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Frontend Metriken



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Abstract

The Boom Software AG has been looking for solutions to gather data about how well their product designs are performing. Up until now, they have not been able to collect details about how users interact with their software, as well as opportunities to evaluate these metrics efficiently.

First, we had to research and test different analytic tools to find the one best suited to our requirements. These include the tracking of button clicks on the web application, switching through different views, or collecting client-based application errors. In addition to the tool research, we also investigated the data privacy rights. To ensure our compliance with the GDPR, we included a consent banner in the application with the possibilities to opt-in and opt-out from the tracking.

Through the integration of an analytic software inside the already existing applications, the real-time data of their users can be gathered and displayed in detail. With these statistics, current projects as well as the customers' satisfaction can be improved. Furthermore, future projects can benefit from these captured details.

The Countly interface provides an easy-to-use way to view metrics and incoming data, enabling the company to make informed decisions quickly and efficiently. Through the power of data analytics, Boom Software AG can stay ahead of its competition and continue to deliver high-quality products that meet their customers' needs and expectations.

Abstract (German)

Die Boom Software AG hat nach Lösungen gesucht, um Benutzerdaten über ihre Produkt-designs zu sammeln, da dies bisher nicht möglich gewesen ist.

Zunächst mussten wir verschiedene Analysetools recherchieren und testen, um dasjenige zu finden, das unseren Anforderungen am besten entspricht. Diese beinhalten das Dokumentieren von Klicks auf der Webanwendung, das Wechseln zwischen verschiedenen Ansichten oder die Erfassung benutzerbasierter Anwendungsfehler. Neben der Recherche zu den Tools haben wir uns auch mit den Datenschutzrechten befasst. Um die Einhaltung der DSGVO zu gewährleisten, haben wir einen Datenschutz-Banner in die Anwendung integriert, welcher die Möglichkeit bietet, das Tracking abzubestellen.

Durch die Integration einer Analysesoftware in die bereits bestehenden Anwendungen können die Echtzeitdaten deren Nutzer gesammelt und detailliert angezeigt werden. Diese Statistiken können dann verwendet werden, um die laufenden Projekte zu verbessern und die Kundenzufriedenheit zu erhöhen. Darüber hinaus können zukünftige Projekte von diesen erfassten Eckdaten profitieren.

Die Countly-Benutzeroberfläche bietet ein einfach zu bedienendes Dashboard, womit man Metriken und eingehende Daten betrachten kann, sodass das Unternehmen schnell und effizient Entscheidungen treffen kann. Durch die Datenanalyse kann die Boom Software AG der Konkurrenz voraus sein und weiterhin qualitativ hochwertige Produkte liefern, welche die Bedürfnisse und Erwartungen ihrer Kunden erfüllen.

Thanks

Without the support of numerous individuals, we would not have been able to complete this diploma thesis.

First, a special thanks to our supervising teacher, Ing. Dipl.-Ing. Paulus Dietmar, BSc., who supported us from start to finish with encouraging words and outstanding proficiency across a diverse range of technical domains. Even when it started to get difficult and nearly impossible to complete, he supported us and gave us a piece of advice to solve our problems, notably on the management side of the project.

Another thanks to our project partner Uroš Šolar. During our cooperation with Boom Software AG, he helped us to understand the local framework and gave us insights about the various categories and methods of tracking user interactions or evaluating the website's performance. The daily meetings were necessary in order to learn every relevant aspect of measuring frontend metrics in this short period of time. Whatever the matter was, Uroš could help almost anytime.

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1 Introduction

To master a project like ours, we, as a well-coordinated team, came up with a concept to create the project together with our project partner. In conjunction with our supervisor, we wrote our diploma thesis. The following chapter describes the team, the supervisor, and the project partner.

1.1 Team

Simon Schöggler

Product Owner

Simon Schöggler tackled the question of how to convince customers/users of the value of a user interface. Furthermore, he implemented the tracking events for CTL, buttons, and pages.

E-Mail: soesia18@htl-kaindorf.at



Fig. 1: Simon Schöggler



Manuel Reinprecht

Scrum Master

Manuel Reinprecht dealt with ways to measure the user experience of the application. He also managed the basic administration of the website and did research on GDPR and other data protection laws.

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Fig. 2: Manuel Reinprecht

David Brannan

Quality Manager

David Brannan dealt with the legal requirements when collecting user data, furthermore he implemented the user tracking consent.

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Fig. 3: David Brannan

Marcel Schmidl

Protocol Officer

Marcel Schmidl dealt with the possibilities of improving the user experience of an application. In addition, he worked on the basics of managing user consent and did research on innovative technologies.

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Fig. 4: Marcel Schmidl

1.2 Supervisor

Dietmar Paulus

Supervisor

Our form teacher, system planning and project development instructor, Dietmar Paulus, offered us his assistance with the project. He also provided us with valuable guidance and advice for the diploma thesis. His expertise in Scrum and programming was indispensable for our success.

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Fig. 5: Supervisor

1.3 Project partner

Boom Software AG

Project partner

Boom Software AG is an internationally active software house with more than 20 years of experience in the development of various types of software, especially maintenance and production management software.

Contact person: **Uroš Šolar**

E-Mail: u.solar@boomsoftware.com



Fig. 6: Project partner

2 Initial situation

Boom Software AG creates software solutions especially for the transport industry. After the product has been delivered to the customer, Boom Software AG has no control over how the end user interacts with the software. It is a very common issue for companies like Boom Software AG: Actually, the only way to find out about an error or a bad user interface in the software is, if the customer points it out to them. Our solution is to implement a tracking tool to detect bad user experience much earlier than it was possible so far.

Firstly, there are many tracking tools or frontend metric collection tools on the market, but with the legal situation and wishes from Boom Software AG, we had to find a tool which was not developed in the United States. Secondly, most of the tools were developed for web pages, but Boom Software AG needed a tool for single page applications, which means, the URL is never changing to another page, it is always rewriting the content on the same page. Another important point is that Boom Software AG does not provide a direct connection to the internet to every customer, so the tool must be able to work offline. With these requirements, we started to search for a tool which fits to our needs.

3 Organisational

To plan a project like ours, it is essential to have a structured and clear planning. This includes the work breakdown structure, RACI-Matrix, milestones and work packages. The following sections will explain the individual planning tools.

3.1 Work breakdown structure

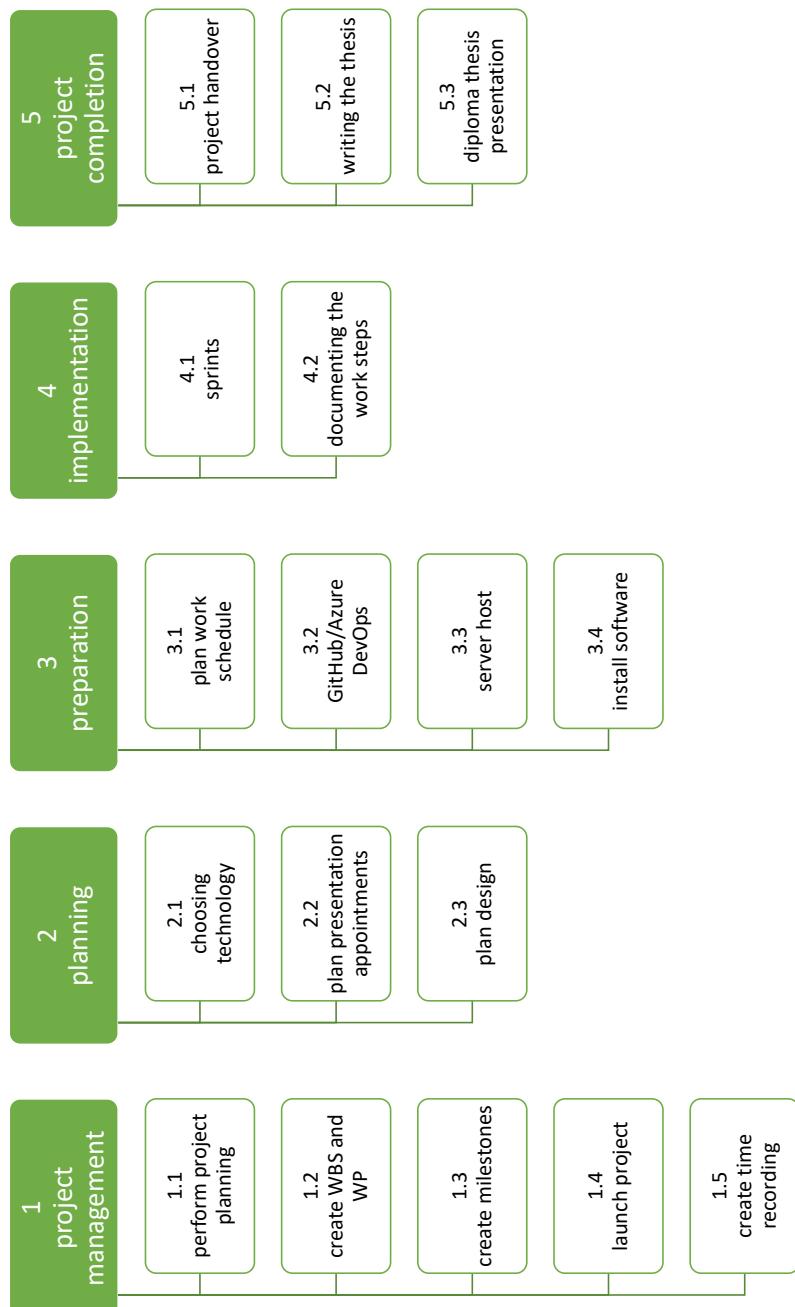


Fig. 7: Work breakdown structure

3.2 RACI-Matrix

subproject "project management"	David	Manuel	Simon	Marcel
perform project planning	I	I	R	I
create WBS and WP	I	I	R	I
create milestones	I	R	A	I
launch project			R	
create time recording	I	I	A	R

subproject "planning"	David	Manuel	Simon	Marcel
choosing technology	C	C	R	C
plan presentation appointments	I	I	R	I
plan design	R		A	

subproject "preparation"	David	Manuel	Simon	Marcel
plan work schedule	-	-	R	-
GitHub/Azure DevOps	R	I	A	I
server host	R	I	I	I
install software	I	R	I	I

subproject "implementation"	David	Manuel	Simon	Marcel
sprints	-	-	R	-
documenting the work steps	I	I	A	R

subproject "project completion"	David	Manuel	Simon	Marcel
project handover	I	I	R	I
writing the thesis	C	C	R	C
diploma thesis presentation	C	C	R	C

Fig. 8: RACI-Matrix

3.3 Milestones

No.	Milestone	Date
1	Research on technologies, platforms, costs, legal, ...	11.07.22
2	Presentation of the research and handing it over	01.08.22
3	Selection of technology and criteria for prototype	15.08.22
4	Implementation of a prototype (integration into a product)	19.12.22
5	Presentation of the prototype to Boom Software AG	16.01.23
6	Completion of the written thesis	01.02.23

Table 1: Milestones

3.4 Work package

No.	Work package	Sprint
1	Data protection law in France	Sprint 1
2	Data protection law in Egypt	Sprint 1
3	Data protection law in Hungary	Sprint 1
4	Data protection law in Austria	Sprint 1
5	Data protection law in Germany	Sprint 1
6	GDPR	Sprint 1
7	Tool research	Sprint 1
8	Posthog	Sprint 1
9	Open Web Analytics	Sprint 1
10	Countly	Sprint 1

Table 2: Work package

No.	Work package	Sprint
11	Matomo	Sprint 1
12	Presentation	Sprint 1
13	Data migration	Sprint 2
14	Feedback	Sprint 2
15	Exploring BORA framework	Sprint 2
16	Deploying Countly on Gallery project	Sprint 2
17	Create click events for the buttons	Sprint 2
18	Create new module from the third-party Countly JS	Sprint 2
19	Add custom pages to Countly (Page Views)	Sprint 2
20	Create Countly-lib module	Sprint 2
21	Consent	Sprint 2
22	trackTabEvent	Sprint 3
23	Outsource splitting	Sprint 3
24	Track CTL focus	Sprint 3
25	Consent integration in Gallery	Sprint 3
26	Deploying Countly on BRS Demo	Sprint 3
27	Design consent banner	Sprint 3
28	Create .less file	Sprint 3
29	Workflow	Sprint 3
30	Onclick from user settings to consent page	Sprint 3
31	Workflow in BRSDemo	Sprint 4
32	Feedback in BRSDemo	Sprint 4

Table 3: Work package

3.4 Work package

No.	Work package	Sprint
33	Countly integration in BRSDemo	Sprint 4
34	Include theme.less	Sprint 4
35	Consent banner in BRSDemo	Sprint 4
36	ConsentMenu-Option in BRSDemo	Sprint 4
37	Consent subpage in BRSDemo	Sprint 4
38	Tabs-head event listener	Sprint 4
39	Edit consent button banner icon	Sprint 4
40	Data information from the page	Sprint 4

Table 4: Work package

3.5 Time Plan



Fig. 9: Gantt Chart

We planned our time management with the Gantt-Project tool. The application allowed us to create a full timeline of the project. With this Gantt chart, we could see a detailed and quick overview of our progress.

3.6 Scrum

For the planning and organisation, we used the agile project management framework Scrum. It was also recommended by the Boom Software AG, who created a Trello board for us with several tasks. With the board, we had an overview of the product backlog, which contains every requirement of the project. Once a week we had a Scrum review with our project supervisor over MS Teams and a short 10-minute daily meeting with a fixed time slot. For the intern planning of the diploma thesis, we used MS Planner, which has a better integration in the Office 365 work environment. Before we started the project, we had a meeting with the Boom Software AG and brainstormed for every requirement, which the analytic tool needed. With the information, we created four sprints with about the same amount of work, which was estimated with story points. For the priority, we used the integrated function in MS Planner, which allowed us to give any task a priority from low to urgent. After we assigned every requirement to a sprint, we gave them a priority and an exact description of what will be necessitated to finish the task.

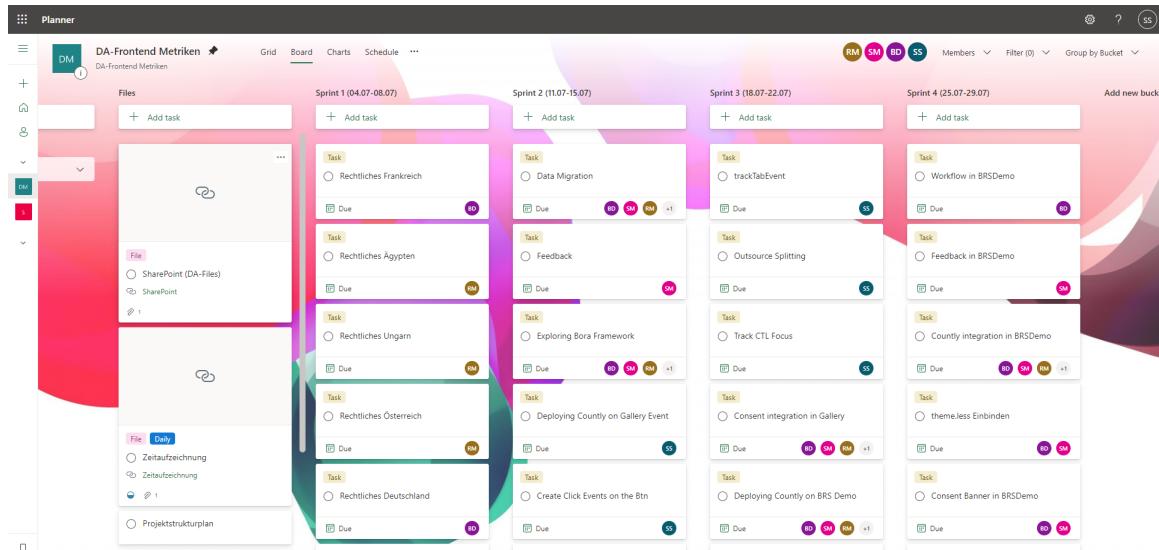


Fig. 10: MS Planner

With the MS Planner board, it was easy to change the priority and postpone tasks to the next sprint if not completed.

4 Technologies

The technologies we used for programming and source control will be listed on the following pages.

4.1 Git



Fig. 11: Git Logo

(“Git-Logo-2Color.png (910×380)”, 2022)

Git is a free, distributed open-source version control system for software projects that was released in 2005. Through the use of version control, it is simple to independently add modifications to the project from any location, to log and track these changes, and to access earlier versions of the project at a later time. It can be used in practically any setting because it is platform independent.

Git is based on a distributed system, whereas other version control systems are based on a centrally stored database. This means, that each member of a project has its own copy of the repository (project database). Theoretically, you can work with Git without a central database at all. Developers mainly program on their local instance of the repository and can share their changes with all participants.

It also offers the possibility to divide a project into different branches or forks, allowing them to separate versions and develop new or experimental features simultaneously alongside the main branch. Changes that are to be published to the end-user can then be merged back with the corresponding project version. Git is designed for teams to regularly use branches and merges to build up an easily traceable history of the project. It has internal tools that can visualise the branches and merges of a project - giving each team member a traceable overview of the project’s development. (Augusten, 2019)

We used Git to simultaneously work on our project and for writing the thesis with LaTeX.

4.2 JavaScript

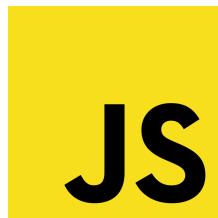


Fig. 12: Javascript Logo

(“JavaScript-logo.png (1052×1052)”, 2014)

JavaScript is one of the three main programming languages used in the WWW, besides HTML and CSS. JS is mostly used to make websites more dynamic by adding interaction features for the users. (A., 2022)

4.3 TypeScript



Fig. 13: TypeScript Logo

(“typescript_original_logo_icon_146317.png (512×512)”, 2020)

TypeScript is the improved version of JavaScript. With new features like typification, the possibility to create objects and a new compiler, the opportunities to develop at a large scale are even bigger. (Shubel, 2022)

4.4 .less

Less is a syntax-extension for CSS, with options like nesting, variables, or extensions. With these methods, there is a variety of new options for designers to choose from. (“Less (Leaner Style Sheets)”, 2022)

4.5 LaTeX



Fig. 14: LaTeX Logo

(“LaTeX_logo.png (600×250)”, 2013)

LaTeX is a free, open-source typesetting system used to create scientific and technical documents. Furthermore, it is excellent as a typeset for mathematical formulas. Notable strengths of LaTeX are its cross-referencing functions, its automatic numbering, and the creation of table of contents, bibliographies, indexes, figures, glossaries, and tables. (“What is LaTeX? | LaTeX Beginner’s Guide”, 2022)

These factors led us to choose LaTeX as the typesetting system for our thesis.

4.6 C#



Fig. 15: C# Logo
("C-Sharp.png (2320×1305)", 2023)

C# is a programming language developed by Microsoft as part of the .NET framework. It is a modern, object-oriented language that is designed to be simple, powerful, and easy to use. C# has a strong type system and supports both imperative and functional programming styles. It is a popular language for developing Windows applications, as well as web and mobile applications, and is used by companies around the world. C# is also used to build video games, tools, and other software for a variety of platforms. ("What is C#?", 2020)

5 Used Tools

The tools used for communication, designing and programming are going to be listed on the following pages.

5.1 Microsoft Teams

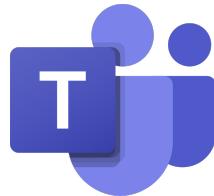


Fig. 16: Microsoft Teams Logo

(“Microsoft_Office_Teams_%282018-present%29.svg”, 2021)

Microsoft Teams is a collaboration software where teams can hold meetings, use a chat functionality or can have a shared calendar. Furthermore, you can make your own teams with each group you are working with to keep yourself organised. (O’Neill, 2021)

5.2 Slack



Fig. 17: Slack Logo

(“Slack_Technologies_Logo.svg”, 2019)

Slack is, like Teams, a collaboration platform for businesses to make the communication between teams easier. In addition to its primary chat function, Slack allows you to make individual channels for each project group and hold meetings within the platform itself. (“What is Slack?”, 2022)

5.3 Visual Studio

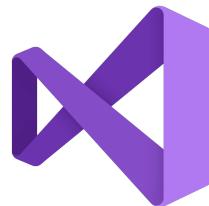


Fig. 18: Visual Studio Logo
("Visual-Studio-Logo.png (2200×1375)", 2022)

Microsoft Visual Studio is a popular-integrated development environment (IDE) used for building applications for Windows, Linux, the web, and mobile devices. It supports a wide range of programming languages and includes a code editor, debugger, and other tools that help developers write, test, and debug code more efficiently. Visual Studio also includes a GUI (graphical user interface) builder, which allows developers to create user interfaces for their applications using drag-and-drop tools.

Some of the features of Visual Studio include:

- **Code completion:** Visual Studio can suggest code completion options as you type, which can help you write code more quickly and accurately.
- **Debugging:** Visual Studio includes a debugger that allows you to step through your code line by line, set breakpoints, and inspect the state of your variables at any point during the execution of your program.
- **Source control:** Visual Studio links with source control systems such as Git, allowing you to track changes to your code and collaborate with other developers.
- **Deployment:** Visual Studio includes tools for deploying your applications to various platforms, including the web, desktop, and mobile devices. ("What is Visual Studio?", 2003)

5.4 Trello



Fig. 19: Trello Logo
("Trello-logo.png (3840×2160)", 2022)

Trello is a web-based project management and collaboration tool that helps teams organise and track their work. It allows users to build a “board” that represent different projects or areas of focus, and add “cards” to the boards to represent individual tasks or items of work. Cards can be moved between lists on a board to represent the progress of work, and can be assigned to team members and given due dates.

Some of the features of Trello include:

- **Collaboration:** Trello allows team members to work together in real-time, with the ability to assign tasks, leave comments, and upload files to cards.
- **Customisation:** Trello allows users to customise the appearance of their boards and cards with labels, stickers, and background images.
- **Integration:** Trello can be linked with a wide range of other tools and services, including Google Drive, Slack, and GitHub, allowing users to seamlessly incorporate Trello into their workflow.

Overall, Trello is a flexible and user-friendly tool that can help teams stay organised and on track with their work, and is popular with both small businesses and large enterprises. (“What is Trello?”, 2009)

5.5 VirtualBox



Fig. 20: VirtualBox Logo

(“Virtualbox_logo.png (512×512)”, 2015)

The virtualisation software VirtualBox is an open-source tool for virtualising the x86 computing architecture. It creates a virtual machine in which the user can run another operating system.

The “host” operating system is the OS where VirtualBox is running. The “guest” OS is the operating system where the virtual machine is running. Windows, macOS as well as Linux are supported as host operating systems by VirtualBox.

The user can decide the amount of CPU cores, disk space and RAM, which should be allocated to the VM. It can be “paused”, which freezes the system’s execution at that time. The user can resume it later. (“What is VirtualBox?”, 2023)

5.6 Docker



Fig. 21: Docker Logo

(“horizontal-logo-monochromatic-white.png (1202×309)”, 2022)

The open-source platform Docker lets developers build, deploy, run, update as well as manage containers. Containers are standardised, practicable components that unite application source code with the operating system libraries and the dependencies that are necessary to run code in any setting. Containers make the development and delivery of distributed applications easier. As organisations shift to cloud-native development in addition to hybrid multi-cloud environments, it has become increasingly popular to use containers. (“What is Docker? | IBM”, 2023)

5.7 Figma



Fig. 22: Figma Logo

(“figma-icon-md.png (800×800)”, 2021)

Figma is a web-based user interface design tool that lets users collaborate to create good-looking and interactive prototypes. In addition, users can share templates, designs, and widgets with other users around the world. It lets teams of designers collaborate in real-time to build and prototype user interfaces and web applications. With the working prototype, a website can be easily tested, to receive feedback quickly. With Figma it is possible to export code from the prototype, which then developers can use to build the website. (“What is Figma?”, 2023)

We used Figma to create the design of our cookie banner.

5.8 GitHub



Fig. 23: GitHub Logo

(“2560px-GitHub_logo_2013.svg.png (2560×730)”, 2022)

GitHub offers a Git repository hosting service, which is based in a cloud. It offers a user-friendly interface, that allows even novice programmers to use GitHub. In addition, anyone can use GitHub for free and host unlimited public as well as private repositories. It is very popular for open-source projects. (“What Is GitHub? A Beginner’s Introduction to GitHub”, 2022)

We used GitHub to host our diploma thesis and work on it together.

6 Frontend Metrics

Frontend metrics are indicators that can be utilised to gauge both performance and user experience. These provide an important insight into how the frontend can be improved.

6.1 Types of metrics

There are several types of metrics that can be tracked, which will be discussed in this section.

6.1.1 Frontend performance

Frontend performance is the time that is needed for an application to get usable. The result of better performance is a better user experience. (Miskoviak, 2022)

The frontend performance can be gauged by the metrics hereunder:

- **Load speed:** How long it takes until the page is fully loaded, and all content is displayed.
- **Load responsiveness:** How swiftly a page can load and execute any essential JavaScript code so that components respond promptly to user interactions.
- **Runtime responsiveness:** How long it takes until the page responds to user input or interactions.
- **Visual stability:** If the page is stable, meaning that the content does not shift around, which can interfere with user interactions.
- **Smoothness:** How smooth the page is rendered, for example, animations or transitions are rendered at a consistent frame rate. Also, how smooth state changes are.

(Walton, 2023)

6.1.2 User behaviour

User behaviour metrics are indicators, that refer to the user's actions and visits on web applications or websites. These metrics can give insights that are extremely valuable for the development. With these metrics, it is possible to evaluate, where the users are struggling and how they are interacting with the web application or website. There are several user behaviour metrics that can be tracked, such as:

6.1 Types of metrics

- **Page views:** Indicate how many times a page is viewed.
- **Users:** The number of users that visit the web application or website for the first time and the number of returning users.
- **Average page time:** The average time a user spends on a page, as well as the time the page was in the foreground.
- **Bounce rate:** The percentage of users that leave the web application or website after visiting only one page.
- **Pages per session:** The average number of pages a user visits during a session.

(Kapoor, 2023)

6.1.3 Custom metrics

Developers can define custom metrics that are specific to a particular web application or website and thus not comparable to others. Examples of custom metrics are:

- **Clicks:** The number of clicks on a specific button.
- **Form submissions:** The number of form submissions.
- **Errors:** The number of errors that occur, for example, when a form is submitted with invalid data.
- **Focuses:** The number of times a user focuses on a specific element.

These metrics can be very different, so it is important to adapt them to the web application or website as needed.

6.2 How to collect metrics

There are many different ways to collect frontend metrics:

- **Real User Monitoring:** This is a technique for collecting data from user interactions with a web application like page loads, page views, network latency, and user actions.
- **Performance APIs:** There are APIs for the browser which track login time, loading time, network requests and other related performance data to have a good overview of the performance of a website.
- **Synthetic Monitoring:** Will simulate transactions or user interactions. After every test, information like response time, availability, or functionality will be gathered. It is similar to the previously mentioned APIs, the big difference is the simulation. A script or program will be used to interact with the web page, this means hundreds of tests can be run simultaneously. The other methods can only be operated manually.
- **Custom code** Developers can write their own unique code to capture user interactions or track the performance of the website or application. This process is very time-consuming and complex, which is why many users resort to third-party providers. A big advantage of this type is the possibility to save all data privately.

6.3 Consent of affected users

Consent is not always clearly defined; this is why there are separate methods for obtaining the consent of a user to let them know certain data will be captured.

- **Opt-in:** This method will often be used. It is very easy to let the user know, their data will be tracked if they accept the consent banner.
- **Dynamic consent:** This way of asking for consent is gradual, it only asks for the data required to let a feature work.
- **Implied consent:** As the name suggests, the user has given his consent through the behaviour and actions on the website or application. As an example, if the user wants to operate a service where GPS data is required, a little notice about the tracking of this kind of data will be enough because the user knows what he wants to do.

6.4 How can they be used

Frontend metrics will provide a valuable insight into the behaviour and problems which the users of a website will have. With this information, anyone can improve the user experience of a website.

- Identify bottlenecks on a website. The frontend metrics show all the different pages of long loading times, many users will try to avoid these areas, which reduces the potential of a website.
- The data can help understand the user behaviour and design of a web page. If a user is confused, frustrated or features do not work properly, it will be recorded and given to the developer who can create a solution based on the information. This provides many options to keep a website as up-to-date and user-friendly as possible.
- After all the changes, someone has done to a website, everyone wants to know, whether the work has paid off. Frontend metrics will help with that, it can measure the impact of any changes or features. For example, after improving the loading time, the metric should measure lower time values.

7 Web analytic platforms

Since there is a variety of analytic platforms, we had to define some criteria to choose the one which is best suited for our field of work.

7.1 Selection process

We determined which analytic platform fits our needs the most by the following measures:

- **Location:** When handling with personal data, it is a must to be complementary with the GDPR guidelines. To fulfil this requirement, we tried to search for companies who have their seat in the European area, or stated to act in ways that are allowed by the GDPR.
- **Field of use:** The specified area of each analytic software is always different, some focus on websites, others on web applications. Thus, platforms which support the analysis of web applications are more convenient for the products of Boom Software AG.
- **Hosting options:** Even though clouds are more practical in terms of cost savings and flexibility, we wanted to self-host our instances to have more ownership of our gathered data, in addition to being less dependent on third-party services.
- **Anonymisation:** To keep the user's information safe, the anonymisation of personal data is a crucial point to cover. The option to hide important details, like IP's or the used OS, is a must to prevent unwanted problems.
- **Personalisation:** To improve the collecting of metrics, the possibility to personalise, which type of action should be captured, is another major point. Through this, we are able to set our main focus on areas like the individual views or buttons, to better understand how our users navigate through an application.

7.2 Countly

Countly is a web analytic platform with which it is possible to track websites and improve the understanding of one's users. They offer features like tracking page views and button clicks, all the way to integrated feedback forms and error reports.

7.2.1 Installation

Countly can be installed as an on-premise solution or via a cloud, being self- or Countly-hosted. We used the option of self-hosting it through a Docker image on a virtual machine running on Ubuntu. The installation itself is a one-liner with Docker:

```
sudo docker run -d -p 8888:80 countly/countly-server:latest.
```

When creating the Docker image, there is a possibility of the port `8888:80` already being used. To fix this, we just used another port, in our case `8889:80`.

After successfully installing Countly as a Docker image, it can be accessed via web using the IP of the Docker container and the given port from the command as the URL.

7.2.2 Advantages

Because of Countly's main seat being located inside Europe, they are GDPR-compliant without taking any special actions. In comparison to other analytic platforms, this is a strong pro argument for Countly's use. In fields where sensitive data is handled, it is better to not have to manage data privacy and regulatory compliance on your own. The possibility to test and self-host a Countly instance on your local device is also a great advantage since you have 100% data ownership when hosting locally.

7.2.3 Disadvantages

One major flaw of this analytic platform is the lack of support. Full support is only available in the enterprise version, whilst using the community version, your only possible way to get help is via the community forum. But unfortunately, the forum contains not as much helpful information as some might wish for.

7.3 Posthog

PostHog is an open-source product analytic platform that helps to understand your users and improve your product. It offers a free version for hobbyists and early-stage startups with community-based support. PostHog also offers a paid version for larger companies with email support. The free version is limited to one million events per month and does not include all features. The costs for the paid version depend on the number of events per month.

7.3.1 Installation

To test PostHog we used the self-hosted open-source version. We followed the instructions on the website to install it on a Linux Ubuntu Virtual Machine. According to PostHog, you can handle about 100k events with 2 GB of RAM, but they recommend at least 4 GB. Therefore, we used 8 GB of RAM and for testing purposes the instance ran without any problems. When handling more than 100k events per month, they recommend using Kubernetes, however this requires PostHog Enterprise. The final requirement is to set up an A-record for the connection of the PostHog instance to the domain. To accomplish this, we created a record in the hosts file of the Ubuntu virtual machine. After executing the `sudo nano /etc/hosts` command, we added the following line: `127.0.0.1 posthogtest.com`. Afterwards, we installed the bind DNS server with the command: `sudo apt-get install bind9` and configured it to host our domain. Then we executed the given one-liner on the website, which asks for the domain name and the release tag. After the installation, we could access the PostHog instance via the domain. To track events, it offers a JavaScript snippet, or you can include the PostHog library.

7.3.2 Advantages

At first glance, the dashboard is very well-designed. Additionally, setting up the self-hosted version was easy to manage. It also offers code integration for many programming languages, like Java and Python. Furthermore, PostHog provides a lot of integrations and plugins, which extend its functionality. Additionally, it also includes functions to anonymise data to help with GDPR compliance, and when using the cloud option, PostHog offers a managed version that is hosted on servers based in the European Union.

7.3.3 Disadvantages

The biggest disadvantage is the lack of support for the free open-source version, as only community support is offered. The dashboard can become very complex, and it is not very intuitive to use. Some dashboards are preconfigured, however, for other metrics you must search a bit. The documentation is not very detailed, and it is difficult to find suitable information.

7.4 Open Web Analytics

OWA is a free and open-source web analytic tool that allows a website owner to track and analyse their website to develop improvements. It provides a lot of useful features for developers like, event tracking, goal tracking, visitor tracking, heatmaps, mouse movement and many more.

7.4.1 Installation

To test this tool, we followed the instructions on the website. We started with the program XAMPP hosting a PHP Apache server, according to the instruction, only 2.x is supported. Then we cloned the “release-1.6.9” branch from the GitHub repository, decompressed the file and put the folder into the document root of our web server. We had to add the php.ini directives, created a SQL database OWA on <http://localhost/phpmyadmin/> and changed the required PHP settings. After this, we run the installation wizard by pointing the web server to <http://yourdomain/path/to/owa/install.php> and logged in using the database and connection info from the owa-config.php. After logging in, you get a snippet of PHP or JavaScript, which you can add to your code.

7.4.2 Advantages

It is a free tool, there are no expenses if you want to get started with it. Since OWA is open source, any user can look into the code and change it as they wish. This allows every developer to set their own functions and priorities. Another very big advantage is the on-premises solution, because it is very important that the recorded data is not stored on a third-party server.

7.4.3 Disadvantages

The privacy advantage is also a disadvantage because the company must ensure that no violations of the local data protection laws are made. Another very frustrating factor is the installation. The creators of OWA are a very small company, which means that they will not provide good customer support for possible questions. Furthermore, there are numerous changes that need to be made, like configurations, hosting a server and installing other dependencies to get it running.

7.5 Matomo

One of the best comparable analytic tool to Google Analytics is Matomo. It is an open-source analytic tool that is free to use. There exists two price models: a free on-premise solution and a monthly paid cloud version. The costs depend on the monthly traffic and can vary from €19, - to €13.900, -. The on-premise solution has several free features included as standard; extra features need to be paid yearly.

A typical Matomo solution can look like the figure 24. The users only see the WordPress page and in the background the MySQL and Matomo servers track and collect user information.

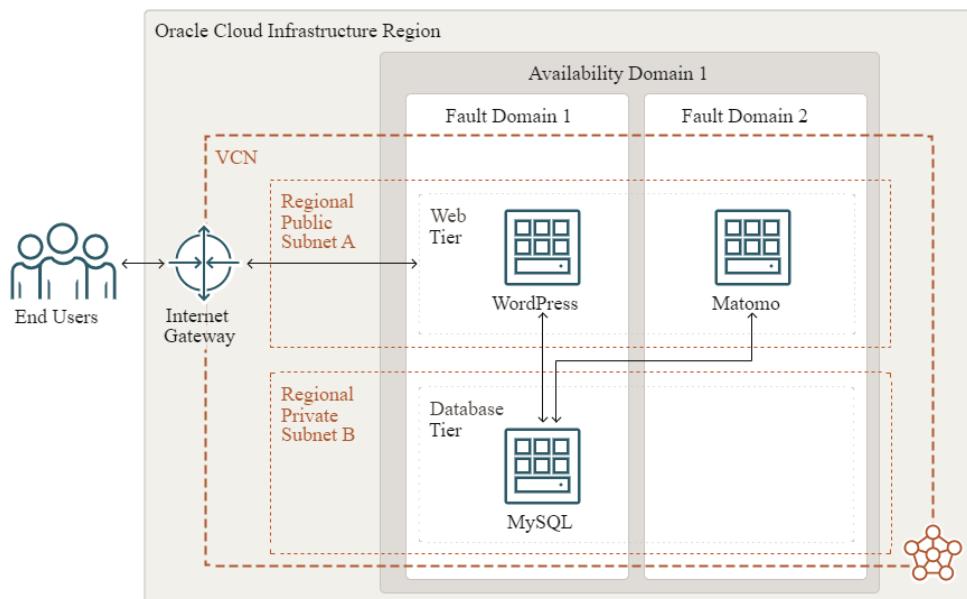


Fig. 24: Architecture

(“Set up WordPress with MySQL Database and Matomo Analytics using Arm-based Ampere A1 Compute resources”, 2021)

7.5.1 Installation

Because of the price model situation, we installed Matomo with an on-premise solution. For the installation, we used the following steps: Download the latest version of Matomo from the official website (<https://matomo.org/download/>), extract the zip file and upload it to a web server. In the case of using an Apache localhost server instead of a paid online web server, you need to paste the files in the “htdocs” folder. An easy way to host an Apache server is the XAMPP web server solution stack. For the data storage, Matomo requires a MySQL database. In the solution stack is also a MySQL module

integrated. This solution eliminates the need to install a MySQL database separately. After the installation, it is essential to create a database. For security reasons, Matomo recommends creating a separate user for the database. In the next step, Matomo will automatically create the required tables. The next two steps are to create a superuser to access the Matomo backend and to configure the web server. The most important step is to set up the website, which will be tracked. After the installation is finished, the Matomo backend is accessible via the URL: “<http://localhost/matomo/>” and the tracking code can be generated. It is a JavaScript snippet that must be included on the website. The tracking code will be generated separately for each website and can be looked up in the administration panel. If the script is implemented correctly, the website will be tracked by Matomo. On the admin panel, there are several settings to anonymise tracking data: Such as how many bytes of the visitors’ IPs should be masked or if tracking without cookies should be forced.

7.5.2 Advantages

The biggest advantage over Google Analytics is the European server location. With this crucial factor covered, it is possible to collect user data in compliance with the GDPR. It is also compatible with the HIPAA, CCPA, LGPD and PECR. Matomo provides several features for even more data security. For example, the IP addresses of the users can be anonymised, or the visit log and visitor profile can be disabled. Contrary to Google Analytics, the user of Matomo has no need to be concerned about their data being used for other purposes. The frontend metrics are stored in the MySQL database and are not shared with third-party services. The data is not used for advertising purposes. Another significant advantage is the same functionality as Google Tag Manager. It is possible to create custom events, and to track custom variables. Matomo offers many useful and interesting features for the website owner. With one feature, it is feasible to create custom reports, goals and to produce segments. A heatmap of the web application can also be created like in the figure 25. The heatmap shows the most clicked areas on the website. This feature is very useful to optimise the website for the users. A user flow feature is important for Boom Software AG to visualise, how the user navigated through a web application.

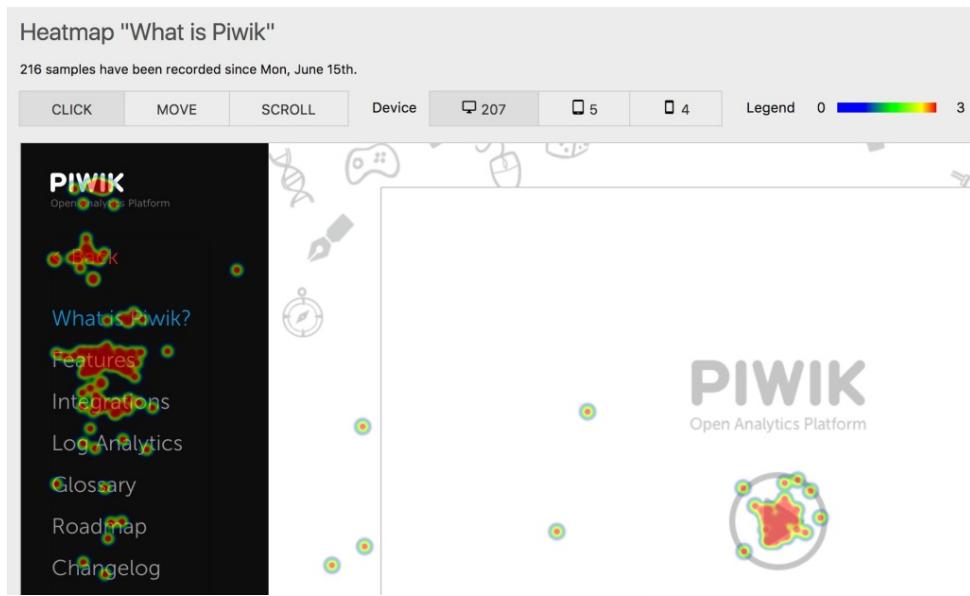


Fig. 25: Heatmap

(“0_Click_Heatmap.jpg (1024×622)”, 2023)

7.5.3 Disadvantages

The biggest disadvantage is the UI from Matomo. For an analytic tool, it is not very intuitive. The user interface is not very user-friendly, and it is really challenging to find the appropriate settings. Another problem, especially for companies, is the missing support from the side of Matomo. In our case, the software is not really suitable for a single-page application because it is more aligned for websites. Some features cannot be implemented in a meaningful context, such as the heatmap. By using the concept of a single-page application, a heatmap will never provide a correct set of data.

7.6 TrackJS

TrackJS is a web application monitoring tool which helps developers to identify and diagnose errors or issues on their web application.

7.6.1 Installation

TrackJS is installed via a browser agent, the agent will be working by including the JavaScript to the website. The script does not need any further extensions to work properly. You need a token, which TrackJS provides after registering on the site and then integrate the script into the source code of the website.

```
1 <script src="https://cdn.trackjs.com/agent/v3/latest/t.js"></script>
2 <script>
3     window.TrackJS && TrackJS.install({ token: "YOUR_TOKEN" });
4 </script>
```

Source code 1: Browser Agent TrackJS

7.6.2 Advantages

A big advantage of this kind of tracking is the detailed information about errors and user interactions. Another very helpful option is the possibility to integrate TrackJS into GitHub, Jira and Slack. This makes it easier to manage error tracking and the development progress. The problem-free installation of the client will also be attractive to many users, you only have to log in and add the JS script to your code in order to get all the features of TrackJS.

7.6.3 Disadvantages

A drawback of using TrackJS as your website tracker is the privacy. The data will be stored on the servers of the TrackJS company, it is very difficult to run the service on a local server. Another big problem is the pricing: If you are a small company with a certain number of customers, the lowest offers for a subscription starts with about €50,- a month up to €700,-. But it is fair to say that these prices are justified for the additional performance that TrackJS offers.

8 Countly integration

Together with Boom Software AG, we decided to use the analytic platform Countly. Due to security and privacy reasons, we opted against the Countly cloud and instead implemented an on-premise solution. Another reason for a private installation is that Boom Software AG's customers typically operate on closed networks.

8.1 Docker installation

To implement an on-premise Countly solution, it is necessary to host it on a server. Fortunately, Countly provides a Docker instance that makes it easy to implement on the test system and for Boom Software AG's customers as well. The Docker server eliminates the need to implement MongoDB, Node.js, Express.js, or a Linux server. To simulate a real Docker service, which is typically installed on the Linux server by the customer, we have decided to use a VM. A virtual machine has the advantage of making it effortless to create a network bridge between our Windows OS and the Docker with the Countly image. To use the network bridge, it is important to change the default network setting in VirtualBox.

The easiest way to install Docker is to use the following command: `sudo apt install docker.io`. To verify the correct version, use the command: `docker --version`. In our case, we use the current version, which is 20.10.12. Another important advanced packaging tool is the net-tools, which allows running the `ifconfig` command to check the network settings. To install the net-tools, use the command: `sudo apt install net-tools`. With the network settings, it is manageable to see the public IP. Using this IP address, it is possible to connect to the Countly server outside the Linux distribution.

8.2 Workflows

To add our own menus or overlays for the manners of consent, e.g., a cookie banner, we had to create workflows inside the existing project. In this case, we created two processes, one to show the consent banner and another to forward the user onto our consent page.

```

1 <Workflow Type="Custom" Name="ShowConsentTextMenu">
2   <Transaction Behavior="NewTransaction">
3     <Set Variable="user">dotNetBF.Modules.Services.Security.
4       SecurityService.CurrentUser</Set>
5     <ShowForm Context="user" Form="consent-form" />
6   </Transaction>
7 </Workflow>
```

Source code 2: Created workflow for the consent banner

A workflow usually consists of four parts:

- **Entity:** The BORA framework uses entities to identify which kind of users can access features. In this case, the current user can always see the consent window. The entity to be used can be set in the [Set](#)-tag.
- **Type:** The kind of workflow is determined through the [Type](#) identifier. The most common option is [Custom](#).
- **Name:** Each workflow must have its own [Name](#) to be identified.
- **Transaction:** Each flow is making a transaction in the program; this transaction is set by the [Behavior](#) identifier. A [NewTransaction](#) typically is used for events which change the program in some way.

Furthermore, each workflow can have its own functions, like using a script, setting a variable, or showing a form.

With our new workflow, we can now create a menu to display our banner or forward the users to our consent subpage. This is accomplished by making a [MenuDefinition](#) inside the already existing [MenuRepository](#).

```
1 <MenuRepository xmlns="urn:bfsvcclib">
2     <MenuDefinition Entity="dotNetBF.Modules.Services.UI.Web.Main, BM
. System.UI.Web" Name="Main">
3         <MenuGroup Name="system" Title="System">
4             <WorkflowMenuCommand Name="Consent" Title="Erklaerung
zum Datenschutz" ContextObject="null" WorkflowName="ShowConsentTextMenu" />
5         </MenuGroup>
6     </MenuDefinition>
7 </MenuRepository>
```

Source code 3: Created menu definition

Inside the **MenuDefinition**, we can set the action of this menu by indicating our previous created workflow, in this case **ShowConsentTextMenu**. This definition now creates our created consent subpage.

At last, we had to include the banner in the GUI of the software.

```
1 <package name="dotNetBF.Modules.Services.Security">
2     <entity name="User">
3         <form name="consent-form">
4             <feature name="cfConsentInfo" />
5         </form>
6     </entity>
7 </package>
```

Source code 4: GUI integration

To accomplish this, we create an entity which contains a form element with the same name as the form in the created workflow. The feature contained inside the consent banner enables the user to view the subpage for further details.

8.3 Collect button clicks

The most common way to collect frontend metrics is to track button clicks. There is no simple solution for on-click events on the defined buttons in the BORA framework. Therefore, it is necessary to loop over all buttons and create a click method for each button. The following code snippet shows how to collect button clicks in the BORA framework.

```

1 function checkButton() {
2     const origBtn = Forms.builder.items.button;
3     Forms.builder.items.button = function (vc: Common.IViewContext,
4         o: Forms.IButtonInfo, p: JQuery) {
5         const btn = origBtn(vc, o, p);
6         btn.click(() => {
7             ...
8         });
9     }
10 }
```

Source code 5: Collect button clicks

To track the button clicks, there are several necessary parameters for the Countly push. For the key value, we decided to take the same name for all buttons: “btnClicked”. The count value is always one, because we only count the clicks. For the name, we created a segmentation called “btnName”. It is essential to implement a unique name for the evaluation. Nowadays, the BORA framework does not initialise buttons with such a value. To ensure that the name is only used once, we built the value for the segmentation through a combination of the button name, the workflow name, and the type. With this value, we were able to make a “add_event” for the button tracking in Countly. The following code snippet shows how this was implemented.

```

1 let href = window.location.href;
2 const type = /type=(\w+)/.exec(href)[1] || 'Custom';
3 const name = /name=(\w+)/.exec(href)[1] || 'default';
4
5 const classList = btn[0].classList.toString();
6
```

8.3 Collect button clicks

```
7 const buttonName = /command-(\w+)/.test(classList) ?  
8   /command-(\w+)/.exec(classList)[1] : o.text || 'no Name';  
9  
9 Countly.q.push(['add_event', {  
10   'key': 'btnClicked',  
11   'count': 1,  
12   'segmentation': {  
13     'btnName': buttonName + ' - ' + name + ' - ' + type  
14   }  
15 }]);
```

Source code 6: Collect button clicks name

After pushing the button click to the server, it will be shown in the Countly dashboard like in the figure 26. With this information, it is manageable to measure user behaviour. An additional useful feature is to see which buttons are clicked the most frequently. This information can be used to improve the user experience. If a UI element is pressed often, it should be moved to a more prominent position.

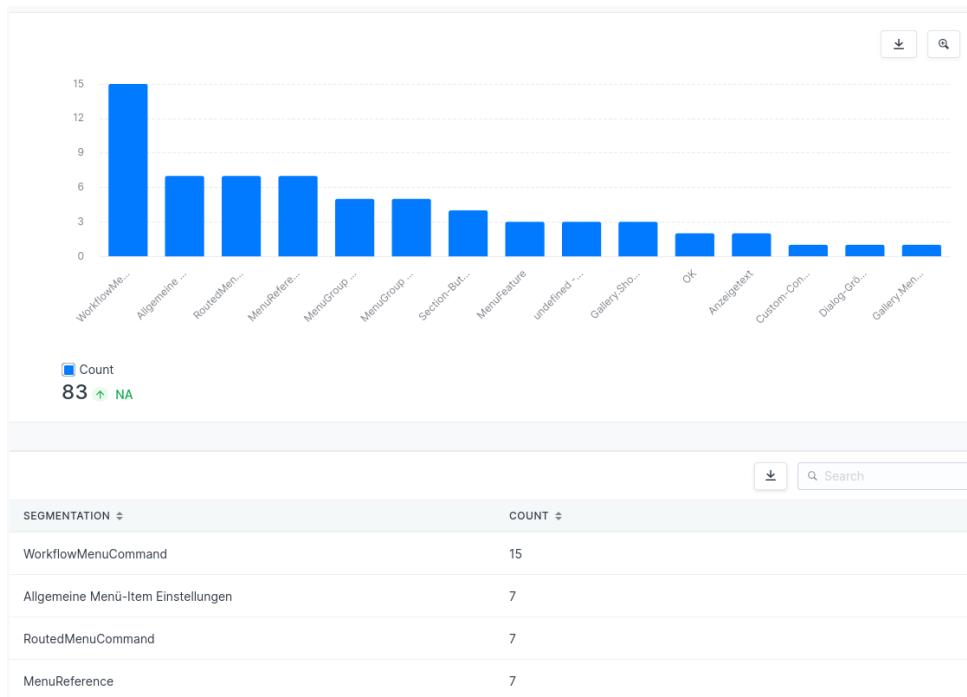


Fig. 26: Button Click

8.4 Collect page views

By default, page views are collected from different pages, but the BORA framework provides only single-page applications. This means the user is always on the same web page with the same default URL. Countly only recognises the page view when the path in the URL changes. Therefore, it is necessary to collect the page views manually. The only way to accomplish this, is by pushing the page's name every time it is changed. The following code snippet shows how to collect the page views in the BORA framework.

```

1 function checkViewChange(app: Common.IApplication) {
2     $(app).on('viewchange', (_qe: JQueryEventObject, v:
3         Common.IView) => {
4
5         if (v.context.requ.wf) {
6             const name = getWfId(v.context.requ.wf);
7             console.log(name);
8             Countly.q.push(['track_pageview', name]);
9         }
10    });
11}

```

Source code 7: Collect page views

To push a page view, we need to set an individual name. If it is a website, Countly automatically detects it by the URL. In our case, we need to set the name manually. The BORA framework provides a function to get the ID of the workflow. This ID is used to define a unique page view name. After pushing it to the server, it will be shown in the Countly dashboard like in the figure 27, it also provides some additional information: For example, the average time or the number of the total visitors.

8.5 Collect tab views

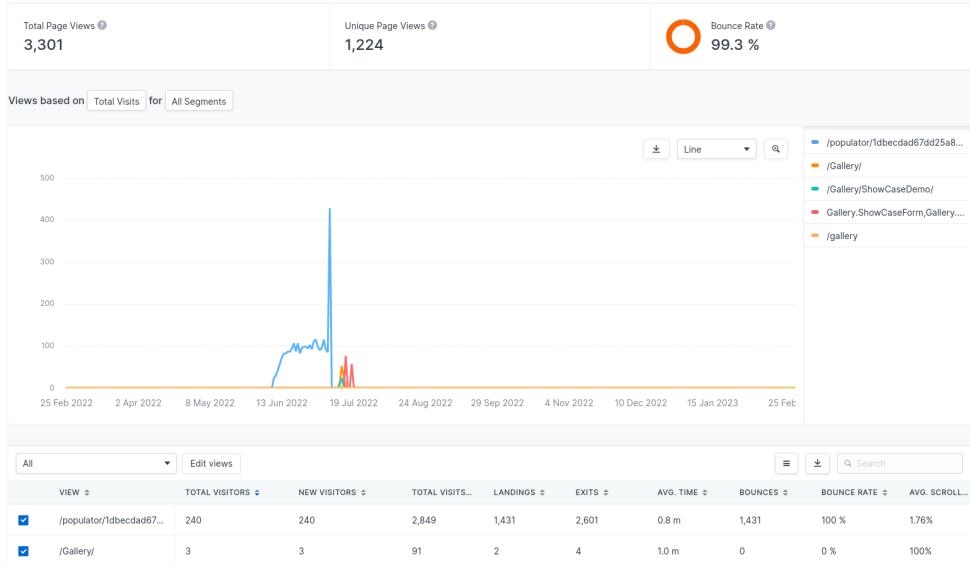


Fig. 27: Page views

8.5 Collect tab views

The BORA framework provides tab views inside a page, it is necessary to track them, to know where the user is. Tab views are not as simple to track as page views are. The BORA framework does not provide a function to track the tab views. Therefore, it is necessary to implement a custom function which finds the nearest element with the class “tabs-head” and add on this element an on-click listener. After a click on a tab, the given `Forms.IFormTabsInfo` parameter provides an array of all tabs. The click event provides the index of the clicked tab. Take the index to obtain the name of the tab. With the same method as seen in the source code 6, it is possible to push the tab view to Countly. The following code snippet shows how to get the index of the page view.

```
1 const tp = $(ev.target);
2 let tpIndex = tp.data("page-index");
3 if (tpIndex === undefined) {
4     return false;
5 } else {
6     tpIndex--;
7 }
```

Source code 8: Collect tab views

8.6 Collect CTL focuses

The BORA framework also includes other types of interactive elements, such as radio buttons and input fields. To track them in bundles, it is possible to add an event to their focuses. It is the same structure as for the button clicks. On every defined element, there will be an on-focus listener added, to track if the element is focused. To get the content of the element, it is essential to find the closest element with the class “feature” first. With this object, it is manageable to obtain the associated data from the feature-context. The following code snippet shows how to collect the CTL focuses on the BORA framework.

```

1 const ctl = origCtl(vc, o, p, type, build, postProc, applySize);
2   const featureContainer = ctl.closest('.feature');
3
4   ctl.focus(() => {
5     const name =
6       getTxtboxId(featureContainer.data('feature-context'));
7     Countly.q.push(['add_event', {
8       'key': o.type,
9       'count': 1,
10      'segmentation': {
11        'focus': name
12      }
13    }]);
14  });

```

Source code 9: Collect CTL focuses

The problem in the BORA Framework is the missing unique names for elements, if there are double names pushed to the Countly server, the data will not contain the true values. To solve this, we implemented two helping functions for the naming convention to create a unique name for the CTL and page views. Use the `getTxtboxId` function to create a unique ID for the CTL focus. A unique name for page views can be created with the `getWfId` function. These two functions are distinguished by the given workflow reference on the page view.

8.7 Privacy Policy Page

For the user to know which of his personalised data is being collected, we needed a privacy policy page. This page will inform the user which types of data will be collected, how the data will be used, third-party sharing and how the user can view or delete his data.

In order to create the page where we can write our guidelines, we first have to create a workflow:

```
1 <Workflow Entity="dotNetBF.Modules.Services.Security.User"
2   Type="Custom" Name="ShowConsentText">
3     <Transaction Behavior="NewTransaction">
4       <Set Variable="user">
5
6       dotNetBF.Modules.Services.Security.SecurityService.CurrentUser
7       </Set>
8       <ShowForm Context="user" Form="consent-form" />
9     </Transaction>
10   </Workflow>
```

Source code 10: Create workflow privacy policy

We also need to create a form with the name “consent-form” so when the workflow will be executed it will open the custom feature “cfConsentInfo” where the privacy policy will be displayed.

```
1 <form name="consent-form">
2   <feature name="cfConsentInfo"/>
3 </form>
```

Source code 11: Create form for customFeature

Lastly, we have to create the custom feature that will let us create the page and write our privacy policy into it.

The text is written into the <expression> element.

```
1 <customFeature name="cfConsentInfo">
2   <style>
3     <web-auto-update>false</web-auto-update>
4     <control-width>400</control-width>
5   </style>
6   <expression>"Privacy Policy Text..."</expression>
7 </customFeature>
```

Source code 12: Create Subpage

The privacy policy page can be viewed by clicking on the highlighted text in the cookie banner. To see the function that calls it, see 8.9 “Cookie banner execute workflow”.

8.8 Integration of libraries

To set up Countly in the existing BORA framework, the library had to be unminified and integrated through an own JS as well as a TS file. Minification is used to lower the loading time of JS, HTML and CSS files on websites. The minified library can be accessed on the following page: <https://cdn.jsdelivr.net/npm/countly-sdk-web@latest/lib/countly.min.js>.

```
1 import CountlyLib = require("./Libs/countly/countly-lib");
```

Source code 13: Import of the library

BORA works with namespaces, thus we needed to create an own `namespace` for Countly using a TS file.

```
1 export = Countly;
2 export as namespace countly;
3
4 declare namespace Countly {
5     export function dummy():void;
6 }
```

Source code 14: Created namespace

Because the TS definition file required a function, we used a void dummy to fulfil this requirement. Using the `export` and `export as namespace` identifiers, we could use our library in the framework.

The following problems occurred while integrating the libraries into the BORA framework:

- **Minification:** Because the Countly library was in a minified version, it did not correlate with the .NET version which was being used by the BORA framework. To solve this problem, we unminified the library using unminify.com.
- **Countly structure:** Normally, the library is being auto-generated by Countly itself to be integrated in the source code. Nevertheless, the structure of our framework did not allow the script to be loaded. So we outsourced it into an own JS file which we imported later in our main file.

8.9 Create Cookie Banner

Since a legal basis is necessary for the data processing, we decided to receive the consent from the user with a cookie banner. This informs the user about what and how we use cookies. Additionally, the user can agree or reject the use of cookies. If the user accepts, we can collect the data we need for our analytics. If the user declines, we do not collect any frontend metrics.

The cookie banner consists of a text, which informs the user about the use of cookies, as well as two buttons, to accept and decline, and a link to the privacy policy. When clicking on the link to the privacy policy, a custom workflow will be executed, which displays the privacy policy:

```

1 highlighted.click(() => {
2   app.runwf({
3     entity: "dotNetBF.Modules.Services.Security.User",
4     type: "Custom",
5     name: "ShowConsentText"
6   });
7 });

```

Source code 15: Cookie banner execute workflow

For the accept and decline button, we had to create a button with the BORA framework. The code for both buttons is very similar, only the text and the click event are different. The code for the accept button is the following:

```

1 const buttonGroup = $("<div
2   class='btnGroup' />").appendTo(container);
3
4 const acceptBt = Forms.builder.items.button(vc, {
5   icon: "",
6   text: "Zustimmen",
7   click: () => {
8     addConsent();
9     container.hide();
10   }
11 }, p);

```

8.9 Create Cookie Banner

```
11 acceptBt.addClass("accept");
12 acceptBt.appendTo(buttonGroup);
```

Source code 16: Cookie banner buttons

The buttons are added to a button group, which is then appended to the container (the cookie banner), which is then appended to the body of the webpage. Additionally, we added a class to the buttons, so that we can style them. Clicking on a button adds or removes the consent and hides the cookie banner. After calling the add or remove consent function, the consent will be pushed to the Countly server.

```
1 function addConsent() {
2     let consents = ['all'];
3     localStorage.setItem("consents", JSON.stringify(consents));
4     Countly.q.push(['add_consent', consents]);
5 }
6
7 function removeConsent() {
8     let consents = ['all'];
9     localStorage.setItem("consents", JSON.stringify([]));
10    Countly.q.push(['remove_consent', consents]);
11 }
```

Source code 17: Add and remove consent

The consent is also stored in the local storage of the browser. This is necessary, because the cookie banner is only shown once. If the user reloads the page, the cookie banner will not be shown again.

In the Compliance Hub in the County dashboard, it is manageable to see the consent of the users. Furthermore, for which features the user has given consent, however, we do not provide the possibility to give consent for specific features. Therefore, the consent is always for all features.

Compliance Hub

Metrics **Users** Consent History Export/Purge History

ID	DEVICE	APP VERSION	CONSENT	TIME
beec6593-8801-4a82-9a66-06b1687fdc70	-	0:0	OPT IN Apm,Attribution,Clicks,Crashes,Events,Feedback,Forms,Location,Re OPT OUT	Tue, 19 Jul 20...

Items per page: 10 ▾ Showing 1 to 1 of 1 entries

1 ▾ of 1 pages << < > >>

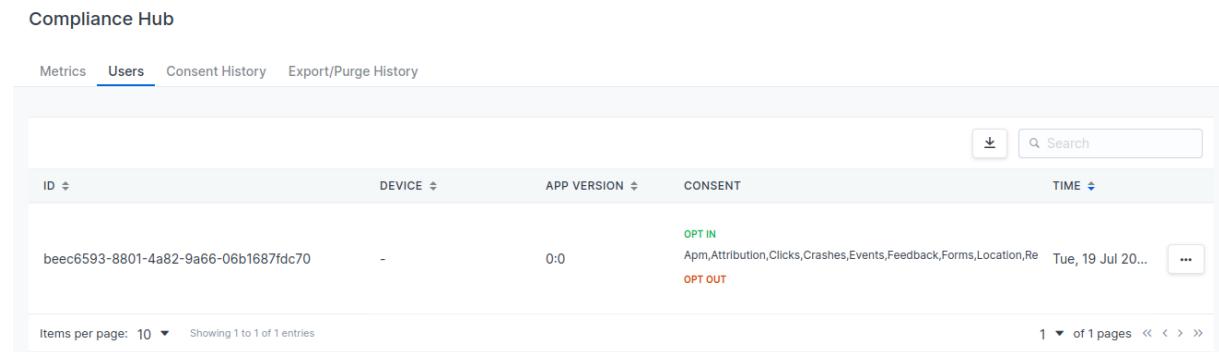
The screenshot shows a table with columns: ID, DEVICE, APP VERSION, CONSENT, and TIME. There is one entry: ID is 'beec6593-8801-4a82-9a66-06b1687fdc70', DEVICE is '-', APP VERSION is '0:0', CONSENT is 'OPT IN' followed by a long list of features (Apm, Attribution, Clicks, Crashes, Events, Feedback, Forms, Location, Re), and TIME is 'Tue, 19 Jul 20...'. Below the table, there are dropdowns for 'Items per page' (set to 10) and 'Showing 1 to 1 of 1 entries'. At the bottom right, it says '1 ▾ of 1 pages << < > >>'.

Fig. 28: Compliance Hub

8.10 Adding feedback options

Besides collecting metrics from our clients, we thought about another way to get information about how the user is interacting with the product. Using the built-in feature from Countly, we could create our own widgets and display them on our application, so the user can give his active feedback if problems occur.

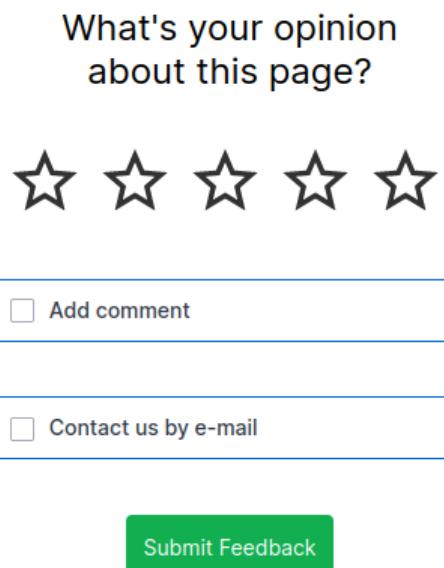


Fig. 29: Feedback form

The form can be seen by a little popup at the side or bottom of the screen, so that it does not bother the user too much whilst working with the software.

```
1 Countly.q.push(['enable_feedback', { 'popups':  
    ['62de785f1779a900806e58d4'] }]);
```

Source code 18: Adding a feedback form on the page

Using this simple command, we can determine which, and how many feedback forms we want to display on our page. By adding the `popups` option, we can say that just one or three different forms are available in the application. The individual forms are being determined by their widget ID.

9 Data protection

What is the legal situation when collecting user data? This is the question addressed in this chapter of the diploma thesis, which focuses on the legal requirements when collecting user data. With the evolving technology, data protection is becoming increasingly important. Everyone is affected by data protection laws, if it is a company or an individual.

9.1 History

In 1890, two students called Samuel Warren and Louis Brandeis from the Harvard Law School published an article called “The Right to Privacy” in the Harvard Law Review. It was one of the earliest known texts on data privacy, talking about the importance of consent when being photographed or recorded. (“A Brief History of Data Privacy Laws | Accountable”, 2022)

The Harvard Law Review is an independent organisation run by students at the Harvard Law School, whose main purpose is to monthly publish a law review from November through June. It is used as a research tool for practising lawyers and law students. (“About the Harvard Law Review”, 2022)

The United States of America led the way with the Freedom of Information Act in 1967, this still only meant that people could request information about themselves from authorities. After the passing of the Data Act in Sweden, which criminalised data theft, the first federal privacy law was approved. Later in Germany, the Data Act was enlarged by the Federal Data Protection Act in 1978, which established basic data protection standards, including the requirement for consent for personal data processing. Once again, another movement for data protection occurred in 1983 in Germany. The right to control how one’s personal data is used has been set as a fundamental human right by the Federal Constitutional Court. Caused by significant advancements in computer technology over the previous decades, the EU’s Data Protection Directive updated data protection laws and proposed more contemporary language and minimum data security requirements to protect sensitive information.

To protect an individual’s health information, the United States of America passed the Health Insurance Portability and Security Act (HIPAA) in 1996. Subsequently, the Data Protection Act passed by the EU in 1998 was used for controlling the movement of personal

9.2 General Data Protection Regulation (GDPR)

data, both within and outside the EU.

Complying with all the existing data protection laws is tough for international business. Therefore, the USA and the EU agreed on the Safe Harbor Act in 2000. Which was used to optimise the secure transfer of sensitive data between them. Later on, the European Court of Justice replaced it with the EU-US Privacy Shield in 2016 because it gave the USA unrestricted access to every European Union citizen. In 2016, the EU adopted the most extensive data protection legislate since today, the General Data Protection Regulation (GDPR). It contains the importance of consent, security and accountability. (“A Brief History of Data Privacy Laws | Accountable”, 2022)

9.2 General Data Protection Regulation (GDPR)

As mentioned above, the EU adopted the GDPR in 2016. All member states had to make sure it is fully applied in their countries by May 2018. (“What is GDPR, the EU’s new data protection law? - GDPR.eu”, 2022)

The GDPR is one of the strictest laws regarding privacy and security around the globe. Even if a company is based outside the EU but handles user data from European citizens, it applies to them. High penalties are charged when not complying with the privacy and security standards. (“What is GDPR, the EU’s new data protection law? - GDPR.eu”, 2022)

9.2.1 Goals and purpose

The regulation has the purpose of protecting natural people, furthermore, the protection of fundamental rights as well as freedoms regarding their personal data. It also intends to guarantee that the personal data can move freely in the EU. (“Art. 1 GDPR - Subject-matter and objectives - GDPR.eu”, 2018)

9.2.2 Personal data

“Personal data is any information that relates to an individual who can be directly or indirectly identified. Names and email addresses are obviously personal data. Location information, ethnicity, gender, biometric data, religious beliefs, web cookies, and political opinions can also be personal data. Pseudonymous data can also fall under the definition if

it's relatively easy to ID someone from it.“ (“What is GDPR, the EU’s new data protection law? - GDPR.eu”, 2022)

9.2.3 Important legal terms

- **Data processing:** “Any action performed on data, whether automated or manual.” (“What is GDPR, the EU’s new data protection law? - GDPR.eu”, 2022)
- **Data subject:** “The person whose data is processed.” (“What is GDPR, the EU’s new data protection law? - GDPR.eu”, 2022)
- **Data controller:** “The person who decides why and how personal data will be processed.” (“What is GDPR, the EU’s new data protection law? - GDPR.eu”, 2022)
- **Data processor:** “A third party that processes personal data on behalf of a data controller.” (“What is GDPR, the EU’s new data protection law? - GDPR.eu”, 2022)

9.2.4 Scope

It applies to all automated and, in some cases, manual personal data processing regarding European citizens wherever the processing takes place. Within the scope of personal or domestic activities, this does apply to a natural person. (“EUR-Lex - 02016R0679-20160504 - EN - EUR-Lex”, 2023)

The GDPR applies to activities of a branch in the EU in relation to personal data processing, while it does not matter if the branch is a data controller nor a processor. Furthermore, it is applicable if the processing for the branch is not occurring within the EU. (“EU-Datenschutz-Grundverordnung (DSGVO): Sachlicher und räumlicher Anwendungsbereich”, 2023)

Manual data processing is covered by the GDPR only if two conditions are met:

- The data is or should be stored in a database.
- Data groups are sorted by specific criteria, however the GDPR does not specify any requirements for the criteria.

9.2.5 Legal basis

For data processing, organisations must determine the legal basis. These six legal bases are described in the GDPR Article 6:

- **Consent:** “the data subject has given consent to the processing of his or her personal data for one or more specific purposes” (“Art. 6 GDPR - Lawfulness of processing - GDPR.eu”, 2020)
- **Contract:** “processing is necessary for the performance of a contract to which the data subject is party or in order to take steps at the request of the data subject prior to entering into a contract” (“Art. 6 GDPR - Lawfulness of processing - GDPR.eu”, 2020)
- **Legal obligation:** “processing is necessary for compliance with a legal obligation to which the controller is subject” (“Art. 6 GDPR - Lawfulness of processing - GDPR.eu”, 2020)
- **Vital interest:** “processing is necessary in order to protect the vital interests of the data subject or of another natural person” (“Art. 6 GDPR - Lawfulness of processing - GDPR.eu”, 2020)
- **Public interest:** “processing is necessary for the performance of a task carried out in the public interest or in the exercise of official authority vested in the controller” (“Art. 6 GDPR - Lawfulness of processing - GDPR.eu”, 2020)
- **Legitimate interest:** “processing is necessary for the purposes of the legitimate interests pursued by the controller or by a third party, except where such interests are overridden by the interests or fundamental rights and freedoms of the data subject which require protection of personal data, in particular where the data subject is a child” (“Art. 6 GDPR - Lawfulness of processing - GDPR.eu”, 2020)

9.2.6 Consent

The data controller must show that the data subject has approved of their data being processed. The data subject also should be entitled to take back the given consent anytime. (“Art. 7 GDPR - Conditions for consent - GDPR.eu”, 2020)

9.2.7 Data subject rights

The GDPR sets out rights for the data subjects, including the following:

- **Right of access:** Grants data subjects the ability to request and obtain information about the personal data that is being processed by a data controller. Thus contains the acknowledgement if personal data processing occurs, additionally access to information about the processing and the data. (“Art. 15 GDPR - Right of access by the data subject - GDPR.eu”, 2020)
- **Right to rectification:** The right to have inaccurate personal data corrected by the data controller without unnecessary delay, and to complete incomplete data. (“Art. 16 GDPR - Right to rectification - GDPR.eu”, 2020)
- **Right to erasure:** The right to have their personal data erased without unnecessary delay by the controller. (“Art. 17 GDPR - Right to erasure ('right to be forgotten') - GDPR.eu”, 2018)
- **Right to restriction of processing:** The right to petition the controller for limiting the processing regarding their personal data. (“Art. 18 GDPR - Right to restriction of processing - GDPR.eu”, 2018)
- **Right to data portability:** The right to get their personal data in a structured form that can be used and read by machines. (“Art. 20 GDPR - Right to data portability - GDPR.eu”, 2020)
- **Right to object:** The right to disapprove of the processing regarding their personal data. (“Art. 21 GDPR - Right to object - GDPR.eu”, 2020)

9.2.8 Obligations of controllers

The implementation of proper technical as well as organisational measures by the data controller, additionally, the controller is obligated to keep records of the processing activities, carry out data protection impact assessments and appoint a data protection officer in certain cases. Furthermore, the controller is obligated to answer to requests to exercise the data subject rights. (“Art. 24 GDPR - Responsibility of the controller - GDPR.eu”, 2020)

9.2.9 Obligations of processors

Processors must follow the controller's instructions, furthermore, they may only process data on behalf of the controller. In addition, processors must support controllers in fulfilling their GDPR obligations. ("Art. 28 GDPR - Processor - GDPR.eu", 2020)

9.2.10 Data Protection Officer (DPO)

The Article 37 of the GDPR states when a DPO is required. The requirement to appoint a DPO can concern the processor as well as the controller. In addition, a DPO must be appointed if a private company's core activities consist of processing activities that require systematic and regular monitoring of data subjects, or if they process personal data of specific categories, as detailed in Article 9(1) of the GDPR, or data related to criminal records and offences. As soon as the appointment has taken place, the controller/processor publishes the contact details of the DPO and informs the supervisory authority. (Paul Voigt, 2018, p. 66)

Specific requirements need to be met by the DPO. According to Article 37(5) of the GDPR, the DPO is selected based on the qualifications, know-how and experience of data protection laws along with the ability to complete the tasks of a data protection officer. (Paul Voigt, 2018, p. 72)

Mainly the duties of the DPO are to inform, cooperate and monitor. According to the Article 39(1) of the GDPR, the DPO must fulfil at least the following tasks:

- Inform and advise the processor as well as the controller about the obligations under the GDPR that affect them.
- Monitor the compliance with data protection laws and strategies of the controller and processor.
- Train personnel who deal with processing operations.
- Advise on data protection impact assessments and monitor their implementation.
- Act as a contact point and cooperate with the supervisory authority.

(Paul Voigt, 2018, p. 78)

9.2.11 Anonymisation

Anonymisation is a procedure in which personal data is processed in such a way that it becomes irretrievable and cannot be used to identify a natural person. Data anonymisation can be accomplished by the following techniques:

- **Randomisation:** The accuracy of data is reduced if it is changed enough. Therefore, it becomes inaccurate, and it cannot be used for the identification of a person.
- **Generalisation:** This technique is used to generalise specific attributes of the data, so that it can no longer be used to identify a person. For example, using a region instead of a specific address or using a month instead of a specific date.

The anonymisation of data provides many benefits for the controller and processor, as well as the data subject. It reduces the amount of data to the size that is really needed for the processing, if it does not require the processing of the exact data. Not collecting personal data that would not be used anyway or deleting the data that is not needed for the processing helps to anonymise the data, which **prevents the GDPR from applying**. (Paul Voigt, 2018, pp. 16–18)

9.2.12 Pseudonymisation

Pseudonymisation is a commonly used method to reduce the ability to identify a person by its data. It is a procedure in which changing the personal data does not make it possible to identify a natural person but combining it with other information does. This can be achieved by replacing the personal data with a pseudonym, for example a number. Imagine the data contains the name, address, and customer preferences. Now the name and the address will be pseudonymised and, for instance, replaced with a reference number. The customer preferences will not be pseudonymised, because it is impossible to identify a person with it. The allocation rule between the reference number and the pseudonymised data (name, address) is stored separately. In this way, the data processor or controller can still work with the data for the processing purpose, but identifying a person with it is impossible. Unlike anonymisation, pseudonymised data still falls within the scope of the GDPR, as the risk of re-identification is still higher than with anonymised data. Pseudonymisation is an appropriate means to implement privacy by design. (Paul Voigt, 2018, pp. 18–19)

9.2.13 Privacy by design

From the start of the development process, concepts for preventive data protection are required. The principle of data minimisation, such as pseudonymisation of personal data and minimising the data which is gathered by only collecting the necessary data, should be followed by developers and manufacturers when developing new technologies. Because of the fast technical evolution, it makes it necessary to implement privacy by design. (Paul Voigt, 2018, p. 81)

9.2.14 Privacy by default

The concept of privacy by default should protect data subjects from processing as much personal data as possible. To achieve this, only the minimum amount of data necessary for the processing should be collected. Privacy by default offers maximum protection, which eliminates the need to change the default settings to protect data subjects. Data subjects should be able to modify the default settings to allow the data processing if they want to (opt-in). This should protect individuals lacking technical knowledge or the time to set up the privacy settings themselves. (Paul Voigt, 2018, p. 82)

9.2.15 Technical and organisational measures

Technical and organisational measures should provide the necessary protection for personal data. According to the Article 32 GDPR, the controller as well as the processor are obligated to implement such measures. The GDPR does not limit the range of measures, any measure regarding personal data processing can be appropriate. Therefore, there are many technical and organisational measures that can be implemented. For example, minimising the personal data processed, pseudonymisation, privacy by default and privacy by design. (Paul Voigt, 2018, pp. 47–48)

9.2.16 Fines

The fines set out in the GDPR are high to ensure that businesses take data protection seriously. The fines defined under Article 83 are flexible and adapt to the company. Any non-GDPR compliant company which processes personal data will face a fine, no matter its size. Some violations are more serious than others. The less serious violations might

lead to a fine of up to 10 million euros or 2 percent of the total amount of money the company made in the financial year before, whichever is greater. Or for more serious violations 20 million euros or 4 percent. An example of a more serious violation is an infringement against the data subjects' rights. ("What are the GDPR Fines? - GDPR.eu", 2019)

9.3 ePrivacy Directive

It is the first legislation from the European Union regulating the use of cookies and other tracking technologies. As a directive, it provides guidance and principles for each member state, which is responsible for implementing it through their own national laws. Before storing or accessing any information, websites must obtain visitor's consent. ("What is the Cookie Law (ePrivacy Directive)?", 2022)

9.3.1 Cookies

Cookies can be useful, but they can also threaten privacy. For example, cookies can be used to identify users and track their online behaviour. However, it is important to distinguish between personal data and non-personal data. The threat lies in the companies' use of the information stored in cookies. (Debussere, 2005, pp. 76–77)

9.4 National law

The GDPR is an EU regulation that is directly applicable in every EU member state. However, it contains a fair amount of opening clauses and leaves plenty of room for the national legislators. ("EU-Datenschutz-Grundverordnung (DSGVO): Das österreichische Datenschutzgesetz - DSG", 2023)

In Austria, the applicable Data Protection Act is the Datenschutzgesetz (DSG), which is divided into five parts. The first part is the most important part for the data controller and processor, because it covers the implementation of the GDPR as well as supplementary regulations.

9.4.1 Children's declarations of consent

According to the GDPR, the consent of a child relating to an offer of information society services made directly to them is only lawful if the child is at least 16 years old. However, the DSG sets this age limit at 14, meaning that if the child is younger than 14, the consent of the parent or legal guardian is required. (“EU-Datenschutz-Grundverordnung (DSGVO): Grundsätze und Rechtmäßigkeit der Verarbeitung”, 2023)

9.4.2 Data processing records

According to the Article 49 of the DSG, data controllers are required to maintain a record of their processing activities, including information about which personal data is being processed, the cause of processing, and the legal basis for processing, with additional information required if profiling is used or personal data is transmitted to a third country, and each data processor must also maintain a record of processing activities performed on the controller’s behalf. (“RIS - Datenschutzgesetz - Bundesrecht konsolidiert, Fassung vom 11.03.2023”, 2023)

9.4.3 Data Protection Officer

Under Article 38(3) of the DSG, the DPO is required to be independent in the performance of their duties. They report to the highest management level of the data controller or processor and are not allowed to receive any instructions regarding the exercise of their duties. (“RIS - Datenschutzgesetz - Bundesrecht konsolidiert, Fassung vom 11.03.2023”, 2023)

9.4.4 Data secrecy

Data controllers, processors as well as their employees are obligated to keep the personal data that has been entrusted to them secret. Employees may only transmit personal data if they have the permission of the employer. (“EU-Datenschutz-Grundverordnung (DSGVO): Das österreichische Datenschutzgesetz - DSG”, 2023)

9.5 Result

When collecting user data, it is crucial to distinguish whether the gathered data can be used to identify a person. If so, it is necessary to follow the rules set out in the GDPR and other laws on the processing of personal data, depending on the country. However, considering the high penalties, it is recommended to handle the data carefully, and when possible, to anonymise the data so that it cannot be traced back to an individual. Additionally, it is crucial that the rights of data subjects are respected.

With this information, we decided to use Countly's built-in feature, to anonymise the gathered data, which is a good practice for handling personal data. However, there are still some risks, and therefore we implemented a cookie banner. With the cookie banner, the user is informed about the data collection and given the option to opt-in and opt-out.

10 UI Improvements

How do you convince users with a user interface? This is the question addressed in this chapter of the diploma thesis. The goal is to improve the user interface of the product. The following sections will explain certain best practices and the different types of user interfaces.

In order to improve any kind of human-computer interaction, it is valuable to understand how a human reacts to different types of components. The ideal interface cannot be created for everyone. Instead, it is best to focus on the goals of the project when designing the interface.

10.1 User / Customer

First, it is very important to understand the difference between a user and a customer. One drawback of this is that the customer of the software is not necessarily the user. If it is not applicable, the contact is usually only with the customer and not with the user. To develop a product, without having information from the people who use it, will be very challenging. In our case, we assume that the customer is also the user of the product. To achieve an excellent user interface, it is essential to understand the differences between the two different roles of a software development model.

10.2 History

Nowadays, nearly everyone in a developed country interacts with a user interface, no matter for entertainment, information or at work. In the early days, people already used symbols to represent a real object, but it was not possible to implement it on the first computer. The limitation of only a user interface and not a graphic user interface made it very complicated to build software like we know these days. Another problem was that the interaction with a mouse, which is the primary interaction style nowadays, was not possible. To click on buttons, there were no types of mouse or controller input. There was no software-like button on a screen at this time; instead, they built the “user interface” as a hardware device. There was a real button on the desk to interact.

With the limit option of buttons, it was only possible to write letters, or to move the cursor

up, down, left, and right. It is called a text-based user interface and was used by Apple. At this time, the first colourful UI was invented. Before, the UI was only monochromatic, which means black and orange or black and green. In 1984, Apple released the Macintosh, which used a desktop and a mouse-based interface. With the new technology of using a mouse, it was feasible to create individual interface designs. No longer was it solely a console application: With the innovative technology, it was possible to open different windows by clicking on a button or a selection.

The introduction of the desktop made it possible to display, move and organize files and folders using a GUI instead of a command line input. The graphical user interface is designed to be more closely to the functionality of a physical desktop and provide a more intuitive and user-friendly way to interact with the computer. With the knowledge of the history, it is realisable to understand the development of the user interface and how it is manageable to create a better user experience. (Carroll, 2014)

10.3 Difference in UI and UX

User interface and user experience are two closely related areas in the design of software. There is no strict separation between those two fields. UI design focuses on the visual and interactive parts of a product, such as control elements, layout, typography, and colour scheme. The overall experience of using the software is what UX design is concerned with. Usability, accessibility, and desirability are factors of the user experience. It is important to understand that UI and UX design are different fields, and that designers should only specialize in one profession.

10.4 Six stages of UI design

To design a user interface, it typically helps not to implement the whole design at once. With some preliminary work, it is often easier to communicate with the customer and to respond quickly to their wishes. A good approach is to start with a sketch and then to develop it step by step. The six stages of UI design are:

-Sketching: For a fast and quick preview of the software, it is an easy method to draw a sketch.

-Wireframe: To give the UI more structure and with more focus on creating a detailed outline for a finished product.

-Components: For an effective web application, it is beneficial to use reusable components. Components can include elements like buttons, input forms, headers, and other UI elements.

-User and task flows: These are design concepts to understand the interaction and actions that a user can do when using the product.

-Mock-ups: They are typically more detailed than wireframes or sketches, but they are not interactive. Mock-ups are great to present, because they should look like the final product.

-Prototype: For testing and demonstrating, a prototype is perfect. With an interactive model of a user interface, it feels like a real software.

10.5 Shape laws

To simplify the topic, we will only be discussing the “Gestalt” laws. However, there are other laws that exist, such as the “Heuristic” laws, “Principle” laws and the “Cognitive Bias” laws.

For the human eye, it is key to have a clear structure in the user interface, therefore Max Wertheimer, Kurt Koffka, and Wolfgang Köhler founded the Gestalt psychology in the early 20th century. Without observing these rules, it may be challenging for people to recognise related content and orient themselves. We humans point ourselves in unfamiliar places by looking for familiar things in order to derive further information from them. (Sternberg, 2019)

10.5.1 Principle of Common Region

According to the **principle of common region**, items that are within a boundary are perceived as belonging to a group and are assumed to have some shared characteristic or function. It is recommended to use a border or background colour to create a container for related items. Users usually make a fast and automatic judgement when they first open an app or webpage, therefore the UI should contain distinct, organised sections. Some

areas like the header, footer, or other navigation panels should be designated by using a different background colour to visually separate it from the content. It is recommended to use cards as a UI element or other visible boundaries to help users to determine which information belongs together. (Harley, 2020a)

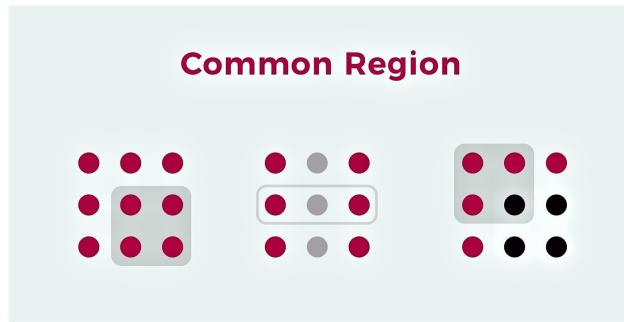


Fig. 30: Common Region
(“Marketing Psych: Image”, 2023)

10.5.2 Law of Proximity

Another very important law is the **Law of Proximity** because it describes how the human eye perceives connection between visual elements. Elements that are close to each other are comprehended as related compared to elements that are far apart. Due to the law, it is possible to use whitespace to build perceived relationships between different elements. The most common sample is written material: Take a paragraph for one topic and put spaces between different contents. The distance between these blocks indicates how likely they are related. With this law, it is an easy way to give the user a quick overview of which elements are grouped. (Soegaard, 2023)

Law of Proximity

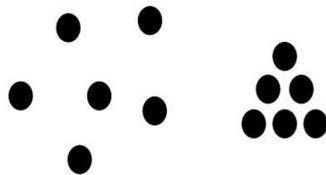


Fig. 31: Proximity
(“maxresdefault.jpg (1280×720)”, 2023)

10.5.3 Law of Prägnanz

The **Law of Prägnanz** will help to understand the intricacies of user-centric design. It suggests that when people are presented with complex shapes or a series of ambiguous elements, their brains choose the simplest interpretation. The aim of this law is to create elements in the most uncomplicated way to improve the user experience. Therefore, it often helps to use very basic elements like circles, squares or triangles. (Fard, 2023)

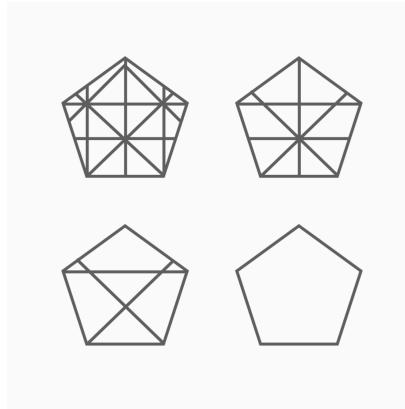


Fig. 32: Prägnanz

(“Prägnanz”, 2021)

10.5.4 Law of Similarity

To visualise related elements, it is essential to give them similar attributes, like the same colour, shape, or size. The items do not have to be identical, this is one of the primary benefits of the law, as it allows designers to create visual similarities that share at least one visible attribute. A typical practice is to use only a single link colour as the main means of indicating to users what is clickable. But this is only meaningful if there are no links which correspond to the opposite, like add and remove. (Harley, 2020b)

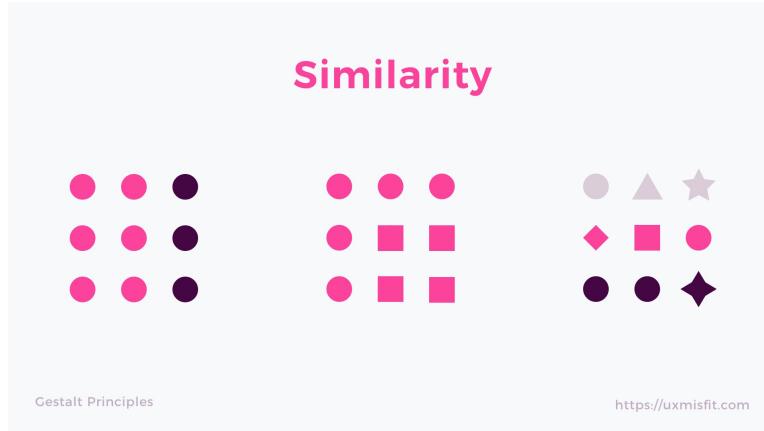


Fig. 33: Similarity

(“UI Design in Practice: Gestalt Principles | UXMISFIT.COM”, 2020)

10.6 Design system

“A design system is basically the story of how an organization builds a digital product.”
(Frost, 2017)

For small and big institutions, it is fundamental to have a consistent UI concept. Due to the differences in design workers, it is not manageable to ask each other how to design. The better solution is to own a design system. It is equivalent to patterns which show how to design different digital products. A style guide, or a determined colour scheme, may also be included in the design system. Other benefits of such a system are faster building of user interfaces or an easy way to scale products.

The design system can be separated into three parts: The most important component of a website is to represent the **brand** and make it unique. The mission of a user interface should be to accommodate the personality of the company. The visual elements are a major part, which should have a high-quality **foundation**. It includes the colour, the iconography and typography. To the end, it is a key part to create adequate and right **content** for the UI. This will include a standardised language and grammar, a fixed list of words for the vocabulary and a writing style. (“Atlassian Design System”, 2023)

Another major benefit is that anyone can access the database, as it serves as a single point of truth. It reduces many questions inside a design team and eliminates mistakes.

10.7 Design tokens

Design tokens are pairs of names and values that represent repeatable design choices. They use descriptive names to represent visual styles, instead of using hard-coded values. This allows the designer to work more flexibly and consistently in design. To give an example, the red colour for an error message uses the design token colour.message.error, instead of a specific colour value like #7676a7 or RGB (207,0,15). More and more people want these days different themes for the user interface: Without a design token, it is very complicated to rewrite every colour which was set. The integrated theme technology allows specifying different values for each theme. This means there exists only one design token, but multiple values. A design token can be separated into three parts and is connected with a dot: The first one is the **foundation**; it is the type of visual design attribute like colour. The middle part is the **property**, it defines where the design should be applied, such as background, text, border, or other property. The last one is the **modifier**, it describes in more detail when the design should be used, for example, if the user hovers over the text. (“Design tokens (beta) - Foundations - Atlassian Design System”, 2023)

10.8 Corporate Design

The most important part is to create a design which represents the brand in the best way. If the web application does not work or does not make a good impression, it will affect the corporate image. The key to creating a good corporate identity is to balance the three tasks: corporate behaviour, corporate communication, and corporate image. All three values should be represented on a brand’s homepage to improve brand equity. It is necessary to implement a web application that is unique and makes a great impression on the first visit. (Birkigt et al., 1998, pp. 15–20)

10.9 Font

Text font and text colour are the main-displayed elements in the user interface of news media. With this information, specialised user interface designers attempt to find the best values for aspects like the font size, brightness conditions, and text clarity. (Zhou et al., 2022)

For the readability of the text, the font size is the most essential factor. It should be large enough to be easily readable, but not too large to be too dominant. Font size is also a factor for the reading time. As shown in the figure 34, the reading time is reduced only by changing the font size from 12-point to 14-point.

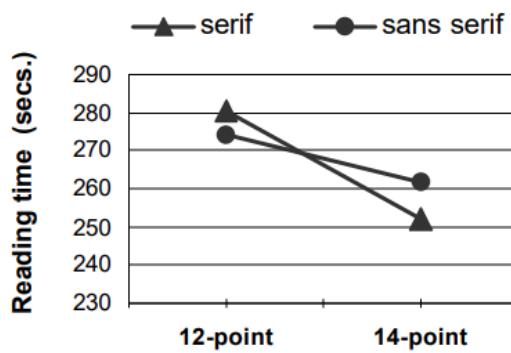


Fig. 34: Time taken to read passages in seconds

(Bernard et al., 2001)

Another important fact is that there are two diverse types of fonts: Serif and sans serif. Serif fonts are the most commonly used type, with small hooks at the end of the letters. Sans serif fonts are the opposite, they have no lines at the end of the letters. The most important difference is that serif fonts are easier to read on printed media than on a computer screen. Therefore, Georgia and Verdana, two very common fonts, were developed specifically for the web. (Bernard et al., 2001)

10.10 Colour

One of the most fundamental aspects of a user interface is the colour, it is the first impression that the eyes perceive. Photography, painting, and UI use colour theory to evoke specific concepts and talk in a non-verbal language. Colour psychology is used to influence the user to find buttons more easily or to generate more interaction. Our brain recognises different colours with different kinds in our life, e.g., the colour green represents

10.11 Gamification

hope or luck, but it also depends on where the user lives, because of different cultures. On the figure 35, it is seen that some colour can be very misinterpreted if it is used in the wrong culture. Therefore, it is helpful to know the culture of the audience before the designing process starts. Especially, big companies provide different UIs in different cultures to reach more satisfied users / customers, as it occurs mainly with web shops. (Mall, 2021)

Cultures	Red	Black	Blue	Green	Yellow
Western	Love Danger Action 	Intimidation Death Mourning 	Depression Trust Calm 	Luck Jealousy Greed 	Happiness Joy Caution 
Far Eastern	Property Good Fortune Vitality 	Health Prosperity Stability 	Healing Relaxation Feminine 	Fertility Hope Life 	Sacred Royalty Masculinity 
Middle Eastern	Danger Caution Evil 	Mystery Mourning Rebirth 	Heaven Spirituality 	Strength Hope 	Happiness Prosperity 
Indian	Beauty Wealth Power 	Evil Darkness Negativity 	Sports Strength 	Harvest Hope Virtue 	Sacred Auspicious 

Fig. 35: Colour psychology

(Mall, 2021)

In the UI topic, it is necessary to understand that designing UI with colour is not everywhere the same. On a traditional desktop, the developer has full control over every single pixel, whereas video-based AR limits the designer to a limited number of pixels. But the most difficult part is the optical see-through AR. During the design, it is hard to know what the user will see. The designer must create a UI which is visible on the screen and in the real world. (Gabbard et al., 2013)

10.11 Gamification

The goal of this approach is to motivate people to achieve their goals by using game elements and mechanics in non-gaming contexts. Gamification can be applied in a wide scope of activities such as education, healthcare, and marketing. After becoming popular in the 2010s, it has proven to be very useful in achieving goals, like to increase employee productivity or to motivate students to study. (Emran, 2020) Gamification is only one of many concepts which are used to motivate people to achieve their goals. The most

important difference between gamification and other concepts is that gamification uses known game elements and has nearly no costs.

The main game mechanics used to gamify a system include points, rewards, leaderboards, badges and levels. Points are used to track the user's progress and motivate them to reach further. Rewards are used to motivate the user to achieve a goal. Leaderboards are used to compete with other users. Badges are used to show off their achievements. In the figure 36, there is visualised that the end goal is to compare the status of the users. Nevertheless, it is essential not to just launch a leaderboard or offer badges, there must be an incentive for the users. The desired effect will not occur if there is no reason to collect rewards. (Liu et al., 2011)



Fig. 36: The Gamification Loop

(Liu et al., 2011)

10.12 Interaction styles

The interaction styles provide users with a concept of how they can interact or communicate with a computer system. The first concept is the **command entry**. Although it is the oldest concept, it is still used today. Especially Linux/Unix users who use the command prompt every day. Some applications only provide console interaction, like Cisco router configuration. The biggest disadvantage is the problem with the error rate, it is typically higher than UI. The second concept is the **form fill**, which was introduced to non-experts so that they could interact in the easiest way possible. Initially, it was designed to avoid using pointing devices. With the tab key, a user can navigate through the form, and with

the enter key, they can submit the form. **Menu selection** was developed to execute predefined commands. The user can navigate through the menu with the arrow keys and select the desired command with the enter key. It has a major advantage over the command entry because it avoids user input. The last concept is **direct manipulation**, which was introduced to make the interaction with the computer more intuitive. The user can interact with the computer by moving the mouse and clicking on the desired object. The greatest drawback is that it is not feasible to interact with the computer without a pointer device. (Soegaard, 2015)

10.13 Contrast

Contrast has a longer history than the user interface itself. The aim of printed media was to create a way to increase the reading speed. It was done by testing different brightness contrasts. (McLean, 1965)

The contrast is the difference between the brightness of the text and the background and can be measured by comparing these two fields. It can be based on different features of UI elements like colour, size, shape, position, texture, and orientation. However, it is not always the case that the most effective contrast colours are white and black. Knowing the colour theory is important to use a variety of different colour combinations to achieve the best contrast for each colour. It is best to use a wheel, which is a circle with different colours arranged in a way that they are next to each other. A combination of complementary colours provides the best contrast for one another. Next to the complementary colours, there also exist analogous, triadic, split complementary and tetradic colour schemes.

To get a contrast in the typography, it is possible to change some properties, like the size, the weight, the direction or to isolate the text from the background. The best way to achieve a good contrast in text, is to follow the “Web Content Accessibility Guidelines 2.0”. Otherwise, it is possible to use an online contrast checker to determine whether the internet site is in a good contrast. (Yalanska, 2022)

10.14 Result

It is fundamental to consider the previously mentioned topics in order to create a great user interface. To design a modern UI, it is essential to be up-to-date with the newest trends, because they are constantly changing. After knowing the audience, it is important to start with a sketch to show the customer how it will look approximately. During the sketching process, it is advantageous to pay attention to the colour, contrast, and shape laws. It will help to design a more appealing interface. For enhanced user interaction, there are several key elements, such as gamification, which can be used to motivate the user to interact with the system. Understanding interaction styles are also important because they are the first impression of a user. The user must be aware of how to interact with the system. Improvements to the user interface can be made by analysing the collected passive metrics from the Countly server. There are various types of collected data, that allow different options for customisation of the user interface: The most important elements are forms, which allow users custom input. Upon the evaluation, it is recommendable to change the placeholder if something is incomprehensible or reposition fields if it takes too long. Furthermore, by using active metrics, it will be possible to change font size or include more shape laws in order to provide the users a better experience.

11 UX Improvements

How can the user experience be enhanced to meet the needs of customers? This chapter of the diploma thesis answers this question by suggesting different techniques with which designers can improve the experience of their users.

11.1 What is User Experience?

To describe user experience, we must dig a bit deeper. What is UX for people who interact with software, and how do they come in touch with it? Many aspects have to be considered to create the best user experience possible for customers.

11.2 What makes a superior design?

This question is hard to answer because design is something everybody interprets differently. For some, design just needs to look pleasing to their eyes, for others, the appearance is more irrelevant, but functionality is most important.

The goal of each design is to create an experience which stays in one's memories. But that is only achieved if designers work with their mind, knowledge and emotions. This is where the two main characteristics of a good design start to show: **discoverability** and **understanding**. While interacting with a device, people get to know how it works, what each specific option does, and which actions are possible, that is discoverability. Understanding, in the meanwhile, lays its focus on what everything means, how individuals should use it, etc.

(Norman, 2013, p. 3)

As mentioned by Don Norman in (Norman, 2013, p. 4), there are 3 kinds of designs which are used in a vast number of areas, being industrial, interaction and experience design. While industrial design focuses on the sheer functionality of the product, interaction and experience designs try to make the experience of the users as enjoyable as possible. But, with all these designs, one aspect is not considered as a factor, which is the interaction between humans and machines. Thus, with the years, human-centred design has become increasingly important.

HCD is a philosophy which starts by determining and understanding what the users need and in which ways the design can fulfil their wishes. But how can HCD be paired with the three design forms mentioned above? Industrial, interactive and experience designs focus on one specific area which the design must cover, whilst HCD ensures that the capabilities and desires of the customers are considered. (Norman, 2013, pp. 7 – 8)

11.3 UX Design

“User experience design, as its name suggests, is about designing the ideal experience of using a service or product.“ (Soegaard, 2018, p. 4)

This sentence mentions the importance of designing a good UX for customers, but what is the best way to begin with the design?

One crucial objective about making a good UX and UXD, is to filter out the target audience and their needs in a software. The chances of making a successful software are much higher, if the focus is laid upon the customers while designing.

To succeed in making a memorable user experience, the goal is to optimise a design over and over in a cycle. Spot the problems of future users and sympathise with it, so they can be dealt with in the best way possible.



Fig. 37: Process of UX Design

(“6stageuxprocess-810x810.png (810×810)”, 2019)

One technique which helps UX designers to describe a product in the beginning is the C-P-S hypothesis. By determining the **c**ustomers and their **p**roblems, the perfect **s**olution

can be offered. Using this information, the base for products is being set and the team working on it can focus on more important factors. Another aspect of the C-P-S hypothesis is, that every point can be questioned. Maybe the group of customers is defined incorrectly, or the solution does not correlate with the problem itself. In that scenario, the hypothesis can just be re-evaluated. (Treder, 2013, pp. 23 – 25)

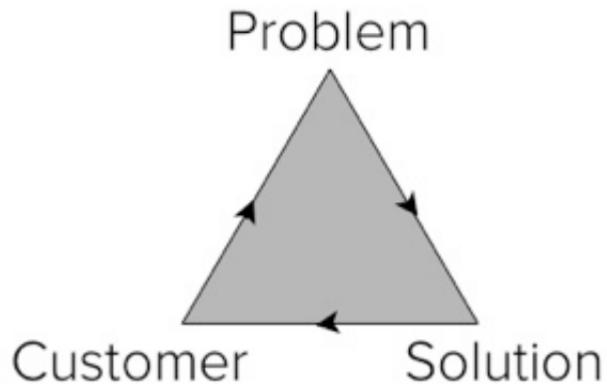


Fig. 38: Illustration of the C-P-S hypothesis

(Treder, 2013, p. 23)

11.4 Design thinking

Some may have come in touch with design thinking, even if they did not notice it at first. It is being used not just by designers, but also by many leading companies in the tech sector. Nevertheless, what is design thinking?

The ultimate goal is to identify what one's users need, to create new and innovative solutions for yet unknown issues. Furthermore, the knowledge about how people interact with products will be deepened using this method. Problems which are hard to define or even unknown can be determined easier through an approach with design thinking.

Design thinking can be split into five distinct phases: **empathise**, **define**, **ideate**, **prototype** and **test**. In more detail, designers should empathise with clients and define their needs or problems, following creating ideas to resolve problems, making a prototype with these ideas and finally test their solutions. Each of these phases can be gone through separately and in no particular order. But they can repeat themselves continuously over and over again.

(Soegaard, 2018, p. 11)

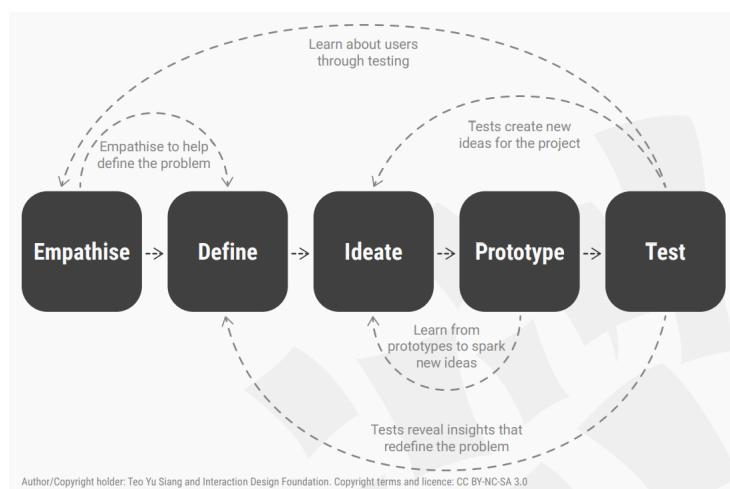


Fig. 39: Process of design thinking

(Soegaard, 2018, p. 18)

11.5 Seven factors of UX

UX can be described using seven different factors, them being **useful**, **usable**, **findable**, **credible**, **desirable**, **accessible** and **valuable**. Each of these factors has its own distinct

value in order to make a user experience unforgettable. (Soegaard, 2018, p. 21)

11.5.1 Useful

Starting with useful, who would use a product if it has no use to them? But, the definition of useful always lays in the eyes of the one using it, so it is hard to really tell whether a product is useful or not. (Soegaard, 2018, p. 22)

11.5.2 Usable

Usable or usability refers to how effectively and efficiently users can achieve their goals using the product. If a significant amount of time is being spent trying to fix issues, the usability downgrades the experience for the clients. (Soegaard, 2018, pp. 22 – 23)

11.5.3 Findable

We often have the problem that some features of our products cannot be used because the way to access them is too difficult. To eliminate this exception, the third factor, findable, is crucial. To ensure the success of a product, the features must be easy to find. Imagine a newspaper where every section is mixed in between, and there is no overview of where something is, after time, people would stop using that newspaper. (Soegaard, 2018, p. 23)

11.5.4 Credible

Nowadays, people are only interested in serious products. They are not going to use a software that is overly colourful and has images of bunnies all over it. Credibility is a serious factor in the success of your design. The importance of one's image in the marketing world is almost as crucial as the functionalities a product offers. The user's trust in a product is what credibility aims for. (Soegaard, 2018, p. 23)

11.5.5 Desirable

If a product is more desirable, people tend to use it more likely than a product which makes its job but is not appealing at all. For example, people would more likely choose a mansion to live in than a small single-family home. (Soegaard, 2018, p. 24)

11.5.6 Accessible

Accessibility is often left behind when designing a product. To create an experience which is accessible for people who are disabled is not just an improvement for a minor group of people. Often, after making a product more accessible, the normal users tend to have an easier and better time working with it as well. (Soegaard, 2018, p. 25)

11.5.7 Valuable

Ultimately, if a product is not offering any value, neither for the business nor the customer, it is a failure. The value of each product is the key factor of its final success.
(Soegaard, 2018, p. 25)

These seven factors of UX are not an exact manual on how to build a good user experience, but they provide a guideline. By comparing the aspects of a product with these points, future problems could be detected and eliminated before becoming an issue.

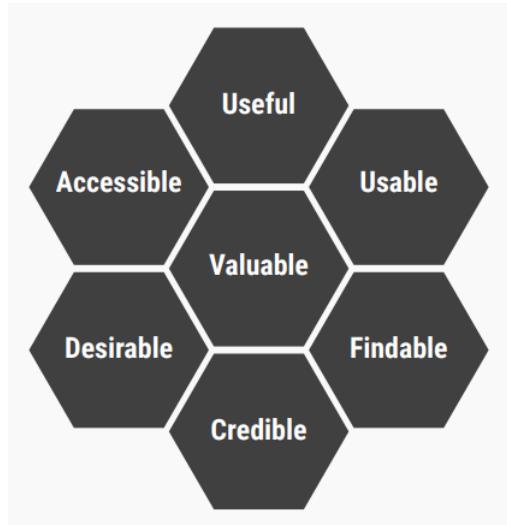


Fig. 40: Seven factors of UX

(Soegaard, 2018, p. 22)

11.6 User Research

Many designers forget the importance of being in touch with their future users and utilising their feedback during the designing phase. There are various ways to conduct user research, some more elaborate than others.

11.6.1 User interviews

Before taking interviews, there are some points that need to be gone through in more detail:

- When interviewing people, who have been working with the product prior to the interview, they tend to say that they are going to do something which is not actually what they are doing in the end.
- People do not remember the details of their actions exactly all the time. Thus, they tend to give the details back in the way they think it happened rather than it actually happened.

Keeping these points in mind while designing your questions for an interview is crucial. Interviews can, when done the right way, help out a ton by designing a remarkable experience for the users. (Soegaard, 2018, pp. 36 – 37)

11.6.2 Create personas

Interviewing individuals is mandatory when starting with user research. Through these interviews, personas can be created with their own needs, challenges and expectations. Using these personas, the teams can identify the goals of the specific audience which is using the product. (the fold, n.d., p. 11)

11.7 Design techniques

Besides user interviews, there is a variety of techniques, which help researchers by gathering information for the designing of a user experience. (Teixeira, 2021)

11.7.1 Customer Journey Map

A customer journey map tries to describe how users achieve their goals using a product. By combining visualisation and storytelling, designers can better understand how clients interact with the product.

(Teixeira, 2021)

11.7.2 User Flow

User flows try to visually represent the ways a user takes to complete a task. Through this representation, it is easier for the designers to improve the product at its weak points. Nevertheless, designing the flow is challenging.

Because the flow of the users is not as easy to predict as some may think, the design of a user flow is costly and time-consuming. But, by visualising every possible step a user can take, the understanding of a product through the client's eyes enables the working team to get a better hold of their current progress. (Singer, 2009)

11.7.3 Metric Analysis

While diagrams or visual representations are easy to read, numbers can represent the effectiveness of a product the best. So, the analysis of metrics, like frontend metrics, is also a good opportunity to improve the UX and UX design. The work that needs to be done before someone might be able to collect metrics is respectable, but if it is done, the numbers can help out a ton by finding issues in your product's design. (Teixeira, 2021)

11.7.4 Eye tracking

Eye tracking is an easy way to see if the important features of a software are easy to find and navigate to. When users look everywhere on the screen multiple times to find what they are looking for, designers know that they have to change something regarding the design. This correlates with some earlier mentioned factors of UX, like that a product must be findable. (Teixeira, 2021)

There are many other design techniques besides the ones mentioned, some more old school like wireframing or scribbles, some more innovative like diary studies or mental models.

Which technique to use is all up to the design team and their preferences, as well as possible experiences with some of these procedures.

11.8 Usability

Usability is not the same as user experience. The usability concerns with how efficient and without troubles, users can achieve their goals. Meaning, if your product is not usable enough, the experience will not be as good as expected. Thus, the user plays a crucial part whilst designing a product. There are five characteristics of products which are usable, being **effectiveness**, **efficiency**, **engagement**, **error tolerance** and the **ease of learning**. These aspects must be considered to create a usable product. (Soegaard, 2018, pp. 28 – 29) (Teran, 2018)

11.8.1 Effectiveness

Working effectively is always the priority when working with a product. So, if, for example, the software a user is using is not helping him to achieve his goals easier, it probably lacks in this aspect. One way to enhance the effectiveness of a product, is by cancelling out possible errors which can occur, whilst users are performing tasks. Showing the maximum number of characters in a field or that a @ has to be contained in the email would be examples. (Soegaard, 2018, pp. 29 – 30) (Teran, 2018)

11.8.2 Efficiency

Though, effectiveness and efficiency might seem similar in some ways, they cannot be more different in this case. While effectiveness aims for the accuracy with which a user can achieve his goals, the efficiency tries to make this happen as fast as possible. The keyword is speed. How can the time tasks take be reduced? Skipping some unnecessary pages or putting some correlated features together in one place? By structuring a product clearly with appropriate names for each button, a lot of time can be saved. (Soegaard, 2018, pp. 30 – 31) (Teran, 2018)

11.8.3 Engagement

Engagement builds mostly on the aesthetics of a product and how pleasant it is to use. Pleasing to the eye but also making sense with a proper layout and structure is the key

for a good engagement in a product. (Soegaard, 2018, p. 31) (Teran, 2018)

11.8.4 Error Tolerance

Reducing the possibilities of errors to a minimum is the goal of each designer and developer. Still, the major point of error tolerance is not to reduce the errors which can occur, but to help the users to recover fast from made mistakes. (Soegaard, 2018, p. 32) (Teran, 2018)

11.8.5 Ease of Learning

To ensure clients are using a product regularly, it must be easy to understand. By making each feature and function a software has to offer understandable, users tend to keep working with it. That ease of use also needs to be considered when making updates and extensions regarding the functionality of a product. When the newer portions are hard to get your head around, the users might stop operating with it as much as they did before. (Soegaard, 2018, p. 33) (Teran, 2018)

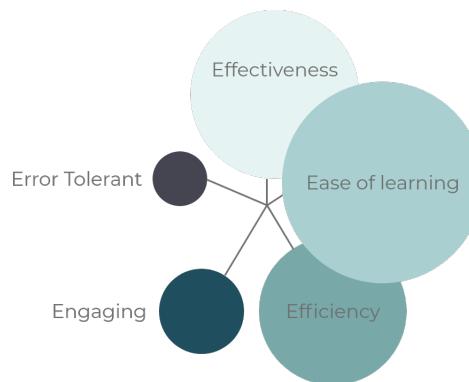


Fig. 41: Importance of the five factors

(“1*Tl9JnTbaPNWiRlgvJc5yhg.png (883×700)”, 2023)

11.9 Testing

Testing is a key factor for creating the perfect experience for your product. The number of methods to choose from is too big to mention them all, so the ones that are more familiar are going to be listed here.

11.9.1 Guerilla testing

This is the simplest form to test the usability of a product. The only prerequisites needed are a prototype and a public place, where a good amount of people walk by. Now, the only

work left to do is ask strangers to test your prototype. In exchange, they get a small gift, like a coffee, for example. Due to its low preparation time, this method is fast and flexible to use.

The most effective time to use guerilla testing, is during the early phases of development, because that is when developers can spot, whether the design and ideas are on the right track. Nonetheless, the tasks which are being tested are crucial for the result and helpfulness of the survey. A simple guideline would be to use a core user flow which is guaranteed to be contained in the final product. (Babich, 2019)

11.9.2 Contextual inquiry

Whilst the definition of this method may be a bit confusing, the process is not. Contextual inquiry just means gathering a group of testers and interviewing them. First, the users are asked about experiences with a product and then they are observed while working in their familiar environment. During this observation, the participants are regularly asked questions about their thinking patterns while performing tasks.

This method provides insights about the emotions and thinking processes of people while using a product. With these results, the design team can work on making an experience which is cut to the likes and needs of the users. Taking notes during the session is crucial for later analysis and creation of a test report. (Babich, 2019)

11.9.3 Card sorting

To determine and prioritise the features which a product should contain, card sorting is a great method to use. The only real preparation needed is a group of testers and a bunch of cards, with each having an own feature written on it. Then we just let the participants sort the cards into different groups of importance and note the results of their doing. At the end, the result is a good amount of data to select the features which are the most important to later users.

Card sorting can be used in earlier stages of development, when core features are not as clear as some would like them to be. Further on, information about how to plan the navigation structure can be gathered. It is important to not forget to test the product with real users on the later basis to validate these earlier collected results. (Babich, 2019)

11.10 Result

User experience changed from being unnoticeably, to setting the cornerstone for the success of every product nowadays. So, the best way to really improve the experience of a product is by simply making use of all the knowledge known about already successful projects as well as interacting with your audience. There are many companies, which documented their formula to success in books or blogs, being available for everyone. By simply engaging with already proven concepts, like the factors of a usable product or conducting user research, the user experience can be enhanced and customised to the needs of one's customers.

Through the gathered data inside the applications of Boom Software AG, we could determine in which aspects of UX the software has its flaws. Furthermore, we were able to conduct a minimised version of user research using the active feedback provided by Countly.

12 UX Measurements

How can you measure the user experience of an application? This chapter deals with the topic of measuring user experience, learning about the different methods and which type of improvement are possible.

”As designers, we want the products we build to be satisfying and easy to use” (“Make It Count. A Guide to Measuring the User Experience”, 2020) The UX is a big factor for a visitor to stay on a website and spend time and effort browsing on it. The designing of a website and the user experience on it are two separate problems which the designer of the website will be encountering. Measuring the UX helps the designer to review his work and correct his mistakes or misconceptions. We can determine the success of a website or app through the measurement of the UX.

12.1 UX research

The UX research is the systematic approach to get insights into the perception, behaviour, actions and opinions of user who utilise a product, service or website of a company. This scientific method will be divided into quantitative metrics and qualitative metrics. (Team, 2023a)

12.2 Quantitative Metrics

Also called behaviour metrics, are measuring the actions and interactions which the customer will do on a website. With this data provided, it is possible to analyse the customers’ engagement, task success rate, retention, abandonment rate, conversion rate from a website. The information can only be described with numbers. (Cimpan, 2020)

12.2.1 Time-on-page

The time-on-page metric describes the average duration, how long a user looks at the page before moving on.

12.2.2 Conversion rate

This rate describes the percentage of users which are performing a certain action on a website, for example, a product purchase. With the provided behaviour data, it will indicate the average percentage whether the customer will buy the product or not.

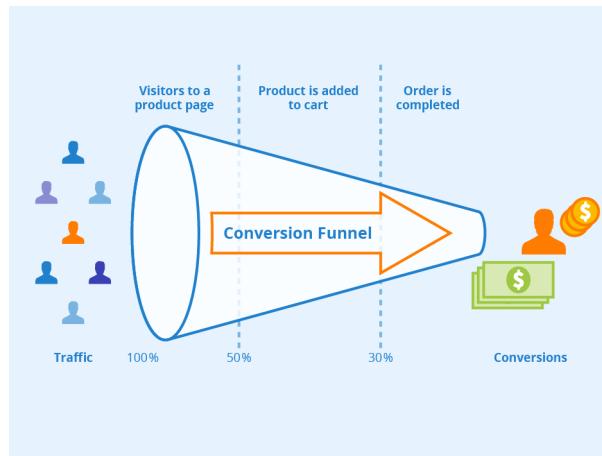


Fig. 42: Conversion Funnel - Author: Seobility - License: CC BY-SA 4.0
 (“Conversion Rate - Definition und Berechnung - Seobility Wiki”, 2022)

12.2.3 CAC

This metric measures the cost of acquiring a new customer, it can be used to evaluate effectiveness of marketing and sales efforts. This can improve user experience and prevent users from leaving the website. (“Customer Acquisition Cost (CAC)”, 2021)

12.2.4 Abandonment rate

This rate will indicate how many people leave or quit without finishing the intended task. It can help to improve the structure or complexity of a website. (Osinusi, 2021)

12.2.5 Retention Rate

The retention rate will describe the percentage of users that continue to use a certain product. There must be a clear definition of what activities will be added to the rate. This could include viewing a certain page or using a feature of the product. The rate is great to get a better insight on the long-term usefulness of a product. (Team, 2023b)

12.2.6 AOV

The average-order-value is the average price which customers will pay to place an order on a website. The current AOV for the company can be obtained, by dividing the total revenue by the total number of orders. (Osinusi, 2021)

12.2.7 Task Time

A good UX requires short loading times and uncomplicated processes, so the customer can engage with the content more easily and faster. A metric for the measurement of this time will help with the tracking and improving of loading time and complex structure on a website.

12.2.8 Task Success Rate

Besides the task time, there is a metric that indicates whether the visitor actually managed to do the task.

12.2.9 Time-To-Value

Time-to-value measures the time it takes for customers to get value out of the product or service. This information can help improve the functions and user interface of a software.

12.3 Qualitative Metrics

Also called attitudinal metrics, it is used to explain the opinion and feelings of the clients about a product. By using these metrics, it helps to gain better insights into the loyalty, trust, and satisfaction levels of the typical user. Although the metric is representing complex human judgments and opinions, it can be presented using numerical values. (Cimpan, 2020)

12.3.1 Customer Satisfaction Score

If someone wants to get a better understanding on how satisfied their clients are with the service, they can use CSAT for this issue. Common methods to get this kind of data is through online surveys and feedback systems.

12.3.2 Customer Effort Score

The CES gauge how easy it is to interact with the product. This contains the ability to resolve a problem by themselves, requesting for new features or just asking a simple question. As an example, if a new feature is too complex or an update has significant bug issues, the CES can indicate which problems the customers are facing.

12.3.3 Net Promoter Score

The NPS is a loyalty metric, it is widely used by companies to measure how likely the customer will recommend the company or product to a friend or family members. (“Net Promoter Score”, 2014)

12.3.4 System Usability Scale

SUS is trying to describe the perceived feeling of a product or service. The UX will be measured through an equal amount of positive and negative wording questions. The final score is calculated between 0 and 100, with rules that add or subtract points depending on the questions answered.

12.3.5 Standardised User Experience Percentile Rank Questionnaire

The SUPR-Q is a standardised set of questions who indicate how end users perceive the quality which the website or application is offering. SUPR-Q is a widely used questionnaire designed to measure the UX of a product or service. (“The SUPR-Q for usability testing”, 2023)



Fig. 43: SUPR-Q

(Winstead, 2019)

12.4 Informational Metrics

This metric is trying to evaluate the quality of the information which the service or product provides to the end user. This includes the usefulness, the presentation and the impact on the intended audience. (“Legibility, Readability, and Comprehension: Making Users Read Your Words”, 2022)

12.4.1 Legibility

The legibility is the least important consideration in the content usability, it is whether the user can read, recognise and differentiate the characters and words in the text. The visual design will mainly be determinate by the typography.

The basic guidelines anyone can do to ensure legibility on their page are:

- A Reasonably large font size and the ability for users to adjust the size
- High contrast, otherwise the letters will sink into the background
- Serif fonts, most of the typesets are fine to use, but ones with extraordinary lettering should be avoided

Testing legibility on a website is a relatively simple process. One common method is to measure the reading speed of a group of participants as they read a sample text using different fonts, sizes, and layouts. To ensure accuracy, participants should test each variation. The results are then compared to a reference text to determine the most legible design. (“Legibility, Readability, and Comprehension: Making Users Read Your Words”, 2022)

12.4.2 Readability

Readability is trying to measure the complexity of words and sentences in a text. The assumption behind this measurement is that longer or more complex words are harder to understand and read than short and simple ones.

There are a few simple rules to improve the readability of the content:

- Use plain-spoken words and phrases, the shorter, the better. Fancy words or complex text structure will damage the experience of the user.
- Write the text in an active voice, it gives a better focus on the content which it is providing.
- Be aware of the target audience who are reading the text, an 8th- grader reading level is recommended for a broad customer audience.

The testing of this metric is very easy to perform. Even the well-known office program Word has its own function where anyone can evaluate the readability of their text. A lot of other websites or applications are also supporting this type of metric, but in their own unique way.

12.4.3 Comprehension

Comprehension focuses on whether the user can understand the meaning and content of the text or not. This also applies to content which is instructive and action oriented.

There are guidelines for a good comprehension in a text:

- Use terms for the content which are familiar to the audience.
- Use an inverted-pyramid writing style, start with the result of the point, it is easier to understand the content if they already know the outcome of it.
- Pictures or diagrams simplifies constructs or data better than any word.
- Try to keep it as short as possible, people are more likely to listen and understand the constructs or matter if it happens in simple and short words.

The only way to test this metric is by standard user testing, get a certain amount of people and perform exercises or realistic tasks on them. A realistic task is a task where the user applies the information he has learned to various examples. Another way would be a simple test where the reader checks what they have learned with a test.

12.5 Vanity Metrics

Vanity metrics are data points or measurements that look impressive on the surface, but do not provide meaningful insights into the performance or the success of a product. These metrics may give a false sense of progress or accomplishment, they do not necessarily correlate with the goals or outcomes that truly matter.

Vanity metrics can indirectly affect user experience, but are not directly connected to each other. These metrics are tracking superficial data such as website traffic, app downloads or number of followers over a certain period of time. (Caveney, 2023)

12.6 Actionable Metrics

Actionable metrics provide clear insights into the performance or success of a business or initiative and that can be used to guide decision-making and drive meaningful improvements. Unlike vanity metrics, actionable metrics are directly tied to the goals and outcomes that matter most to a business and provide specific guidance on how to improve performance of a product or service. (Caveney, 2023)

12.7 KPI

A Key Performance Indicator (KPI) is the resulting value of a metric that demonstrates how effectively the UX is fulfilling the desired objectives for the business. Key Performance Indicators (KPIs) and User Experience (UX) metrics are different but related concepts. UX metrics will help to measure the satisfaction, engagement and loyalty of a user. The KPI describes the success of the company or a product. It can be said that it acts like a link between IT and the business department. Those KPIs will often be used to help developer teams understand the impact of their work on the areas which they are managing. (Twin, 2022)

There are seven types of KPI metrics:

12.7.1 Financial Metrics

This metric tries to describe the financial situation in the company, how high the profit margins are, how profitable the project is, as well as expenses and interest payments. How a company weighs these results depends on their goals or overall approach. A few examples for this KPI are:

- **Liquidity Ratios:** This is a set of financial ratios to measure the ability to meet short-term obligations of a company.
- **Profitability Ratios:** This measures the potential on how much profit the company can generate relative to revenue assets and equity.
- **Solvency Ratios:** This is the opposite of the liquidity ratio. Solvency ratios measure the ability to meet long-term obligations of a company.
- **Turnover Ratios:** This ratio measures the productivity of the company's operations and the ability to manage the assets.

12.7.2 Customer Metrics

This is the umbrella term qualitative and quantitative metrics, they focus on the measurement of the UX, how developers can improve their work and what impact the work has on the different areas. Metrics like CSAT, NPS, CAC or SUPR-Q play an important part.

12.7.3 Process Performance Metrics

This type of KPI measures the performance and effectiveness of a business process. The goal is to identify the area where they can improve quality, reduce waste and increase productivity of the process.

There are some common metrics for this type:

- **Cycle Time:** Measures the time from the beginning to the end of the creation of a process.
- **Throughput:** This describes the output rate from the process, and is often expressed in units per hour or day.
- **Error Rate:** This KPI focuses on the total number of errors made during production. This allows to streamline the process and increase profits and cut costs.
- **Customer Wait Time:** The name is self-explanatory, it measures the amount of time which customers have to wait until they can access a page or start working with an application.

12.7.4 Marketing

This type of metrics attempt to describe the effectiveness of marketing and promotional efforts on customers. With this information, the marketing department can use other strategies or methods to attract more clients.

Examples of the KPI:

- **Click-through rate (CTR):** This measures the percentage of people who click on an ad or link, compared to the people who saw it.
- **Brand awareness:** Measures the level of recognition and familiarity which the customer has with the brand.
- **Return on investment (ROI):** Provides the financial return of a marketing campaign compared to the invested money in it.
- **Customer lifetime value (CLV):** This will measure the total revenue a customer will expect to generate over the lifetime of an average business relationship.

12.7.5 IT

IT metrics specialise in tracking the IT infrastructure, devices and providing statistics to administrators, so that they always have an overview and implement improvements or changes more easily.

The most important KPIs in the IT are listed here:

- **Total System Downtime:** Records the time, on how long different systems go offline, to be repaired or updated.
- **Number of tickets/resolutions:** This KPI divides the tickets by the solutions to get an overview of the areas who cause problems in the IT.
- **Back-up frequency:** Counts the amount of critical data which will be duplicated and stored on safe locations. The duplication ensures that a current backup is always available in case of data loss or damage.
- **Number of developed features** Counts the amount of developed features. This gives an insight into the development status of a project.

12.7.6 Sales

The ultimate goal of any company is to generate revenue. Sales KPIs are helping to understand the sales process by evaluating non-financial data. Metrics like CAC, conversion rate or AOV will help to understand the process.

12.7.7 Staffing

KPIs are also utilised to assess the performance of employees within a company, as it is crucial to evaluate the satisfaction, well-being and productivity of the workforce. Examples of such metrics are listed below:

- **Employee satisfaction:** To be capable of measuring this, each employee must carry out a survey, which is subsequently gathered and assessed. Best practice is to repeat the surveys annually to determine changes.
- **Number of applicants** It displays the potential new employees of a company.
- **Number of hours worked** This metric will measure the workload and staffing levels of a team or department. For example, if a team has consistently high numbers, it could indicate that the team is understaffed and needs additional resources.
- **Turnover rate:** This metric indicates the proportion of employees who have departed from the organisation during a defined time frame.

- **Time-to-productivity:** This measures the time it takes, a new hired staff, to become productive for the work which they are doing.

12.8 Result

Measuring the user experience is essential to track the quality and performance of the website or application. The metrics allows reacting and develop improvements or alternatives in case of any misconception or complexity issues. The topics, mentioned earlier, can help differentiate between relevant and irrelevant data, which statistics should be shared to the particular developer team and how to understand them. The metrics consists of extracting the opinion and the behaviour of the user. Which actions will often be used, how the user feels while navigating through the website. Additionally, these metrics can also be applied for a better understanding of the employee satisfaction, finances and the company's IT infrastructure. The UX measurement can be used in many different ways, no matter if it is web development, business administration, IT or something else.

With the data, which we received from the countly server, we created some statistics with the help of calculations, questionnaires and countly features. These statistics could be generated by simple metrics like page views, element clicks or time-on-page. Furthermore, we also can detect the JS errors and save them on the server, so that the developers have the possibility to fix them at any time.

13 Summary and prospect

The result of the diploma thesis is the implementation and integration of the Countly analytic platform into the BORA framework, and to evaluate the user's interactions and experience with the application.

An important aspect was the compliance with the legal requirements of the GDPR. Therefore, a cookie banner and a privacy policy page were implemented to inform the user about what data will be collected and for what purpose, and to offer them the ability to opt-in and opt-out.

Furthermore, Countly offers various features out of the box, like error collecting, user tracking and user feedback. However, we had to implement custom event tracking, such as button clicks, page views, tab views and CTL focuses. With the gathered data, it is feasible to analyse the user's interactions, identify potential errors, collect user feedback, and gain important insights for the frontend development.

During our diploma thesis, we managed to improve our teamwork skills, solve initially unknown problems, and communicate with different departments in our surroundings. Further, we acquired skills in new programming languages like C# and TypeScript.

In the future, Boom Software AG will update its customer contracts, to allow the collection of user data. With the integrated Countly analytic platform, it is possible to gain insights into how users navigate and interact with the applications. This process helps the frontend developers to enhance the user experience and to create more intuitive applications. In future projects, it could be expanded by adding a feature that notifies developers immediately when a client-side error occurs. In addition, it would be possible to develop a software that compares the incoming data from different Boom applications, to identify similarities and differences in user interactions.

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17 Abbreviation

AOV	Average Order Value
AR	Augmented Reality
BTN	Button
CAC	Customer acquisition cost
CCPA	California Consumer Privacy Act
CES	Customer Effort Score
CLV	Customer lifetime value
CTR	Click-through rate
CSAT	Customer Satisfaction Score
CSS	Cascading Style Sheets
DNS	Domain Name System
DSG	Datenschutzgesetz
DSGVO	Datenschutz-Grundverordnung
EU	European Union
GDPR	General Data Protection Regulation
GUI	Graphical User Interface
HCD	human-centered design
HCI	Human Computer Interaction
HIPAA	Health Insurance Portability and Accountability Act
HTML	HyperText Markup Language
JF	Jour fixe
JS	JavaScript
KPI	Key Performance Indicator
less	Leaner Style Sheets
LGPD	General Personal Data Protection Law
NPS	Net Promoter Score
OS	Operating System
OWA	Open Web Analytics
PECR	Privacy and Electronic Communications Regulations
PHP	Hypertext Preprocessor
ROI	Return on investment
SQL	Structured Query Language
SUPR-Q	Standardised User Experience Percentile Rank Questionnaire
SUS	System Usability Scale

TPI	Task Performance Indicator
TS	TypeScript
UI	User Interface
URL	Uniform Resource Locator
USA	United States of America
UX	User Experience
UXD	User Experience Design
VM	Virtual Machine
WBS	Work Breakdown Structure
WP	Work Package
WWW	World Wide Web

A Meeting minutes

All meetings made before, during, and after the start of the project are listed here.

Date	Subject of the meeting	Duration
30.11.2021	Kickoff-Meeting for the diploma thesis	1 h
27.01.2022	Determining the subject of work	1 h
05.07.2022	Daily JF - Discussing progress and further work	0.5 h
06.07.2022	Daily JF - Discussing progress and further work	0.5 h
07.07.2022	Daily JF - Discussing progress and further work	1 h
08.07.2022	Daily JF - Discussing progress and further work	0.5 h
12.07.2022	Discussing BORA framework and test project integration	2.5 h
14.07.2022	Discussing menus and pages inside the BORA framework	1.5 h
20.07.2022	Meeting about specialised research of each member	2 h
21.07.2022	Introduction to Rail Solutions project	2 h
21.07.2022	Meeting about specialised research of each member	1 h
22.07.2022	Meeting about specialised research of each member	1 h

Table 6: List of all meetings

B Timesheets

On the following pages, the time spent by each individual member on his working tasks is going to be listed.

B.1 Simon Schöggler

Description	Duration
Technology research	21 h
Testing of researched tools	13 h
Getting familiar with the BORA framework	17 h
Setting up Countly in the BORA test project	15 h
Adding tracking events for buttons	22 h
Adding customer pages to Countly	8 h
Adding tracking events for tabs	10 h
Setting up Countly in the Boom Rail Solutions project	19.5 h
Research about UI	35 h
Writing the diploma thesis	37 h
Sum	197.5 h

Table 7: Timesheet of Simon Schöggler

B.2 Manuel Reinprecht

Description	Duration
Legal research	33 h
Technology research	6 h
Testing of researched tools	6 h
Getting familiar with the BORA framework	13 h
Setting up Countly in the BORA test project	12 h
Creating a subpage for consent reasons	21.5 h
Adding consent features	6 h
Setting up Countly in the Boom Rail Solutions project	18 h
Research about the measuring of UX	32 h
Writing the diploma thesis	34 h
Sum	181.5 h

Table 8: Timesheet of Manuel Reinprecht

B.3 David Brannan

Description	Duration
Legal research	35 h
Technology research	2.5 h
Testing of researched tools	4 h
Getting familiar with the BORA framework	16 h
Setting up Countly in the BORA test project	15 h
Adding and testing personalised plugins	6 h
Adding consent banner	21 h
Adding consent features	8.5 h
Setting up Countly in the Boom Rail Solutions project	17 h
Research about legal rights and data privacy	32 h
Writing the diploma thesis	35.5 h
Sum	192.5 h

Table 9: Timesheet of David Brannan

B.4 Marcel Schmidl

Description	Duration
Technology research	20 h
Testing of researched tools	13.5 h
Getting familiar with the BORA framework	17 h
Setting up Countly in the BORA test project	16 h
Adding consent and feedback options	17 h
Adding and testing personalised plugins	11 h
Creating a subpage for consent reasons	6 h
Setting up Countly in the Boom Rail Solutions project	19.5 h
Creating workflows	6 h
Research about UX	30 h
Writing the diploma thesis	35 h
Sum	191 h

Table 10: Timesheet of Marcel Schmidl

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