Visualization of High Load Transactional Data

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Abstract

IKEA is a Swedish company that has been the largest retailer of furniture for the past fifteen years. Selling orders worth EUR 44.6 billion in 2022, IKEA has to meet great logistic needs in order to maintain a functioning business. In the current IKEA landscape teams that consume order data have to listen to multiple sources and compare the data they receive to get specific information from an order. All this logic is built by each team themselves. This means that the same process is done by multiple teams at IKEA, demanding valuable time and effort that could be spent on development. IKEA is therefore developing 'Customer Order 360' (CO360) - a software product meant to re-organize IKEA's order flow and gather all order events regarding customer orders in one place. CO360 has not yet been adopted by all teams within IKEA. Therefore they need a visualization tool to help them demonstrate what CO360 is and convince future consumers why they should switch to the CO360 solution. A user centered design process rooted in thorough research was conducted. Various processes, methods, and tools within the design science were utilized such as prototypes, brainstorming, data analysis and usability testing. Several iterations of the Double Diamond phases were undertaken, including many interviews and discussion with the team, and analysis throughout the entire process. The most significant aspects of CO360 to convey to its future consumers are the shielding from complexity and tailored so-called "business events" it provides them. These factors were included and prioritized in the prototypes developed which were followed up with evaluations from the team. A final implementation was reached that displayed the data flow before, during and after being processed by CO360. The visualization also showed these processes that CO360 utilizes to create the events it exports. An evaluation was carried out with participants from both the CO360 team, but also other teams within IKEA. It was concluded that the visualization showed good understanding of the product, and could be used to assist in a presentation of CO360.

Sammanfattning

IKEA är ett svenskt företag som varit ledande inom möbelindustrin de senaste femton åren. Som ett företag som under 2022 sålde produkter för 44.6 miljarder euro måste IKEA uppfylla stora logistiska behov för att upprätthålla en fungerande verksamhet. I det nuvarande landskapet inom IKEA måste teamen som konsumerar orderdata lyssna på flera källor och jämföra datan för att få den specifika informationen de vill åt. Denna logik hanteras av varje enskilt team, vilket betyder att samma process genomförs flera gånger av olika team. Detta tar onödig tid som istället skulle kunna läggas på utveckling av teamens egna produkter. IKEA utvecklar därför Customer Order 360 (CO360) - en mjukvaruprodukt som omorganiserat IKEAs orderflöde och samlat all information kring kundordrar på ett och samma ställe. CO360 används inte än av alla team på IKEA. De är därför i behov av ett visualizerings verktyg som ska hjälpa dem demonstrera vad CO360 är och varför deras framtida konsumenter borde byta till deras lösning. En användarcentrerad designprocess framtagen efter ingående studerande genomfördes. Ett flertal processer, metoder och verktyg inom designvetenskapen nyttjades under designprocessens gång, såsom prototyper, brainstomring, dataanalys och användartestning. Designprocessen bestod av iterationer av Double Diamonds faser, vilket inkluderade många intervjuer och diskussioner med teamet och analyser som genomfördes genom hela processen. De mest betydande aspekterna av CO360 som var viktiga att förmedla till framtida konsumenter var skyddet mot komplexitet och de skräddarsydda så kallade business eventssom erbjuds dem. Dessa faktorer inkluderades och prioriterades i de framtagna prototyperna som följdes upp med utvärderingar från teamet. En slutgiltig implementation togs fram som visade dataflödet innan, under tiden, och efter det processats av CO360. Visualiseringen visade också vilka dessa processer är som gör att CO360 kan skapa de event de exporterar. En utvärdering av den slutgiltiga produkten utfördes med deltagare från både CO360 teamet, men även andra team inom IKEA. Slutsatsen var att visualiseringen visade på god förståelse av CO360 och att den skulle vara till hjälp vid en presentation av denna produkt.

Acknowledgements

We would like to express our appreciation and gratitude to everyone who made this thesis possible.

First and foremost, we want to thank our supervisor at IKEA, Tobias Friberg, for his support throughout this entire process. From the very beginning, he has been instrumental in making us feel welcomed and valued as part of the team. We are immensely grateful to have had such a driven, dedicated and supportive supervisor.

We also want to give a great thank you to our supervisor at LTH, Joakim Eriksson, who has given us valuable feedback throughout this thesis, and has greatly contributed to the improvement of this work.

We want to thank IKEA and the CO360 team for giving us an opportunity to do our thesis work at such an iconic company within an immensely talented team. The CO360 team consists of highly skilled developers with limitless knowledge. They have all contributed to a welcoming atmosphere, and assisted when we've needed participants to evaluate our visualization.

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We have not only been given invaluable insights by these people, but also had a lot of fun along the way. Thank you for making this thesis such an enjoyable experience.

Contents

1 Introduction

1.1 Background

IKEA is a Swedish multi industry company that has been the largest retailer of furniture for the past fifteen years [1]. With over 230 000 employees [2], 680 million customers [3] and selling orders worth EUR 44.6 billion in 2022 [2] IKEA has to meet great logistic needs in order to have a functioning business. In the current IKEA landscape teams at IKEA that consume order data have to listen to multiple sources and compare the data to each other to get specific information from an order. All this logic is built by each team themselves. This means that the same process is done by multiple teams at IKEA, demanding valuable time and effort that could be spent on development. IKEA is therefore developing 'Customer Order 360' (CO360), a software product meant to re-organize IKEA's order flow and gather all order events regarding customer orders in one place. CO360 takes all data from the different sources, unifies them and creates specific events for IKEA's internal consumers. The biggest challenge for the CO360 team is to handle the large amount of data that different source systems produce. Source systems creates events when something happens or changes within an order. An event could for example contain information if the order has been delivered or if the order has been paid. During the busiest hour of a Thursday in may, CO360 received 22 events per second from just one of the source systems. This can be seen in figure 1.1. This amounts to 77 724 events during the full hour. With multiple sources that produces similar amounts of data, it quickly becomes a heavy data load. This puts a lot of pressure on the CO360 system to effectively sort and process the high amount of events.

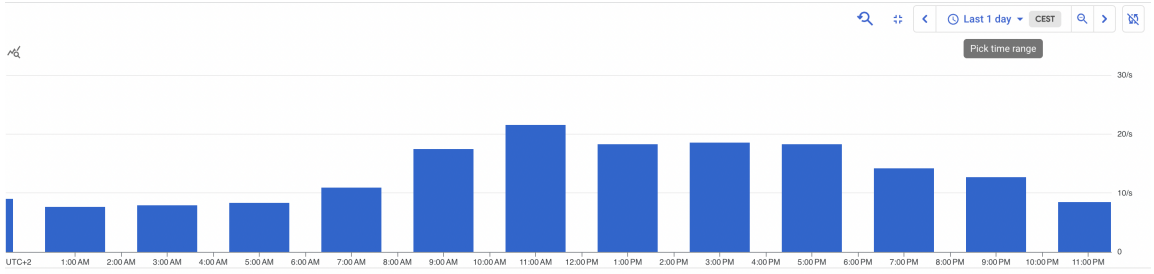


Figure 1.1: Events received by CO360 from fulfillment

Another challenge CO360 is facing is convincing future consumers to switch to their unified event flow. Currently the CO360 team only has metric tools at their disposal to show what the team does and produces. This is because the CO360 product is integrated within IKEA's systems without having an interface that can be viewed by a person. The team needs to be able to show the benefits with CO360 and what the system really does, therefore there is a need to visualize their work. This type of data visualization is done in many fields and visualization research is growing constantly.

It is done in fields such as cyber security, healthcare, biologic research and many more [4]. These fields implement and utilize visual representations in their professional work. Even if current research on visualization frequently neglects wider non technical audiences, there is emerging new research such as "Reaching Broader Audiences With Data Visualization" [4]. This is especially important for consumer teams that have less technical people as decision makers.

1.2 Related work

Studies on how to convert data into visual storytelling interfaces to present it have been made before. Lee et al [5] deep dives into how the visualization community has approached the concept of visual storytelling and introduced a process within the field. Conclusions included that different techniques can be used to engage the audience such as underlining important parts of the system through annotation, highlighting and zooming.

Overviews and dashboards of real-time data are constantly being developed to help stakeholders and teams make decisions [6]. CityDashboard is a web application built for handling high load of real-time data of various cities in the United Kingdom and presenting it through different visualizations [6]. Both IKEA's and CityDashboard's challenge is to handle "big data" while enhancing the diversity and frequency of information through a visualization.

There has been other thesis work in this field done at IKEA. Svensson and Trpeski [7] visualize other types of data within IKEA, such as activity data of all the kiosks in a store. Their thesis was rooted in research questions such as "How can activity data be visualized from both a store and global perspective for IKEA's IT development team?" and "Is it possible to gather and filter through activity data, so that it can be visualized in real time?". Their work was relevant to further understand IKEA's data and how it could be visualized, but it also had its limitations. Svensson and Trpeski mainly focus on presenting data metrics and not the flow of data which limited what could be useful for this thesis project.

1.3 Purpose

The purpose of the thesis was to help the CO360 team at IKEA to find which visualization is mostly needed for their product. To achieve this, it was necessary to first understand what CO360 is and what its main components are. It was explored what different stakeholders wanted in the visualization overview and what was needed for achieving it. The research questions that this thesis aims to answer:

- Who are the stakeholders of the CO360 product?
- What are the stakeholders needs and how are they identified?

- How can CO360 be visualized in order to satisfy identified needs?

1.4 Scope and Delimitations

There were early signs of multiple solutions being needed to satisfy all needs, but due to time and resource constraint it was decided early on to develop one solution that satisfied the greatest needs. The time limit was 20 weeks for the full thesis, which limited how advanced the final implementation could be. The development was also delimited to only produce a web application and skip any other versions such as mobile, tablet or desktop application. The project scope contained both primary and secondary users, but the main focus become on primary users, due to easier access to them. Security features were not prioritized and therefore the code could not be deployed. There was also some data that is up to the CO360 team to create and maintain, such as descriptions of business events. IKEA is also very careful with their data and their trademark name. Therefore the implementation could not use real names of for example sources.

1.5 Thesis structure

The first chapter is an introduction to the thesis, including necessary background information, related work, the purpose and research questions as well as the scope and delimitations. The second and third chapter presents all technical and theoretical background needed for the thesis, containing all processes, methods, tools and programming languages used throughout.

Chapters four through eight depict the design process divided into five iterations. An overview of the iteration chapters is shown in figure 1.2. The first iterations conclude in protoypes, and the following in MVPs which are designed and implemented.

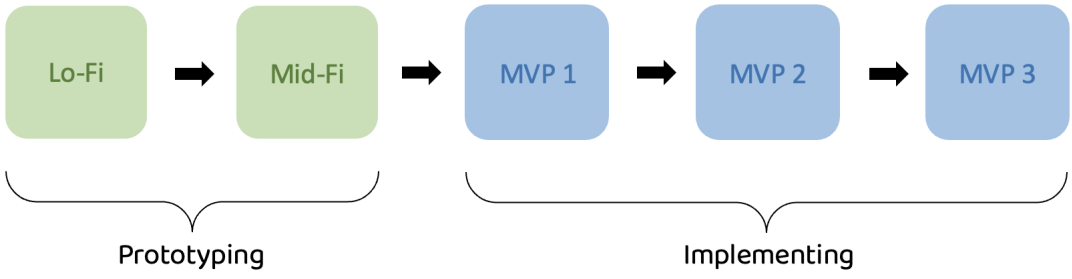


Figure 1.2: The structure of the different iterations that assemble the design process.

The ninth chapter contain the evaluation of the final products, consisting of a four part process. Lastly, chapter ten provides discussion and conclusions, providing answers to the research questions by evaluating the design process and results from the previous chapter.

2 Technical Background

The purpose of this chapter is to present the technologies used throughout the thesis work. The technologies are described briefly and are meant to give an insight on what they are and how they are used. This chapter will introduce the following technologies: programming languages, data communication services, configuration systems, the CO360 product itself and data tracking systems. The purpose of this chapter is also to serve as a reference point. If the reader comes across any unfamiliar technology while reading the thesis, one can revisit this chapter. This way, it is easier to follow along with the thesis, giving a clearer understanding of the technologies involved.

2.1 Programming languages

2.1.1 JavaScript

Brendan Eich created JavaScript in 1995 at Netscape Communications. It is a dynamic, simple and easy-to-use programming language which, enabling developers to embed snippets of code within web pages [8].

Today, JavaScript is most often used in web development for creating interactive web pages and web applications. Developers can incorporate dynamic elements into web pages, such as animations, interactive forms, and other features. Beyond web development, JavaScript has found use in server-side programming with platforms like Node.js, as well as in desktop applications, mobile device applications, fitness trackers, robots, and numerous embedded systems [8].

Stack Overflow conducted a survey in 2020 that showed that JavaScript was the most widely used programming language in the world, utilized by 71.5 percent of professional developers [8].

In this thesis project an interactive web application was developed, which creates a need for JavaScript. The programming language will also make it easier to incorporate server-side solutions like Node.js that can fetch and connect to IKEAs data.

2.1.2 HyperText Markup Language

HyperText Markup Language (HTML) was designed to add semantic meaning to text documents shared via the World Wide Web (WWW). It was a crucial tool to increase the flexibility of data shared on the WWW.

HTML works as a markup mechanism, assigning content with semantic significance but not changing the actual content. HTML describes the content but doesn't decides its presentation. For example when an HTML author marks a phrase for emphasis, it doesn't specify the visual representation, like bold or italics. This decision is left to the individual browser, which determines how to visually represent the emphasis.

HTML's primary function is to provide metadata about the content of a document. This metadata gives the client program the necessary context to process and render the information for the user [9].

2.1.3 Cascading Style Sheets

Cascading Style Sheets (CSS) is a stylesheet language used to describe the design and formatting of documents written in any XML-based markup language. CSS is used to control and design contents on web pages. It can manipulate and change layouts, colors, fonts and many more stylistic components. By changing how web pages are displayed, CSS can be used to adapt pages to different screen sizes or viewing devices [10].

2.2 Node

Node is is a JavaScript environment used for back-end development. It facilitates server-side JavaScript execution and runs on the V8 engine, also called the V8 JavaScript Engine. When handling concurrent execution, Node uses an asynchronous I/O event-driven model, as opposed to multi-threading. This setup enables Node to operate similarly to a single-threaded daemon that integrates a JavaScript engine for customization. Node also enables the possibility of running JavaScript code outside of the web browser [11]. Using Node creates the possibility to write the implementation code for this project in JavaScript for both the front-end and back-end.

Express is a back-end web framework for Node.js that is streamlined and adaptable for both web and mobile applications. With Express it is possible to set up middleware, which allows for customization of the application's responses to HTTP requests. Another feature is the routing table functionality. A routing table in Express is like a road-map for HTTP requests, directing them based on their method (for example like GET or POST) and the URL they're trying to access. Express also supports dynamic rendering of HTML pages, which means it can generate different HTML content based on the data it receives [12].

2.3 REST API

APIs can handle different type of calls, return different data formats and exchange information between computer programs. They can also be designed to be stateless. By being stateless the server does not need to know anything about what state the client is in and vice versa. REST (Representational State Transfer) APIs are common in web development and they are designed to be stateless and provide client-server communication protocol that is largely used over HTTP [13].

2.4 GitHub and its API

GitHub's core functionality lies in Git, a decentralized version control system. Git operates based on master-less peer-to-peer replication, allowing any copy of a given project to exchange any information with any other copy. GitHub has built multiple unique features around Git, for example an issue-tracker, support for pull requests, mechanisms for watching and following projects, and much more. These features are created to enhance collaborative work and social interactions around projects. GitHub also has enabled access to the metadata of hosted projects that can be accessed through the GitHub API [14]. Currently, GitHub is the most popular social coding platform with over 100 million users [14, 15].

2.5 Customer Order 360

IKEA uses several databases, termed **sources**, to store customer order data and publish events to queues for extraction by other systems. Customer Order 360 (CO360) simplifies this process by managing and unifying **order events**. Order Events are order specific occurrences that relates to what happened in an order or something that affected the order. These will usually be referred to simply as "events".

CO360 main job is to pause data flow until specific information is received, flag irregularities in the data and to process standardizes events into either data or business events. Data events contains the full order information and business events contains specific order information. This makes data consumption easier for **consumers**. Consumers are teams or systems within IKEA that listen and consume order events within the IKEA landscape. I.e they receive information about orders and produces their own information based on this data.

2.6 Google Cloud Platform

Through a multitude of services, Google Cloud Platform (GCP) facilitates the securing, storing, serving, and analyzing of data. There is a great level of security in GCP which forms a secure cloud ecosystem for data. The data can be manipulated and

transformed in different ways without it leaving the ecosystem [16].

Within IKEA GCP it works as a monitoring service where it uses logging and diagnostic features to enhance application performance and up time, thereby enabling users to maintain optimal application functionality and availability. GCP logs a great variety of metrics relevant to the CO360 team and provides and API to access these metrics.

Pub/Sub is a part of the Google Cloud Platform and is used to transfer data between systems. It works as a message delivery system asynchronously and is scaleable, acting as an intermediary between message-producing and message-processing services, thus eliminating direct dependencies. Pub/Sub has low latency, typically around 100 milliseconds, which makes it ideal for large-scale, high-speed data processing tasks. Pub/Sub is suitable for data integration pipelines, a middleware focused on messaging for service integration, or as a queue to distribute tasks for parallel execution. In a Pub/Sub system, there are event creators, or 'publishers', and event receivers, or 'subscribers'. The publishers send out events without worrying about when these will be handled. The Pub/Sub system then makes sure that these events reach all the subscribers that should get them [17].

2.7 React

React was created by Facebook (now called Meta) and is a JavaScript framework. It was created to handle large-scale user interfaces with constant changing data. This would help Meta to develop both Instagram and Facebook which both had exceptional large-scale user interfaces with high-load data [18]. React is the view layer and builds the user interface [19]. In react it is possible to create components which consist of coding blocks that can be reused, making it easier to have a large-scale interface that uses multiple components over and over again. It is also useful for smaller projects to avoid duplicated code.

2.8 Visual Studio Code

Visual Studio Code is used for code development and it is a powerful integrated development environment (IDE). Many different languages can be used to develop web applications, mobile applications and cloud programs. It contains tools such as debugging, git integration and control capabilities [20].

This IDE is lightweight, simple and easy to use [20] and was therefore chosen as the development tool in this thesis.

3 Theoretical Background

There are many ways to carry out a design process, and numerous methods and analyses that can be used. This chapter describes the procedures and tools which are utilized throughout this thesis. The main areas are user centered design, Norman's design principles and the Double Diamond design process. The Double Diamond section describes the tools that were used, such as usability testing, the system usability scale, prototypes, minimum viable product etc. These are included in the sections where they are most effectively used according to the Double Diamond's different phases. Just as chapter 2, this chapter acts as a reference point where the reader can revisit this chapter for a deeper understanding of the theoretical methods mentioned throughout this thesis.

3.1 A User Centered Design Process

The thesis has a *user centered* approach, rather than a technology- or feature-centered approach. The two latter put the technology itself in the center, often disregarding the users' viewpoint. This can lead to design choices that give poor user encounters. A user centered design process keeps the users in focus at all times in order to design a solution with an optimal user experience. The users' tasks and goals are the motivation behind the development, which requires deep diving into the users' perspective and understanding their needs and wishes for the product [21].

It might seem trivial, but taking the time to truly understand the users can often be overlooked. It is easy to assume things about the user and become too focused on the solution before accurately apprehending the problem. The consulting firm Niels Norman Group (NNG), founded by two of the most well-known researchers in the design field Jakob Nielsen and Don Norman, have put forward 18 fundemental slogans that form their design philosophy [22]. Their first and perhaps most important slogan is "You are not the user" which emphasises that the designers themselves cannot assume what the user needs and what their experience with the product will be - this information needs to come from the user. The user has to be a part of the process from the beginning to the end in order to deem if it is a successful product or not [23].

"UX is people" is another one of NNG's slogans, which underlines that a UX, or user experience, design process should be more about the user than the technology [24]. The users are humans, who function very differently to computers. It is important for designers to try to bridge that gap, by understanding how the user interacts with the interface. While technical solutions are important, the usability of a product will be determined based on the human interaction with it.

A user centered design requires understanding the users. For this thesis that will include many discussions and interviews with the team at IKEA, as well as spending

time in their work environment. This is to asses their needs and get their input on the problem and potential solutions.

3.2 Norman's Design Principles

3.2.1 Visibility

Visibility shows users which options that are available. These options should be easily accessible. This means that users should know by just looking at the screen what actions are possible and how to perform those actions [25].

3.2.2 Feedback

Every action a user makes should be replied with some type of immediate informational response. The user will then be informed that the application has acknowledged their input and signals the outcome of the action. Users should never be left guessing on what action they have taken and they always need to be informed of what response each action will result in [25].

3.2.3 Affordance

Affordance is the relation between how components look and how they are used. Components gives clues to the user on how it can be used. For example a round door knob gives the clue that it should be turned to open the door and a flat door handle gives a clue that it should be pushed down to open the door. A high affordances results in a high celerity on how something should be used [25].

3.2.4 Mapping

Mapping connects control and effect. Controlling something should resemble what is affected. For example when increasing the volume it could be done with a slider. When the user moves the slider the volume increases and there is a connection between the control and the effect [25].

3.2.5 Constraints

Constrains are used to limit the actions of a user. It brings rules to an application and shows what can be done and what cannot be done [25].

3.2.6 Consistency

Consistency means having the same reaction for the same actions. This also refers to styling where the same components or same elements should look similar throughout the whole design. Patterns helps the user to recognise elements and actions [25].

3.3 Double Diamond Design Process

The thesis will have a user centered approach based on the *Double Diamond* design process. The Double Diamond is a widely used design process developed in 1996 [26]. It emphasises the importance of having divergent and convergent phases in your design process, meaning the designer should widen their thinking and explore as many options possible before narrowing in and focusing on one or few solutions. The Double Diamond process consists of four stages: Discover, Define, Develop and Deliver. Discover and Develop are divergent stages, while Define and Deliver are convergent. The name of the design process comes from the visualisation shown in figure 3.1, where the divergent and convergent phases create two diamonds. The first diamond focuses on the problem, while the second focuses on the solution.

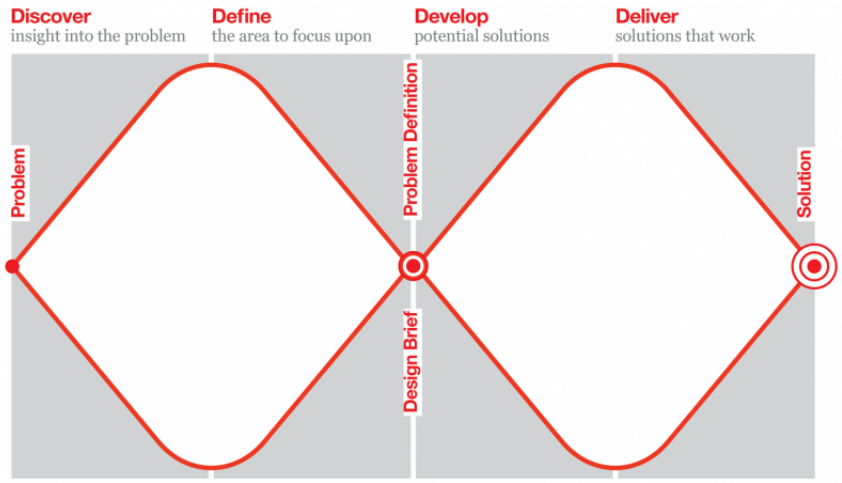


Figure 3.1: The Double Diamond design process.

In order to achieve the best results the Double Diamond process will be used in an *iterative* way meaning the four stages will be re-visited multiple times. The problem and solutions will be built up gradually. The first solutions is very rarely the best solution, and it is important to be prepared to improve, and perhaps completely re-think certain designs.

It is important to note that all design processes look different. The Double Diamond is rather an inspiration for the process of this thesis, than a process that will be followed meticulously. The number of times a certain phase will be revisited and in what order is not determined beforehand, but rather based on the users in a certain design process. This is what a user centered design process is all about - letting the users have a large influence on the process and solutions. No users are the same, and thus no user centered design process will be the same.

3.3.1 Discover - Gathering Data

The first phase, Discover, aims to get insight into the problem the designers are here to solve. It is important to remember this phase is all about the problem, not the solution. It can sometimes be easy to immediately start tackling problems that one is met with, but the first diamond is all about getting the *problem* right and exploring different perspectives. There might be several problems, which all need to be explored in order to understand the users' needs and desires. The designer should gather as much data on the problem as possible during this phase.

Interviews

Interviews are conducted between at least two people, where one is the interviewer. It is a qualitative research method that gathers data through series of questions. Interviews allow researchers to gather detailed data, going beyond surface-level responses to dig deeper into the individual's experiences, perceptions, and opinions. The drawbacks of having interviews is that the interviewer can affect data gathering through subjective choices and non consistent data gathering. This can happen if the interviewer asks leading questions that are affected by the interviewers bias [27]. Interviews and studies can be used to discover different problems. According to a research made by Jakob Nielsen all the usability problems can be found if you study at least 15 users [28]. This means in theory that multiple smaller studies/interviews can be conducted with a small amount of users each time that eventually amounts to 15 users to find all the usability problems.

Semi Structured Interviews have generally a pre-defined plan, but the order of the questions, the phrasing and follow up questions can change between interviews. They still keep a certain structure but gives an opportunity for flexibility [27]. An open-ended interview is a method of collecting information where interviewers ask questions without knowing the precise content of the responses in advance [29]. The aim is to understand the participant's perspectives, experiences, knowledge and ideas. There are three types of open-ended interviews: informal, interview guide, and structured. For this project, informal open-ended interviews were used. In informal open-ended interviews the interviewer will not plan any questions in advance, instead asking questions spontaneously based on the conversation. This offers highlights of individual experiences and emotions rather than providing quantifiable data.

Usability Testing

Usability Testing is an empirical evaluation method where the researchers observe users perform several tasks presented to them to see how well they are executed. It is important to keep in mind that it is the usability of the design that is being tested, not the user. If the user cannot complete a task, this is a reflection of the design, not the participant [30].

Usability testing is accessible and cheap while being very helpful with identifying and

understanding the issues prominent in the design. It provides insights into potential design enhancements and offers valuable lessons about user behavior [30, 31].

The tasks are developed beforehand by the researchers to test the most important parts of the design. They should also reflect realistic actions that a user would want to perform in real life. It is important to phrase the tasks correctly, so there is no room for misunderstanding. In order to avoid not bias the user, the researchers should remain quite during the execution of the task [30, 31].

Usability testing can be both quantitative and qualitative. The most common quantitative metrics are "task succeeded" vs "task not succeeded". These can help get a good overview of how the solution is perceived, but qualitative usability testing should be used for a deeper insight into the usability of the product. Qualitative data is collected by observing the user and listening to feedback they might have [30].

Thinking Aloud

Thinking aloud is a tool used during the usability testing. Nielsen states that "Thinking aloud may be the single most valuable usability engineering method". As the name implies, the users are asked to verbalise their thoughts while executing the tasks presented to them, adding to the qualitative data collected. This tool helps get an even greater insight into the user experience, and understanding of why the user makes certain decisions, whether they are fulfilling the task or not. While talking out loud may seem uncomfortable to the users at first, this usually only lasts for a short amount of time. Thinking aloud is a straightforward, cost-effective method that provides valuable insights [32].

3.3.2 Define - Analyzing Data

After gathering as much data as possible, the define phase focuses on converging and defining the problem. This is done by evaluating the findings in the Discover phase with a convergent mindset. Look at the main areas brought up in the Discover phase and synthesise them to a more concise problem. The Define phase should bring you closer to answering what the goal of your project is. Once again, it is important for the designer to remember to be impartial and not focus on what *they* consider to be important, but rather looking at all the gathered data with an open mind and see what the users truly think [33, 34].

Quantitative Data Analysis

There are several ways to evaluate the success of the solutions put forward. In order to evaluate the usability of a solution, the user has to be involved. The evaluations are therefor empirical rather than theoretical. Quantitative studies are most often used as en evaluation method to indicate the usability of a *finished* product. It is recommended to have a larger number of users participate to get a representative result

[35]. System Usability Scale (SUS) is a standardized questionnaire that can be used to review usability and is also used for quantitative data analysis. When created it was said to be a “quick and dirty usability scale” With time it has come to be known as the most frequently used questionnaire, maintaining its quickness but not seen as ”dirty” anymore. In industrial usability studies, 43 percent of post-study questionnaires uses SUS [36]. The questionnaire consist of 10 statements that gathers the users perspective on the application's complexity, ease of use, and functionality. Each questioned is answered a five-point Likert scale, from ”Strongly Disagree” to ”Strongly Agree” [36]. The full usability questionnaire can be found in Appendix B.1. SUS is very easy to set up and saves a lot of time as it has pre-written questions. Since they are always the same questions it allows for bench marking and comparison between different systems or iterations of the same system.

To calculate the SUS score start by adding up the value of each odd-numbered questions (1, 3, 5, 7, 9). The values are in a range from 0 (Strongly Disagree) to 4 (Strongly Agree). From the total subtract 5 and save it as your ”odd score”. Then add up the values of all the even-numbered questions (2, 4, 6, 8, 10). Subtract the total score from 25 and save it as your ”even score”. Add the ”odd score” and ”even score” and multiple the sum by 2.5. This is the final score and it will always be between 0-100 [36]. In a research [37] made by Bangor, Kortum, and Miller it was look upon almost 1000 cases that used SUS and they made a scale to interpret the SUS score. The scale is as following:

- SUS score of 12.5 = Worst imaginable
- SUS score of 20.3 = Awful
- SUS score of 35.7 = Poor
- SUS score of 50.9 = OK
- SUS score of 71.4 = Good
- SUS score of 85.5 = Excellent
- SUS score of 90.9 = Best imaginable

Worth noting is that the researcher warns to interpret 50.9 = OK as a satisfactory value and that no improvements are needed. On the contrary a SUS score of 50.9 is according to the researcher ”clearly deficient in terms of perceived usability”. Instead an acceptable user experience should be around 70 [37].

Qualitative Data Analysis

To be effective, qualitative research needs to use careful and detailed methods. These methods should aim to answer questions about experiences, people's thoughts or feelings about a system, and also why things happened the way they did [38]. This type of data usually appears as words or text and can include pictures as well. Qualitative

data from interviews, conversations or documents can be quite extensive and requires time, structure and a workflow that is consistent.

Coding can be used to organize data and categorize it [38]. For instance when analysing an transcript from an interview, a paragraph where a patient discusses fear of surgery and fear of unrelieved pain could be assigned the codes "fear of surgery" and "fear of pain". Then more often fear continuously appears in the transcript, then these codes can eventually be combined into a broader category called "fear". Recurring patterns across the data will be interpreted and become more abstracted and identified as themes. When broader and broader categories are formed it is important to keep its original richness, depth, and context. Including quotations to exemplify categories and themes ensures that the analysis stays rooted in the data. The analysis inherently involves subjective decisions, which will require that each step is documented and its rationale is essential to provide a transparent audit trail [38]. Documenting the rationale is also important because it provides context and understanding of why certain steps were taken or conclusions were drawn in the research process.

Tag cloud is a qualitative data analysis and is chosen for coding the data. They have become a central technique for visualizing data. The most common usage is text and data summarizing, where they are used to highlight the most frequently used words [39]. For the reader it provides a great and fast what to understand types of topics within a text. Tags in this project represents words. The font size of the words is often directly correlated to their frequency in the text. Which creates a fast and visual statistical overview. Since tags in this project represents words the term word cloud is used instead of tag cloud. One limitation of word clouds is that they offer a strictly statistical summary of individual words, disregarding linguistic understanding of the words and their relationships [39]. Meaning that word clouds are a good initial point of reference, but should not be interpreted as pure facts.

As previously mentioned the analysis inherently involves subjective decisions. These are especially important for when deciding which words will have higher weights over others [38]. Word cloud analysis can lead to words having the same frequency and therefore subjective decisions are necessary to decide which words will have bigger weights that others.

3.3.3 Develop - Generating Ideas

In the develop phase the solution comes into focus. Potential solutions are explored based on the findings in the discover and define phases. The develop phase is divergent - the designer should explore multiple concepts and ideas that could solve the problem and expand the possibilities [33, 40].

Brainstorming

Brainstorming is a technique for generating ideas, either in a group or individually. By using brainstorming one can increasing creative efficacy or find solutions to problems

[41]. In this project the research is mostly based on group brainstorming. Certain guidelines has been set for this project. These guidelines are based on the conclusion made in "Based on the "The Oxford Handbook of Group Creativity and Innovation" [42].

Guidelines:

1. Quantity rule
2. Brief breaks
3. Sessions structure
4. Brainwriting
5. Small groups
6. Alternating idea generating

The first rule is based on the Osborn rules that one should aim for quantity. By going for quantity over quality more ideas would be generated and a chance of finding a good one would be higher. Evaluation of ideas comes after the brainstorming session, and therefore it would not harm the quality afterwards. For the second rule, research have shown that the number of ideas generated enhanced by having brief breaks. The brief breaks should be taken when the group have significant pauses in their idea generation. By having clear and good structure one can achieve the third rule. The structure should be based around topics and these topics should be gone through one by one. Each topic should be dug into thoroughly before one is moving onto a new topic. The fourth rule shows that brainwriting, a process of sharing ideas on a piece of paper, generates more ideas than verbal brainstorming processes. As for the fifth rule, there is an objective to keep the group small, which in this project is highly relevant since only two people are generating ideas. The argument against bigger groups is the increase in production blocking. The sixth rule says that one should alternate group and individual brainstorming. This will lead to better group stimulation [42].

Mind Maps

A mind map is a visual tool utilized to represent a mental model of a specific process or concept. It does this in an hierarchical way by representing these concepts or ideas as subtopics to central topics. Mind maps can be used to give new perspectives on these topics, help bring an overview to the intricate ideas and concepts produces, and figure out connections between items. They are a simple but useful tool in a UX process [43].

MoSCoW Analysis

The MoSCoW Analysis is a prioritization technique that assists designers in making objective decisions when prioritizing items such as research questions, user segments,

ideas, and/or tasks. It aids in the process of determining the importance of these elements, enabling designers to allocate their resources effectively [44, 45]. The MoSCoW Analysis is used to separate the items into four categories:

-*Must Have*: The items that are crucial to reach an acceptable solution. Without these items, the solution would be meaningless [44, 45].

-*Should Have*: While not essential to the solution, these items are important to reach a satisfactory solution. The solutions would lose great value without them [44, 45].

-*Could Have*: Items that would be nice to incorporate, but are not necessary to deliver a good solution [44, 45].

-*Won't Have*: These items are not beneficial to achieve a solution, and will not be used in the design process [44, 45].

Before starting the process of dividing the items into these categories, it is important to consider why the prioritization is necessary. This helps with understanding the scope of the categories. The MoSCoW analysis works best for projects with clear time frames, as everything can be considered 'Must Haves' if the designers have several years to reach a solution [44].

The team is presented with the items that require prioritization. Each team member is given weighted votes: 1, 2 and 3. Each member distributes their votes among the items based on their perceived level of importance. Once all team members have cast their votes, the categorization can start. Add up the scores for each item and divide them into the MoSCoW categories. There are no strict guidelines regarding the number of items in each group, but the items with the highest scores should be categorized as 'Must Have.' Subsequently, items with the next highest scores should be classified as 'Should Have,' and so forth. The size of the clusters will be based on the scope of the project [44].

3.4 Deliver - Prototyping and Implementing

Once the designer has explored potential solutions for the problem, the deliver phase looks to bring forward the best solutions(s). In the earlier stages of a design process, this usually means a prototype, and later on an implementation of the solution [26, 33, 40]. When talking about prototypes, it is common to speak about low fidelity and high fidelity prototypes. There is no one true definition of what a prototype needs to achieve to be considered of low fidelity, or high fidelity [46], but there are common characteristics that will be brought up in the following sections.

Lo-Fi Prototypes

Low fidelity (Lo-Fi) prototypes are usually used in the beginning stages of a design process. They are characterised by having no interactive elements and can even be drawn by hand on paper. They are used to get an overall look and feel of what the product would look like and do. The Lo-Fi prototype might not contain all the content that would be in the finished product, and the individual components will rarely look exactly like the final product [46].

The main benefit of Lo-Fi prototypes is that they are low effort and quick to generate. This is usually apparent for the user, who will be more prone to giving authentic feedback. If the user understands re-doing or changing the prototype will be easy and quick, they will be less reluctant to say something negative about the design. The painlessness of redoing a Lo-Fi prototype will also effect the *designer's* approach to feedback. They are likely to be more open to making changes to the product since they are probably not as attached to the design. Lo-Fi prototypes open up to a higher number of, and less painful, modifications of the design [46].

Hi-Fi Prototypes

Further in the design process high fidelity (Hi-Fi) prototypes are often used. These are almost always done on the computer, usually with the help of some UX-tool such as Figma [47], and take longer to develop. They are more realistic and similar to what the potential final product could look like, with more details and accurate components than a Lo-Fi prototype. Most or all of the components and menus are clickable to make the prototype more interactive. The prototype will respond to the user, which is usually lacking in a Lo-Fi prototype [46].

Hi-Fi prototypes are more interactive and realistic. This means the users are more inclined to use the prototype as they would the actual product - the feel will be similar. The users' interactions will therefor be more realistic and the assessment of usability more accurate than if a user felt it was interacting with a piece of paper. Clickable components also helps the designer see more clearly what interactions the user has with the prototype. Hi-Fi prototypes also takes pressure of the designer to have to explain things, and they can focus on assessing the interaction, instead of explaining the prototype [46].

Minimum Viable Product

The true meaning av a minimum viable product (MVP) is defined by the person credited with popularizing the term, Eric Ries, as "The version of a new product which allows a team to collect the maximum amount of validated learning about customers with the least effort." [48] This means a product with minimal implementation, while including enough elements to provide an impression of the user experience. While this is the original and traditional meaning, the term is more often used to describe a product with as little details as possible, while still being useful for a potential user

- a solution with the key necessities. MVPs are utilized in UX to obtain feedback at the earliest stage of implementation possible, to help improve future iterations. For each iteration data is collected and something is learned about the current features, if users does not like something it is easy to discard it early. Those features that are described as valuable to customer are developed further for the next iteration. For each iteration a new MVP is developed that satisfy the new feature needs that users has described [49, 50, 51].

4 First Iteration - LoFi

Before creating an initial visualization it needs to be understood how CO360 works. In this chapter the CO360 product is investigated through interviews and analysis. By tracking different keywords during the interviews it is easier to showcase the main points of each interview. The CO360 product is later in the chapter defined and an overview is created to get a better picture of CO360. With a clear picture of CO360 the problem can be defined. The chapter also explores various visualization needs for CO360, which help in problem identification. Once the problem is well-defined, idea generation becomes easier. By identifying goals and needs, it becomes possible to generate ideas that align with these objectives. Based on the ideas generated, two low-fidelity prototypes were created. Finally, the chapter presents the feedback received from the CO360 team regarding the prototypes.

4.1 Gathering Data

4.1.1 Understanding CO360

Before any investigation into the problems or solutions could start, there was a need to understand the CO360 concept in depth. By having no prior knowledge of the CO360 concept it would be very difficult to come up with any concrete interview questions beforehand to ask the CO360 team. Therefore informal open-ended interviews were chosen to start a discussion, have the team lead the way and ask questions that came up along the way. Firstly the team was asked to introduce the IKEA landscape of systems and how CO360 was integrated into this landscape. A total of three individual sessions were booked, one session with a senior engineer from the CO360 team, one with the engineering manager for the CO360 team and one with the product manager for the CO360 team. All of the interviewees were males between 40 and 50 years old. To see the complete list of anonymized interviewees for all the interviews in this thesis, with information such as: gender, age and role, see Appendix C. All of the interviewees will be refered with a letter corresponding to Appendix C. In these first sessions the interviewees A, B and C presented their overview of CO360 independently of each other. These overviews contained different details and different components to each other. When the interviewees were confronted with their conflicting images, the response was that the IKEA landscape and CO360 have a lot of different levels of details which engineers deem more or less important. This lead to having follow up interviews were it was concluded that CO360's sources, middle-ware and output events were the main components. It was important to understand the details within these main components, but not of the systems between them.

The understanding of CO360 was deepened by attending a team day for the CO360 team. The team day was at IKEA and throughout the whole day different sessions

with the team were attended. Each session covered different components of CO360. A lot of focus was put on metrics and also on a need for a visualization for CO360. When discussing the visualization, the team discussed multiple solutions such as overview of the flow, zooming into a single order and what state an order is in.

The following is a summary of all the interviews and the team day sessions: IKEA order information is stored in a variety of ways in different databases. For example, to retrieve an order number, you might need to use different methods for different databases. In database 1 the order number might be retrieved by "order.number", while you have to call "order.orderinformation.ordernumber" to get the same information from database 2. There is a lot of information to gather from each database, and managing these differences is tedious and time consuming. CO360 is designed to simplify this by unifying all these different formats. It translates all order data into a single format, simplifying the process for consumers who only need to comprehend and remember a single structure. The ultimate goal is for CO360 to become the central hub of all order data listening, and for every other team within IKEA to only listen to CO360 when it comes to order information.

4.1.2 Internal team interviews

To create and set up interviews, a structure was needed. This was done by using the five W's and one H. The five W's and H are meant to be an inspiration [52] for the interview questions and not all of them were asked as direct questions, some were weaved into the broader discussion of the interview. The purpose of the five W's and H is to create a good structure and for getting the most information out of a user [52]. The following questions were created:

- What? What is the problem that a visualization could solve?
- Who? Who would the users be?
- Where? Where could this problem occur within IKEA?
- When? When does the problem occur?
- Why? Why is it important that this problem is solved?
- How? How do you currently solve the problem?

These were created by using the examples from the following source [52] and adapting them to the case at IKEA. Based on the The five Ws and one H a trial interview was created. The trial interview addressed first the problem itself with questions such as "What is the problem that needs to be solved?" and "What's the source of the problem?", it then evolved into questions about the users of the CO360 product and lastly it covered questions about the thesis work such as "Is there anything specific we should research?" and also "Are there any constraints (technical, commercial, etc.)?". The complete trial interview schedule can be seen in Appendix A.1 The purpose of the trial interview was to ensure that the questions were easily understood and that the

answers provided will deliver the appropriate type of information. The trial interviewee (D) was a male 30 year old junior engineer.

Based on the trial interview it was concluded that the structure of the interview was good. It also become clear that there were multiple problems and that an additional question to prioritize these problems was needed. The trial subject also suggested that more direct questions should be used in the real interview to gather more specific data. This lead to a new interview schedule and the question "Prioritize the different problems you have brought up" was also added and can be seen in Appendix A.2

After the trial interview, four semi structured interviews were conducted. The interviewees were two senior software (B and E) engineer, one engineering manager (A) and one product manager (C). These were all males in their 40s and 50s. Since the product that is being developed involves many different stakeholders it was important that the users selected for the initial interviews also had different roles. After analyzing the interview a follow-up interview was created. The follow-up interview was much more narrow and focused on gatherings details for the problems that were found in the first interview. The completed interview schedule that can be seen in Appendix A.3

4.2 Describing CO360

If an IKEA team needs data on customer orders, they currently usually have to fetch it from multiple databases. They receive a ton of unnecessary information they need to sort through in order to retrieve the specific information they are interested in. In the IKEA landscape there are three main databases that contain the most important customer order data - 'Selling, 'Fulfillment' and 'Returns' (these databases are called something else, but the names have been censored). When a customer buys an IKEA product, either online or in an actual store, the order will be placed in the database called 'Selling'. All of the order information such as article numbers, customer information etc. is saved into the database to ensure a smooth transaction. The 'Fulfillment' database takes care of all deliveries and all the information associated with them. It tracks all the bought items and notifies when something is delivered to a customer. If a customer were to make a return of any of the bought items then the database called 'Returns' will handle and manage all data involved in the return.

All of these databases provide documentation necessary for many teams within IKEA. The databases produce data in different ways, have different code schemas and are expected to be used in different ways. Code schemas describe the structure of for example JSON data and is an informative document for developers to know how data should be processed and used [53].

CO360 effectively manages all the logical work concerning the databases and produces unified events in the form of so called 'data events' and 'business events' for other teams within IKEA to listen to. CO360 has a unified code schema, meaning that data will always be handled in one way only. This makes it much easier to con-

sume the data for other teams.

An advantage of CO360 is that it shields consumers from the other sources. Currently, if a system such as 'Selling' would be replaced by another system, then all consumers of 'Selling' would have to rebuild their logic around the new system. But if the consumer uses CO360 they would not notice any difference since CO360 is the one handling all the logic and will continue to produce the same events.

CO360 has three main components: 'On Hold', 'Anomaly Detection' and 'Processing'. 'On Hold' uses a mechanism that pauses the flow of data inside of CO360, it puts it "on hold". Orders must have data originating from the 'Selling' database, otherwise they remain on hold. For instance, if data of a certain order is coming from 'Fulfillment', but no data of that order has yet come from 'Selling' the system will wait for the data from 'Selling'. When the main data from 'Selling' is received the other data can be sent through the rest of the CO360 pipeline. There are cases where CO360 receives multiple data updates on the same customer order, where a later update (number 2) reaches CO360 before a sooner update (number 1). The sooner update will in this case be discarded. This is because the later update (number 2) contains all the information from the previous one (number 1). Hence, only the most recent data is preserved for further processing, and the consumer will not get the same information twice.

CO360 looks for anomalies in the data it consumes. An anomaly could be that tax information is missing, or that there is some sort of item mismatch between different data on the same order. The events that contain anomalies are tagged, and the anomaly is described in the payload. This is the process called 'Anomaly Detection'

The processing in CO360 converts events from all sources and as previously mentioned unifies them to either data events or business events. Data events contain the full information of an order and business events contain specific information of the order. An example of a business event is the order information of when an order has been fully paid. Data and business events are published to consumers through Pub/Sub. By utilising the benefits of Pub/Sub, a consumer can subscribe to tailored specific business events from CO360. Thus a consumer only receives exactly the data it wants and avoids unnecessary data. The overall overview of CO360 integrated into the IKEA landscape can be seen in figure 4.1.

4.2.1 Defining the Problem

Some conclusions could be drawn based on the insights gained from the interviews. All of the interviewees mentioned three types of needs for a visualization of CO360:

- increase understanding when presenting CO360 to future consumers / selling CO360
- technical visualization for the internal team
- external team self-service tool for effective troubleshooting

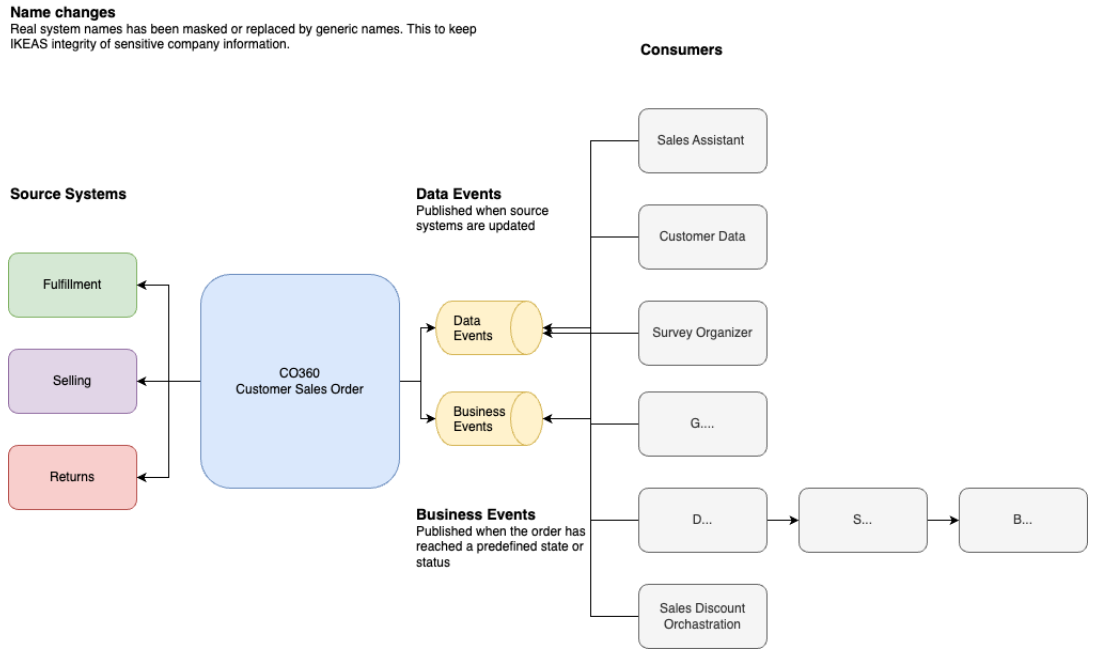


Figure 4.1: Overview of CO360 in the IKEA landscape - specific sources and consumers are censored or renamed

The first need refers to a visualization that would show future consumers the value of CO360 and what solutions it provides for its users - a visualization that would help "sell" CO360 to the other teams. If consumers understand why CO360 is better than their current solution, then the chance increases that they will transition to the CO360 product. A technical visualisation comes from the need of helping the internal team with their work as developers. The visualisation would help the team to discover and handle errors in the CO360 pipeline and monitor the whole process. The last need comes from the interviewees describing that the CO360 team spend a lot of time helping other teams understand where different errors have occurred within the system. This is time wasted that could be spent on development. There is therefore a need for a self-service tool that external teams can use to troubleshoot errors and find the source by themselves. The internal team could also use this self-service tool to help with their own trouble shooting.

To get an even further understanding of the interviews the most commonly used words were found and marked as *keywords*. Frequency of the key words used were measured and thereafter visualized in figure 4.2. A word cloud was also used to get a deeper understanding of what the main needs were from the interviews. This will help generate ideas and solutions will easier be found to the given problems. The word cloud can be seen in figure 4.3. What can be seen from both word visualizations is that the four main key words are: order-flow, selling, helicopter-view and individual orders. The users mention that there are needs of an order-flow to see a real-time flow of the system and a constant overview of what is going on. When discussing selling the users emphasize on the importance to sell the CO360 concept to other teams and consumers. Helicopter-view was the most common discussed view. It was important to understand exactly what needs there were within an order-flow and what representation was most needed. An order-flow can both be shown from a helicopter perspective and from a

closer more detailed way with for example information about where a single order is in the order-flow and therefore it was important to understand the bigger need. The individual order need was also very high and therefore it was concluded that both a helicopter view and an individual order view were important.

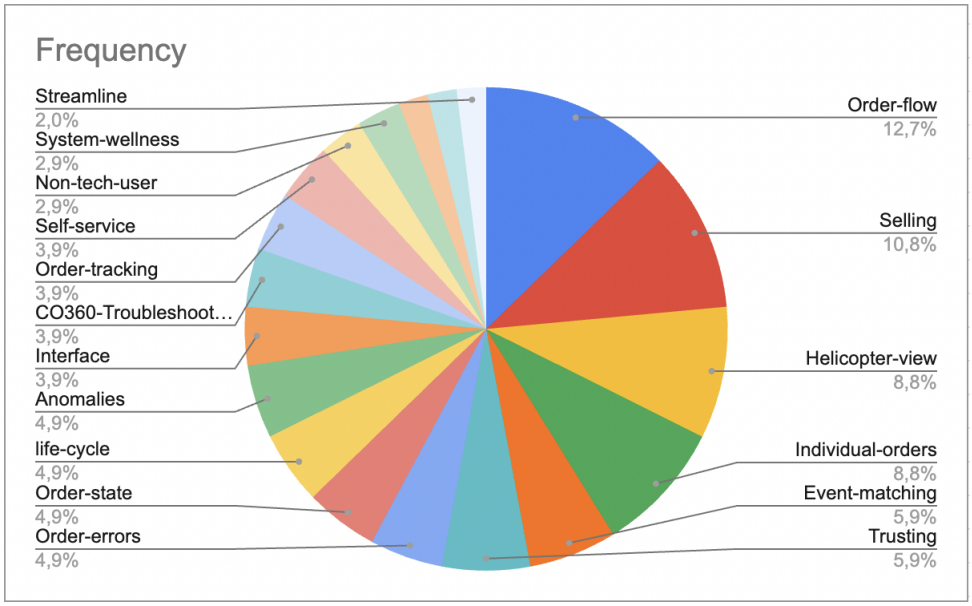


Figure 4.2: Frequency of keywords, interview 1

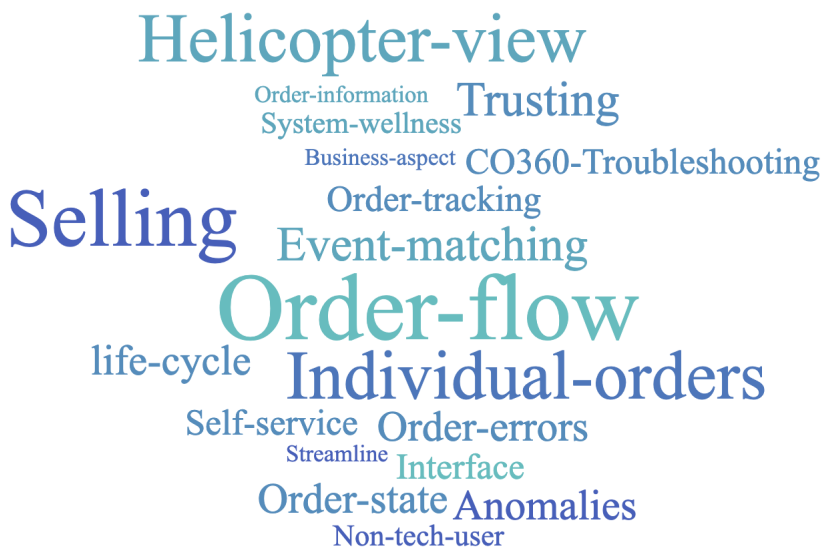


Figure 4.3: Word cloud, interview 1

Since it was known from the trial interview that there was potential for the interviewees to bring up more than one need for a visualization, it was asked to the interviewees to prioritize which need was most important. Every interviewee said that ”selling CO360” was the number one need. This was therefore the problem focused on from

this stage. This also aligns with the word cloud, where it is evident that selling was mentioned a lot during the interviews.

4.3 Generating ideas

Even if the word cloud is just a sign of direction and not the objective truth it was important to satisfy it as much as possible since it covered the main points of the user interviews. Order-flow was the first keyword to be chosen to be a part of a potential solution. This was because an order-flow can be used in a helicopter view, individual-order view and in selling. It remained to conclude if individual-order views can be combined with an order-flow view or if a choice between them had to be done. By going through all the interviews in depth it could be conclude that the helicopter view had a higher weight and importance when mentioned. An example of this is when the engineering manager said: "A helicopter view will give the most value, it will help me to have demos and explain what CO360 view does and it gives a better overview" in contrast to "the best thing would be if we could handle two different perspective, in other words the life cycle of a single order and the life cycle of multiple orders". Individual orders were mentioned a lot but often in a discussion and it was less clear that it was the best solution, just a solution. The helicopter view arguments were more direct and often mentioned in combination with "the best solution". Although they were both mentioned an equal amount of times, the importance of a helicopter view had higher weight. The final conclusion was that the solution should involve an order-flow from a selling point and showing it from a helicopter view.

To have a more structured idea generating the goals and needs were defined.

Goals:

- Sell the CO360 concept.
- Show an order overview (helicopter view).
- Visualize the order flow.

Needs:

- A way to present CO360 and have demos.
- Showing the benefits and values of CO360.
  - Show that sources are abstracted.
  - Display that consumers handles less data with CO360.
  - Show that consumers are shielded from errors in the sources.
- A way of showing how events are handled in CO360.
  - Show how events with anomalies are handled.

  - Display which events are discarded and which are not.

- Visualize the order flow.

Brainstorming was used to discover the needed services/solutions for the prototype and they were based on the goals and needs. This was done in a group of two consisting of both thesis workers. The aim was to produce multiple solutions that later could be evaluated. The structure of the brainstorming session revolved around the goals and needs. Meaning that each need and goal were dug into thoroughly before moving to the next need or goal. All of the ideas from the brainstorming session were written down onto a piece of paper, both individually and in a group of two. When the group encountered a significant decrease in their idea generation a pause was taken. This due to the fact that taking breaks can enhance the number of ideas generated afterwards. The following ideas were generated:

- Three sources become one
- Metrics from GCP
- Messy events on the left becomes unified on the right
- Shielding middle layer
- On hold, anomalies and discarded process
- Order flow from the left to the right
- List of business events
- Animated flow
- Future landscape
- Single consumer view
- Metrics for a single order
- Log in page

The next step was to take all these quantitative ideas, evaluate them and categorize them. The categorization was based on their significance, depending on whether they are considered essential, desirable or unnecessary.

The result can be found in figure 4.4.

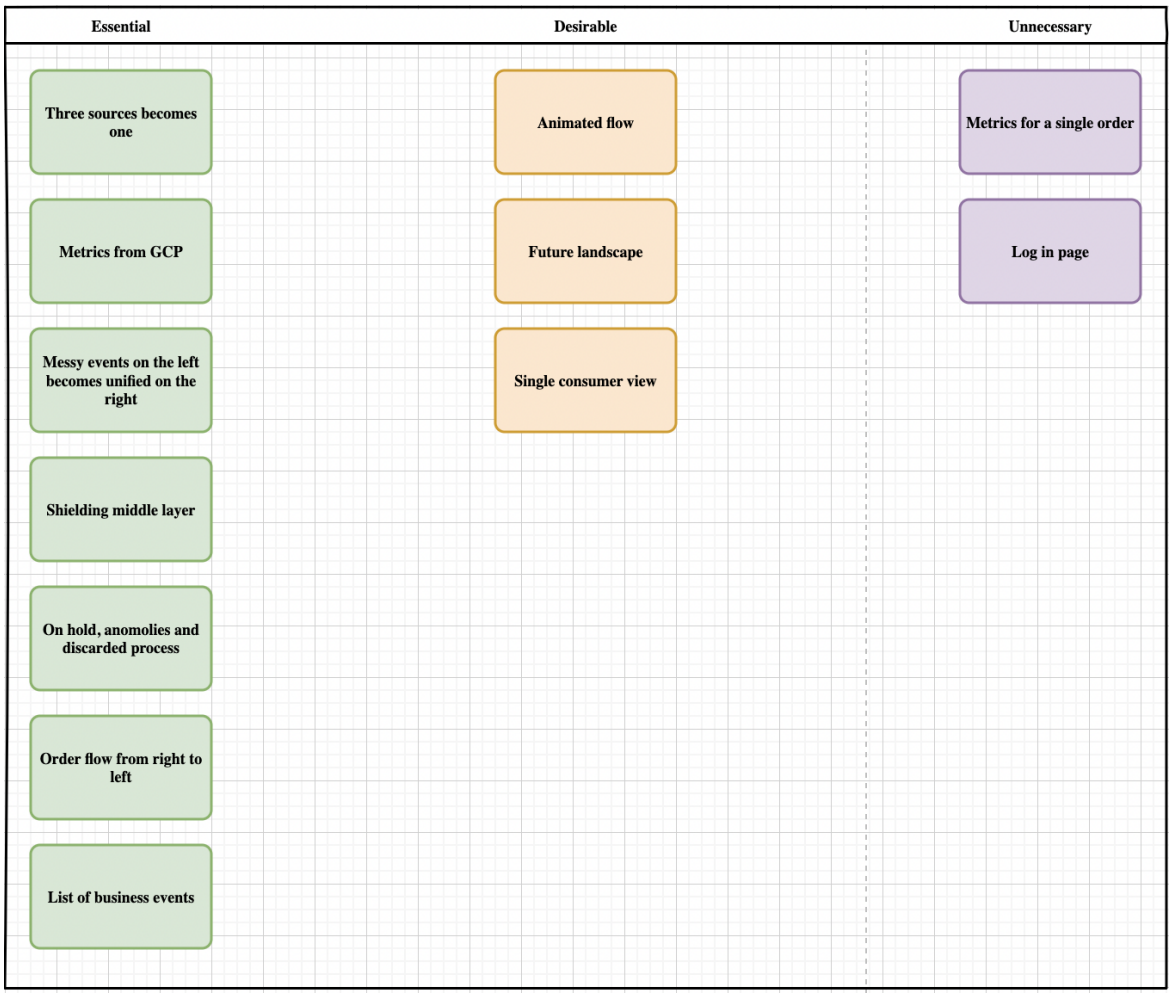


Figure 4.4: Significance Categorization, iteration 1

4.4 Prototyping

To satisfy the identified solutions two different different Lo-Fi prototypes were developed. One version was delivered with more details and a lot going on and another version that was more clean but had less details. These were delivered to the internal team. The first Lo-Fi can be seen in figure 4.5 and the second Lo-Fi can be seen in figure 4.6 and 4.7.

Both prototypes focus on showing the order view from a helicopter perspective. The idea is to show the whole flow with different sub-parts of the flow that are clickable and should make it easier for presenting the CO360 concept. The flow starts from the left with the three different databases, 'Selling', 'Fulfillment' and 'Returns'. These sources are abstracted into the CO360 process and it can be seen that there is only one output source on the right side of CO360. By showing that the input of three different colors/ shapes arrives from the left and then outputs on the right as unified events, will show the consumers that they will handle data with less complexity. The protecting middle layer is displayed as CO360 in the middle with clear shielding boarders.

The first version has a detailed view of how CO360 handles all the events and how they

are processed. There is also a second version with less details. It will be examined in the evaluation which level of details is needed to satisfy the needs and goals of the project. The second version shows that events can be discarded but not the process and anomaly detection. The idea with the second version was that what happened within CO360 was of less importance, and that the focus should be on what the consumer gets from CO360.

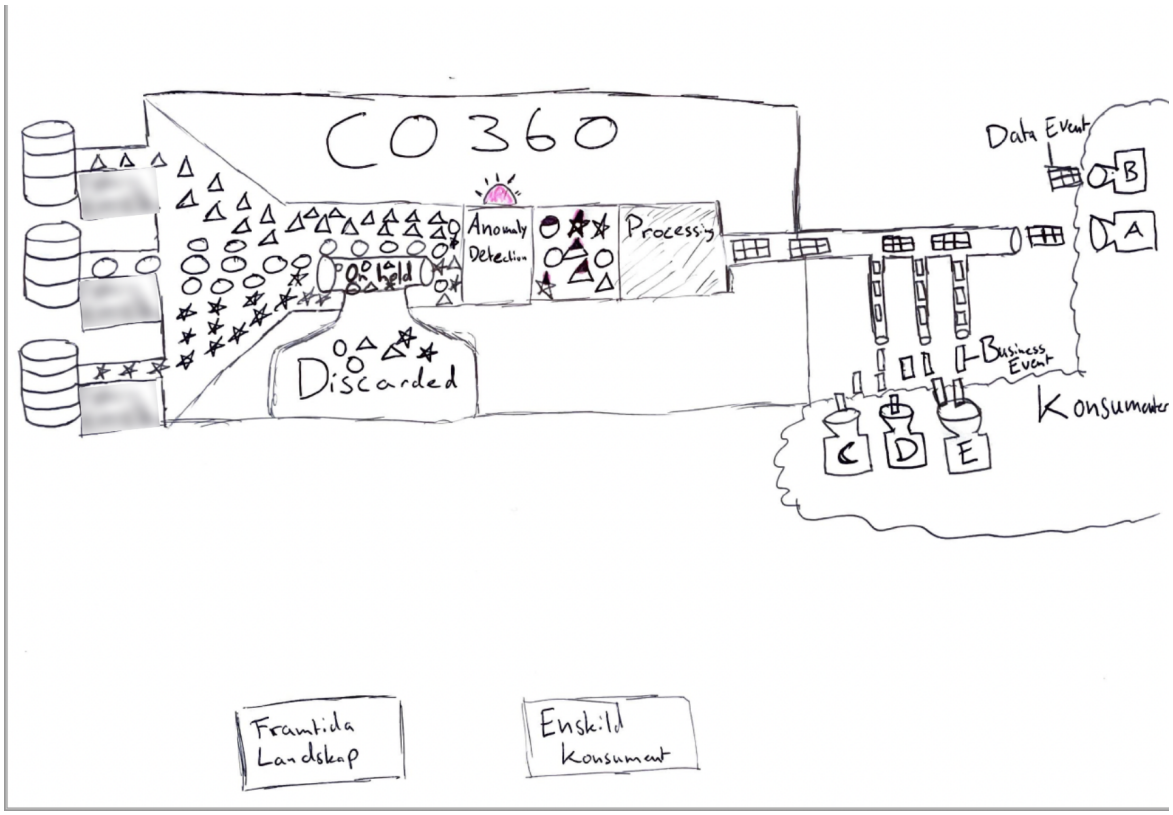


Figure 4.5: Lo-Fi prototype I. The names of the databases are censored.

4.5 Main Selling Points and Feedback

The prototypes were presented to and evaluated by three members of the CO360 team, same engineering manager as before (A) and two interviewees D, and F. Interviewee D is the same junior engineer from the trial interview and interviewee D is a new male senior engineer in his 50s. They were interviewed in a focus group session to encourage discussion. Since the design process was still in the early stages, there was still much to learn, and the hope was that discussions would lead to a deeper understanding of CO360. A group discussion could bring up things that would not occur in single interviews, since there can be things the interviewers do not know to ask for. It also helps with knowing if there is a consensus in the team on everything that is brought up. In individual interviews there is a risk that a topic only occurs in one interview, and the others' opinions on it are not present. A group discussion of course has the potential negative side of peer pressure. The CO360 team is used to having meetings and discussions with each other where they need to make their opinions heard, which minimizes this risk. As the design process is once again in a Discover phase, there

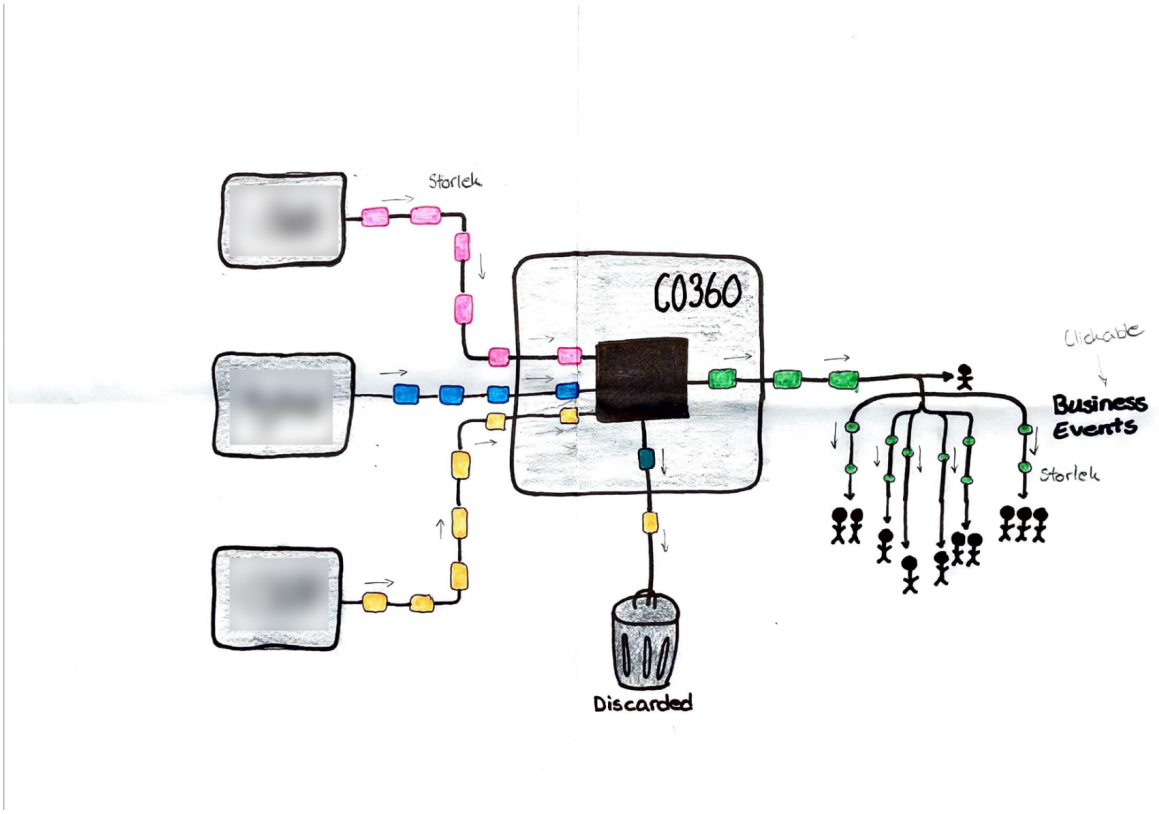


Figure 4.6: Lo-Fi prototype II, view 1. The names of the databases are censored.

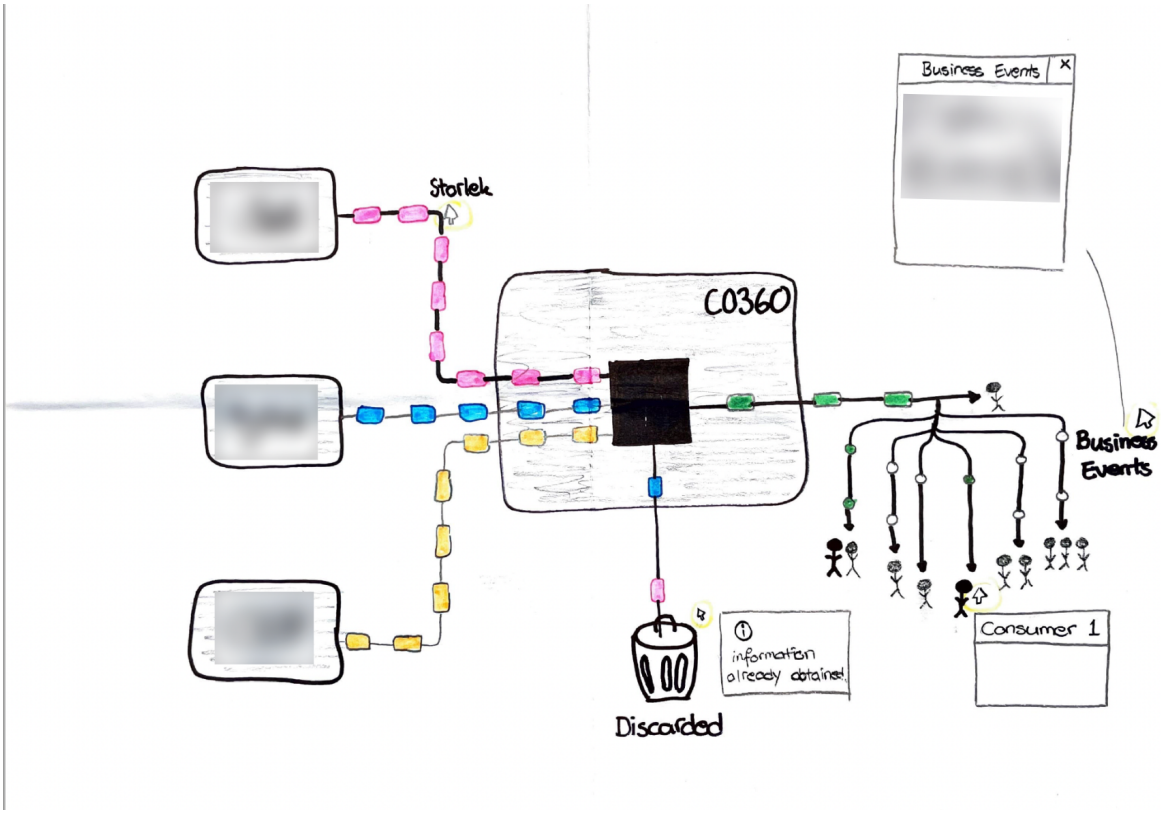


Figure 4.7: Lo-Fi prototype II, view 2. The names of the databases and business events are censored.

was an openness to gain a deeper understanding of the problem, and be prepared to rethink the solutions put forward.

4.5.1 Focus Group Session

The discussion started with some questions regarding the narrowed scope of selling CO360 to other teams. These were asked prior to presenting the prototypes, since exposure to the prototypes could potentially influence their responses. With a narrowed-down scope, the questions posed in this iteration of Discover were more specific than before. The following were the questions asked:

-From a selling perspective, what key aspects of CO360 should be conveyed to potential consumers?

-In order to ensure that consumers fully comprehend the value of the product, which specific components of CO360 should be highlighted?

The importance of business events being tailored and solely containing necessary information for the consumers was emphasised by the team. They said business events can be seen as "events handed to consumers on a silver platter". The shielding offered by CO360 was also recognized as significant - to show the consumers they do not have to be concerned about any alterations to databases or logistics. The team also emphasized the importance of CO360 doing a lot of the work that the consumers would otherwise have to handle independently, while also enriching the data. This is of importance as it enables consumers to focus on their main task rather than concerning themselves with the intricacies of retrieving accurate data. CO360 takes the same problems different teams have, and provides a centralized platform for their resolution. The core essence of CO360 was summarized in the word 'simplification' - listening to CO360 would simplify the work the consumers are currently doing.

The main individual components within CO360 mentioned by the team were anomaly detection, and discarded events, since this reduces work for consumers.

4.5.2 Feedback on First Prototypes

After the questions had been answered, the prototypes were demonstrated. Since the prototypes were Lo-Fi, explanations of them were presented alongside the prototypes. This included what animations were meant to be in the implementation, what would happen with the clickable objects and clarifying why some decisions were made, such as the different colours and shapes.

After the presentation, the feedback and discussion began. The team members expressed that the main understanding of what CO360 does was shown in the prototypes, mainly prototype I, that can bee seen in figure 4.5. Having the elements of 'Discarded', 'Anomaly Detection' and 'Processing' were deemed important as it shows the shielding CO360 does for its consumers. The choice of different colours, instead of

different shapes, for the events from the databases was opted to give a "cleaner" look, and should therefore be the choice to move forward with. A list of all business events was regarded as a good idea for consumers to see what options are available to them.

A change that should be considered was changing the databases names to more general ones, such as "Selling" instead of their actual names. This would not only make the design last longer in case there would be changes to the databases, but the names are also irrelevant for consumers of CO360. They will be relieved from managing these databases, and therefore do not need to know exactly which ones they are. This is part of the shielding CO360 provides its consumers.

Additional changes were discussed. The 'On Hold' function CO360 offers should be added in the prototype, since it is also an important part of the shielding CO360 offers. The 'discarded' had too much focus in prototype II - while it is important, it is not the main function CO360 has, which prototype II seems to imply. It is also important to make clear that no data is lost due to CO360, which might be misinterpreted with the 'Discard' component. The size of the data was not deemed relevant, since bites are generally not talked about as much as it used to in the tech field. Events per second was suggested as an alternative to show how much data CO360 handles. The team also wanted more real-time data that would show what CO360 is doing right now.

Two clarifications of CO360 were made. Firstly, business events are currently derived from data events, but this will not be true in the future. These prototypes will therefore have an expiry date. It would perhaps be better to have them completely separated. The making of data events and business events happen *within* CO360. The prototypes make it seem as though this is not the case. Secondly, the main purpose of anomaly detection is not to show the consumers that something is wrong and alarm them. It is rather to give feedback to the systems where the anomaly showed up, and show consumers that the anomaly has already been detected and reported, relieving them from the need to take that action. The alarm light in prototype I is interpreted as something negative and might alarm consumers who see the visualization.

4.5.3 Summarizing the Focus Group Session and Feedback

A summary of what was deemed most important was conducted by going through the group interview/discussion regarding the prototypes, and listing the points that were emphasized by the team members. The main takeaways were compiled in a bullet point list:

- There was too little detail presented in prototype II. More details are needed for consumer to understand the power of CO360.
- Prototype II was too messy
- Shielding is one of the most important features CO360 offers. Incorperating elements 'On Hold', 'Anomaly Detection', 'Processing' and 'Discarded' would emphasize this.

- Another important aspect is the tasks CO360 does, that the consumers would otherwise have to do themselves.
- CO360 reduces the complexity of events, and simplifies for the consumers.
- Prioritize the main ideas of CO360 being visualized, instead of what it looks like *right now*. This includes changing to more general names for databases, and changing the layout of business events in regard to data events.
- Be clear that discarded events do not mean any data is lost.

5 Second Iteration - MidFi

After creating and evaluating the first prototype it was time to look to new improved solutions to visualize CO360. This chapter depicts the process of designing a second Mid-Fi prototype, as well as deciding on the next step in the design process. First, a mind map was put forward based on the takeaways from the first iteration, focusing on the feedback on the previous prototypes as well as the interviews based on the narrowed scope. From there, the prototype was created. Three IKEA employees evaluated the prototype, and after primarily good feedback and thorough discussion it was decided that the next step would be to create an MVP.

5.1 Second Prototype

Taking the conclusions made in the first iteration into consideration, potential components for the second prototype were brainstormed and a mind map was created. This is shown in figure 5.1.

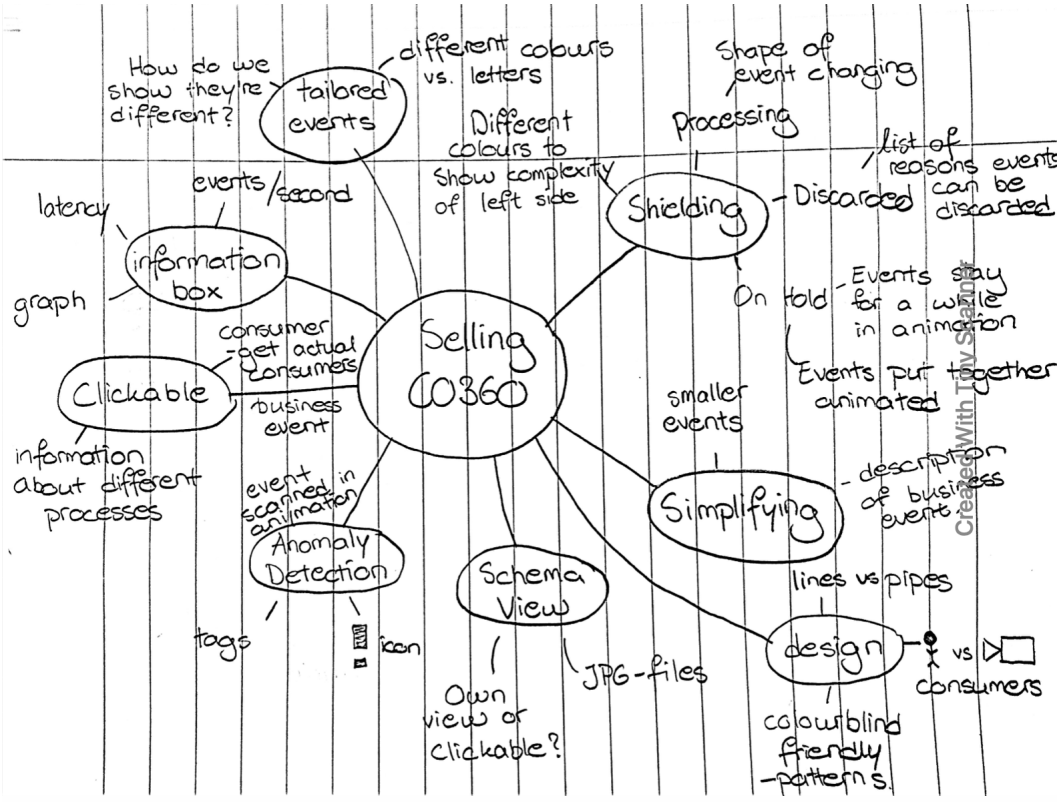


Figure 5.1: Mind map of potential components included in second prototype

The different solutions were analyzed and discussed. The prototype that was delivered is shown in figures 5.2, 5.3 and 5.4. Figure 5.4 shows the hoverable and clickable ele-

ments. The interactive components are shown, but the user is not able to actively click or hover on anything. This prototype should therfore be considered a Mid-Fi prototype, somewhere inbetween Lo-Fi and Hi-Fi.

It was concluded that 'On Hold', 'Anomaly Detection' and 'Processing' needed to be part of the CO360 chain to show consumers the most important functions CO360 offers. The intention was first to show animations of the different processes the events go through, but once the prototyping started, it was considered too time consuming to be favorable. Hence, only the names of the processes were included, and the visual changes to the events happen "behind" them.

The Business Events and Data Events are shown coming out of CO360 as two separate pipelines instead of Business Events being derived from Data Events. While this is not completely accurate, it conveys the point of business events and data events being different from each other, and both being produced by CO360. This visualization will be more fitting over a longer period of time.

Database icons and user icons were used for visualizing the databases and consumers, as these are generally well-known and makes it easier for viewers to understand what these components represent in reality. Additionally to using different colours for the events from the different databases, different patterns were added to accommodate colour blindness.

An information box with 'Latency CO360', 'Events in / second' and 'Events out / second' was added to give an overview of how much data CO360 handles, as well as showing consumers CO360 handles a large number of events.

The 'Selling' events are bigger than the events from 'Fulfillment' and 'Returns' to show that the 'Selling' events are the main component of any order - data from the 'Returns' database will not go through CO360 if it does not have accompanying 'Selling' data.

To clarify that no data is lost 'Discarded' was changed to 'Information already received'. Anomalies are visualized with a tag icon to not *alarm* viewers when they see the anomalies, but rather imply that it is simply extra information about the event being added. Other options were considered, such as an exclamation point, or info icons, but a tag was deemed most neutral.

5.1.1 Evaluating

The second prototype was presented to two male engineers around 40 years old, interviewees G and H, from the CO360 team, accompanied by a male manager which also was around 40 years old from one of IKEA's front-end teams (I). They had no prior knowledge of the thesis work in detail. The received feedback acknowledged there was a strong conceptual foundation for presenting CO360, while also noting that there might be adjustments in specific details once the implementation began. They noted challenges associated with obtaining real-time data, and suggested a 5-10 minute delay should be considered to simplify the retrieving of this data. The objective of

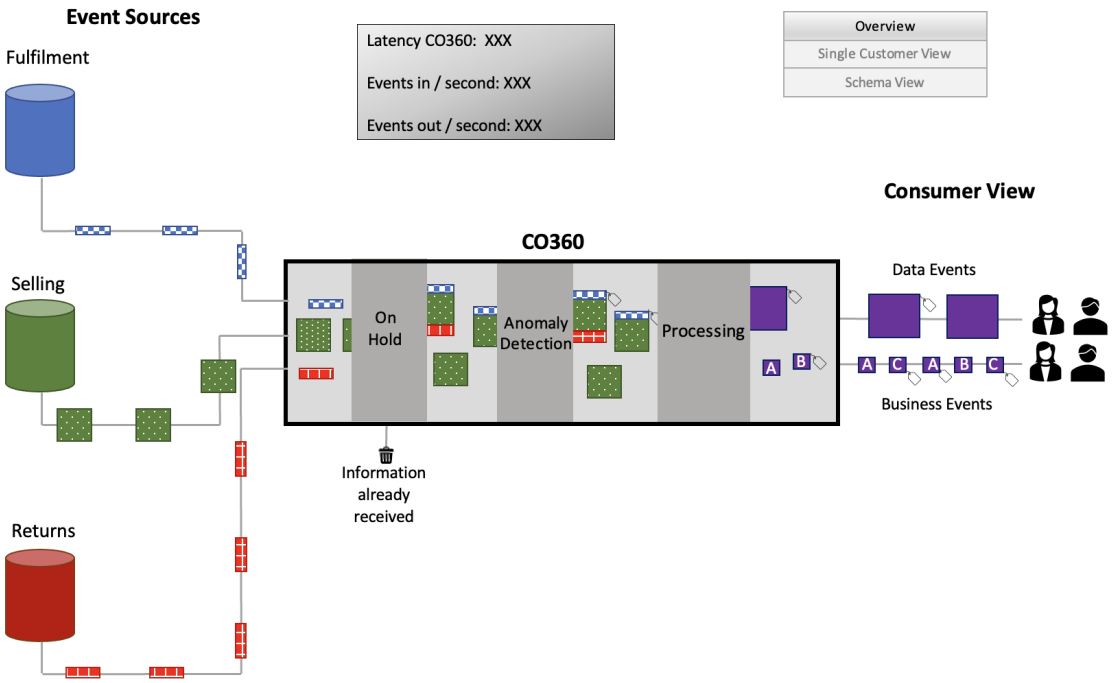


Figure 5.2: Prototype from second iteration - showing the "Overview" menu option.

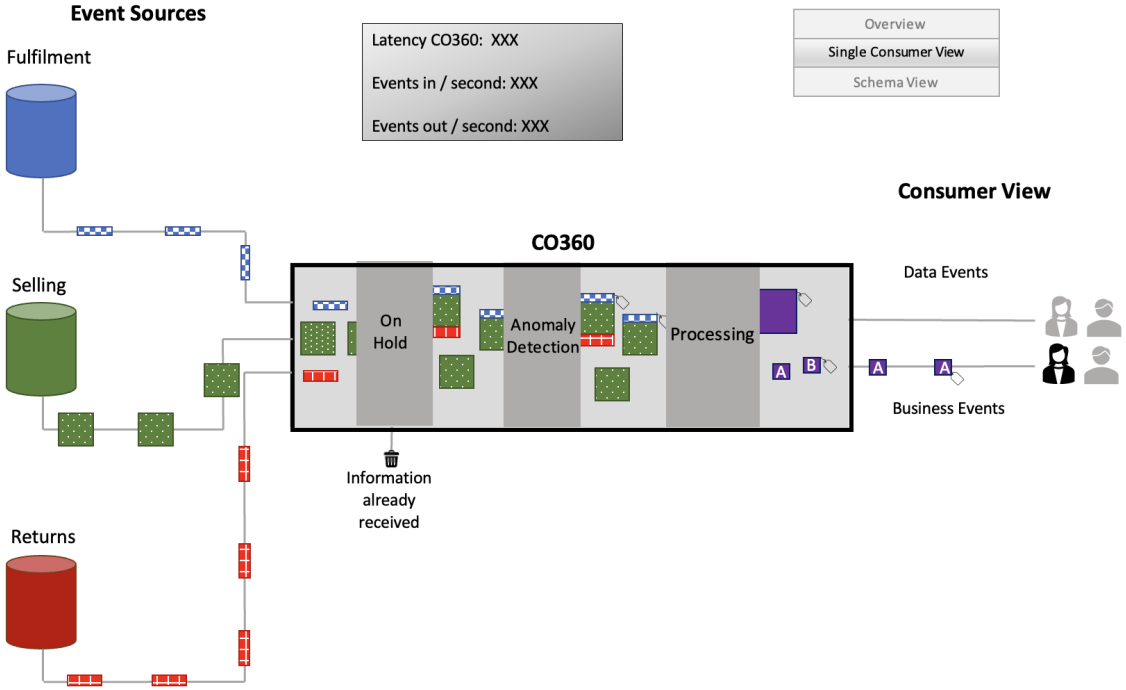


Figure 5.3: Prototype from second iteration - showing the "Single Consumer" menu option.

the visualization is for consumers of CO360 to get a grasp on how much data CO360 processes. They do not need to see what happens at this exact moment. They do however need to understand the difference between data and business events, which

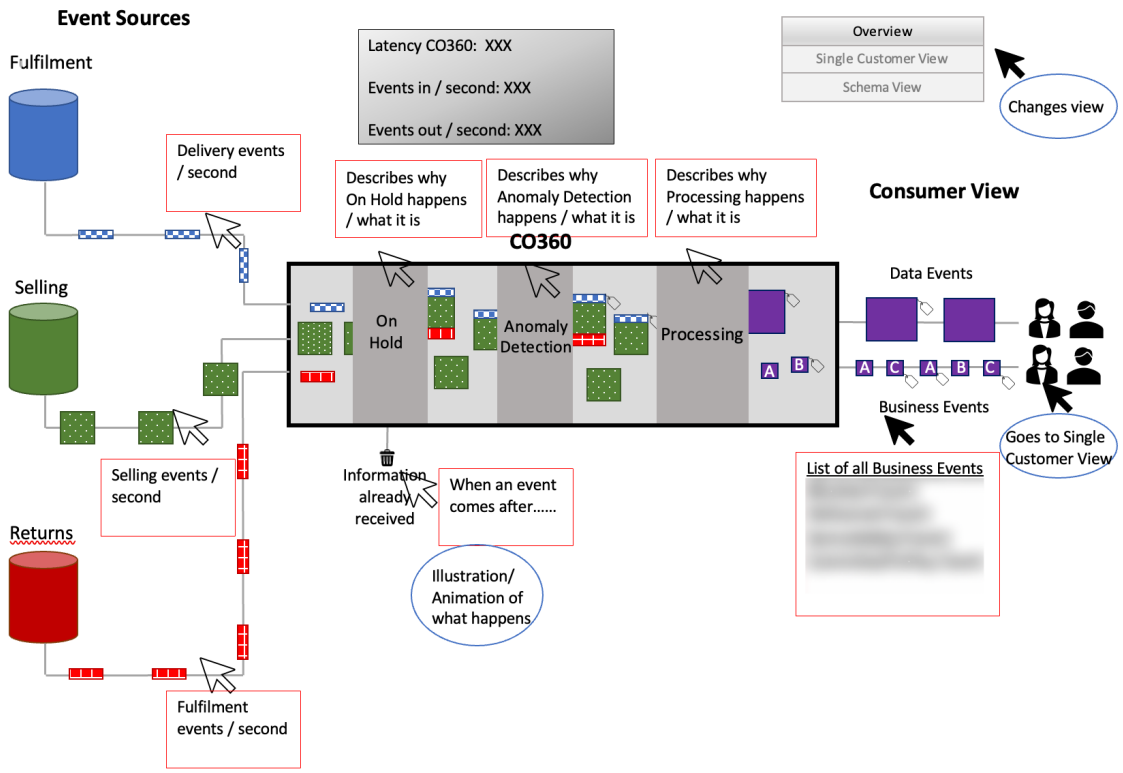


Figure 5.4: Prototype from second iteration - showing which components are clickable and what happens when you click. The black pointers indicate clickable components, while the white pointers show hoverable elements. The business events have been censored.

the team members thought could become clearer.

During the discussion it was mentioned that the planned next step was to create a Hi-Fi prototype. The CO360 team members as well as the front-end manager thought it was a better idea to start implementing this solution, as the main components were considered well-thought out, and a Hi-Fi prototype would take unnecessary time to develop. The front-end manager suggested creating an MVP with the most essential components, evaluate those, and later add more details.

5.2 Takeaways and the Next Step

The feedback on the second prototype was overall positive, and it was clear that the participants thought the solution was satisfactory enough to start implementing it. The option of creating a Hi-Fi prototype was discussed but deemed unnecessary, as the current prototype already described what elements would be hover-able and clickable. Learning a Hi-Fi tool such as Figma [54] would take considerable time, and the team's wishes was for an implementation to begin soon. While a Hi-Fi prototype would give a better look into how the user would interact with the product, starting an implementation was regarded more important due to the time constraint on the thesis.

An MVP was deemed a favorable approach to at least deliver an implementation with the most important components, as well as to receive feedback on the most basic parts of the visualization. Consequently, the objective of the next iteration became the development of an MVP for implementation.

6 Third Iteration - MVP 1

In this chapter an MVP is put forward. This has its basis in the Mid-Fi prototype from the previous chapter. The MVP will be designed, implemented and evaluated throughout the following chapter, starting by prioritizing which parts of the solutions should be included in this first MVP. This is done by prioritizing the components from the prototype using a MoSCoW Analysis and using the results to decide which elements should be included in the MVP. This MVP is then prototyped and implemented before being evaluated by three senior engineers.

6.1 MoSCoW Analysis of Components

It was necessary to determine the most essential elements to the design. This was done with the help of a modified MoSCoW analysis. The components of the design were listed, and then the MoSCoW process began. Since the design team consists of only two people, both persons were given votes of 1, 2, 3, 4, 5, 6 instead of the usual 1, 2, 3. Many of the items got 0 votes. The MoSCoW method was repeated on these elements to establish a ranking within them, but this time with the usual 1, 2, 3 votes for each person. Table 6.1 depicts the results. They are written in declining order based primarily on votes in the first round, and secondary on votes in the second round.

The next step in the MoSCoW process is to separate the items into the four categories. The aim of prioritizing the components was to see which should be added to the first MVP. This was taken into consideration when creating the clusters. The 'Must Have' represents what should be in the first MVP, while the second group suggests what could be added in the iteration after. Of course the feedback on the first MVP would also be taken into consideration before starting the second implementation. The components were divided into the categories as shown in table 6.2. The 'Must Have' elements were the minimum components required for the implementation to still have value and describe the components that should be in the MVP. It is important to remember that the MVP serves as a starting point rather than a representation of the final product's appearance. The business and data events are what the consumers of CO360 will receive, and therefore the most important components they need to understand. The 'Single Consumer View' will represent a potential scenario of their situation if they start using CO360, illustrating a reduction in data load. The databases are of importance since they show the complexity CO360 handles, which their consumers are *shielded* from. Particularly the business events and the shielding CO360 provides were as mentioned earlier brought up as main selling points during discussions and interviews.

Table 6.1: The MoSCoW votes for the different components in the second prototype

Item	Votes Round 1	Votes Round 2
Business Events	11	N/A
List of Business Events	11	N/A
Data Event	7	N/A
Databases	5	N/A
Single Consumer View	5	N/A
Processes within CO360	3	N/A
Information Box	0	6
Descriptions of processes	0	4
Schema View	0	1
Discarded events	0	1
Animations	0	0
Tags	0	0
Hover-able lines	0	0

Table 6.2: The components divided into the MoSCoW categories

Must Have	Should Have	Could Have	Won't Have
Business Events	Processes within CO360	Schema View	
List of Business Events	Information Box	Discarded events	
Data Event	Descriptions of processes	Animations	
Databases		Tags	
Single Consumer View		Hoverable lines	

The 'Won't Have' columns is empty, as all components were deemed valuable to a final product at this stage. The 'Could Have' section contained smaller details such as 'tags' and 'hoverable lines', but also 'animations'. This was because animations are difficult and time consuming to make. Animations are also known to draw the eye of the user to that part, and would perhaps distract from other important elements of the visualization. They were therefore considered of lesser priority than other elements.

6.2 Creating the MVP prototype 1

Once the components of the first MVP were decided with the help of the MoSCoW method, it was time to create the MVP 1 prototype. The latest prototype was reused, but only the components in the 'Must Have' category in table 6.2 were kept. The MVP 1 prototype is shown in figure 6.1

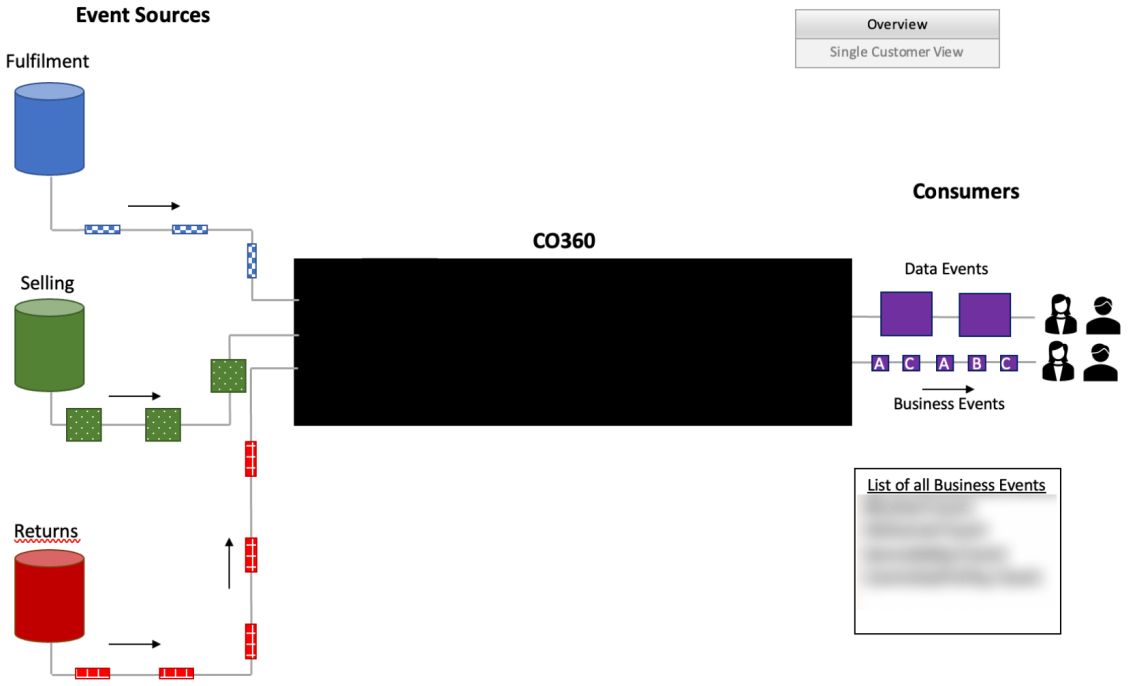


Figure 6.1: MVP 1 prototype. The business events have been censored.

6.3 Implementation of MVP 1

A GitHub repository was established for a smooth collaboration during the implementation process. For the implementation of the MVP, JavaScript, HTML, CSS and Node were used as the key technologies while using the React library. All coding languages were apprehended prior to this thesis, but a thorough repetition was made prior to the implementation phase. Node was the only new environment and required a steeper learning phase.

JavaScript was needed for simple logic such as clicking and switching between "Overview" and "Single Consumer View" but also for more complex logic were the GitHub API was fetched.

CSS was used a lot, mainly for creating blocks, lines and dimensions that could be reused. Since the visualisation required many manually placed objects, it was very important to have pre-determined lengths and dimensions that could be used to place objects all over the screen. This saved a lot of time and laid the foundation for the coming iterations.

React components were created so that they could be reused between multiple views. These components worked as building blocks for the rest of the implementation.

The CO360 team has a list of the current business events in a schema-repo uploaded on their CO360 GitHub repository. These business events and their descriptions were

accessed through the GitHub API. First, the thesis workers were granted access to the CO360 GitHub by IKEA. Then a personal access token [55] was set up in GitHub and was authenticated with octokit [56] to grant the project access to the CO360 data. The project now had access to the business-events JSON file and could display a list of business events in the implementation.

The running implementation can be seen in figure 6.2.

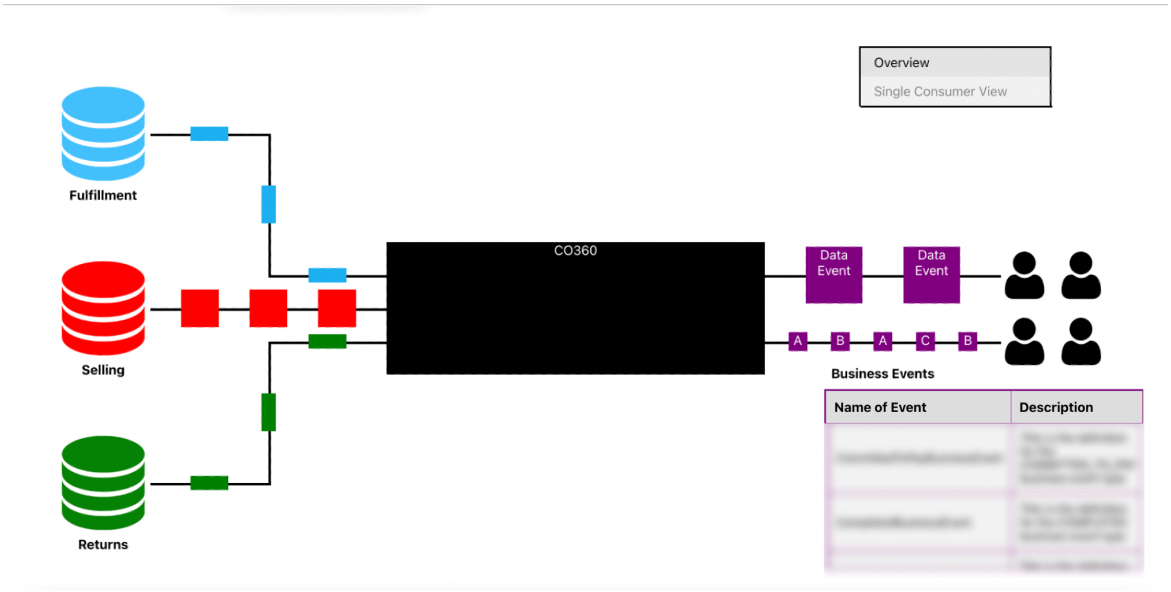


Figure 6.2: MVP 1 implementation - menu option 'Overview' selected. The business events have been censored.

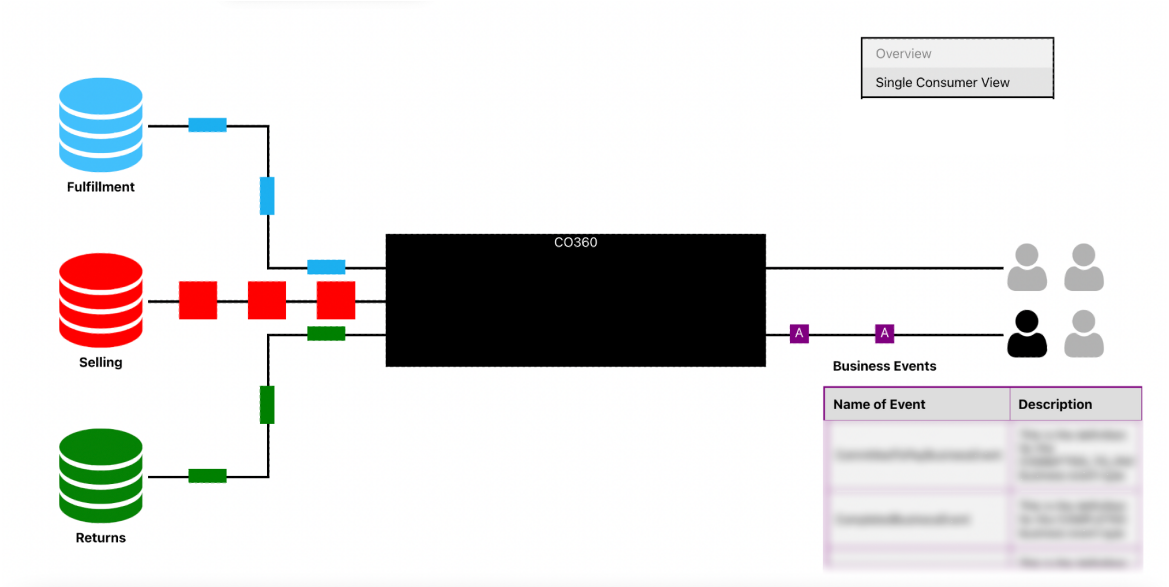


Figure 6.3: MVP implementation - menu option 'Single Consumer View' selected. THe business events have been censored.

6.4 Evaluating MVP 1

An evaluation interview was set up with three senior engineers, interviewees B, J and K, from the CO360 team. All males between the ages of 40 and 50. Two of the senior engineers had never been interviewed before and that would help us get a new perspective and new feedback. One of the interviewees (B) had been interviewed two times in the first iteration but he had not seen any prototypes or MVPs. The interview consisted of questions about what they thought about MVP 1, such as "What do you like about MVP 1?" and "What do you dislike about MVP 1?", then there were question about what they wanted to change overall and more in depth changes such as " Is there anything that you want to change in "Could have" in the MoSCoW prioritization?" and lastly there were questions about how they perceived MVP 1. The full interview schedule can be found in Appendix A.4. The main focus was to evaluate the current MVP (MVP 1) but also focus on the next MVP (MVP 2). The aim of the interviews was to collect enough basis for the MVP 2 solution. It was also discussed how a presentation could be done with the current solution and what is needed for a successful presentation.

The overall feedback was that MVP 1 was a good start but that it lacked enough details to be good enough for a first implementation. The information inside CO360 was considered essential to be able to hold a presentation and this needed to be implemented for the visualization to be presentation ready. One of the senior engineers (J) thought it needed to be more interactive, but the others thought the interaction level was good enough for a presentation and that more details was of a higher priority. During the interviews they also brought up that there are two different types of users: primary and secondary. The primary users are the ones using the visualization as a presentation tool for demos and has a lot of knowledge of CO360. The secondary user are the ones watching the presentation and will receive the presentation as a link afterwards to go back and learn more about CO360.

They liked the switch between 'Overview' and 'Single Consumer View' and pointed out that it was helpful for a presentation. The business event list was also very appreciated, especially that it was being automatically updated through the GitHub API. Unfortunately, during the discussion of the business event list integration, a problem was discovered. The integration of the business event list raised a security concern since the personal access token was used directly in the code to access the GitHub API.

In the discussion the team mentioned that fetching metrics for the 'Information Box' and integrating them in the visualisation would be one of the more time consuming components and therefore it was recommended to not have many other functions when implementing this step.

6.4.1 Summarized analysis of MVP 1

A short analysis was conducted on the interviews by summarizing the most important feedback. The main points were:

- Security concerns needs to be fixed.
- Keep business event list, database sources and menu ('Overview' and 'Single Consumer View').
- More details needed inside of CO360 box.
- Presentations will be done first in person by the CO360 team and then a link to the visualisation will be sent to the consumers afterwards.
- Do not implement too much other functionality in the next iteration if metric fetching is done.

More interaction was not deemed of priority by the majority of interviewees and was therefore not taken up as a main point. With the prior knowledge that selling CO360 is the focus of this visualization there was a need to define how the presentations could be done with the visualisation. It was defined that focus for the first MVPs should be as a tool for the actual presentation. Later MVPs could introduce functionality that is important in a visualisation for consumers who are sent the presentation afterwards. The next iteration should focusing on having the minimum functionality to be used as a tool to have a presentation but does not need to have functionality for post-presentation. There was no need to redo the MoSCoW prioritization since it was in line of what the team thought should be prioritized next.

7 Fourth Iteration - MVP 2

The feedback from the previous iteration allowed an MVP 2 to be developed. During this iteration there was a lot of focus on adding more details, since MVP 1 had very little details. To do that it was important to firstly identify potential solutions. This was done through the help of the previous MoSCoW prioritization. After that, a MVP 2 prototype was delivered. Lastly the prototype was used to implement MVP 2. Both server and security implementations were done, and in the end an implementation with more details was delivered as the MVP 2.

7.1 Potential solutions

More details were concluded to be one of the main priorities. Therefore, from the MoSCoW prioritization the 'Processes within CO360' was chosen to be of the highest priority and to be implemented in MVP 2. This would give the visualization enough details to have a basic presentation. To have a basic presentation it would also be necessary to show at least some metrics and therefore 'Information Box' from the MoSCoW prioritization was chosen to be implemented in MVP 2. Since the 'Information Box' would take a lot of resources to implement and the philosophy of MVP is "a product with minimal implementation, while including enough elements to provide an impression of the user experience", it was decided to not add other functionality. The component 'Descriptions of processes' was not needed for this MVP since it would be more necessary for post-presentation. The design of the business events list would be kept the same but the security concern needed to be fixed. Instead of automatically updating it through a GitHub API, a JSON file was created in the project that the CO360 would need to manually update. The scope of this project was to have a good visualisation and not streamline the work of the CO360. Therefore it was decided that a manual solution was a necessary trade of to be able to keep an appreciated business list component.

The potential solutions concluded were:

1. Processes within CO360

2. Information Box

3. Security fixes

7.2 Creating the MVP prototype 2

A prototype was created for MVP 2 and it now contained an information box that had the following metrics: 'Latency CO360', 'Events in' and 'Events out'. The black CO360 box was now replaced with a more detailed view of CO360 main components 'On Hold', 'Anomaly detection' and 'Processing'. The full prototype can be seen in figure 7.1.

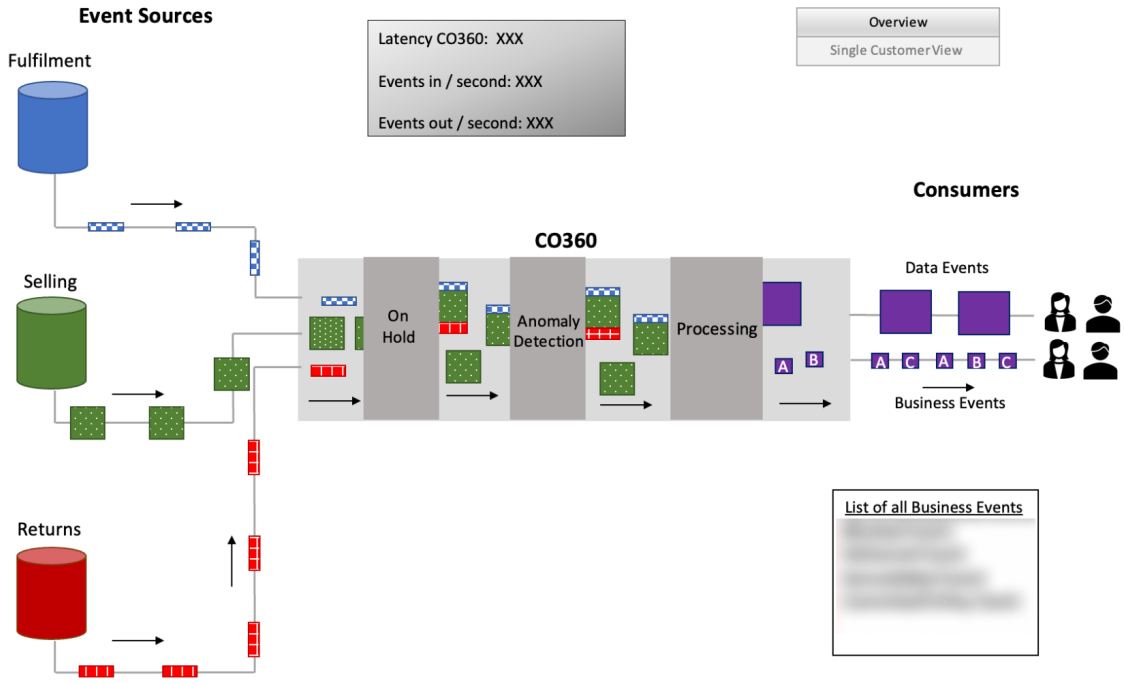


Figure 7.1: Prototype for MVP 2. The business events have been censored.

7.3 Implementation of MVP 2

The processes within CO360 were implemented mainly through CSS where old blocks were reused, and some new blocks were created, adjusting to the previously implemented lengths and dimensions from MVP 1. To fix the security issues the code for the GitHub API and the personal token were removed. It was replaced with a JSON file that requires manual updates. The JSON file is iterated and displayed in the business event list.

Then it was time to create the server that could fetch all the relevant data from GCP and create an API for it. Node and Express were both required for the setup of the API. Before any data could be fetched from GCP, it was necessary to research more about GCP. A quick guide was set up by IKEA and a senior developer was asked to show how GCP worked. The main components of GCP are 'Dashboards' and 'Metrics

Explorer'. 'Dashboards' displays data from different sections of the CO360 pipeline. All of these dashboards can be converted into fetchable metrics. In 'Metrics Explorer' metrics can be accessed directly and fetched. It was difficult to find all the metrics in 'Metrics Explorer', so the recommendation was to first find the relevant data in 'Dashboards' and then convert it to the 'Metric Explorer'. For MVP 2 it was necessary to retrieve latency, and the amount of events going in and out of CO360. In the event processor there was a suitable metric called "latency" that was used to get the total CO360 latency. The following metrics were collected to get the total events in: Fulfillment Acks/s, Selling-Europe Acks/s, Selling-USA Acks/s, Selling-Asia Acks/s and Returns Acks/s. Selling is split into different regions - Europe, US and Asia, three different metrics from 'Selling' therefor needed to be collected. To retrieve the events out the total business and data events through Pub/Sub was collected.

When all the metrics where found in GCP it was time to implement the code to fetch them. An example of how one metric could be fetched through GCP filtering is showed in Figure 7.2. For each fetch (every 10 second), the metric data is retrieved in an interval of 20 minutes and the median of those values are stored. This was to avoid showing any inconsistent spikes and always show reliable values. The important thing for consumers to see is how much data CO360 handles, not the few times deviations are occurring. By fetching every 10 second, the data would be close to real time. The filtering was done for each metric, and an API could be created. A REST API was written in JavaScript using the Express.js framework. Endpoints were created that communicates with GCP Monitoring service to retrieve time-series data for the specific metrics. The API was fetched with JavaScript from one of the React files and could display metrics. The final implementation of MVP 2 can be seen in figure 7.3.

```
app.get('/api/fulfillment-acks', async (req, res) => {
        const request = {
            name: client.projectPath(project_name),
            filter: 'metric.type="pubsub.googleapis.com/subscription/ack_message_count" AND resource.labels.subscription_id="fulfillment-sourceevent-global-ext"',
            interval: interval2,
            view: 'FULL',
        };
```

Figure 7.2: Server code for fetching Fulfillment Acks

The flow of the site when it's running with a server, react application, GCP and the local browser(with possibility to run it through the internet later on) can be seen in figure 7.4.

7.4 Evaluation

Once again, an evaluation discussion was set up. Three members from the CO360 team were present during the discussion, participants A, D and E. They were chosen in the evaluation interview since they had all been interviewed before. Due to time constraints the next iteration was going to be the final iteration, so emphasis was placed on the notion that feedback even on minor details was highly encouraged and valued.

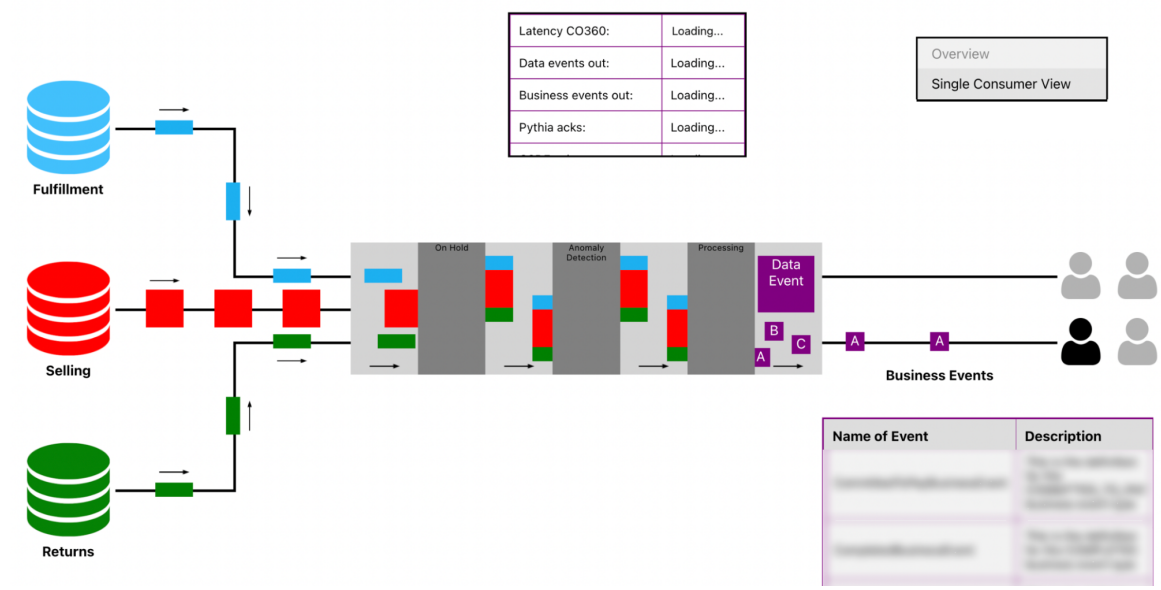


Figure 7.3: Implementation MVP 2. The business events have been censored.

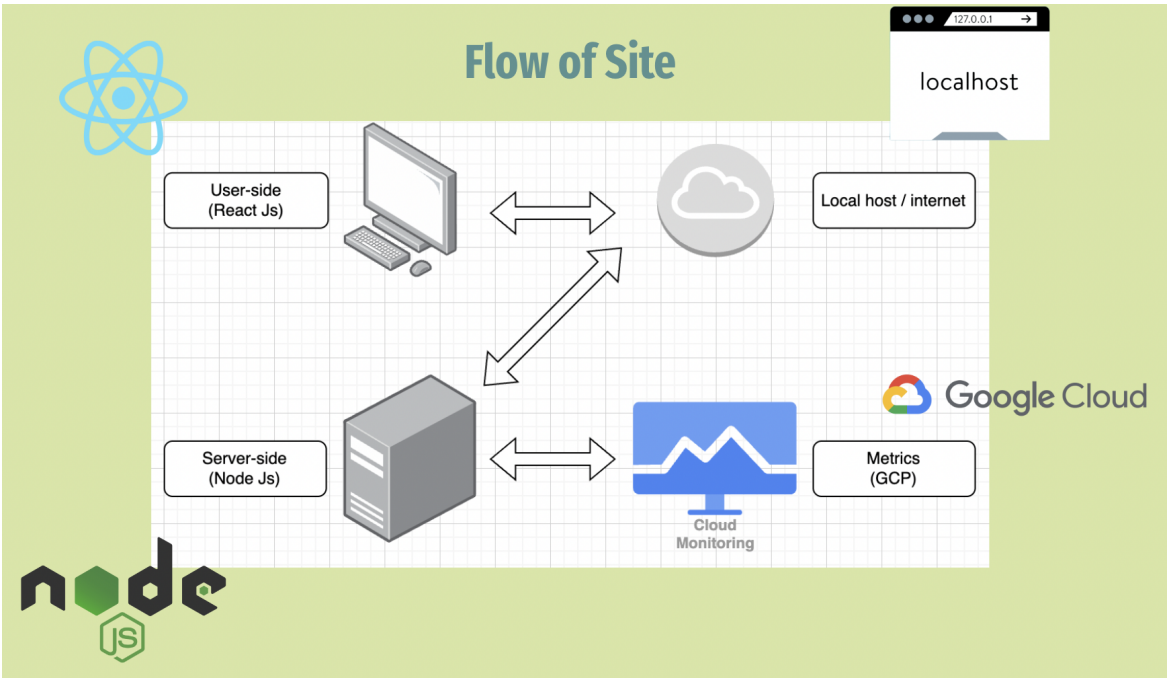


Figure 7.4: Flow of Site

The overall feedback was that the visualization contained all information necessary to hold a presentation of what CO360 was. The flow of CO360 was considered well represented with the different processes and arrows indicating a flow, but an animation would emphasise this even more. The team felt the existing components were insufficient for consumers to effectively re-learn the product if they were directed to the website at a later time. The importance of the description of the processes within CO360 were brought up as a priority during the next implementation. This was in line with what had been discussed previously. Another criticism received was that the website looked ”unprofessional”. While the team had difficulty pointing out exactly what gave this feeling there were some suggestions as to what might be part of the

problem: the colour scheme as well as the placement of the menu, information box and business event list. It was also suggested that the visualization was cluttered with too many components.

The description of processes within CO360 were deemed of the highest priority, but all components in the 'Could Have' category in table 6.2 were believed to be valuable to the implementation if there was time for them.

7.5 Summary

Following the interview, a concise analysis was carried out, resulting in the following key points which should be taken into the final iteration:

- Descriptions of processes within CO360 are of highest priority
- The site needs to look more professional
- The items listed in the 'Could Have' category in table 6.2 should be included if time permits.
- Animations are of least priority

Animations were deemed of last priority due to being time consuming. Since the team considered the flow of the events to be evident without it, the value it would bring would most likely not justify the time investment at such a late stage.

8 Final Iteration - Final Implementation

The following chapter describes the process of designing the final implementation, and then implementing and evaluating it. The main focus of designing and implementing was to find ways to make the visualization look more professional, which included changing the colour scheme and making certain elements appear only when the user wants to. This chapter is also centered around the interactive elements to the visualization, such as the hoverable and clickable components that are implemented.

8.1 Creating MVP prototype 3

Extensive research and deliberation were undertaken on how to enhance the professional appearance of the website. It is recommended to adhere to a limited color palette [57, 58]. While this would add to the visualization looking more professional, the different colour serve a purpose: to differentiate between the different sources and events. This was deemed more important as the main purpose of the website is to create a clear understanding of what CO360 does, which includes the data it handles. Except for this, colors are recommended to be more muted. The current colours on the visualization are very bright, which does not look as sophisticated [58]. Different colour schemes with more muted colours were considered, before landing on the ones shown in the final prototype in figure 8.1 8.2. Since consistency is also important for a good user experience [58], these colours were also used for the implementation of 'Schema View'. By having the same color for the fulfillment schema box and the fulfillment database, it makes it easier for the user to know that they are the same source even if the view has changed. Large websites, such as Facebook, LinkedIn, etc, were looked at to see commonalities. Two differences found to the CO360 visualization was that most websites have a header on top of the page where the menu options are available, and most components have rounded edges. These were therefore considered to be changed in the CO360 visualization.

To make the visualization look less cluttered, some component could be removed from the default mode, and only be shown if the user chooses to do so. The business event list was most reasonable, since the other components are important for the full overview of CO360, while the specified events are more important *after* the full concept of CO360 has been understood.

A final prototype was delivered, shown in figure 8.1 and 8.2. The main new components are the header with the menu options, and the new color scheme. To give the visualization a more professional and cohesive look, more muted colours were chosen, and the components were given rounded corners to imitate the larger websites dis-

cussed earlier. The other main implementations for this iteration were to make object hover- and clickable to show more information, as shown in figure 5.4.

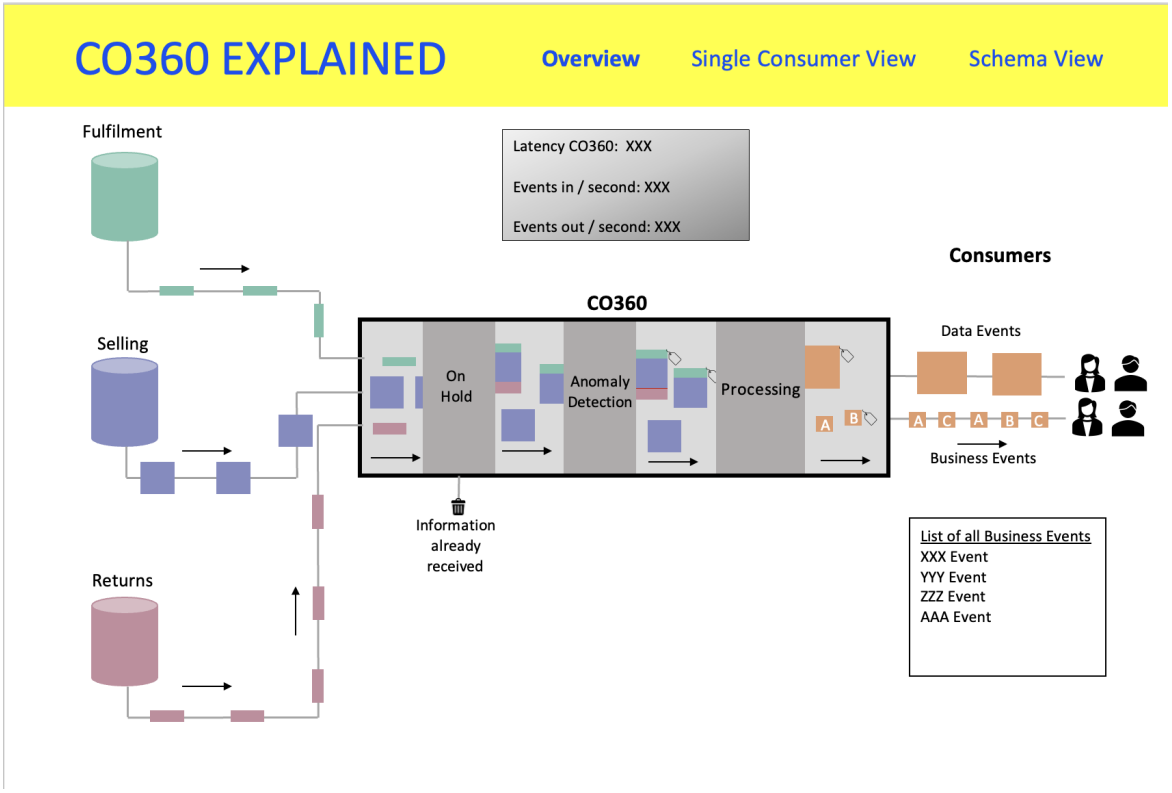


Figure 8.1: Final prototype - menu option 'Overview' selected

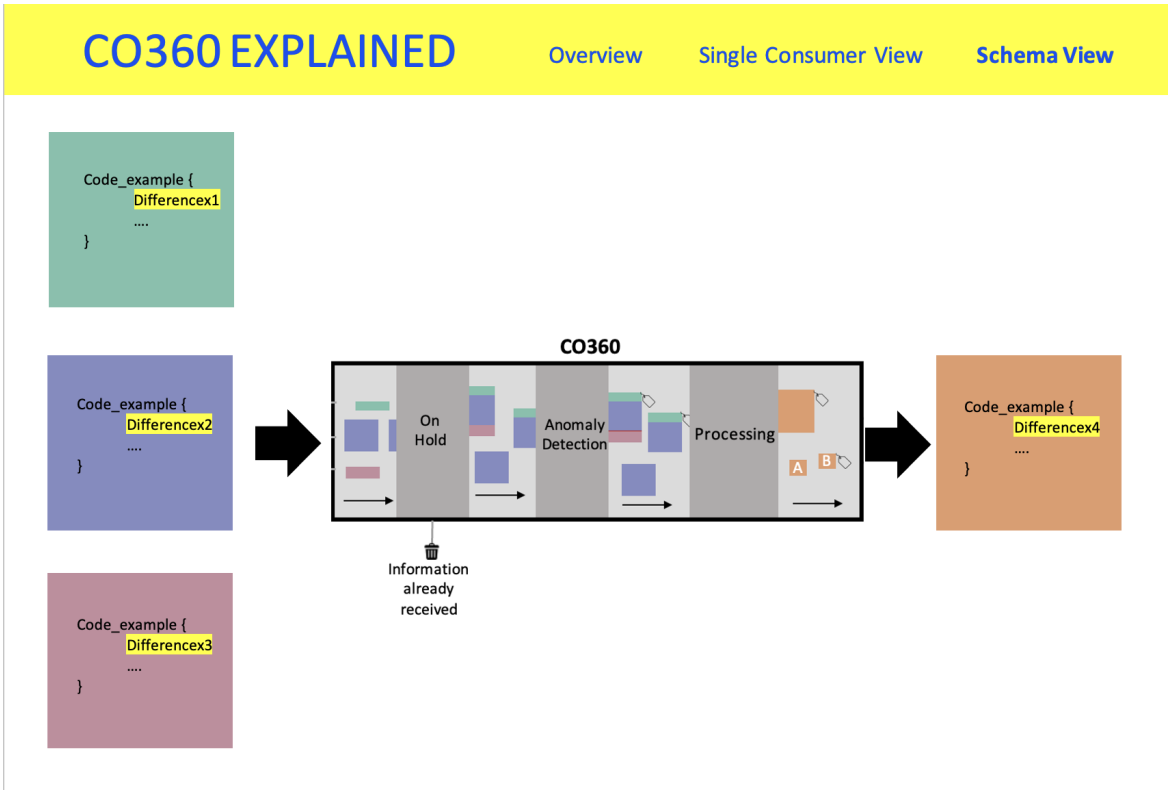


Figure 8.2: Final prototype - menu option 'Schema View' selected

8.2 Final Implementation

To make the components hover- and clickable, JavaScript functions were implemented. Most other changes were made in the CSS-classes, concerning colour, shape and positioning. The colour pallet was changed, and a header with the available menu options was added. These changes can be seen in figure 8.3. Menu items being on top of the page increase their visibility. By being more visible it will be more likely that a user acknowledges them and uses them. This is backed up by Normans design principle: visibility.

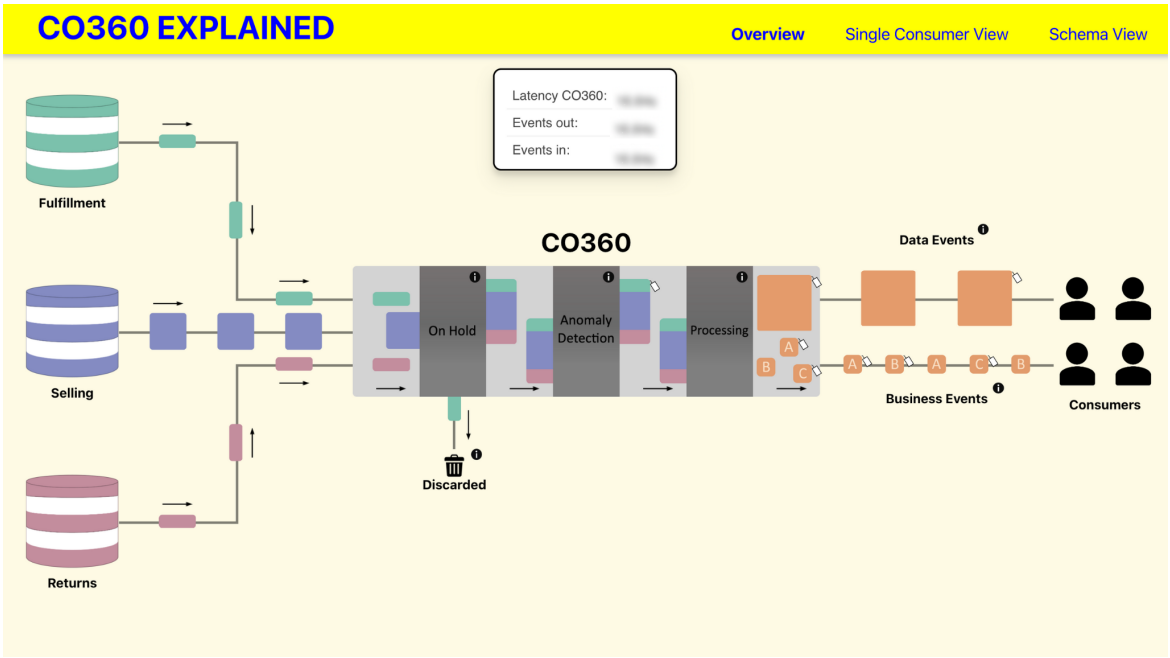


Figure 8.3: Final implementation - menu option 'Overview' selected. The numbers in the information box have been censored.

At first, the information text on the processes of CO360 were made to appear when hovering over the dark grey blocks representing them. After implementing it, it was realised that it was not intuitive that there was information to be gathered about the processes. Since this information is vital to understanding CO360 it was decided to design with high affordance. This resulted in a signifier being incorporated, an 'i-icon', that affords clicking it. These 'i-icon's are used by companies such as Facebook, LinkedIn and HM, proving it is a well-known icon to show the user that information is available. Information about 'On Hold', 'Anomaly Detection', 'Processing', 'Discarded', data events and business events all show up when hovering over respective accompanied 'i-icon's, as demonstrated in figure 8.4.

The specific number of events coming from each database were added, as shown in figure 8.5. The lines were implemented to change colour when hovered over - a signifier that they are clickable and a feedback to the user that the right database line has been clicked. Something worth noting is that smaller clickable elements, such as the lines between the databases and CO360, are activated not only when directly on the component, but within an area around it. This way, the user does not have to be *exactly* on the right pixel to click the component, which could be frustrating. The

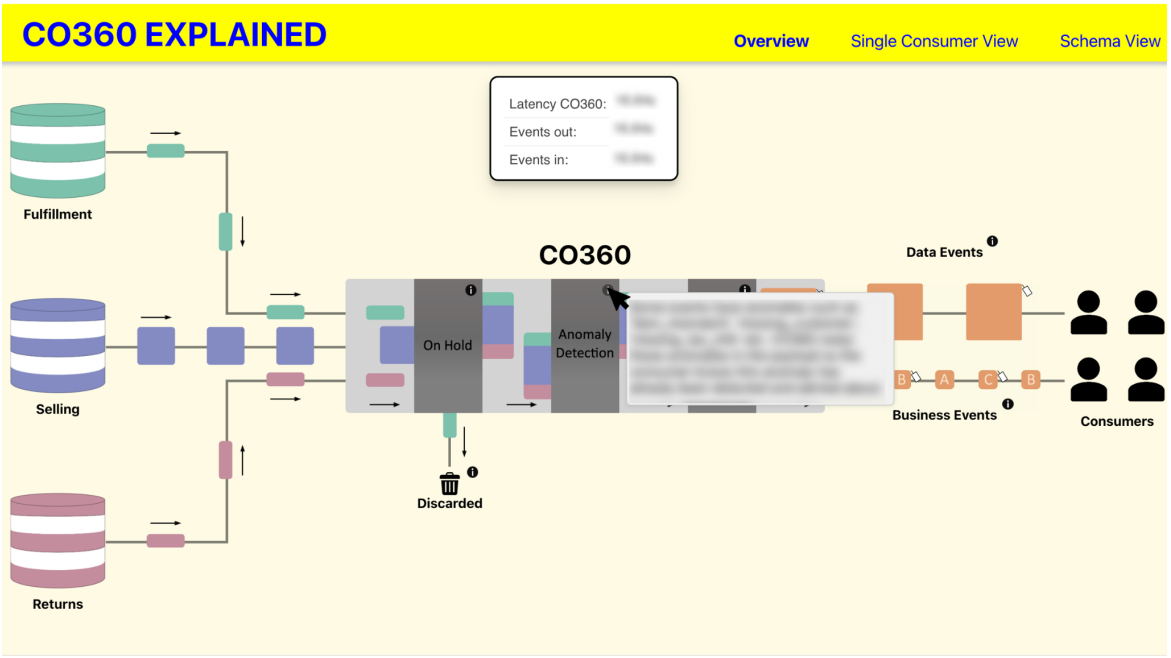


Figure 8.4: Final implementation - menu option 'Overview' selected. Hoverable information icons demonstrated. The numbers in the information box and the anomaly detection description have been censored.

business event list was made clickable to de-clutter the visualization. The list appears when hovering over the "Business Event" text. Both the database numbers and event list show up with an opacity of 0.8 when hovering over them, indicating they are not constant. If you press the lines or "Business Event" text the accompanying event number / list will be permanent until you click it again. In this way, the user themselves pick how much information they want at the screen at a time, and it is not too cluttered as default.

The 'Single Consumer View' menu option has not been altered other than the colour, shape and positioning decisions made for the 'Overview'. The final implementation is shown in figure 8.7.

The last menu option, 'Schema View', was implemented and can be seen in figure 8.8. Each schema box on the left represents schemes from different databases. The schema box shows only a part of the schema and highlights how order numbers are represented in each database. The user can scroll inside the schema box to see more of the schema code, but not all. By using the design principle of constraints, the user is limited to only a certain part of the code. This choice was made so that the user is not overwhelmed with to much code to scroll through and only limited to what is important in the code. When scrolling inside the schema box, there is vertical bar moves alongside the scrolling with the same tempo. This is an example of when the design principle mapping is incorporated in the design. The schema box on the right show how order numbers are represented in CO360. The purpose of the 'Scehma View' is to show the consumers how different databases have different types of logic and different names for the same attribute. By using CO360 the consumer will only need to handle one type of schema.

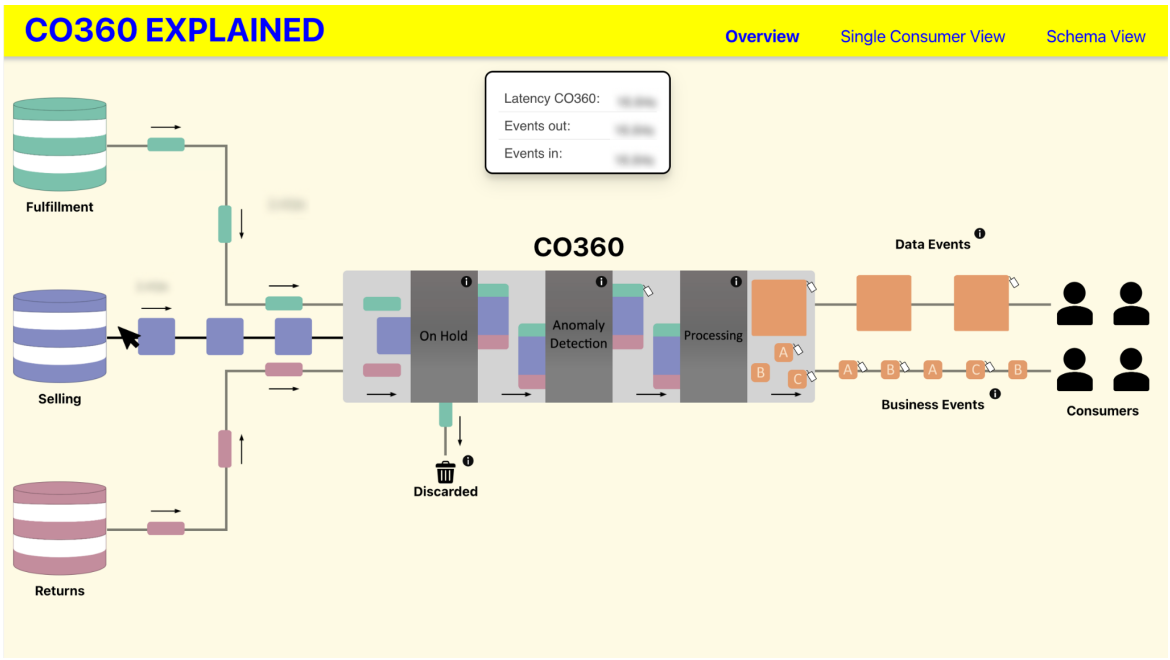


Figure 8.5: Final implementation - menu option 'Overview' selected. Hover- and click-able lines illustrated. The numbers in the information box as well as the database numbers have been censored.

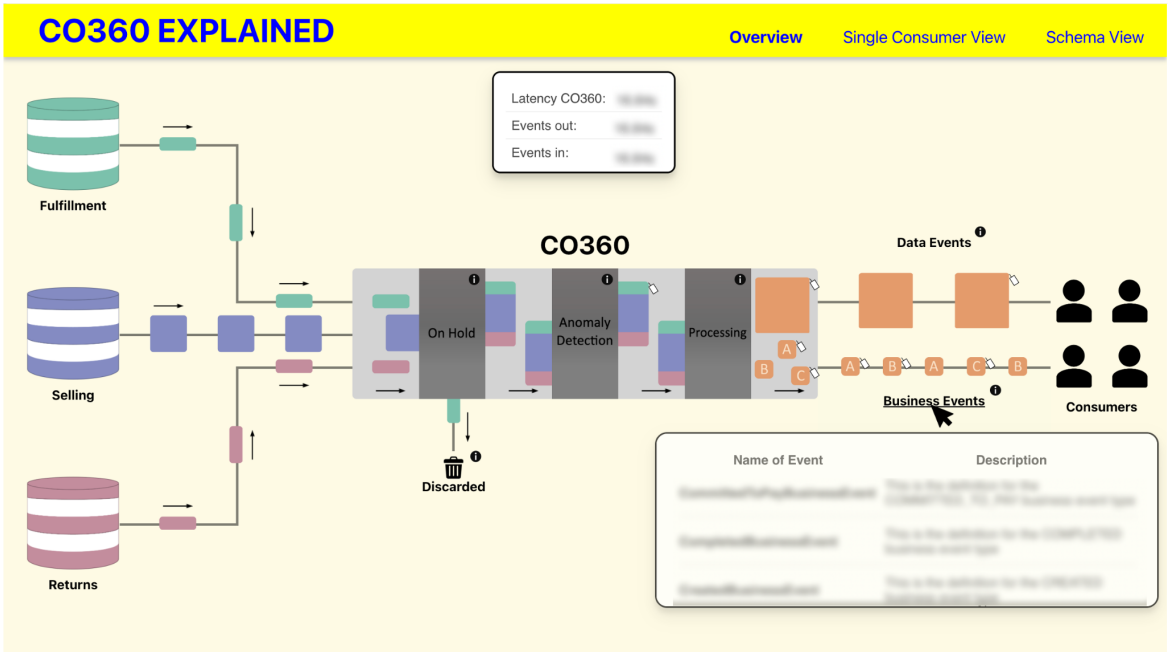


Figure 8.6: Final implementation - menu option 'Overview' selected. Hover- and click-able Business Event list illustrated. The numbers in the information box and the business events have been censored.

Feedback was used as a design principle for switching views. When hovering on a view, the menu item changes color to black giving the user feedback that it is clickable. This is shown in figure 8.9. When the user releases the mouse click the menu item goes

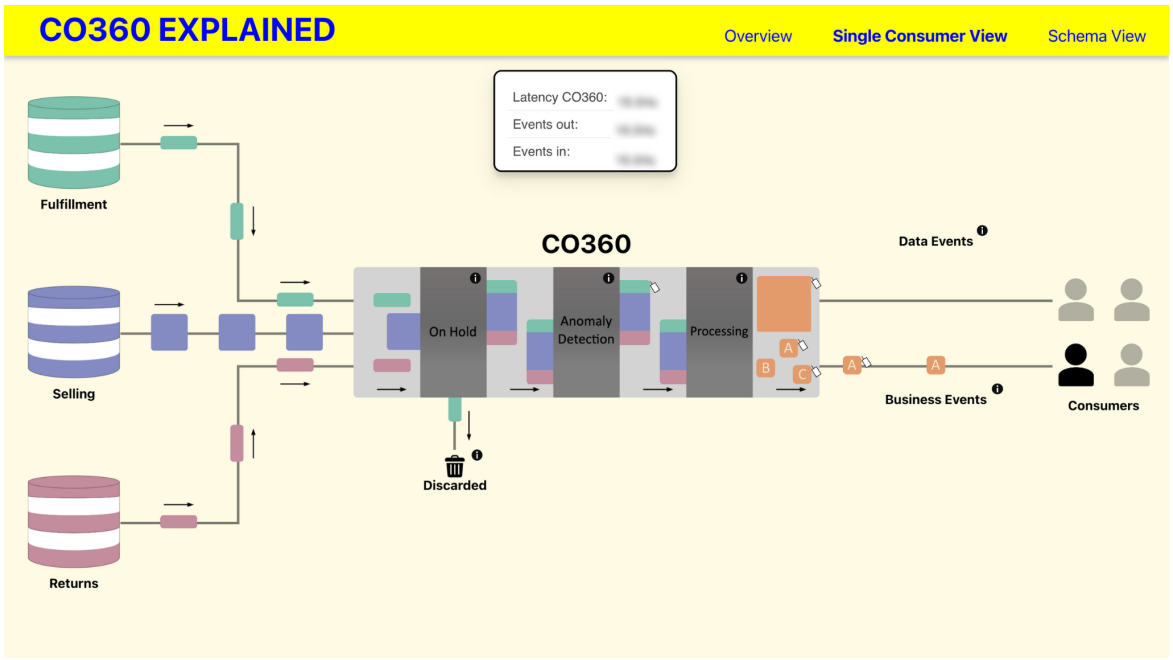


Figure 8.7: Final implementation - menu option 'Single Consumer View' selected. The numbers in the information box have been censored.

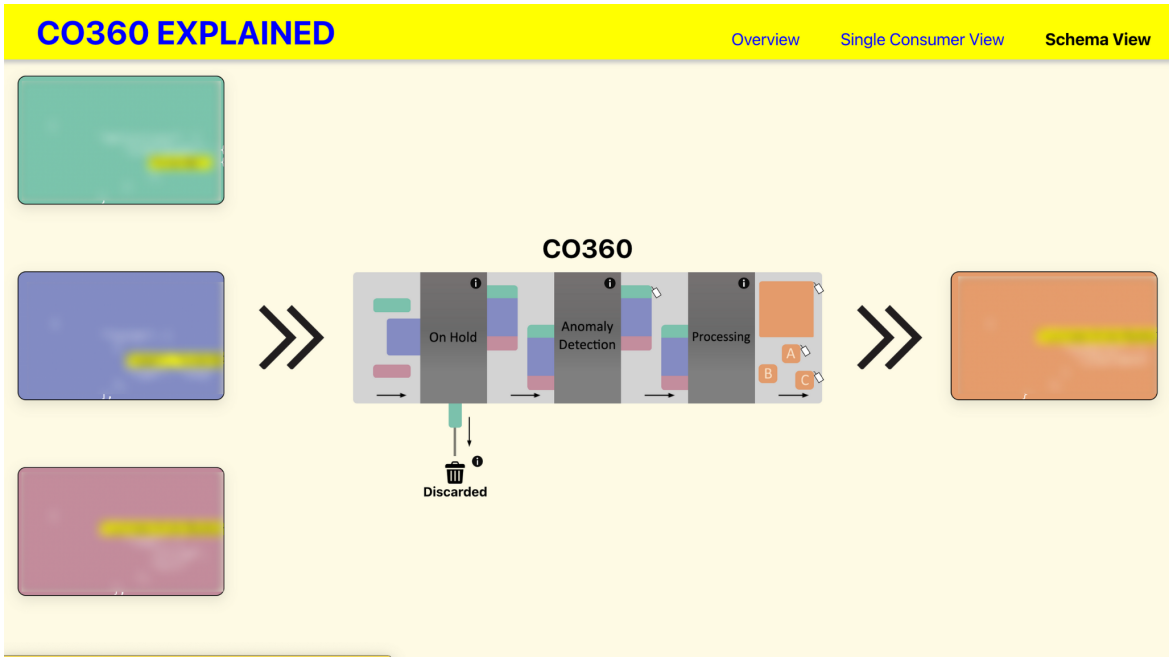


Figure 8.8: Final implementation - menu option 'Schema View' selected. The code in the boxes has been censored.

back to blue but now the text is bold indicating that the view is selected, which can be seen in figure 8.3 - 8.7.

No animations were implemented due to time constraints.

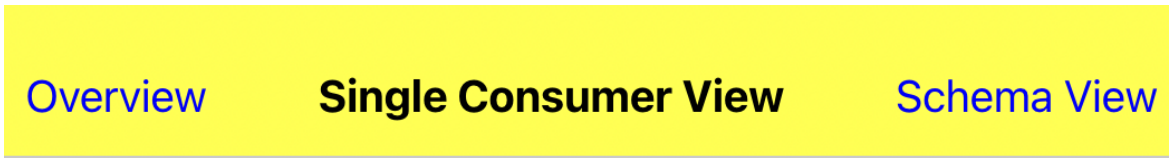


Figure 8.9: Feedback when clicking on a menu item

9 Evaluation of Final Product

This chapter describes the evaluation of the final product. Upon completing the last implementation, it was time to proceed with a final evaluation to help assess the success of the visualization and its usability. This was done by a four part evaluation process which included presenting the CO360 product, a usability test, the system usability scale questionnaire and questions regarding the visualization. The chapter also depicts the results from the evaluation. These are mostly positive while also including improvements that can be made in the future.

9.1 Evaluation Process

Choosing representative users is important. The real life users of the visualization will be both internal and external teams within IKEA with an engineering background, so both employees from within the CO360 team as well as from other teams at IKEA were part of the evaluation. The team members from CO360 had not been part of the last few iterations, and were therefore not familiar with the visualization. The focus during the CO360 team evaluations was more directed at how well of a representation of CO360 the visualization was, while external teams got questions aimed at if the visualization helped with their understanding of CO360. All evaluators were tested and questioned on the usability of the page. Three members from the CO360 team and two senior engineers from another team at IKEA took part in the evaluation - participants D, L, M, N and O. Four of these had never seen the visualization prior. The evaluation was divided into four parts, which are summarized in figure 9.1. These are more thoroughly explained in the next sections.

9.1.1 Presentation of CO360

Before anything, the external team members were asked to give a short explanation of what they knew about CO360, in order to have a starting level.

The intention is that future consumers will always firstly see the visualization alongside a presentation of the CO360 product. The external team members were therefore given an oral presentation of CO360 with the help of the visualization created in this thesis. This presentation gives the evaluators a more accurate experience of how the visualization would actually be used in the future. The purpose of the presentation was for participants to get an understanding of CO360, not the visualization. Thus, during the presentation of CO360 the interactive parts of the visualization were avoided in order to still correctly assess the usability of the design in the following parts of the evaluation process. Since the internal team already know everything about CO360, this part of the evaluation was not included for them.

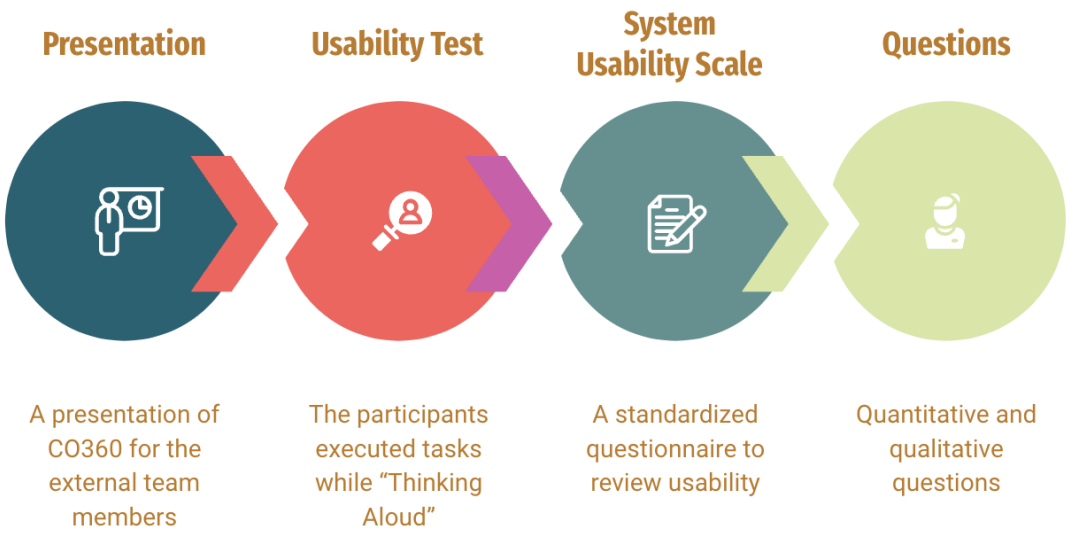


Figure 9.1: A summary of the four parts that make up the evaluation process.

9.1.2 Usability Test - Think Aloud

The evaluators were asked to use the Think Aloud method while being presented with different tasks. The tasks were created to test the interactive elements of the design and test the signifiers. The task was deemed "Succeeded" if the task was performed immediately or quickly after a minor error. These errors were noted in the qualitative parts of the results. If they could not succeed with a task, they were giving hints. This is also mentioned in the results. The following are the tasks presented to the participants:

1. Display the list of Business Events.
2. Tell me how many events are coming from Selling.
3. Display information about what "On Hold" means.
4. Display Single Consumer View.

9.1.3 System Usability Scale

After the Usability Test they were allowed to play around with the website for a few minutes in order to get the feel of it, and explore all the components and interactive elements. They were then asked to fill out the SUS questionnaire. They were informed that the answers were anonymous to remove some bias, as they might feel uneasy to give bad scores otherwise.

9.1.4 Quantitative and Qualitative Questions

Finally, the evaluators were asked a series of questions. These questions differed for the internal and external team. The internal team were asked questions about how

accurate the design visualized CO360, whereas the external team were asked if the visualization helped them learn more about CO360. Both teams were asked quantitative and qualitative questions. The following were the quantitative questions which were asked to get an overview of the success of the visualization:

Internal:

1. Do you think the visualization will help future consumers of CO360 understand CO360 better?
2. Do you think the visualization is a good representation of what CO360 is?
3. Do you think the most important aspects of CO360 are included in the visualization?

External Team:

1. Do you have a better understanding of what CO360 does?
2. Do you get a negative or positive impression of CO360?
3. Would you use this visualization if you wanted to be reminded of what CO360 does?
4. Do you think the visualization makes the understanding of CO360 easier?

The qualitative questions bring more insight into what the participants thought about the design choices. The qualitative questions asked were:

Internal Team:

1. What do you think is good about the visualization?
2. What do you think is less good about the visualization?
3. What would you change about the visualization?

External Team:

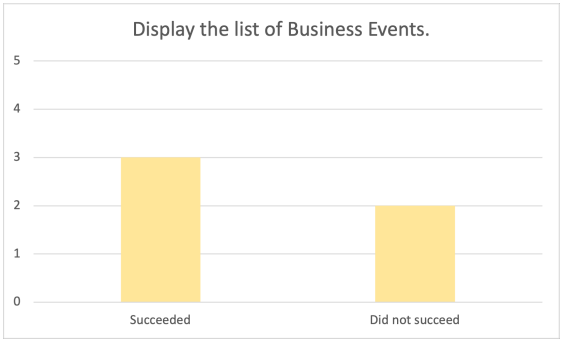
1. Can you give a short explanation of what CO360 is?
2. What do you think is good about the visualization?
3. What do you think is less good about the visualization?
4. What would you change about the visualization?

9.2 Results of Evaluation

9.2.1 Quantitative Data

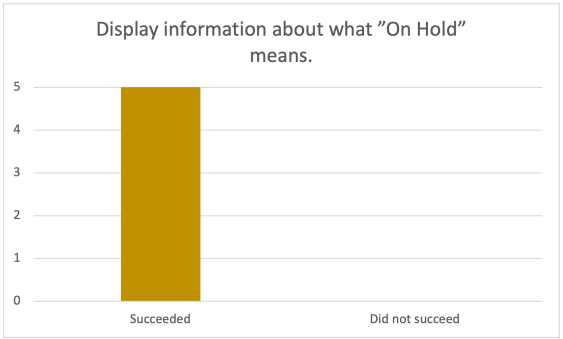
Usability Test Data

Most tasks were succeeded by the majority of the participants. All participants could retrieve how many events were coming from 'Selling' and find the information about 'On Hold'. One participant from the external team struggled with displaying the Single Consumer view. Two participants could not display the list of Business Events - one from the CO360 team and one from an external team. The results are shown in figure 9.2.

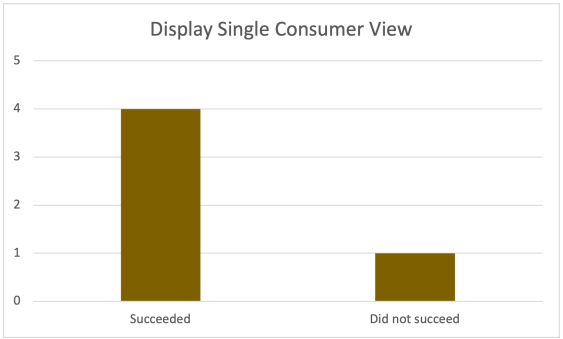


(a) The results of the task: "Display the list of Business Events".

(b) The results of the task: "Tell me how many events are coming from Selling".



(c) The results of the task: "Display information about what 'On Hold' means".



(d) The results of the task: "Display 'Single Consumer View'".

Figure 9.2: The number of participants that succeeded, and did not succeed with the tasks during the usability testing.

SUS data

The result of the SUS questionnaire can be seen in figure 9.3. Compared with the interpretation in figure 9.4 it can bee seen that two users scored "Best imaginable" outcome, two users scored almost "Excellent" outcome and lastly one user scored almost "Good" outcome. The average value of the SUS scores is 85, which falls under the "Excellent" category.

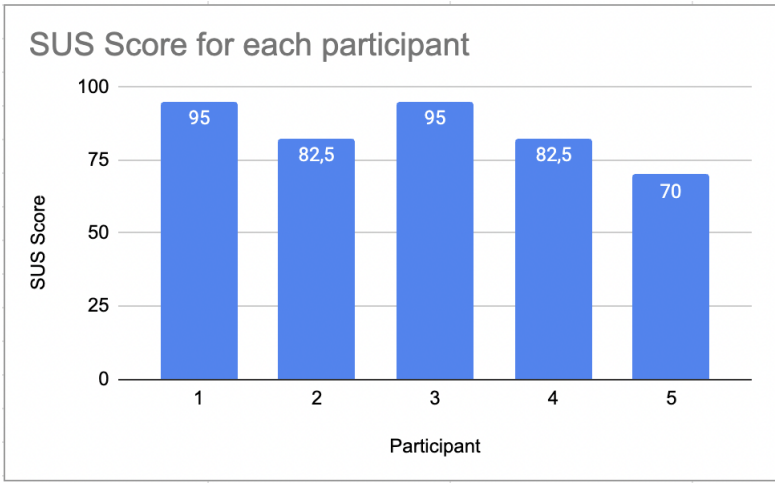


Figure 9.3: The SUS scores for the evalutation participants.

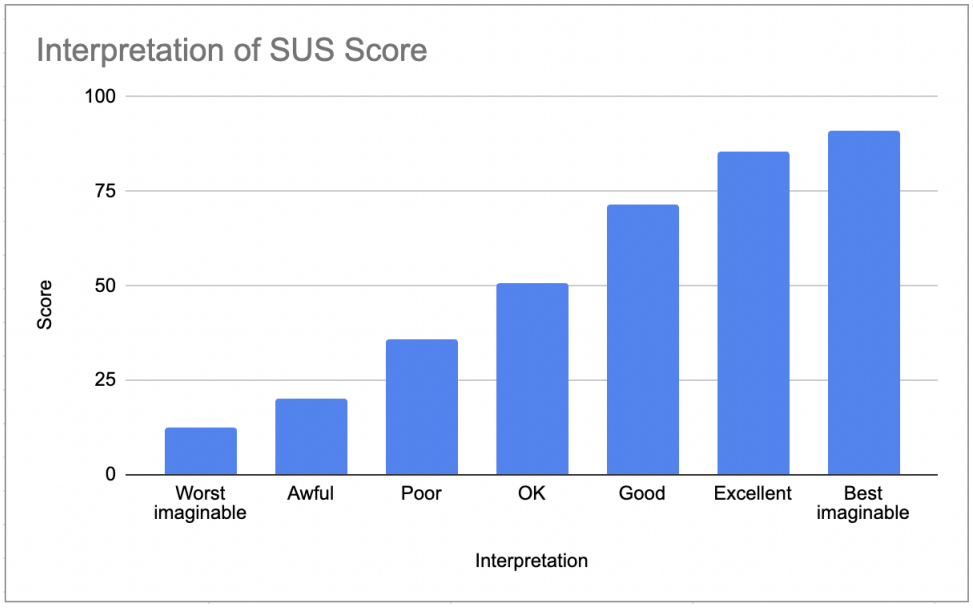


Figure 9.4: This graph shows how different SUS scores should be interpreted.

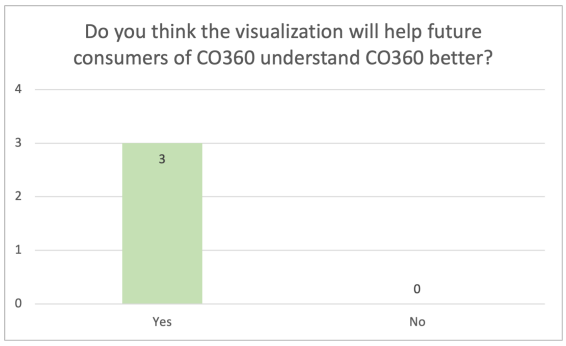
Quantitative Questions

The answers to the quantitative questions are shown in figures 9.5 and 9.6. All questions except for two got only positive responses.

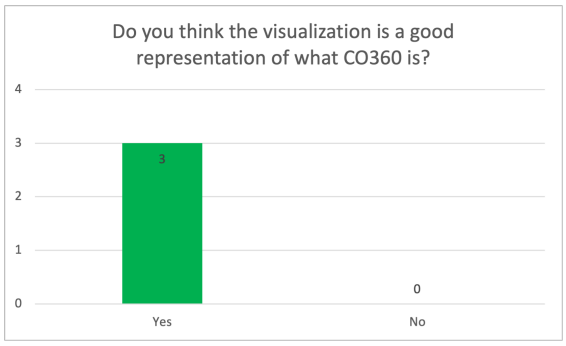
9.2.2 Qualitative Data

Usability Testing

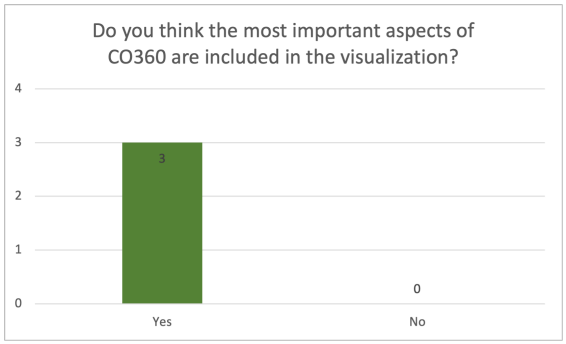
When asked to display the list of business events four of the five participants mentioned "it should be in the business event area" and started by hovering over the business event line and business event icons first, and then quickly moved on to hovering over the "Business Event" text. One of these participants needed a clue - "You are in the



(a) Answers to "Do you think the visualization will help future consumers of CO360 understand CO360 better?"



(b) Answers to "Do you think the visualization is a good representation of what CO360 is?"



(c) Answers to "Do you think the most important aspects of CO360 are included in the visualization?"

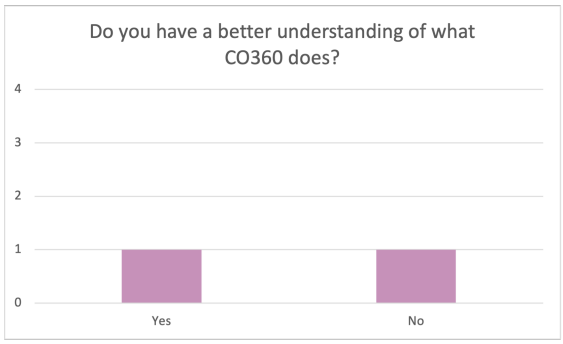
Figure 9.5: Answers to the quantitative questions asked to the CO360 team during the final evaluation.

right area", to fulfill the task. Three of these participants also mentioned it was not evident that the text was clickable to get the list to stay up. The fifth participant went into the 'Schema View' menu option and started searching for the list there, and did not succeed with the task.

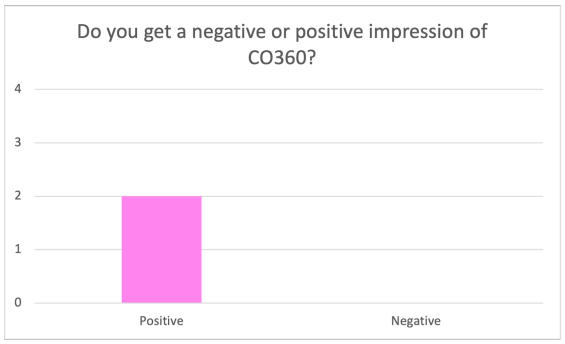
All participants were deemed successful in gathering how many events were coming from 'Selling'. However, three of the participants first tried clicking the 'Selling' database icon before moving on to the 'Selling' line and 'Selling' events. Three participants also mentioned that the lines did not look clickable, and thought something should be added/changed to indicate there was information there to be received.

The 'On Hold' information was quickly found by all participants. They all mentioned the 'i-icon' made it clear there was information to gather there.

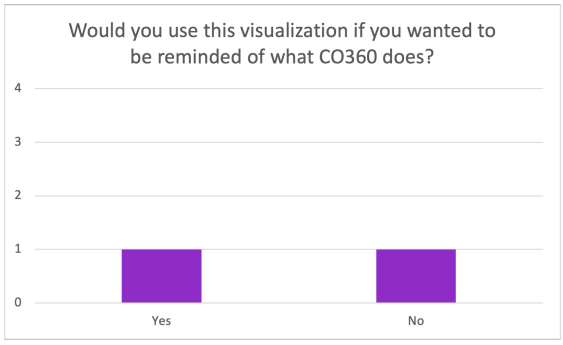
All CO360 team participants started by pressing the user icons when asked to display the 'Single Consumer View', before quickly going to the menu option instead. One of the external team participants immediately went to the menu option while the other struggled with understanding what 'Single Consumer View' meant.



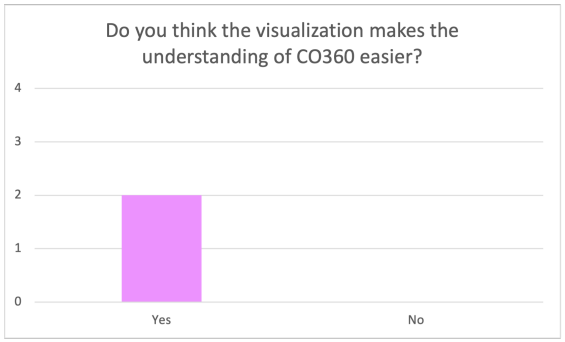
(a) Answers to "Do you have a better understanding of what CO360 does?"



(b) Answers to "Do you get a negative or positive impression of CO360?"



(c) Answers to "Would you use this visualization if you wanted to be reminded of what CO360 does?"



(d) Answers to "Do you think the visualization makes the understanding of CO360 easier?"

Figure 9.6: Answers to the quantitative questions asked to the members from other teams at IKEA during the final evaluation.

Qualitative Questions

The participants from the CO360 team thought the visualization was a good representation of CO360. Positive feedback included that it was a simple yet distinct visualization, and that the flow of events was clear. The information box also got praise for showing consumers what is happening within CO360 right now. Several participants mentioned that it was evident that events coming from the databases were different due to their different colours, and that this emphasized the shielding CO360 does. The information about the different processes were considered easy to find due to the signifiers and practical for future consumers.

Many users mentioned that other than the signifying 'i-icons', it was not evident that some elements were hoverable and clickable, such as the business event list and database lines. Three users mentioned they would leave the database numbers up at all times, since they did not think they added to any clutter. Other constructive criticism received was quite different from each participant. Two mentioned more components, such as the databases and consumers, should have a description as well. One user suggested the entire website should have a description so that you would not need the presentation at all in order to understand the visualization. This was mainly a need for users without prior knowledge to CO360. Another user had a similar suggestion but focused on first time users, the need was regardless of prior knowledge. The suggestion was a user guide for first time users, that would explain how to use

the web application and how its functions worked. The 'Single Consumer View' was not initially understood by two participants. They suggested lowering the opacity of the other elements even more, perhaps change the name of the menu option and add some information about what it means. The same was true for the 'Schema View'. Aesthetically, the colours did not follow IKEA's standard colour-schemas. Another aspect brought up was the accessibility of the page.

10 Discussion

In this chapter the results and findings will be discussed. The iterative design process will also be discussed and how it could have been improved. Using the final evaluation the results will be interpreted and aspects such as accessibility will be brought up. Further discussion will take a look into the research questions and if they have been answered. Lastly it will be described what could be done in the future to develop the product even further.

10.1 Design Process

During the research, an iterative user centered design process was conducted. Before this could start, there was a comprehensive study on what a design process entails, and which components are necessary to achieve the best solutions. The findings included different analyzing-, idea generating- and evaluation methods which were then put into practice.

Throughout the research on a design process, it was evident that there are many different methods and tools that can be used in each part of the process. A selection of these, such as brainstorming, SUS, and prototypes, were implemented in this thesis where it was deemed appropriate. The main components of the design process was that it was user centered, and based in the Double Diamond. Each iteration included users evaluating the developed prototypes (or implementations) and getting the users‘ input on future development in order to always stay close to the user needs. The solutions were first prototyped with Lo-fi and Mid-Fi and then implemented with the help of MVPs. These can be seen in the different iterations. By prototyping one step at a time, it became easy to continuously evaluate and changes could be done early in each step. The same concept was kept for the implementation and by evaluating one step at a time it was easy to re-evaluate and modify upon user requests.

The first step in the design process was to understand the product that was being visualized - Customer Order 360, and who the stakeholders and users are. Thorough interviews were conducted, as well as participation in the teams‘ discussions and meetings. During the design process more information on CO360 and its users was gathered, deepening the understanding. In order to create a representative visualization of CO360, this was an important part of the process which was given plenty of time. The users and their needs were identified and analyzed throughout the entire thesis by focusing on having a user centered design process, where the users‘ input was frequent and of priority.

10.2 Final Evaluation

The SUS scores that were given to the visualization were high. This indicates that the implementation was very well made from a usability perspective. The visualisation handles two types of users with different amount of prior knowledge - the ones presenting CO360 (primary) and the ones learning about CO360 (secondary). Worth noting is that three out of five people in the interviews had very good knowledge of CO360, and would be in the primary user category, while the other two represented the secondary users. The main focus throughout this thesis has been to meet the primary users needs, but it is also important to look closer into the interview with the people with less prior knowledge of CO360.

The overall feedback was good, but it is pointed out that it would be good to have an additional presentation/guide stored inside the visualization. Then when the user with less knowledge will have easier to learn when they go back to the presentation. Not everything will stick during a presentation and therefore some type of repetition would elevate the implementation. A guide for using the visualization was proposed as an improvement. The need of the guide was less for repetition but more for first time users that do not know how to use the application. In this way the visualization could be used without having a prior oral presentation of CO360. Selling CO360 has been concluded to be the main priority of the visualisation and therefore there is a need to both satisfy the primary user holding the presentation and the secondary user that will be revisiting the presentation.

Even if the evaluation interviews and the SUS score proved that the implementation was good, there is some points that could improve. Mostly there was an issue with icons such as the consumer icons and the database icons. Most users during the usability test thought they were clickable and gave a false affordance to be used. Since many participants thought to click these icons first, they should be made clickable to make the implementation less confusing. The same thing goes for the user icons. Many participants clicked those instead of the menu option when asked to go to 'Single Consumer View'. It would therefore make sense to also make the user icons clickable, and direct the user to the 'Single Consumer View'.

Having only five participants in the final evaluation is fewer than what is optimal. Many more employees within IKEA were contacted, but either gave no response or were not available within the time frame of the thesis. There are studies that show qualitative testing with five participants can find 85% of usability issues [59, 60]. This shows that the results of the evaluation are still reliable in this aspect, but would ideally be improved by having more participants. In hindsight participants outside of IKEA could have been used to evaluate the visualization. Employees at IKEA are the ideal testers, since they represent the future users of the product the best, but non-IKEA participants would still have given valuable insight to the usability of the product.

Worth taking into account is that the participants might have given favorable scores and feedback due to knowing the visualization was part of a Master Thesis. This can put pressure on the participants as they might think their scores and feedback will

affect how well the thesis is received. Knowing a Master Thesis is an important part of our degree can therefore lead to them giving favorable scores to be nice. They also want to see their investment in a thesis give good results. This is an additional reason why bringing in testers from outside IKEA could give more reliable un-biased results.

10.3 Accessibility

An aspect that one of the participants of the final evaluation brought up was the accessibility of the visualization. Accessibility refers to a design being accessible and usable by users with a spectrum of abilities, such as visual or hearing impairments [61]. In 2020, there were 120 million people in the EU living with some form of disability [62]. Accessibility in design can be crucial to these people performing daily tasks and help them feel included. While of course being of important ethical concern, accessibility has also taken steps to become more and more included in the law. In June of 2025 the European Accessibility Act (EAA) will come into effect [63], demanding products fulfill certain accessibility requirements. Accessibility is of great importance to a good design for everyone. The CO360 visualization has great improvement potential in the accessibility area. The different colours used for the different data events were considered to also have different patterns to adhere to colourblind people's needs. It was later in the process decided against this, since it created a messy look for the website. There are other solutions than patterns that could meet this need, and these should be explored. Accessibility should be incorporated throughout the entire design process, as it does not exist in its own vacuum, which is greatly regretted that it was not during this thesis.

10.4 Research questions

Throughout this study, the thesis aimed to address the following research questions:

- Who are the stakeholders of the CO360 product?
- What are the stakeholders needs and how are they identified?
- How can CO360 be visualized in order to satisfy identified needs?

Very early on it was clear that there were three different types of stakeholders of the CO360 product. These were the developers within the CO360 team, consumers of the CO360 product and "business people". Business people are engineering managers, product owners and overall decision makers that had business aspect in mind when taking decisions. The difficult part was to establish which interest should be prioritized and which stakeholder should be a user of the visualisation. To be able to determine which one should be the user it was important to identify the stakeholders needs which was brought by the second research question. Since it was established early on that consumers of the CO360 product where one of the stakeholders, it would have

made sense to interview them early on before deciding upon the CO360 visualisation. Instead, consumers of the CO360 were brought into the design process late and had less of an impact in contrast to the other stakeholders. One of the reason for this was that the CO360 team themselves controlled a lot of the process and since the thesis work was ordered by them it was less objective. The lack of objectiveness most likely affected the result. A more objective thesis would have taken into account all of the stakeholder needs equally.

After identifying the stakeholders needs it could be established that there were two different types of users: primary and secondary. As previously mentioned the primary users are the ones presenting CO360 and the secondary users are the one that receives the presentation. The secondary user has often less or even no prior knowledge of CO360. The main needs for the primary users are that they need a tool to help them present, explain and sell CO360 to others, mainly teams within IKEA. The major need of the ones watching the presentations is to understand CO360.

The CO360 team members gave feedback that there was a good understanding of CO360 throughout the design process, and the answers to the questions shown in figure 9.5b and 9.5c indicate the team were happy with the understanding of CO360. Since the CO360 team are the most knowledgeable of their own product, it is safe to say the thesis fulfilled in achieving the goal of understanding what CO360 is and what its main components are.

The primary needs seems to be meet by looking at the positive user results. What could be improved is the secondary user needs. The research question "How can CO360 be visualized in order to satisfy identified needs?" can be therefore seen as partly answered.

10.5 Future work

For future work it would be necessary to make the implementation less confusing by making all the icons clickable and have the supposed actions. Event data coming from sources could also be visible from the start without the need of clicking the database pipeline. This would increase visibility. When something is not visible for the user it becomes hard for the user to know that it even exists, especially if there are no signifiers for it.

A guide would not only serve the purpose of re-giving information but also from a user perspective to know how the application should be used. Future work should focus on what secondary users often lack in knowledge and how that can be complemented with an additional presentation. A guide should also be considered for both primary and secondary users to ease the user experience. Since most of the primary users needs are met there should be a higher focus on secondary users in future work.

11 Conclusions

The goal was to create a visualization of CO360 through a user centered iterative design process. Through each iteration there was a big weight put on the users' opinions and feedback that eventually resulted in either a prototype or an implementation. The stakeholders identified were: developers within the CO360 team, consumers of the CO360 product and decision makers from a business aspect. These groups were all interviewed to create a better understanding of what the visualization should do. The findings concluded that selling was the main priority. The visualization would act as a presentation tool for CO360 team members to help future consumers understand the benefits of switching to the CO360 solution. Primary users were concluded to be the CO360 team when holding presentations with the visualization as a helping aid. Secondary users has been concluded to consist mostly of consumers of the CO360 product. The main selling components that should be included the visualization were determined to be the business and data events CO360 produces, the complexity reduction it offers, and the processes within CO360. A high SUS score and positive evaluation interviews indicates that the implementation satisfy the primary user needs. However, it is important to note that the number of evaluating participants was small, and that there were incentives to give favorable scores. Having a higher number of evaluating participants with no connection to the thesis writers would solidify the results further. There was a lack off early inclusion of secondary users in the design process. It can be concluded that this highly affected the result and less consumers needs were met. An important step for IKEA to have a useful visualisation would be to include more secondary user needs and develop the visualization further.

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Appendix A

Appendix A - Interview Schedules

A.1 Interview Schedule - Trial Interview, iteration 1

Questions:

1. Could you tell us what you work with in the CO360 team?
2. What is the problem that needs to be solved?
3. Why is it important that this problem is solved?
4. What's the source of the problem?
5. Who are the users / customers of the product going to be?
6. What are your customers / users trying to achieve on a higher scale?
7. What should the user be able to obtain from the product?
8. What determines if this is a problem? Is there any data on this?
9. What assumptions do you think you are making about your users?
10. Who are the primary decision-makers of this project?
11. What solution are you looking to achieve (website, web app, app, etc)?
12. Is there anything specific we should research?
13. What data measurements is needed to decide if the product is successful or not?
14. Are there any constraints (technical, commercial, etc.)?

A.2 Interview Schedule - Real Interview, iteration 1

Questions:

1. Could you tell us what you work with in the CO360 team?

2. What is the problem that needs to be solved?
3. Why is it important that this problem is solved?
4. What's the source of the problem?
5. Who are the users / customers of the product going to be?
6. What are your customers / users trying to achieve on a higher scale?
7. What should the user be able to obtain from the product?
8. What determines if this is a problem? Is there any data on this?
9. What assumptions do you think you are making about your users?
10. Who are the primary decision-makers of this project?
11. What solution are you looking to achieve (website, web app, app, etc)?
12. Is there anything specific we should research?
13. What data measurements is needed to decide if the product is successful or not?
14. Are there any constraints (technical, commercial, etc.)?
15. Prioritize the different problems you've brought up.

A.3 Interview Schedule - Follow-up Interview, iteration 1

Questions:

1. How many different business events exists and will there be more created?
2. How many business events does a customer listen to?
3. Do you have information on what a customer listen to before and after?
4. Who is the biggest consumer? Do they listen on data events?
5. What happens to an anomaly?
6. What are discarded events and why are they discarded?

A.4 Interview Schedule - Evaluation Interview, iteration 4

Questions:

1. What do you like about MVP 1?
2. What do you dislike about MVP 1?
3. Is there anything you want to remove or change?
4. Is there anything you want to add for MVP 2?
5. Is there anything that you want to change in "Should have" in the MoSCoW prioritization?
6. Is there anything that you want to change in "Could have" in the MoSCoW prioritization?
7. How do you think this MVP would be used in a presentation setting.
8. What is needed to have a successful presentation.

Appendix B

Appendix B - Final Evaluation Schedules

B.1 System Usability Scale questionnaire

Questions:

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome/awkward to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

Appendix C

Appendix C - Interviewees

C.1 Interviewees

Anonymized interviewees, age, gender and role at IKEA

A Age: roughly 40, Gender: Male, Role: Engineering manager, CO360 team.

B Age: roughly 50, Gender: Male, Role: Senior software engineer, CO360 team.

C Age: roughly 50, Gender: Male, Role: Product manager, CO360 team.

D Age: roughly 30, Gender: Male, Role: Junior software engineer, CO360 team.

E Age: roughly 40, Gender: Male, Role: Senior software engineer, CO360 team.

F Age: roughly 50, Gender: Male, Role: Senior software engineer, CO360 team.

G Age: roughly 40, Gender: Male, Role: Senior software engineer, CO360 team.

H Age: roughly 40, Gender: Male, Role: Senior software engineer, CO360 team.

I Age: roughly 40, Gender: Male, Role: Engineering manager, external team.

J Age: roughly 40, Gender: Male, Role: Senior software engineer, CO360 team.

K Age: roughly 50, Gender: Male, Role: Senior software engineer, CO360 team.

L Age: roughly 40, Gender: Male, Role: Senior software engineer, CO360 team.

M Age: roughly 50, Gender: Male, Role: Senior software engineer, CO360 team.

N Age: roughly 40, Gender: Male, Role: Lead software engineer, external team.

O Age: roughly 40, Gender: Male, Role: Senior UX engineer, external team.