MSc Thesis Proposal

Geomatics for the Built Environment

Assessing a successful open spatial data infrastructure from a user participation perspective: A qualitative comparison between user groups in the OpenStreetMap community

P2 – Graduation Plan

June 2022

Guilherme Spinoza Andreo

5383994

1st Supervisor: Dr. ir. F.M. Welle Donker

2nd Supervisor: Dr. S. Calzati

TU Delft Delft University of Technology

Contents

1. Introduction 3
2. Related Work 5
1.1 Volunteered Geographic Information & User participation 5
1.2 OpenStreetMap 8
3. Research Questions 9
4. Methodology 11
4.1 Method of approach 11
4.2 Motivation for chosen methodology 12
4.3 Assessment Factors 12
5. Time Planning 13
6. Tools and datasets used 14
7. Bibliography 15

1. Introduction

Spatial data infrastructures (SDI) can be summarised as a set of instruments, such as policies, technology, data, institutional arrangements and individuals, that can provide the means for sharing and using geographic information (GI) through standardisation and protocols for compatible and available spatial data (Tonchovska, 2012; GSDI, 2012;). At the start, the SDIs were mostly focused on the diffusion and promotion of data inside the public sector (Vancauwenberghe & van Loenen, 2017), however, with the advancements in technology, institutions and our society, SDIs needed to include the commercial sector as well as private individuals as important participants and users of the infrastructure (Vancauwenberghe & and van Loenen, 2018).

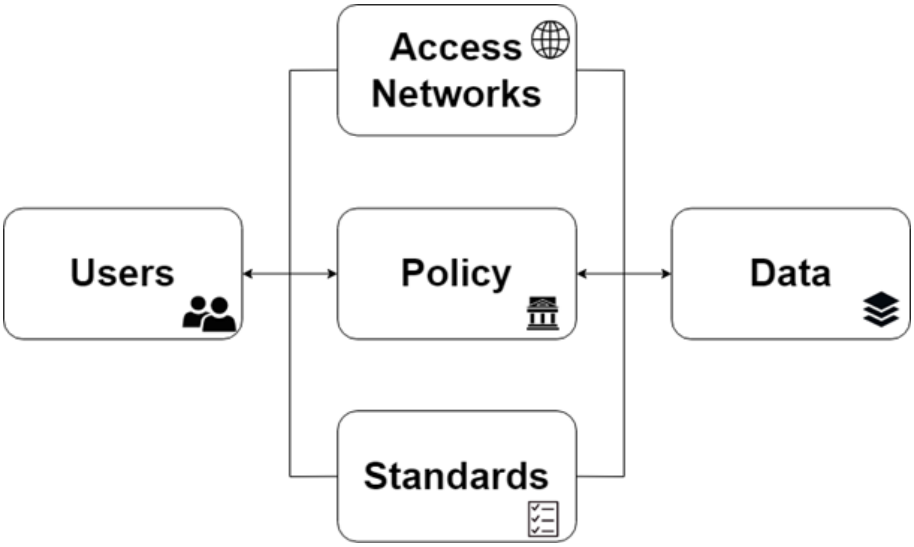


Figure 1: Fundamental components of an SDI (adaptation from [Rajabifard et al., 2002]).

Initially, the SDI's, as depicted in Figure 1, were focused on the product-based design, yet research later suggested the implementation of a process-based format for SDIs (Rajabifard and Williamson, 2002). With the realisation that users could be an important asset in an SDI, the focus was aimed towards user access and engagement in the geographical systems. In fact, citizens are capable of being valuable resources for the collection of geospatial data, due to their vast numbers, concurring movement on the planet and their local knowledge; a mix that could provide unique geospatial information (Goodchild, 2007; Budhathoki, 2008).

The further development of SDIs should allow for citizens and non-governmental users to create new datasets (Crompvoets et al., 2014, cited in Vancauwenberghe and van Loenen, 2018), along

with an increased availability for participating in important governance and organisational decisions, which in turn is what defines an Open SDI (Vancauwenberghe et al., 2018). Open SDI is considered to be a valuable addition to the open data ecosystem, since it enables the means to publish, find, assess, interact, and view data (Zuiderwijk, Janssen, and Davis 2014; Izdebski, 2021). An open data ecosystem can be defined as a circular, inclusive, sustainable network, in which data is accessible, reusable, and oriented for the cooperation of its interdependent environment with its users (Boley & Chang, 2007, as cited in van Loenen et al., 2018; Charalabidis et al., 2018), where sustainability is defined broadly as functioning self-sustaining system that is preserved over time (Penzenstadler, 2013). A well-performing user driven open data ecosystem could potentially stimulate citizen participation, innovation, use and re-use of data between users and data suppliers (Zuiderwijk et al., 2014; van Loenen 2021).

Lately, cities have been incentivised to publish data in an open data format, which is any data that is free, machine-readable, unrestricted and licence free (van Loenen, 2018), since this format facilitates the connection of data from different providers that use the same standards. This enables people to innovate, use or create applications and APIs as they please and engage in public decisions (Fox, 2013; Varga et al., 2022). Although the increase in open data exists, the re-use and sharing of the same is not guaranteed, even with the means to its access, such as is the case with open data portals (data.europa.eu, 2022)

To understand the status of geoinformation in these infrastructures and to identify the factors of a well-performing one, further research is required into how they can be assessed properly. An assessment framework can be a strong instrument to develop open data ecosystems (Welle Donker & van Loenen, 2017). However, to further understand and evaluate the value and success of open geoinformation in relation to the assessment of the participation of different user groups and communities in open SDI is still a challenge. For these reasons, this research addresses the following question: *What are the key socio-technical drivers for user participation and advancement of a sustainable open SDI community?*

This thesis aims to assess a successful open SDI from a user participation perspective in relation to the key factors in developing a sustainable open SDI community. This work will include indicators developed through qualitative research by questioning and comparing two selected user groups of OpenStreetMap that are involved in developing spatial data within the community. To answer this question, an extensive bibliographical research will be performed to aid the exploratory nature of this research, along with preliminary surveys and semi in-depth interviews

for the selected user groups of OpenStreetMap. The end result should be an aspirational guideline that can be used to evaluate the level of user participation in open SDI, to provide the best practices on creating a sustainable open SDI community and to serve as a foundation for future discussions.

In this thesis, following this chapter of introduction, Chapter 2 contains the literature review, followed by the main research questions in Chapter 3. Afterwards, Chapter 4 elaborates on the research methodology, which is detailed according to a specific time plan In Chapter 5. Finally, Chapter 6 provides an overview for the datasets and tools that will be used in this research.

2. Related Work

The scope of participation of users in SDIs has been researched to a wide extent. The academic work that has been done has been in relation to user's involvement in the SDI, ranges from engaging their needs (Hennig, S., & Belgui, M. 2013), developing user-centric SDIs frameworks for reusability (Páez, 2018), historical and heritage purposes (De Kleijn et al., 2013), land administration (Ngo, 2016; Naghavi et al. 2022), and discussing the quality of communication between users and the infrastructure itself (Alexopoulos et al., 2014). Furthermore, the use of volunteered geographic information (VGI) has also enabled common citizens to participate in SDIs and potentially generate valuable spatial data (Goodchild, 2007). The inclusion of VGI in user-centric SDIs is important due to the fact that it can promote active user participation, to the extent that citizens and users participate in the further development of infrastructure projects (Shakeri, 2013).

Although the connection between SDI and VGI has been shown to be possible (Rajabifard et al., 2006), most of the work that has been done in relation to understanding the factors about user participation in both Open SDI and VGI have not been properly covered in pratice, which validates the scientific purpose of the proposed research.

The goal of this chapter is to summarise concepts and relevant studies related to this research proposal.

1.1 Volunteered Geographic Information & User participation

The concept of volunteered geographic information (VGI), is defined as collection of spatial data that is freely given from common citizens, where citizens can become providers of geoinformation (Goodchild 2007; Naghavi, 2022). This concept of mapping geospatial data in a participatory approach have been in place since the 1960s, where humans would use mental maps to understand the different views of geographic locations in their surrounding (Pánek, 2016, cited in

Zhang, 2019). Currently, the growth and availability of communication technologies within everyday cell phones and applications allow citizens to provide a surplus of VGI (Mooney & Corcoran 2011), for land administration information (Naghavi et al.,2022), as well as the ability for communities to effectively contribute geoinformation in developing countries (Iliffe, 2017).

Previously Goodchild (2007) had mentioned that the ability of citizens to supply volunteered geographic information (VGI) to SDIs, as is the case with OpenStreetMap, at a substantially high technical level. There is a clear increase in participation from both specialists, citizens, and non-specialists in the development of connected geoinformation analysis (Mooney & Corcoran 2011). Mooney & Corcocan (2011) propose that there is indeed a potential application, for both consumers and geoinformation producers, for the use of VGI from citizens to become a fundamental component of SDI after an experimental study of OpenStreetMap in Europe. If a community based VGI can be achieved for SDI, this would potentially save cost and time, produce more satisfaction within the users, and improved work and data quality (Balas et al., 2021, cited in Naghavi 2022). With the use of VGI, SDI specialists and users raise the question: “Why aren’t SDIs gaining more users while there is an excessive interest in participating in VGIS?” (Budhathoki et al., 2008).

In the same regard, user participation indicates that people are willing to engage on a personal and organizational level to contribute their knowledge on specific issues. As claimed by the study of Montalvo (2003, cited by Rajabifard et al., 2006), user participation in relation to spatial data contributions vary according to the amount of social pressure to be involved or to have a sense of inclusion in important components within organizations. This can result in a limited engagement the actors that are responsible for promoting data re-use in distinguished initiatives. Other studies have shown that some of the factors that play an important role to user participation in open data are mainly the quality of infrastructure and of the knowledge shared, the confidence the users had in the open data, how useful it was and if it was up to their expectations (Krismawati & Hidayanto, 2021).

As for public user participation, Olausson (2016) applies an assessment in regards the level of satisfaction that users feel when they participate in developing spatial data portals and what changes the public body decided to adopt, yet, the participation in these public services are considered to have hardly any motivation to improve the engagement of the users. As part of assessing the different levels of citizen participation, the following model below was made.

Figure 2: Modified ladder of user involvement in supply of open data (Olausson 2016)

There exists an indicator in each branch of the ladder above, where it serves to show the level of involvement with users that participate with open data, however, changes can be made to the provided indicators (Olausson, 2016).

With this in mind, the current research will attempt to assess some of the aforementioned topics and issues in relation to the participation of users, with a modified approach for testing purposes to find the common factors between users that promote interaction with the SDI.

1.2 OpenStreetMap

Although, OpenStreetMap (OSM) is not by any means the sole repository for VGI data, though it is one of the most common. Initially, it was created in 2004 to map streets as a means to overcome licensing restrictions of certain maps at the time and to supply crowdsourced geographical information for users (Bennett, 2010). The purpose for which it was made was intrinsically connected to gathering freely provide available spatial data which was previously restricted for small businesses, individual users and community organizations that could not afford, access or modify the traditional geoinformation that was provided through the data steward (Budhathoki, 2016).

OSM can be considered a technical database infrastructure project built by VGI, where a large number of contributors collaborate to mutually edit the world map, along with a core structure for the software that enables the output of geoinformation to be shared (Halkay & Weber 2008). The main goal of the project is to possess a digital twin of every possible geographic component that exists, from simple streets, waterways and up to more detailed features, like buildings, individual trees, and land administration information (Bennet, 2010). One of benefits of OSM is that all the data is open, free, interoperable, and available for use, copying, modification and re-use, whereas that would not be the case with other crowdsourced services (Bennet, 2010). There are some community standards that apply for OSM, which is the case for obtaining data, editing standards and convention for maps (OSM, n.d.1), styling or tags for the description of features (OSM, n.d.2), however, these are community-oriented standards for the purpose of good practices (OSM, n.d.2). One can argue that by having a completely open standard for their data, by means of not conforming it to any standard, like OGC, enables the complete interoperability between any potential software or application and the theoretical commitment to the most open data standard possible, even though open standards. Furthermore, OSM does have certain licenses (OSM, n.d.3), privacies, restrictions for disputed territories and usage policies, (OSM, n.d.4) to help the user to organize the sharing of spatial information.

As mentioned previously, SDI is considered to be a dynamic set of components, policies, people, data, and technological access network that enables the sharing, exchange, storage and use of geographical information between users (Budhathoki, 2008; GSDI, 2012; Tonchovska, 2012; Vancauwenberghe et al., 2014 Van Loenen; Mulder, Wiersma & van Loenen 2020;). By the fundamental concepts of SDI proposed by Rajabifard, (2006) or as it has been shown in figure 1,

there is a clear indication that OpenStreetMap could be identified as an SDI, seeing what it represents and provides for the world, although it claims to be a VGI database project. This could be taken even further by saying it could also be an Open SDI (Vancauwenberghe et al., 2018a), because of the openness of the infrastructure and user-centric, non-profit nature in which non-government users or professionals can contribute to the development and the implementation of the geographic information on OSM. Therefore, by opening the participation aspect for all users to contribute, and even participate in the development of the infrastructure, it should be treated as an Open SDI and potentially be recognized as such by this research as show in figure 3.

Part of this proposal will attempt to contribute to the transition of the theoretical assessment of how these communities of users can be motivated to participate in an open SDI ecosystem to a practical approach. Assessing quality of the spatial data is beyond the scope of this thesis.

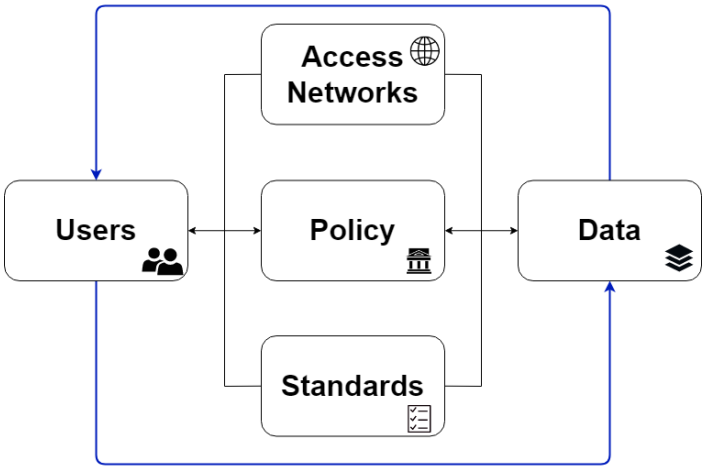


Figure 3: Open spatial data ecosystem of OpenStreetMap

3. Research Questions

This research aims to answer the following question:

What are the key socio-technical drivers for user participation and advancement of a sustainable open SDI community?

In order to answer question above, further sub-questions are required, of which are the following:

a) *What are the intrinsic and extrinsic aspects necessary for the selected user groups to participate in an Open SDI?*
b) *How and to what extent are the selected users participating to OpenStreetMap?*
c) *What is essential to sustain an active community in an open SDI?*
d) *How can the communities of user groups be motivated to participate in an open SDI ecosystem?*

4. Methodology

4.1 Method of approach

This chapter elaborates on the methodology that will be followed to answer the research questions posed in the previous chapters. As mentioned before, the method of approach start with a literature review and an exploratory research. Then preliminary surveys, and semi-structured in-depth interviews, which are proven to be one of the most important sources of information for case studies (Yin 2009). The two user groups will still be determined after the initial analysis at a later stage.

The chart below (Figure 3) presents analytically the steps of research, application, and results process:

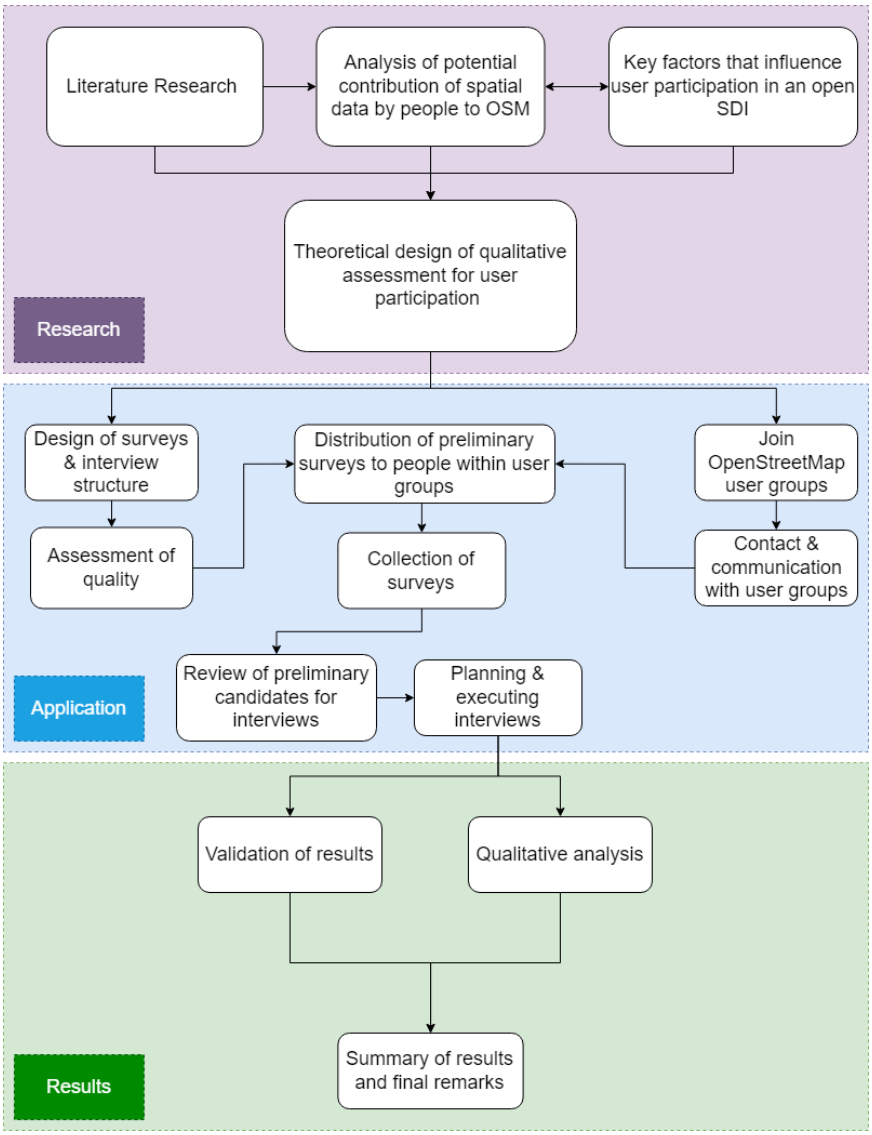


Figure 3: Proposed Methodology for a qualitative user participation assessment of OSM

4.2 Motivation for chosen methodology

The main difficulty on the methodology setting for this research is the lack of ability to publish data on public or governmental SDI's and the availability of access and communication to the user community. In public SDIs, citizens may ask for permission or licences to access and publish data in the geospatial infrastructure, yet the complex information about why users choose to participate in the SDI is not available to the public. Hence, the research could not be conducted by comparison / analysis of SDIs and their user participation on a GI data owner level, but rather by mirroring the experience of using an SDI from a citizen point of view.

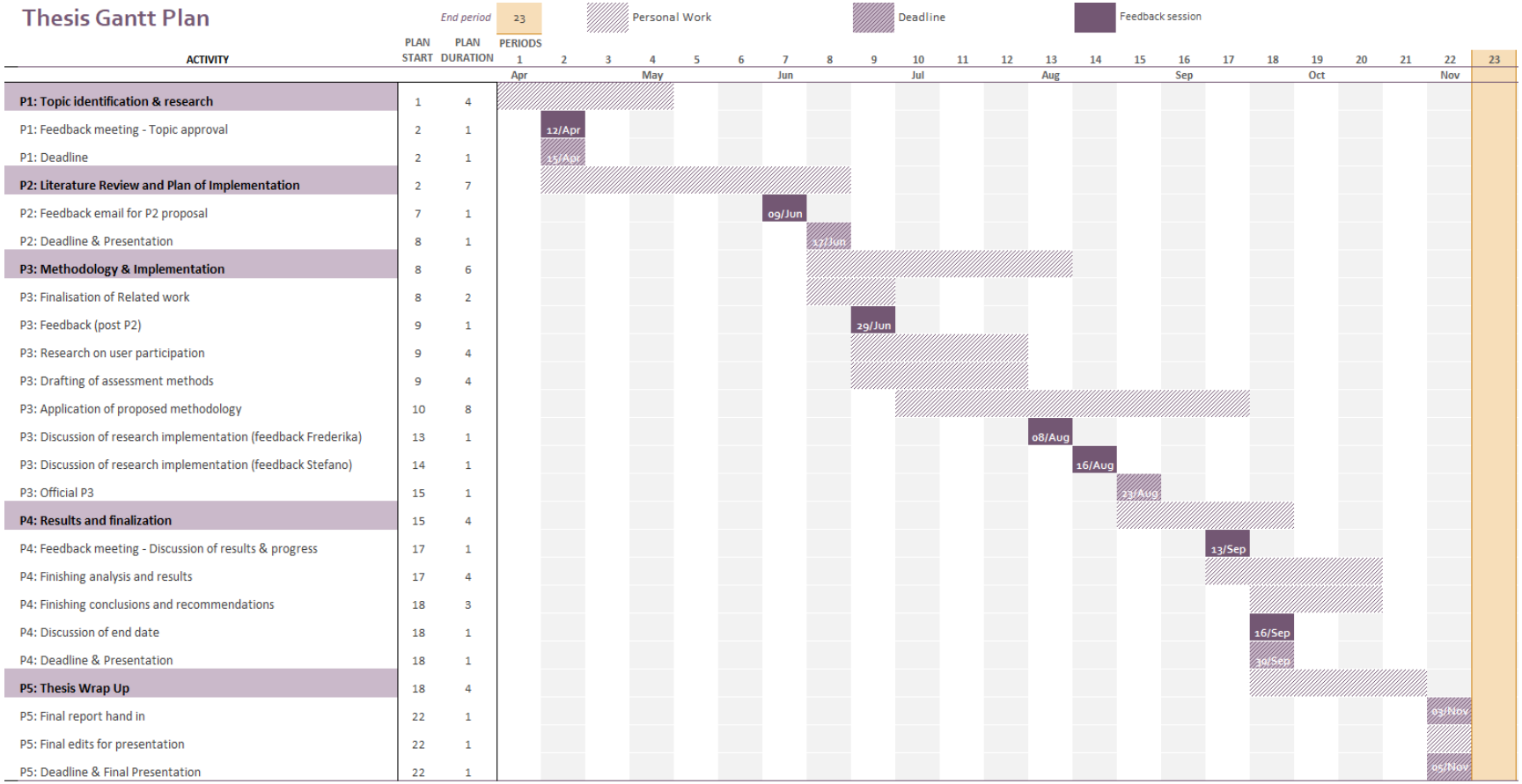
Even though there has been some academic research on the qualitative assessment with academic users for the development and participation geoportals (Jimenes, 2018) and public sector bodies (Olausson 2016), the current research will seek to comprehend the socio-technical elements that make a sustainable user community within the open SDI and to understand how these communities can be motivated to participate in an open SDI ecosystem. In doing so, the usability and replicability of this research could serve as a will be further evaluated, not only by the users that are familiar with the concepts and limitations of SDIs, but also by the ones that are not. The final outcome and significance is a guideline for open SDIs that want to understand and improve the community in the open spatial data ecosystem.

4.3 Assessment Factors

Following figure 3, an assessment will be designed and put into practice to examine the key indicators and motivations towards the selected user groups to participate in an Open SDI. The factors still require further research but will seek to answer what has been proposed so far.

5. Time Planning

Thesis Gantt Plan



ACTIVITY	PLAN START	PLAN DURATION
P1: Topic identification & research	1	4
P1: Feedback meeting - Topic approval	2	1
P1: Deadline	2	1
P2: Literature Review and Plan of Implementation	2	7
P2: Feedback email for P2 proposal	7	1
P2: Deadline & Presentation	8	1
P3: Methodology & Implementation	8	6
P3: Finalisation of Related work	8	2
P3: Feedback (post P2)	9	1
P3: Research on user participation	9	4
P3: Drafting of assessment methods	9	4
P3: Application of proposed methodology	10	8
P3: Discussion of research implementation (feedback Frederika)	13	1
P3: Discussion of research implementation (feedback Stefano)	14	1
P3: Official P3	15	1
P4: Results and finalization	15	4
P4: Feedback meeting - Discussion of results & progress	17	1
P4: Finishing analysis and results	17	4
P4: Finishing conclusions and recommendations	18	3
P4: Discussion of end date	18	1
P4: Deadline & Presentation	18	1
P5: Thesis Wrap Up	18	4
P5: Final report hand in	22	1
P5: Final edits for presentation	22	1
P5: Deadline & Final Presentation	22	1

6. Tools and datasets used

The information for the data that will be used will be provided from the user groups of OpenStreetMap, as well as other studies conducted with the intention of analysing the level of participation within OpenStreetMap. Microsoft office tools will be used for the elaboration of documents, framework structure, presentation, and results for this research, along with google survey that is going to be the used as the platform for elaborating and sharing the surveys and interview questions. Further analytical software and tools for the coding of the interview results will be decided at a later stage.

7. Bibliography

Alexopoulos, C., Zuiderwijk, A., Charalabidis, Y., & Loukis, E. (2014). Closing the open public data feedback loop: the ENGAGE platform. *SHARE-PSI Workshop (Lisbon)*.

Benítez Páez, M. F. (2018). A user-centric framework to improve the reusability of open geodata in cities *(Doctoral dissertation, Universität Jaume I).*

Bennett, J. (2010). OpenStreetMap. Packt Publishing Ltd.

Budhathoki, N. R, Bruce, B. and Nedovic-Budic, Z. (2007). 'Reconceptualizing the role of the user of spatial data infrastructure'. *GeoJournal*, 72(3-4), p.149-160.

Budhathoki, N. R., & Haythornthwaite, C. (2013). Motivation for Open Collaboration: Crowd and Community Models and the Case of OpenStreetMap. *American Behavioral Scientist*, 57(5), 548–575. https://doi.org/10.1177/0002764212469364

Charalabidis, Y., Zuiderwijk, A., Alexopoulos, C., Janssen, M., Lampoltshammer, T., Ferro, E. (2018). The Multiple Life Cycles of Open Data Creation and Use. In: The World of Open Data. *Public Administration and Information Technology, vol 28. Springer, Cham.* https://doi.org/10.1007/978-3-319-90850-2_2

Coetzee, S., McCormack, B., Mohamed-Ghouse, E. Z. S., & Scott, A. G. (2021). Towards a sustainable geospatial ecosystem beyond SDIs. 10.13140/RG.2.2.22555.39203.

Data.europa.eu, (2021). Measuring Data Demand Within the Public Sector: Discussion Paper 2021. Available online: https://data.europa.eu/sites/default/files/report/Discussion_Paper_Measuring_Data_Demand_Within_the_Public_Sector.pdf, accessed on June 2022.

De Kleijn, M., Van Manen, N., Kolen, J., & Scholten, H. J. (2013). User-centric SDI framework applied to historical and heritage European landscape research. *Research Memorandum*, *2013*, 32.

Donker, F. W. (2016). From access to re-use: a user's perspective on public sector information availability. *A+ BE*| *Architecture and the Built Environment*, (21), 1-282.

Donker, F. W. & van Loenen, B. (2017): How to assess the success of the open data ecosystem?, *International Journal of Digital Earth,* 10:3, 284-306, DOI: 10.1080/17538947.2016.1224938.

Fox, M.S.: City Data: Big, Open and Linked (2013). *Enterprise Integration Lab, University of Toronto*, Toronto, pp.1-20, http://www.eil.utoronto.ca/wp-content/uploads/smartcities/papers/City-Data-v5.pdf, accessed on June 2022.

Goodchild, M. F. (2007). Citizens as voluntary sensors: spatial data infrastructure in the world of Web 2.0. *International journal of spatial data infrastructures research*, *2*(2), pp. 24-32.

GSDI [Global Spatial Data Infrastructure] (2012). Spatial Data Infrastructure Cookbook 2012 Update, GSDI, at

http://gsdiassociation.org/images/publications/cookbooks/SDI_Cookbook_from_Wiki_2012_update.pdf [accessed June 2022].

Haklay, M. and Weber, P. "OpenStreetMap: User-Generated Street Maps," in *IEEE Pervasive Computing,* vol. 7, no. 4, pp. 12-18, Oct.-Dec. 2008, doi: 10.1109/MPRV.2008.80

Hennig, S., & Belgui, M. (2013). User-centric SDI: Addressing Users Requirements in Third-Generation SDI. The Example of Nature-SDIplus.

Iliffe, M. P. (2017). The praxis of community mapping in developing countries *(Doctoral dissertation, University of Nottingham).*

Jiménez, G, M., Towards open geo-information science; Assessing academic user involvement in portal development and its effect on their usage and perceived satisfaction, *Master's thesis, GIMA (TUD, UT-ITC, UU, WUR),* pp. 98, 2019.

Krismawati, D. & Hidayanto N., A., "The User Engagement of Open Data Portal," 2021 *International Conference on Advanced Computer Science and Information Systems* (ICACSIS), 2021, pp. 1-6, doi: 10.1109/ICACSIS53237.2021.9631357.

Mooney, P., Corcoran, P. (2011). Can Volunteered Geographic Information Be a Participant in eEnvironment and SDI?. In: Hřebíček, J., Schimak, G., Denzer, R. (eds) Environmental Software Systems. Frameworks of eEnvironment. ISESS 2011. *IFIP Advances in Information and Communication Technology, vol 359. Springer, Berlin, Heidelberg.* https://doi.org/10.1007/978-3-642-22285-6_13

Mulder, A. E., Wiersma, M. G., & van Loenen, B. (2020). Status of National Open Spatial Data Infrastructures: a Comparison Across Continents. *International Journal of Spatial Data Infrastructures Research,* 15, 56-87. https://doi.org/10.2902/1725-0463.2020.15.art3

Naghavi, M., Alesheikh, A. A., Hakimpour, F., Vahidnia, M. H., & Vafaeinejad, A. (2022). VGI-based spatial data infrastructure for land administration. *Land Use Policy*, *114*, 105969.

Ngo, D. M. (2016). A policy framework for a provincial user-centric SDI to support land administration in Vietnam: case study of Vinh Long Province *(Doctoral dissertation, RMIT University)*

Olausson, K. (2016). A step towards aligning supply and demand? Dutch public sector bodies.

OpenStreetMap, (n.d.1) Editing Standards and Conventions - OpenStreetMap Wiki, https://wiki.openstreetmap.org/wiki/Editing_Standards_and_Conventions. accessed on June 2022

OpenStreetMap, (n.d.2) Good practice – OpenStreetMap Wiki, https://wiki.openstreetmap.org/wiki/Editing_Standards_and_Conventions. accessed on June 2022

OpenStreetMap, (n.d.3) License/Use Cases – OpenStreetMap Wiki, https://wiki.openstreetmap.org/wiki/Editing_Standards_and_Conventions. accessed on June 2022

OpenStreetMap, (n.d.4) Policies and other Documents – OpenStreetMap Wiki, https://wiki.openstreetmap.org/wiki/Editing_Standards_and_Conventions. accessed on June 2022

Penzenstadler. (2013). “Towards a definition of sustainability in and for software engineering. In Proceedings of the 28th Annual ACM Symposium on Applied Computing (SAC '13)”. *Association for Computing Machinery*, New York, NY, USA, 1183–1185. https://doi.org/10.1145/2480362.2480585

Rajabifard, A., A. Binns, I. Masser, and I. Williamson. (2006). “The Role of Sub-National Government and the Private Sector in Future Spatial Data Infrastructures.” International Journal of Geographical Information Science 20 (7): 727–741. https://doi.org/10.1080/13658810500432224

Rajabifard, A., and Williamson, I. P. (2002). ‘Spatial Data Infrastructures: An initiative to facilitate spatial data sharing’. In R. Tateishi and D. A. Hastings, *Global environmental databases: Present situation, future directions*. Chiba, Japan: International Society for Photogrammetry and Remote Sensing (ISPRS) Working Group IV/6 (1996-2000), Center for Environmental Remote Sensing, Chiba University.

Taylor, L., Richter, C., Jameson, S., & Perez del Pulgar, C. (2016). Customers, users or citizens? Inclusion, spatial data and governance in the smart city. University of Amsterdam.

Vancauwenberghe, G., Ezra, D., Crompvoets, J & Vandenbroucke, D. (2014). Realizing Data Sharing: The Role of Spatial Data Infrastructures. 10.1007/978-1-4614-9563-5_10.

Vancauwenberghe, G., Valečkaitė, K., van Loenen, B. and Donker, F.W. (2018a). ‘Assessing the Openness of Spatial Data Infrastructures (SDI): Towards a Map of Open SDI’. I*nternational Journal of Spatial Data Infrastructures Research,* 13, pp.88-100.

Vancauwenberghe, G. and van Loenen, B. (2018b). Exploring the Emergence of Open Spatial Data Infrastructures: Analysis of Recent Developments and Trends in Europe, in Saeed, S., Ramayah, T., and Mahmood, Z. (Eds.), User Centric E-government. Challenges and opportunities. (pp. 23-45). New York, NY: Springer International Publishing.

van Loenen, B. (2018). ‘Towards a User-Oriented Open Data Strategy’. In: B. van Loenen, G. Vancauwenberghe and J. Crompvoets, *Open Data Exposed*. pp.33-53.

van Loenen, B., Zuiderwijk-van Eijk, A. M. G., Vancauwenberghe, G., Lopez-Pellicer, F. J., Mulder, I., Alexopoulos, C., Magnussen, R., Saddiqa, M., Dulong de Rosnay, M., Crompvoets, J., Pollini, A., Re, B., & Casiano Flores, C. (2021). Towards value-creating and sustainable open data ecosystems: A comparative case study and a research agenda. JeDEM eJournal of eDemocracy and Open Government, 13(2), 1-27. https://doi.org/10.29379/jedem.v13i2.644

Varga, F., Hrustek, L., Welle Donker, F. M., & Šalamon, D. (2022). Urban dog spaces: The openness of dog-related government data in the city of Zagreb, Croatia. Interdisciplinary Description of Complex Systems (INDECS), 20(2), 125-135. https://doi.org/10.7906/indecs.20.2.5

Izdebski, W., Zwirowicz-Rutkowska, A. & da Costa, J, N. (2021) Open data in spatial data infrastructure: the practices and experiences of Poland, *International Journal of Digital Earth,* 14:11, 1547-1560, DOI: 10.1080/17538947.2021.1952323

Welle Donker, F., & van Loenen, B. (2017). How to assess the success of the open data ecosystem? International Journal of Digital Earth, 10(3), 284-306.

Yin, R. K. (2009). *Case study research*: Design and methods (Vol. 5). sage.

Zacharopoulou D, Skopeliti A, Nakos B. Assessment and Visualization of OSM Consistency for European Cities. *ISPRS International Journal of Geo-Information*. 2021; 10(6):361. https://doi.org/10.3390/ijgi10060361

Zuiderwijk, A., Janssen, M., & Davis, C. (2014). Innovation with open data: Essential elements of open data ecosystems. *Information polity*, *19*(1-2), 17-33.

Zuiderwijk, A., Shinde, R., & Janssen, M. (2018). Investigating the attainment of open government data objectives – Is there a mismatch between objectives and results? International Review of Ad-ministrative Sciences, 86(1). doi:10.1177/0020852317739115