ETH*zürich*

HCI Lab

Advanced GIS, Spring Semester 2023

Chunyang Gao, Aline Pironato, Thierry Weber, Juliette Wicki
May 2023

Abstract

Human Computer Interaction (HCI) is an important aspect to consider while designing interfaces to ensure the usability. Likewise for web GIS an appealing, simple, and user-centred design is crucial. To evaluate and compare the usability of the GIS of Obwalden and St. Gallen a user study is performed including several tasks and a questionnaire. The results show that in general the web GIS of St. Gallen is preferred.

Content

List of Figures

Glossary

GIS   Geoinformation System

HCI   Human Computer Interaction

UCD   User-Centred Design

1   Introduction

Human Computer Interaction (HCI) is an important aspect to consider while designing hardware, software, and interfaces in general. The usability of products is highly dependent on the design of the interaction between its users and the product itself. A User-Centred Design (UCD) facilitates such communication and interaction between humans and computers because it focuses on the users, their tasks and skills while developing the product. (Mordechai (Muki) Haklay, 2010)

This report analyses and compares the usability of two web Geoinformation Systems (GIS) from Swiss cantons. The first GIS to examine is the one from the canton of Obwalden. It is combined with the GIS from canton of Nidwalden which is why they share the same layout and design. The web GIS is maintained by the company GIS Daten AG. Before a map is displayed, it has to be chosen which topic, e.g. agriculture (Landwirtschaft), is of interest. Therefore, it is not possible to combine layers from different topics. Nevertheless, the topic can be switched once a map is opened (see Figure 1, mark 1). The layout is not modern but kept simple. It includes the basic features of a web GIS such as zooming, measuring, and exporting (see Figure 1, mark 2, 3, 4 respectively). (GIS Daten AG, n.d.)
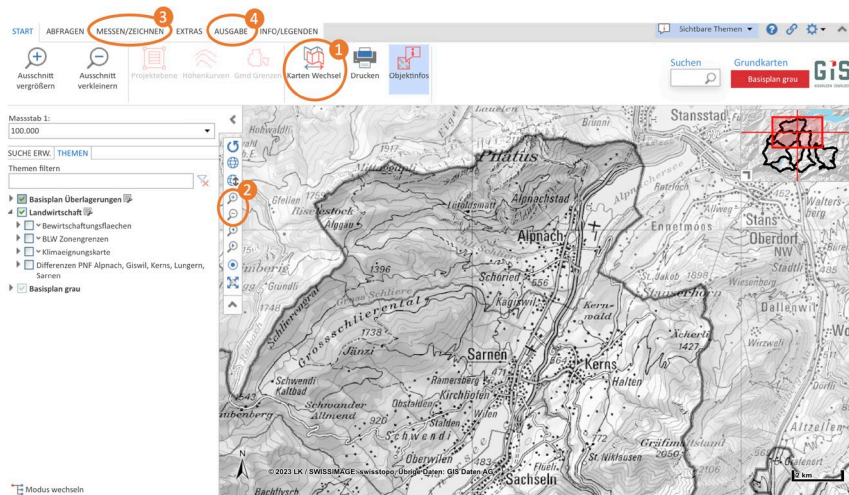

Figure 1: Screenshot of the web GIS of Obwalden, showing the topic agriculture (GIS Daten AG, 2023)

The web GIS of canton St. Gallen is the other GIS to analyse. The GIS is maintained by IG GIS AG and published on the publication portal GEOPORTAL by GEOINFO Applications AG (GEOINFO Applications AG, 2022). In contrary to the GIS of Obwalden, it is possible to open the portal without selecting a topic and to overlay several maps with different topics (see Figure 2, mark 1). The design is modern, simply structured, and more appealing than the one of Obwalden. Basic functions such as zooming, measuring, and exporting (see Figure 2, mark 2, 3, 4 respectively) are featured as well. (IG GIS AG, n.d.-a)

By performing a user study (see section 2), the usability of these GIS is evaluated (see section 3 and 4). The study is conducted for the HCI Lab of the lecture Advanced GIS, Chair of Geoinformation Engineering at ETH Zurich in Spring Semester 2023.
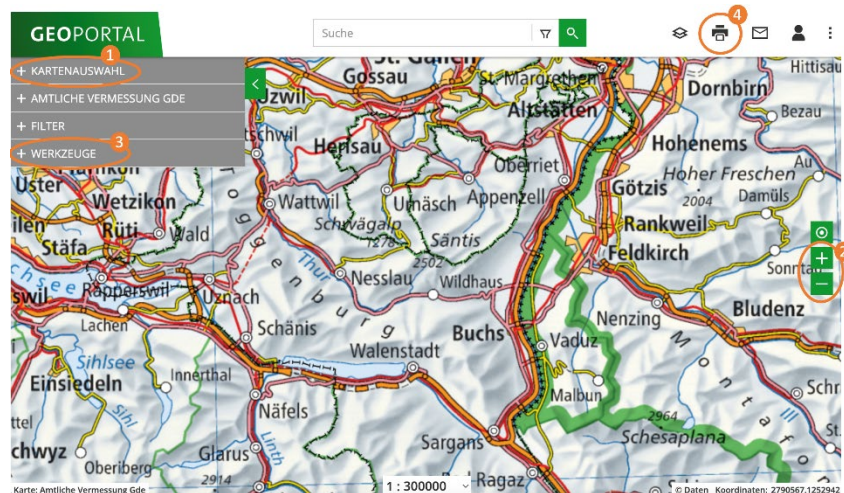

Figure 2: Screenshot of the web GIS of St. Gallen (IG GIS AG, n.d.-b)

2 Methodology

The following subsections focus on the user study and how it is conducted.

2.1 Study Design and Hypotheses

Different tasks are defined to evaluate the usability of the two GIS, our two independent variables. Starting point is a zoomed excerpt of an airport with the layer featuring the agricultural zones (Landwirtschaftzonen) activated. In Obwalden the airport Kägiswil, scale 1:15000 and in St. Gallen the airport St. Gallen Altenrhein, scale 1:17500 are chosen. The scales differ due to the scales available by the GIS. First, the participant should name the zone the airport is located in. Afterwards, the base map has to be changed to an orthophoto. Last, the runway length should be measured (see Appendix A). To avoid misunderstandings, one should measure from where the pavement starts to where it ends. Figure 3 gives an overview how the GIS could look after performing the different tasks.
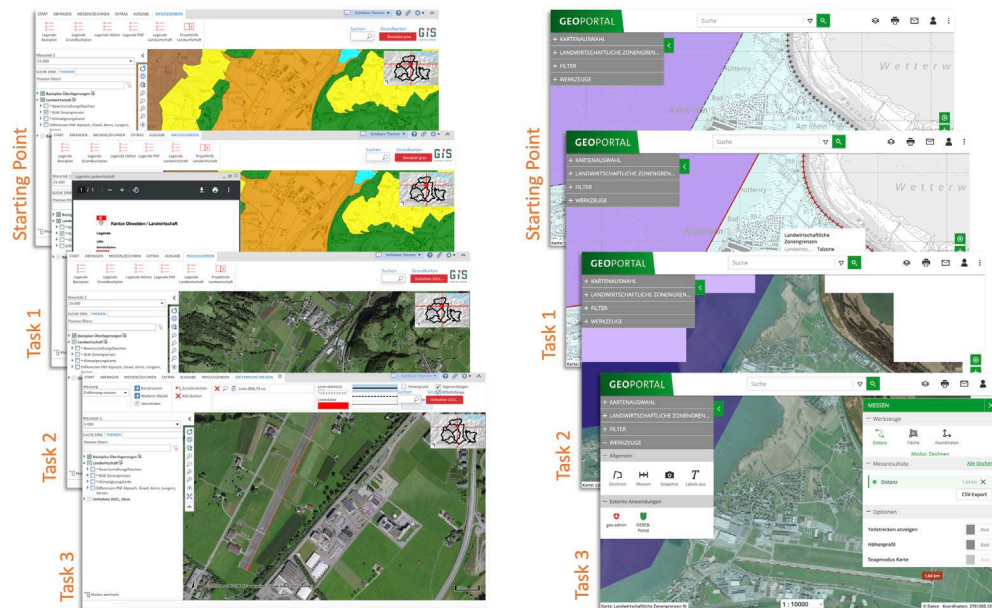

Figure 3: Overview of the GIS after performing the different tasks

Beside the correct performing of the task, the time needed to perform each task is taken. The measuring of the time starts after having read the instructions and lasts until the task is performed. For the second task, the clicks needed are counted as well. These are important measures to assess the effectiveness of the design of the GIS. Hence, among others the dependent variables are the time measured and the clicks counted.

Furthermore, a questionnaire is set up (see Appendix B). The questionnaire aims to collect information about the participant as well as their general impression of the different GIS. Moreover, answers of the first and third task are collected. The personal information forms the process variables, and the general impression complements the dependent variables.

Based on the three tasks defined above the following hypotheses can be formulated:

1. Performing task 1 correctly takes less time for the GIS of St. Gallen.
2. The second task is completed faster for the GIS of Obwalden.
3. Working with the measuring tool using the GIS of St. Gallen is more favourable.
4. Participants fluent in German can complete the tasks faster.

2.2 Participants

The number of participants is limited as the study has to be performed during the lesson. Two female and three male students from the same field participated which is why all of them rated their web GIS skills rather high, with an average of 4.6 on a scale from 1 (no experience) to 5 (very experienced). Two of the participants are non-German speakers. Only one person had once worked with the GIS of St. Gallen. All the other probands are unfamiliar with the present web GIS.

2.3 Study Setup and Procedure

Each participant performs the three tasks defined in section 2.1 for both GIS, so the study follows a within-case design. Half of the people start with the GIS of Obwalden, the other half with the one of St. Gallen to account for possible learning effects. A computer with the relevant GIS already opened is provided. After solving the tasks for one GIS, the questions from the questionnaire referring to this GIS are answered. Then, the procedure is repeated for the second GIS by first performing the task and afterwards answering the questions. In the end, questions about the participants are answered to not loose precious time at the beginning of the study (see Appendix A).

To conduct the study, one person is needed to take the time and one person to count the clicks. The person counting the clicks can give a brief introduction at the beginning describing the setting. In general, the instructions are given in written form to create equal conditions for all participants (see Appendix A). They are formulated in English as the corresponding lecture is held in English.

2.4 Data Analysis

To analyse the gathered data from the questionnaire, an excel spreadsheet is prepared. The gathered data per web GIS as well as the general feedback are evaluated separately to assess the hypotheses. The mean and median of the time and clicks needed is computed as well as the rating of GIS is compared. Furthermore, results for non-German speakers and German speakers are assessed individually to see the impact of a foreign language. The corresponding results are listed in section 3.

Moreover, other evaluations have been performed according to the interest of the study conductors (see Appendix C).

3 Results

To assess the hypothesis 1 and 2, Figure 4 is created that shows the time needed for both GIS. Additionally, for hypothesis 2, the evaluation of the required clicks to complete task 2 is displayed in Figure 5.
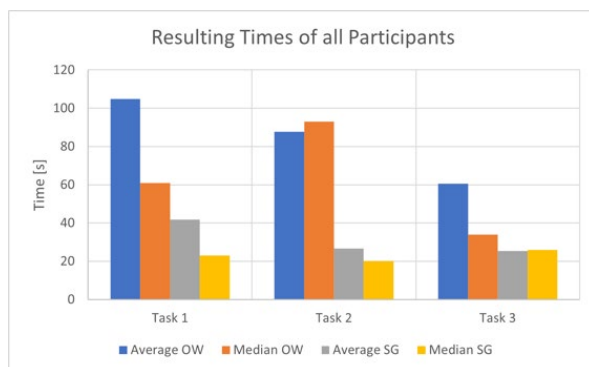

Figure 4: Average and median time needed for each task and web GIS
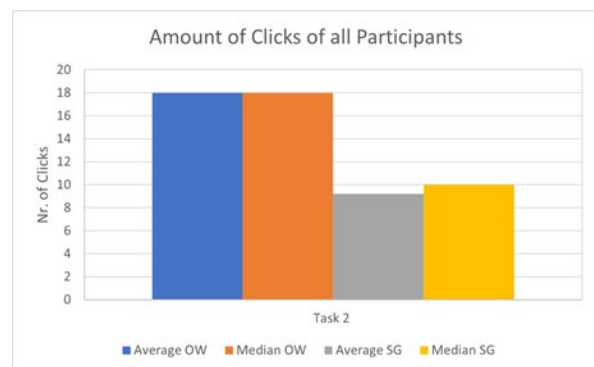
Figure 5: Average and median clicks needed for task 2 in each web GIS

For evaluating hypothesis 3, the preference for each task at hand is analysed and displayed in Figure 6. Likewise, key factors for the preference are listed Figure 7.

Figure 6: Preferred GIS for each task

Figure 7: Key factors for preference

Furthermore, the German and non-German speaking probands are evaluated separately to see the impact of the foreign language on the performance (see Figure 8, Figure 9, Figure 10 and Figure 11).

Figure 8: Time needed for each task for German-speaking participants

Figure 9: Time needed for each task for non-German speaking participants
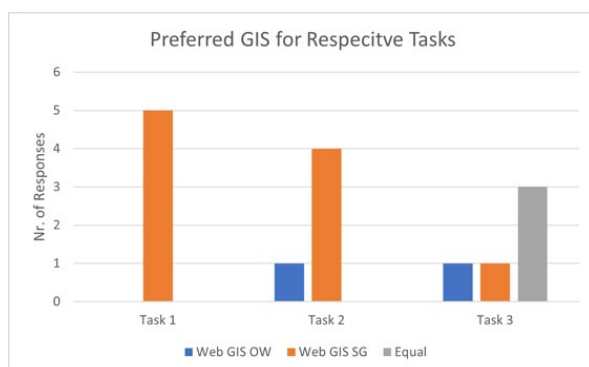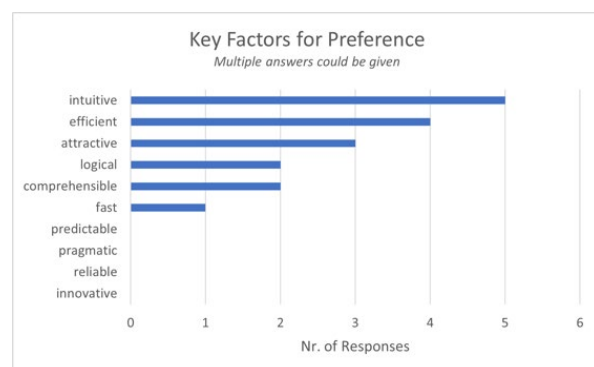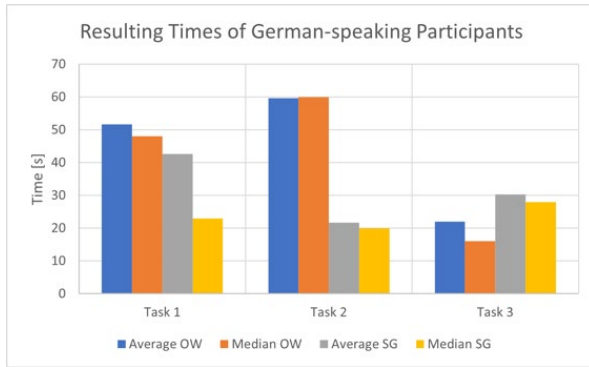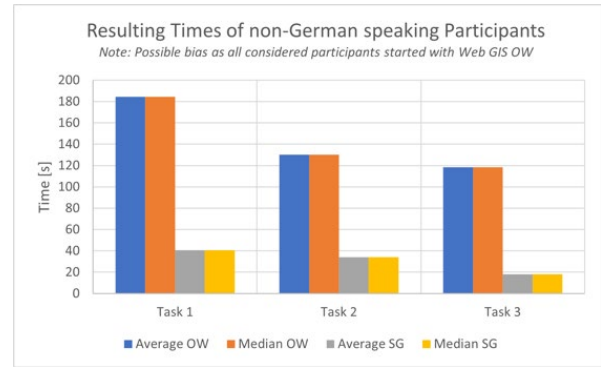

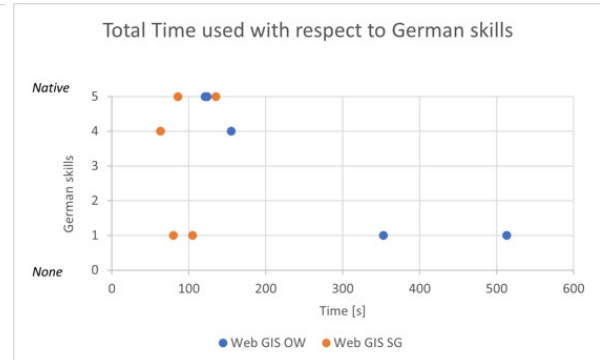Figure 10: Comparison of total time needed for German and non-German speakers

Figure 11: Total time needed with respect to German skills

To get some deeper insight, the study conductors evaluated some other aspects (see Appendix C).

4   Discussion

While analysing the results of the user study, it can be shown that in general the web GIS service of the canton of St. Gallen was preferred by the participants. Another interesting finding was, that the language barrier for non-German speakers influenced the process of fulfilling the tasks as well as the overall preference of the web GIS service. Non-German speakers where in general slower in solving the tasks since both web GIS services are only available in German. It is important to mention that due to the small number of participants the findings cannot be generalized and are therefore not necessarily representative or statistically relevant. In addition to the low number of participants, the fact that all probands are familiar with using GIS, must be noted as well. This influences the result in a way that one can assume that performing the study with people with no GIS experience would take longer.

The main conclusion for task 1, finding information about an agricultural zone, was that it can be performed faster in the web GIS of the canton St. Gallen. This can be justified with the information pop-up functionality provided. It allows the user to neglect the search of a legend, as required in the GIS of Obwalden, to find the needed information. Additionally, the web GIS of Obwalden had a rather unfortunate choice of the colour pallet for the agricultural layer. It included two, very similar hues of orange which can easily be misleading and confusing.

The main finding for task 2, changing the base map, was that although the user needs to know the symbol for base maps in the GIS of St. Gallen, the change is still performed faster than in the web GIS of Obwalden. Initially, the presumption was that the task is easier to complete in Obwalden's GIS as the button is labelled and automatically translated to "Base Map" as the web browser was set to English. Evidently, this was not the case. This might be because the button of the base map in the GIS of Obwalden is placed far away from the other tools/features. This is also reported as feedback from one of the participants in the general feedback section of the questionnaire. The counted clicks needed by the user to perform the task underlines the more user-friendly design in the web GIS of St. Gallen.

The main finding for task 3, measuring the runway, was that the subjective preference of the participant is more or less equal for both web GIS. When looking at the time used for the task, the web GIS of St. Gallen has allowed to perform faster. However, this only applies when all participants are accounted for the analysis. If the time needed is solely evaluated for German-speaking partakers the task was completed faster in the web GIS of Obwalden. The accuracy of the measured distances between the two web GIS cannot be meaningfully compared, as the web GIS of St. Gallen does not specify as much decimal places as the web GIS of Obwalden. The rough accuracy however can be labelled as equivalent for both web GIS.

Furthermore, the results allow us to verify or falsify the proposed hypotheses. We can verify three out of the four hypotheses. Only the assumption that task 2 is completed faster in the web GIS of the canton Obwalden has to be falsified if all participants are included in the evaluation. We are correct in assuming that performing task 1 correctly takes less time in the web GIS of the canton St. Gallen, that working with the measuring tool is more favourable in the GIS of St. Gallen and that participants fluent in German can perform the tasks faster.

5   Conclusion

As part of the Advanced GIS course in the spring semester 2023 at ETH Zurich a small pilot user study has been conducted in the HCI Lab at the Chair of Cartography and Geoinformation. The goal of this study is to compare two web GIS services according to their usability. Our group compares the web GIS of the canton St. Gallen with the web GIS of the canton Obwalden. As part of the study, each participant has to perform three tasks on each web GIS and subsequently fill out a questionnaire. The tasks are designed to explore different features of a web GIS. They include finding information, changing a layer, and working with the measuring tool. Next to specific questions about each web GIS, we ask the participants about their German skills and their experience with GIS. This information is helpful to later compare the results of German speakers with non-German speakers. We have conducted the pilot study with two non-German speakers and three German speakers, which leads to a total number of five participants.

While analyzing the results, it can be shown that in general the web GIS of St. Gallen is preferred by the participants. As assumed, the German skills influence the performance of the participants while working with the web GIS. Furthermore, the results allow us to verify and falsify the proposed hypotheses respectively. We can verify three out of the four hypotheses. Only the assumption that task 2 is completed faster in the web GIS of the canton Obwalden has to be falsified. We are correct in assuming that performing task 1 takes less time in the web GIS of the canton St. Gallen, that working with the measuring tool is more favourable in the GIS of St. Gallen and that participants fluent in German can perform the tasks faster.

In conclusion, we were able to answer our research questions by verifying or falsifying our proposed hypotheses. The low number of participants in our study does not allow to have a statistically relevant result, which is why this study can only be considered as a small pilot study. The study would have to be further extended in number of participants as well as the time frame in which the study has to take place. We are limited with a maximum of ten minutes per participants, which does not allow us to collect all the information needed to make a profound quantitative and qualitative comparison of the two web GIS services.

For a more elaborate study, we would invite more participants including people from different fields and take more time per participant in the study. In addition, we would also have to consider excluding non-German speakers from participating to have more control over the study. This exclusion of course depends on whether we would like to further investigate on the hypothesis that non-German speaker are more efficient when working with these two Swiss web GIS services or not. As these services are created to mainly be used by the Swiss population, one can argue that it is more interesting to compare the feature and tools with only German speaking participants. In terms of tasks, there are more interesting features to explore and compare. This could be included in form of additional tasks in a more profound study. To make the study easier to compare with other studies, it could be considered to include standardized questionnaires for future work.

Bibliography

GEOINFO Applications AG. (2022). *GEOPORTAL Impressum*. https://www.geoportal.ch/services/file/Geoportal_Impressum.pdf

GIS Daten AG. (n.d.). *Webkarten Obwalden*. Retrieved April 8, 2023, from https://www.gis-daten.ch/?active-map=ow

GIS Daten AG. (2023). *WebGIS Landwirtschaft OW*. https://www.gis-daten.ch/map/ow_landwirtschaft

IG GIS AG. (n.d.-a). *GEOPORTAL Kanton St. Gallen*. Retrieved April 8, 2023, from https://www.geoportal.ch/ktsg

IG GIS AG. (n.d.-b). *WebGIS SG*. Retrieved April 8, 2023, from https://www.geoportal.ch/ktsg/map/40?y=2743944.00&x=1231900.00&scale=300000&rotation=0

Mordechai (Muki) Haklay. (2010). *Interacting with Geospatial Technologies*. Wiley.

GEOINFO Applications AG. (2022). *GEOPORTAL Impressum*. https://www.geoportal.ch/services/file/Geoportal_Impressum.pdf

Appendix A: Instructions
HCI LAB – Usability study web GIS   Group A

Welcome to our usability study on web GIS services. In the following 10 minutes you will perform 3 tasks on two different web GIS services. During this study you will be asked different questions about your experience with the web GIS. The questions will be distributed on a separate sheet of paper. The instructions on how to proceed will be given in the following paragraphs. If you have any questions beforehand, feel free to ask any group member.

Instructions

The computer screen in front of you should show the web GIS of the canton Obwalden with the "Landwirtschaftszonen (farmland zones) activated. The map is zoomed in to a local airport called Kägiswil. You will now be asked to perform three different tasks to gather information about this airfield.

Instructions Task 1 on web GIS of canton Obwalden

The first task is to find out in which "Landwirtschaftszone" (farmland zone) the airport is located in. Please write down the name of the zone on the questionnaire sheet.

Instructions Task 2 on web GIS of canton Obwalden

For the second task, change the displayed base map to orthophoto 2021, 10cm. Please keep the map section the same. Nothing has to be filled in on the questionnaire for this task.

Instructions Task 3 on web GIS of canton Obwalden

Before starting with the final task, make sure to deactivate the "Landwirtschaftszone" layer. In the final task, we ask you to measure the runway at the Kägiswil airport. Please use the measuring tool of the web GIS service to measure from the beginning of the pavement of the runway to the end of the pavement. Write down the measured distance on the questionnaire as accurately as possible.

You completed all three tasks on the web GIS of canton Obwalden. Please fill out page 1 on the questionnaire before proceeding here.

The second web GIS service is from the canton St. Gallen. We start with the same setting but zoomed in to the airport St. Gallen Altenrhein.

Instructions Task 1 on web GIS of canton St. Gallen

The first task is to find out in which "Landwirtschaftszone" (farmland zone) the airport is located in. Please write down the name of the zone on the questionnaire sheet.

Instructions Task 2 on web GIS of canton St. Gallen

For the second task, change the displayed base map to orthophoto. Please keep the map section the same. Nothing has to be filled in on the questionnaire for this task.

Instructions Task 3 on web GIS of canton St. Gallen

In the final task, we ask you to measure the runway at the St. Gallen Altenrhein airport. Please use the measuring tool of the web GIS service to measure from the beginning of the pavement on one end of the runway to the end of the pavement on the other end of the runway. Write down the measured distance on the questionnaire as accurately as possible.

You completed all three tasks on the web GIS of canton St.Gallen. Please fill out pages 2 and 3 on the questionnaire. Thank you very much for participating in our usability study during the HCI Lab, ETH Zurich.

HCI LAB – Usability study web GIS   Group B

Welcome to our usability study on web GIS services. In the following 10 minutes you will perform 3 tasks on two different web GIS services. During this study you will be asked different questions about your experience with the web GIS. The questions will be distributed on a separate sheet of paper. The instructions on how to proceed will be given in the following paragraphs. If you have any questions beforehand, feel free to ask any group member.

Instructions

The computer screen in front of you should show the web GIS of the canton St. Gallen with the "Landwirtschaftszonen (farmland zones) activated. The map is zoomed in to a local airport called St. Gallen Altenrhein. You will now be asked to perform three different tasks to gather information about this airfield.

Instructions Task 1 on web GIS of canton St. Gallen

The first task is to find out in which "Landwirtschaftszone" (farmland zone) the airport is located in. Please write down the name of the zone on the questionnaire sheet.

Instructions Task 2 on web GIS of canton St. Gallen

For the second task, change the displayed base map to orthophoto. Please keep the map section the same. Nothing has to be filled in on the questionnaire for this task.

Instructions Task 3 on web GIS of canton St. Gallen

In the final task, we ask you to measure the runway at the St. Gallen Altenrhein airport. Please use the measuring tool of the web GIS service to measure from the beginning of the pavement on one end of the runway to the end of the pavement on the other end of the runway. Write down the measured distance on the questionnaire as accurately as possible.

You completed all three tasks on the web GIS of canton St. Gallen. Please fill out page 1 on the questionnaire before proceeding here.

The second web GIS service is from the canton Obwalden. Here we start with the same setting but zoomed in to the airport Kägiswil in canton Obwalden.

Instructions Task 1 on web GIS of canton Obwalden

The first task is to find out in which "Landwirtschaftszone" (farmland zone) the airport is located in. Please write down the name of the zone on the questionnaire sheet.

Instructions Task 2 on web GIS of canton Obwalden

For the second task, change the displayed base map to orthophoto 2021, 10cm. Please keep the map section the same. Nothing has to be filled in on the questionnaire for this task.

Instructions Task 3 on web GIS of canton Obwalden

Before starting with the final task, make sure to deactivate the "Landwirtschaftszone" layer. In the final task, we ask you to measure the runway at the Kägiswil airport. Please use the measuring tool of the web GIS service to measure from the beginning of the pavement on one end of the runway to the end of the pavement on the other end of the runway. Write down the measured distance on the questionnaire as accurately as possible.

You completed all three tasks on the web GIS of canton Obwalden. Please fill out pages 2 and 3 on the questionnaire. Thank you very much for participating in our usability study during the HCI Lab, ETH Zurich.

Questionnaire for Web GIS Usability

Evaluation of Web GIS 1

Task 1
[1] In which *"Landwirtschaftszone"* (agricultural zone) does the airport lie?

_____

Task 3
[2] Which runway length did you measure?

_____

[3] Assess the following statements:

"The use of Web GIS 1 was intuitive."

Strongly disagree   ◯   ◯   ◯   ◯   ◯   *Strongly agree*

"Web GIS 1 allows for efficient solving of the tasks."

Strongly disagree   ◯   ◯   ◯   ◯   ◯   *Strongly agree*

"The organisation of information in the Web GIS 1 is clear."[1]

Strongly disagree   ◯   ◯   ◯   ◯   ◯   *Strongly agree*

"Finding the according *"Landwirtschaftszone"* in Web GIS 1 was easy." *(Task 1)*

Strongly disagree   ◯   ◯   ◯   ◯   ◯   *Strongly agree*

"Switching between base maps was easy in Web GIS 1." *(Task 2)*

Strongly disagree   ◯   ◯   ◯   ◯   ◯   *Strongly agree*

"Working with the measuring tool in Web GIS 1 was easy." *(Task 3)*

Strongly disagree   ◯   ◯   ◯   ◯   ◯   *Strongly agree*

---

[1] Perlman, Gary (1998) Questionnaire for User Interface Satisfaction QUIS
https://garyperlman.com/quest/quest.cgi?form=QUIS

Evaluation of Web GIS 2

Task 1

[1] In which *"Landwirtschaftszone"* (agricultural zone) does the airport lie?

_____

Task 3

[2] Which runway length did you measure?

_____

[3] Assess the following statements:

"The use of Web GIS 2 was intuitive."

    Strongly disagree   ○   ○   ○   ○   ○   *Strongly agree*

"Web GIS 2 allows for efficient solving of the tasks."

    Strongly disagree   ○   ○   ○   ○   ○   *Strongly agree*

"The organisation of information in the Web GIS 2 is clear."[2]

    Strongly disagree   ○   ○   ○   ○   ○   *Strongly agree*

"Finding the according *"Landwirtschaftszone"* in Web GIS 2 was easy." *(Task 1)*

    Strongly disagree   ○   ○   ○   ○   ○   *Strongly agree*

"Switching between base maps was easy in Web GIS 2." *(Task 2)*

    Strongly disagree   ○   ○   ○   ○   ○   *Strongly agree*

"Working with the measuring tool in Web GIS 2 was easy." *(Task 3)*

    Strongly disagree   ○   ○   ○   ○   ○   *Strongly agree*

---

[2] Perlman, Gary (1998) Questionnaire for User Interface Satisfaction QUIS
https://garyperlman.com/quest/quest.cgi?form=QUIS

General Feedback

[1] Which Web GIS did you prefer for…

… Task 1?	○ Web GIS 1	○ Web GIS 2	○ equal
… Task 2?	○ Web GIS 1	○ Web GIS 2	○ equal
… Task 3?	○ Web GIS 1	○ Web GIS 2	○ equal

[2] Overall, which Web GIS would you prefer to work with?

    ○ Web GIS 1   ○ Web GIS 2

[3] What were the determining key factors leading to this preference? (Multiple answers are possible)

❏ efficient   ❏ innovative   ❏ intuitive   ❏ attractive   ❏ comprehensible

❏ fast   ❏ reliable   ❏ pragmatic   ❏ logical   ❏ predictable

❏ other: _____

[4] Were there any major issues you encountered while solving the tasks? If yes, what were they?

Web GIS 1:

_____

Web GIS 2:

_____

[6] Additional comments or remarks:

_____

_____

_____

Personal Details

[1] Gender: ○ female   ○ male   ○ diverse

[2] Native language: _____

[3] German skills: ○ none ○ A1-A2 ○ B1-B2 ○ C1-C2 ○ native speaker

[4] How would you rate your skills in the use of GIS?

no experience   ○   ○   ○   ○   ○   *very experienced*

[5] How often do you use Web GIS services?

never   ○   ○   ○   ○   ○   *very often*

[6] Were you already familiar with the tested GIS?

○ Yes, with both   ○ Yes, with St. Gallen's   ○ Yes, with Obwalden's   ○ No, with neither

Preliminary Evaluation Results

Will be filled out by study conductor – Please leave blank!

[A] Group: _____

[B] Required Time for Web GIS 1:   Required Clicks for Web GIS 1:

        Task 1: _____

        Task:2: _____   Task:2: _____

        Task 3: _____

[C] Required Time for Web GIS 2   Required Clicks for Web GIS 2:

        Task 1: _____

        Task:2: _____   Task:2: _____

        Task 3: _____

Preliminary Evaluation Results

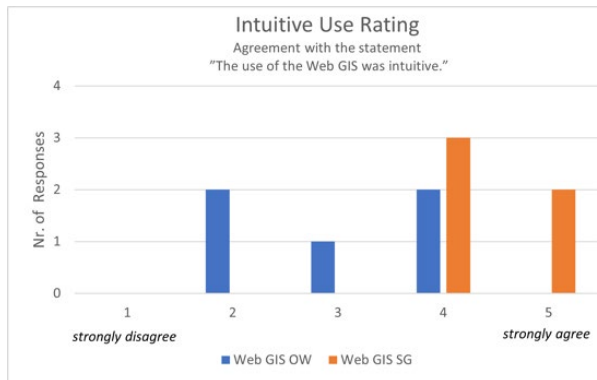*Will be filled out by study conductor – Please leave blank!*
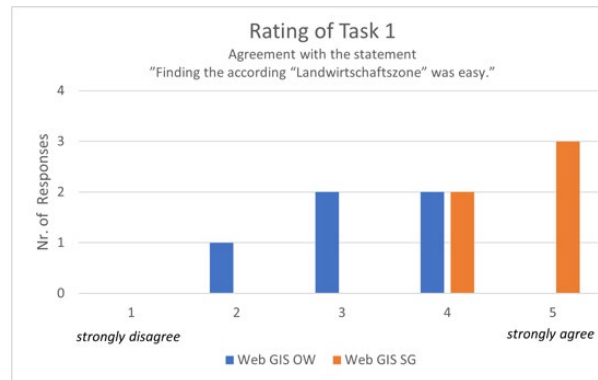
Appendix C: Additional Results
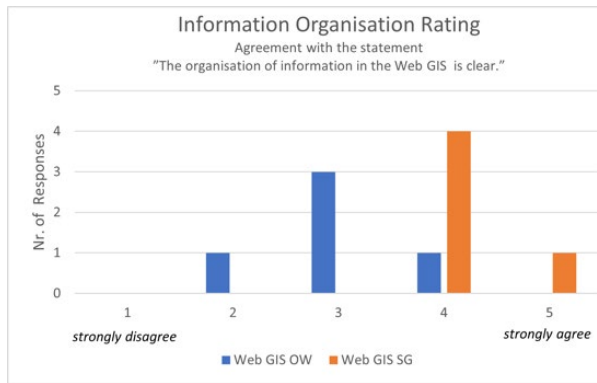
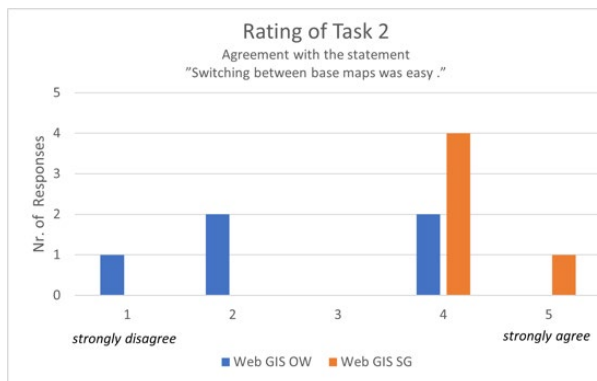Appendix C.1: Information Organisation Rating
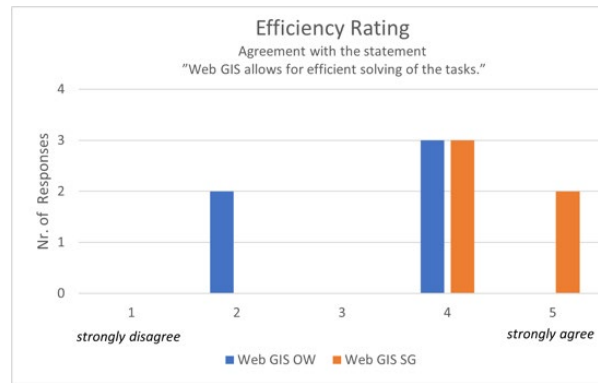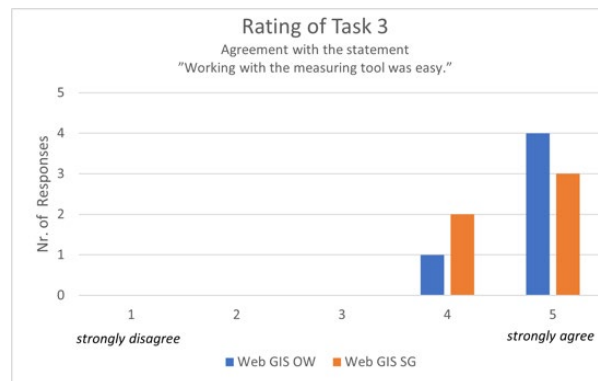

Appendix C.2: Efficiency Rating
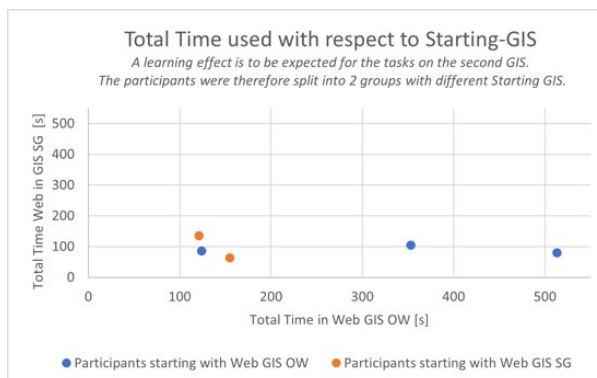

Appendix C.3: Intuitive Use Rating

Appendix C.4: Rating of Task 1 depending on the GIS

Appendix C.5: Rating of Task 2 depending on the GIS

Appendix C.6: Rating of Task 3 depending on the GIS

Appendix C.7: Total time used with respect to the Starting-GIS

Declaration of originality

The signed declaration of originality is a component of every semester paper, Bachelor's thesis, Master's thesis and any other degree paper undertaken during the course of studies, including the respective electronic versions.

Lecturers may also require a declaration of originality for other written papers compiled for their courses.

_____

I hereby confirm that I am the sole author of the written work here enclosed and that I have compiled it in my own words. Parts excepted are corrections of form and content by the supervisor.

Title of work (in block letters):

Authored by (in block letters):
For papers written by groups the names of all authors are required.

Name(s):   **First name(s):**

With my signature I confirm that
- − I have committed none of the forms of plagiarism described in the 'Citation etiquette' information sheet.
- − I have documented all methods, data and processes truthfully.
- − I have not manipulated any data.
- − I have mentioned all persons who were significant facilitators of the work.

I am aware that the work may be screened electronically for plagiarism.

Place, date   **Signature(s)**

05/05/2023   *Chunyang Gao*
                                               A. Riusto
                                               [signature]
                                               JWichi

For papers written by groups the names of all authors are required. Their signatures collectively guarantee the entire content of the written paper.