Business Intelligence meets Smart-Glasses

Mobile BI Reporting and Data Visualization on Google Glass

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0.1	20.05.2015	Document Outline.
0.5	03.06.2015	First draft version with open questions and comments.
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1.5	15.06.2015	Revised version with second incorporated feedback and proof-reading. First formatting, referencing, and all tables/figures.
2.0	16.06.2015	Final version for submission with last corrections, final formatting, referencing and layout. Signed by company tutor.

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Foreword

Dear reader,
Every study comes to an end. Now it is my turn and the end of my 4-year Bachelor studies at Fontys University of Applied Sciences (UAS) in Eindhoven, Netherlands.
In the search of an interesting graduation project, I came across JUGO vof, a consultancy in business intelligence, and (management) data visualization, located in 's-Hertogenbosch, Netherlands.
Both JUGO and I share the same fascination and interest for combining innovative technologies with modern data visualization and business intelligence methods.
This report is written for Fontys UAS as part of my Bachelor thesis. After submission of this report, a defense presentation at the beginning of July at Fontys UAS will complete the graduation, leading into a degree in Bachelor of Information Systems (B.Sc.). Within the following report, I describe my graduation assignment, respectively, project carried out at JUGO vof. The report covers about five months, a period from 1st February till 30th June 2015. It describes in detail the purpose and scope of the assignment, how it is phased and executed, all problems and risks encountered, as well as results and final conclusions and recommendations.
I would like to take this opportunity to thank my university tutor, Mr. Kuah, and company tutor, Mr. van Lent, for their guidance, feedback, and collaboration. Furthermore, I would like to thank Fontys for providing the Google Glass during the graduation period. Finally, I also thank all proof-readers and individual reviewers for their work and input.
Enjoy reading and who knows what your standpoint in regards to smart-glasses and their BI and business practicability will be.

With best regards,

(Max Scholz)

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Summary

This report provides an exploratory research and development initiative to combine smart-glass technology with mobile BI reporting.
The assignment was performed at JUGO vof, a SAP consultancy in business intelligence and (management) data visualization. The company's interest in innovative technology lead to combine BI reporting with this rather unexplored wearable technology (here Google Glass).
The assignment aimed for a proof-of-concept for instant notifications, real-time alerting and mobile BI reporting functionalities on smart-glasses.
The project was phased and executed following a traditional waterfall methodology, except for the design and implementation phase, which incorporated a rapid application development approach. For guidance during the assignment and validation of project activities, the DOT-framework was used.
Results of the conducted surveys reveal that smart-glasses in their current state are predominately used for operational business use-cases. Independent research provided a good knowledge base in smart-glass technology and data visualization, which lead to the establishment of an application concept. As a result of development efforts, prototypes were created and single BI reporting functionalities were implemented on the testing device.
The report finds the prospects of smart-glasses used for mobile BI reporting promising, since they transform information retrieval and presentation to an innovative dimension.
As a conclusion the project showed, that the presence of a clear design and user experience strategy in addition to an assessment of underlying IT infrastructure is necessary. Additionally, hardware and software restraints of current smart-glasses come with limited implementation possibilities resulting in limited mobile BI functionalities. Since smart-glasses are not yet suitable for mobile BI reporting given their prototype status, this leads to the recommendation of waiting for hardware improvements of future releases of smart-glasses in order fully integrate them in the business environment. To make use of information systems, i.e. SAP BW or HANA, as real-time data sources, further investigation and assignments are advised.
To sum up, the report reveals that smart-glasses offer great possibilities in operational, tactical, and strategic reporting with regard to the future, although their development is difficult to predict due to the early prototype status.

Glossary

Abbreviation	Definition
API	Application Programming Interface: a set of routines, protocols, and tools for building software applications.
APK	Android Package: package file format for distribution and installation of application software onto Google's Android operating system.
AR	Augmented Reality: a technology enriching the real world with digital information and media.
B.V.	Dutch: Besloten vennootschap (met beperkte aansprakelijkheid) English: equals private limited liability company.
BI	Business Intelligence
BW	Business (Information) Warehouse, a SAP software product.
BYOD	Bring Your Own Device: an IT policy where employees are allowed to use their personal mobile devices to access enterprise data and systems.
CIO	Chief Information Officer: a job title.
CMS	Content Management System
CRM	Customer Relationship Management
DOT	Development-Oriented Triangulation, an applied research framework.
DW	Data Warehouse
ERP	Enterprise Resource Planning
GDK	Glass Development Kit, an add-on for Android SDK for native Glassware development.
Glassware	Software / Applications running directly on Google Glass.
HANA	High-Performance Analytic Appliance, a SAP software product.
IBCS	International Business Communications Standards
IDE	Integrated Development Environment

Abbreviation	Definition
ISSD	International Student Service Desk, department of Fontys that provided the Google Glass.
IT	Information Technology
ITIL	Information Technology Infrastructure Library
JAD	Joint Application Development
KPI	Key Performance Indicator: a measurable value that demonstrates how effectively a company is achieving key business objectives.
MOOC	Massive Open Online Courses
MSP	Managed Service Provider
MSR	Managed Service Recipient
OAuth	Authorization framework that enables a third-party application to obtain limited access to an HTTP service.
PHP	Hypertext Pre-processor: Server-side HTML embedded scripting language.
QR code	Quick Response code (trademark for a type of matrix barcode or two-dimensional barcode)
RAD	Rapid Application Development: a software development process.
SDK	Software Development Kit: a set of software development tools that allows the creation of applications for a certain software package.
SLA	Service Level Agreement: a part of a service contract where a service is formally defined.
SLM	Service Level Manager: is responsible for negotiating SLAs and ensuring that these are met.
UI	User Interface
USB	Universal Serial Bus
UX	User Experience
vof	Dutch: Vennootschap onder firma English: equals general partnership between companies.
VR	Virtual Reality: using computers to create a simulated three-dimensional world.

Chapter 1: Introduction

The graduation company, JUGO vof, looks always for new opportunities to thrive for business value either for them or their clients and, therefore, wants to be on the technological frontier and ahead of competition by exploring new technologies in their early stages.

Amongst others, JUGO specializes in Business Intelligence (BI) and data visualizations. This led to their interest in combining smart-glass technology with BI reporting. From the perspective of smart-glasses, their current state, potential, and business practicability will be investigated. The focus of the assignment combines mainly two aspects of BI that come together: technology-driven and concept-driven BI. An in-memory computing solution is rather technology-driven, whereas the visualization part of data and information in terms of BI is more concept-driven. Therefore, a proof-of-concept with examples of (real-time) reporting and a feasibility study of data visualization elements for smart-glasses are developed.

Given this relatively new smart-glass technology, problems arise in the areas of implementation choice and user interface design, both very specific and bound to the smart-glass itself (here Google Glass).

Starting by carrying out an independent research and conducting surveys for getting an understanding of the public perception and their opinions on smart-glass technology, the project follows the waterfall methodology for the rest of the project. Within the design and implementation phase, an agile approach is taken for rapid prototyping and delivery of new iterations. The Development-Oriented Triangulation (DOT) framework is used for reference throughout the course of the assignment.

The structure of the report, its chapters and their respective content is as following: Chapter 2: About the Company provides information about the company where the graduation project was carried out. Chapter 3: Assignment Overview gives all the details about the assignment, its phasing, execution, deliverables, and problems and risks encountered. Chapter 4: Results with its subsequent chapters describe the systematic execution of the project following the proposed phasing and final results of the project. Chapter 5: Discussion(s) debates about the practicability and integration of smart-glass technology in the business environment. Chapter 6: Conclusion(s) and Recommendation(s) closes the official report by providing conclusions derived from the project and recommendations are given for further investigation and research topics.

Chapter 2: About the Company

This chapter provides the reader with all information around the graduation company. It describes how the company is structured and organized. Additionally, an organizational chart depicts the domain of the assignment within the company.

2.1 JUGO vof

JUGO vof is a SAP consultancy with focus areas in BI and data visualization based on SAP tooling. It was founded in June 2004 and is located in 's-Hertogenbosch, Netherlands.
Besides advising, JUGO vof is also sparring partner for its clients and partners. This is reflected in the motto "JUGO connects", which refers to the consultants connecting processes, people and technology all empowered by SAP.
JUGO has opted for a vof structure so that partners can easily join. The company JUGO consists of two parts: JUGO Contracting B.V. and JUGO vof itself.
JUGO Contracting B.V. hires third parties, such as freelancers, when additional capacity is needed to accomplish defined customers goals. Through this separate B.V. (apart from the general partnership), any risks, such as chain liability, can be kept low.
JUGO vof on the other hand, acting like an umbrella organization, consists of several partners. With this structure it is intended that work streams remain separate and no competition is arising between the partners.
JUGO Service Centre B.V. is the managing partner and provides back office services to the remaining partners. JUGO Consultancy 3 B.V. specializes in SAP CRM. JUGO Consultancy 6 B.V. specializes in SAP NetWeaver. These members have no own employees.

2.2 JUGO BI Expertise Centre B.V.

As described above, JUGO vof consists of several partners.
JUGO BI Expertise Centre B.V. (BIEC) focusses on BI driven by SAP tooling and is the largest partner in the general partnership.
The graduation takes place within JUGO BIEC.

Figure 01 shows the organizational chart of JUGO vof and the graduation project. The graduate student reports to Mr. van Lent as company mentor, and managing partner of JUGO vof. Furthermore, communication and information exchange takes place amongst all JUGO colleagues.
Fontys, more precisely the International Student Service Desk (ISSD), is depicted because it provides the smart-glass device during the graduation period.

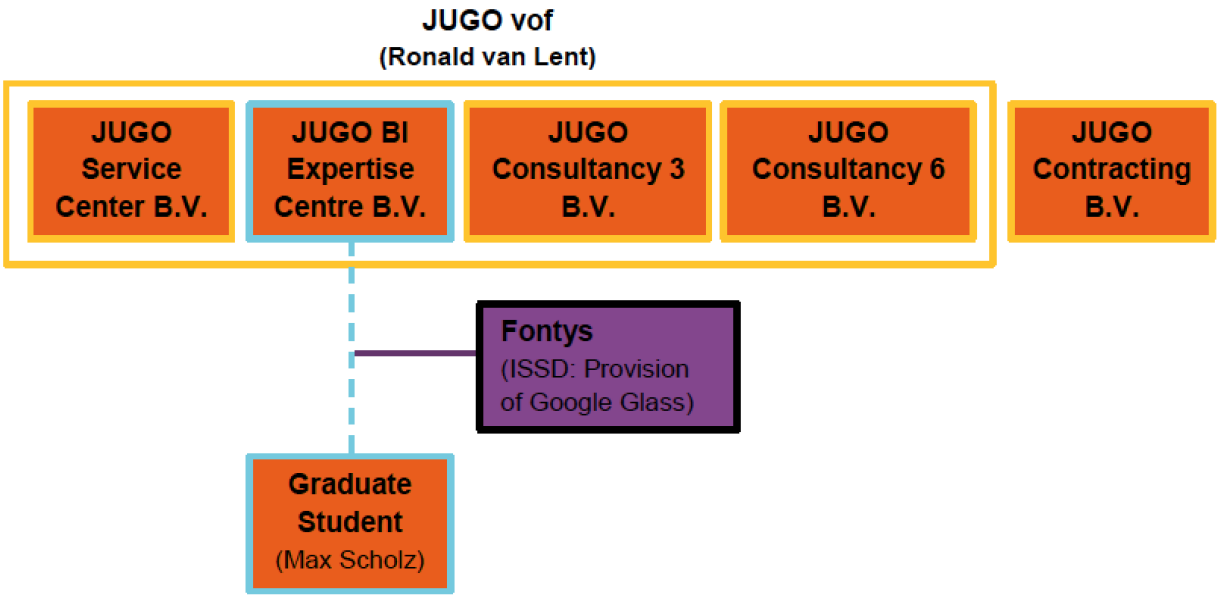


Figure 01: Organizational Chart

Chapter 3: Assignment Overview

This chapter provides a detailed and comprehensive overview of the assignment. Due to lack of knowledge in various areas, such as Android development and (technical) possibilities of the testing device prior to the project, the initial assignment plan couldn't anticipate all factors relevant to the project and its execution. Therefore, the attached assignment plan in Appendix B: Assignment Plan might differ in content and descriptions in various sections.

3.1 Current Situation

The phenomena of Big Data creates new opportunities for businesses by applying tools and methods of BI on data to gain better insights into their own business or customers, to support decision-making processes, and to help management in strategy planning.
The amount of data, being internal or external, is rapidly growing and comes in much unstructured formats, i.e. social media data. This poses new challenges for data processing and provisioning for operational, analytical, or strategic purposes.
A need for real-time in-memory computing arose that makes use of latest database technologies. SAP addresses this need with their SAP HANA solutions, which JUGO already supports and includes in their portfolio. HANA provides the analytical processing platform for the data which is normally extracted from operational SAP ERP or BW systems. HANA can be seen as rather technology-driven BI, whereas the data visualization part of BI is more concept-driven.
New innovative technologies also introduce new device formats that need special consideration during development and when applying data visualization, for instance in form of BI reporting. In the field of augmented reality (AR), smart-glasses are examples of such new technologies that transform information retrieval, and presentation.
With JUGO's great interest in exploring such new technologies, an assignment was initiated that focuses on innovative smart-glass technology and its potential in mobile BI reporting.
Below all details of the assignment are provided that includes scope, execution, deliverables, constraints, and problems.

3.2 Purpose and Scope

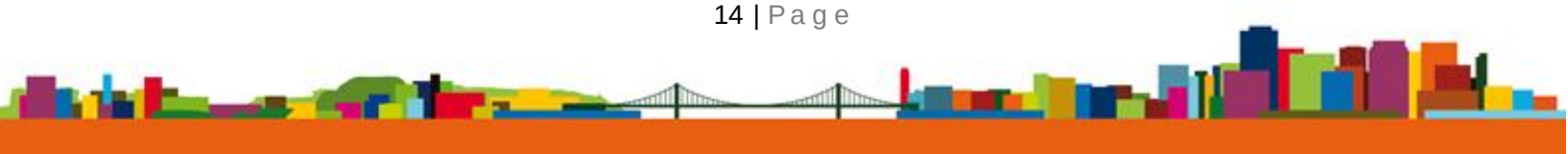
The main purpose of the assignment is to get a deep understanding of the current state of smart-glass technology and its readiness and usefulness for business applications.
Instead of looking for operational use-cases, the assignment focuses more on strategic applications and how smart-glasses could be used mobile BI reporting and serves an information display.
During the assignment this will be reflected in the example of general reports, following the International Business Communication Standards (IBCS) notation form where possible, and an application concept that provides limited mobile BI functionalities such as dash-boarding, navigation, and data processing from static to real-time data input. For more details and additional reading material on IBCS, please see Appendix H: IBCS – International Business Communication Standards. A proof-of-concept environment for exploration of technical possibilities and limitations with the testing device, has to be built. Furthermore, a feasibility study of data visualization elements on this new smart-glass format is conducted. Other aspects of smart-glasses such as managing security of the devices within an enterprise Information Technology (IT) architecture, will only be briefly discussed where needed in the scope of the assignment. An exploratory, opportunistic approach in terms of research and development is taken to seek for potential business value in smart-technology and mobile BI reporting.

3.3 Prerequisites and Equipment

The following prerequisites have to be fulfilled and equipment available in order to get started with the assignment.

Smart-glass
The device used during the assignment is Google Glass. Background information, technical specifications, and why Google Glass was chosen can be found in Appendix B: Assignment Plan under 1.4.1 Google Glass.
Hereinafter Google Glass will be referred to as Glass.

Google account
The account is used to access and use Google services, i.e. authorization process for development purposes. A user needs to associate Glass to that same account. It is needed for setup, adding new WIFI networks by generating QR codes on the screen and then scan them with Glass.



For development purposes later on, the account is required to log in into Google's Developer Console. The console provides features such as creation of a client ID that can be used for Application Programming Interface (API) requests between a registered web service and the associated Glass.

Smartphone and computer
A smartphone provides services such as Bluetooth, personal hotspots, and data connections. Additionally, a computer is needed when the development takes place in native Android. Then Glass gets connected via Universal Serial Bus (USB) to the computer. For adding WIFI networks by generating QR codes with network credentials.

3.4 Phasing

Please see Appendix F: Project Phasing for all details regarding the phasing of the project. For each phase a description of activities is given. Furthermore, the project phasing is depicted with references to the used research framework.

3.5 Deliverables and Non-deliverables

The deliverables of the assignment can be separated into three main categories:

1) Application concept
   This includes conceptual designs and prototypes for an application that demonstrates BI functionalities, focusing on the reporting part of BI using IBCS standards

2) Proof-of-concept environment
   Using Glass as project device, the application concept has to be implemented using available resources. For the context of Glass, this is limited to two basic options: native Android implementation or using a so called Mirror API solution where web services interact with Glass and insert content remotely. Sub-deliverables of this category are all software projects and pieces of code.

3) Reports
   At the end, at least two reports will be delivered: the final graduation report for Fontys and a report (in form of an advisory report, respectively, white-paper) documenting the results and further investigation topics for JUGO in the area of smart-glass usage in their business service catalogue.

In agreement with both tutors, the student will document his progress by blogging about the project progress. As blogging platform LinkedIn©[1] is used. Each blog post is first posted on his personal profile page, then added to the showcase page[2] "Young Talent" of JUGO. The frequency of publishing posts is decided by the student. The blog posts will be used instead of bi-weekly status reports for both tutors.

Non-deliverables of the assignment are the following:

- Connecting the application to an enterprise IT architecture (here SAP systems), since the focus lies just on the theoretical outlook for connectivity of smart-glasses in the business environment.
- Given complexity and limited time available for the project, a complete application ready for adoption, sale, or direct usage is outside of the scope. Therefore, the focus lies on application parts and single mobile BI functionalities.

3.6 Constraints and Expectations

The assignment only focuses on the specific combination of smart-glasses and the data visualization part of BI. This means in regards to other aspects of smart-glasses, such as security and connectivity with other information systems, are out of scope.
Therefore, data used for reports within the application will only be static and real-time processing of data powered by systems such as SAP BW or HANA are excluded from the active development.
For conclusions and recommendations on further research and development assignments, only information and intelligence systems powered by SAP are in focus.

[1] https://www.linkedin.com
[2] https://www.linkedin.com/company/jugo-young-talent

Given JUGO's expertise and services in SAP tooling, the direction toward SAP systems used as data sources for reporting on smart-glasses is the long-term outlook for JUGO.

The exploratory, opportunistic nature of the assignment leaves expectations low and outcomes of the project very open. Looking at the difficulty level of implementation and specific Glass development methods available, only functional parts of a reporting application are expected.

3.7 Problems and Risks

The level of development difficulty for Glass depends on desired functionalities and flexibility in data navigation, processing, and visualization on Glass. Each iteration is delayed due to time and effort put into each new prototype that introduces more and more complex and difficult functionalities. Limitations of Glass in terms of development and technical possibilities are rather unknown or unclear in the beginning of the assignment. This could introduce risks of time delays in the project phasing and deliverables. These risks are mitigated by breaking-down complexity for each iteration and re-prioritizing desired functionalities. Furthermore, since the device used during the assignment is Glass, any outcome may only be partly applicable from a conceptual point of view to other smart-glass devices.
Next to the graduation assignment, the graduate student participates together with three fellow students in a Fontys-wide contest of innovative and creative ideas and products in the field of ICT. The contest, named ICTalent Awards 2015, and the continuation of development of the application will consume time. Therefore, a risk is present that, especially during the time of the finals, the student will have to plan and align his time carefully with the graduation assignment. Please find in Appendix I: ICTalent Awards 2015 more information and links to the ICTalent Awards 2015.

Chapter 4: Results

This chapter provides all information about the execution and results. The assignment results are grouped into four major categories. In alignment with the project phasing, each category documents activities related to each phase and summarizes their results.

4.1 Surveys: Conduction and Evaluation

Conduction

In order to gain insights into the current business environment, understand people's view on smart-glass technology, and get ideas and inspirations for use-cases, the surveys were one of the first activities within the project. Since this has been the first time conducting surveys, the student didn't know which tool to use for creating the surveys. Given the fact that he was mostly working during the assignment with Google products, services, and generally using his Google account frequently, he chose as survey tool Google Forms[3]. The tool is free and provides easy-to-use creating, editing, and sharing options for surveys. With built-in organizing and analyzing capabilities using other Google services, as well as page branching and question skip logic, this makes Google Forms a tool which matches perfectly the purposes.

After the right tool was found and the student acquainted himself with its features, he moved on and created a question catalogue that documents all questions he would like to use in the surveys. From the beginning it was clear that two different survey versions will be prepared. They vary slightly from each other, because the student wanted to separate them into a general (more generic) and a commercial (more business-oriented) version. This way, in the commercial version, he could already go into more specific questions regarding smart-glasses and their usage for business reporting. Overall, with two versions that were aiming for two different target audiences, ideas and inspirations for use-cases could differ given their respective background and ambitions for smart-glasses. Next to more general questions that were quite obvious to ask, such as occupation and sector, the student looked at the business perspective and what is important there. This resulted in specific reporting questions, such as tools and methods used and what kind of reporting level.

[3] https://www.google.com/forms/about

Table 01: Question Topics, Types and Motives – General Survey lists structure, main topics, and question sequence, respectively, logic of the general version of the surveys. In contrast, Table 02 lists the same information only for the commercial version.

Topic	Question Types	Question Motives	Probes
General	Closed questions	Occupation and background of participant	n/a
Smart-Glasses: General	Bipolar question	Participant owns a smart-glass?	Yes: Usage, motivation, and overall experience? No: Purchase planned in near future? What could be the motivation?
Smart-Glasses: Use-Cases	Closed and open-end questions	Most prevailing use-cases to participant	n/a
Smart-Glasses: Outlook	Closed and bipolar questions	Wanted future improvements, price categories, and integration in daily life	n/a
Smart-Glasses: Personal Opinion	Bipolar and scale question	Smart-glasses practical innovation to participant?	n/a

Table 01: Question Topics, Types and Motives – General Survey

Topic	Question Types	Question Motives	Probes
General	Closed and bipolar questions	Industry, challenges, and success measures for participant	n/a
General: Data Factors	Closed and bipolar questions	Get insights into data and information systems usage	n/a
General: Performance Measures	Bipolar and open-end questions	Get insights into usage and composition of performance measures used	n/a
General: Reporting	Bipolar and closed questions	Insights into reporting methods/tools in place	Yes: What methods/tools used? What level of reporting? No: Motivation for reporting?
Smart-Glasses: General	See general version.		
Smart-Glasses: Use-Cases	See general version.		
Smart-Glasses: Reporting	Scales and bipolar questions	Positioning of smart-glasses in reporting for participant	n/a
Smart-Glasses: Outlook	See general version.		
Smart-Glasses: Personal Opinion	See general version.		

Table 02: Question Topics, Types and Motives – Commercial Survey

In the beginning, especially for participants rather unfamiliar with smart-glass technology and how and for what they can be used, the student provided some explanation and links to example use-cases from various industries. The student found those examples by searching the web for already existing applications (specifically for Glass).

After the introduction page, general questions were following, such as occupation and industry, respectively, sector in which the participant is working in.
In the commercial version, the general questions were more business-specific. These questions were aiming to understand the current situation in which the business is operating and the internal/external factors that drive business success. Therefore, what are the most significant challenges in your business and how do you measure business success were amongst those questions targeted to businesses. In addition, the commercial version included questions specific to the topics of important data factors for the business, performance measures used within the business, and eventually current reporting structures. Especially the last topic was important in order to understand what methods and tools are mostly used nowadays for reporting and what technologies or methods are seen to be the future successors of current developments. It also provided insights into the level of reporting most commonly used within a business.
Both versions then continued with specific smart-glass questions. These questions were aiming to grasp an understanding of what are the most important technical and functional features wanted in a smart-glass, as well as getting ideas and inspirations for use-cases. Here, again, the commercial version featured one additional set of questions specific to the usage of smart-glasses for reporting purposes. After that, the survey moved on to the outlook of smart-glasses, in specific with two questions regarding the desired features to be improved and price ranges that are acceptable for the participant. Both versions then close with questions on personal opinions, i.e. if smart-glass technology is a practical innovation or how long does smart-glass technology needs to mature and become both privately and commercially considerable for mass adoption.
Throughout both surveys, the student used follow-up questions, or so called probes, in order to gain more insights behind a given answer. These probes were provided for questions like whether or not the participant owns a smart-glass or in the commercial version whether or not a reporting structure is in place.
The finished surveys can be found in Appendix D: Final Surveys.
As one might see, most if not all required questions were closed questions. This made it not only easy for the participant to fill out the survey in a timely manner, but also helped in evaluating later on the survey responses.

The distribution and sharing of the surveys was also carefully planned and executed. The distribution plan is depicted in Table 03: Surveys: Distribution Plan.

Version	Target Group	Medium Used	Comments
General	IT students	Email	Fontys ICT students mailing list was used (reaches over 100 students). Most responses received out of this target group.
Commercial	Professionals (partners/clients of JUGO and d business contacts of student from internship)	Email	Less participation than expected.
Both	Professionals and general public	Social media platforms (LinkedIn©, Xing©[4], Facebook©[5])	In form of blog post(s) and reposted by JUGO colleagues.

Table 03: Surveys: Distribution Plan

Using social media and mailing lists from the university helped reaching a broader audience and resulted in most responses within days after sharing. The surveys were sent out and open for several weeks for participation. In the meantime, the student was doing his independent research part, which is described in the paragraph 4.2 Research Findings.

Evaluation

At the beginning of April a preliminary survey evaluation from around 70 participants was available. In order to collect more responses, the surveys were kept open until April 20th before the student closed them. However, the surveys themselves were kept open for participation, but only their responses were excluded from the evaluation. As mentioned with the choice of Google Forms, it provided analyzing capabilities to easily collect and export all

[4] http://www.xing.com

[5] https://www.facebook.com

responses to a spreadsheet where columns are the questions and each row a respondent's answers. By merging all answers from the same set of questions from both versions, it was easy to evaluate directly both versions. Of course, the commercial version with its additional, more specific questions needed to be evaluated separately. Overall, the number of participants was around 85. The number is divided into 57 students (74%), 10 employed (13%), 7 others (9,1%), and 11 businesses (business owner, managers, and the like from both versions). The student had to discard about 7-10 responses – mostly from other students – because of counterproductive, childish, or simply absurd answers. Unfortunately, the number of participants in the commercial version was lower than expected. This provided only limited insights when it came to reporting and what to read out of the answers given.

After an evaluation of all responses was done with the help of Google Sheets[6], the student prepared visual representations of the survey results to use for his blog post. The complete results from all questions are available in his blog post[7] writing about the survey evaluation. Note: All blog posts, respectively, their links can be found in Appendix J: Blog Posts.

A selection of interesting and most important survey results can be found in Appendix G: Selection Survey Results.

As a conclusion, the surveys were revealing and insightful. They showed what is important to the general public and business people when it comes to smart-glass technology. Interestingly, for the same questions provided to both target groups, answers differed not that much from each other. Unfortunately, amongst the provided use-case ideas, none was pointing to a good reporting example that can be tried out on Glass. For the application concept that meant that the student needed to find inspiration somewhere else. The process of inspiration finding is explained in more detail under 4.3 Application Concept.

4.2 Research Findings

In his independent research the student focused on two major topics: smart-glass technology and data visualization. By using unobtrusive methods of information gathering, he looked into three sub-topics for each major topic.

[6] https://www.google.com/sheets/about/

[7] https://www.linkedin.com/pulse/graduation-bi-smart-glasses-week-8-9-preview-10-max-scholz

For smart-glass technology, the following three sub-topics were covered:
- Current status smart-glasses
- Cross-industry use-cases
- Knowledge acquisition for Glass

Whereas, data visualization sub-topics included:
- Visualization elements and IBCS
- Performance dashboards

Unobtrusive methods in the research including observation and analysis of available material and information, mainly online, but also of several books, were very insightful.

4.2.1 Current Smart-glasses and Use-Cases

Since the testing device for the student was Google Glass, he primarily focused also his research part of specific Google Glass use-cases. However, before looking into use-cases, a brief familiarization with other smart-glasses took place. A smart-glass comparison chart can be found in Appendix B: Assignment Plan under chapter 1.4 Smart-Glasses.

The research for use-cases revealed mainly operational usages. Early pilots of Google Glass applications have been made with the, yet, in prototype status device. The research didn't reveal any examples related to BI reporting, which can be also on operational level. However, the examples[8&9] found showed rather use-cases where the increased employee performance is derived from the device's direct benefits: hands-free mobility and optimized processes and completion times (reduction of interaction with cumbersome handheld devices).
More examples found can be found also in the beginning of the final surveys, in Appendix D: Final Surveys.

[8] https://www.youtube.com/watch?v=QPbZy2wrTGk
[9] http://www.healthcare.philips.com/main/about/future-of-healthcare/

4.2.2 Knowledge Acquisition for Glass

For the testing device Glass, the student found lots of material, demo applications, and actual real-life business use-cases. Most of the resources were provided by Google itself, as it offers a complete reference guide on their dedicated Google Developers Glass website ([01] Google, Inc., 2015). Findings of Glass-specific research provided important information and guidelines that were needed and kept in mind when prototyping and implementing. The following information and findings specific to Glassware development were results of this research part:

- Design principles when building Glassware to ensure the best experience for users ([02] Google, Inc., 2015).
- User interface (UI) components, their usefulness and interactions between users and UI components ([03] Google, Inc., 2015).
- Design patterns, such as voice invocation model or periodic notifications, to provide consistent experience across all Glassware ([04] Google, Inc., 2015).
- General style guide for Glass, including card regions and dimensions, standard typography and colors, as well as text writing guidelines for Glass ([05] Google, Inc., 2015). Important to mention already at this point is that the standard typography (here Roboto[10] Light, Regular, and Thin) was used throughout the development for faster prototyping and implementation.
- Usage guidance and setup instructions for both implementation strategies for Glassware: native Android Glass Development Kit (GDK) ([06] Google, Inc., 2015) and Mirror API ([07] Google, Inc., 2015) using web-based services to interact with Glass. Both strategies are explained and compared in Table 04: Comparison GDK vs Mirror API ([08] Billinghurst, M., 2014).

Please note that almost exclusively Google's official websites were used for referencing, since they were the most accurate and insightful sources in regards to Glassware development. Furthermore, all information, guidelines and best practices gathered during research were incorporated whenever possible in prototyping and implementation phase. Some references will be made in 4.4 Prototyping and Implementation to the respective source.

[10] https://www.google.com/fonts/specimen/Roboto

However, the above provided information represents already all important references and source material and, therefore, will not be repeated later on.

Criteria	GDK	Mirror API
Programming	Android (i.e. Java)	Server (online/web application)
IDE	Standard Android IDE (here: Android Studio)	Standard web IDE (here: Dreamweaver & browser for accessing web application)
Technology	Android SDKs (4.4.2, API 19) & GDK (Glass specific APIs)	Representational State Transfer (REST) APIs (Java servlet, PHP, and more) Basic HTTP service
Card Usage	Live cards & immersions	Static cards: Text, HTML, media attachment (image & video) Standard and custom menu items
Main Features	Touch pad and gestures Media (sound, camera & voice input)	Subscribe to timeline notifications Sharing with contacts Location-based services
Main Setup	Get correct versions with Android SDK Manager. Apply project (compiler & theme) and device (USB debugging) settings.	Create Google APIs Console Project Prepare a web server Create web application
Summary	Real-time interaction Offline functionality Access to hardware	Platform independence Common infrastructure Built-in functionality
Essence	Install software on Glass	Interact with Glass via Internet

Table 04: Comparison GDK vs. Mirror API

From Table 04 one can see that both strategies have their benefits, but also downsides. The decision was made that first the native Android solution was to be tested, however, given the nature of the assignment and limited availability to Glass during the assignment, made the usage of the Mirror API solution more prevailing toward the end, as discussed in 4.4 Prototyping and Implementation. Figure 02: GDK to Glassware Process shows the typical

native Android implementation approach for Glassware using the Android Software Development Kit (SDK) as basis and compiling the application into an Android Package (APK) for installation on Glass. Shown in Figure 03: Android SDK with GDK add-on are the building blocks provided by both, SDK and GDK. In comparison, when using the Mirror API solution, no compiling or installation on Glass is required, as depicted in Figure 04: Mirror API Overview.

Figure 02: GDK to Glassware Process

Figure 03: Android SDK with GDK add-on

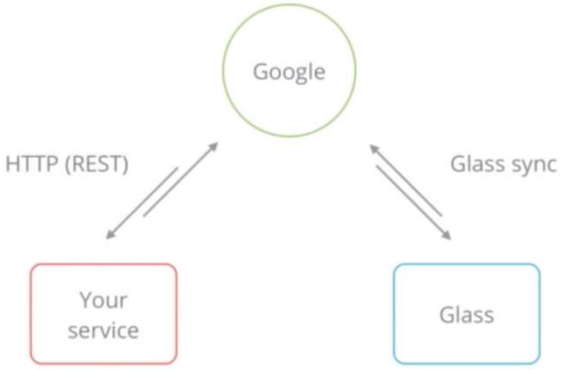


Figure 04: Mirror API Overview

Before going further with specifics on Glass, Figure 05: Glass Timeline Metaphor depicts the fundamental principle on which Glass is built on, the so called timeline metaphor. As one can see in the figure ([09] Android Zeitgeist, 2013), the screen is separated into cards, which contain content varying in type. By swiping gestures on Glass, the wearer can go to past events or more current events, respectively, cards. More details on cards and immersions are provided within the next paragraphs.

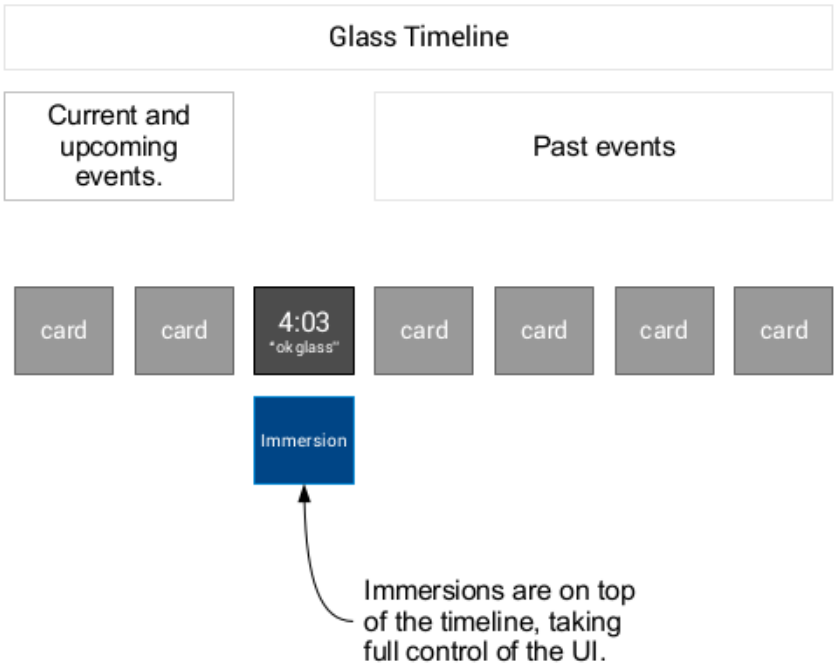


Figure 05: Glass Timeline Metaphor

In terms of information presentation, respectively, visualization on Glass, Table 05: Comparison Cards vs. Immersions shows a comparison of each available card option and provides short explanations of usages.

Benchmark	Static Cards	Live Cards	Immersions
Appears in the timeline	Yes	Yes	No
Access to user input	No	Yes, but timeline takes precedence	Yes, no restrictions
Control over UI	No, must be in the form of a card	Yes, no restrictions	Yes, no restrictions
Major uses	Information display without user interaction	Rich and live content with low user interaction	Rich and live content with high user interaction

Table 05: Comparison Cards vs. Immersions

At this point, the decision was made to primarily use static cards for prototyping and implementation efforts, since real-time user and data interactions were outside of the scope. The main focus of the assignment was to test the data visualization aspects on Glass by using static content. This eliminated the need for real-time data provisioning or any sophisticated user interaction. Therefore, the static cards were ideal for the purposes of the assignment.

However, within the development activities beyond the submission of this report, 4.5 Closure Phase and Activities Beyond explains future usage of the combination of static and live cards. Figure 06: Principle Static Cards shows how a static card is inserted into the timeline on Glass and how it effects older cards on the timeline. For comparison with live cards, please see Figure 07: Principle Live Cards. For completion, Figure 08: Principle Immersions shows how immersions interact with the timeline.

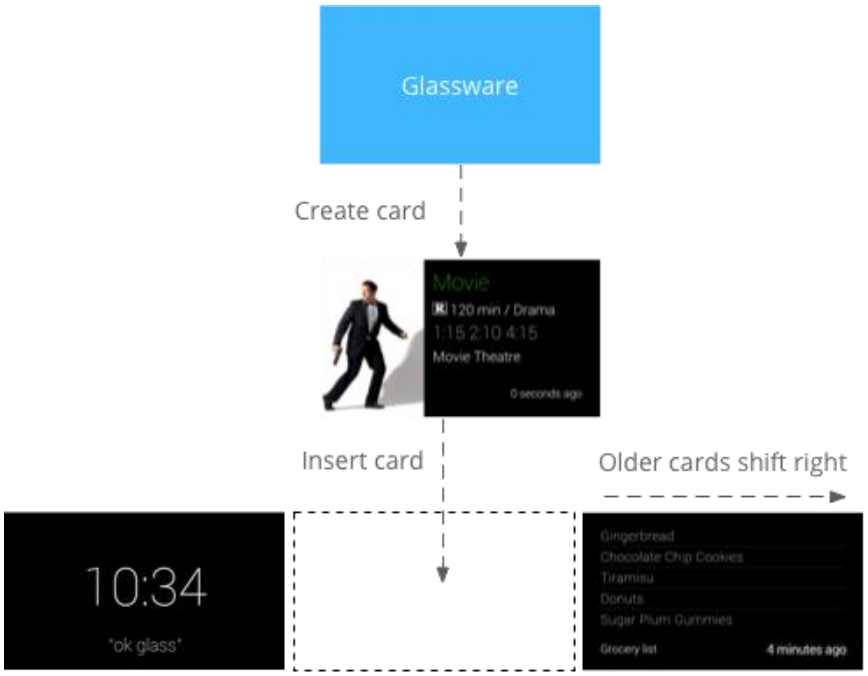


Figure 06: Principle Static Cards

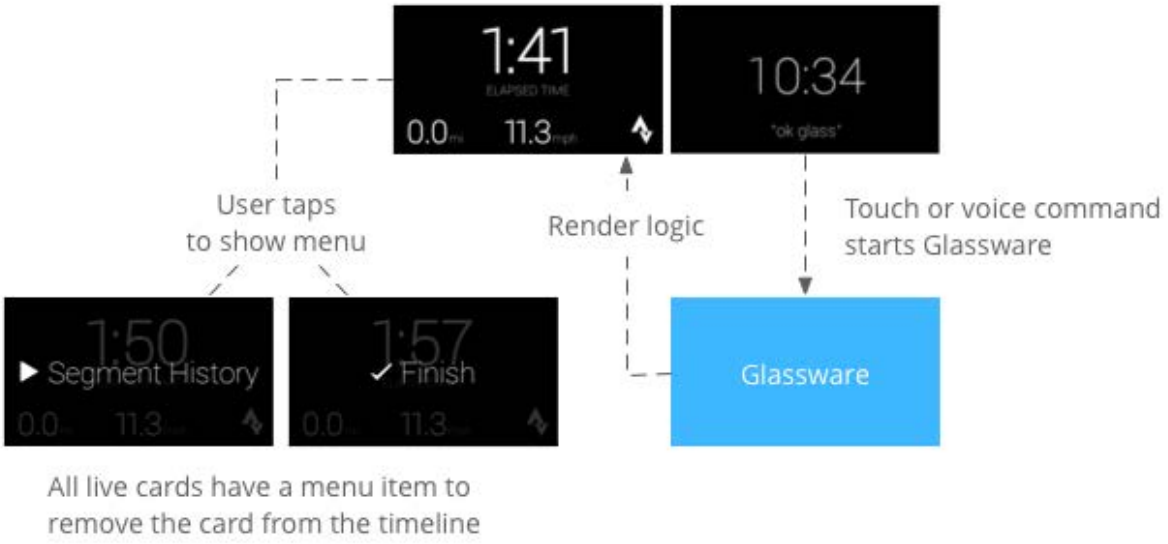


Figure 07: Principle Live Cards

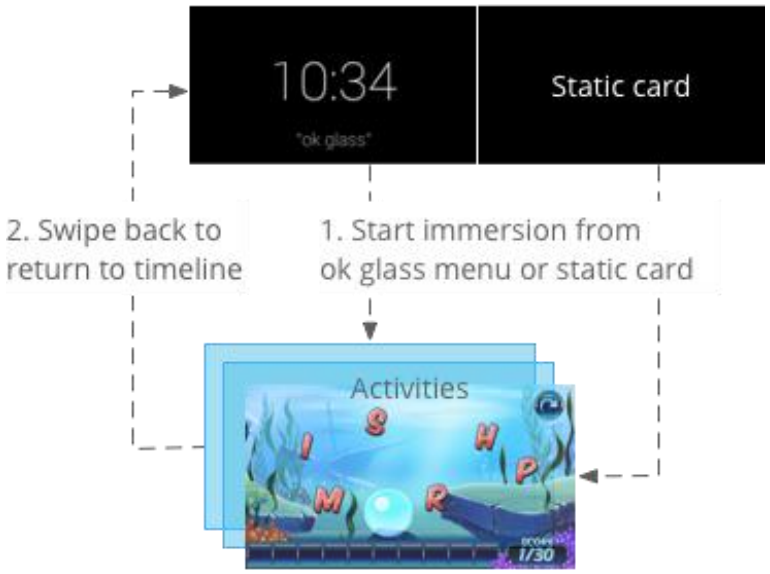


Figure 08: Principle Immersions

In conclusion, the research part for specific to Glass was more than helpful, because of all available (official and non-official) resources and even communities around Glass. This lead to a proper and organized preparation for the prototyping and implementation phase later on.

4.2.3 Visualization Elements and IBCS

After research has been done for Glass, the student moved on to the data visualization topic of his independent research. There, he started by looking into terminologies, best practices, and usage of visualization elements in different contexts, here in conjunction with a new device format. This served for familiarization of the overall topic of data visualization. He also already tried to differentiate and just focus on elements that are most commonly used in the context of BI reporting (see also next paragraph about dashboards). As a result, Appendix P: Data Visualization Elements lists commonly used elements (already following IBCS standards) and a conclusion why or why not that particular element is useful on Glass. Please note that the listing and justification of elements was moved to the appendix for readability reasons.
"The International Business Communication Standards (IBCS) are proposals for the conceptual, perceptual and semantic design of comprehensible business reports and presentations[.]" ([10] International Business Communication Standards (IBCS) Association, 2014). For simplicity and readability of this report, please see Appendix H: International Business Communication Standards (IBCS) for more background information and additional links. Only the most important findings in regards to IBCS and the scope of this assignment are provided next.
The incorporation of IBCS standards can be achieved by HICHERT®SUCCESS rules, "[…] a set of rules for conceptual and visual design of successful business communication compliant with the International Business Communication Standards […] ([11] Hichert+Faisst, 2015).
There are seven primary SUCCESS© rules, each one for a specific purpose within the process of dashboard or report creation.

1.	**S**ay	Convey a message	IBCS: Conceptual
2.	**U**nify	Apply notation standards	IBCS: Semantic
3.	**C**ondense	Increase Information density	IBCS: Perceptual
4.	**C**heck	Ensure visual integrity	IBCS: Perceptual
5.	**E**xpress	Choose proper visualization	IBCS: Perceptual
6.	**S**implify	Avoid clutter	IBCS: Perceptual
7.	**S**tructure	Organize content	IBCS: Conceptual

Note that each one falls under one of the three IBCS design proposals.
In the context of the assignment and the device format of Glass, the conceptual rules did not apply in the project. The perceptual rules were the most prevailing set of rules to follow, followed by the semantic rules.

After the research was completed, an application concept needed to be created, which ultimately in its prototyping and implementation would incorporate the information provided above.

4.2.4 Performance Dashboards

After a general acquaintance with data visualization in the context of BI reporting was done, the student looked more closely into the areas of dashboards and their categories. Since he already had classes on performance indicators and dashboard creation during his minor at Fontys, he was already familiar with the basic concepts and best practices. However, Table 06: Types of Performance Dashboards provides a brief overview of the types of dashboards ([13] Eckerson, Wayne W., 2010) with a short explanation of usage.

Dashboard Type	Usage / Purpose
Operational	Monitor operational processes, events, and activities as they occur (every minute, hour, or day)
Tactical	measure and analyze the performance of departmental activities, processes, and goals
Strategic	Track progress toward achieving strategic objectives in a top-down fashion (e.g. a Balanced Scorecard)

Table 06: Types of Performance Dashboards

Interesting point worth mentioning here is that "[I]n fact […] the three dashboards are complementary: Each serves a unique purpose, and no organization is truly effective without all three[.]" ([12] Eckerson, Wayne W., 2010).
Note that the application concept in the next sub-chapter can be associated to operational and tactical reporting.

4.3 Application Concept

As stated in the assignment description, an application concept had to be developed providing limited mobile BI functionalities such as dashboards, navigation, and data processing from static to, if possible, real-time data input.

The starting point was initially with the results of the surveys and inspiring use-case ideas. But since they couldn't provide a prevailing BI reporting use-case, the student had to continue his search for a good demonstration application. During the search, online and in the physical world by looking at example management reports and operational reporting examples, two major thoughts were kept in mind: firstly, a real-life use-case that is transformed to the new Glass format and, secondly, finding a use-case that follows a long-term goal of using SAP systems as data processing platforms and for data provisioning to Glass have to be found.

An obvious solution occurred shortly after: the work with performance reports that the student had done within his first internship at Siemens AG[11] in Erlangen, Germany. A detailed background is given in Appendix K: Original Reporting Basis. The original management and KPI reports used for further prototyping and implementation can also be found in Appendix K. They are separated by ITIL process that is involved between the Managed Service Provider (MSP) and Managed Service Recipient (MSR).

In essence, from the scenario described above the following was derived and established as **application concept (or user story)**:

Company X had a structural change in their IT department (ITIL processes) and has outsourced their IT operations (incidents, change and demand requests) to a MSP. The Service Level Manager (SLM) is negotiating and implementing Service Level Agreements (SLA) and responsible for the Managed Service in company X. He evaluates the status of the operations and can take appropriate actions on-the-fly based on the KPI reports displayed on his Glass. Additional activities between MSP and MSR are requirements engineering and contingent and contract negotiations which are included in the reports.

[11] http://www.siemens.com

4.4 Prototyping and Implementation

Within the research phase the student could already gather lots of material around Glass development, guidelines, and use-case examples. In addition, with guidelines and best practices in data visualization with IBCS at his disposal, the student knew from the beginning what elements could get in consideration when prototyping and implementing the application concept. There are several things important to mention upfront which had influence on the prototyping and implementation phase time schedule:

- The phase followed an exploratory approach with a proof-of-concept in the end to demonstrate mobile BI functionalities on Glass. However, the ultimate goal was also to grasp the magnitude of the assignment dynamics, meaning the time and effort needed for a smart-glass application project, and lay out groundwork for further research and assignment topics.
- The access to and availability of the device was limited and bound to the following constraints:
    - Official agreement between all parties was that the student could borrow the Glasson on a weekly basis from Wednesdays till Fridays in order to take home or to the office.
    - On national holidays and official vacation days, when Fontys was closed, the student also couldn't borrow the device. For one complete week Fontys was closed because of vacations, which resulted in delays in the development progress.
    - When borrowing the device, it was never assured that the same device can be borrowed. This meant out of six available devices at the ISSD, the student could end up every week with a different device, yet same specifications and only colors were different. However, this meant that there was always a setup required before continuing the development.

With the application concept and original reports available, the student began with an online search for prototyping tools where he found the perfect tool that offered specific Glass prototyping features, such as widgets and predefined cards with demo content. The tool called Justinmind Prototyper[12] was available with all functionalities for 30 days as a trail version, after that the license changed to a free version with only limited functionalities.

[12] http://www.justinmind.com

However, after the pro version expired, the available functionalities were still sufficient for the prototyping purposes. Figure 09: Justinmind Prototyper Tool shows the interface of the prototyping tool.

Figure 09: Justinmind Prototyper Tool

As one can see in the figure on the left sidebar, there are Glass widgets available such as application, action, or operating system cards. The editing of text, images, or other objects on Glass cards was made very simple and easy-to-use since the general interface and available options reminded one of the rich photo-editing application Adobe Photoshop[13]. One feature that came handy offered by the tool was a simulation in the browser where gestures could be simulated by mouse-clicks.

After the right prototyping tool was found, the approach was as following: first the student designed several cards incorporating IBCS standards showing potential elements to be used and tried out during implementation. For the IBCS cards he took arbitrary content, since another motivation was present. He wanted first to test the prototyping capabilities of the chosen tool and, secondly, to figure out the designing boundaries of individual cards, which

[13] http://www.adobe.com/products/photoshop.html

means testing appearance, flexibility in arrangement of elements, and general usage of space. Google's official design guidelines found during the research phase provided all specifications on default typography, font sizes, and dimensions for the card regions. The template card with all dimensions can be found in Figure 10: Card Template with Dimensions. All details on design principles, patterns used, and style guide can be found on the official Google website[14]. The decision was made at this point, in order to speed up further prototyping and development, to use the default typography and suggested font sizes, where possible. In addition, of course, the card template with all dimensions will be used throughout further prototyping for reference.

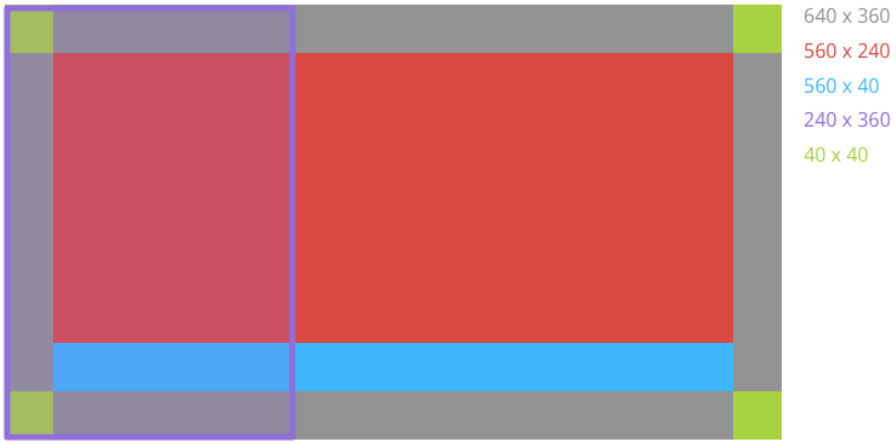


Figure 10: Card Template with Dimensions

The student started the actual prototyping of the IBCS cards with sketches on paper. Please note at this point that the inspiration for the IBCS cards, respectively, reports were taken out of dashboard examples found during research online. They were mixed for the purpose of trying different typical visualization elements. After sketches were finished, the student moved on to the prototyping tool and added piece by piece to the empty card. After a while the adding and editing of additional elements became smoother and quicker. As a result, please see Appendix L: IBCS Prototype Cards for the finished IBCS prototype cards. As mentioned before, please discard the actual content and numbers, since it only served demonstration purposes. The reasoning behind creating cards in both versions, bright and dark, was to later test on Glass how the different backgrounds would affect the perception of the wearer. One thing important to mention in order to understand the IBCS example cards is

[14] https://developers.google.com/glass/design/principles

that the symbol in the top right corner is a stack indicator indicating to the user that at least one other card is stacked behind. This additional card can be accessed by either voice command or swipe gestures, depending on the implementation. So the first goal in terms of prototyping was completed: designing several IBCS cards to be taken into the next stage, development. But before starting with the development, the student designed one more card from the actual application concept, here incident management KPIs. See Appendix M: Incident Mgmt. KPI Prototype Cards for the final prototype card. The student had chosen for the incident management KPIs because he wanted to start with the implementation using that particular reporting part since it should serve with its underlying table structured as a basis for all further cards. As already described, he was using a RAD approach, which meant that he only designed a couple of cards. Then went on to the implementation because he wanted to first test the actual technical possibilities and limitations when it came to realizing the proposed prototypes. With an increased knowledge base the student could then go back again to prototyping and continue in transforming the old reports into the new format of reporting, iteration by iteration. This allowed for fast evaluation and quick adoption of requirement changes, improvements to design and layout, and added functionalities with each iteration.

Satisfied with the designed prototypes, the first implementation activities came next. However, before an actual implementation could have been started, the student needed to decide first on the desired implementation strategy out of the available two options presented in 4.2 Research Findings. So native Android using Android SDK and GDK for hardware access or Mirror API leveraging webs services and insert cards remotely. In order to make the decision, the student first tested the native Android solution since he was not familiar at the time with Android development, therefore striving to expand his Android development knowledge. This resulted in the native Android solution being first more of a familiarization and acquaintance process. As depicted in Figure 11: Native Android IDE - Android Studio, the student used Android Studio[15] as IDE tool. In the figure one can also see on the left side the project structure of the demo application ([14] GitHub, Inc., 2015) found during research and used for testing purposes, which contained several examples cards and actions natively running on Glass or using APIs. To learn the basics of Android development, the student started out by following

[15] http://developer.android.com/tools/studio/index.html

general Android beginner tutorials ([15] Vivz and Anky [slidenerd], 2015) found on YouTube©[16]. After he had grasped the basics, he moved on to a video series ([16] Human Interface Technology Laboratory New Zealand (HIT Lab NZ) [hitlabnz], 2014) found on YouTube© specifically for Glassware development.

The results of his learning efforts turned out to small application parts, playing around especially with more GDK features like usage of voice commands. However, when attempting to implement the incident management KPIs report, the student experienced the complexity of native Android development with all different files and dependencies in order to compile and built the application. Although he consulted with fellow students whose experiences and expertise in Android development spanned already over years, the student couldn't get quite comfortable with the environment and just saw the process of native Android development as laborious and long-winded. A time-consuming, slow-moving process quickly brought the student to the decision of trying the API implementation strategy.

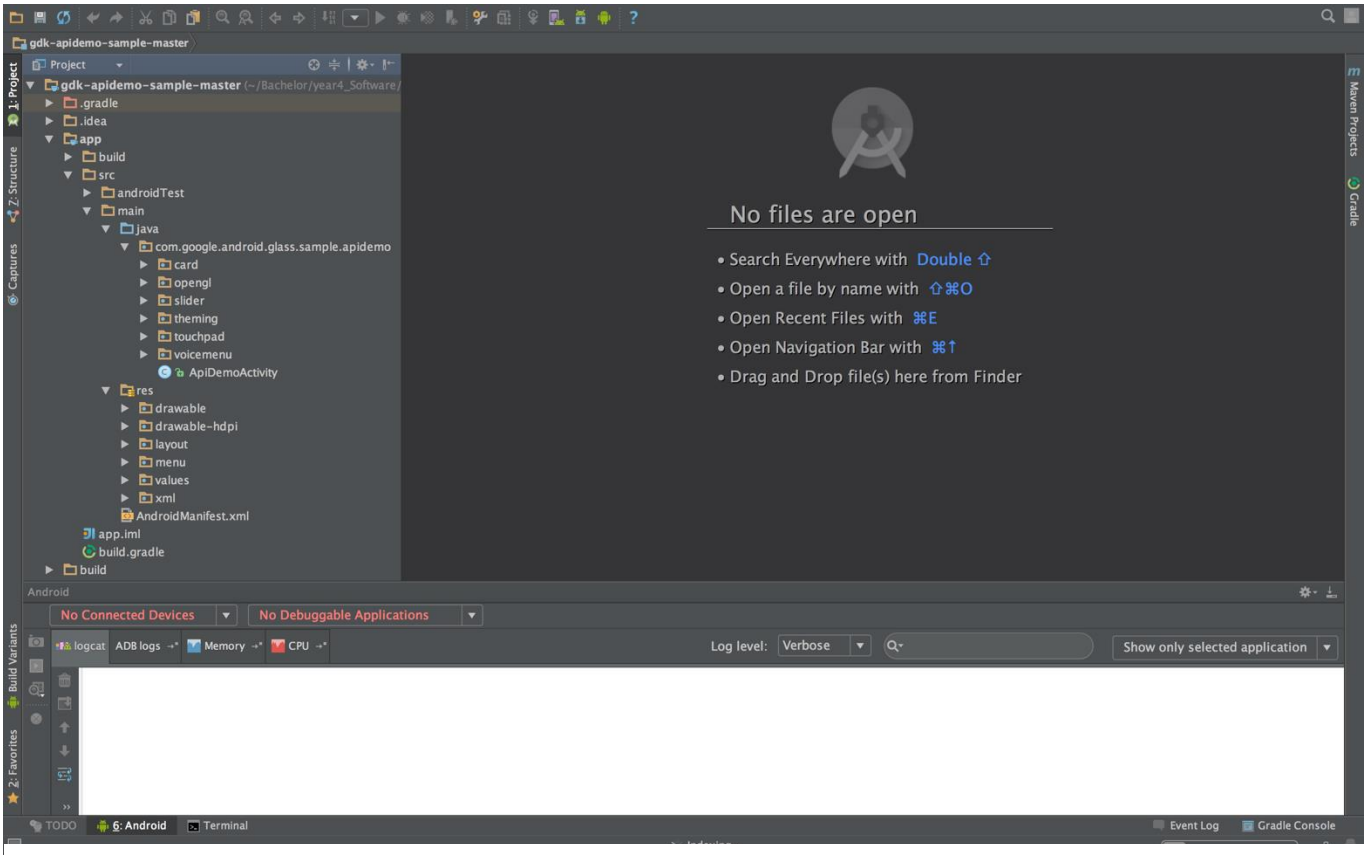


Figure 11: Native Android IDE - Android Studio

[16] https://www.youtube.com

After the student had decided to stop with native Android and moved on to the Mirror API strategy, the development process was speeding up. He had chosen for the Mirror API solution using the PHP edition. A quick start project ([17] GitHub, Inc., 2013) officially released by Google could be obtained from Google Glass's GitHub repository[17]. The usage of web languages, here PHP in conjunction with HTML and CSS for content creation and styling, and typical IDE tools for web development used by the student, here Adobe Dreamweaver[18], came in a very natural way since he already had profound web programming knowledge and the environment was rather familiar. This solution only needed familiarization with the starter project itself and its implemented testing functionalities, as well as understanding the available methods and API calls within the PHP project. Before the student could start with implementing the actual prototypes, certain settings were required in order to use Glass with an API web service solution.
See Figure 12: PHP Starter Project Configuration for configuration variables needed to get desired access and permissions for using APIs. The student needed to create an OAuth 2.0 client ID, which his application uses when requesting an OAuth 2.0 access token. When using OAuth 2.0 for authentication, users are authenticated after they agree to terms presented to them on a user consent screen. Figure 13: Local User Consent Screen shows my consent screen for the student's local testing environment.

```
$api_client_id = "1027279074121-k6uae9hqvekchvlqkcutqoptfmbbvohl.apps.googleusercontent.com";
$api_client_secret = "T[redacted]c";
$api_simple_key = "A[redacted]";

$base_url = "http://localhost:8888/glass";
$callback_url = "https://mirrornotifications.appspot.com/forward?url= " . $base_url . "/notify.php";

// This should be writable by your web server's user
$sqlite_database = "/tmp/database.sqlite";
```

Figure 12: PHP Starter Project Configuration

[17] https://github.com/googleglass
[18] http://www.adobe.com/products/dreamweaver.html

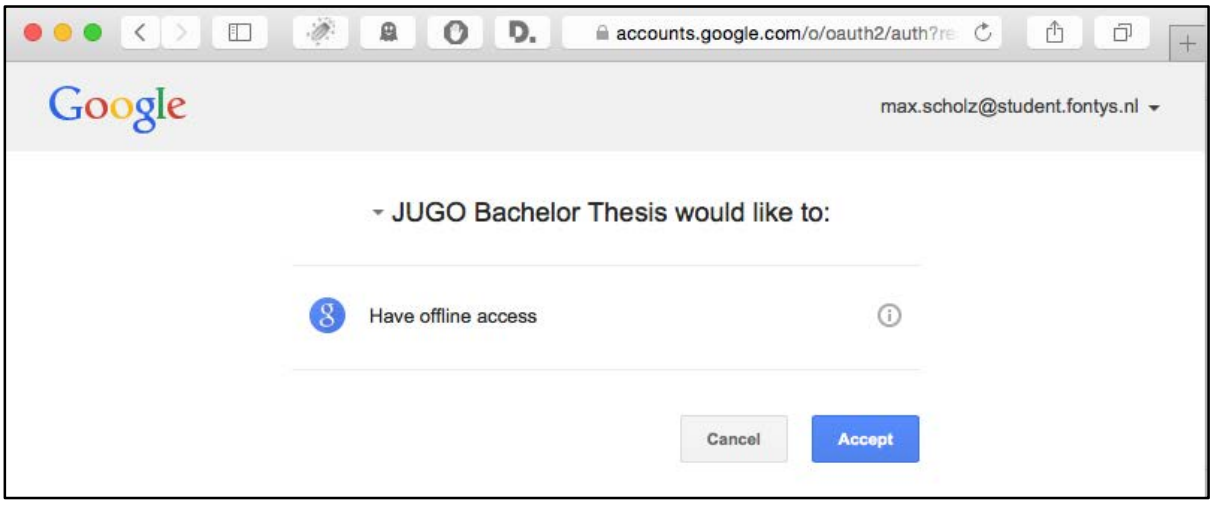


Figure 13: Local User Consent Screen

Additionally, two important settings ([18] Google, Inc., 2015) needed to be set:

- Applications that use JavaScript to access Google APIs must specify authorized JavaScript origins. The origins identify the domains from which your application can send API requests.
- Applications that use languages and frameworks like PHP must specify authorized redirect URIs. The redirect URIs are the endpoints to which the OAuth 2.0 server can send responses.

Both entries can be found in Figure 14: Mirror API: OAuth and API Credentials obtained from the Google Developer Console.

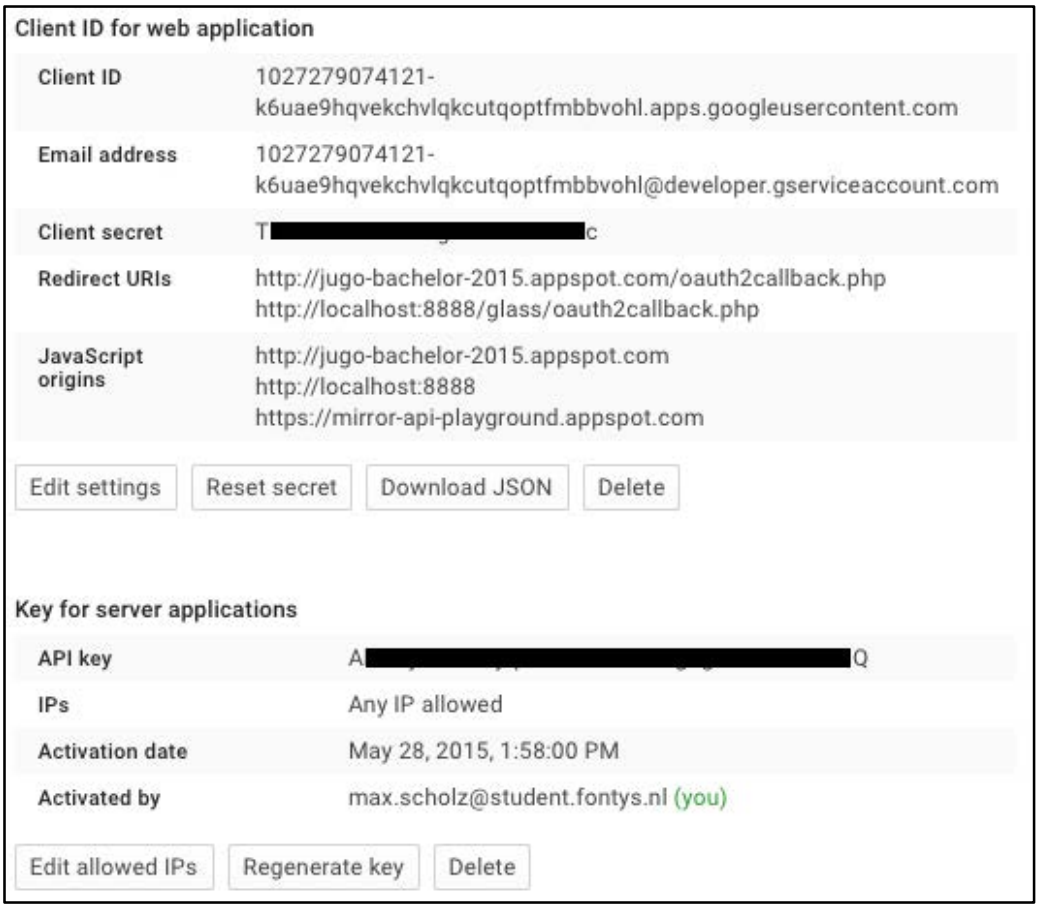


Figure 14: Mirror API: OAuth and API Credentials

After all required credentials and settings have been done, the student customized his local testing environment, respectively, dashboard, as one can find in Figure 15: Local Testing Environment to fit his testing purposes. Please note that all implementation basically takes place behind the scene since content is created and inserted hard-coded behind the desired button using available methods to make use of. As mentioned before, the student started out by taking the incident management KPI prototype and worked on the implementation for that card. Since the API solution used HTML for content creation and CSS for styling, the student could start simple by laying out the HTML structure. First, a table structure was needed that also served later as basis for other cards. The student was just using static cards, which means that content is static as well and no real-time data processing or the like needed to be done. Figure 16: PHP Method for HTML Content shows the default method for inserting HTML code into a card which then was sent to Glass and appears also on the student's local timeline, as shown with Figure 17: Local Incident Mgmt. Timeline Item.

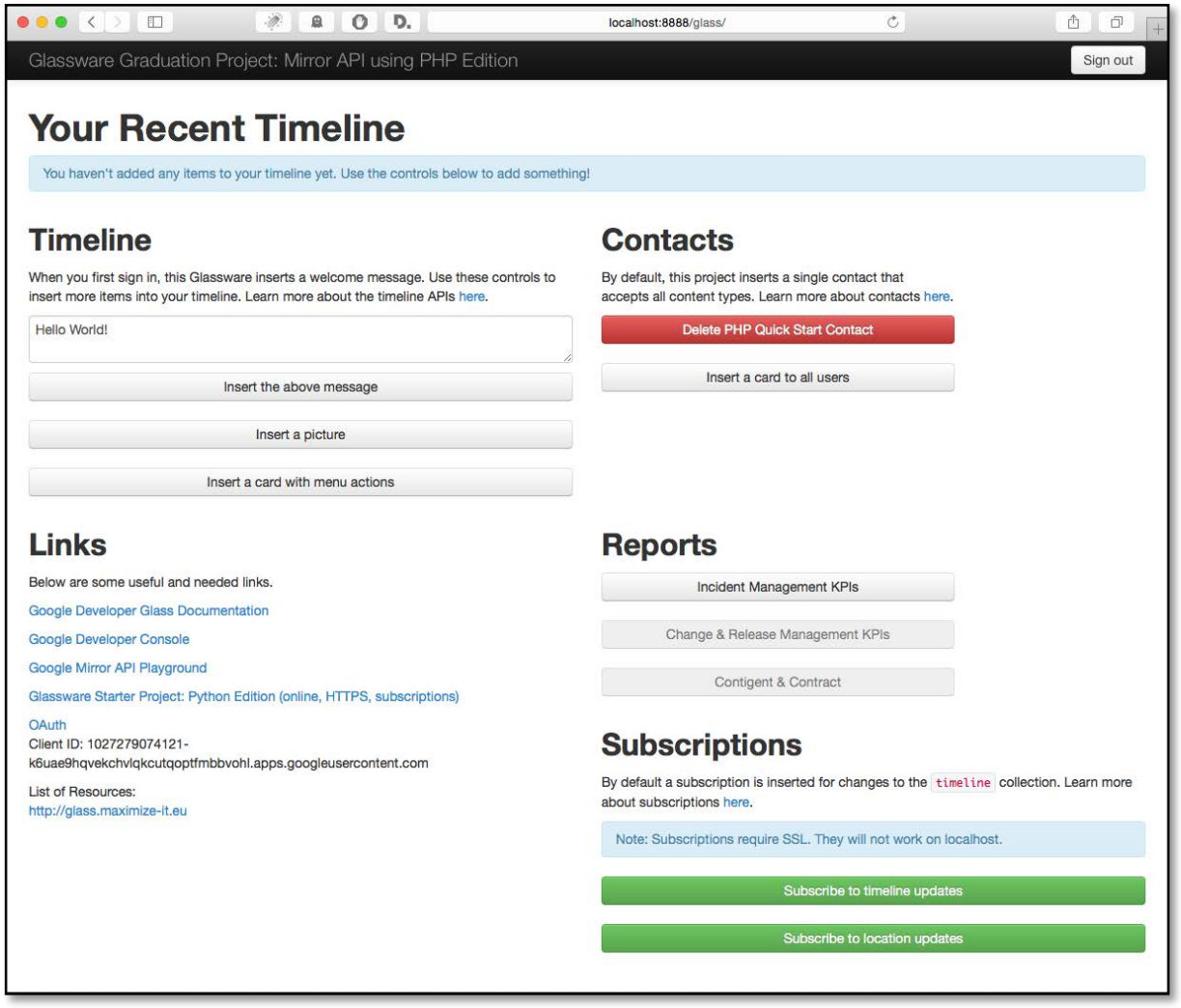


Figure 15: Local Testing Environment

```php
// Handle POST data from the form (if there is any)
switch ($_POST['operation']) {
  case 'IncidentMgmt':
    $new_timeline_item = new Google_TimelineItem();
    $new_timeline_item->setHtml(" HTML structure / content");

    $notification = new Google_NotificationConfig();
    $notification->setLevel("DEFAULT");
    $new_timeline_item->setNotification($notification);

    insert_timeline_item_html($mirror_service, $new_timeline_item);

    $message = "Timeline Item inserted!";
    break;
}
```

Figure 16: PHP Method for HTML Content

The method in Figure 16 "setHTML("…")" was used to insert the designed HTML structure. The base CSS style sheet ([19] Google, Inc., 2015) was provided by Google in order to ensure consistent typography, font sizes, and ensure adherence of dimensions. The outcome, respectively, individuals cards of the incident management KPIs can be found in Appendix N: Incident Management KPIs on Glass.

Figure 17: Local Incident Mgmt. Timeline Item

After successful insertion of a static set of cards (incident management KPIs), it was time to evaluate and re-iterate. This meant comparing the initial attempts and possibilities with native Android with the just successful tested API solution.

In conclusion, the development with PHP-based content creation and interaction with Glass from the student's browser was far more easy and straight-forward than the native Glassware development. The student didn't need to enable special settings on Glass or ensure prerequisites such as correct SDK and GDK versions. No connection via USB to the IDE was required, no compiling and building of an APK. The API way enabled fast implementation and testing since it was just interacting with HTML and CSS and the rest will be handled by Glass itself with the help of base CSS sheets and provided PHP methods to easily insert content into a card and send it to Glass. In terms of time, the implementation of the incident management KPIs cards only took a couple of hours since the student's knowledge in HTML and CSS was more profound than in Android development. This lead to the decision that for any further development activities the student was using the Mirror API solution to implement the prototypes.

All activities done up until this point are summarized again here:

- Design of several prototypes using Justinmind Prototyper tool, including cards with IBCS standards and the first KPI cards, which can be found in Appendix L: IBCS Prototype Cards and Appendix M: Incident Mgmt. KPI Prototype Cards.
- Installation and configuration of required software and frameworks needed for prototyping and implementation, here Android Studio, and local Mirror API quick start project in addition to the SDK Platform and GDK Preview for Android 4.4.2 (API 19).
- Testing of both implementation strategies, native Android and Mirror API solution using PHP.
    - Conclusion: Mirror API is for easy content manipulation and visualizations based on powerful web languages (HTML, CSS, plus more available frameworks if needed). Native Android is only suitable if the application needs hardware access or specific Android SDK and GDK functionalities.
- Implementation of report parts, here based on the incident management KPI report, and tested flexibility in terms of styling and implementing with Mirror API solution.

- Conclusion: The implementation was simple and realizable within a short amount of time. It already provided good insights into the possibilities and behavior of HTML-based card contents.

At this point, the student needed to make a cut in order to finalize his report and document everything from the prototyping and implementation phase for submission. Therefore, the future tense is now used to share the student's intentions on how to continue with the development once this report has been submitted. In 4.5 Closure Phase and Activities Beyond the student describes his intentions for the continuation of development.

4.5 Closure Phase and Activities Beyond

At the time of writing this report, the student was simultaneously still in the implementation phase. Given the additional time between submission of his thesis on June 16th and the official end of his contract with JUGO on June 30th, he will continue working with Glass and extend the groundwork done up till this point. This means that the application parts implemented so far will be extended in such a way that it reflects most if not all of the original reports used for the application concept. The ultimate goal is to build a complete application that combines navigational and functional mobile BI features. A combination of native and API-based solution is aimed-for, also referred to as hybrid model or hybrid Glassware. In this scenario, the user is subscribing to a web service that sends periodic notifications to his or her Glass, which then invokes a live card on Glass based on native GDK functionalities. The combination of both implementation strategies is depicted in Figure 18: Hybrid Glassware.

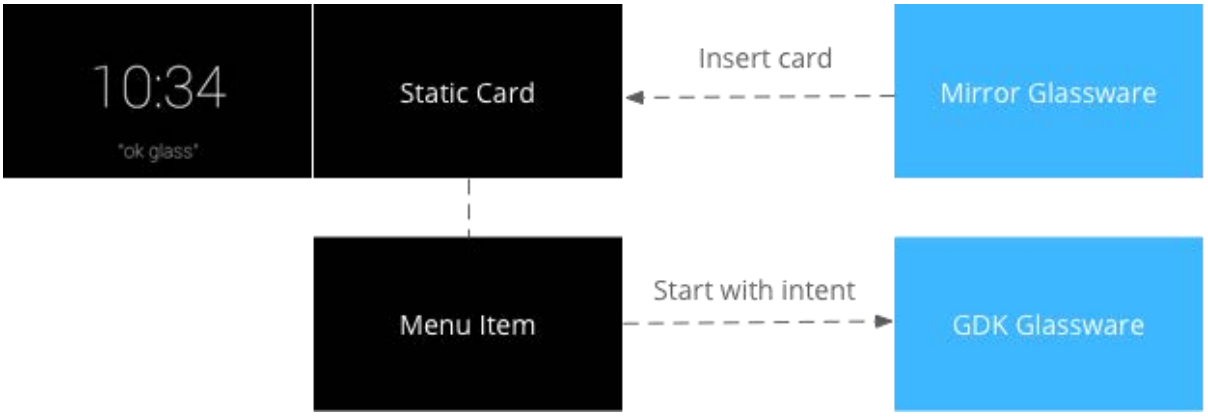


Figure 18: Hybrid Glassware

The development activities will continue with an exploratory and trail-and-error approach, since limitations in all directions, i.e. navigational, functional, and technical, are still unknown. Nevertheless, it is still unlikely that actual real-time data processing and provisioning can be incorporated within the time frame left. In order to give at least an impression on how an actual application could look like in the future, the static content will be combined with other features such as voice commands for future reactions taken by the user and supporting immediate decision-making by offering predefined menu items. Furthermore, various other visualization elements will be tested for feasibility and implementation on Glass.

Next to the further development, the student will work together with JUGO on a white-paper that can be used for publication and distribution to clients and other partners. This white-paper will describe the insights, experience, and prospects gained from this assignment working with Glass. Because white-papers are of promotional nature, the document will target potential customers, partners, and students to learn more about the project, outcome, and possibilities with smart-glasses (here Glass) in the area of mobile BI reporting. This white-paper will be publicly available on JUGO's new website and is branded following JUGO's design guidelines.

Amongst other activities beyond the submission date of this report and eventually the official end of my contract, are the development and implementation of a new website for JUGO. The current website is rather static and is built using a Joomla!©[19] Content Management System (CMS). A preliminary proposal document for that new website can be found in Appendix E: New JUGO Website – Proposal Document. It contains all requirements, wishes, and technical details around the new website. Please note that this document was drawn up within the first couple of weeks at JUGO. Since other activities and priorities didn't leave that much time working on the website project, the project will most likely also extend into the following month.

Next to the website project, the student will finish the e-learning course SAP BW – Advanced BI sponsored by JUGO, and follow other Massive Open Online Courses (MOOC) offered by SAP and other institutions. To find all details about

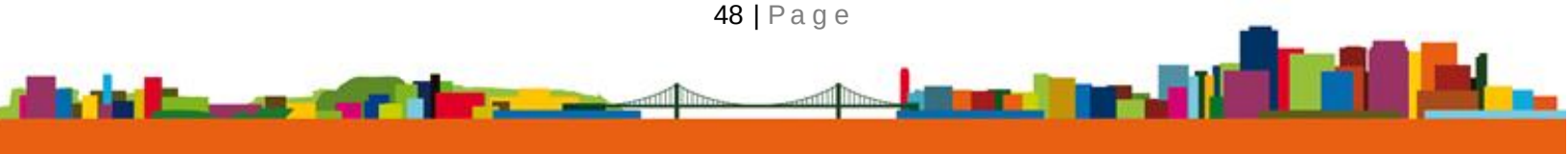
[19] http://www.joomla.org

further educational courses and self-study initiatives, please go to Appendix O: Further Educational Initiatives.

The student will also continue blogging about his progress of development and implementation activities. All blog posts, respectively, their links can be found in Appendix J: Blog Posts. The appendix contains all links with a short description to posts published on LinkedIn© during the graduation period until the date of submission.

For completion of his graduation, there will be also a final defense presentation in front of a jury in his university on July 8th. The jury consists of both tutors of his graduation, an additional assessor from Fontys, and an external expert. In the presentation, the student will have to defend his project, respectively, thesis and answer questions from the jury about the project. All members of the jury will receive a copy of the thesis in advance for preparation. The continuation of development hopefully provides enough time until the presentation date to deliver an application with more mobile BI functionalities combined in one application flow.

At submission date, it was already clear that the contract will be extended to end of July. In accordance with the company tutor, Mr. van Lent, the additional month will be used not only for the activities mentioned above, but also for involvement in the daily business. Admittedly, it is difficult to do just for one month given a certain preparation or training phase into the current situation would be needed. Another idea is to take the opportunity to expand the student's knowledge in SAP tooling and data visualization by making use of training and certification material available to JUGO. But all details and final arrangements on his activities within JUGO beyond the submission date are not available by this point.



Chapter 5: Discussion(s)

This chapter was written for discussion inducements and mainly focuses on the business perspective in terms of smart-glass usage.

Discussion 1: Smart-glasses and reporting?

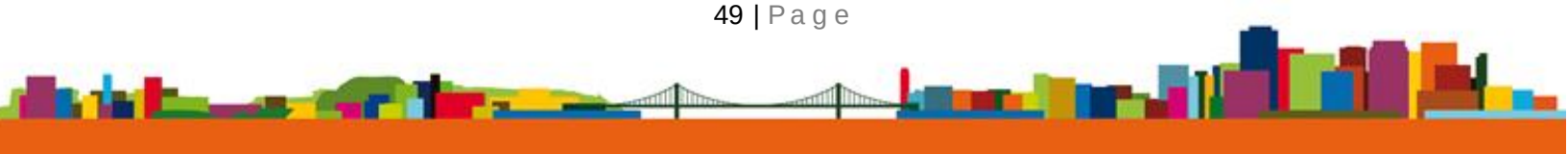
During the course of the assignment we have seen various aspects of mobile BI reporting on smart-glasses. Although the development efforts are high, there are potential use-cases for smart-glasses serving as reporting device. The level of reporting, based also on the survey responses, is seen as rather operational at the moment. In order to prove also their practicability for strategic decision-making, the right scenario and environment must be provided. But this leads to the next problem.

Discussion 2: Smart-glass integration and IT enterprise architecture?

Nowadays, with increasing numbers in mobile (and wearable) smart devices, companies face the challenge of "Bring Your Own Device (BYOD)" policies. Those IT policies must include and support various factors of mobile devices, e.g. connectivity and user management. Most importantly, the nature of the smart-glass use-case also determines the existence (and importance) of security and privacy measures in place. It needs a strong alignment with the existing IT infrastructure and processes like authorization and authentication, to successfully integrate smart-glasses. This means, depending on the modernity of the IT infrastructure in place, companies new to re-think device management, connectivity, and introducing enterprise applications. With an early and right approach, employee performance and satisfaction will increase over time.

Discussion 3: All together: Smart-glasses, SAP systems, and mobile BI reporting?

Looking not too far into the future, basically just looking at the present, we already see prevailing operational use-case for smart-glasses that are powered by sophisticated IT and intelligence systems. An example for that is



SAP with their augmented reality apps[20] to transform the mobile experience with wearables and SAP. Technical possibilities are already provided with Google Glass. However, the use-cases again only focus on operational usages where the most obvious benefits from using a wearable device come to the fore. For more strategic decision-making, other SAP systems must be used in order to provide BI insights. An example is the latest technology of SAP, called SAP HANA[21]. It is an in-memory (normally could-based) computing platform for real-time data processing. By using the presented hybrid model in the context of Google Glass and having the required tools and systems available, one of the further assignments could be to connect Google Glass with SAP HANA. First approaches were already made within the SAP community[22]. However, until now we have not seen comprehensive mobile BI reporting on smart-glasses (here Google Glass) powered by SAP HANA (or any other information system).

[20] http://www.sap.com/pc/tech/mobile/software/lob-apps/augmented-reality-apps/index.html
[21] http://go.sap.com/solution/in-memory-platform.html
[22] http://scn.sap.com/community/cloud/blog/2014/03/25/developing-a-google-glass-application-on-sap-hana

Chapter 6: Conclusion(s) and Recommendation(s)

This chapter will round up the report by conclusions and recommendations derived from the assignment described and executed above.

The user experience (UX) and data visualization elements used during the design and implementation of a smart-glass application must be handled with great attention. Applications for smart-glasses are more interface-oriented than applications for other formats such as tablets or desktop computers. This still leaves all other factors untouched, which would need special consideration when integrating smart-glasses in an existing IT infrastructure, i.e. security (authorization and authentication of users/employees) or data privacy.

Conclusion 1: From the beginning of any smart-glass application project, there must be a clear UX strategy and an assessment of the underlying IT infrastructure that supports data processing and provides readable data input for smart-glass application.

Within the scope of the assignment to demonstrate mobile BI functionalities, prototyping was made very easy with Google's official guidelines and best practices together with tools offering rich editing options. However, the transition to the actual implementation is rather complicated given the limitations throughout the project: Glass hardware features, i.e. battery life and constant network connectivity, and implementation options available, both with their downsides.

Conclusion 2: With the current state of smart-glass technology (here Google Glass), hardware limitations allow only for limited use-cases and development efforts are highly time-consuming (implementation of UX strategy). This calls out for a comprehensive requirements analysis and feasibility study of desired features and functionalities prior any further design or development.

In terms of mobile BI reporting, smart-glasses are simply not suitable yet to support a comprehensive reporting structure. This means that navigational options, such as drill-down or drill-through within a specific card via voice commands, are very limited to their implementation. Furthermore, the visualization possibilities within reporting on smart-glasses are very limited due to the device's format and the perception of the wearer.

Conclusion 3: Smart-glasses at their current state (here Google Glass) are not – yet – suitable for mobile BI reporting. Although a whole new experience can be created with smart-glasses, mobile BI reporting is not amongst the most needful use-cases. The deployment and usage of smart-glasses serve primarily operational use-cases, i.e. for warehouse workers, where employee performance can be increased with benefits like hands-free.

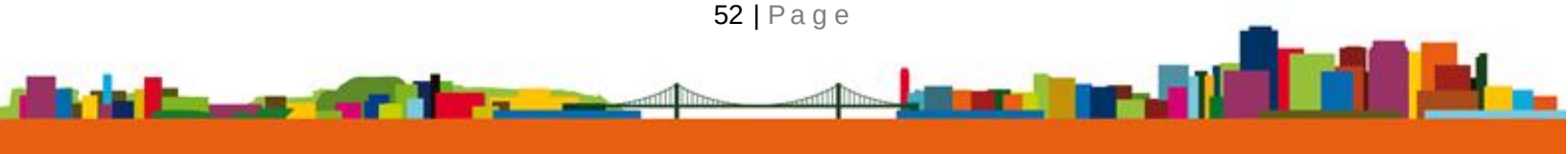
At this point, smart-glasses have been deployed sporadically within specific businesses where a prevailing and immediate added value resulted from smart-glass usage. For those use-cases, the implementation is specific and bound to the respective application and its desired functionalities. This means no intuitive user actions can be taken on the data visualized except those options made available during implementation.

Current developments not only show that Google ([20] 9TO5, 2015) is working on a new release of Glass, but also the general momentum of AR and smart-glass technology holds encouraging and optimistic promises for future usage of smart-glasses in years to come. However, if, at this point, a concrete business application is planned for a smart-glass, one has to be aware of limitations with current devices, both hardware and software-wise.

Recommendation 1: Hold off with actual deployments with smart-glasses, within the scope of this report, for mobile BI reporting purposes until hardware components, like battery, have improved and acceptance and adoption of smart-glasses in society and businesses gradually increased.

Nevertheless, there are several further research topics and assignments that could follow this project here. This includes, again within the scope of mobile BI reporting, the data processing and controlling part. Real-time user interaction and live cards provide a complete different UX, assuming that data provision is guaranteed and the processing part is fully done on the back-end systems.

Recommendation 2: Take the basis developed up until this point for mobile BI reporting functionalities and by using web services that interact with underlying information systems, such as SAP BW or HANA, create reports that are provided to the user in real-time with real data.



Evaluation

Overall the graduation assignment was a challenging, but interesting and rewarding experience, giving me the opportunity to broaden my knowledge and skills in various areas. I was able to expand my skills in data visualization with specific focus on smart-glass formats in forms of mobile BI reporting, and generally gain knowledge in enterprise IT / BI architectures powered by SAP. Uncertainty at the beginning of the assignment gave me a few hesitant moments with constant re-evaluation of the current situation and tasks ahead. Time management, especially toward the end, became very important and crucial in order to successfully complete an assignment like this where expectations were very broad and open.

Working with the new technology and its ways of implementation has provided me with valuable insights and I greatly appreciated the freedom given to me to explore, experiment, and finally develop an application concept and implement it on my own terms. The whole process and development efforts have introduced me to the concept and usage of APIs in combination with transformative data visualization and management reporting using a new category of mobile devices. Seeing functional and navigational mobile BI features in action, all developed and implemented following a trial and error philosophy, was very satisfying. The initial expectations were very low, since the potential of technology and development was unclear in the beginning. During the course of the assignment, once a suitable development environment was ready, expectations grew and resulted in a successful proof-of-concept pilot application.

Looking forward toward a master studies and career in the field of strategic information management and BI, the graduation project has provided me with good insights into SAP software products combined with a futuristic but realistic outlook on a mobile device landscape and potential of mobile BI in coming years. We are just at the beginning of integrating AR and smart-glass technology in businesses and use them for operational or strategic use-cases. For future students this enables and inspires to do more research and development assignments to explore in-depth the growing and untapped potential in innovative mobile BI.

I was given a lot of responsibility and the trust and support that was provided by the company have made this an unforgettable experience and I am grateful to have been a part of it. Further contact and collaboration between JUGO and me will remain.

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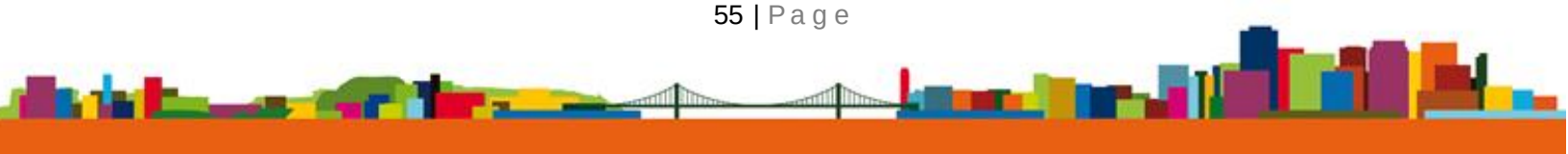


Attachments

Note: The attachments (page 56 and 57) in their full length are only available in the digital version. The final PDF version of each appendix is added as attached comment in the final digital version of this report. Note that the best applications for reading the document and opening attachments are Adobe© Acrobat Reader[23] or FoxitReader[24], both freeware tools. For print-outs or other purposes, please contact the author and request a separated copy (see page 1 for contact details).

Appendix A: Assignment Survey

File: "*Appendix A Assignment Survey 2186625 Max Scholz JUGO Graduation Project.pdf*"

Appendix B: Assignment Plan

File: "*Appendix B Assignment Plan 2186625 Max Scholz JUGO Assignment Plan v2.0.pdf*"

[23] https://get.adobe.com/reader/
[24] http://www.foxitsoftware.com/Secure_PDF_Reader/

Appendix C: Development-Oriented Triangulation (DOT) Framework

File: *"Appendix C DOT-The Five Strategies Framework for Research.pdf"*

Appendix D: Final Surveys

Files: *"Appendix D-1 Final Surveys General.pdf" and "Appendix D-2 Final Surveys Commercial.pdf"*

Appendix E: New JUGO Website – Proposal Document

File: *"Appendix E JUGO WP Proposal Document.pdf"*

Appendix F: Project Phasing

The assignment starts with an orientation phase that includes setup of the working environment within JUGO and acquaintance with the company, colleagues, and systems, respectively, materials used and available. Within the orientation phase, the assignment and communication plan are written and distributed amongst all parties. Appendix B: Assignment Plan holds further details about the project planning and activities. However, both are again described within this chapter in more detail.
Figure 19 depicts the project phasing after the orientation phase together with references to the DOT framework within each phase. Background information and explanations to the DOT framework can be found in Appendix C: Development-Oriented Triangulation (DOT) Framework. Please note that Figure 19 is a revised version, so differences are present from the original phasing in the attached assignment plan.

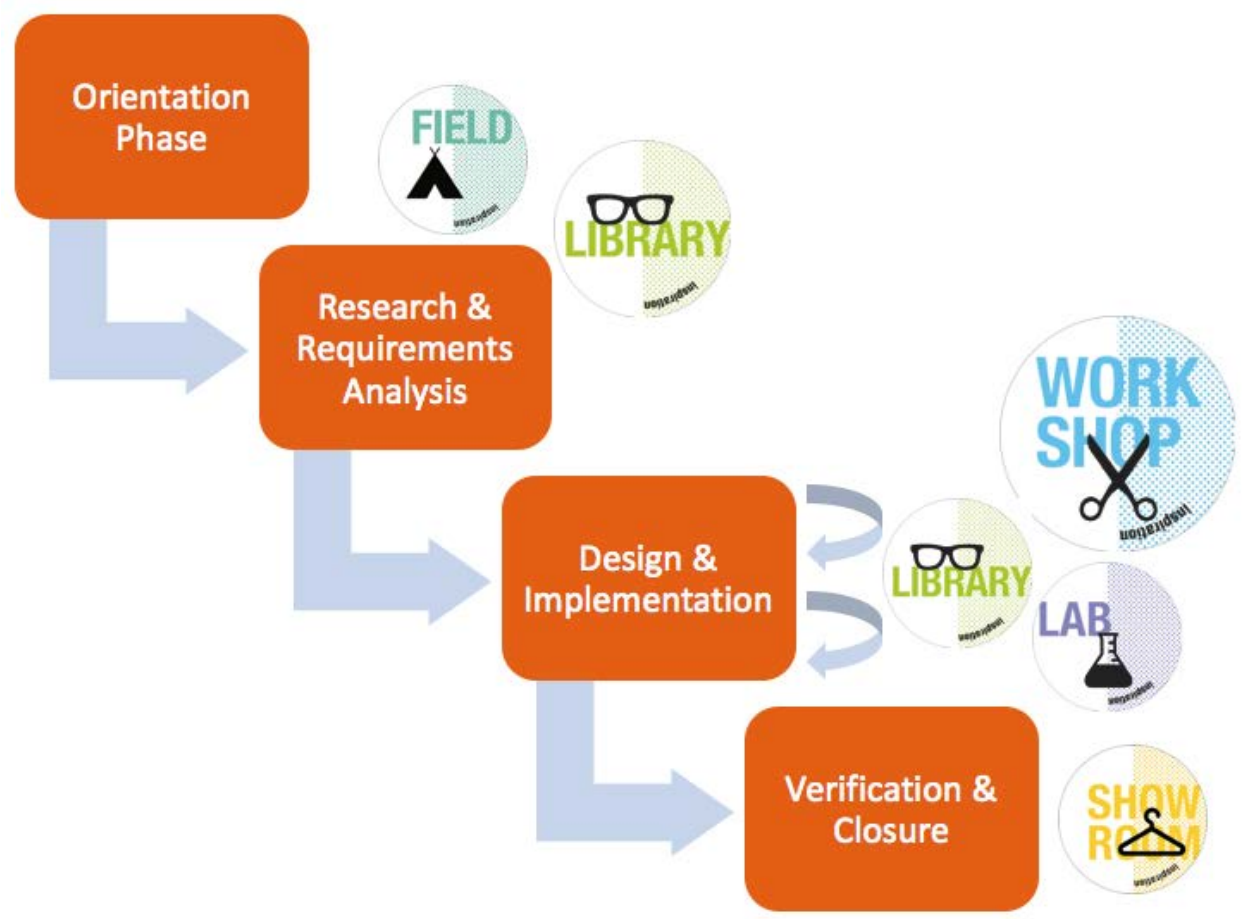


Figure 19: Project Phasing

The phasing follows a mixture of two major software development processes. For the overall project, a waterfall methodology with phases of requirements analysis, design, implementation, and verification is chosen, whereas in the phases of design and implementation itself a more rapid application development (RAD) approach is taken. The waterfall model allows a structured approach toward a final application at the end of the process. It provides a framework for keeping design and development activities within defined boundaries. In contrast, given by the nature of the assignment and smart-glass software development being rather design- and interface-oriented, RAD offers quick response times when user interface requirements change. With more emphasis on development instead of specification and planning, RAD can be used as an iterative approach to deliver new prototypes as the project progresses and new knowledge has been gained from previous prototypes. Both methodologies combined with the underlying DOT framework for applied research represent a profound foundation on which the project can follow a structured phasing and still remain flexible within certain phases of the project.
The following sub-sections provide an explanation of activities within each phase.

Research and Requirements Analysis
The requirements analysis phase is divided into two parts: the first part consisting of an independent investigative research and the second part establishing an application concept for further design and implementation.

The independent research part concentrates on the following topics:

1) Smart-glass technology
    a. Current status of available devices and their integration and development possibilities.
    b. Applications and usage: cross-industry use-cases for operational and/or strategic purposes.
    c. Knowledge acquisition for testing device (Glass).
2) Data visualization
    a. Data visualization elements: terminologies, best practices, and usage of elements in conjunction with new device format.
    b. Key Performance Indicator (KPI) dashboards: categories, guidelines, and visual objectives.

c. IBCS: notation standard of conceptual, perceptual, and semantic design for business communication and management reports (supported and applied by JUGO).

The above will be achieved by means of unobtrusive information gathering methods, such as analyzing documentation material, books, and especially websites for design and development references for Glass.
In addition, the research includes interactive methods, specifically by means of surveys, to grasp an understanding of the current public perception of smart-technology and its usage and possible use-cases. Individual interviews and Joint Application Development (JAD) sessions will take place during the course of the assignment to jointly collaborate and work on specifications and requirement changes for the desired application functionalities.
Next to all research efforts, an application concept needs to be created that demonstrates BI reporting functionalities that are visualized on Glass. This creates a need for an example data set and reporting slides that can be used for demonstration purposes.

References to the DOT framework are as following:
Library strategy: Interviews with individuals and surveying general public.
Field strategy: Analyzing published material, brochures, websites, and other information sources.

Design and Implementation
After an application concept is established during the first phase of the project, the concept is carried over to the design and implementation phase. As mentioned before, the design and implementation phase follows a RAD approach. This results in close coordination and accordance of both phases.
During the designing of the application for this new device format, two aspects should be kept in mind: Firstly, an identification of the usefulness of data visualization elements and their feasibility for reporting purposes on smart-glasses. Secondly, the prototype designs should incorporate the perceptual part of IBCS. Depending on complexity and feasibility, the IBCS standard should also be included in further development activities of the designs.
Using modeling tools that specifically offer prototyping support for Glass, enable a rapid prototyping process of application parts, respectively, Glass screens.
In addition to modeling tools, the Integrated Development Environment (IDE) are split into two categories: native Android and API. Native Android means

that an application needs to be compiled, built, and run on Glass. This is normally called an Android Package (APK). Whereas the API solution is platform-independent using other programming languages, i.e. PHP or Python, and web services for data provision.
The ultimate choice of IDE and implementation method is decided by the student as the project moves forward because of missing experience and knowledge in smart-glass development at the beginning of the assignment. Since the project aims for a proof-of-concept environment, all means currently available are explored that technically support to the implementation of the proposed application concept.

References to the DOT framework are as following:
Library strategy: Design patterns, guidelines, and styles, together with complete native and API specific Glass documentation is provided by Google's developer website.
Field strategy: Inspiration and input gained by interviews with field experts, fellow colleagues, and results from surveys influence the design and development phase.
Workshop strategy: A lot of prototypes are produced in this phase that serve for continuous improvements on design, layout, and appearance of the application.
Lab strategy: Internal assessment and evaluation of each iteration is crucial for delivering a sophisticated application that has been reviewed and critically evaluated before release.

Verification and Closure
The final phase, verification and closure, completes the project by verifying, evaluating, and closing all activities of the project and application development. In this phase the results of the development efforts are collected and processed to be presented not only in this report here, but also used for the final presentation of the Bachelor thesis.

References to the DOT framework are as following:
Library strategy: Empirical writing of Bachelor thesis requires reliable qualitative sources and the right format of expectations of an applied research project and its concluding thesis.
Showroom strategy: Justification of project outcomes, defense of Bachelor thesis (with final presentation following the submission of this report).

Appendix G: Selection Survey Results

However, a selection of the most important results visualized in figures can be found below, together with some explanation, respectively, interpretation.

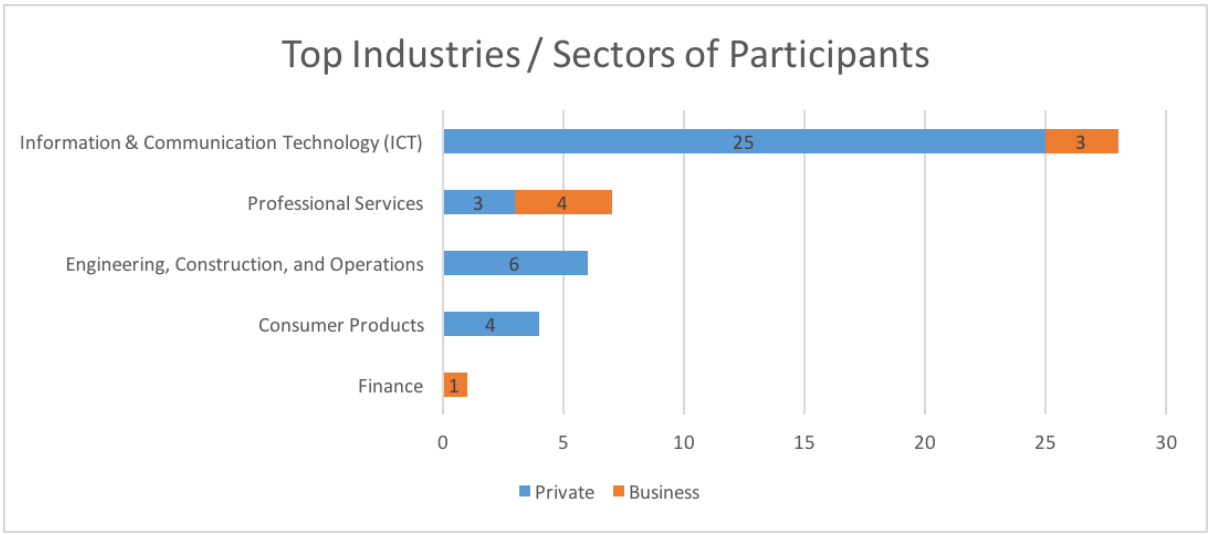


Figure 20: Surveys: Top Industries and Sectors of Participants

Figure 20 shows that the ICT sector dominates simply due to the fact that most responses came from the ICT students from my university. Given the majority of responders probably being students, we are talking about the generation that eventually will use the smart-glass technology in their daily (business or private) life at some point. It's also the generation that might be most enthusiastic about the technology and its usage.

Although the number of respondents was rather low for the commercial version, Figure 21 shows the currently used reporting tools and methods in businesses.

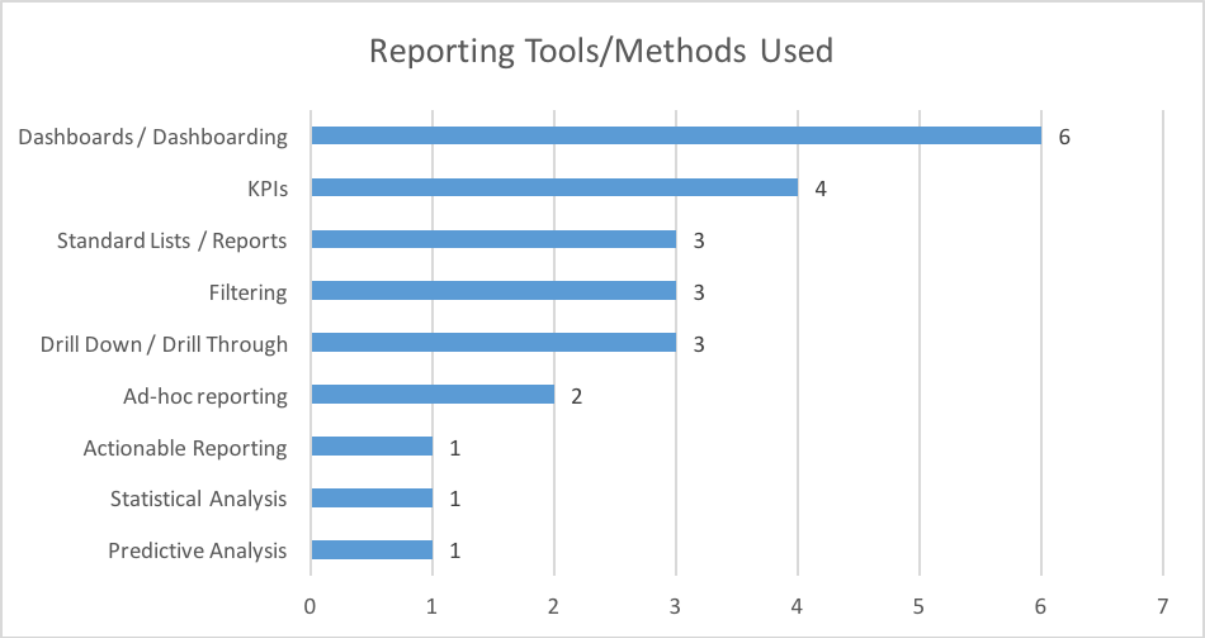


Figure 21: Surveys: Reporting Tools and Methods Used

The top three to five items in Figure 21 were also taken into the next phase as they represent the most important focus areas developing in the context of reporting for Glass later on.

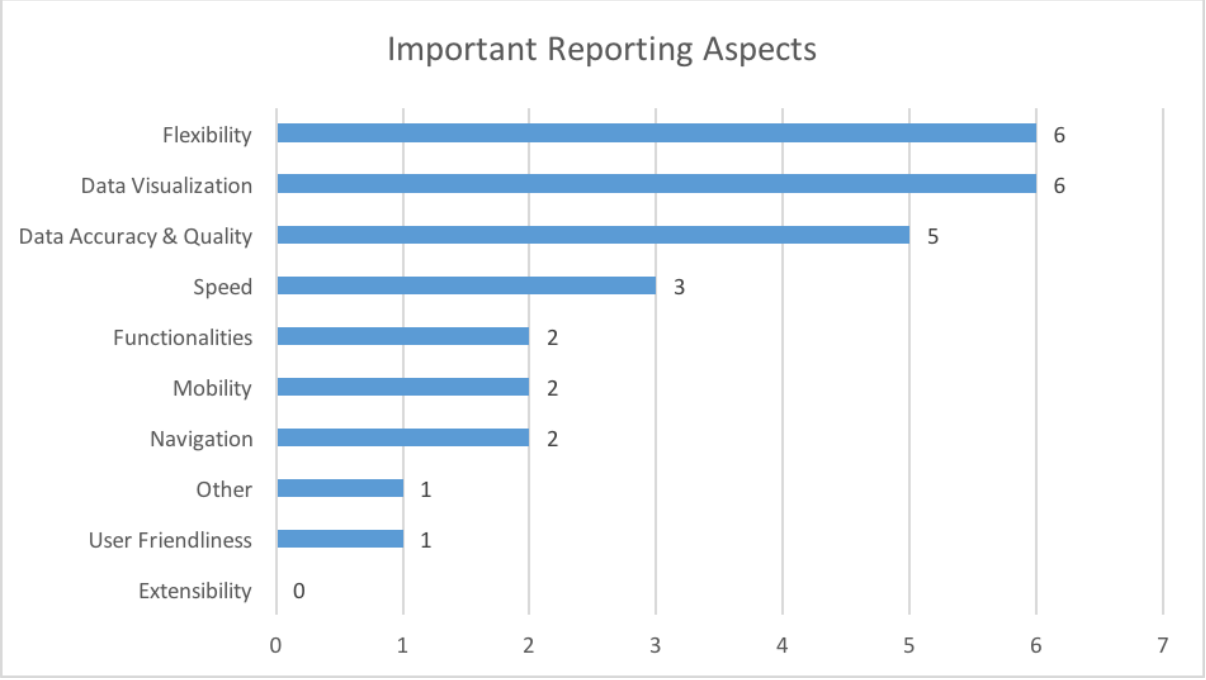


Figure 22: Surveys: Important Reporting Aspects

The top three aspects shown in Figure 22 are, indeed, very important in terms of reporting. Data visualization will get its own focus later on during the course of the project when designing and implementing for Glass.

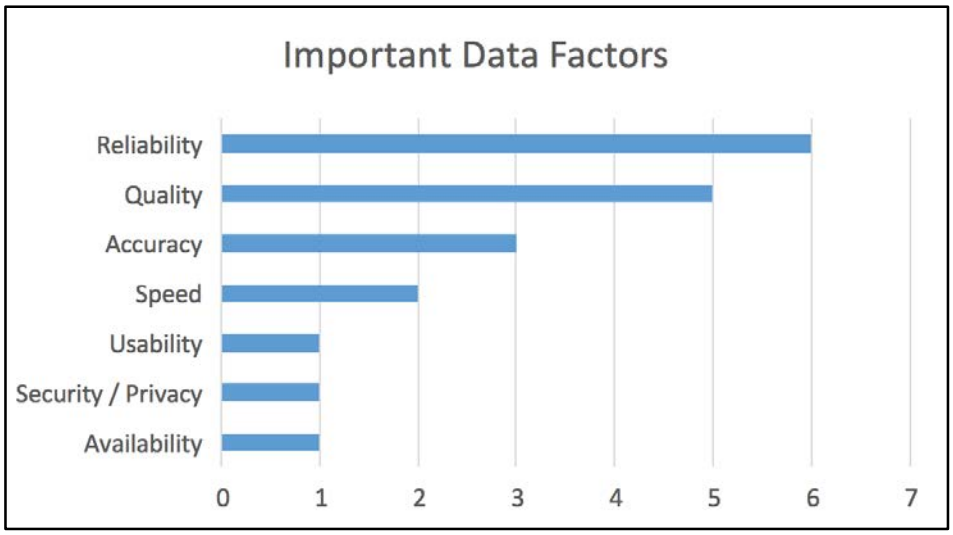


Figure 23: Surveys: Important Data Factors

Unquestionably, reliability, quality, and data accuracy are the most important aspects when using data in reporting, as in Figure 23. This is especially true for strategic decision-making where decision-makers have to rely on accurate and high-quality data.
In terms of reporting, Figure 24 shows an assignment of smart-glasses and their practicability within the respective reporting level.

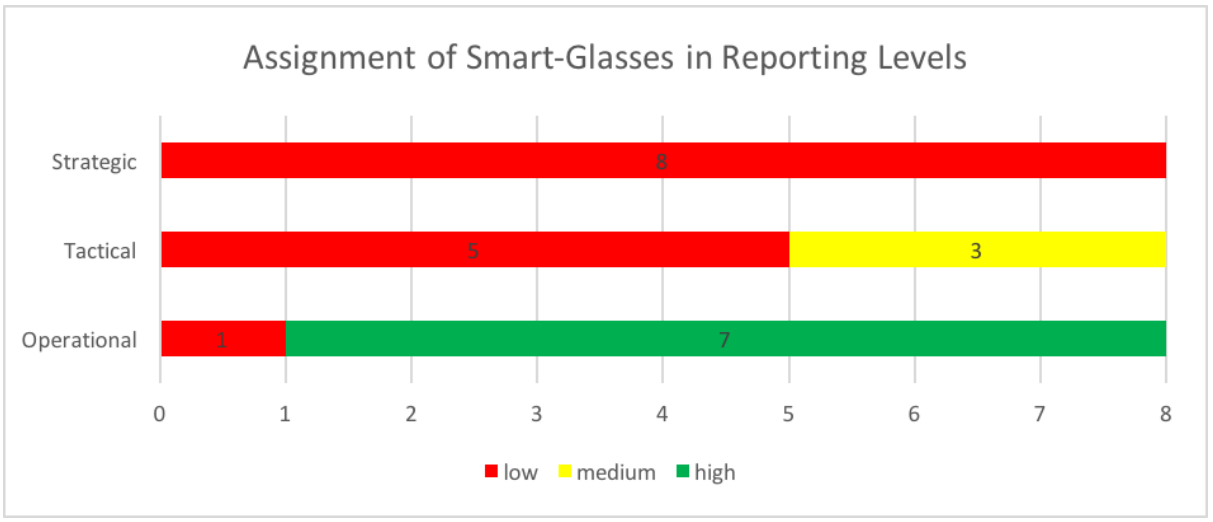


Figure 24: Surveys: Assignment Smart-glasses in Reporting Levels

Apparently, there is no strategic usage for smart-glasses at the moment according to the respondents of the commercial survey version. However, as Figure 24 shows as well, the practicability of smart-glasses in conjunction with reporting is very high on operational reporting level.
Lastly, since the both surveys were also aiming to collect use-case suggestions and inspirations, in Figure 25 industries, respectively, sectors are listed where respondents saw most prevailing use-cases.

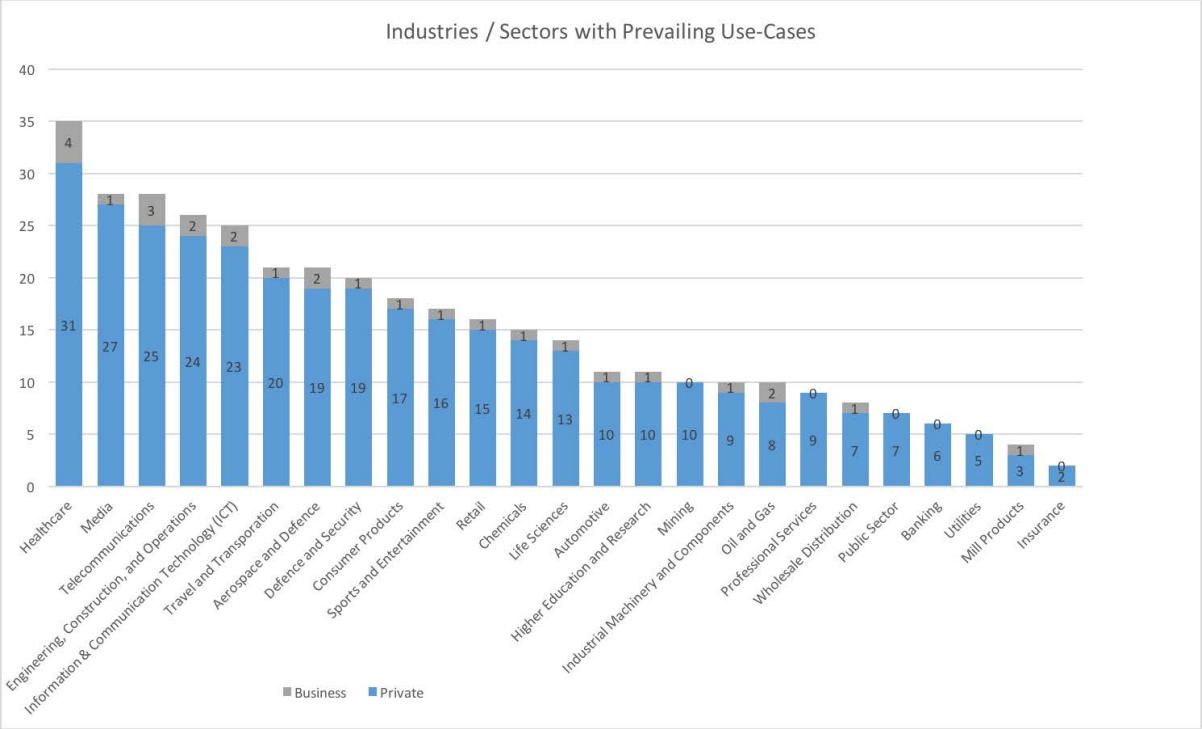


Figure 25: Surveys: Industries and Sectors with Prevailing Use-cases

Specific use-cases described by respondents were interesting, but unfortunately not helpful in the area of BI reporting.
Here are the most useful use-cases suggested by the respondents:

- Flight controller: Data on planes in the air around airport and so forth
- News anchors: Replacement for teleprompter
- Trainers/Coaches: Monitor players' performances (e.g. heart rates)
- Virtual museums
- Insurance agents: out in the field / at the customer site

Each use-case above would need its own discussion on whether or not it's feasible, realistic, and actual adding value in terms of better employee performance or customer experience, i.e. virtual museum. Therefore, the student will not expand on the above since they also pose no particular relation to the assignment and its reporting purposes with smart-glasses.

Appendix H: International Business Communication Standards (IBCS)

The graduation company supports and applies standards in their work in data visualization and BI reporting. One of these standards is a set of practical design proposals for business communication and presentations, called International Business Communication Standards (IBCS). The overall goal is a standardization in communication and reporting documents (of various kinds). Behind the IBCS notation standards is the IBCS Association, a non-profit organization that develops and publishes these Standards. The IBCS Standards are based on the HICHERT®SUCCESS rules, an action-oriented approach for the conceptual and visual design of successful Business Communication (already presented in 4.2.3 Visualization Elements and IBCS). However, Figure 26: IBCS with HICHERT®SUCCESS depicts again the respective SUCCESS® rule in accordance with IBCS.

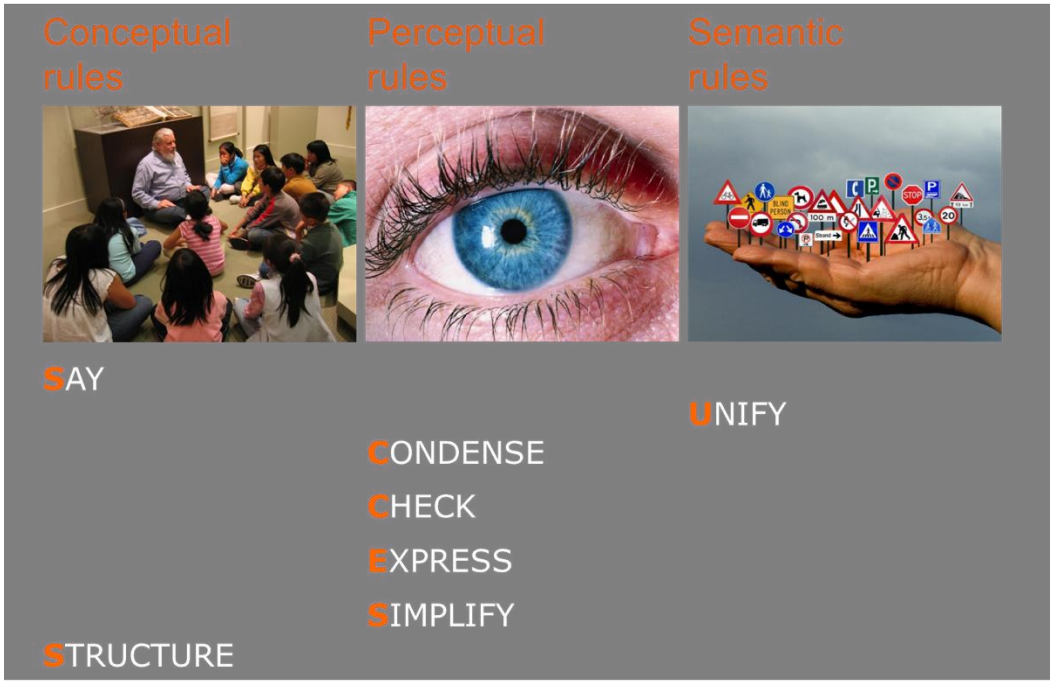


Figure 26: IBCS Proposals with HICHERT®SUCCESS

Given the volume of information, the author kindly refers the following links to (A) Official IBCS Homepage, (B) Official HICHERT®SUCCESS Rules Homepage, and (C) Official IBCS Association Homepage:

(A) http://www.ibcs-a.org
(B) http://www.hichert.com/en/success
(C) http://www.ibcs-a.org/association

Appendix I: ICTalent Awards 2015

The student participated in the ICTalent Awards 2015 together with three fellow students from Fontys. This is a Fontys-wide contest for innovative and creative ideas in the area of ICT.
The group was participating with a decentralized, peer-to-peer file sharing and messaging application (starting on Windows platform) called Sharedesk.
Table 07 shows all events that the student participated in the course of the ICTalent Awards 2015.

Date	Event	Location
30th April 2015	ICTalent Awards: Training Presentation Skills	Fontys, Eindhoven
11th May 2015	ICTalent Awards: Training Entrepreneurship	Fontys, Eindhoven
20th May 2015	ICTalent Awards: Rehearsal	Fontys, Eindhoven
21st May 2015	ICTalent Awards: Finals	Fontys, Eindhoven

Table 07: ICTalent Awards Event Dates

In the finals each out of the ten participating groups had a two-minute pitch. Together with two other groups Sharedesk made it under the top three finalists. As known before the date of the finals, thanks to some online marketing and mobilization of social media contacts, Sharedesk already received the Viral Award, one of the three prices given away in the finals. Sharedesk was able to collect the most likes (combined) for their YouTube© video[25] and Facebook© post[26] on the respective official Fontys Hogeschool ICT site[27] [28].
Unfortunately the idea wasn't persuasive enough for the jury, so the group left with interesting experiences and the Viral Award in their pockets.
Nevertheless, Sharedesk is continuing their work.
The latest information on the project can be found on its official website, maintained by the student: http://sharedesk.maximize-it.eu.

[25] https://www.youtube.com/watch?v=0Jo6Y821OEs
[26] https://www.facebook.com/FontysHogeschoolICT/posts/1083261105034474
[27] https://www.facebook.com/FontysHogeschoolICT
[28] https://www.youtube.com/user/FontysHogeschoolICT

Appendix J: Blog Posts

During the graduation, the student was blogging about the progress of the project to inform and engage with followers on recent updates.
The primary platform used was LinkedIn©, but other distribution channels were also used, i.e. Facebook© or Xing©.
Below are all blog post listed sorted by date published.

Post Topic	Date Published	Link
Introduction to Graduation Project	25.02.2015	https://www.linkedin.com/pulse/graduation-bi-smart-glasses-week-1-25-02-2015-max-scholz
Research	09.03.2015	https://www.linkedin.com/pulse/graduation-bi-smart-glasses-week-2-31-09-03-2015-max-scholz
Surveys	20.03.2015	https://www.linkedin.com/pulse/graduation-bi-smart-glasses-week-4-5-20-03-2015-max-scholz
Preliminary Survey Evaluation	05.04.2015	https://www.linkedin.com/pulse/graduation-bi-smart-glasses-week-6-7-05-04-2015-max-scholz
Final Survey Evaluation	21.04.2015	https://www.linkedin.com/pulse/graduation-bi-smart-glasses-week-8-9-preview-10-max-scholz
Application Concept	24.04.2015	https://www.linkedin.com/pulse/graduation-bi-smart-glasses-week-10-24-04-2015-max-scholz
Bachelor Thesis and Development Process	08.06.2015	https://www.linkedin.com/pulse/bi-smart-glasses-week-1117-08-06-2015-max-scholz

Table 08: Graduation Blog Posts

The blogging was a good experience in growing writing skills and usage of social media platforms as communication channels.

Appendix K: Original Reporting Basis

During the time at Siemens, the student was supporting the project management team of an IT transformation project in the Healthcare IT SAP department. In the following context the department will be referred to as Managed Service Recipient (MSR). The goal of the project was to reduce commodity work related to SAP systems deployed and maintained by the department and outsource these tasks to Atos[29], hereinafter as Managed Service Provider (MSP), that offers global IT services. In the position as project assistant, the student involved in all major processes and activities within the project. Part of the work was to prepare and support the weekly status meetings of the core project team. This meant working with sophisticated management and KPI reports created with Microsoft© Office[30] applications (here PowerPoint© and Excel©). The data for the reports was provided by the individual team leads. This data ultimately was extracted out of the underlying SAP systems. During this IT outsourcing project, the Siemens Healthcare IT SAP department was undergoing further internal changes, such as implementing IT processes according to Information Technology Infrastructure Library (ITIL) ([21] AXELOS Limited, 2011) standards. Furthermore, establishing a reporting structure around the MSP processes that serves all the way up to higher management, here the Chief Information Officer (CIO) of Siemens Healthcare IT. In summary, the student had found this a perfect basis for the application concept. It provided a relevant, real-life example of BI reporting. Now it was the challenge to transform the established reports, including summaries, statistics, and data-driven content, to fit the new Glass format. Ultimately, it still serves the same purpose, just on a futuristic reporting device.

The original reports used for major processes around the MSP and MSR are depicted on the next pages. For further background information on the individual ITIL process, i.e. incident or change and release management, please see the ITIL wiki ([22] AXELOS Limited, 2010) with process descriptions.

Note that each ITIL process is always adapted to the individual environment and scenario within a company. The reports used fit the requirements of the MSR and were customized to their needs.

[29] http://www.atos.net

[30] https://products.office.com

Incident Management

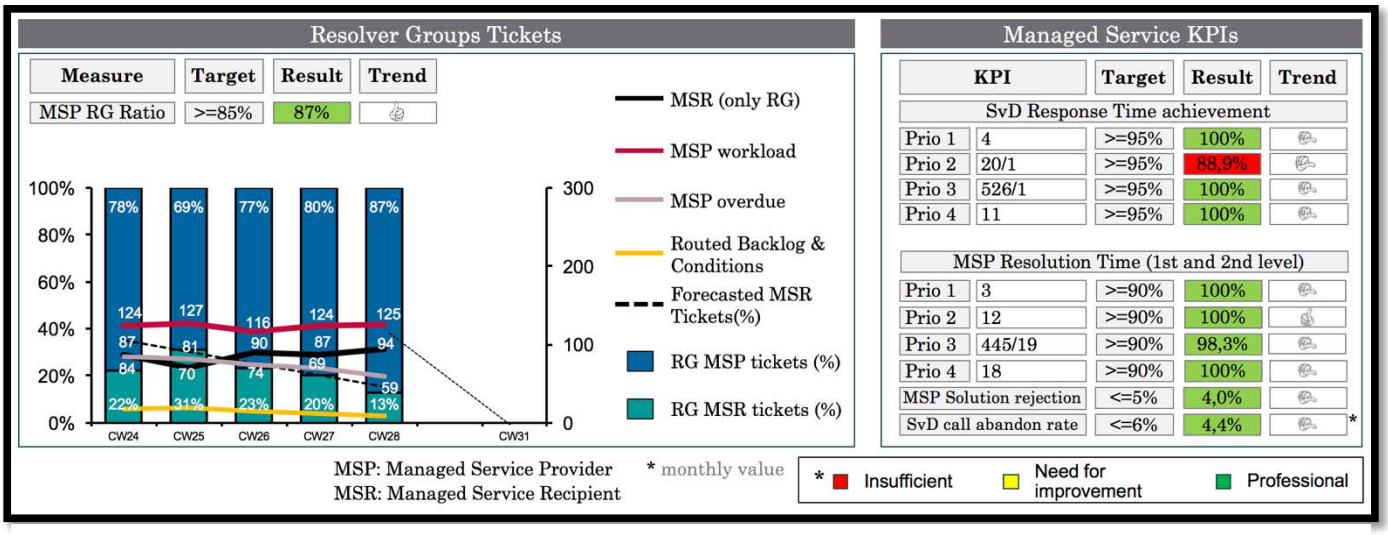


Figure 27: Original Reporting Basis – Incident Mgmt.

Change and Release Management

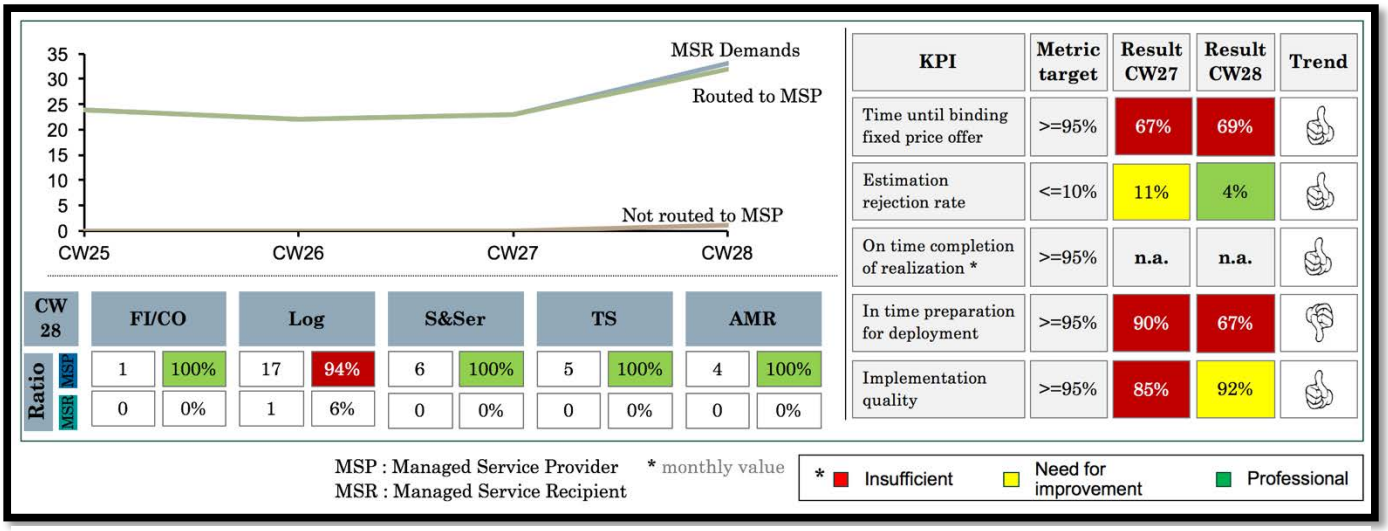


Figure 28: Original Reporting Basis – Change and Release Mgmt.

Contingent and Contract

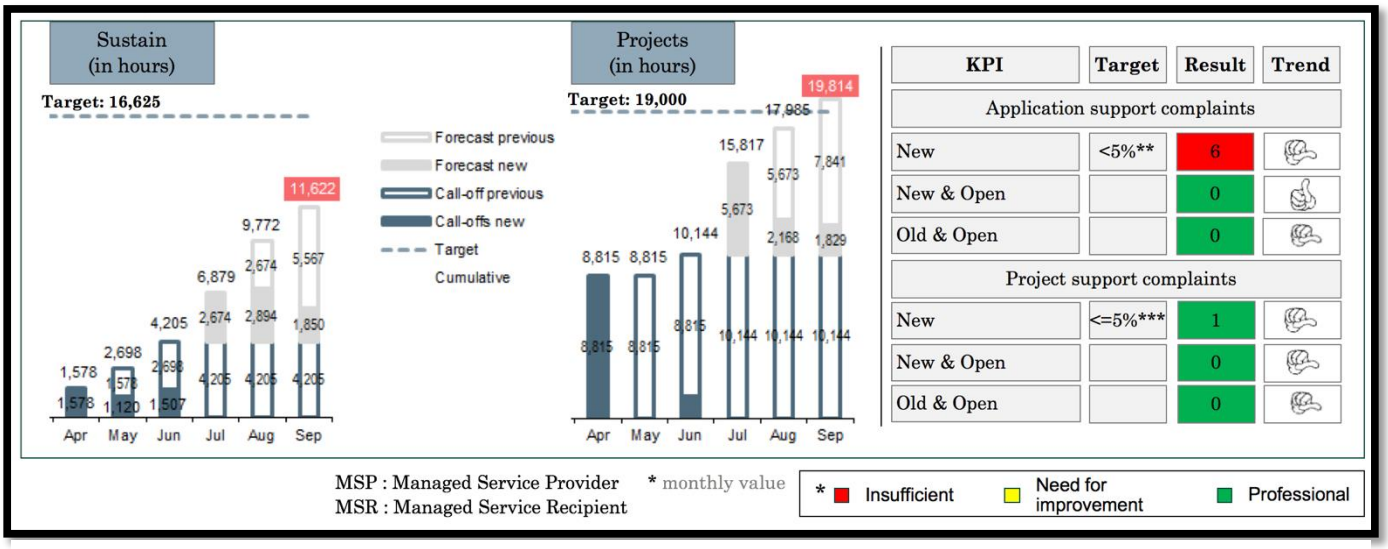


Figure 29: Original Reporting Basis – Contingent and Contract

Requirements Engineering

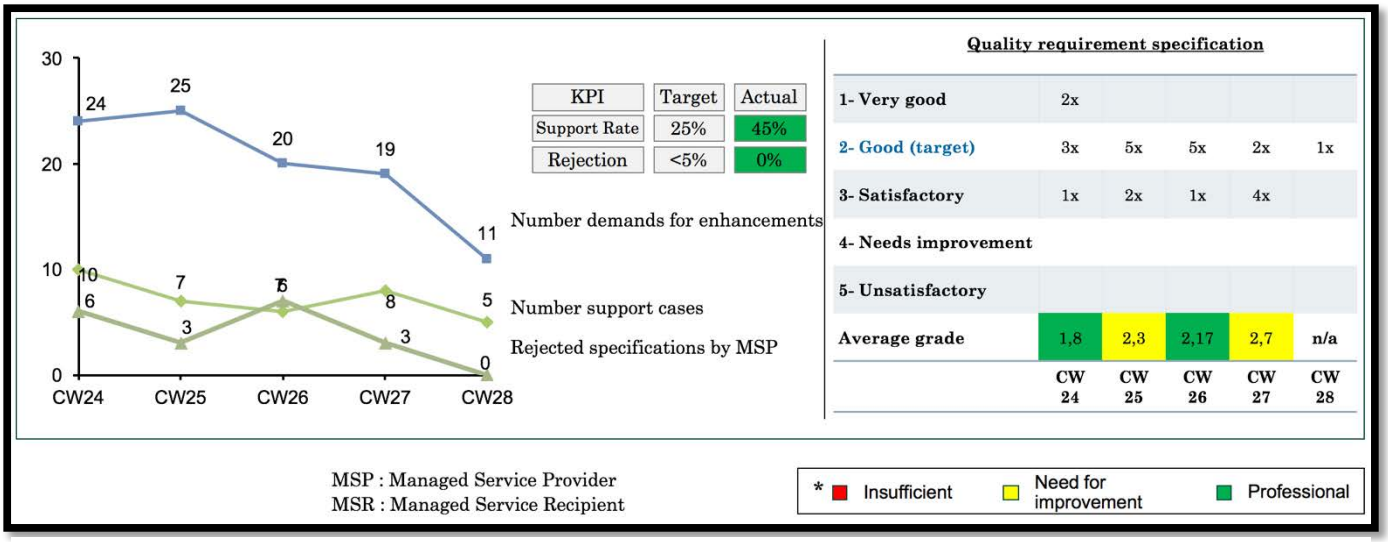


Figure 30: Original Reporting Basis – Requirements Eng.

Appendix L: IBCS Prototype Cards

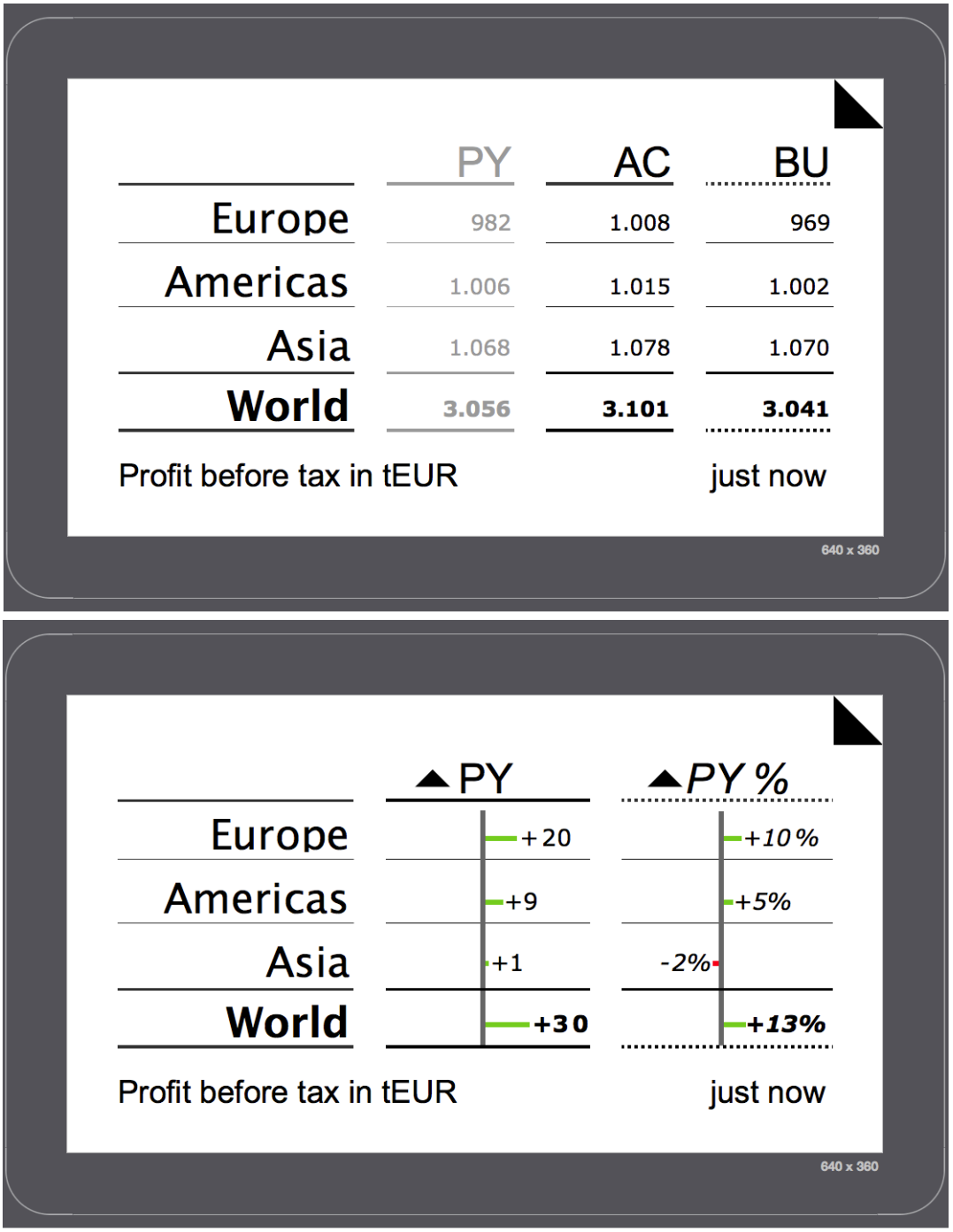


Figure 31: IBCS Prototype Cards bright

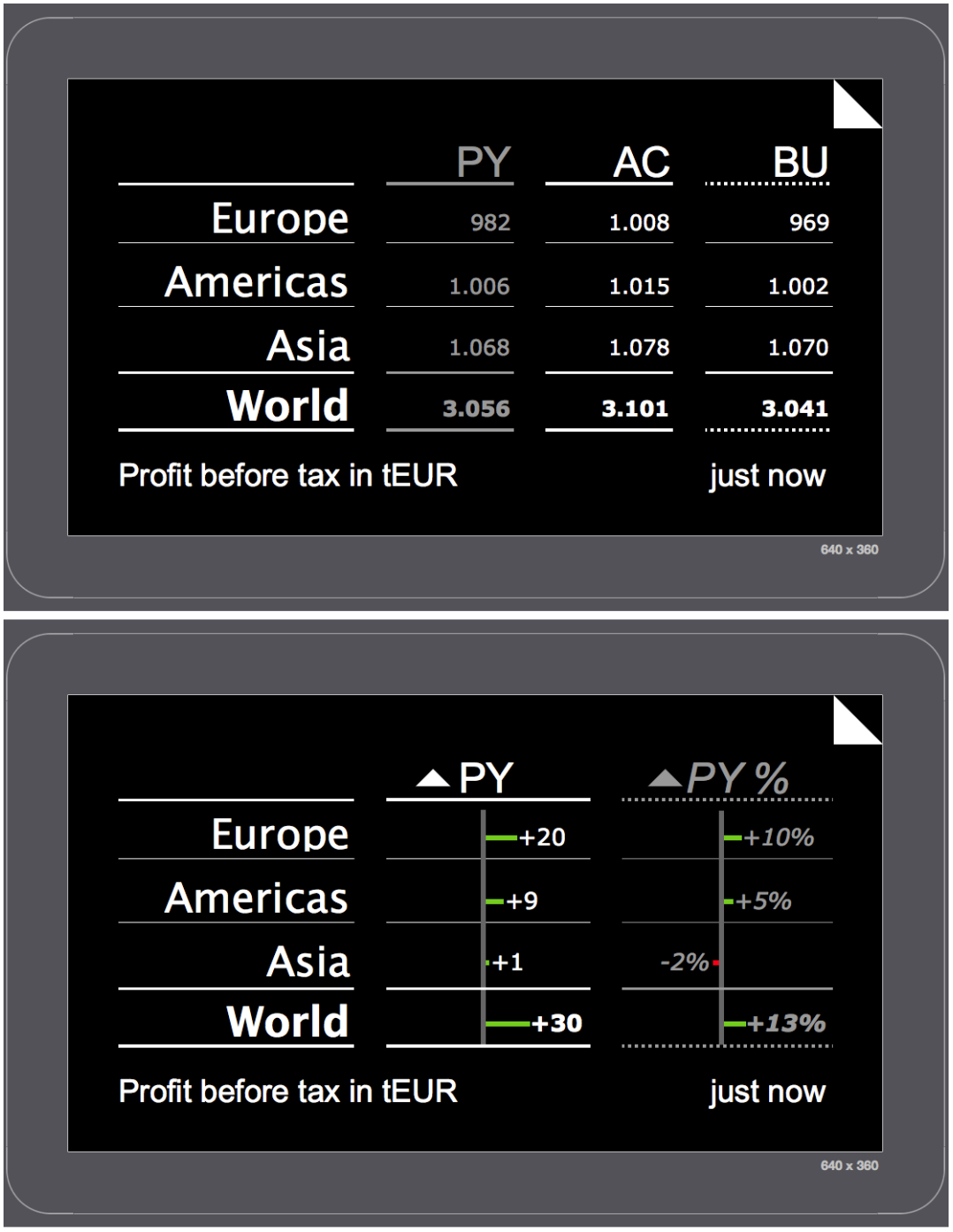


Figure 32: IBCS Prototype Cards dark

Appendix M: Incident Mgmt. KPI Prototype Cards

Figure 33: Incident Mgmt. KPIs Prototype

Appendix N: Incident Management KPIs on Glass

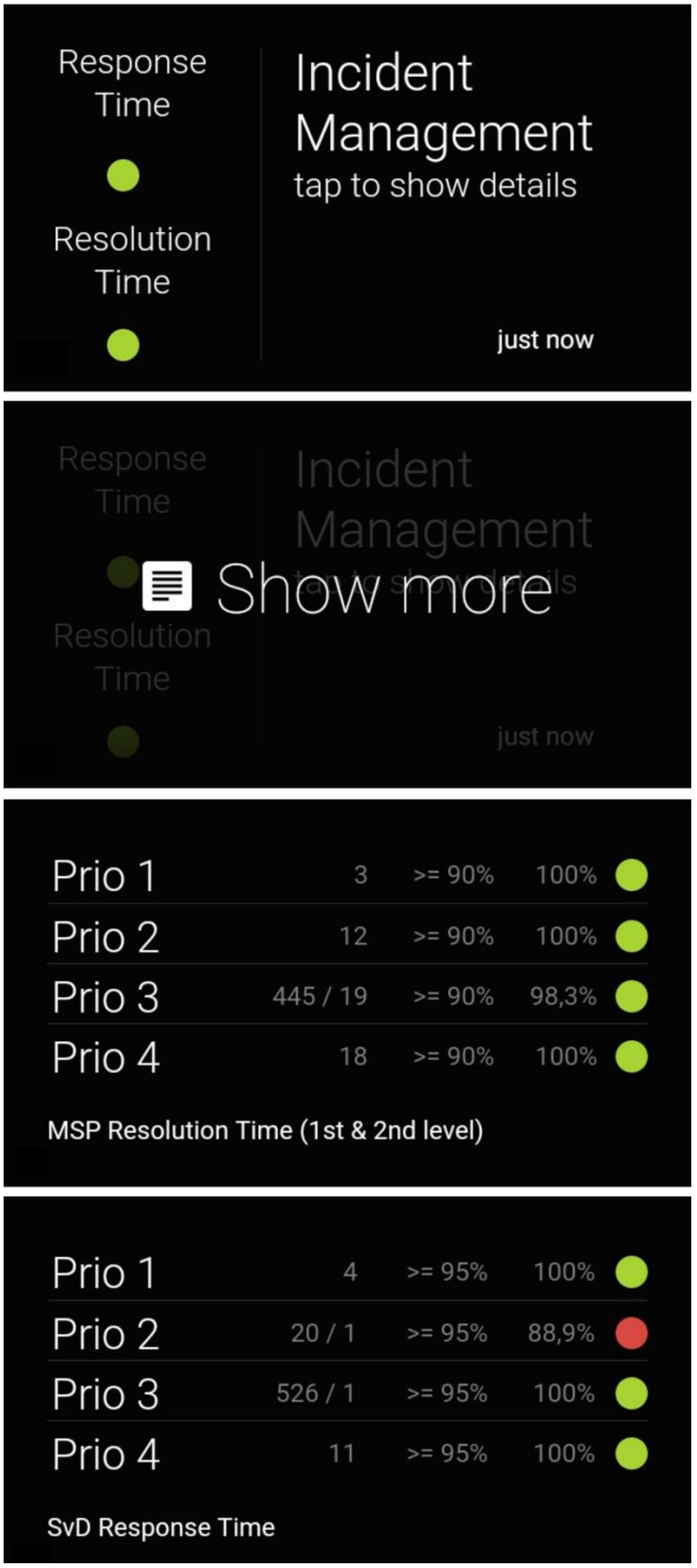


Figure 34: Incident Mgmt. KPIs on Glass

Appendix O: Further Educational Initiatives

During the period of the graduation project, the student followed (and continues to follow) several additional educational programs. These programs are following the MOOC principle. The most important programs, respectively, courses are two accredited SAP e-learning courses from ERP4Students[31]. More information on the ERP4Students online courses can be found in Appendix B: Assignment Plan under attachments in Appendix E: Further Education. Table 09: ERP4Students Courses provides an update on the progress regarding the ERP4Student courses.

Course	Content	ECTS	Notes
Integrated Business Processes with SAP ERP (TERP10)	General overview of the theoretical base of enterprise resource planning using the business software SAP ERP.[32]	6 (180h workload)	Exam on 10th April passed. Official SAP certified application associate.
SAP BW – Advanced Business Intelligence	The goal of this course is the development of expertise in the range of the SAP BW-software solution.[33]	6 (180h workload)	Start of course: 11th March. At submission date, half of the scripts were completed.

Table 09: ERP4Students Courses

In addition to the paid courses, there are free MOOC courses about enterprise software and technology (mostly powered by SAP) on openSAP[34] and openHPI[35].
Figure 35: MOOC Courses depicts all MOOC courses finished by the time of submission and lists courses beyond the official end of the graduation period and expiration of the JUGO contract.

[31] http://www.erp4students.eu
[32] http://www.erp4students.eu/live/Course-Integrated-Business-Processes-SAP-ERP/integrated-processes.aspx
[33] http://www.erp4students.eu/live/Course-Advanced-Business-Intelligence/sap-bi-abi.aspx
[34] https://open.sap.com
[35] https://open.hpi.de

MOOC Courses

Site	Course	Status	Course Start	Course End
openSAP	BI 4 Platform Innovation and Implementation (Repeat)	finished	25/03/15	14/04/15
openSAP	Digital Transformation and Its Impact	finished	24/02/15	24/03/15
openSAP	How the Internet of Things and Smart Services Will Change Society	finished	25/03/15	25/03/15
openSAP	SAP Business Suite 4 SAP HANA in a Nutshell	finished	25/03/15	25/03/15
openSAP	SAP Business Warehouse powered by SAP HANA	finished	21/03/15	22/03/15
openSAP	SAP's UX Strategy in a Nutshell	finished	25/03/15	25/03/15
mooc.house	Design for Non-Designers (Beta)	in queue		
openHPI	Sichere Email	in queue		
openHPI	Sicherheit im Internet	in queue		
openHPI	In-Memory Data Management (2014) - Implications on Enterprise Systems	in queue		
openSAP	Creating Business Value with User Experience	in queue		
openSAP	Sustainability and Business Innovation	in queue		
openSAP	BI Clients and Applications on SAP HANA	in queue		
openSAP	Introduction to Mobile Solution Development	in queue		
openSAP	Introduction to SAP Fiori UX	in queue		
openSAP	SAP Business Suite powered by SAP HANA	in queue		
openHPI	In-Memory Data Management 2015	optional		
openHPI	Automated Visual Software Analytics	optional		
openHPI	Business Process Modeling and Analysis (2013)	optional		
openHPI	Knowledge Engineering with Semantic Web Technologies	optional		
openHPI	Web Technologies	optional		
openSAP	Build Your Own SAP Fiori App in the Cloud	optional		
openSAP	Facilitating ERPsim: Running Successful Business Simulation Games with ERPsim (Partner Course)	optional		
openSAP	Get to Know SAP's Innovative Enterprise Solutions	optional		
openSAP	In-Memory Data Management In a Nutshell	optional		
openSAP	Introduction to SAP HANA Cloud Platform (Repeat)	optional		
openSAP	Next Steps in SAP HANA Cloud Platform (Repeat)	optional		
openSAP	Rapid Deployment of SAP Solutions (Update Q1/2015)	optional		
openSAP	SAP Screen Personas	optional		
openSAP	Software Development on SAP HANA (Delta SPS 09)	optional		

Figure 35: MOOC Courses

Appendix P: Data Visualization Elements

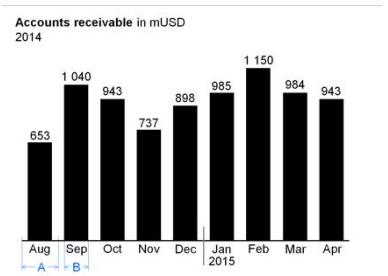
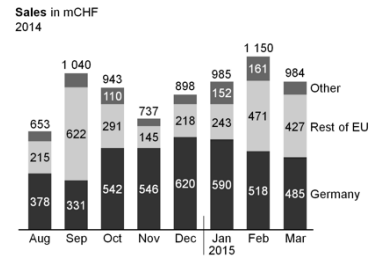
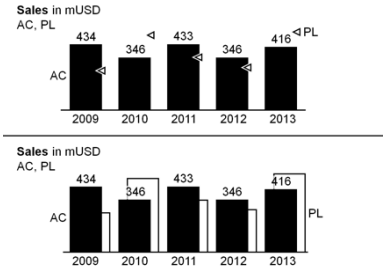
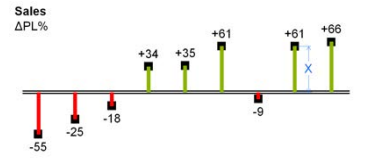
Visualization Element	Sub-Element	Example	Conclusion
Charts with horizontal category axes[36]	Single Column charts		Possible to use & fairly easy to implement (only with fewer columns per card). Element was to be considered & tested.
	Stacked Column charts		Styling could get difficult for static content. Element was optionally to be considered & tested.
	Grouped Column charts		Styling difficult. Vertical solution could be better. Element optionally for testing.
	Horizontal pin charts		Styling very difficult. Vertical solution better (for fewer entries). Horizontal element not considered.

Table 10: Data Visualization Elements - Part 1

[36] https://www.ibcs-a.org/standards/138

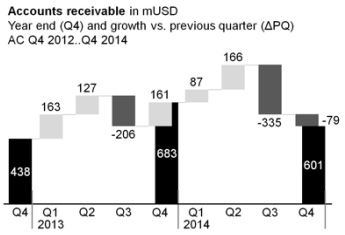
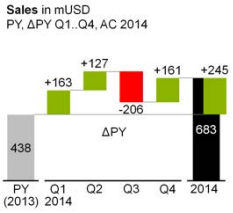
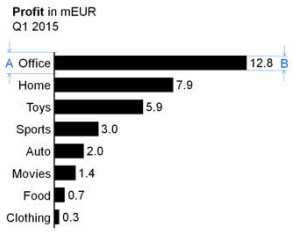
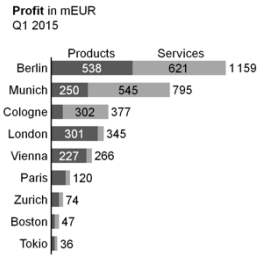
Visualization Element	Sub-Element	Example	Conclusion
Charts with horizontal category axes	Growth waterfalls		Element not in consideration. Vertical again better approach.
	Horizontal variance waterfalls		Good combination of elements, but probably better in vertical representation.
	Line Charts		Due to implementation effort of static content, for now not in consideration.
Charts with vertical category axes[37]	Single bar charts		Simple element, which was considered for testing and implementation.
	Stacked bar charts		See above, but more styling work for content. Element optionally in consideration.

Table 11: Data Visualization Elements - Part 2

[37] https://www.ibcs-a.org/standards/139

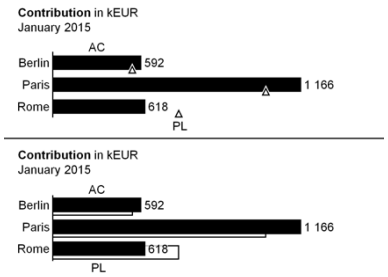
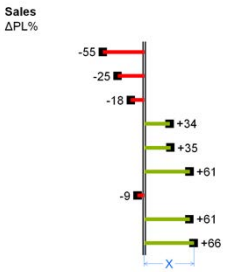
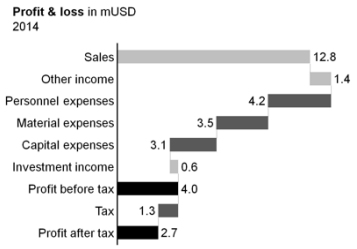
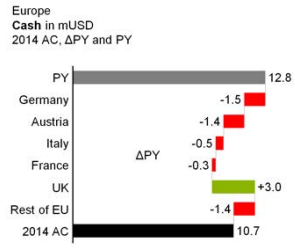
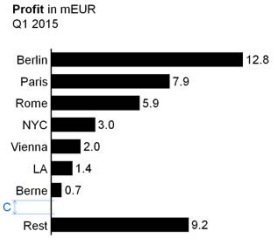
Visualization Element	Sub-Element	Example	Conclusion
Charts with vertical category axes	Grouped bar charts		Per card three bars possible (see image left), so element is good example. In consideration for implementation.
	Vertical pin charts		Element in consideration for implementation. Prototyping for similar card was done amongst the first activities of 4.4 Prototyping and Implementation.
	Calculation waterfalls		Difficult in styling. Element not in consideration.
	Vertical variance waterfalls		With fewer bars (than on image on the left), possibly in consideration for testing.
	"Rest" bar		Element only optionally in consideration.

Table 12: Data Visualization Elements - Part 3

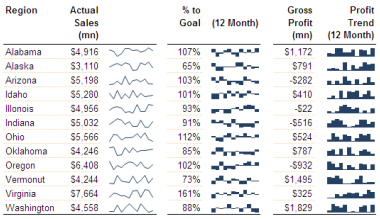
Visualization Element	Sub-Element	Example	Conclusion
Embedded Chart Elements in Tables[38]	Traffic Lights	n/a	Element optionally in consideration depending on space availability.
	Warning Dots	See Appendix N: Incident Management KPIs on Glass	Good for highlighting important parts of a table. Easy to use/implement (image or just CSS). Element used during 4.4 Prototyping and Implementation.
	Sparklines		Omitted if proper scaling on device not possible.
Integrated Explanation	n/a	n/a	Given the limited space available on Glass cards, additional text and explanations should be omitted whenever possible.
Others	Tiles	 [39]	Data-driven element that (in context with cards) that should perfectly fit into a clean card design. Element in consideration.

Table 13: Data Visualization Elements - Part 4

[38] https://www.ibcs-a.org/standards/158

[39] http://documents.software.dell.com/site-admin-for-sharepoint/5.1.1/user-guide/working-with-site-administrator-for-sharepoint-information-portal/reporting/dashboards/dashboard-descriptions

I would like to end this report with a nice comparison made by Barack Obama. It illustrates how much we can discuss, debate, and speculate now about new technologies and their integration in our life but after all we cannot predict the future.

"Tim Berners-Lee […] invented the World Wide Web in 1989 […]. The great epochs in human history — the Bronze Age, Iron Age, Agricultural Revolution, Industrial Revolution — they spanned centuries. We're only 26 years into this Internet Age [here generally digitalization]. We've only scratched the surface. […] We haven't even begun to imagine the discoveries and innovations that are going to be unleashed in the decades to come."

Barack Obama,
Cyber Security Summit 2015 at Stanford