person.

On the other hand, ZWN reveals all reports on the platform and only allows for very basic filtering and sorting. The information displayed is not piece-meal wise, contrarily it falls into the transparency-opacity paradox by Birchall (2011). The analyses of the different pages showed that it is not straightforward to get a general overview over all the reports. Either one can use the map to navigate the reports, which is neatly done but only allows viewing reports one by one. By navigating through the listed reports, a general overview is difficult to achieve. The easiest way of getting an overview is by sorting the reports, but the sorting options are very basic and even features a sorting category that does not even apply to ZWN (sorting category 'most frequent comment', but making comments is not possible!). Further, there are only rudimentary statistics available showing only the quantity of reports during the last week and the last month but allow no other insights. The vastness of information and lack of processing of the data leads to the paradox situation of opacity through transparency as brought up by Birchall (2011) leaving users with significant burdens to inform themselves.

Both the visibility of reports and information on the website should in theory ensure accountability of the administration by allowing people to understand and "evaluate realistically the capacities of their government and assign accountability directly to responsible actors" (Cahlikova, 2019). The findings show that although information is visible it is managed in ways that make it difficult for users to evaluate capacities of the administration or to even know who is responsible. The visibility of reports led the administration to answer reports more carefully deliberately hiding potentially conflicting information. The decision to talk as 'the city of Zurich' through the platform hides internal responsibilities and the information displayed on the platform is either reserved and focuses on the functionality of the platform or in the case of the reports so vast and scattered that transparency creates opacity.

As discussed in the section Background, the increased accountability through infrastructure reporting platforms is not only associated with the visibility of reports and the information on the website discussed in the paragraphs before but is further associated with more controllability through the availability of data (Stürmer and Ritz, 2014; Schmidthuber and Hilgers, 2018). Although the data of ZWN is openly available, the available categories are sometimes misleadingly labelled as for example the report status attribute 'fixed'. Deriving from the spatial analysis, the report status is, already briefly touched upon in the section Report status, misleading and the exact meaning was not explained anywhere on the platform but had to be derived from the interviews. The report status 'fixed' does not mean that the reported damage has been resolved but that the administration processed the report. These findings show that the availability of data alone does not guarantee more accountability but depends on the thorough description of the data enabling people to evaluate something based on data.

More controllability through e-governance tools also stems from the argument that ICT are a way to offer tools to assign judgment to responsible actors (Cahlikova, 2021; Sharma, Kar and Gupta, 2021). As discussed in the section Delegation of power the dialog function has been omitted with the superficial legitimation that users are not really interested in a dialog anyways. Leaving out dialog possibilities removes an important tool to assign judgment to the administration and thus limits the controllability through ZWN. The platform interface does not enable users to answer back an answer by the city and allows no judgment except for issuing another report, scattered amongst all others (and attracting very little attention

amidst the vastness of reports). Further, the walkthrough shows that not only a dialog is prevented by the platform design but also the function implemented in FMS to mark a report as fixed has been omitted (Baykurt, 2011). The limited possibilities to express judgment limit the immediate controllability the platform ensures and are compared to FMS, where user can comment on reports and mark them as fixed, of even lower degree (Baykurt, 2011). Overall, the administration actively manages not only the communication hiding details by standardized answers but removed the only possibilities to assign immediate judgment namely the dialog possibilities and the fixed box and leaves the data accumulated by the platform unprocessed creating opacity through transparency. The argument that ZWN helps to hold administrations accountable (Abu-Tayeh, Portmann and Stürmer, 2017; Stürmer, Neumann and Loosli, 2017) appears naïve considering how the administration of the city of Zurich actively manages the interaction in ways that limit in how far they can be held accountable.

5.1.3. Protection through distance

By delegating the power over all decisions made on or through the platform towards the city, by disenabling dialog and nudging users into simplistic reporting, the administration created an easily manageable tool to interact with users at comfortable distance: the interaction and all resulting decisions whether it be on the form of the interaction at the first place, or what can be reported by users or what happens with a reported damage all is controlled and managed by the city. Whereas literature on e-governance highlights the transformative character of adopting ICT tools in governance with respect to the relationship between the public, the private and the people (Sandoval-Almazan and Gil-Garcia, 2012: 572-573; Tomczak, Andermatt and Schedler, 2020: 203; Loukis, Macadar and Meyerhoff Nielsen, 2021: v), ZWN appears to mediate this relationship in a one-sided, and simplistic way shaped and managed exclusively by the city. This allows the city to meet publicly visible reports with standardized answers and a restrictive flow of information and ultimately the removal of the two main controllability aspects found in FMS, the dialog possibilities and to mark reports as fixed. The way in how accountability is managed through the platform results in limited accountability and keeps users at a distance instead of including them in the management of the city infrastructure or fostering more accountability of the administration.

The way in which the interaction between the city and users of the platforms are mediated, ensures distance to its users that protects the city from stirring up wrong expectations or political discussions. Exemplarily are the standardized answers which fulfil the purpose of dealing with potentially delicate information preventing that an answer accidentally reveals to much sensitive or speculative information. Why the city of Zurich is so prudent with stirring up wrong expectations is best illustrated by the depiction of the so-called 'naggers'. 'Naggers' are depicted as overtly engaged users in need of offloading critique after critique and never being satisfied. The 'naggers' are said to be using the wrong platform and are characterized as annoying as they absorb energy and time (20220520_Interviewtranskript_A2, pos. 144-156). By using template-like answers, the administration makes it easier to not stir up wrong expectations leading to potentially lengthy discussions. The interview section Depoliticization elaborates on the role of 'naggers' and the fear of the administration to stir up wrong expectations. The platform and the administration are afraid of political discussion on the platform as they are not able to deal with political questions via ZWN. If political issues are brought up by users, the room for manoeuvres of the administration is limited as they are only allowed to pursue operational tasks. A political process is beyond the mandate of an official of the administration and requires a parliamentary process (20220624_Interview_A6, pos. 206-218). The usage of the platform can be seen as mediated in ways that protect the administration from stirring up wrong expectations by creating distance between the administration and the users through a standardized, one-sided communication, allowing them to deal better with time consuming users and prevent political discussion the administration is unable to deal with due to a structural problem. Thus, the platform can be understood less as a medium to interact with users but more as a tool to specifically avoid certain interactions.

5.2. Improving service provision

While the chapter before illuminated how the interaction mediated through ZWN enables the city administration to balance distance and proximity to its users by delegating littler power over all decision to users and by managing the accountability fostered through the platform in ways that limit the degree to which the administration can be held accountable, this chapter inspects another key characteristic attached to e-governance tools especially in the

context of the 'smart city' namely that ICTs improve the service provision of governments and administrations. E-governance in so called 'smart cities' are said to improve service provision from governments by enhancing the efficiency through automated and interconnected services (Shelton and Clark, 2015; Li, Batty and Goodchild, 2020). The perception of e-governance tools as enabling efficient service provision is also attached to infrastructure reporting platforms (Abu-Tayeh, Portmann and Stürmer, 2017) but debated especially due to the manual classification of reports inflicting additional work on administration bodies having to correct them (Granero Moya, Phan and Gatica-Perez, 2021; Peng *et al.*, 2022). Efficiency gains through the adoption of ICTs in e-governance is further debated on a more general level due to organizational mismatches (Cahlikova, 2019, 2021). Studies from Switzerland suggest that efficiency in digitizing and digitized governments is less an issue of technology but more of organizational learning and careful planning (Cahlikova, 2019, 2021: 117). Infrastructure reporting platforms have further received widespread criticism due to unequal contributions alongside ethnicity (Pak, Chua and Vande Moere, 2017) and socioeconomic means (Matthews *et al.*, 2018; Rae and Nyanzu, 2021) eventually resulting in unequal service provision disadvantaging minorities living in already more deprived areas (Wichowsky, Shah and Heideman, 2021). In the case of ZWN the service provision relates to managing and maintaining infrastructure services in the city of Zurich.

The following sections will firstly discuss the efficiency of ZWN for users to contribute and more importantly for the administration to work with, secondly discuss how ZWN is integrated into a broader planning, thirdly the geographies of difference in contribution to ZWN will be discussed in relation to the infrastructure service provision through ZWN. Lastly, the improvement of service provision through ZWN will be related to the infrastructure management already in place besides ZWN showing that the platform does not actually contribute much to a 'Zurich Like New'.

5.2.1. Efficiency

The efficiency of ZWN is discussed based on results from all three methods and briefly touches upon the efficiency for users to contribute and subsequently discusses efficiency of ZWN to work with in more detail. Results from the walkthrough, namely the User interface arrangement show the importance of geolocation to support the ease of use of the platform allowing an ad-hoc spontaneous use also reflected in findings from the Scenarios of use.

Results from the spatial analysis show that efficiency for users is complemented by rather fast replies. The interview section Strategy hints that overall ZWN is assessed only on a very basic quantitative analysis and there seems to be a lack of strategy how to move forward with ZWN. ZWN appears as an isolated tool with questionable benefits for the efficiency of the administration to process infrastructure requests serving the purpose of a visiting card for the public to showcase the service provision of the administration.

The efficiency of ICTs and e-governance tools for users to contribute is an often discussed topic in literature on e-governance (Abu-Tayeh, Portmann and Stürmer, 2017; Cahlikova, 2021; Peng *et al.*, 2022). The user interface arrangement of ZWN is focused on functionality and centred around the geolocation possibility via either automated geolocation or drag and drop on the map. Not only the geolocating but also contributions via photos are highly encouraged which make tedious descriptions less important. The interface is created to enable an easy understandable and quick way of reporting which can happen in spontaneous scenarios ad hoc. The ease of use is further procured by basic and rather minimalistic design focusing on functionality over aesthetics. The platform seems to ensure ease of use and spontaneous usage and offers a guarantee to receive a timely answer. The data of the response time from the spatial analysis shows that the short response time of 5 days promised by the platform is more or less achieved. Although there are some heavy outliers that took 1 year to answer, most of the reports are answered within those 5 days. This finding is also reflect in Abu-Tayeh, Portmann and Stürmer (2017) showing that users judge ZWN as offering a quicker way to interact with the city. Therein, the design and arrangement of the platform interface seems to play an important role to facilitate and speed up access.

On the other side, the efficiency gains for the administration are questionable as the time needed to process a report depends on the quality of the latter. The geolocation exemplifies this well as the geolocation function was described as making it easier and thus quicker to identify the location of the reported damage allowing to give a quicker response. Nevertheless, the efficiency gained through the geolocation depends heavily on the precision with which the location is submitted by users. If the location does not make sense, officials from the administration either have to contact the user or try to guess the location by looking at thematic maps to identify the right location. Both are said to require a substantial amount of time.

Further the efficiency gains for the administration are limited due to the missing involvement of all service departments of the city of Zurich in ZWN. The work with ZWN is thus not more efficient in general because work simply accumulates at other tasks. As the organization of communication is not harmonized with and around ZWN and service departments can choose whether to join ZWN, still a lot of manual work has to be done to process a report. If a service department is not involved in ZWN, the delegation of the report is a classic copy-paste job, and the reported issue is delegated via mail. When asked how long it takes to process a report, some interviewees even say ZWN takes slightly longer to answer a request due to platform specific affordances. Besides platform specific affordances such as marking a report as accepted but not yet answered and so on, knowing who is responsible for which tasks is described as a lengthy task which is difficult and requires time with or without the platform. The efficiency gains through the platform are thus a mixture between technological affordances and organizational burdens similar to problems with other ICTs in e-governance researched by Cahlikova (2021: 117). The digitization of governments is hindered by organizational mismatches (Cahlikova, 2019) well visible in the case of ZWN where the organization is not harmonized within the city of Zurich and efficiency gains through the adoption of digital technology are limited at best.

Further and again similar to what Cahlikova (2021: 117) finds for the uptake of e-governance in Switzerland in general, there seems to be a lack of strategies and roadmaps into which ZWN is integrated. ZWN is just a tool amongst others with little strategic planning nor assessments about the performance of the platform which would be necessary to use the functionalities of ZWN more efficiently according to the studies of Cahlikova (2019, 2021). The assessment of the performance of the administration and ZWN is not internally assessed as the interview section Strategy shows. The platform's data is not used for anything within the administration except for a basic quantitative assessment about how many people use the platform and how many new users used the platform (20220624_Interview_A6, pos. 62; 20220516_Interview_Transkript_A1, pos 124). Resulting is a planning or strategy based on the number of users not respecting any qualitative aspects of the interaction. The lack of strategy in organizing the work with and around ZWN is also reflected in the integration of ZWN into a broader political, city-wide strategy. Although GeoZ is the leading unit and the communication unit supports the project team consisting of GeoZ and all involved service departments with inputs on communication strategies, there is only one yearly meeting to

discuss eventually emerging topics (20220624_Interview_A6, pos. 62; 20220602_Transkript_A3, pos. 108). ZWN is said to just 'run on the side' and is not integrated into a broader political discussion on higher levels and appears as an isolated platform.

If one considers the origin of ZWN namely an idea competition, the isolation of the platform seems a logical result. Everyone was able to submit ideas through the competition and the selection was based on the most popular proposition making it potentially difficult to integrate the winning idea into an existing organisational structure of the city. One might speculate that the idea competition was more a crowd pleaser than a thought through process towards a more digitized administration. The aspect of pleasing the crowds came up during the interviews where interviewees uttered that ZWN acts as a visiting card for the administration showing the public that their tax money is at work. The platform is seen as showcasing the work of the administration and that they provide services. If one again considers Cahlikova (2019, 2021) the mismatch of ZWN appears evident. Instead of carefully planning and integrating the tool into existing structures while fostering organisational change and discussions to manage infrastructure and infrastructure requests from the public more efficiently, the idea was gathered in an openly visible process and the platform serves the purpose to showcase the service provision of the administration of Zurich.

5.2.2. Geographies of difference

Regarding the provision of service various studies found that less privileged minorities and women tend to be underrepresented in infrastructure reporting platforms (Minkoff, 2016; Stürmer and Kölliker, 2016; Pak, Chua and Vande Moere, 2017; Rae and Nyanzu, 2021; Wichowsky, Shah and Heideman, 2021). This underrepresentation potentially leads to disadvantaging areas and inhabitants with infrastructure maintenance and repairs which are already more deprived and thus factually more in need of the latter (Rae and Nyanzu, 2021). The studies follow longstanding discussions in participatory GIS in general showing the skewed nature of participation through GIS applications (Harris and Weiner, 1998; Elwood, 2008; Brown and Kyttä, 2014). The underlying geographies of difference in contribution to ZWN are thus an important aspect of the service provision through the platform. The results of the spatial analysis that can be summarized under the topic of geographies of difference are concerned with the Zonal statistics of the response time and response characteristics of

the administration from the Hotspot analysis with Getis Ord, Report counts and underlying fabric of space, and the correlation of report counts with a median taxable income dataset.

To begin with, regarding the contribution of reports there seem to be no evident under- or overrepresentations. Even when normalized with population densities, no notable variation in space are visible suggesting that the report distribution seems to reflect population densities as hypothesized by Rae and Nyanzu (2021: 215-217) and no areas are over- or underrepresented. Both the normalization with resident and daytime population resulted in a uniform distribution of the counts. Nevertheless, for future research a more accurate population distribution could be helpful to investigate the connection between population density and report counts with more precision. Especially when considering the results of the non-spatial analysis of Stürmer and Kölliker (2016) showing imbalance of the user base with respect to sex, educational level and age, a spatial manifestation of this skewed demographics seems at least worth researching in further detail.

The lack of fine-grained data hinders conclusions on the correlation between median taxable income and report counts. Whereas various other studies on infrastructure reporting platforms highlighted the correlation between indicators of economic means and distribution of reports (Minkoff, 2016; Matthews *et al.*, 2018; Rae and Nyanzu, 2021; Wichowsky, Shah and Heideman, 2021) the dependence of reporting distributions on the distribution of economic means remains unclear because the data on median taxable income is too coarse and no other dataset for socioeconomic measures with a higher resolution was found for the city of Zurich.

When looking closer at the response texts coming back from the administration to the users, it gets evident that the content of the answers does not vary over the space. The analysis of the hotspots with Getis Ord and manually looking through the answer texts shows that regardless of where the hotspot is, the administration writes back in a similar way irrespective of the location of the report. The only difference in the response texts can be found between service codes which seems natural as different service departments manage them accordingly. Additionally, the topic modelling shows that although response texts are mostly service code specific, responses from different service codes share certain words. Some commonalities between the texts from different service codes persist although the greetings have been removed from the analysis which are anyway always the same.

That the administration answers reports irrespective of space is contrary to how users use ZWN to report issues which reflects aspects of the fabric of urban space such as the local infrastructure and expectations of people towards it. For example, areas with higher proportions of streets or important traffic routes show higher reporting in related service codes. But moreover, the reporting might reflect how people experience their surrounding as findings for graffiti in the Niederdorf hint, where although not a lot of graffiti are present, reports in this service code are rather frequent. This findings support Rae and Nyanzu's (2021: 215-217) assumption that the underlying fabric of urban infrastructure influences reporting behaviour and further highlights that the expectations of users towards their surroundings influences the reporting behaviour. The assessment was not controlled with data and is based on personal experiences and knowledge of the city of the author.

Lastly, the zonal statistics of the response time of ZWN show no remarkable variation over space and response times are rather uniformly distributed, although there are a few responses that took a very long time for the administration to answer which are most likely exceptions. Whereas the finding of Wichowsky, Shah and Heideman (2021) for Milwaukee shows that ethnic minorities receive less timely responses, the response time patterns of ZWN do not suggest any geographies of difference. As the correlation between ethnicity and response time was not tested the answer is not final but the findings suggest that the response time of the administration is independent of space.

Concluding, the geographies of difference in contribution are not striking and patterns in report counts and response time were not detected. Thus, resulting disadvantaging of certain areas in the service provision seems unlikely in the case of Zurich. This might be the case because the reports are managed by service department responsible for a service code and the request processing is not separated by regions meaning that the report processing is topic related and not dependent on regions. Nevertheless, the fact that the study of Stürmer and Kölliker (2016) and Neumann and Schott (2021) showed such skewed user demographics with respect to gender, women making up 23.7% of the user base while also contributing 25% less, can be read as a warning beep. Especially as the available data on economic means was too coarse and rather simplistic (median taxable income), calculating correlation measures with more precise and more holistic datasets could lend to different results.

5.2.3. Züri wie neu?

Besides the fact that the platform appears as an isolated tool with limited benefits for the efficiency of the administration while serving as an image caretaker, some interviewees explicitly questioned the benefits of the platform for the provision of infrastructure management and maintenance services of the administration. Interviewees formulated that firstly it is not possible to say if the city infrastructure is better intact than before the uptake of ZWN due to a lack of indicator, secondly and based on personal judgment some interviewees uttered that the repair of a damage or the collection of trash might happen a bit quicker than before but overall, the issues would have been taken care of anyways. Whereas it is not within the scope of this thesis to entangle the precise apparatus of the city working and managing the infrastructure of the city, the interviews provided some information on the organization of the latter which questioned the relevance of ZWN for providing infrastructure services. An example are periodical cleanings in the service department DAV responsible for the service code 'Signalisation/Lichtsignale' removing stickers on signposts. Reports on stickers do not contribute to their removal but the organization beyond ZWN already handles the issue (20220601_Transkript_A4, pos. 38). Another example also touched upon in the section Improving service provision was brought up by the responsible person from the TAZ for the service code 'Strasse/Trottoir/Platz'. For infrastructure related to this service department regional managers together with experts check the whole street infrastructure of their region within 3 years. A damage on infrastructure related to this service department might be detected a bit faster but would have been detected and fixed anyways (20220520_Interviewtranskript_A2, pos. 132).

Geographies of difference in contribution were not detected and no patterns in the response time of the administration were found and thus no unequal service maintenance due to the reports on ZWN can be expected. The administration processes reports on ZWN per service department and not per region also visible in the fact that responses of the administration do not differ over space and are mostly irrespective of local conditions. On the other hand findings from looking through the response texts and obersvations by the author living and working in Zurich for over ten years suggest that the usage of ZWN reflects aspects of the fabric of urban space with respect to local specialties of infrastructure conditions and what people expect from it. In the end ZWN does not contribute much to a different provision of service to maintain and manage infrastructure. The structures within service departments to

manage infrastructure are still in place and play a significant role in providing infrastructure services in the city of Zurich irrespective of ZWN being in place.

6. Conclusion

This thesis argues that the interaction mediated through ZWN is regulating proximity and distance of users to the administration by delegating little power over decisions to its users and meeting the visibility of reports with standardized answer and removing crucial possibilities for users to control the work of the administration that limit in how far and for what the administration can be held accountable. Distance is favoured over proximity because this protects the administration from having to deal with time-consuming, overtly engaged users and potentially political discussions. While contributing little to the efficiency of the service provision in maintaining and managing infrastructure which is already extensively taken care off through already existing infrastructure services still in place besides ZWN, the platform acts as a visiting card showcasing the performance of the administration. At least, the findings suggest that the platform does not disadvantage already more deprived areas as the report contributions are uniformly distributed over space. The interaction mediated through the platform thereby gets the aftertaste of functioning as a tool to regulation the distance and proximity of users and image polishing of the city instead of improving the service provided by the administration and the platform contribution to a 'Zurich Like New'.

Findings of this thesis question some of the key promises made by e-governance in smart city contexts namely that they contribute to more bottom-up, inclusive modes of governance and improve the service provision of governments due to increased efficiency (Abu-Tayeh, Portmann and Stürmer, 2017; Neumann *et al.*, 2019; Li, Batty and Goodchild, 2020). Buzzwords such as participation, efficiency, transparency, and accountability cannot be unreflectively attached to the interaction mediated through e-governance tools but need to be thoroughly discussed and looked at depending on the city which is deployed, on the configurations of the tool and the institutional and organizational structures it is embedded. Investigating how e-governance tools are deployed and integrated into institutional structures and processes and whom they serve for which ends might help to raise a range of fruitful research questions when researching e-governance in the future.

Additionally, merging qualitative and quantitative methods such as a heuristic platform walkthrough, semi-structured interviews and a data-based spatial analysis are presented as a fruitful way to investigate the interaction mediated by e-governance tools. While this thesis considered only one platform in the city of Zurich, the methodological approach can be deployed around the world. Future research could profit from refining the spatial analysis conducted in this thesis based on more statistical measures such as the chi-squared test of goodness of fit (Snedecor and Cochran, 1989) to better extract meaning out of spatial open government data. An especially interesting research direction already brought up by Rae and Nyanzu (2021) is to investigate the fabric of urban space and what can be said about expectations of people towards infrastructure based on data gathered through infrastructure reporting platforms. For future research on infrastructure reporting platforms, it is further crucial to consider more accurate representations for population distribution and in the case of Zurich checking spatial correlations of a high-resolution measure for socioeconomic means with the report count distribution.

Practical implications are manifold and this thesis first and foremost wishes to stimulate thorough theoretical considerations and hopefully discussions about the reasons ZWN is deployed and how it is and could be organized. The author of this thesis would like to propose two paths he considers interesting lines of thought solidifying themselves on the question if ZWN is about interacting with users at the first place.

If ZWN is in place to interact with people the findings of this thesis propose to take the time to individualize the communication, to enable discussion possibilities and control functions for users, to be open about internal responsibilities and the complexity of the city apparatus, to provide more information about the process, and to update the labelling of the data and to pre-process the data to offer informative statistics on the website. The wildest proposition would be to include the possibilities to report wishes and ameliorations but for that the possibilities for the administration to channel them into a political process would need to be considered most probably requiring profound organizational changes. This way ZWN could bring people closer to the work of the administration and thereby foster more accountability and transparency of the administration while enabling users to use a tool to voice opinions all in one platform.

If ZWN is not about interacting with people, why even bother to make it look like? There are other ways to include the public and to offer ways to actually participate. Automating the

processing of reports through classifications proposed by the likes of Granero Moya, Phan and Gatica-Perez (2021) and Peng *et al.* (2022) and further automate the communication might actually increase the efficiency of infrastructure management in the city of Zurich. Nevertheless, to automate the report processing the organization within the city and the flow of information need to be modernized and adapted. Thinking about ways that process reports, clarify unprecise reports and delegate tasks internally requires serious planning and restructuring of the administration and their work. It is questionable if this is realistic and at first desirable as it sounds a lot like yet another technocratic dream of the smart city Zurich, 'like new'.

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Appendix

Interview Codes

Code System

Code System	Memo	Frequency
Code System		416
Gebrauch von ZWN		0
Gebrauch von ZWN\Organisation in der Stadt	Grobste Kategorie Organisation in der Stadt. Fokussiert auf Stellen, bei denen die Organisation von ZWN in der Stadt beschrieben wird.	20
Gebrauch von ZWN\Organisation in der Stadt\Kommunikation ZWN und restliche Dienstabteilungen	Fokussiert auf Stellen, bei denen die Kommunikation innerhalb der Stadt zwischen Dienstabteilungen und Personen die bei ZWN direkt mitmachen und anderen, 'externen' Dienstabteilungen und Personen.	15
Gebrauch von ZWN\Organisation in der Stadt\Performance Assessment	Dieser Code bezieht sich auf den Umgang der Stadt mit der Beurteilung des Nutzen und der Funktionen von Züri wie neu. Oft im Zusammenhang mit Fragen, die nach Statistiken oder einer Auswertung der Platform und deren Daten fragt.	3
Gebrauch von ZWN\Organisation in der Stadt\Performance Assessment\Externe Assessments (+)	Dieser Subcode von Performance Assessment umfasst Abschnitte, in welchen erzählt wird, wie und von wem die Leistungen von ZWN extern überprüft worden sind. 08.07.22 14:31 - lino Merged with code Gebrauch von ZWN\Organisation in der Stadt\Performance Assessment\Externe Assessments\Zufriedenheit der Nutzenden Zufriedenheit der Nutzenden Created: lino, 20.06.22 13:35 Dieser Code bezieht sich auf externe Assessments, welche Hauptsächlich die Zufriedenheit der Nutzenden untersucht hat.	3
Gebrauch von ZWN\Organisation in der Stadt\Performance Assessment\Interne Assessments	Dieser Code umfasst Textstellen, bei denen formuliert wird wie wann und von wem interne Assessments der Plattform vollzogen werden.	1

Interview guiding questions

Interview Leitfaden

Informationen
Datum:
Interviewte Person:
Ort:
Dauer:
Einwilligungserklärung:

1. Begrüssung

Danksagung
Frage ob Aufzeichnung erlaubt
3 Oberthemen: Implementierungsphase, Organisation innerhalb der Stadt, täglicher Betrieb

2. Einstieg

Kurzer Einschub zu Entstehungsgeschichte: 2013, Zürich spezifische Spezifizierungen in Zusammenarbeit mit mySociety und nun kamen immer mehr Dienstabteilungen dazu.

- Wie wurde die Plattform in die eigene IT und Organisation der Verwaltung integriert?
  - *Budget?*
  - *Hindernisse und Hürden?*
  - Wie reagierten Mitarbeitende auf die Einführung der Plattform?
  - *Gibt es Schnittstellen zu anderen IT-Lösungen?*

- Wie zufrieden sind sie mit der technischen Umsetzung der Plattform?

3. Hauptfragen

- Wie ist Züri wie neu eingegliedert in städtische Verwaltung und Departemente?
  - Wie werden die eingegangenen Schadensmeldungen delegiert?
    - Wer schreibt die Antworten?
    - Wie viele Stellen beschäftigen sich mit Züri wie neu?
  - Wie wird überprüft, ob Schäden geflickt worden sind?
    - *Was geschieht mit den Daten der Plattform?*
    - *Wie wurde entschieden welche Daten veröffentlicht werden?*
    - *Ist die Stadt sauberer/sicherer geworden?*
  - Wie wird die Plattform beworben?
    - Wie werden Entwicklungen rund um die Plattform kommuniziert?

- Wie läuft der Arbeitsprozess mit Züri wie neu ab?
  - Wie und wann arbeiten Sie mit der Plattform?
    - Wieviel Zeit beansprucht die Arbeit mit Züri wie neu?
    - Was ist für Sie die wichtigste Eigenschaft der Plattform?

Declaration of consent

Masterarbeit zu Züri wie neu

Einverständniserklärung für Interviewteilnehmende

Das Interview zwischen Lino Asper und [redacted] am 23.6.2022 10:00 fand im Rahmen der Masterarbeit zum Thema Interaktionen zwischen Regierung und Bevölkerung via der Plattform Züri wie neu statt. Es handelt sich um eine Masterarbeit der Fachrichtung GIS mit Aspekten der Humangeographie. Die Arbeit ist Bestandteil des Geographie-Studiums am Geographischen Institut der Universität Zürich (GIUZ) und wird von Prof. Dr. Ross Purves und Prof. Dr. Hanna Hilbrandt betreut.

Thema der Masterarbeit:
In dieser Arbeit wird die Forschungsfrage untersucht, wie die Interaktion zwischen Regierung und Bevölkerung über die Plattform Züri wie neu ausgehandelt wird. Interaktionen über die Plattform umfassen diverse Formen und Verhältnisse der Kontaktaufnahme von Bevölkerung und Regierung via genanntes Medium. Dadurch sollen neue und vertiefte Einsichten gewonnen werden, wie durch den Einsatz von GIS Plattformen das Verhältnis zwischen Politik und Bevölkerung (neu) ausgehandelt wird.

Verwendung Ihrer Aussagen und Anonymität:
Das Interview wurde auf Schweizerdeutsch geführt und wurde für die spätere Auswertung aufgezeichnet sowie in deutsche Sprache übersetzt. Ihre Aussagen können in verdichteter Form oder durch direkte Zitierung ausgewählter Passagen dazu verwendet werden, im Rahmen der Masterarbeit Forschungserkenntnisse zu erzielen. Die erhobenen Daten können zudem für die wissenschaftliche Weiterverarbeitung verwendet werden, z.B. für Artikel in wissenschaftlichen Publikationen oder Blogbeiträgen. Angaben zu Ihrer Person wie Name oder Departements-/Firmenzugehörigkeit werden in jedem Fall anonymisiert. Sie werden zudem die Gelegenheit haben, das Interview-Transkript gegenzulesen, ebenso wie Passagen der unveröffentlichten Masterarbeit, die explizit auf Ihre Aussagen verweisen, sollten Sie letzteres wünschen. Die fertige Masterarbeit wird innerhalb des Bibliothek-Katalogs der Universität Zürich öffentlich zugänglich sein. Auf Ihren Wunsch hin wird Ihnen die Arbeit zusätzlich per E-Mail zugesandt.

Datenschutz und Widerrufsrecht:
Die Transkription und inhaltliche Auswertung des Interviews erfolgen ausschliesslich durch mich. Ihre Daten und Interview-Transkripte werden stets nur auf lokalen Datenträgern gespeichert. Sie haben jederzeit das Recht, einzelne Aussagen oder Ihr Einverständnis zur Teilnahme am Forschungsprojekt rückwirkend vollumfänglich zu widerrufen. In diesem Fall werden die entsprechenden Daten gelöscht. Nach Abschluss der Arbeit werden die erhobenen Daten bis maximal zehn Jahre aufbewahrt und anschliessend gelöscht.

Bitte füllen sie die nachfolgenden Felder aus.

Sie haben die Inhalte dieses Formulars gelesen und sind mit ihnen einverstanden: Ja Nein

Name, Vorname: ……..

Ort, Datum: …….. Unterschrift: …….

Besten Dank für Ihre Unterstützung meiner Masterarbeit. Bei Fragen stehe ich Ihnen gerne zur Verfügung.

Freundliche Grüsse

Lino Asper

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076 383 70 76

Interviews

Interview	Date	Labelling
Interview 1	16.05.2022	20220516_Interview_Transkript_A1
Interview 2	20.05.2022	20220520_Interviewtranskript_A2
Interview 3	02.06.2022	20220602_Transkript_A3
Interview 4	01.06.2022	20220601_Transkript_A4
Interview 5	03.03.2022	20220603_Transkript_A5
Interview 6	23.06.2022	20220624_Interview_A6

R Scripts

GEO511_1

Lino Asper

6/8/2022

1. Loading data

1.1 Defining paths

1.2 loading data

```
#load data with sf package, transform crs
zh_wie_neu_basedata <- st_read(dsn = file.path(path, fn_zhwieneu), quiet = TRUE ) %>% st_transform(crs =
municipalities <- st_read(dsn = file.path(path, fn_municipalities), quiet = TRUE) %>% st_transform(crs =
districts <- st_read(dsn = file.path(path, fn_districts), quiet = T) %>% st_transform(crs = 2056)
population_basedata <- st_read(dsn = file.path(path, fn_population), quiet = T) %>% st_transform(crs = 
median_income <-read_csv('data/einkommen.csv')
```

```
## Rows: 2142 Columns: 8
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (2): QuarLang, SteuerTarifLang
## dbl (6): SteuerJahr, QuarSort, SteuerTarifSort, SteuerEinkommen_p50, SteuerE...
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
#filter out unnecessary columns in the datasets
zh_wie_neu_filtered <- zh_wie_neu_basedata %>% dplyr::select(objectid, service_code, status, media_url,
population_filtered <- population_basedata %>% dplyr::select(geometry, PERS_N)
```

1.3 Correct geometries

1.4 Plot the data points for service category

```
#bbox for visualization
bbox_new <- st_bbox(zh_wie_neu_filtered) # current bounding box

xrange <- bbox_new$xmax - bbox_new$xmin # range of x values
yrange <- bbox_new$ymax - bbox_new$ymin # range of y values
bbox_new[1] <- bbox_new[1] - (0.1 * xrange)
bbox_new[2] <- bbox_new[2] - (0.25 * yrange)
bbox_new[3] <- bbox_new[3] + (0.25 * xrange)
bbox_new[4] <- bbox_new[4] + (0.25 * yrange)

bbox_new <- bbox_new %>%  # take the bounding box ...
  st_as_sfc()
```

```
#plot the data for zhwm and the districts for the service category
tmap_mode('view')
```

```
## tmap mode set to interactive viewing
```

```
tm_shape(districts_corrected, bbox = bbox_new) +
  tm_polygons(id= 'qname',
              alpha = 0.01) +
tm_shape(zh_wie_neu_filtered) +
  tm_dots(title = "Service code",
          col = 'service_code',
          id = 'description') +
  tm_layout(title= 'All entries from Züri wie neu for each service code',
            legend.title.size = 1,
          legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
## legend.postion is used for plot mode. Use view.legend.position in tm_view to set the legend position
```

```
## PhantomJS not found. You can install it with webshot::install_phantomjs(). If it is installed, pleas
```

2.1 Histogram of counts per category.

```
#group by the service code and count reports per service code
category_count <- zh_wie_neu_filtered %>% group_by(service_code) %>% count()

#hashed out png or svg commands and corresponding device off commands can be found throughout the thesi
#png("reportcount.png", width = 6, height = 6, units = 'in', res = 300)
  ggplot(category_count, aes(service_code,n)) +
  geom_col() +
  theme(axis.text.x = element_text(angle = 90))+
  labs(title="Report count per service code") +
  ylab("Count") + xlab("Service code")
```

```
#dev.off()
```

2.2 Histogram of counts per district per category.

```
#calculating count values on district level per service code.
district_servicecat <- st_join(districts_corrected, zh_wie_neu_filtered, join = st_contains, left=T) %>%

#png("histogramreportcount.png", width = 6, height = 4, units = 'in', res = 300)
ggplot(district_servicecat, aes(qname,n, fill = service_code)) +
  geom_col() +
  theme(axis.text.x = element_text(angle = 90))+
  labs(title="Report count per district and service code", fill = "Service code") +
  ylab("Count") + xlab("District")
```

```
#dev.off()
```

3. Plot the overall count of entries

3.1 Compute population count on district level

```
#svg("populationdistrict.svg") #the symbols are not well placed, thus export as svg to manipulate in a 
tmap_mode('plot')
```

```
## tmap mode set to plotting
```

```
#join the two data frames on district borders and population, count population per district polygon via
dis_pop <- st_join(districts_corrected, population_filtered, join = st_contains, left=T)
dis_pop <- dis_pop %>% mutate(PERS_N = replace(dis_pop$PERS_N, dis_pop$PERS_N<0,0)) %>% group_by(qname)

tm_shape(st_centroid(dis_pop), bbox = bbox_new) +
  tm_dots(size = 'Totalpop',
          title.size = 'Population count',
             col = 'red',
             perceptual = TRUE,
          id = 'qname') +
tm_shape(dis_pop) +
  tm_polygons(alpha = 0.001) +
  tm_layout(title= 'Population count on district level',
            legend.title.size = 1,
          legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
## Legend labels were too wide. Therefore, legend.text.size has been set to 0.53. Increase legend.width
```

```
## The legend is too narrow to place all symbol sizes.
```

```
#dev.off()
```

3.2 Compute report count on district level

```
#svg("reportdistrict.svg")

#join the two data frames on district borders and zhwn entries into a new one
dis_zhwn <- st_join(districts_corrected, zh_wie_neu_filtered, join = st_contains, left=T)

#group by districts and count total entries per district
dis_zhwn <- dis_zhwn %>% group_by(qname) %>% count()

#visualization
tm_shape(st_centroid(dis_zhwn), bbox = bbox_new) +
  tm_symbols(title.size = 'Report count',
             col = 'blue',
              size = 'n',
              id = 'n' ) +
#these commands can be used for labelling of the district polygons
#tm_shape(dis_zhwn, bbox = bbox_new) +
  #tm_polygons("qname", legend.show = F, alpha = 0) +
  #tm_text("qname", size = 1/4) +
  tm_shape(dis_pop) +
  tm_polygons(alpha = 0.001) +
  tm_layout(title= 'Report count on district level',
```

```
           legend.title.size = 1,
          legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off()
```

3.3 Compute population count per grid

```
#create a grid, 200 x 200m appears to be a meaningful size as it is a walkable distance and enables a r

grid = zh_wie_neu_filtered %>% st_make_grid(cellsize = c(200, 200), what = "polygons", square = F) %>% s
  write_rds(grid, 'data/grid.rds')  #safe grid to use in other rmd files and load grid to save computat
  grid <- readRDS('data/grid.rds')

#join the grid with the population counts
population_grid <- st_join(grid, population_filtered, join = st_contains)

#clean data, all negative numbers to 0
population_grid <- population_grid %>% mutate(PERS_N = replace(population_grid$PERS_N, population_grid$l
population_grid <- population_grid %>% group_by(ID) %>% summarise(totalpop = sum(PERS_N))
  #saveRDS(population_grid, 'data/population_per_grid200.rds') #save the grid and load it to lower comp
population_grid <- readRDS('data/population_per_grid200.rds')

#png("residentpopgrid.png", width = 6, height = 6, units = 'in', res = 300)
tmap_mode('plot')
```

```
## tmap mode set to plotting
```

```
tm_shape(population_grid, bbox = bbox_new) +
  tm_polygons(title = 'Population count',
              as.count = T,
              col = 'totalpop',
              palette = "Reds",
              breaks = c(0, 43, 133, 227, 336, 470, 1202),
              id = 'totalpop',
              n = 6, lwd = 0.05) +
  tm_layout(title= 'Resident population count on grid level',
          legend.title.size = 1,
          legend.text.size = 0.6,
          legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off()
```

3.5 Compute report count per grid

```
#join the grid from above with the züri wie neu data to get reports per grid
  report_grid <- st_join(grid, zh_wie_neu_filtered, join = st_contains, left=T)
  st_geometry(report_grid) <- 'x' #set geometry
  write_rds(report_grid, 'data/report_grid.rds') #save reports per grid to lower computation time
  report_grid <- readRDS('data/report_grid.rds') #load reports per grid

#count reports per grid cell
```

```
  report_grid_count <- report_grid %>% group_by(ID) %>% summarise(n = sum(!is.na(objectid)))
  saveRDS(report_grid_count, 'data/report_grid_count.rds')   #write and load sf object due to long comp
  report_grid_count <- read_rds('data/report_grid_count.rds')

#png("reportcountgrid.png", width = 6, height = 6, units = 'in', res = 300)
report_grid_count$n = as.numeric(report_grid_count$n)
tmap_mode('plot')
```

```
## tmap mode set to plotting
```

```
tm_shape(report_grid_count, bbox = bbox_new) +
  tm_polygons(title = 'Report count',
              as.count = TRUE,
              col = 'n',
              id = 'n',
              palette = 'Blues',
              breaks = c(0,1,2,6,12,23,286), #there was an error with the standardized quantile style a
              showNA = F, lwd = 0.05)+
  tm_layout(title= 'Report count on grid level',
            legend.title.size = 1,
           legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off()
```

3.6 Compute and plot normalized report counts per grid

```
#join datasets population per grid and counts for normalized counts
normalization <- st_join(population_grid, report_grid_count, join = st_equals) %>% distinct()
#normalized entry column
normalization_grid <- normalization %>% mutate(totalpop = replace(totalpop, is.na(totalpop), 0),
                                               n = replace(n, is.na(n), 0 ),
                                               normalizedcount = round(n/totalpop, 4), #round the
                                               normalizedcount = replace(normalizedcount, is.infin
#visualization
#png("normalizedreportcount.png", width = 6, height = 6, units = 'in', res = 300)
tm_shape(normalization_grid, bbox = bbox_new) +
  tm_polygons(title = "Normalized count",
              as.count = TRUE,
              col = 'normalizedcount',
              id = 'normalizedcount',
              palette = 'Purples',
              style = 'quantile',
              n = 6, lwd = 0.005) +
  tm_layout(title= 'Normalized report count by resident population',
            legend.title.size = 1,
           legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off()
```

4. Report density with daytime population

4.1 Get population counts for daytime population

```
#read population data
density <- read_csv('data/density.csv') %>% rowid_to_column()
```

```
## Rows: 9545 Columns: 7
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## dbl  (6): tile_id, score, lower_left_lon, lower_left_lat, upper_right_lon, u...
## date (1): time
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
#as the daytime_pop dataset has four columnns with geometric information (lower left point of the grid
density2 <- density %>% dplyr::select(c('rowid','lower_left_lon','lower_left_lat'))  %>% st_as_sf(coord

density <- density %>% st_as_sf(coords = c('upper_right_lon', 'upper_right_lat'), crs = 4326) %>%  as.d

daytime_pop <- left_join(density, density2, by = 'rowid') %>% st_as_sf %>% st_transform(crs = 2056)

#instead of calculating the grid, the centroids of the 100x100 grid were calculated which can later be
daytime_pop$geometry = daytime_pop$geometry.x + (daytime_pop$geometry.x-daytime_pop$geometry.y)/2

#activate the centroid
st_geometry(daytime_pop) <- 'geometry'

#delete other geometry columns, set crs
daytime_pop = daytime_pop %>% dplyr::select(-c(geometry.x, geometry.y))  %>% st_set_crs(2056) %>% mutat
```

4.2 Compute population count on grid level for daytime population

```
#join the swisscom grid with intitially used grid
population_grid_swisscom <- st_join(grid, daytime_pop, join = st_intersects, left=T)

population_grid_swisscom$totalpop <- as.integer(population_grid_swisscom$totalpop)
#save for use in other scripts
saveRDS(population_grid_swisscom, 'data/population_grid_swisscom.rds')

#plot
#png("daytimepop.png", width = 6, height = 6, units = 'in', res = 300)
tm_shape(population_grid_swisscom, bbox = bbox_new) +
  tm_polygons(title = "Population count",
              as.count = TRUE,
              col = 'score',
              id = 'score',
              palette = 'Reds',
              breaks = c(0, 222, 805, 1248, 1794, 2854, 14832), #there was again agan error with the st
        lwd = 0.005) +
  tm_layout(title= 'Daytime population count on grid level',
            legend.title.size = 1,
           legend.text.size = 0.6,
```

```
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off()
```

4.3 Compute and plot normalized report density on grid level for daytime population

```
#join datasets population per grid and counts for normalized counts
normalization_swisscon <- st_join(population_grid_swisscom, report_grid_count, join = st_equals) %>% di
#normalized entry column as in n
normalization_grid_swisscom <- normalization_swisscon %>% mutate(totalpop = replace(totalpop, is.na(tot
                                                                  n = replace(n, is.na(n), 0 ),
                                                                  normalizedcount = round(n/totalpop, 4
                                                                  normalizedcount = replace(normalizedc


#visualization
#png("normlaizedreportcount_daytime.png", width = 6, height = 6, units = 'in', res = 300)
tm_shape(normalization_grid_swisscom, bbox = bbox_new) +
  tm_polygons(title = "Normalized count",
              col = 'normalizedcount',
              palette = 'Purples',
              id = 'normalizedcount', style = 'quantile', n= 6, lwd = 0.005) +
  tm_layout(title= 'Normalized report count by daytime population',
            legend.title.size = 1,
           legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off()
```

4.4 Check the distribution of the normalized values

```
#png("normalizedhistogram_reportcounts.png", width = 6, height = 4, units = 'in', res = 300)
ggplot(normalization_grid_swisscom, aes(rowid,normalizedcount)) +
  geom_line() +
  ylim(0,max(normalization_grid_swisscom$normalizedcount, na.rm = TRUE))+
  labs(title="Histogram of all report counts") +
  ylab("Count") + xlab("Grid cells")
```

```
#dev.off()
```

5. Check hotspot with getis ord

```
#define neighboorhod list and weights (binary), important to choose the grid polygons as geometry not t

nb_grid_report <- poly2nb(report_grid_count)
fixed_weights <- nb2listw(nb_grid_report, style = "B")

#calculate getis ord, append to dataframe, to global G test
report_grid_count$getisord <- spdep::localG(report_grid_count$n, listw = fixed_weights)
globalG.test(report_grid_count$n, listw = fixed_weights, alternative = "two.sided")
```

```
#visualization
tmap_mode('plot')
```

```
## tmap mode set to plotting
```

```
#png("getisord_overall.png", width = 6, height = 6, units = 'in', res = 300)
tm_shape(report_grid_count, bbox = bbox_new) +
  tm_polygons(title = "Getis ord",
              style = "cont",
              id = 'getisord',
              col = 'getisord',
              midpoint = NA) +
  tm_layout(title= 'Getis ord of all reports',
            legend.title.size = 1,
            legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
  #+tm_shape(zh_wie_neu_filtered)+
  #tm_dots(id = 'service_notice')
#dev.off()
```

6. Check for spatial correlation of report counts and taxable income

6.1 Compute median taxable income for grid level aggregation

```
#only look at most recent year. Some districts have missing valies (over all years) which might be due
median_income2019 <-  median_income %>% filter(SteuerJahr == 2019) %>% na.omit()

#as the data set differentiates between three different tax categories, the mean of all three categorie
median_income2019 <- median_income2019 %>% group_by(QuarLang) %>% summarise(meantax = mean(SteuerEinkom

#join district data set for geographic representation
median_income_spatial <- merge(x = median_income2019, y = districts_corrected, by.x = 'QuarLang', by.y =

saveRDS(median_income_spatial, 'median_income_spatial.rds')
#join with grid via intersection
tax_reportcount_grid <- st_join(report_grid_count, median_income_spatial, join = st_intersects, left=T)

#visualization
#svg('scalebar.svg') #export as svg for scalebar for LISA plot
tm_shape(tax_reportcount_grid, bbox = bbox_new) +
  tm_polygons(col = 'meantax',
              id = 'meantax',
              n = 7) +
  tm_layout(title= 'Median taxable income on grid level',
            legend.title.size = 1,
           legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off() #closing graphical device.
```

6.2 Compare report counts and taxable income per grid

6.2.1 bivariate LISA for grid level

```
#delete NA values, else weights function and bimoran function does not work properly
tax_reportcount_grid <- tax_reportcount_grid %>% na.omit()

#calculate spatial weights. Queen as all eight possible neighbors are valid neighbors in our case.
wij <- rgeoda::queen_weights(tax_reportcount_grid)

#calculate bivariate moran's i
qsa <- local_bimoran(wij, tax_reportcount_grid[c('n', 'meantax')])
  lisa_colors <- lisa_colors(qsa)
  lisa_labels <- lisa_labels(qsa)
  lisa_clusters <- lisa_clusters(qsa)

#svg('lisa.svg') #save as svg to modify legend and add scale bar manually as the author did not manage
plot(st_geometry(tax_reportcount_grid),
     col=sapply(lisa_clusters,function(x){return(lisa_colors[[x+1]])}),
     border = "#333333", lwd=0.2)
     title(main = "Bivariate LISA") +
     title(sub = "Median taxable income and report counts on grid level", line = -16)
     legend('bottomleft', legend = lisa_labels, fill = lisa_colors,
     border = "#eeeeee")
```

```
#dev.off() #closing graphical device.
```

6.2.2 Spearmans Rank Correlation Test for grid level

```
#spearmans rank correlation test is a non-parametric test, suitable for variables not meeting the norma
#null hyptohesis is that the values of income and report count are randomly distributed
#the alternative hyptohesis of interest is that income and report count are correlated.
corr_income_reportcount <- cor.test(x=tax_reportcount_grid$meantax, y=tax_reportcount_grid$n, method =
corr_income_reportcount
```

GEO511_2

Lino Asper

6/8/2022

1. Loading data

1.1 Defining paths

1.2 Loading data

1.3 Correct geometries

```
#check for errors in geometry

st_is_valid(districts)
st_is_valid(municipalities)

st_is_longlat(municipalities)
st_is_longlat(districts) #if true, oriented = True in st_make_valid

sf_use_s2(FALSE) #see https://github.com/r-spatial/sf/issues/1732

municipalities_corrected = st_make_valid(municipalities, oriented= TRUE)
districts_corrected = st_make_valid(districts)

st_is_valid(municipalities_corrected)
st_is_valid(districts_corrected)
```

2. Response time

2.1 calculate response time, make boxplot

```
#convert time column to datetime
zh_wie_neu_filtered<-zh_wie_neu_filtered %>% mutate(updated_datetime = as_datetime(updated_datetime),
                                                    requested_datetime = as_datetime(requested_datetime)
#calculate response time variable via the two available time stamps and time_length function from lubri
zh_wie_neu_filtered <- zh_wie_neu_filtered %>% mutate(response_time = time_length(updated_datetime-requ

#plot the responsetime
reponsetimeplot = ggplot(zh_wie_neu_filtered, aes(x=service_code, y=response_time)) +
                  geom_boxplot() +
                  theme(axis.text.x = element_text(angle = 70,hjust=1))

#compute lower and upper whiskers
ylim1 = boxplot.stats(zh_wie_neu_filtered$response_time)$stats[c(1, 5)]
```

```
#scale y limits based on ylim1
#png("responsetime_boxplots.png", width = 6, height = 4, units = 'in', res = 300)
reponsetimeplot + coord_cartesian(ylim = ylim1*1.5) +
  labs(title="Response time per service code") +
  ylab("Response time") + xlab("Service code")
```

```
#dev.off()
```

2.2 map response time as points

```
#bbox for map visualization
bbox_new <- st_bbox(zh_wie_neu_filtered) # current bounding box

xrange <- bbox_new$xmax - bbox_new$xmin # range of x values
yrange <- bbox_new$ymax - bbox_new$ymin # range of y values
bbox_new[1] <- bbox_new[1] - (0.1 * xrange)
bbox_new[2] <- bbox_new[2] - (0.25 * yrange)
bbox_new[3] <- bbox_new[3] + (0.25 * xrange)
bbox_new[4] <- bbox_new[4] + (0.25 * yrange)

bbox_new <- bbox_new %>%  # take the bounding box ...
  st_as_sfc()

#mapping response time, log10 transfrom for visualization
tm_shape(zh_wie_neu_filtered, bbox = bbox_new) +
  tm_dots(title = "Response time",
          col = 'response_time',
          id = 'response_time',
          style = 'log10') +
  tm_shape(districts_corrected) +
  tm_polygons(id= 'qname',
              alpha = 0.01)+
  tm_layout(title= 'Response time for every entry',
            legend.title.size = 1,
            legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

2.3.1 Zonal Statistics of response time

```
#for the cell statistics we can use the grid from section 2 again. Intersect the grid polygons/cells wi
grid <- readRDS('data/grid.rds')
response_grided <- st_join(grid, zh_wie_neu_filtered, join = st_contains)
#calculate standard deviation and mean for each grid cell
response_grided <- response_grided %>% group_by(ID) %>% mutate(mean_response_time = mean(response_time)

#join back to the grid for aggregation on grid level
response_time_grid <- left_join(response_grided %>% as_tibble(),grid %>% as_tibble(), by = 'ID')  %>% s

#visualization
p1 <- tm_shape(response_time_grid, bbox = bbox_new) +
```

```
  tm_fill(
    col = "mean_response_time",
    palette = "Reds",
    style = "cont",
    contrast = c(0.1, 1),
    title = "Mean response time",
    id = "mean_response_time",
    showNA = FALSE,
    alpha = 0.8,
    popup.vars = c(
      "Mean Response Time" = "mean_response_time"
    ),
    popup.format = list(
      mean_response_time = list(format = "f", digits = 0)
    )) +
  tm_layout(title= 'Mean response time for each grid',
            legend.title.size = 1,
           legend.text.size = 0.6,
             legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
#visualize report counts, helps to look closer at the mean/sd
#   +tm_shape(report_grid_count)+
#   tm_polygons(col = "n", id = "n", alpha = 0.001) +
#visualize all reports as points, helps to look closer at the underlying report texts and answers from
# tm_shape(zh_wie_neu_category) +
#    tm_dots( id = 'service_notice',
#             col = 'blue',
#             size = 0.01,
#             alpha = 0.1)

p2 <- tm_shape(response_time_grid, bbox = bbox_new) +
  tm_fill(
    col = "sd_response_time",
    palette = "Blues",
    style = "cont",
    contrast = c(0.1, 1),
    title = "Standard deviation of response times",
    id = "sd_response_time",
    showNA = FALSE,
    alpha = 0.8,
    popup.vars = c(
      "Standard deviation of response times" = "sd_response_time"
    ),
    popup.format = list(
      sd_response_time = list(format = "f", digits = 0)
    )) +
  tm_layout(title= 'Standard deviation of the response time for each grid',
            legend.title.size = 1,
           legend.text.size = 0.6,
             legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
#visualize report counts, helps to look closer at the mean/sd
#   +tm_shape(report_grid_count)+
```

```
#   tm_polygons(col = "n", id = "n", alpha = 0.001) +
#visualize all reports as points, helps to look closer at the underlying report texts and answers from
# tm_shape(zh_wie_neu_category) +
#    tm_dots( id = 'service_notice',
#             col = 'blue',
#             size = 0.01,
#             alpha = 0.1)

#t <- tmap_arrange(p1, p2, nrow = 1, ncol = 2)
png("responsetime_mean.png", width = 6, height = 6, units = 'in', res = 300)
p1
dev.off()
png("responsetime_sd.png", width = 6, height = 6, units = 'in', res = 300)
p2
dev.off()
```

2.3.2 Zonal Statistics of response time, outlier removed

```
#this part is the same as in 2.3.1  but without outliers to better investigate the distribution of the

#for the cell statistics we can use the grid from section 2 again. Intersect the grid polygons/cells wi
grid <- readRDS('data/grid.rds')
response_grided <- st_join(grid, zh_wie_neu_filtered, join = st_contains)

#calculate standard deviation and mean for each grid cell
response_grided <- response_grided %>% group_by(ID) %>% mutate(mean_response_time = mean(response_time)
                                                               sd_response_time = stats::sd(response_ti

#join back to the grid for aggregation on grid level
response_time_grid <- left_join(response_grided %>% as_tibble(),grid %>% as_tibble(), by = 'ID')  %>% s

#remove outliers
response_time_grid <- response_time_grid %>% filter(mean_response_time < 20, sd_response_time < 20)

#import report counts to overlay with the response time grid
report_grid_count <- read_rds('data/report_grid_count.rds')

p1 <-
   tm_shape(report_grid_count, bbox = bbox_new)+
    tm_fill(
   id = "n"
  ) +
  tm_shape(response_time_grid, bbox = bbox_new) +
  tm_fill(
    col = "mean_response_time",
    palette = "Reds",
    style = "cont",
    contrast = c(0.1, 1),
    title = "Mean response time",
    id = "mean_response_time",
    showNA = FALSE,
    alpha = 0.8,
```

```
    popup.vars = c(
      "Mean Response Time" = "mean_response_time"
    ),
    popup.format = list(
      mean_response_time = list(format = "f", digits = 0)
    )
  ) +
  tm_borders(col = "darkgray", lwd = 0.7) +
  tm_layout(title= 'Mean response time (outliers removed)',
            legend.title.size = 1,
           legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))

p2 <-
   tm_shape(report_grid_count, bbox = bbox_new)+
  tm_fill(
  id = "n"
  ) +
  tm_shape(response_time_grid, bbox = bbox_new) +
  tm_fill(
    col = "sd_response_time",
    palette = "Blues",
    style = "cont",
    contrast = c(0.1, 1),
    title = "Standard deviation of response times",
    id = "sd_response_time",
    showNA = FALSE,
    alpha = 0.8,
    popup.vars = c(
      "Standard deviation of response times" = "sd_response_time"
    ),
    popup.format = list(
      sd_response_time = list(format = "f", digits = 0)
    )
  ) +
  tm_borders(col = "darkgray", lwd = 0.7)+
  tm_layout(title= 'Standard deviation of the response time (outliers removed)',
            legend.title.size = 1,
           legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))

#t <- tmap_arrange(p1, p2, nrow = 1, ncol = 2)
#png("responsetime_mean_outlierremoved.png", width = 6, height = 6, units = 'in', res = 300)
p1
```

```
#dev.off()
#png("responsetime_sd_outlierremoved.png", width = 6, height = 6, units = 'in', res = 300)
p2
```

```
#dev.off()
```

3. report status

3.1 plot report status counts

```
reportstatus <- zh_wie_neu_filtered %>% group_by(status) %>% count()

#png("reportstatus.png", width = 6, height = 4, units = 'in', res = 300)

ggplot(reportstatus, aes(x = status, label = n)) +
  geom_col(aes(y = n)) +
  geom_text(aes(label = n, y = n), size = 3, position = position_stack(vjust = 0.8), col = 'violet') +
  labs(title="Histogram of report status") +
  ylab("Count") + xlab("Report status")
```

```
#dev.off()
```

4. Interface used to report

4.1 bar chart of the interface

```
reportinterface <- zh_wie_neu_filtered %>% group_by(interface_used) %>% count()

ggplot(reportinterface, aes(x = interface_used, label = n)) +
  geom_col(aes(y = n)) +
  geom_text(aes(label = n, y = n), size = 3, position = position_stack(vjust = 0.8), col = 'violet') +
  labs(title="Histogram of interface used to report") +
ylab("Count") + xlab("Interface")
```

GEO511_NLP

Lino Asper

2/21/2022

1. Loading data

1.1 Defining paths

1.2 Loading data

1.3 Correct geometries

```
#check for errors in geometry
st_is_valid(districts)
st_is_valid(municipalities)

st_is_longlat(municipalities)
st_is_longlat(districts) #if true, oriented = True in st_make_valid

sf_use_s2(FALSE) #see https://github.com/r-spatial/sf/issues/1732

municipalities_corrected = st_make_valid(municipalities, oriented= TRUE)
districts_corrected = st_make_valid(districts)

st_is_valid(municipalities_corrected)
st_is_valid(districts_corrected)
```

2. Natural language processing of response texts

2.1 Plot response lenght per category

```
#get column as character
zh_wie_neu_filtered$service_notice <- as.character(zh_wie_neu_filtered$service_notice)

#calculate length
zh_wie_neu_filtered$TextLength <- nchar(zh_wie_neu_filtered$service_notice)

#plot length per category
TextLengthplot = ggplot(zh_wie_neu_filtered, aes(x=service_code, y=TextLength)) +
  geom_boxplot() +
  theme(axis.text.x = element_text(angle = 70,hjust=1))

#compute lower and upper whiskers
ylim1 = boxplot.stats(zh_wie_neu_filtered$TextLength)$stats[c(1, 5)]
```

```
#scale y limits based on ylim1
#png("responselenghtboxplot.png", width = 6, height = 4, units = 'in', res = 300) #again all png/svg +
TextLengthplot + coord_cartesian(ylim = ylim1*1.8) +
  labs(title = "Response length per service code") + ylab("Text length") + xlab("Service code")
```

```
#dev.off()
```

2.2 Get datasets for every service category, remove empty responses

3. Tokenization, stemming, removing stopwords

```
#make tokens for all responses, lower capital letters, remove stopwords, stem the tokens
#make function, distinguishes between listed and unlisted as we need listed
tokenize <- function(wordvector) {

tokens(wordvector, what = 'word', remove_punct = TRUE, remove_symbols = TRUE, remove_numbers = TRUE, re
tokens_remove(pattern =  c('br', 'dass', 'freundliche', 'freundlich', 'gruss', 'grüsse', 'stadt', 'züri
tokens_wordstem(language = 'german') %>%
  tokens_tolower() %>%
    tokens_remove(pattern = stopwords("de")) %>%
        tokens_keep(pattern = "^[\\p{script=Latn}]+$", valuetype = "regex") }
```

3.1 Tokenization, stemming, removing stopwords and calculate frequency and wordcount per service name/category

```
abfall_sammelstellen_tokens <- tokenize(abfall_sammelstellen$service_notice)

allgemein_tokens <- tokenize(allgemein$service_notice)
beleuchtung_uhren_tokens <- tokenize(beleuchtung_uhren$service_notice)
brunnen_hydranten_tokens <- tokenize(brunnen_hydranten$service_notice)

graffiti_tokens <- tokenize(graffiti$service_notice)
gruenflaechen_spielplaetze_tokens <- tokenize(gruenflaechen_spielplaetze$service_notice)
schädlinge_tokens <- tokenize(schädlinge$service_notice)
signalisation_tokens <- tokenize(signalisation$service_notice)
strasse_trottoir_tokens <- tokenize(strasse_trottoir$service_notice)
vbz_oev_tokens <- tokenize(vbz_oev$service_notice)
```

4. Cosine similiarity

```
#calculate cosine similarity via textstat_simil function which needs document feature matrix as input d
allgemein_cosine <- dfm(allgemein_tokens) %>% textstat_simil(method = "cosine", margin = "documents") %:
abfall_sammelstellen_cosine <- dfm(abfall_sammelstellen_tokens) %>% textstat_simil(method = "cosine", ma
beleuchtung_uhren_cosine <- dfm(beleuchtung_uhren_tokens) %>% textstat_simil(method = "cosine", margin =
brunnen_hydranten_cosine <- dfm(brunnen_hydranten_tokens) %>% textstat_simil(method = "cosine", margin =
graffiti_cosine <- dfm(graffiti_tokens) %>% textstat_simil(method = "cosine", margin = "documents") %>%
gruenflaechen_spielplaetze_cosine <- dfm(gruenflaechen_spielplaetze_tokens) %>% textstat_simil(method =
schädlinge_cosine <- dfm(schädlinge_tokens) %>% textstat_simil(method = "cosine", margin = "documents")
signalisation_cosine <- dfm(signalisation_tokens) %>% textstat_simil(method = "cosine", margin = "docume
strasse_trottoir_cosine <- dfm(strasse_trottoir_tokens) %>% textstat_simil(method = "cosine", margin =
vbz_oev_cosine <- dfm(vbz_oev_tokens) %>% textstat_simil(method = "cosine", margin = "documents") %>%
```

```
#make dataframe for visualization
servicecode <- c(unique(zh_wie_neu_filtered$service_code))#handles

#calculate mean cosine similarity as the values are calculated for each document to each other document
mean_cosinesimilarity <- c(round(mean(strasse_trottoir_cosine$cosine), 3), round(mean(abfall_sammelstel

#make dataframe to latter visualize via ggplot
cosine_df <- data.frame(servicecode, mean_cosinesimilarity)

#png("cosine_simil.png", width = 6, height = 4, units = 'in', res = 300)
ggplot(cosine_df, aes(servicecode, mean_cosinesimilarity)) +
  geom_col() +
 theme(axis.text.x = element_text(angle = 70,hjust=1)) +
  labs(title="Mean Cosine Similarity of Response Texts") +
  ylab("Mean Cosine Similarity") + xlab("Service Code")
```

```
#dev.off()
```

5. Topic modelling

```
#the parameter k was set to 3 as it resulted in a little to no words in more than one topic for almost


allgemein_lda <- textmodel_lda(allgemein_tokens %>% dfm() %>%
              dfm_trim(min_termfreq = 0.8, termfreq_type = "quantile"), k = 3) #make the topics based o
allgemein_terms <- terms(allgemein_lda, 5)#save as variable to be able to change column names. Only rel

abfall_sammelstellen_lda <- textmodel_lda(abfall_sammelstellen_tokens %>% dfm() %>%
              dfm_trim(min_termfreq = 0.8, termfreq_type = "quantile"), k = 3)
abfall_terms <- terms(abfall_sammelstellen_lda, 5)

beleuchtung_uhren_lda <- textmodel_lda(beleuchtung_uhren_tokens %>% dfm() %>%
              dfm_trim(min_termfreq = 0.8, termfreq_type = "quantile"), k = 3)
beleuchtung_terms <- terms(beleuchtung_uhren_lda, 5)


brunnen_hydranten_lda <- textmodel_lda(brunnen_hydranten_tokens %>% dfm() %>%
              dfm_trim(min_termfreq = 0.8, termfreq_type = "quantile"), k = 3)
brunnen_hydranten_terms <- terms(brunnen_hydranten_lda, 5)


graffiti_lda <- textmodel_lda(graffiti_tokens %>% dfm() %>%
              dfm_trim(min_termfreq = 0.8, termfreq_type = "quantile"), k = 3)
graffiti_terms <- terms(graffiti_lda, 5)


gruenflaechen_spielplaetze_lda <- textmodel_lda(gruenflaechen_spielplaetze_tokens %>% dfm() %>%
              dfm_trim(min_termfreq = 0.8, termfreq_type = "quantile"), k = 3)
gruenflaechen_terms <- terms(gruenflaechen_spielplaetze_lda, 5)


schädlinge_lda <- textmodel_lda(schädlinge_tokens %>% dfm() %>%
```

```
              dfm_trim(min_termfreq = 0.8, termfreq_type = "quantile"), k = 3)
schädlinge_terms <- terms(schädlinge_lda, 5)


signalisation_lda <- textmodel_lda(signalisation_tokens %>% dfm() %>%
              dfm_trim(min_termfreq = 0.8, termfreq_type = "quantile"), k = 3)
signalisation_terms <- terms(signalisation_lda, 5)


strasse_trottoir_lda <- textmodel_lda(strasse_trottoir_tokens %>% dfm() %>%
              dfm_trim(min_termfreq = 0.8, termfreq_type = "quantile"), k = 3)
strasse_terms <- terms(strasse_trottoir_lda, 5)

vbz_oev_lda <- textmodel_lda(vbz_oev_tokens %>% dfm() %>%
              dfm_trim(min_termfreq = 0.8, termfreq_type = "quantile"), k = 3)
vbz_terms <- terms(vbz_oev_lda, 5)

#visualization
#prepare dataframes for all topic models of each service code
all_topic_df <- as.data.frame(allgemein_terms)
all_topic_df$Servicecode = 'Allgemein'
names(all_topic_df)[1] = 'Topic 1'
names(all_topic_df)[2] = 'Topic 2'
names(all_topic_df)[3] = 'Topic 3'
names(all_topic_df)[4] = 'Service Code'

abfall_topic_df <- as.data.frame(abfall_terms)
abfall_topic_df$Servicecode = 'Abfall/Sammelstellen'
names(abfall_topic_df)[1] = 'Topic 1'
names(abfall_topic_df)[2] = 'Topic 2'
names(abfall_topic_df)[3] = 'Topic 3'
names(abfall_topic_df)[4] = 'Service Code'

beleucht_topic_df <- as.data.frame(beleuchtung_terms)
beleucht_topic_df$Servicecode = 'Beleuchtung/Uhren'
names(beleucht_topic_df)[1] = 'Topic 1'
names(beleucht_topic_df)[2] = 'Topic 2'
names(beleucht_topic_df)[3] = 'Topic 3'
names(beleucht_topic_df)[4] = 'Service Code'

brunnen_topic_df <- as.data.frame(brunnen_hydranten_terms)
brunnen_topic_df$Servicecode = 'Brunnen/Hydranten'
names(brunnen_topic_df)[1] = 'Topic 1'
names(brunnen_topic_df)[2] = 'Topic 2'
names(brunnen_topic_df)[3] = 'Topic 3'
names(brunnen_topic_df)[4] = 'Service Code'

graffiti_topic_df <- as.data.frame(graffiti_terms)
graffiti_topic_df$Servicecode = 'Graffiti'
names(graffiti_topic_df)[1] = 'Topic 1'
names(graffiti_topic_df)[2] = 'Topic 2'
names(graffiti_topic_df)[3] = 'Topic 3'
names(graffiti_topic_df)[4] = 'Service Code'
```

```
gruen_topic_df <- as.data.frame(gruenflaechen_terms)
gruen_topic_df$Servicecode = 'Grünflächen/Spielplätze'
names(gruen_topic_df)[1] = 'Topic 1'
names(gruen_topic_df)[2] = 'Topic 2'
names(gruen_topic_df)[3] = 'Topic 3'
names(gruen_topic_df)[4] = 'Service Code'

schad_topic_df <- as.data.frame(schädlinge_terms)
schad_topic_df$Servicecode = 'Schädlinge'
names(schad_topic_df)[1] = 'Topic 1'
names(schad_topic_df)[2] = 'Topic 2'
names(schad_topic_df)[3] = 'Topic 3'
names(schad_topic_df)[4] = 'Service Code'

sign_topic_df <- as.data.frame(signalisation_terms)
sign_topic_df$Servicecode = 'Signalisation'
names(sign_topic_df)[1] = 'Topic 1'
names(sign_topic_df)[2] = 'Topic 2'
names(sign_topic_df)[3] = 'Topic 3'
names(sign_topic_df)[4] = 'Service Code'

strass_topic_df <- as.data.frame(strasse_terms)
strass_topic_df$Servicecode = 'Strasse'
names(strass_topic_df)[1] = 'Topic 1'
names(strass_topic_df)[2] = 'Topic 2'
names(strass_topic_df)[3] = 'Topic 3'
names(strass_topic_df)[4] = 'Service Code'

vbz_topic_df <- as.data.frame(vbz_terms)
vbz_topic_df$Servicecode = 'VBZ/ÖV'
names(vbz_topic_df)[1] = 'Topic 1'
names(vbz_topic_df)[2] = 'Topic 2'
names(vbz_topic_df)[3] = 'Topic 3'
names(vbz_topic_df)[4] = 'Service Code'

#there was a problem with GT save and png format due to the operating system (macos), therefore the out
topic_df_1 <- rbind(all_topic_df, abfall_topic_df, beleucht_topic_df)
topic_df_1 <- topic_df_1[, c(4, 1, 2, 3)]

topic_df_2 <- rbind(brunnen_topic_df, graffiti_topic_df, gruen_topic_df)
topic_df_2 <- topic_df_2[, c(4, 1, 2, 3)]

topic_df_3 <- rbind(strass_topic_df, sign_topic_df, schad_topic_df, vbz_topic_df)
topic_df_3 <- topic_df_3[, c(4, 1, 2, 3)]

#load gt for nicer visualization possibiities
p_load("gt")
p_load('webshot2')

#style gt table
topic_gt_1 <- topic_df_1 %>% gt(groupname_col = "Service Code") %>% tab_header(title = md('**Topic Mode

topic_gt_2 <- topic_df_2 %>% gt(groupname_col = "Service Code") %>% tab_header(title = md('**Topic Mode
```

5

```
topic_gt_3 <- topic_df_3 %>% gt(groupname_col = "Service Code") %>% tab_header(title = md('**Topic Model

#save as html
topic_gt_1 %>% gtsave(filename = "topicmodelling_gt_1.html", path = "/Users/lino/Desktop/Master thesis/l

topic_gt_2 %>% gtsave(filename = "topicmodelling_gt_2.html", path = "/Users/lino/Desktop/Master thesis/l

topic_gt_3 %>% gtsave(filename = "topicmodelling_gt_3.html", path = "/Users/lino/Desktop/Master thesis/l
```

6. Generate wordcloud for overall textual content

```
zhwn_frequency_wc <- tokens(zh_wie_neu_filtered$service_notice, what = 'word', remove_punct = TRUE, rem
  tokens_tolower() %>%
    tokens_remove(pattern = stopwords("de")) %>%
      tokens_remove(pattern = c('br', 'dass', 'freundliche', 'grüsse', 'stadt', 'zürich', 'besten', 'da
        tokens_keep(pattern = "^[\\p{script=Latn}]+$", valuetype = "regex") %>%
          #tokens_wordstem(language = 'german') %>%
            unlist() %>%
            table() %>%
              as.data.frame() %>%
                arrange(desc(Freq)) %>%
                  dplyr::rename(word = 1, frequency = 2)

#png("wordcloudoverall.png", width = 6, height = 6, units = 'in', res = 300)
wordcloud(zhwn_frequency_wc$word, zhwn_frequency_wc$frequency, min.freq = 50, scale=c(2.5,.5),
          max.words=Inf, random.order=FALSE, rot.per = 0,
          colors=brewer.pal(5, "Blues"))
```

```
#dev.off()

#wordcloud for most diverse (schädlinge)
category = 'Schädlinge'
zh_wie_neu_category = zh_wie_neu_filtered %>% filter(service_code == category)

zhwn_frequency_wc <- tokens(zh_wie_neu_category$service_notice, what = 'word', remove_punct = TRUE, rem
  tokens_tolower() %>%
    tokens_remove(pattern = stopwords("de")) %>%
      tokens_remove(pattern = c('br', 'dass', 'freundliche', 'grüsse', 'stadt', 'zürich', 'besten', 'da
        tokens_keep(pattern = "^[\\p{script=Latn}]+$", valuetype = "regex") %>%
          #tokens_wordstem(language = 'german') %>%
            unlist() %>%
            table() %>%
              as.data.frame() %>%
                arrange(desc(Freq)) %>%
                  dplyr::rename(word = 1, frequency = 2)

#png("wordcloudschaedlinge.png", width = 6, height = 6, units = 'in', res = 300)
wordcloud(zhwn_frequency_wc$word, zhwn_frequency_wc$frequency, min.freq = 50, scale=c(2.5,.5),
          max.words=Inf, random.order=FALSE, rot.per = 0,
          colors=brewer.pal(5, "Blues"))
```

```
#dev.off()

#wordcloud for least divers category (allgemein)
category = 'Allgemein'
zh_wie_neu_category = zh_wie_neu_filtered %>% filter(service_code == category)

zhwn_frequency_wc <- tokens(zh_wie_neu_category$service_notice, what = 'word', remove_punct = TRUE, rem
  tokens_tolower() %>%
    tokens_remove(pattern = stopwords("de")) %>%
      tokens_remove(pattern = c('br', 'dass', 'freundliche', 'grüsse', 'stadt', 'zürich', 'besten', 'da
        tokens_keep(pattern = "^[\\p{script=Latn}]+$", valuetype = "regex") %>%
          #tokens_wordstem(language = 'german') %>%
            unlist() %>%
            table() %>%
              as.data.frame() %>%
                arrange(desc(Freq)) %>%
                  dplyr::rename(word = 1, frequency = 2)

#png("wordcloudallgemein.png", width = 6, height = 6, units = 'in', res = 300)
wordcloud(zhwn_frequency_wc$word, zhwn_frequency_wc$frequency, min.freq = 50, scale=c(2.5,.5),
          max.words=Inf, random.order=FALSE, rot.per = 0,
          colors=brewer.pal(5, "Blues"))
```

```
#dev.off()
```

GEO511_Allgemein

Lino Asper

6/17/2022

1. Loading data

1.1 Defining paths

```
#specify data with path
path = 'data'
fn_zhwieneu = '20220221_zh_wie_neu.json'
fn_municipalities = 'stzh.adm_stadtkreise_a.json'
fn_districts = 'quartiere_exakt.json'
fn_population = 'BEVOELKERUNG_HA_P.shp'
```

1.2 loading data

```
#load data with sf package, transform crs
zh_wie_neu_basedata <- st_read(dsn = file.path(path, fn_zhwieneu), quiet = TRUE ) %>% st_transform(crs =
municipalities <- st_read(dsn = file.path(path, fn_municipalities), quiet = TRUE) %>% st_transform(crs =
districts <- st_read(dsn = file.path(path, fn_districts), quiet = T) %>% st_transform(crs = 2056)
population_basedata <- st_read(dsn = file.path(path, fn_population), quiet = T) %>% st_transform(crs = 2
median_income <-read_csv('data/einkommen.csv')
```

```
## Rows: 2142 Columns: 8
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## chr (2): QuarLang, SteuerTarifLang
## dbl (6): SteuerJahr, QuarSort, SteuerTarifSort, SteuerEinkommen_p50, SteuerE...
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
#filter out unnecessary columns in the datasets
zh_wie_neu_category <- zh_wie_neu_basedata %>% dplyr::select(objectid, service_code, status, media_url,
population_filtered <- population_basedata %>% dplyr::select(geometry, PERS_N)
```

1.2.1 Defining the category

```
#define category, filter based on category
#categories = 'Allgemein', 'Schädlinge','Brunnen/Hydranten', 'Beleuchtung/Uhren', 'Abfall/Sammelstelle'
#insert the desired service code and run the script. If one removes the hashed out png/svg commands and
category = 'Allgemein'
zh_wie_neu_category = zh_wie_neu_category %>% filter(service_code == category)
```

1.3 Correct geometries

```
#check for errors in geometry

st_is_valid(districts)
st_is_valid(municipalities)

st_is_longlat(municipalities)
st_is_longlat(districts) #if true, oriented = True in st_make_valid

sf_use_s2(FALSE) #see https://github.com/r-spatial/sf/issues/1732

municipalities_corrected = st_make_valid(municipalities, oriented= TRUE)
districts_corrected = st_make_valid(districts)

st_is_valid(municipalities_corrected)
st_is_valid(districts_corrected)

#calculate bound box for visualization
#bbox for visualization
bbox_new <- st_bbox(zh_wie_neu_category) # current bounding box

xrange <- bbox_new$xmax - bbox_new$xmin # range of x values
yrange <- bbox_new$ymax - bbox_new$ymin # range of y values
bbox_new[1] <- bbox_new[1] - (0.1 * xrange)
bbox_new[2] <- bbox_new[2] - (0.25 * yrange)
bbox_new[3] <- bbox_new[3] + (0.25 * xrange)
bbox_new[4] <- bbox_new[4] + (0.25 * yrange)

bbox_new <- bbox_new %>%  # take the bounding box ...
  st_as_sfc()
```

1.4 Plot the data points for service category

```
#plot the data for zhwm and the municipalities for the service category
tm_shape(districts_corrected) +
  tm_polygons(id= 'qname',
              alpha = 0.01) +
  tm_shape(zh_wie_neu_category) +
  tm_dots(col = 'service_code',
          id = 'description')
```

2. Plot the overall count of entries

2.1 Compute report density per grid

```
#join the grid from GEO511_1 with the züri wie neu category data to get reports
  grid <- readRDS('data/grid.rds')
  report_grid <- st_join(grid, zh_wie_neu_category, join = st_contains, left=T)
  st_geometry(report_grid) <- 'x'

#count reports per grid cell
```

```
report_grid_count <- report_grid %>% group_by(ID) %>% summarise(n = sum(!is.na(objectid)))

#png("reportcount_category.png", width = 6, height = 6, units = 'in', res = 300)
tm_shape(report_grid_count, bbox = bbox_new) +
  tm_polygons(title = 'Report count',
              as.count = TRUE,
              col = 'n',
              id = 'n',
              palette = 'Blues',
              showNA = F, lwd = 0.05)+
  tm_layout(title= paste('Report count on grid level for:', category),
            legend.title.size = 1,
           legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off()
```

2.2 Look for hotspot with getis ord

```
#define neighboorhod list and weights (binary), important to choose the grid polygons as geometry not t

nb_grid_report <- poly2nb(report_grid_count)
fixed_weights <- nb2listw(nb_grid_report, style = "B")

#calculate getis ord, append to dataframe, to global G test for both status categories fixed and extern
report_grid_count$getisord <- spdep::localG(report_grid_count$n, listw = fixed_weights)

globalG.test(report_grid_count$n, listw = fixed_weights, alternative = "two.sided")

#visualization
#png("getisord_category.png", width = 6, height = 6, units = 'in', res = 300)
tm_shape(report_grid_count, bbox = bbox_new) +
  tm_polygons(title = "Getis ord",
              style = "cont",
              id = 'getisord',
              col = 'getisord',
              midpoint = NA) +
  tm_layout(title= paste('Getis ord of', category),
            legend.title.size = 1,
            legend.text.size = 0.6,
            legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off()
```

2.3 Compute and plot normalized report counts per grid

```
#load population counts per grid, already calculated in the main script GEO511_1
population_grid <- readRDS('data/population_per_grid200.rds')
#join datasets population per grid and counts for normalized counts
normalization <- st_join(population_grid, report_grid_count, join = st_equals) %>% distinct()
```

```
#normalized entry coumn
normalization_grid <- normalization %>% mutate(totalpop = replace(totalpop, is.na(totalpop), 0),
                                               n = replace(n, is.na(n), 0 ),
                                                 normalizedcount = round(n/totalpop, 3),
                                                 normalizedcount = replace(normalizedcount, is.infin
#visualization
#png("normlaizedreportcount_daytime_category.png", width = 6, height = 6, units = 'in', res = 300)
tm_shape(normalization_grid, bbox = bbox_new) +
  tm_polygons(title = "Normalized count",
              col = 'normalizedcount',
              palette = 'Purples',
              id = 'normalizedcount', n= 6, lwd = 0.005) +
  tm_layout(title= paste('Normalized report count by daytime population for', category),
            legend.title.size = 1,
           legend.text.size = 0.6,
             legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off()
```

3. Report density with daytime population

3.2 Compute and plot normalized report density on grid level for daytime population

```
#load population counts per grid, already calculated in the main script GEO511_1
population_grid_swisscom <-  readRDS('data/population_grid_swisscom.rds')
#join datasets population per grid and counts for normalized counts
normalization_swisscom <- st_join(population_grid_swisscom, report_grid_count, join = st_equals) %>% di
#normalized entry coumn
normalization_grid_swisscom <- normalization_swisscom %>% mutate(totalpop = replace(totalpop, is.na(tot
                                               n = replace(n, is.na(n), 0 ),
                                                 normalizedcount = round(n/totalpop, 3),
                                                 normalizedcount = replace(normalizedcount, is.infin
#visualization
#png("normlaizedreportcount_daytime_category.png", width = 6, height = 6, units = 'in', res = 300)
tm_shape(normalization_grid_swisscom, bbox = bbox_new) +
  tm_polygons(title = "Normalized count",
              col = 'normalizedcount',
              palette = 'Purples',
              id = 'normalizedcount', style = 'quantile', n= 6, lwd = 0.005) +
  tm_layout(title= paste('Normalized report count by daytime population for', category),
            legend.title.size = 1,
           legend.text.size = 0.6,
             legend.position = c("right", "bottom")) +
  tm_scale_bar(position = c('left', 'bottom'))
```

```
#dev.off()
```

4. Check for spatial correlation of report counts and taxable income

4.1 Compute median taxable income for grid level

```
#load spatial representation of median taxable income calculated in geo511.1
median_income_spatial <- readRDS('median_income_spatial.rds')

#join with grid via intersection

tax_reportcount_grid <- st_join(report_grid_count, median_income_spatial, join = st_intersects, left=T)

#visualization
tm_shape(tax_reportcount_grid) +
  tm_polygons(col = 'meantax',
              id = 'meantax',
              n = 7)
```

4.2 Compare report counts and taxable income per grid

4.2.1 bivariate LISA for grid level

```
#delete na values, else wights function and bimoran function does not work properly
tax_reportcount_grid <- tax_reportcount_grid %>% na.omit()
#calculate spatial weights. Queen as all eight possible neighbors are valid neighborhood in our case.
wij <- rgeoda::queen_weights(tax_reportcount_grid)

#calculate bivariate moran's i
qsa <- local_bimoran(wij, tax_reportcount_grid[c('n', 'meantax')])
  lisa_colors <- lisa_colors(qsa)
  lisa_labels <- lisa_labels(qsa)
  lisa_clusters <- lisa_clusters(qsa)

plot(st_geometry(tax_reportcount_grid), col=sapply(lisa_clusters,
     function(x){return(lisa_colors[[x+1]])}),
     border = "#333333", lwd=0.2)
title(main = "Bivariate Local Moran")
legend('bottomleft', legend = lisa_labels, fill = lisa_colors,
       border = "#eeeeee")
```

4.2.2 Spearmans Rank Correlation Test for grid level

```
#spearmans rank correlation test is a non-parametric test, suitable for variables not meeting the norma
#null hyptohesis is that the values of income and report count are randomly distributed
#the alternative hyptohesis of interest is that income and report count are correlated.
corr_income_reportcount <- cor.test(x=tax_reportcount_grid$meantax, y=tax_reportcount_grid$n, method =
```

```
## Warning in cor.test.default(x = tax_reportcount_grid$meantax, y =
## tax_reportcount_grid$n, : Cannot compute exact p-value with ties
```

```
corr_income_reportcount
```

5. response time

5.1 Zonal Statistics of response time

```
#for the cell statistics we can use the grid from section 2 again. Intersect the grid polygons/cells wi
response_grided <- st_join(grid, zh_wie_neu_category, join = st_contains)
#calculate standard devuation and mean for each grid cell
response_grided <- response_grided %>% group_by(ID) %>% mutate(mean_response_time = as.numeric(mean(res
#join back to the grid for aggregation on grid level

response_time_grid <- left_join(response_grided %>% as_tibble(),grid %>% as_tibble(), by = 'ID')  %>% s

p1 <- tm_shape(response_time_grid) +
  tm_fill(
    col = "mean_response_time",
    palette = "Reds",
    style = "cont",
    contrast = c(0.1, 1),
    title = "Mean response time",
    id = "mean_response_time",
    showNA = FALSE,
    alpha = 0.8,
    popup.vars = c(
      "Mean Response Time" = "mean_response_time"
    ),
    popup.format = list(
      mean_response_time = list(format = "f", digits = 0)
    )
  ) +
  tm_borders(col = "darkgray", lwd = 0.7) +
  tm_shape(report_grid_count)+
  tm_polygons(col = "n", id = "n", alpha = 0.001) +
tm_shape(zh_wie_neu_category) +
   tm_dots( id = 'service_notice',
            col = 'blue',
            size = 0.01,
            alpha = 0.1)

p2 <- tm_shape(response_time_grid) +
  tm_fill(
    col = "sd_response_time",
    palette = "Blues",
    style = "cont",
    contrast = c(0.1, 1),
    title = "Standard deviation of response times",
    id = "sd_response_time",
    showNA = FALSE,
    alpha = 0.8,
    popup.vars = c(
      "Standard deviation of response times" = "sd_response_time"
    ),
    popup.format = list(
      sd_response_time = list(format = "f", digits = 0)
    )
  ) +
  tm_borders(col = "darkgray", lwd = 0.7) +
```

```
tm_shape(report_grid_count)+
  tm_polygons(col = "n", id = "n", alpha = 0.001) +
tm_shape(zh_wie_neu_category) +
   tm_dots( id = 'service_notice',
            col = 'blue',
            size = 0.01,
            alpha = 0.1)

#t <- tmap_arrange(p1, p2, nrow = 1, ncol = 2)
p1
```

```
p2
```

6. report status

6.1 plot report status counts

```
reportstatus <- zh_wie_neu_category %>% group_by(status) %>% count()

ggplot(reportstatus, aes(x = status, label = n)) +
  geom_col(aes(y = n)) +
  geom_text(aes(label = n, y = n), size = 3, position = position_stack(vjust = 0.8), col = 'violet')
```

7. Interface used to report

7.1 bar chart of the interface

```
reportinterface <- zh_wie_neu_category %>% group_by(interface_used) %>% count()

ggplot(reportinterface, aes(x = interface_used, label = n)) +
  geom_col(aes(y = n)) +
  geom_text(aes(label = n, y = n), size = 3, position = position_stack(vjust = 0.8), col = 'violet')
```

Platform Walkthrough Mobile

Walkthrough mobile version

Environment of expected use

The environment of expected use of the app including vision and operating model is equal to the environment of expected use of the website and is only listed for the sake of completeness. Same accounts for the textual content and tone and user interface arrangement. The technical walkthrough differs and is only made for the mobile app version as the other walkthrough can be found in the section Results of the thesis.

Vision

Purpose

- Reporting of damage to city government
- Enabling people to voice things about broken infrastructure they are bothered by
    - Clearly stated: improvements or beautifications are not welcome so it is really about fixing and maintaining existing things
- Maintaining a sense of newness as the name implies

Target user base

- Population is stated but not further specified. As reports can only be made for the extent of Zurich the website is addressing people located in Zurich encompassing all people living in, working, or visiting Zürich. There are no further restrictions to use the platform except for the basic needs to enter an email address and having internet access.

Scenarios of use

- The geolocation is of vital importance visible in the centered position of the address entry field, the map being the background of the starting page and in the fact that the address entry field also suggests using the actual position via GPS tracking. Further pictures of the reported damage can be included via a photo upload or in the web version taking a picture directly in the app. Both the geolocation and the direct photo upload indicate that the app is meant to be used ad hoc when encountering a damage in the street. The computer version suggest that the report is most probably not made ad hoc but afterwards at home when the damage has been photographed and the address has been noted.

Symbolic representation

The colors are minimal mainly white, black, grey but also blue. Blue and white are the colors of the city of Zurich establishing a close relationship via the colors. The logo of the city is also prominent on all pages of the website and the app. Maps are always around and are thus important features of the app highlighting the geographic importance of issuing a report. In general, there are limited number of symbols and styles which are rather basic. The styling of the app appears simple, neutral and practically oriented leading to a website and an app which is less about

appearance and more about practicality. An example delivers the 'Alle Meldungen' page from the web version where the map is the most prominent feature, including limited features to enable navigation, the logo of the city and else only the brief overview over the latest reports.

Operating Model

Revenue generation

- By using the app, users provide information about city infrastructure meaning that the users do infrastructure assessment which is a duty of the city apparatus. The workload needed for checking the city infrastructure on that scale with such regularity costs a lot of workforce and thus money. One could argue that users generate revenue for the city in the sense that they help in assessing the state of the infrastructure. Else there is no direct revenue for the city through this platform.

Business strategy

- The platform is part of eZurich by the canton originally initiated by the city of Zurich, trying to foster more cooperation between various actors involved in the use and production of ICTs. Overall, a measurement to augment the attractiveness of the IT location Zurich by highlighting competences and youth development. (See under 'bereits realisierte Projekte': https://www.zh.ch/de/wirtschaft-arbeit/wirtschaftsstandort/wirtschaftszweige/ict/ezuerich-buendelt-energien.html#840558620)
  The tool is further part of smart city Zürich, reffering to it as a tool to augment an active citizen participation.
  (see: https://www.stadt-zuerich.ch/portal/de/index/politik_u_recht/stadtrat/weitere-politikfelder/smartcity/projekte/Zueriwieneu.html).
- On the platform itself, Züri wie neu is advertised as a tool specifically for citizens enabling them to notify the city about defects and damages. Financially the app is backed up by the government, but the development was done by an external developer.

Governance

- No regulation except for the need of an email address and a telephone otherwise no report can be made.
- "Rules" of writing a report are indicated twice: on the help page in detail and when entering a report on the right between map and report entry infrastructure.
  - Users should make as clear descriptions as possible
  - No suggestions or improvement wishes
  - Only one damage per report
  - Avoid submitting pictures indicating personal information of others
  - No emergencies
- Guidelines are indicated three times: front page, help page and when entering a report. Presented as numbered sequence
- Compared to the little text overall, rules and guidelines make up a big part of the text bodies.
- The impressum and legal note are very little on the bottom of the page and lead to standardized page of the city indicating information about the general points of contact of the city and the legal framework for using the website of the city of Zurich with a lot of different topics. To get a quick overview over the editor in the

impressum is really difficult. Same accounts for the legal notes which are difficult to see through because there are various under chapters not even related to Züri wie neu.

- The governance of the platform is focused on enabling an easy and understandable access to issue a report by clarifying guidelines on almost every page. At the same time the rules described twice indicate that governance model tries to make very clear how a correct report looks like. Further a correct report in the sense of the platform follows a rather narrow definition, suggestions for improvement or creative inputs are clearly not welcome and only broken or misplace things are to be reported, emergencies should be directed to the police. All in all, the governance model indicates that the platform is a tool to maintain momentary order and opinions as well as wishes are not welcomed.

Technical walkthrough

Functions and features

Pages

The first time the mobile app is opened, personal details must be entered containing email address, phone number and an optional name. Afterwards every time the app is opened it tells you to either use GPS tracking or to enter the address manually. The landing page consist of the map where users can manually geolocate the report via drag and drop and an address entry field. Further page is the navigation page leading to pages on personal data, the help page, and a disclaimer page all accessible via the dropdown menu on the top right of the landing page. The disclaimer page is only found in the app version and displays information about open government data policy of the city which is noted on a separate webpage on the web version

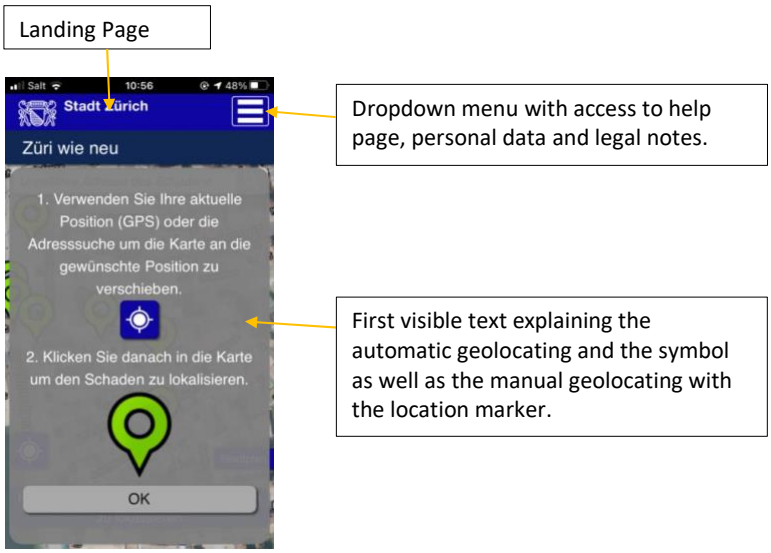

Figure 1: Landing page of the app version.

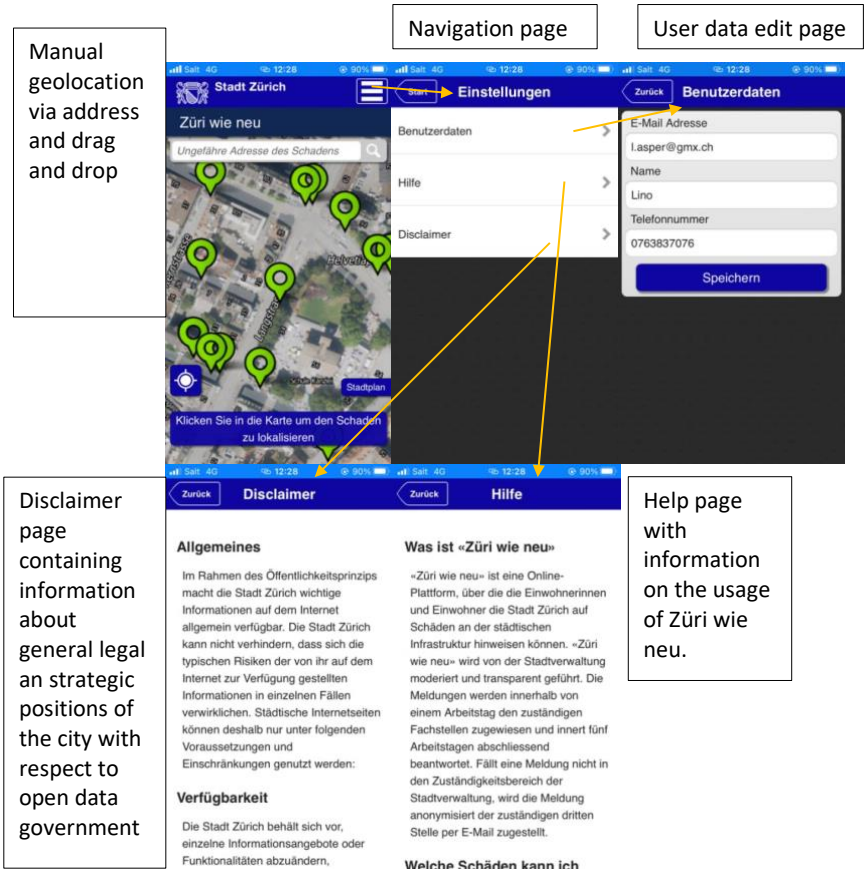

Figure 2: All the pages of the app version except those for the report procedure

Reports

issuing a report is accessed via locating a damage and clicking on the blue labelled button on the bottom of the map indicating “Hier eine Meldung erfassen”. Afterwards the user gets into a step-by-step process with 3 steps not really including a first step but meaning probably the first step was the geolocating, secondly a photo, thirdly the description and categorization as well as the personal details again which can be changed. The process is direct and very fast, if the report is really issued at the location the whole process takes probably less then 3 minutes as the personal details are also already entered.

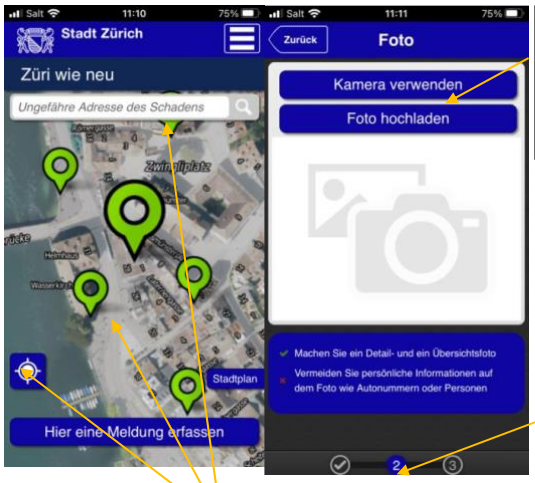

Figure 3: Report procedure in app version.

Compulsory fields

To start the app one needs to enter personal data including name, telephone number and email. During the report procedure, a photo for the report is needed else one cannot progress to the next page and is therefore unable to finish a report.

Maps

The map is a central feature of the mobile app and appears as the first thing users see on the landing page. Overall, the maps have equal functionalities like on the web version.

Textual content and tone

The tone of the platform is formal and pragmatic without special formulations or adjectives indicating feelings. Text in general is seldomly present and is often used to guide the user, explain procedures and indicate do's and don't's. The only page with more text is the "Hilfe" page which is presented in a q&a style again mostly explaining how it works and what can be submitted but also a little background information on the platform, indication of a contact person and the original developer of the website.

User interface arrangement:

- The geolocation is of vital importance visible in the centred position of the address entry field, the map being even the background of the starting page and else always in the focus of the pages. The geolocating is facilitated by the omnipresence of the map.

- The app and the website focus on being used ad hoc and spontaneously. This is visible in the fact that the geolocation can be automated, that the map enables a quick adjustment of the position in a graphic and tangible way and that photos of the damage are highly encouraged. In the app version the spontaneous ad hoc nature of the app is even more emphasized and reporting an issue takes up very little time and instantly accessible. Nevertheless, when using the computer not the mobile app the report is most probably not made ad hoc but after the damage has been photographed and the address has been noted.

- Ease of use and thereby encouraging participation appears to be important. The website and the app are minimalistic, the focus lies on the entry field and the immediate begin suggested by the big and blacked out 'Los' button. The automatic GPS tracking is also much in the focus of the starting page which enables users to easily geolocate their report which is a key step in filing a report. The other two eye catching elements are a numbered description how the tool works, two counts of the reports in the last week and the completed reports within the last month. On the right are examples of recently reported damages. This can be seen as encouraging users to contribute because the affordance are clearly described and simultaneously examples are delivered. The text bodies are minimal and most of the text bodies is describing the affordances and the procedure to report thus making it even easier to users to get a report done.

- The design choice of all the buttons, the entry fields and the maps are basic and do not try to impress users but rather focusing on mere functionality. This is visible in the minimalistic coloring, simple use of shapes and the simplicity of the maps as well. Although the guidance through the menus is slightly confusing the affordances to issue a report a little and the purpose of the website is clear. The simplistic design might also support ease of use.

Personal Declaration

I hereby declare that the submitted thesis is the result of my own, independent work. All external sources are explicitly acknowledged.

Lino Asper, January 2023.