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Project Report

Shadow IT at HTI: **The HTI AppStore**

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Executive Summary

In recent years, as remote work and cloud adoption has increased, shadow IT has grown exponentially because cloud-based applications and services can be easily downloaded and used. Statistics show that 80% of workers admit to using SaaS applications at work without getting approval from IT. While 77% of surveyed professionals believe that their organization could gain an advantage from embracing shadow IT solutions, still many companies do not have fitting solutions to their underlying shadow IT challenges (Julio, 2020).

In general, shadow IT describes hidden IT systems that are managed by the business units themselves. It is any hardware, software or other solutions used by employees within the organizational ecosystem without being officially approved by the IT department. Shadow IT at HTI is constituted by a multitude of aspects, which all add to its usage across the organization, creating urgency to address and resolve the problem as has several negative impacts. The main issues are the lack of awareness to the existence of the IT service catalogue as well as the lack of usability of the tool. This leads to the main purpose of reducing shadow IT with, but even more importantly without the knowledge of the IT department at HTI. The developed solution addresses this goal by being constituted as an integral and flexible platform that can be built upon. The proposed solution, the HTI AppStore, involves numerous features promoting ease-of-use and user awareness, such as intelligent search functions, social-share features, and visually appealing information processing on every tool. Furthermore, the app store contains a smooth user interface with the IT landscape at HTI in general and the ticketing system and IT portal. By addressing the identified needs, the app store benefits HTI among other things, that costs and IT security risks are to be reduced by considerable amounts and further by increasing productivity and resource allocation throughout the whole company.

Project Structure

We structured our project in the following four phases covering all core activities of a typical software development process.

Illustration 1: Project structure

Requirements Analysis

In the first phase, we carried out a requirements analysis in order to be able to derive the requirements specification. Prior to the interview with the client HTI which served as our main source to define the requirements, we conducted our own literature search to gather the theoretical foundation of shadow IT, it's inherent challenges and how to address it (Haag & Eckhardt, 2017, Eckhardt et al. 2019). The findings were also very helpful to identify the most important questions for our interview. We designed our interview questions with the goal to clearly identify our client's needs, key boundaries and conditions of the projects including resources required (e.g. time schedule, finance conditions, personnel, etc.). This provided us with in-depth insights on the purpose and goals of the project. As an interview technique we chose semi-structured interviews with a fairly open framework that allowed us to follow a guideline but also enabled us to follow topical trajectories when it seems appropriate.

Design

The second phase consisted of drawing our project proposal and project demand form for our client. This included defining the problem space, solution space, technical aspects, required resources, task delegation and a roadmap as an outlook on how we envision the project proceeding. In our project proposal, we presented a first mockup of our artifact and proposed several possible software architectures.

Implementation
After aligning our proposal with the client's requirements during the second phase, we started with the implementation in the third phase. Here, we arranged regular sprint meetings to enhance our development speed and quality. Therefore, we defined small product increments for each circle which were then built and tested during the week and reviewed in the next sprint meeting. These sprints also served as occasion to bring in new ideas and discuss them in the project team.

Testing
After we transformed all the design ideas and requirements into a running system, the artifact was tested in the fourth phase. In addition to the continuous testing of the product increments during every week as part of our sprints, we executed a comprehensive test-phase after the artifact was finished. Thereby we defined multiple test cases (e.g. for each feature) and executed them on different browsers (e.g. Mozilla Firefox, Google Chrome, etc.) as well as mobile devices (Android and iOS). Deviations between the expected and the actual behavior of the system were documented and communicated to the technical team, which immediately worked on solving the errors. Testing the finished product was vital to ensure a smooth hand-over of our artifact to the client.

Finally, as closure of the projekt, our artifact was presented virtually to our client HTI including several members of the management board, our main contact person Hannes Klotz and lecturer Prof. Dr. Andreas Eckhardt.

Project Governance

Our project team consisted of six members who are highly qualified in their respective area of application. Responsibilities were divided as follows:

Project Team Member	Role
Fiona Hoppe	Project Lead
Alexander Farbmacher	Senior IT Project Consultant
Oskar Kreidl	Quality Assurance
Tobias Auckenthaler	Director of Hapiness
Florian Gels	Junior IT Consultant
Leonhard Zacharias	Software Engineer

In addition to the roles, the team was subdivided into business and technical experts. The business experts, equipped with a deep understanding and knowledge of project management, include Fiona Hoppe, Tobias Auckenthaler and Florian Gels. They were responsible for documentation, keeping track of the results and the communication to the customer. Alexander Farbmacher, Oskar Kreidl and Leonhard Zacharias enriched the team as technical experts. These three specified the requirements and developed the HTI AppStore. In addition to the sprint meetings, in which all project members participated, the respective teams held meetings on their own in an ad-hoc manner.

The project lead, Fiona Hoppe, was responsible for communicating with the customer and ensuring the success of the project. With regard to the project's success, adherence to the project plan and the budget as well as controlling and reporting of defined milestones were essential.

The Senior IT Project Consultant, Alexander Farbmacher, primarily acted as an interface between the business experts and technical experts. The main task in this role was to define the customer's needs and to derive the corresponding technical requirements so that the functionality of the artifact is aligned with the customer's business needs and problems.

Oskar Kreidl, responsible for Quality Assurance, was mainly responsible for the constructive and qualitative quality assurance of the artifact. The primary goal of the project was the product quality, but also the process quality as a crucial factor to achieve product quality. Therefore, constructive quality assurance techniques were applied and supervised by Oskar Kreidl. This included defining quality criteria, software guidelines, development methods and to avoid failures. Regarding the analytical quality assurance, both dynamic (e.g. testing) and static methods (e.g. manual assessment) were applied.

With Tobias Auckenthaler, our Director of Happiness, we established another crucial role to ensure project success. Especially the mandatory home-office due to the corona crisis, it is vital to keep the team spirit and focus of the team high.

The Junior IT Project Consultant, Florian Gels, supported both the Senior IT Project consultant and the business experts in daily administrative tasks. Furthermore, documentation, preparation and management of the sprints were part of his duties.

The software development was under the responsibility of our Software Engineer Leonhard Zacharias, taking care of all the functionalities required to address the identified business needs of the customer.

To choose risk management and control modes that suit the project, we first evaluated the project risk in order to ensure appropriate governance. With the three contingency factors size, technology experience and requirement volatility, Applegate et. al (2003) provide a fitting framework to evaluate the project risk of software development projects.

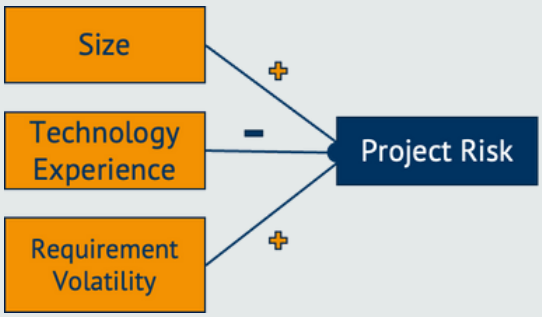

Illustration 2: Project risk model according to Applegate et al. (2003)

Considering the money and FTE (full-time equivalents) involved in our project, the size of the project can be characterized as moderate (6 students á 10h per week). Technology experience, described as the development team's familiarity with the hard- and software involved was assessed to be low, as no member of the team can demonstrate a purely technical degree. The third variable, requirement volatility, is the degree to which the project objectives are subject to change. The customer HTI provided very clear objectives from the very beginning that enabled us to precisely define the problem space and derive our solution space intended to address the challenges HTI faces regarding Shadow IT. To sum it up, the overall project risk was evaluated to be rather medium, as only one of the three factors really increases the risk in our context. However, since we are still students with no superior experience in IT project management yet, implementing appropriate control modes to govern our project was expected to be vital.

Consequently, we implemented formal control modes as an attempt to ensure that the individuals act according to the agreed-upon strategy and to achieve the desired objectives. Specifically, we applied behavior and outcome control as we evaluated it as the most appropriate mode for our project, as the clear definitions of requirements led to high outcome measurability and also the knowledge of the transformation process was assessed to be high due high behavior observability through our implemented behavior control mechanisms. This included prescribed software development methods, where we followed an agile approach with our sprint method to plan, build, test and review our deliverables. The sprints, documented in greater detail later in the report, also served as formal meetings to keep communication and cohesion among team members high. Moreover, as mentioned above, our Quality Assurance Manager followed several procedures to ensure both product and process quality. Testing, also led by Oskar Kreidl, contributed to outcome control as well as target schedules and costs, governed by our Project lead.

To further structure ourselves as a group and keep the efficiency high, we implemented a Kanban board in our Microsoft Teams environment. A Kanban board visualizes work packages and structures them according to the categories “To-Do”, “Doing”, and “Done”, each of them representing a specific process-phase. It facilitates an optimal workflow among the team and helps to structure the day-to-day work. The following screenshot demonstrates as an example how our Kanban board looked like during the project:

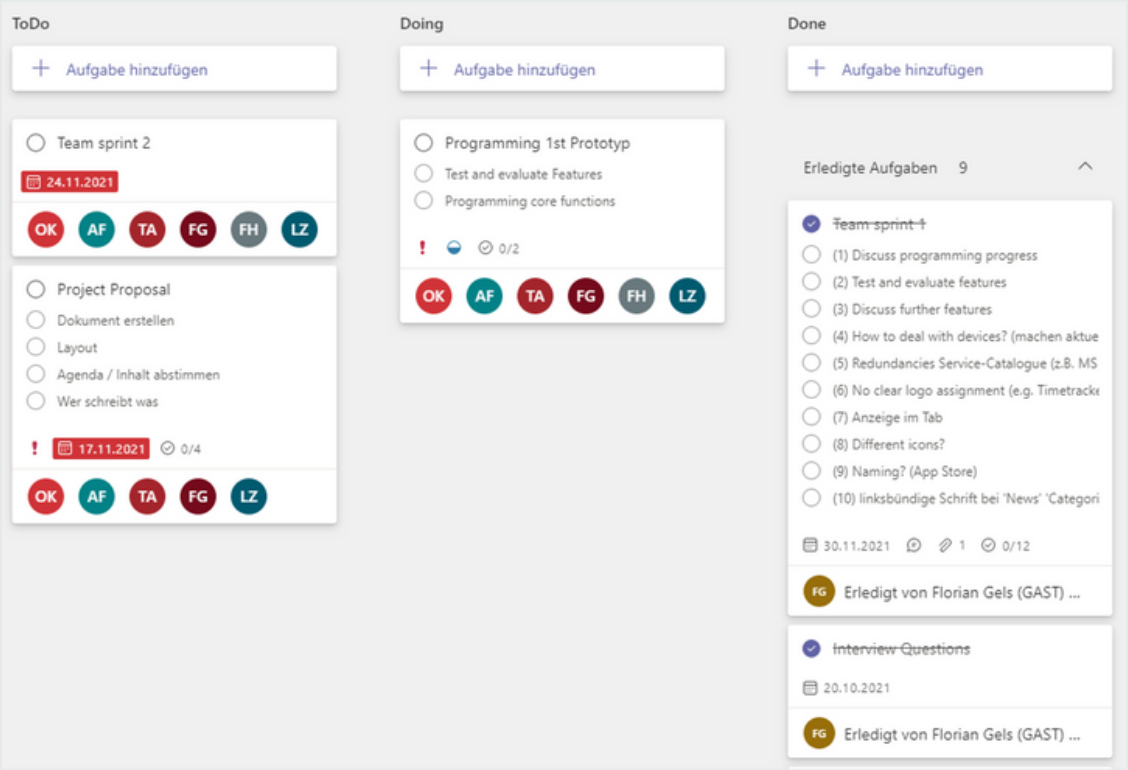

Illustration 3: Kanban board used for project management / governance)

Requirements

With the purpose of reaching the goal of minimizing shadow IT at HTI, time, economic and internal resources are required.

The time horizon of the project covers 15 weeks, starting with a kick-off meeting on 07.10.2021 and ending with the final presentation on 20.01.2021. The end date only refers to the completion of the HTI AppStore as the HTI AppStore can be seen as a component of the final solution and can be extended by implementing other functions. The follow-up projects are not considered. A detailed timetable including all project phases and milestones can be found in the appendix.

Economic requirements include the budgetary requirements. As the solution HTI AppStore provides IT security this is considered as the cost driver of the solution. At HTI, all departments and business units are affected by the HTI AppStore. Shadow IT is used across the whole company, therefore, the HTI AppStore shall provide a help for all employees to use the correct tools and avoid using shadow IT. HTI does not have internal business efforts in terms of monetary resources.

EXTERNAL BUDGET:
€58,500

The external budget is composed of our six consultants, each of them at disposal for 10 hours a week during the 15 weeks project phase á 65 Euro per work hour.

Furthermore, internal resources are required for a successful implementation of the project. It is necessary to have access to the IT Service Catalog in Excel format. In addition, the possibility to contact Mr. Klotz and Ms. Mayer if information and a consultation are needed is of high priority.

As outlined by Mr. Klotz, legal requirements must not be considered in this project.

Budibase is an open-source solution, thus no licensing costs will apply when self-hosted. If it is favored to deliver the portal as a Saas, cost-effective hosting options are offered by Budibase. We expect the requests made to third-party APIs Apify and Agolia to be within free tier usage, thereby not imposing any licensing costs on the project.

Tools Applied

Throughout the project a variety of tools were used and applied by the project team in order to achieve the best possible solution within the defined problem-solution space.

Project Management and Communication
Microsoft Teams was used as the main communication and project management tool. MS Teams was leveraged for internal communication amongst team members, but further also for external communication with the client. In addition, the project team made use of MS Teams' project management features to plan and organize the tasks as well as to keep track of progress. In particular the Kanban-board-function was leveraged to outline and organize project tasks including responsibilities, schedules, deadlines, milestones and resources (i.e. files).

Moreover, the project team used Microsoft PowerPoint to create presentations on the needs analysis, the project proposal and update presentations on the software artifact. For the final presentation, it was decided to use Canva in order to create a visually appealing and customized presentation for our client.

Application Development

For application development an open-source low code platform named Budibase was used. It is widely used for building business applications and was chosen because it entails a variety of advantages over comparable alternatives. The project team, in particular the technical experts unter the lead of our software engineer used Budibase to build the foundation of the HTI AppStore as well as to integrate nearly all key features such as the search function, integration of / interface to the IT Service Catalog as data source, as well as the user interface. Additionally, we made use of two API's, Apify and Algolia. Those APIs were integrated via REST APIs. Apify was leveraged to web-scrape descriptions of the tools included in the HTI AppStore and thus reduce workload for employees. Algolia was integrated as a search provider. It was used to implement filtering functions and ML algorithms for search with the goal to better display relevant search results to the users.

In order to make the development of the HTI AppStore as effective as possible, we decided to draw on tools from the field of agile software development. A central point here are the executed sprints with the associated sprint planning meetings. The duration of the sprints was fixed at one week and the duration of the sprint planning meetings was fixed at two hours. In the following, the respective contents of the sprint planning meetings are listed in order to provide a continuous, clear and easily comprehensible structure of the development.

Project Task and Solution

Problem Space

Shadow IT at HTI is composed of a variety of aspects that all contribute to its usage throughout the company and thus create an urgency to address and solve the problem by negatively affecting IT security, costs, efficiency (resource allocation), and productivity while simultaneously harming creativity and innovation. These aspects involve the lack of perception and awareness-raising about the IT Service Catalog's existence, importance, and functioning, the absence of ease-of-use and user-friendliness of the tool itself as well as the slow speed of approval for and implementation of new software.

Furthermore, there are two overarching types of shadow IT usage that are to be addressed. First, the reduction of shadow IT usage without knowledge of the IT department. This is the main need issued by HTI and should be reduced to zero. A main issue for the company is that the detection of certain shadow IT systems occurs at a stage where the underlying system is difficult to integrate and harmonize with the existing IT landscape. Second, the reduction of shadow IT usage with knowledge of the IT department which should also be reduced but not necessarily to zero as there are positive aspects that can be leveraged from the usage of shadow IT such as the chance for driving creativity and innovation within HTI. The key dilemma lies in the lack of employee awareness and perception that a large basket of services is already available and the absence of easy access to all those systems. Addressing these problems can, not only, result in a decrease in costs and risks, but further lead to benefits, such as higher productivity, creativity and innovation which are considered vital given HTI's vision of being a digitized company and their direction for the future.

Identified client needs and goals

A variety of client needs and goals to be addressed by our solution are derived from the problem space. The identified client needs reflect the boundaries of the project and solution and must be clearly distinguished from the non-goals that are discussed in the next paragraph.

The client needs and goals for this project are:

01 Reduce shadow IT with & without knowledge of IT

02 Unfold potential of & build upon IT service catalogue

03 Reduce workload of IT personnel & increase productivity

04 Raise awareness & increase commitment of employees

The reduction of shadow IT is the main client need and therefore goal of the project as well as solution issued by the client. The developed solution should add to the reduction of shadow IT at HTI, that is lead to less usage of unauthorized tools or tools of which the IT department does not have knowledge about. Another client need and requirement for the solution which is vital for HTI is that the solution must be built upon the existing IT Service Catalog. The IT Service Catalog must serve as a base for the solution in terms of the structure of information and data contained. Hence, our solution must integrate the existing IT Service Catalog as its main data source

Furthermore, the reduction of workload for the HTI IT department was analyzed to be a major client need for the project. Shadow IT at HTI provokes a lot of unnecessary work for IT employees such as the integration of shadow IT tools into the company's IT infrastructure at late stages and therefore binds valuable resources within the company and the IT department in particular that are needed and should be leveraged elsewhere. Hence, to reduce the workload of IT employees and therefore increase productivity within this department and in further consequence the company as a whole is identified as another vital project goal. Analyzed as another client need, raising awareness for the topic of shadow IT within HTI and increasing the commitment of employees regarding shadow IT is a further project goal. However, as will be outlined in the upcoming paragraphs, in this specific project this need will only be addressed within the boundaries, that is possibilities, of our solution. Ultimately, ease-of-use was issued as a crucial need for our client. The development of an easy-to-use solution that facilitates great usability and user experience is therefore a major goal for the solution and project at hand.

Identified non-goals

In addition to the client needs identified and outlined above, there are further aspects that the company faces and that are contributing to the problem space, but are not (at the moment) addressed by the tool due to the scale of the project and nature of the problem. These include organizational change, awareness building, and monitoring. Although the HTI AppStore intends to support organizational change it should be accompanied with organizational change measures so that the HTI AppStore is accepted by employees in the best possible way and that negative and rejecting attitudes are avoided. Furthermore, even though the creation of awareness is part of the problem space and is addressed by our solution within usage, raising awareness can partly also be classed as an identified non-goal. The HTI AppStore in general and specific features such as the comment function in particular help to create employee awareness for the topic of shadow IT, but further measures, in a more company-overarching way, not limited to AppStore usage, are recommended. Training, motivation and rewards, as well as tool-accompanying measures, such as sending out a newsletter to create awareness for the topic in general and when new tools are added to the store in particular are actions that the HTI AppStore does not directly address, but worth thinking about. Furthermore, the monitoring of employees' usage of shadow IT is another non-goal of the app store solution. Despite the fact that the HTI AppStore offers the possibility to keep track of the most popular tools and applications demanded, downloaded, and requested, surveillance of employee's IT software tools usage is not a goal that is to be addressed by our solution. Lastly, the slow speed of approval, outlined in the problem space and contributing to the problem of shadow IT at HTI is not something that is possible to address and solve within this project and our solution since a major shift in our client's processes would be necessary.

Problem-Solution-Fit

We knew that the lack of awareness about the existing numerous software systems due to the sober listing of applications in the IT service catalog was a key problem at HTI. Therefore, we had to find a solution that combined two fundamental aspects: On the one hand, the application must obviously bring technical benefits and guarantee flawless functionality. On the other hand, however, the application must be designed in an appealing way, as we want to bind users to this app and have them be enthusiastic about it. If there is an appealing design and also a high level of user-friendliness - only then do the other technical details matter at all. Because in order for the user to get to know intelligent and innovative aspects of the app, they need to be convinced to use it with the help of a truly thoughtful design.

Our solution, the HTI AppStore solves the problem outlined above by accurately addressing the client needs and further offering additional features fueling the added value for users as well as for HTI.

Problem	Solution
Reduce Shadow IT	All-in-one solution as go-to-place for employees with great UX
Unfold potential of & built upon IT Service Catalog	Visually appealing and user-friendly UI
Reduce workload of IT department and thus increase productivity	Web-scraped info to reduce IT employees' workload (& enable intuitive search)
Raise awareness & increase commitment of employees regarding shadow IT	Specific features to facilitate knowledge sharing / exchange & raise awareness

The desired reduction of shadow IT usage at HTI, issued as the main need by our client, is addressed by an all-in-one solution that serves as the go-to-place for employees in need of a software application with great user experience. The conception of the HTI AppStore as an integral platform incorporating all necessities into one application is vital in order to reduce shadow IT. The catalog of existing software applications, the possibility to request them as well as IT support are all bundled in one place. Furthermore, additional features fueling knowledge exchange decrease the possibility for employees to search elsewhere for fitting software applications or to build them on their own and thus the HTI AppStore very accurately addresses the problem of reducing shadow IT at HTI.

Going into more detail, our proposed solution not only addresses the overarching goal of reducing shadow IT at HTI, but also the additional underlying client needs outlined above. The HTI AppStore is built upon the IT Service Catalog and uses it as its main data source.

A visually appealing and user-friendly design and user interface of the HTI AppStore allows to unfold the potential of the IT Service Catalog. By providing an appealing user interface, the HTI AppStore counteracts the existing user unfriendliness of the IT Service Catalog. Information from the IT Service Catalog, such as infos on Key and Power Users, is provided in a visually pleasant and clear manner. Some unnecessary categories from the IT Service Catalog are not displayed in the solution with the purpose of increasing clarity and user-friendliness. Taking the IT Service Catalog as the underlying data source, adjust and customize it to the specific needs of our solution and process and display its valuable information in a visually attractive way for users addresses the client need of unfolding its potential perfectly. The client's need to reduce the workload of the IT department of HTI is addressed in a twofold manner. First, through the implementation of the HTI AppStore, the workload caused by employees using shadow IT should be reduced drastically with the usage of shadow IT also decreasing. Second, through the integration of specific features, such as the web-scraping of information about the software tools included in the AppStore, the workload of employees is limited and no additional workload is loaded upon IT employees through the implementation of the HTI AppStore. Moreover, the goal of raising awareness and increasing the commitment of employees regarding shadow IT is taken into account by our solution. Specific features, such as the comment-function, facilitate knowledge sharing and exchange and therefore add to the commitment of employees. Additionally, special categories like new, recommended, or popular allow the IT department to raise awareness for specific software applications as well as to steer employee's software usage.

USPs

The HTI AppStore further composes a variety of special features that all facilitate the overarching goal of reducing shadow IT.

Feature	Rationale
Intelligent search function	Intuitive user search enabled through web-scraped description (e.g. spelling mistakes)
Ratings, feedback, suggestions	Enabling knowledge sharing / exchange amongst employees & enabling company to actively affect and suggest applications
Simple interface to IT Ticketing and IT Demand System	User-friendly and easy-to-use interface with all the necessary information for IT department (mandatory fields)

Feature	Rationale
In-depth, but easy-to-process information about IT applications	In-depth information to give employees opportunity to inform themselves before using tool, but in an easy-to-process way and not overwhelming (i.e. screenshots, descriptions, nice UI)
References to Service Owners & Service Advisors and Key Users & Power Users	Facilitating knowledge exchange within company
Integral and flexible platform	HTI AppStore as base for further applications / features (e.g. chatbot)
Intuitive & visually appealing user interface	Easy-of-use and satisfaction for users - UI of app store is known by employees
Easy to manage for IT department & easy maintenance	User-friendly admin mode (e.g. drag-and-drop feature)

The intelligent (keyword) search function, enabled through web-scraping tool descriptions, allows for quick and intuitive user searches and provides great user experience by being error-tolerant in terms of finding the intended tool also when spelling mistakes are part of the search query. Next, ratings, feedback, and suggestions are integrated as features to facilitate knowledge sharing amongst users and enable the company to actively affect and suggest applications. The simple interface to the IT Ticketing and IT Demand Systems facilitates workload reduction and the possibility to customize fields and information necessary (mandatory fields) gives freedom to HTI to ask for exact information necessary. Moreover, in-depth, but easy to process information about the IT applications contributes to achieving the issued client needs. In-depth information, provided in an easy-to-process and not overwhelming manner gives employees the opportunity to inform themselves about the tools. A visually pleasant user interface, clear and informative descriptions, as well as screenshots are a major improvement compared to the IT Service Catalog and facilitate great user experience. Furthermore, references to Service Owners & Service Advisors as well as to Key Users & Power Users, integrated in a visually clear and easy-to-process way, facilitate knowledge exchange within the company and reduce the risk for shadow IT usage. In addition, an intuitive and visually appealing user interface contributes to the ease-of-use of the HTI AppStore and thus the satisfaction for users. The app-store-like design is known by employees, fuels intuition, and facilitates great user experience. The client's need for ease-of-use and a reduction of workload is also addressed by the solution's user-friendly admin mode. The HTI AppStore is easy to manage for the IT department and allows for easy maintenance. Features, such as the drag-and-drop function for inserting pictures, are examples for the ease-of-use on the company-side.

Ultimately and probably one of the most important arguments for the app store solution as perfect fit for addressing the client needs is that the HTI AppStore can be seen as the base for further increments. It is an integral and flexible platform that can be expanded with additional or accompanying features and measures. Those can either be technical expansions, such as the integration of a chatbot to support usage, or expansions through accompanying organizational measures, with the release of a newsletter to accompany the integration of a new tool in the HTI AppStore as an example.

Theoretical foundation of our solution

The HTI App Store addresses Nielsen's five quality dimensions of usability: learnability, efficiency, satisfaction, memorability, and errors. According to Nielsen (1993) to some extent, usability is a narrower concern compared to the broader issue of system acceptance, which is basically whether the system is good enough to meet all the needs and requirements of users and other potential stakeholders such as IT and corporate management. The overall acceptability of a computer system is, in turn, a combination of its social and practical acceptability. From the very beginning the overall goal of the App Store was to give HTI's employees guidance in using software tools for their work. Moreover, it seemed as a great fit to display the IT Service Catalog as an all-in-one solution with great user experience, by being visually pleasant as well as having a user-friendly interface. Within the means of the five dimensions of usability, the usage of shadow IT should be reduced to a minimum in the whole company.

The HTI AppStore supports and facilitates learnability since it is very easy to accomplish basic tasks at first time usage. The clear and intuitive user interface allows users to carry out the main task, that is to search for an IT tool, without obstacles. Moreover, learnability is supported through the intelligent search feature which allows to find the intended tools also if keywords are wrongly spelled. Next, the solution addresses efficiency in that once the design is learned, essential tasks can be performed very quickly & efficiently. Only two to three steps are necessary to perform the main task i.e. request IT application. Likewise, the HTI AppStore offers a visually pleasant user interface and an intuitive user experience and thus facilitates user satisfaction. Also, app stores are common platforms in today's digitized world and thus their structure is known by users, further fuelling an intuitive user experience. Furthermore, memorability, that is easy re-establishing of proficiency of usage, is enhanced by the logical and intuitive user interface and user experience of the HTI AppStore. Lastly, the potential for errors by users is near zero. Users cannot make mistakes since the critical path, that is the actions that need to be taken in order to request an IT tool via the HTI AppStore is very straightforward. Also, recoverability is given via the admin functions.

Software Artifact

The user interface (UI) is the point at which users interact with a computer, website, or application. Our goal within the HTI AppStore is to create an effective UI, to make the user's experience simple and intuitive, so that the employees have to put in a minimum of effort to get the desired result. It is important to have a user interface that meets user expectations and supports the effective functionality of the app store. A well-executed user interface facilitates effective interaction between the user and the program, app, or device through high-contrast visuals, clean design, and responsiveness. When designing the user interface for the HTI AppStore, it is crucial to consider user expectations in terms of accessibility, visual aesthetics, and usability. An optimal mix of effective visuals and efficient responsiveness will improve app conversion rates by anticipating the user's needs and then meeting them. The information architecture, interactive design and visual design are crucial pillars in building an attractive and efficient UI that optimizes the user experience (UX).

The main overarching elements of the great user interface within the HTI AppStore are as follows:

Information Architecture	• Intelligent Search Function (Search Bar, Alphabetical, Business Domain & Application Category) • Organization Systems (Categories: Popular, Recommended & New) • Navigation Elements (Buttons, Tabs, Icons)
Interactive Design	• Social-share features (Comment-, Support-, & Admin-Function)
Visual Design	• Company Aligned Design (Color, Logo & Web Banner) • Photo & Contrast Elements (Brand Emblems & Application Screenshots)

In the following, the most important elements that lead to the intuitive design of the user interface are described in more detail.

Intelligent Search Function

In our opinion, an intelligent search function is especially essential for an app store that has many tools such as our solution, to ensure user satisfaction. Users almost always know what they are looking for. At the very least, they have a specific tool or name in mind, or a rough idea.

Those who do not know what they are looking for will ultimately not use a search bar and instead browse the categories. It can therefore be assumed that visitors to an app store will see the search bar as the most important tool for quickly and successfully finding what they are looking for. To meet these requirements, an intelligent search function must first be integrated and then continuously optimized. The most important thing here is the existing error tolerance - standard search functions often fail to recognize that single and plural forms of words often denote the same subject - and synonyms of the searched term are also completely ignored. In order to provide a high level of quality for the search functionality, we decided to integrate two third party resources via REST APIs. To implement filtering functions and machine learning algorithms for search – with the goal to display relevant search results to users – the search provider “Agolia” was implemented via REST APIs.

In case a user is looking for a certain software tool that he wants to use in the daily work, there are several options in the HTI AppStore on how to find the desired tool. On the one hand, the search bar is available, and on the other hand, one can use the filter functions or the alphabetical sorting to display all apps. All possible options are presented in detail below. The search bar is the easiest way to find a software tool, which the user can find on the top right of the homepage. Since this is an intelligent search, even small spelling mistakes can lead to the software of interest. Not only by entering the name of the software, but also with a keyword that describes the function of the tool, it is possible to find any tool in the App Store. In addition to the search bar, there is the option to use the filter functions integrated within the App Store. The button business domain includes a drop-down menu with all company areas used at HTI. Besides the business domain search function, the application category is a measure to further filter the results. Lastly, if the employee is not sure what the name of the software tool they are looking for is, but knows that it starts with a certain letter, they can use the alphabetical order displayed below the filter functions on the homepage.

The advantages of the intelligent search integrated in the HTI AppStore are as follows:

- Users can find their tool faster and more efficiently
- It improves all-round user-friendliness
- A smart search usually increases the conversion rate
- Satisfaction from the other 3 factors increases the number of regular customers

Web-scraping

The provided service catalog contained only a few keywords to which an employee's search query could be linked. To overcome this obstacle, our application automatically added keywords by searching web search results for related keywords. A third-party API from "Apify" is used for this purpose.

Web scraping is an automated method of extracting large amounts of data from websites, which can then be saved to a file in our tool or retrieved in a spreadsheet. When you go to a web page, the data can only be viewed, but not downloaded. One can manually copy and paste some of the data, but this is time consuming and not scalable. Web scraping automates this process and quickly extracts accurate and reliable data from web pages that one can use for tool information.

Comment Function

The function to add comments, tips or tutorial information by posting a text and selecting the appropriate tag is intended to help share knowledge between colleagues. This is great for exchanging your knowledge about the software tool with co-workers and helping them use the software tool correctly. First of all, it is important to have a good commenting system for a tool. A good commenting system attracts users to comment on the tool, and it also improves user interaction. Secondly, admins can also ask questions to users. This gets users to answer the admins questions and keep the discussion going. They will then find the tool interesting and actively use it.

The goal of implementing comment and feedback features was to encourage employees to share and use certain apps, thus contributing to the reduction of shadow IT. Based on social capital theory (Wasko & Faraj 2005), we wanted to figure out how to design the commenting function to optimize the number and helpfulness of contributions. Social capital theory can be viewed as an integrative framework for understanding how knowledge is created and shared in organizations/groups/networks. Social capital theory attempts to answer the questions of why and under what circumstances people create and share knowledge in social contexts and how social capital can be used for better information and learning outcomes. According to results from several studies, individual motivation, tenure in the field and centrality play a crucial role when it comes to knowledge sharing. Therefore, central aspects in the design of the commenting function were therefore the participation of individuals who are at the center of the network and who are connected to a large number of other individuals. Furthermore, contributions are perceived in such a way that participation increases one's own standing, and that individuals who have practical experience with the tool, which is an important predictor of knowledge contribution, can easily enter into discussion.

Categories

From the beginning of the development of the tool, the goal was to implement the homepage of the HTI App Store simply structured and with user-friendly design. One aspect of this is the Popular, Recommended and New categories. The top 5 most popular software tools and the top 5 recommended software tools for the user are displayed on the landing page. An employee can click on each tool to get a detailed view of the software tool.

Newly approved and released software tools are displayed below and can also be viewed in detail. The appealing and user-friendly presentation of the categories should help to improve the user interface and achieve a high user experience. In the further course of the app store, the user journey should inform many potential users about apps (USPs, usability, etc.) and encourage them to download them. The goal is thus to increase the conversion rate.

The advantages of the categories integrated in the HTI AppStore are as follows:

- Users can find popular tools faster and more efficiently
- IT department can suggest targeted apps to spread throughout the company
- Attention for new interesting applications can be gained faster

Support Function

An important concern when designing the HTI AppStore was to simplify contact with the IT Department. Therefore, several support functions have been implemented. If the user is not able to find a software tool he/she is looking for, it is possible to click on the "Contact IT" button at the bottom of the page (red box) or at the top right of the homepage. This allows the user to request a new software tool to be approved by the IT department. A request form will open. After filling it out, an email will be sent to the IT Service Center. Note: The "Your message" field is mandatory. The support solution developed should help reduce shadow IT at HTI, i.e., use fewer unauthorized tools or tools of which the IT department has no knowledge.

Admin Functions

The duties of a system admin are broad and vary greatly from one organization to another. System admins are typically tasked with installing, supporting, and maintaining servers or other computer systems, as well as scheduling and responding to service outages and other problems. Other duties may include scripting or light programming, project management for system related projects. In the case of the HTI AppStore, an important task of the admin is to be able to create new IT services in the app store and make them available to users. Among other things, he/she must specify the name, service type, business domain, application category and IT category. Furthermore, it is possible to provide detailed information about the service owner, key user, pricing or re-invoicing. The goal was to create an easy-to-manage app store for the IT department with simple maintenance solutions. With the help of all functions in the admin mode, the customer's need for ease of use and workload reduction should be met by the user-friendly features of the solution. Examples of ease of use on the enterprise side are features such as the drag-and-drop function for inserting images and screenshots of a given application. One of the most important arguments in favor of the App Store solution as suitable for customer needs, is that the HTI AppStore can be seen as the basis for further extensions. The HTI AppStore is easy for the IT department to manage and enables simple maintenance.

Project Evaluation

In order to evaluate our artifact, we must first define relevant requirements in this framework. Basically, a distinction is made here between functional requirements and quality requirements. In our case, the functional requirements were very broadly or loosely formulated by the client. Nevertheless, the overall concept or the benefit to be achieved by the application was clear. Therefore, we will naturally base our evaluation on what we consider to be important quality requirements regarding our artifact. In our eyes, an essential point was to inspire the user for the new application. In order to alleviate the problem at HTI, high functionality is not enough. We knew that only paired with an appealing modern user-friendly design, the project can have the desirable benefit. Therefore, elementary quality requirements are usability, modifiability and compatibility. Our decision for an HTI App Store was clearly made with the ulterior motive of high usability. In our eyes, the clear structure of the start page combined with the very easy and efficient search engine, contributes enormously to the increase of usability. Furthermore, an app store represents an environment that is familiar to the broad majority through smartphone usage and therefore makes it easier for users to quickly get used to the artifact. We fulfill the aspect of modifiability by the fact that the App Store can be seen as a kind of basic building block for a limitless platform, which is open for modifications and especially extensions. One the one hand, this aspect is supported by the use of the coding platform “Budibase”, which allows modifications or extensions to be made without much programming effort. However, it must be noted, that on the other hand, the use of this low code platform may bring restrictions regarding the possible level of customization of these extensions. Furthermore, by building our HTI App Store as a web application, we achieve a high degree of platform independency and thus compatibility. Additionally, it is possible to integrate the artifact in various ways into existing systems.

If we now look at the implementation of the project, we refer to the temporal, the financial and the social aspect. Due to our agile development approach and the scrums that were set, our time allocation for the project was quite efficient. Decisions were made together in online meetings that were kept as short as possible. The clear allocation of roles also helped to ensure that work was structured and distributed appropriately among all participants in order to avoid unnecessary overlaps.

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Appendix

A1: Project Roadmap

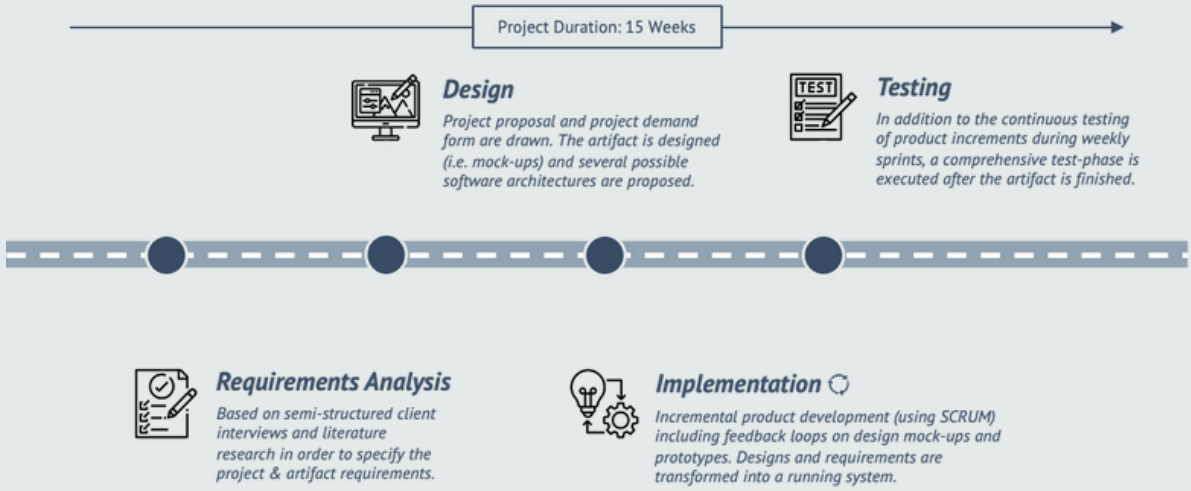

Illustration 4: Project roadmap)

A2: Team Sprints

Sprint 1

Plan	The focus was on a rough implementation of the HTI App Store interface. In addition, the implementation of the login and authentication mechanism with the two roles "User" and "Admin" was a core aspect. Also, the search function with the help of "*Agolia*" and "*Apify*". Furthermore, it was about the installation of the tracking procedure for software applications that should be listed under the branch "Popular".
Build	All the aspects were implemented.
Test	We noticed that the search function only returns results when the input was entered 100% correctly, and that the display in the "Popular" field depends on things we didn't intend it to do.
Review	The bugs found were discussed and we came to the conclusion that we would have to add additional features such as the detection of input errors in the search function later on. We also rated the interface as not yet appealing enough.

Illustration 5: Sprint 1

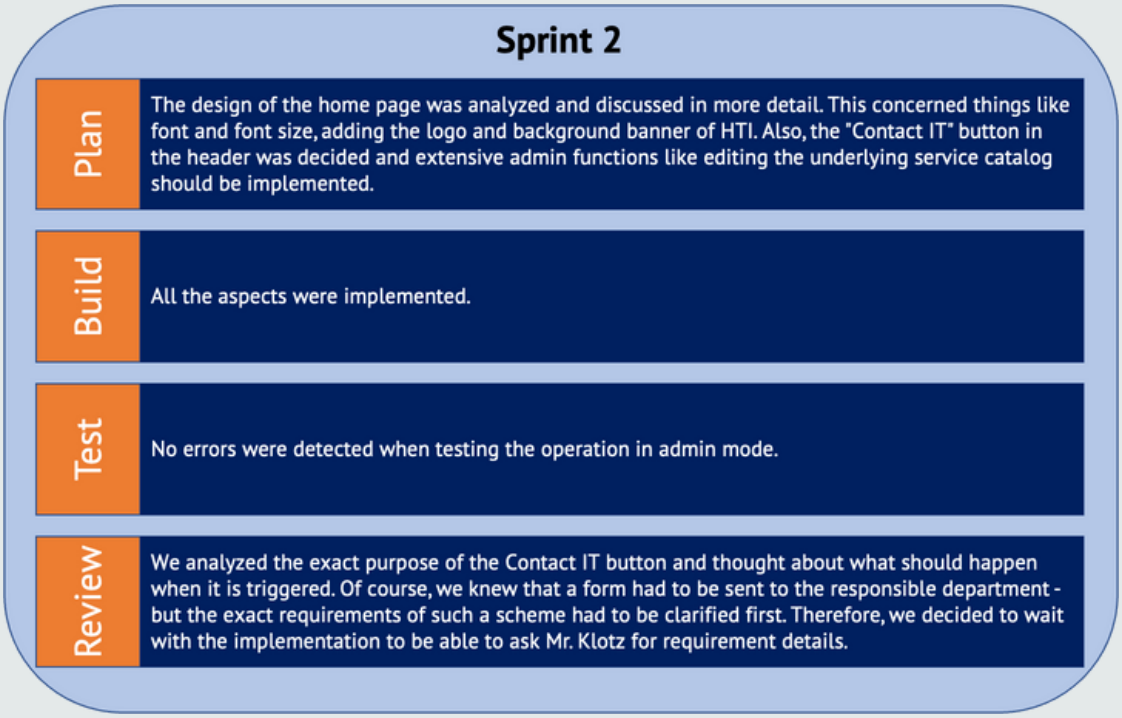

Illustration 6: Sprint 2

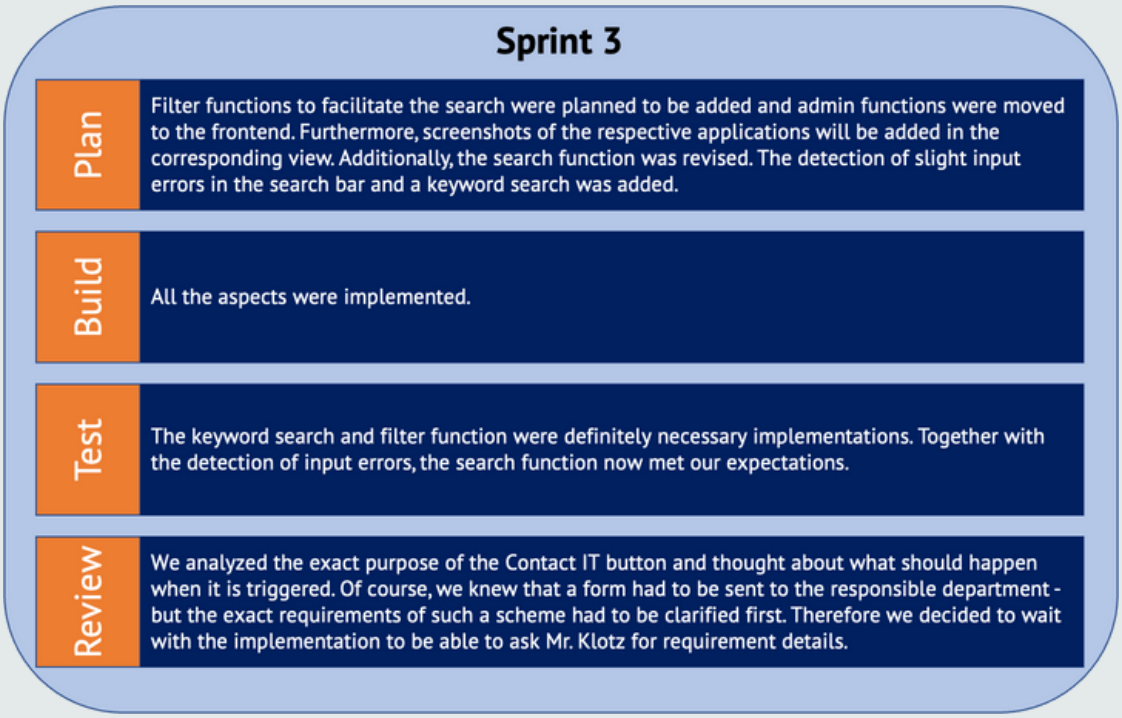

Illustration 7: Sprint 3

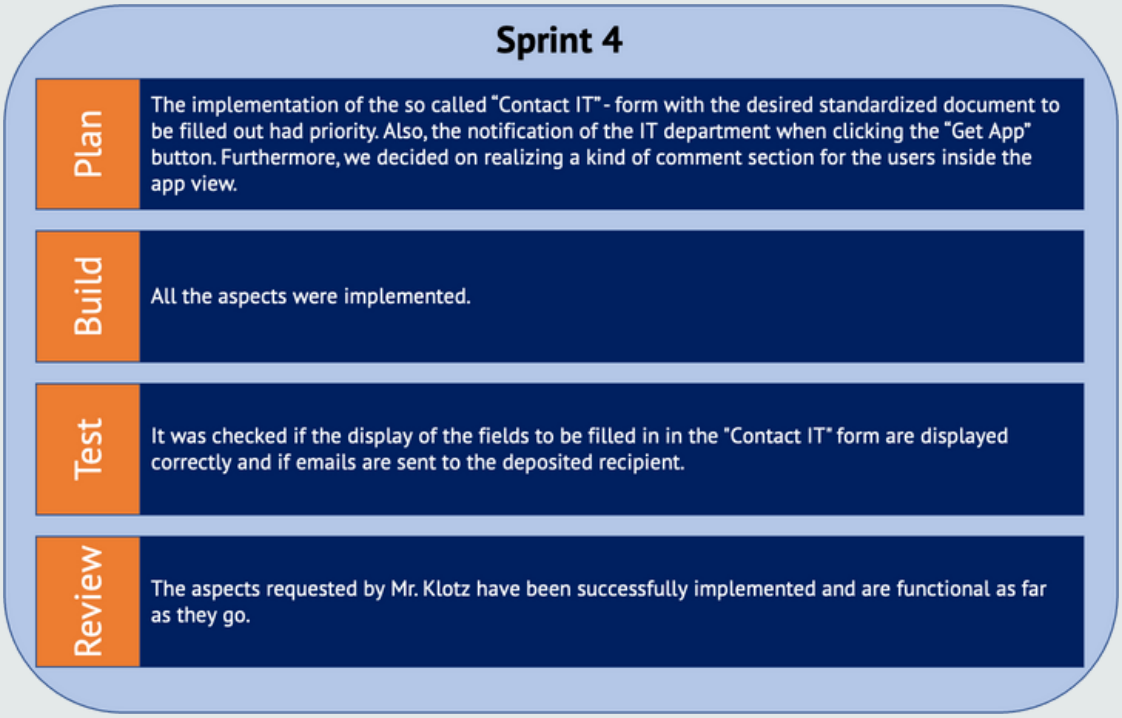

Illustration 8: Sprint 4

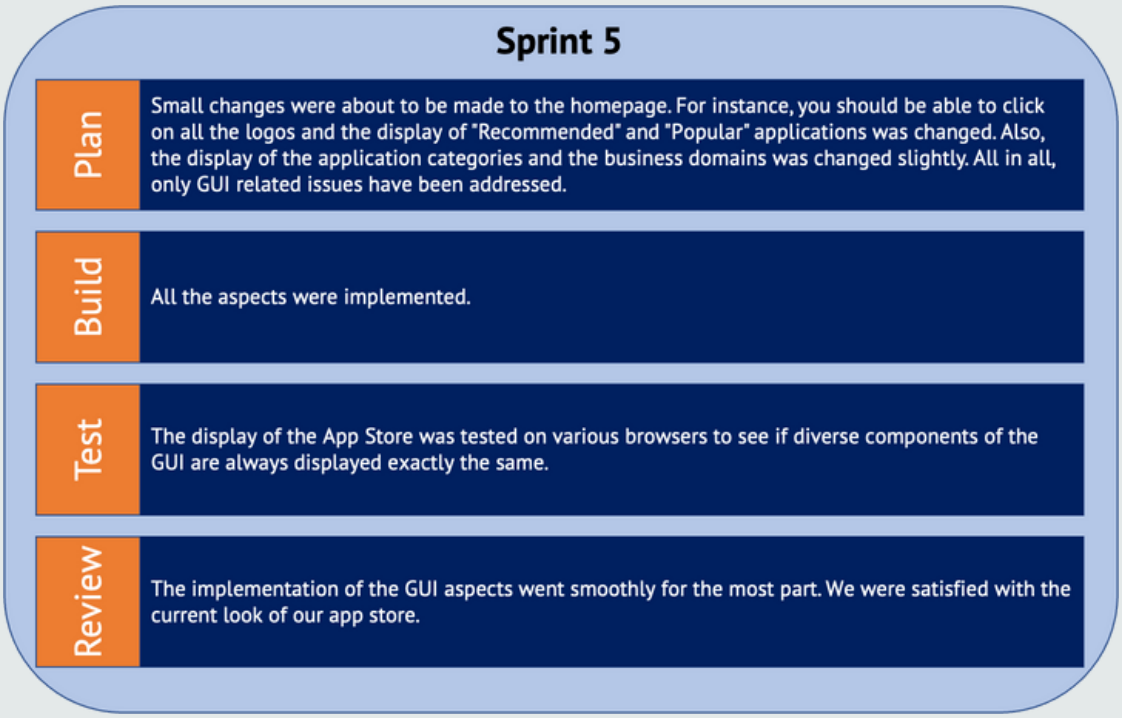

Illustration 9: Sprint 5

A3: Theoretical Foundation of our Solution

The HTI App Store addresses usability's 5 quality dimensions.

Learnability – easy to accomplish basic tasks at first time usage

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Efficiency – once design is learned, essential tasks can be performed quickly & efficiently

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Satisfaction – visually pleasant UI & intuitive UX

Memorability – re-establishing proficiency of usage is made very easy for users

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Errors – potential for errors by users is near 0, recoverability is given via admin functions

Illustration 10: Quality dimensions of usability according to Nielsen (1993)