

Collaborative Note Sharing System

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Abstract

The constant creation of content and the consequent increase in the amount of information available, has changed the way humans capture and handle a thought process or ideas they might want to store. With technological development, several devices and programs have emerged that respond to the need for note entry. In this context, the Infinitebook was created, which provides a reusable alternative for writing notes by hand. Taking this product into consideration, it is proposed to develop its technological component, where it should be possible to publish, store and manage the contents of notes made in the notebook securely and instantly, with the possibility of being shared among several users. This product will consist of the following parts: Infinitebook App, Infinitebook Cloud and Infinitebook Admin. The different parts of the product form a multiplatform system, which is available in mobile application and browser versions, and the main focus during its design and development should be its usability and ease of transition between the different versions of the product.

Keywords: note-taking, interface, real-time, cross-platform, user experience

1. Introduction

The high rate of data growth facilitated by technological advances has led to the creation of tools that allow the safeguarding of information, without compromising the user's quick and easy access to it. To this end, note-taking systems have emerged, where you can view, create or edit notes for different purposes.

The emergence of smartphones and other mobile devices and the consequent improvement in their performance and storage capacity were key to the growth of note-taking systems, enabling them to be developed as mobile phone applications for widespread use. Currently, these types of systems have features for storing and managing documents of various formats, photos, videos and the creation of elaborate notes that are useful not only to the everyday user, but also in the professional context.

1.1. Problem

Given the large number of users simultaneously using existing note-making and editing tools, it is difficult to store information quickly, efficiently and securely in real time. This gives rise to problems in terms of synchronization, since if a common repository is to be maintained between the various members of a team, information can often be available first to certain users before it is to others, causing some data to be lost or even overwritten. In addition to the issues mentioned above, existing

applications for this purpose have interface defects on the different platforms on which they are available, making it difficult to use them quickly and effectively. Likewise, there are applications with inconsistent interfaces on different platforms, presenting the information differently on different devices, which, as a result, reduces the ease of use and the process of memorizing tasks of systems, reducing the quality of the user experience.



Figure 1: Infinitebook Starter Kit A5.

1.2. InfiniteBook Notebook

Considering the gaps pointed to this type of system, the product InfiniteBook¹ is presented. The product in question, developed by the company InfiniteBook in 2014, consists of a notebook that has reusable sheets for writing any type of information. The purpose of the notebook is to represent

¹Infinitebook - <https://www.infinitebook.com/>

a portable whiteboard that, together with a pen, allows writing content on the pages. This content can later be erased by a brush placed at the bottom of the pen, leaving the page clean, with no trace of the previous content.

1.3. InfiniteBook Application

It was proposed to implement a mobile application, designed to accompany the use of this notebook, with the purpose of taking photographs to its pages, to be properly stored and automatically distributed by users who should have access to this information. This product is intended for personal users and business organizations who need to distribute information instantly and quickly.

The application allows the creation of accounts, as well as folders or projects, allowing users included in them to receive stored data immediately. The system was built from a multi-platform perspective and the considered formats were a native iOS and Android application and a corresponding browser version, with information shared between them.

1.4. Objectives

This project considered the implementation of the system referred to in the previous paragraph, and its development was made by the student in a company environment, together with the company Chilltime². In addition to product realization, an interface analysis was performed on different existing and competing product devices in the same industry. This analysis focused mainly on user experience, emphasizing the problems that need to be solved in this type of system and the identification of the positive and negative aspects pointed out by the users. The results of this study were analyzed and taken into account in the design of the product interface and later on in the implementation of the InfiniteBook product application. The user tests were also performed based on the previous study. Taking into account that the system is multi-platform and to accompany the new technologies available for this purpose, the product was made using the React framework. This framework, created by Facebook, allows the creation of software for different types of devices and facilitates the transition from a mobile to web environment, as well as from Android to iOS, making it a framework for hybrid applications.

In short, the main goals of the project are the creation of a multi-platform system based on an intensive theoretical-practical study, which would allow the creation of the most appropriate user interface, correcting the errors of existing products. The purpose of the application was to automatically store notes and instantly transfer them between users

²Chilltime - <https://www.chilltime.com/>

if it was a shared note. In addition to this, the junction between the application and the physical notebook was always taken into account throughout the design and development of the product in order to produce a system dedicated to transforming the reusable notebook physical notes into processed digital notes.

2. Background

The InfiniteBook product, mentioned earlier in section 1.2, is made up of a physical notebook for the purpose of recording any kind of handwriting. Like this product, the creation of note-taking products came from the use of notebooks, diaries, and physical sheet calendars. These types of objects, although not recent - the first products called notebooks date back to the 17th century [3], made up of half-folded sheets with hand-made lines - continue to be present in everyday life, and are often desired by users looking for an object that allows them to organize tasks or notes quickly and in a structured way. This is because paper writing is often preferred over writing on touch systems or even on computer or mobile keyboards, as it facilitates the visual memorization of content and the transmission and expression of the idea. [9] - whether it is in text, drawing or any other graphic form. In the late nineteenth century, after the invention of the Legal Pad [1] - a collection of typically yellow lined sheets, joined together at the top - by Thomas W. Holley of Holyoke, several stationary companies emerged that sold rugged notebooks and, in some cases, to the luxury market, such as the Smythson³ and Rhodia⁴ brands, founded respectively in 1908 and 1934 in central Europe (England and France).

With the technological improvements, the need arose to convert these objects into electronic devices and, later on, into smartphone applications, passing through the creation of PDAs [10] (Personal Digital Assistants) and reaching *smartphones*, which we currently use. Note-taking on electronic devices has now taken the form of mobile applications, where four of which stand out in terms of service and number of users: Evernote, Microsoft OneNote, Google Keep, and Dropbox.

2.1. Evernote

The worldwide increase in the number of smartphone users, along with the improvement of the internet, has created the problem of the constant and rapid growth of information volume. Driven by this problem, many companies found approaches to solutions in the form of applications and information storage software in a way that was efficient, fast and simple to use [2]. A company that is worth mention-

³Smythson - <https://www.smythson.com/eur/smythson-story>

⁴Rhodia - <https://rhodiapads.com/brand.php>

ing in this area is Evernote⁵, which introduced an application for creating, formatting, and managing notes and tasks that could be archived and stored according to each user’s preferences. The first Evernote app was released on June 24, 2008, and it was initially available in a web version only, having released a smartphone *app* version later on in 2011. At the moment, the app is multi-platform and available for any operating system for desktop (except Linux) and for Android and iOS on *smartphones*.

The latest version of Evernote contains features such as “scan” that allow you to take photos of any kind of physical sheet and include them in the note in question and even associate business cards with LinkedIn profiles. You can also use a Web Clipper (feature that lets you crop portions of websites, articles, or PDF files⁶), and include in notes as an image or save as a separate note. One feature that stands out in this product is “Search Handwriting”, which allows you to search for the text made by the user. This feature requires handwriting recognition and search algorithms that analyze both text written in virtual notes and text in photographs, Post-its, or paper to-do lists. Another feature that is available in Evernote is the real-time writing of notes through voice.

2.2. Microsoft OneNote

One relevant application in the note-taking software market is OneNote⁷ from the American company Microsoft, which was first announced in November 2002 and released the first version in 2003. This product aims to create all kinds of notes, whether smaller and faster to create or larger and more elaborate in formatting. OneNote saves information on large, limitless pages where text, images, tables, drawings and, in the latest versions, voice files can be inserted. Similar to a dossier, Microsoft decided to allow the user to organize pages into sections, which in turn are contained in notebooks [4]. It is also important to mention the OneNote multi-user collaboration feature, which allows multiple users to collaborate simultaneously. The software, initially only available as a desktop application, comes in its latest release, Microsoft OneNote 2016, as a standalone product available for various operating systems such as macOS and Windows, and smartphones in Android, iOS, and Windows Phone app format [6] [8].

2.3. Google Keep

Google Keep⁸ is a note-taking and note management application developed by the company

Google, having had its first release in March 2013. In addition to being available for the different platforms mentioned in the previous examples, Google Keep can keep up with Evernote in the most of its advanced features. Examples of these features are the creation of text notes or dots, as well as links, images and audio. Google Keep also has a number of note search benefits, and you can place tags and labels on each note you create. Subsequently, in-app search lets you filter results by tags or labels beyond the note title, making it easier to reach the desired note or a set of notes for the same topic (tag or label) [5] [7]. Google Keep features a beautifully structured interface that allows you to customize colors and note layout. However, one of the main benefits of Google Keep is the direct synchronization of notes with Google Drive⁹, a management system and file storage developed by the same company.

2.4. Dropbox

During the development of the project of this dissertation, a new version of Dropbox¹⁰ was released. This update brought new features to the product previously presented by the company. Dropbox, Inc, founded in June 2007 in San Francisco in the United States of America, launched a product that same year that became known worldwide. This product is a cloud system for storing and managing various types of files. This software is equally multi-platform and has demonstrated over its 12 years of existence an expansion to different types of platforms, including the mobile application formats for Android, iOS and Windows Phone. In the latest mobile application update, features have been added that allow you to scan documents to be stored in the previously existing storage system. The company also included Dropbox Paper¹¹, which allows users to create their own handwritten or drawn notes and instantly share them with others users. These new features are available for Android and iOS mobile devices and have been integrated into versions released from early 2019 and has been successively enhanced.

3. Infinitebook’s Technological Component

The technological component of the Infinitebook product originated from the product company itself which, after some time in the market and after some customer requests, decided to create a system where the notes produced by notebook users could be stored and available not only to the creator, but also for users included in projects where the note was inserted.

The format chosen for the system was a mobile

⁵Evernote - <https://evernote.com/>

⁶Portable Document Format (PDF)

⁷OneNote . <https://products.office.com/pt-pt/onenote/digital-note-taking-app>

⁸Google Keep - <https://keep.google.com/u/0/>

⁹Google Drive - <https://www.google.com/drive/>

¹⁰Dropbox - <https://www.dropbox.com/>

¹¹Dropbox Paper - <https://www.dropbox.com/paper>

application because it is suitable for quick and practical use, which is easily combined with the use of the physical notebook. The creation and development of this was delivered to the company Chilltime, after the definition of the following requirements:

- Account creation;
- Creating shared projects between accounts;
- Publication of documents in one or more projects;

Throughout the development process, some features have been added to the application to make the product as complete as possible, highlighting the following:

- Detection and image processing of notebook pages, forming a document;
- Posting comments on documents;
- Share, duplicate, move and edit documents;

3.1. High-level Architecture

In addition to the features that appeared throughout the development of the application, the need for content management has allowed the product to be rethought in a context beyond mobile. With Chilltime's technology and availability for this purpose, the deliberation of both companies led to some additions on the product to be considered. The technological component of the product then consists of 3 different parts:

- **Infinitebook App** is a mobile app available for Android and iOS devices;
- **Infinitebook Cloud** which corresponds to a version available on a web browser for viewing and organizing content produced by the mobile application;
- **Infinitebook Admin** whose purpose is to serve as a backoffice with restricted access to company constituents or administrator accounts for content control, management and data analysis.

3.2. Conceptual Model

Analyzing the scheme presented in figure 3 it is possible to verify that there is a user type that is common to the mobile application and the web version, and also a different user type only connected to Infinitebook Admin. This distinction between both users is due to the fact that Infinitebook Mobile App and Infinitebook Cloud are the products that, in fact, are available to the average user who wants to use the service provided.



Figure 2: Infinitebook products: notebook, Cloud version and App version.

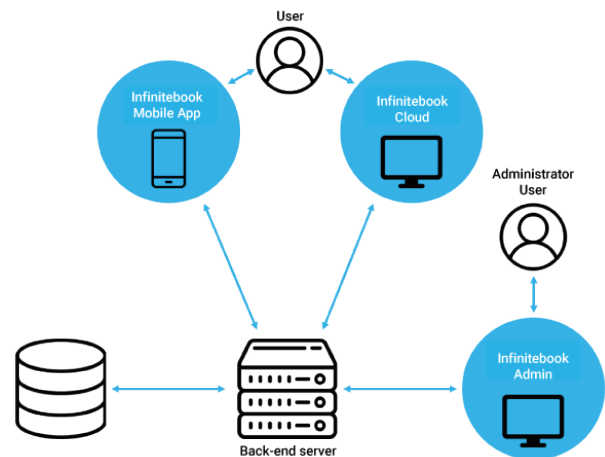


Figure 3: Infinitebook product constitution scheme.

The backoffice is a system that shares the same back-end as the other product constituents. However, only users with administrator status (of type *admin*) are allowed to access it. This system aims to present the content stored in the database, which is also shared between the three parts of the product shown in the diagram. In addition to this, Infinitebook Admin allows you to edit and delete the content of the database, making it essential that only users that are product administrators (notably members of the Chilltime development team and the Infinitebook company team) have access to it.

The databases contain all the data coming from the application as well as the data necessary for its use. The information from all user accounts, the data needed to connect to the application, the documents, projects and comments, and the notifications that users have received are some examples of the data that is stored in these databases. In addition, all the language structuring and product translation is also present in these databases and the distinction between account types and in-store purchase records. Since it is important that this content is handled in part by the Infinitebook team, the creation of Infinitebook Admin has proved to be strictly necessary for a clearer and easier-to-use interface.

The server connected to the three constituents of the product is the server that contains all of the back-end code, implemented in the PHP programming language. It has the purpose of receiving requests in https from the client and returning a response to it, connecting to databases for writing, replacing, removing or obtaining data or performing operations that should be performed in the server-side. At an early stage of development, the team chose to create a separate Node.js¹² server that would perform the image processing necessary for the application, however, it was removed when it was possible to develop this processing directly on the application side, avoiding calls to the application programming interface (API) that decreased the performance of the application while using this functionality.

3.3. Chosen Technology

The mobile application was developed in React Native¹³ and the Cloud and Admin versions used React.js¹⁴ (both strands of the React framework). This framework, developed by Facebook in 2015, allows the creation of mobile or web applications using the Javascript language. It is a constantly growing open-source framework, with ever-increasing functionalities and creating applications that are as fast and smooth as applications created natively. The advantages of using this framework over the development of separate applications for each of the mobile device softwares are focused mainly in the rapid development and the help available from the community. In a separate development environment, separate programming of the same application is required, and programs such as XCode¹⁵ must be used to develop the version of iOS and Android Studio for the Android version. In a cross-platform development environment, such as React Native, you can develop the entire application interface on any operating system and any text editor. Chilltime has chosen to use this framework for the advantages mentioned previously in this section, but also for its existing experience in the development team, which has also accelerated the implementation of the application and browser versions.

The OpenCV¹⁶ library (Open source computer vision) was used in the application in a section dedicated to finding the corners of the document to be scanned. This library was developed at an early stage by Intel and then supported by Willow Garage, a research lab based in California. Having been released in June 2000 and undergoing significant changes and improvements to date, this li-

brary is considered to be one of the most complete libraries for image processing. Throughout the product development, various solutions were found and tested for using OpenCV in React Native that would allow the camera to have document "live-detection" (real-time detection while the camera was in use). However, after incorporating some existing solutions and libraries into the application, it was found that they still have yet to be tested and corrected, so the team decided that the live-detection of documents would remain as one of the points intended for future work of the application.

The ImageMagick¹⁷ library is a library that is dedicated to image manipulation and alteration for the PHP programming language. It was initially launched in 1990, and its team has been generating new versions to this day. For the application in question, ImageMagick was incorporated in the phase prior to the publication of the image documents, when the cropping and correction of the perspective of the image is done. The library also takes care of the image color, in order to achieve the best possible reading in the formulated document.

3.4. User Interface

The user interface was designed by Chilltime's team designer, taking into consideration all of the reviews pointed out by the CEO (Daniel Vila Boa) and the development team. For the product, an image that was consistent with that of the brand in question (Infinitebook) was chosen, and as a result all of the screens (application pages) and pages of the web version included were based on the main colors of the product, which are blue and white. The following interface points were also defined:

- The **Users** are shown in circles with each user's picture and are usually arranged in sequence and horizontally (in sections where the users included in a project are shown, for example). There are also product-specific sections in which they are vertically listed with the user's name next to their photograph (in project member selection screens);
- The **Documents** are always represented on all the product screens as the document (processed photograph) resulting from the capture of notebook pages and are arranged in various ways;
- The **Projects** are arranged vertically and in a list and each of the project's types are represented by a blue folder containing an indicator symbol of the type in question, which goes along with the project name and its members.

¹²Node.js - <https://nodejs.org/en/>

¹³React Native - <https://facebook.github.io/react-native/>

¹⁴React - <https://reactjs.org/>

¹⁵XCode - <https://developer.apple.com/xcode/>

¹⁶OpenCV - <https://opencv.org/>

¹⁷ImageMagick - <https://imagemagick.org/index.php>

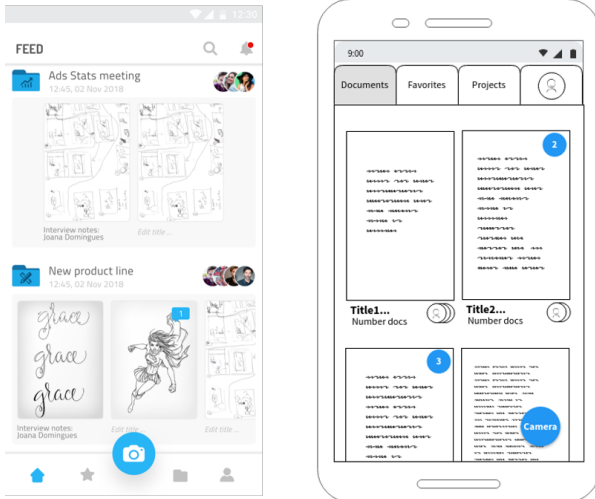


Figure 4: Comparison between the final interface (on the left) and the interface designed before the development of the mobile application began (on the right).

Since one of the initial goals of the product was to maintain the consistency across product versions to improve and facilitate their complementary use, the design of Infinitebook Cloud was developed taking into account all the user experience standards for a web platform, however resembling a design that was similar to that implemented in the mobile application. In terms of icons chosen for the various features, the same were used as those of the mobile application, in order to allow the user to associate the same action in both versions. Apart from this, the colors and typographic fonts used were also the same as those used in the application. In the same order, we took into consideration the entire structure of the mobile application, which starts by presenting a main area where there is a navigation bar between the four main screens (Feed, Favorites, Projects and Account), while the rest of the screen is used for visualizing the application content. In the web version a similar structure was used, in which the top bar also has access to these four sections, except for the "Account" section, since it is only available in this version by the use of a drop down menu placed next to the user photo.

4. Evaluation

In order to achieve product validation, usability tests were executed in which two questionnaires were included. The first one was related to the user profile, while the second one consisted of a task guide corresponding to the actual user test (both will be described in the following sections).

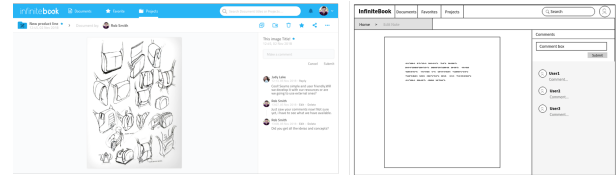


Figure 5: Comparison between the final interface (on the left) and the interface designed before the development of the screen of document visualization in Infinitebook Cloud.

4.1. User Profile Questionnaire

The main points that were considered relevant to point out regarding the test users were, firstly, the gender and age range, their area of activity, the frequency with which they use objects or devices to make notes, and finally the user experience on devices such as smartphones with app access. An important point regarding the use of applications from the same field was also included, to enable a further comparison of similar tasks in different applications, allowing the development and design team to understand what is well structured and what can be improved for the user. This data may help to understand certain difficulties that may have been encountered by certain users during testing, and, conversely, to identify the strengths or new features that should be included, in particular by users with extensive experience in using these types of services.

4.2. Test Guide and User Test Questionnaire

The second document filled out by the users is considered both a guide and a questionnaire, based on a set of 11 pre-selected tasks. When the user completes each of the proposed tasks, he or she was asked to indicate a rating corresponding to an ease of execution scale (1- Very difficult, 2- Difficult, 3- Easy, 4- Very easy) to allow the team to set an overall level on each task for future corrections and improvements. The tasks included were the following:

1. Create an account.
2. Complete/edit your profile.
3. Invite a user to a project.
4. Create a project and create a member invite.
5. Insert 4 photos of the pages in the created project.
6. Set a project and a document as favorites.
7. Comment 2 photos.
8. Move 2 documents.
9. Duplicate a document.

10. Delete the moved documents.

11. Delete a project.

In addition to the tasks section mentioned above, a separate component was created in the questionnaire, where open-answer questions were presented to the tester. This section aims to understand if the purpose of the application is clear to the users, as well as to record the main difficulties they have had in the tasks they have just performed and to point out the improvements and features that should be made to the product to improve product quality and user experience.

4.3. User Characterization

The usability tests were executed by 20 people in total. In a first analysis, the questionnaires pointed out that 55% of the tests were performed by females, and the remaining 45% by males. The age distribution factor is particularly relevant in this context as it is directly related to the ease of use of smartphone devices where the application is inserted. As a result, it can be concluded that most test takers are between 18 and 24 years old, which may be an indicator of their frequent use of such devices and applications. Next, it appears that the goal of including people from various industries in usability testing was achieved, however, it was noticed that a significant portion of these users works or studies in the area of Engineering and Production.

Another focus of the user profile questionnaire was to understand the user's habits regarding note-taking procedures. Questions were asked about the normal usage of notes by the user, in addition to the type of notes they usually use and prefer (either digital notes or notes made on paper or by hand). Thus, it is concluded that, within the selected sample, 90% usually takes notes on a daily basis, and that the preferred means to do so is the digital format, such as using a smartphone or a computer. Finally, the student wanted to get some data on the level of usage by the users of technological devices or components, such as mobile applications or smartphone devices. It was found that 55% of testers use the Android mobile operating system and the remaining 45% use an iOS smartphone. In addition to this, the frequency of the testers' use of applications of any scope was measured on a timescale to analyze the ease of handling of such technologies. This concluded that all users in the sample use smartphone applications at least once a month, having 90% of them doing so more than once a day and 5% about once a day.

4.4. Results of the Open Answer Questions

1. What is the use of this application for you?

The answers to this question revealed that the main purpose of the product was well understood by the users who performed the usability test. It was pointed out by several testers that the main utility of the application, for them, would be that they can share notes with several people at once. It was positive to note that some users pointed out that the combination of the notebook and the mobile application was not only an added value in note creation and sharing, but also in an ecological level as it allows the users to not carry their other notebooks around, and instead use the app to store Infinitebook notes. It was also mentioned that it could be a very useful application for professional purposes as well as for a student context for sharing notes of projects involving groups that need to access the same kind of information at any time.

2. Which of the tasks did you have the most difficulty executing? Why?

The project creation task was considered one of the most difficult tasks to complete due to the fact that this option is only present on one of the screens, making it difficult for some users to find it. Secondly, the task of publishing documents has also caused some confusion for some of the users. In this case, problems were pointed out in terms of the complexity of this feature, and some users stated that the process could be improved at an interface level, making it more user-friendly. It was also mentioned that it should be possible to publish multiple photographs in the selected projects at once, something that isn't yet possible in the current version of the application. Finally, the account creation task was also considered difficult by some of the testers because it took them a considerable amount of time to find the account creation screen.

3. What improvements do you consider necessary for the current application?

The testers pointed out several improvements to the application during the user tests. One improvement that was common to many users was the long-press feature (pressing and holding an element until the available operations regarding that element appeared), mentioned earlier in the document in question. Of course, this behavior is common to a large number of applications used by the average user on a daily basis, which made it become an intuitive behavior when navigating in a mobile application and, therefore, it should also be included in the product in question. Another suggestion pointed

out by some users was a help element for navigating and learning about the application and its features. These users have indicated that an explanation balloon in certain application components or a window with a demo video that appears on the first application login would be useful in clarifying not only the various sections of the application, but also the functionalities available, which, according to these users, were not always evident. One feature that was widely criticized by a large portion of users was the fact that the current version of the application does not allow multiple projects or documents to be selected simultaneously for any kind of operation. This feature is already available in the web version (Infinitebook Cloud), however, the development and design team recognizes that this is an indispensable addition and will soon be included in the next version of the application.

Finally, some suggestions were made to correct the tasks that most users had difficulty completing. Users suggested that a button for creating a project should be included in the initial feed, allowing this option to be available in more than one place in the application. In addition to this, users who had difficulty finding the account registration screen requested that this option should be more visible and apparent as soon as they entered the application.

4. What features do you think could add value to this application?

Users who performed the usability tests indicated several features that they would like to see in the Infinitebook application in the future. At a first glance, a large number of users pointed out that it would be a great asset to the application if it was possible to identify text written in the Infinitebook notes when processing the page image. This feature, which is called OCR (Optical Character Recognition), is one of the key points that the development team will take into account for future releases, and from the beginning of product design, both teams (Infinitebook and Chilltime) wanted this feature to be included in it at some point. Then it was also pointed out by several users that it would be a good option to allow writing and drawing freely and in different colors over the processed notes. This feature is easily found in a number of note-taking apps that don't use physical notes, such as the pre-installed note apps found on Android and iOS smartphones, making it a well-known feature to many users and, therefore, desired for certain circumstances.

Additionally, it was found that an option to export the processed documents to PDF would be a nice addition to the application as it is a feature that was quite mentioned in the answer of this question.

Current forms of content organization in the application, such as the document separation into projects and bookmarking, were considered insufficient for some of the users, who suggested creating the possibility of organizing content within the projects through tabs with different colors and titles.

Finally, it was pointed out by many users that exporting to different storage applications or software (such as Dropbox, Google Drive and OneDrive) should be a possibility in the future. These products are used on a worldwide scale and the ability to share documents across them would be very useful, however, the Infinitebook Cloud platform was also created to provide this type of storage and facilitate content viewing management, making this a matter for future discussion between product creator teams.

4.5. General Analysis of Results

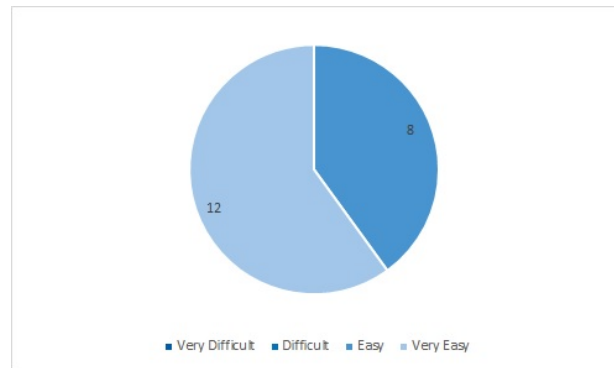


Figure 6: Graph regarding the ease of usage of the application in a global context.

After the completion of the tasks included in the usability test guide, each user was asked to indicate a value, on the execution scale given previously, regarding the ease of use of the application in general and for all tasks they had just completed, as well as as other things they might have noticed. The result indicates that in terms of ease of execution there were no users who found the application difficult or very difficult to use. It is also important to mention that 60% of the testers found the application to be very user-friendly in general. Considering all the results obtained by the usability tests, it can be pointed out that certain components of the application need improvements, namely those that allow it to perform the core tasks of the application, such as the publication of documents in projects and the creation of projects shared across multiple accounts. However, the results can be considered quite positive as they presented a dominance of the ratings of "Easy" and "Very Easy" in all tasks. In a general analysis of the results, it was found that 10

tasks (out of 11 existing ones) had the classification of "Very Easy" as the predominant one and only one obtained "Easy" as the classification most attributed by testers (in the "Insert 4 page photos in created project" task). In addition what was mentioned previously, the "Very Difficult" rating has been assigned only once by a user in the "Move 2 Documents" task during all the usability tests performed. The "Hard" rating was presented more often than the "Very Difficult" rating, but on a global scale this was the classification for 10 tasks out of the 220 tasks performed by the users, corresponding to a percentage of 4.5% of the total tasks executed.

Once the user tests were completed, the app was released to the real market and was added to the Play Store (Android App Store) on September 12, 2019 and to the App Store (App Store for iOS devices) on 19 September 2019. This brought another type of user results in the real context, and the app currently has over 1000 installs on Android systems and over 120 on iOS systems. The app currently has a score of 4.1 (on a scale from 0 to 5) and has 18 reviews (app review comments, available to any user who goes to the app install page) on Android platforms, however, no reviews have yet been made on the iOS store, but it shows a frequency of 8 impressions per day (number of times the app appears to users when browsing the store).

5. Conclusion

This dissertation had as its main purpose the creation of a system that focused on the usability of interfaces for different types of platforms. The fact that the Infinitebook product needed a technological component that would allow the construction of a multi-platform system that focused on both the mobile and web components, made it clear that the development of this product would be a good option for this dissertation.

Initially, different products that presented solutions for note-taking were selected and analyzed in order to identify their positive and negative aspects and to understand what kind of gaps currently exist in them. At first glance, it was found that none of the existing products focuses on a parallel use with a physical note-taking product (such as the Infinitebook). Secondly, it has also been found that there is no major concern on the part of product companies to make the interfaces of different platforms easily passable to users. That is, the different versions of each product feature interfaces with little similarity, making it difficult for the user to recognize the functionalities by increasing the learning curve from version to version. Finally, the analysis of reviews made by product users have found that they sometimes have problems with data synchronization and information loss.

Taking into account the points mentioned above, the Chilltime team has designed and developed the technological component of the Infinitebook product. The application was the first element of the suite to be developed, followed by the Infinitebook Admin component and, finally, the Infinitebook Cloud. The reason why the web component was implemented after the mobile application is to ensure that it is presented in a similar version to the application in terms of functionality and appearance.

The development of all the product components was accomplished by the dissertation author, along with the remaining Chilltime team. The interfaces were designed by the team's designer and the image processing algorithm was implemented by a development team member who was specifically devoted to this matter. However, the entire team worked together to reach the final state of the product. This development represented a profound increase in knowledge of the technologies used in the product, such as React.js, React-Native, PHP and OpenCV, as well as learning about the design and implementation phases of a product of this scope.

Finally, usability tests were carried out to understand the ease of use of the product in conjunction with the Infinitebook notebook. The usability tests, whose results were analyzed in the "Evaluation" section, made it possible to identify the main problems of the product, as well as the points that the users considered positive. The purpose of the application was found to be well understood by the users and the results were generally very positive. After analyzing these results and making some of the necessary adjustments, the application was launched and, afterwards, so was the Infinitebook Cloud version.

In short, the product is currently on the market and being used by a considerable number of users. As mentioned before, the result has been positive, especially for notebook users. However, there are several aspects that should be improved, which are the focus of the team's future work.

5.1. Future Work

In terms of improvements, the team must continue to address the usability issues and difficulties encountered in the usability tests (mentioned in the previous section), particularly in sections dedicated to performing core product operations or functionalities, such as the publication of photos in projects and inviting other users to share projects.

Currently, the image processing is done both in front-end and back-end, however, incorporating OpenCV allows for all this processing to be done on the application side only, allowing offline processing, for example. The team is already making this transfer and, everything is indicating that it will be

included in the next version of the application.

Regarding the features that should be added, there are numerous possibilities. However, according to the usability testing results and the product development perspectives, two features can be highlighted: the document word processing (OCR) and the ability to draw or write freely on top of the documents.

In conclusion, although the product is already in a solid state that meets all the requirements initially defined, its context and possibilities of technological evolution, will allow the development of new features and improvements whose limit is not yet determinable, giving this product characteristics of innovation and dynamism.

References

- [1] M. Brand. The history of the legal pad. <https://www.npr.org/templates/story/story.php?storyId=4673512>, 2005. [Online; Acedido em Outubro 2018].
- [2] J. Duffy. The 10 best note taking apps in 2018. <https://zapier.com/blog/best-note-taking-apps/>, 2018. [Online; Acedido em Outubro 2018].
- [3] M. D. Eddy. The nature of notebooks: How enlightenment schoolchildren transformed the tabula rasa. *Journal of British Studies*, 57(2):275–307, 2018.
- [4] S. Malter. Onenote for beginners: Onenote in office 2019: Finally certainty! <http://onenote-for-beginners.com/onenote-office-2019>, 2018. [Online; Acedido em Outubro 2018].
- [5] N. Messieh. Make use of: 7 google keep features for perfect lists. <https://www.makeuseof.com/tag/google-keep-lists/>, 2017. [Online; Acedido em Novembro 2018].
- [6] Microsoft. Office blogs: Onenote now on mac, free everywhere, and service powered. <https://www.microsoft.com/en-us/microsoft-365/blog/2014/03/17/onenote-now-on-mac-free-everywhere-and-service-powered/>, 2014. [Online; Acedido em Novembro 2018].
- [7] J. Raphael. 11 ways to get the most out of google keep on android. <https://www.computerworld.com/article/3064305/android/11-ways-to-get-the-most-out-of-google-keep-on-android.html>, 2016. [Online; Acedido em Novembro 2018].
- [8] L. Spector. Pc world: The best onenote 2016 tips: 10 ways anyone can get organized. <https://www.pcworld.com/article/3145376/software/the-best-onenote-2016-tips-10-ways-anyone-can-get-organized.html>, 2014. [Online; Acedido em Novembro 2018].
- [9] O. Tech and Learning. Taking notes in class: Laptops vs. handwriting. <http://oftechandlearning.com/taking-notes-laptops-vs-handwriting/>, 2016. [Online; Acedido em Outubro 2018].
- [10] A. Viken. The history of personal digital assistants 1980 – 2000. <https://web.archive.org/web/20131030153659/http://agilemob.history-of-personal-digital-assistants1/>, 2009. [Online; Acedido em Outubro 2018].