

Evaluation and Design of a Scanning Application

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1) Summary

In this paper we analyze, evaluate and redesign a document scanning application using human-centered design principles. Initially, we study some available applications and from them we choose one that seemed to have some areas which could be improved. Afterwards we do user analysis, that is, we analyze the typical users, the scenarios in which they may use a scanning application and we define personas. At the same time, we do task analysis, that is, we study the context in which users use this application, for what purpose and in what way. This allows us to define the functional and non-functional requirements of the application. Moreover we evaluate the application with both expert and user based evaluation methods to receive feedback. Next, we design a new scanning application to respond to observations made from us and the users. Additionally, we show the prototypes to users to let us know what they think and make corrections to the proposed design according to their comments. Finally, we compare the application we designed with the original and report conclusions.

2) Study of scanning applications

In order to choose a scanning application, we first study the existing applications and choose the one that we think needs more improvement.

i) Tiny Scanner

It is an application with a free trial period of a few days that allows all the functions of scanning, digitizing, editing and sharing documents. It is also easy to understand how to manage the application.

ii) Microsoft Lens

This application is free, however we found it can be significantly improved because when we scan a document it displays a huge red square that confuses us and also has some usability issues, such as that when you take the first photo it automatically transfers you to the overview menu regardless of whether you want to scan other photos. Therefore, the application can be improved and we will focus on this application.

iii) PDF Scanner – EZTech Apps

This application is free, but we found it particularly problematic due to several choices made by the designers. During the scan, the page size selection is made by displaying a long list of all available options, where the user has to search a lot to find the desired size (in fact, the most popular option, which is the A4 file, was not quickly and easily accessible). At the same time, there is no option to directly replace the pages of a file from one photo to another.

iv) Easy Scanner

Easy Scanner is a free application, in which we detected some problems during use. While for a single page the application works fine, when scanning more pages is required, it is not possible to edit the pages directly after scanning. Also, the option to rearrange pages is difficult to detect, as it is placed in the extra options.

v) TurboScan

This application is free and allows all functions of scanning, digitizing, editing and sharing documents. The only problem we found was that the design was too simple using icons without words, so it might confuse a user.

3)User Analysis

In order to be able to evaluate the application, we first perform user analysis. Specifically, we define the stakeholders of the application, we state various typical use cases and we design personas, i.e. representative individuals who will use the application. In fact, to understand typical users, we asked our acquaintances how they use scanning apps, what they do with them, and how often they need them.

Stakeholders

Stakeholders are people who interact with or are influenced by the app. They are divided into three categories: primary users who are regular users, secondary users who are occasional or indirect users, and tertiaries who are affected by the app without using it themselves. In the document scanning application, primary users are all users who use the application to scan their documents, secondary users are the system development and maintenance team, and tertiaries are the owner of the application and individuals who develop various competing applications affected by ours. Also tertiary users are the marketing and management team of the company that will build the scanning application.

Scenarios

To better understand typical users, we first asked acquaintances why they use scanning apps. Based on the answers we received and our own experience, we mention below some typical scenarios of using scanning applications.

Send a doctor's prescription

This particular scenario came from a neighbor who had mentioned that when she was sick with the flu she had to send her daughter a doctor's prescription and had asked us if we knew a good scanning application.

Katie is retired and visited her doctor to write her prescription for otitis that has been bothering her for the past week. He told her which medications to take and gave her a prescription, but since there is no pharmacy in the neighborhood and Katie does not drive, she wants to send the prescription to her daughter so that she can get the medicines. That's why Katie used a scanning app to digitize and send the recipe to her daughter. However, it took many efforts to use it because her hands trembled and the photos were blurry.

Business agreement

This scenario came from an internet search for why an employee uses a scanning application

Charalambos has concluded a large contract with his client for the supply of computer equipment and wants to send the signed documents to the sales manager for copy. In fact, it is important for him to have on his mobile a specialized application that has a nice and easy-to-use design to scan contracts and send them. In particular, he wants to be able to scan many pages and organize files in order to be able to distinguish the different contracts he has and organize them according to his clients.

Job Delivery

This scenario has arisen from our participation in various remote exams.

Panos is a student studying philosophy remotely and wants to deliver his answers for the exam in the course "Ethics and Science" within the next 30 minutes. He had previously used a different app during online exams, but he has uninstalled it. Now he has installed a new application and wants to immediately scan 8 A4 size pages and join them into a pdf file, which he can rename and send quickly.

Change Power Provider

This scenario comes from everyday life as our parents change power providers.

Marina wants to change her electricity provider because her provider has increased prices for the next month and she needs to send a copy of her identity card. Because she doesn't have a scanner at home, Marina installs a scanning app on her phone. She wants the app to produce good results for smaller documents, such as ID, while showing all her personal information clearly.

Personas

Based on the scenarios we analyzed, we can form personas of typical users.

As we mentioned, Katie wants the app to have readable text and remove the shaking she has in her hands from the photo.



Image 1 Katie is a retired employee persona (text in Greek).

Charalambos wants above all documents to have clarity and high quality.

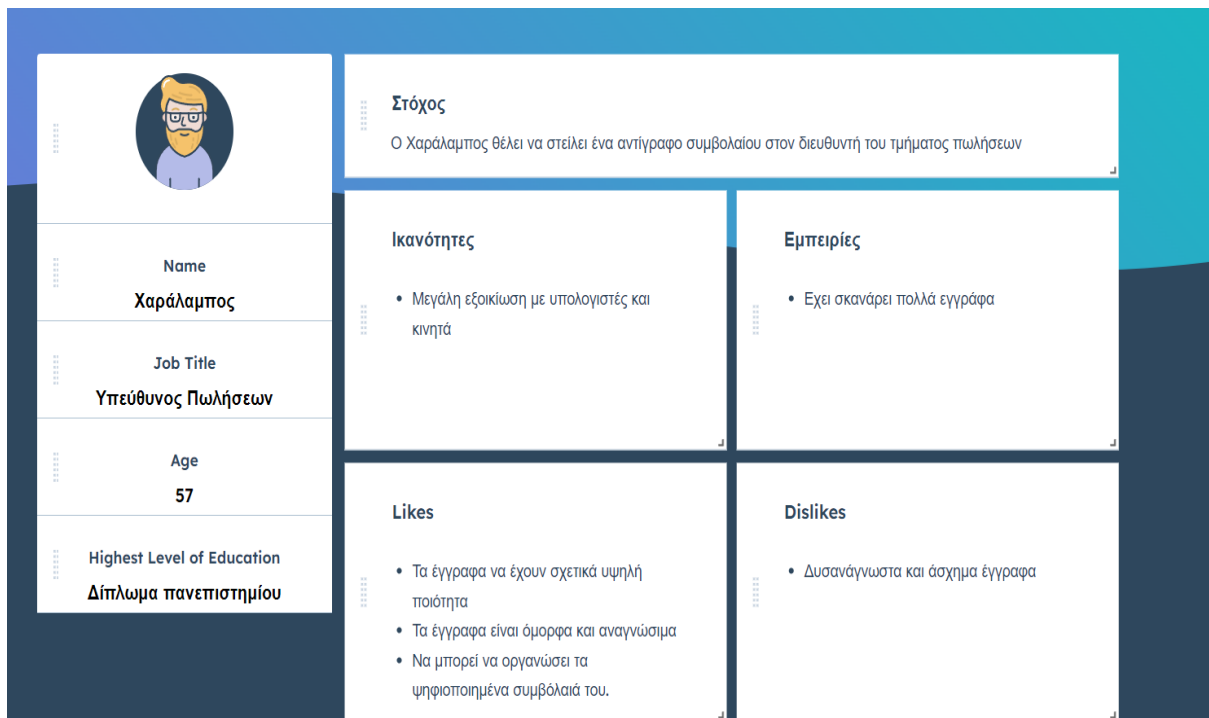


Image 2 Charalambos is a professional employee persona (text in Greek).

Panos is in a hurry to scan his exam assignment and therefore wants to be able to understand how to use the app.


| | | |
|---|---|--|
|  | Στόχος Ο Πάνος θέλει να σκανάρει την εργασία του γρήγορα και με καλή ποιότητα. | |
| | Ικανότητες <ul style="list-style-type: none"> Εξοικίωση με κινητά τηλέφωνα | Εμπειρίες <ul style="list-style-type: none"> Έχει ξαναχρησιμοποιήσει διαφορετική εφαρμογή σκαναρίσματος στο παρελθόν |
| | Likes <ul style="list-style-type: none"> Εύκολες και γρήγορες στη χρήση εφαρμογές | Dislikes <ul style="list-style-type: none"> Να κολλάει το κινητό Να διαβάζει οδηγίες χρήσης |
| | Name Πάνος | |
| | Job Title Φοιτητής | |
| Age 22 | | |
| Highest Level of Education Δίπλωμα Λυκείου | | |

Image 3 Panos is a student persona (text in Greek).

Marina appreciates the result of the digitization of her identity to be beautiful and readable.

| | | |
|---|--|---|
|  | Στόχος Η Μαρίνα θέλει να σαρώσει την ταυτότητα της για να αλλάξει πάροχο ρεύματος | |
| | Ικανότητες <ul style="list-style-type: none"> Μεγάλη εμπειρία στη χρήση υπολογιστών και κινητών συσκευών | Εμπειρία <ul style="list-style-type: none"> Έχει ξαναλλάξει πάροχο και ξέρει τα αναγκαία έγγραφα Έχει χρησιμοποιήσει ξανά σαρωτή και εφαρμογές σάρωσης |
| | Likes <ul style="list-style-type: none"> Γρήγορες στη χρήση εφαρμογές Όμορφο και ευανάγνωστο αποτέλεσμα | Dislikes <ul style="list-style-type: none"> Πολύπλοκο σχεδιασμό που απαιτεί χρόνο για το επιθυμητό αποτέλεσμα |
| | Name Μαρίνα | |
| | Job Title Υποδιευθύντρια | |
| Age 30 years | | |
| Highest Level of Education Δίπλωμα Λυκείου | | |

Image 4 Marina is an adult persona (text in Greek).

4) Task Analysis

Context of use

As part of the task analysis, we first investigate how typical users use the application. As we observed from the use scenarios, the workspace of individuals is usually a flat surface with sufficient space, such as a desk or a table. In fact, users use the application to send a third person a digitized document in front of them. This document is of great importance to the user or to the recipient, since it can be a prescription, a contract, an identity card or a student's answers to the exam. However, while some users may not be under time pressure, others may have strict time limits for sending the document.

PACT framework

The PACT framework (People, Activities, Context, Technologies) involves the people who will use the system, the actions they will take with it, the context in which they will use it and the technologies they will use (Nis, 2023). In user analysis we defined the typical users of the system and the actions they take with it. We also defined under what conditions the system is used in the context of use. Regarding the technology based on the system, it is obvious that the interaction of the user with the application takes place through a mobile or a tablet since the device must be easily transported so that the user can photograph the document he wants.

In fact, it is very important to study the effect of technology on user experience. The application is used exclusively by mobile phones or tablets to scan documents with the device's camera. Therefore, the quality of scanned documents largely depends on the quality of the user's camera. For this, the same application may have a positive impression on some users and a negative one on others depending on how good the users' camera is. Of course, the technology used by the scanning application should not require that users have particularly good cameras so that the application works in a user-friendly way on many devices.

Hierarchical Analysis

In order to understand the individual actions that a user who wants to scan a handwritten document needs to perform, we perform hierarchical analysis, that is, we break down the work into individual elementary actions. This is shown below in Image 5

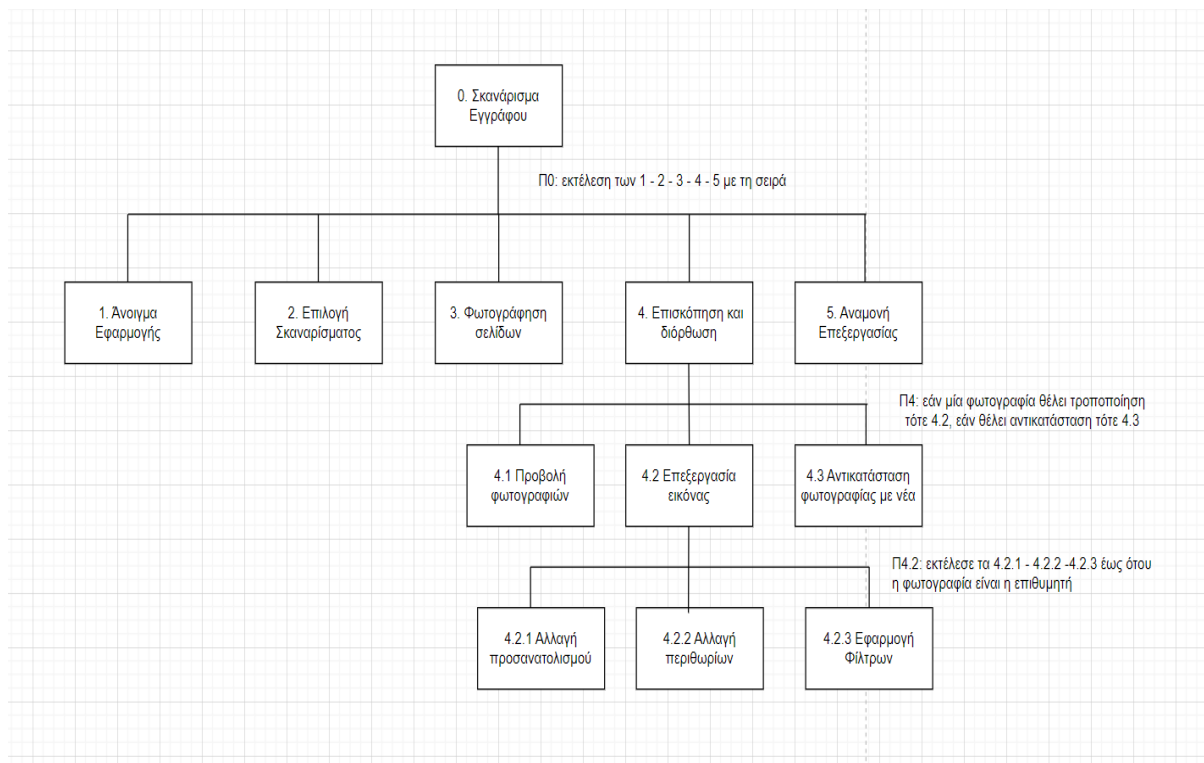


Image 5 Hierarchical Analysis of Tasks (text in Greek).

We observe that the ideal application to be effective and easy to use must either provide the user when he opens it the option to select document scanning or this should be the default option. Then, the user has the ability to photograph the document he wants to digitize and make the necessary corrections which can be either editing a photo or replacing it with a new one. Finally, the user waits until the digitization of the document is complete.

Requirements

Functional requirements.

Functional requirements are the functions we want the system to have, that is, what we want the system to do. Based on the analysis of users, the scenarios and the personas we have created, we conclude specifically that the functional requirements are the production of high-quality digitized documents, the organization of files, their compression, their processing, their sharing, and the protection of documents with a password so that someone who gains access to the mobile can not read them. Also important functional requirements are the ability to replace a digitized page with a new one and remove the effect of trembling from the hands or shadow from the hand of the person scanning the photo. Moreover, it is desirable to have character recognition (OCR) capability to produce text documents and then be able to translate them into other languages. Also, the app could offer the ability to save files to the cloud to make documents accessible from other devices as well. We record these requirements according to how important they are in the following categories.

The application must have:

- Ability to scan and produce high quality digitized documents.
- Ability to replace a digitized page with a new one.
- Ability to share documents.
- Ability to organize documents.

The application should have:

- Ability to remove the effect of trembling from hands.
- Ability to remove the shadow effect of the person holding the phone.
- Ability to put a password on documents.

The application could have:

- Compression capability for efficient document storage.
- Cloud storage capability.

We want the application to have, but not in an original version:

- Character recognition capability (OCR).
- Ability to translate documents into other languages.

Non-functional requirements

Non-functional requirements are the requirements that determine how the application should be designed. Specifically, based on user analysis, we conclude that the non-functional requirements are for the application to be responsive to devices with different screen size so that it can be used from a mobile phone. Additionally, it needs to be easy to use so that someone who has never used it before can immediately understand how to use it. It is also important that the vocabulary is simple so that even older people understand it. Finally, it must be aesthetically nice, that is, have beautiful color coding and a nicely designed interface. Finally, some users would like the ability to personalize the app. We then list these requirements according to how important they are in the following categories.

The application must have:

- The application should be responsive to devices with different screen sizes.
- Easy to understand how it can be used by a new user.
- Simple and understandable vocabulary.

The application should have:

- Beautiful color code.
- Nicely designed interface.

We want the application to have, but not in an original version:

- The user can personalize the application.

5) Evaluation

Next, we evaluate the Microsoft Lens scanning application. First of all, we define the objectives of the evaluation. The evaluation is initially formative, i.e. the goal is to extract specific proposals for improving the application that we will then use to redesign it. Of course, we want to know if the design we will make is better, so we will compare the applications with a concluding evaluation.

In fact, the context of use of the application and the technology to be used have been determined during the analysis of tasks. Also, the users to evaluate the app will match the standard users defined in the user analysis.

In addition, the evaluation will be done both by us, i.e. it will be Expert Based, and by typical users, i.e. it will also be User Based. However, for formative assessment we will use expert heuristic evaluation and the thinking aloud protocol to get feedback from users about their interaction with the application. In fact, to assess whether the Microsoft Lens application is well designed and to make a conclusive evaluation based on users, we will use the method of questionnaires and specifically the UEQ questionnaire. Finally, to compare the app with our redesign, we will use the KLM method, which is a method of concluding evaluation from experts.

Expert Based evaluation

Initially, the evaluation is done by experts in order to identify the particular problems of the application.

1. Heuristic Evaluation

Heuristic evaluation is an expert-based method of formative assessment (Nielsen, 1993). In fact, there are ten heuristic rules, and if someone is violated, a degree of severity is assigned from 0 if it is not considered to be a problem to 4 if it is destructive to the user experience. More specifically, grade 1 is simply an aesthetic problem, grade 2 a minor usability problem and grade 3 a major usability problem. Additionally, heuristics have emerged from the experience of many designers and are as follows:

- 1) Provide feedback on system status: The system must inform users of its status so they know what is happening.
- 2) Use language understandable to users: The app must use language that is understandable to its users.
- 3) Provide easy and clear escape routes: If the user makes a mistake he can easily exit the wrong state.
- 4) Maintain consistency, continuity and standards: The app should have the same design features between different screens.

- 5) Design to prevent user errors: The system should make it easy to avoid user errors.
- 6) Minimize user memory load: The system should enable users to recognize what to do each time so they don't have to remember things.
- 7) Adaptability, shortcuts: The system must be adaptable to user needs and efficient, i.e. an experienced user has the ability to quickly do what he wants but a beginner can also easily find what he is looking for.
- 8) Minimalism, avoidance of unnecessary elements: The system should be stylish and not contain unnecessary things.
- 9) Provide clear error messages: The system should recognize user errors and make it easier for them to correct them.
- 10) Adequate Support – Help and Manuals: The application must provide adequate instructions for its use, if necessary.

In fact, both team members conducted independent heuristic evaluation and then discussed to piece together our results. It is worth noting that the problems we identified were largely common, it was just the level of significance we had assigned that differed, and for this we took an average.

Violations of heuristic rules are as follows:

A)

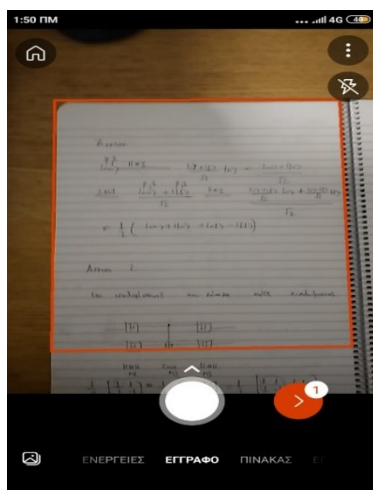


Image 6 Red box that searches for page margins and changes quickly

When photographing a page, the app shows in a red square which part of the page will be placed within a margin and will be scanned. When the mobile phone camera is not very good, the application often recognizes the wrong boundaries of the page and even if the user moves, the frame might change but it often is still wrong. Other times, the frame changes on its own without the user moving. If these problems recur a few times, the user will have a bad experience and is likely to choose to use another application. Moreover, when the algorithm for automatic recognition of boundaries does not work properly, the user is forced to take the photo while

seeing that the margins are wrong. This violates heuristic rule 5 according to which the system must make it easy for the user not to make errors. In fact, the severity of the problem is big and is considered to be a major usability problem, especially for the users who do not have a device with a good camera, and therefore it is very important to fix. To correct this error, margins should not change so quickly and, in terms of design, the user should be given the option to deactivate the automatic margin recognition frame.

(B)

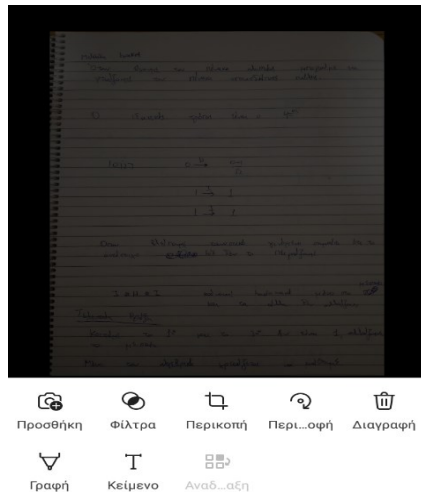


Image 7 Edit an image during overview (options in Greek)

After the user has finished scanning the pages and is in the review phase, if he has made a mistake and decides that he wants to change one photo and place another in its place, he cannot do it easily, as shown by the editing possibilities presented in image 7. That is, suppose the user has scanned a 20-page document and realized that page 3 is blurry. Ideally he would use a "Retake" button that when the user is on page 3 and presses it, he will be automatically transferred to the scanning screen and the next photo scanned by the user will be automatically placed in position 3 and will replace the previous blurry photo. However, this option is not present in the application menu. Therefore, the user must press the back button to be taken to the scanning screen and take a new photo that will be placed at the end of the document. He then needs to delete the original blurry photo and rearrange images to place the new photo in position 3. This violates heuristic rule 7, for adaptability and provide shortcuts to user actions that happen frequently. In fact, it has a big impact on those who make a mistake and is therefore considered a serious usability problem that needs to be fixed. The correction can be easily done by adding the option to replace a photo with a new one in the review phase.

(C)

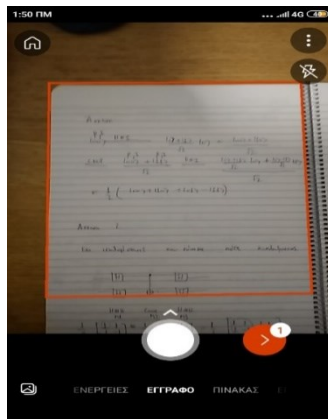


Image 8. Bright red square

The square shown in Image 8 showing the selected margins of the photograph during scanning is brightly colored and is particularly noticeable. Therefore, rule 8 for minimalism and avoidance of unnecessary elements is violated. Of course, this is considered just a small aesthetic problem. To fix this, designers can enable the user to hide the red square. Users can check that margins are selected correctly and change them themselves. Of course, if the margin selection algorithm works correctly, then there will be no need to modify the margins frequently.

(D)

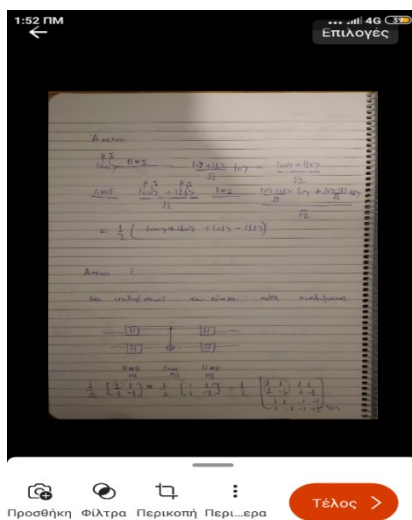


Image 9 Menu to which the user is automatically transferred after taking a photo

When the user takes the first photo then he is automatically transferred to the overview menu, shown above. In fact, if the user wants to scan a document with multiple pages, then he must press "Add" and continue scanning pages. However, he is not given the option to specify that he wants to scan multiple pages before opening this menu. Therefore, rule 7 for adaptability is violated since shortcuts are absent for users who want to scan multiple pages together. This is a major usability problem as it takes longer to scan a document and the user experience is unpleasant. Of course, in order to correct this problem, there could be an option during scanning so that the user can take many photos and he wouldn't be automatically transferred to the overview menu.

(E)

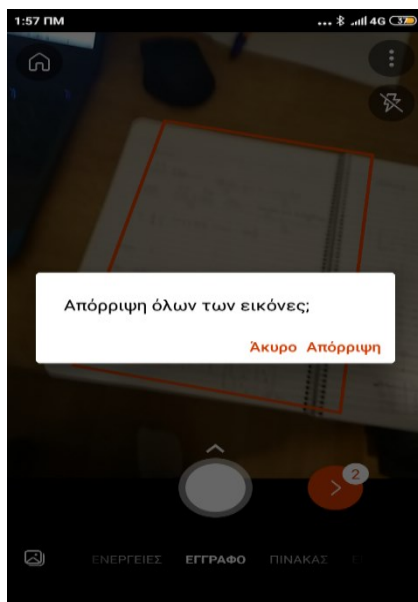


Image 10 Abort scan (message in Greek).

If the user scans a document with many pages and presses the button on his mobile phone to go "back" then the above message appears. Logically, the user expects according to the message to reject the photos and return to the scanning screen. However, the back button does not transfer him to the scanning screen but instead closes the app. Therefore, rule 3 is violated, i.e. a clear and understandable escape exit is not provided to the user, as he expects to return to the application scanning screen but it closes completely. This is considered a minor usability problem. To fix this, the back button must either return the user to the scanning screen, or the displayed message to the user must change so that it is clear that the application will close.

(G)

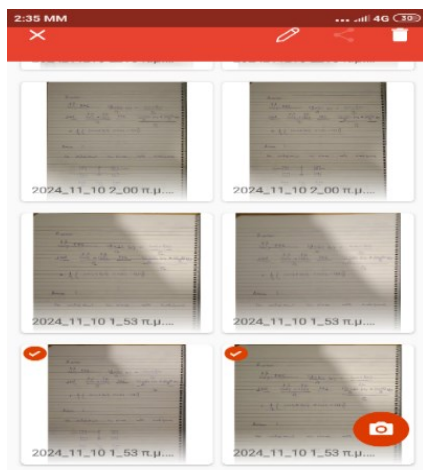


Image 11 Two or more pages can not be shared

Suppose the user has scanned a five-page document and saved it as photos (save to gallery option). The user may want to send someone some of the pages they scanned. However, the application gives the right to send only one page at a time. As shown in image 11, if someone

selects two photos the share symbol is disabled. This violates rule 7 for adaptability to various user needs. In fact, this is considered a minor usability problem as the user can save the document in PDF format and send it all at once.

(H)

As we see in images 9 and 11, some pages in the application have a dark background and the rest light white. This violates rule 4 to maintain consistency on pages. In fact, it is considered to be just an aesthetic problem. To correct this, a slightly darker color, e.g. gray, can be selected on pages that have a white background.

(I)

The user who wishes to rearrange the pages must first press the "More" button shown in Image 9 and then the option he wants will be displayed. Therefore, the rearrangement feature is placed in a relatively hidden place and the user must remember where to find it. This violates rule 6 to minimize the user's memory load. In fact, it is judged to be a minor usability problem. Because the option to rearrange is something that many users use, the option could be present in the main menu shown in Image 9 without having to press "More".

2. KLM/GLM evaluation

The KLM (Keystroke Level Model) evaluation method derives from the Human Processor model (Avouris et al. 2018). We will use this method to calculate the time it takes for a user to scan a three-page document and save it to a PDF named myfile, using the Microsoft Lens application. Afterwards, when we have designed our own scanning application, we will compare the times. However, since it is a mobile application we will use the Gesture Level Model variant (Nyström, 2018). The operators, their explanation and the corresponding times of the model are shown below.

| Operator | Description | Time (sec) |
|----------|---|---|
| P | Move fingers | 0.34 |
| T | Tap on the screen | 0.73* |
| D | Drag an item | 0.44 |
| M | Mental thinking | 1.35 |
| H | Focus on a different area of the screen | 0.4 |
| X | Distraction | Little: +6% of total time Very: +21% of total time |

Table 1 GLM model response times (* Typing time calculated from experimental tests of team members)

In fact, for time T we measured our own typing times with a special application ([Free Mobile Typing Speed Test for Your Smartphone - Find out Your Wpm on iPhone and Android, 2024](#)). The average typing times we measured for the two members of our team were 1.2sec and 0.25sec which shows how much variation there is in typing times from person to person. Therefore, for our research we take the average of the above two measurements and select $T = \frac{1.2+0.25}{2} = 0.73\text{sec}$.

The process we will study concerns a user who scans 3 photos with the default dimensions and options and finally saves the file as a PDF with the name "myfile".

First, the user opens the application and scans the first page, as shown in Image 12. These steps correspond to the following elementary actions of the GLM model:

M: Open home menu

The: Focus attention on the take picture button

P: Finger movement

T: Press take picture button

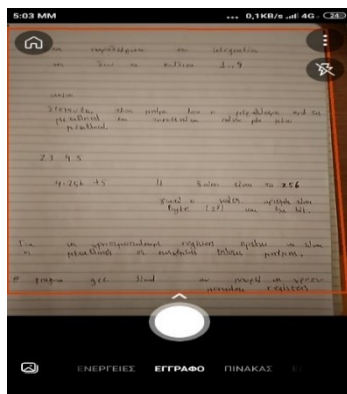


Image 12 Application home menu

After the first photo, the app automatically opens the overview menu shown in image 13.

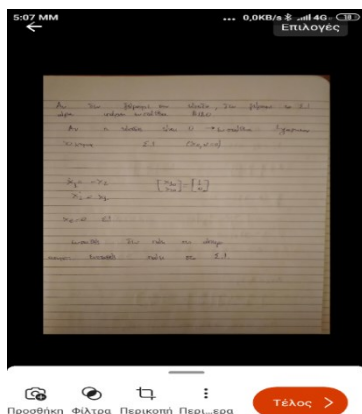


Image 13 The overview menu opens automatically after the first photo

The user then chooses to add another photo to return to the scanning screen in image 12 and continue scanning. So the following actions are taken:

M: Opens the photo overview menu

Or: Focuses on the add photo button

P: Moves his fingers

T: Presses the button

M: The photo screen of image 12 opens

H: Focuses on the photo button

P: Moves his fingers to the photo button

T: He presses the button to take the 2nd photo

After the first photo, the photo overview menu does not automatically open as happened before. So the user continues to photograph the third page and complete the scan, as shown in image 14.

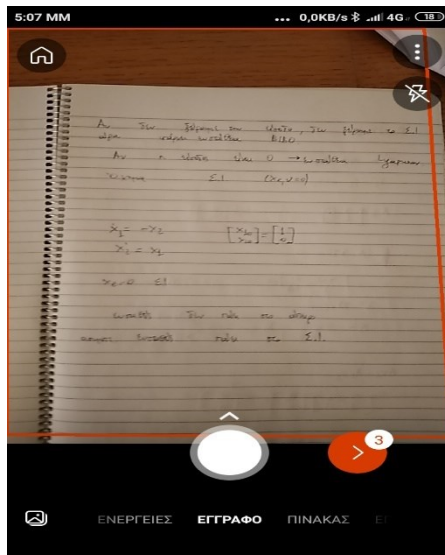


Image 14 The user has scanned the 3 pages he wants

Therefore, the user performs the following actions:

H: Focuses his attention on the photo shoot area to take the 3rd photo

H: Refocuses on the photo button

T: Press the photo button for the 3rd photo

M: He's thinking about how to move forward

H: Focuses his attention on the circle with the photos (red circle with label 3).

P: Places his fingers over the circle

T: Taps the circle with the photos

The user is then taken back to the overview menu in image 13. This time he wishes to proceed with the completion of the scan so he takes the following actions:

M: The overview menu appears

Or: Focuses on the Done button

P: Moves his fingers

T: Presses the Done button

Then he is taken to the save menu shown below and wishes to change the predefined name and rename the file to "myfile".

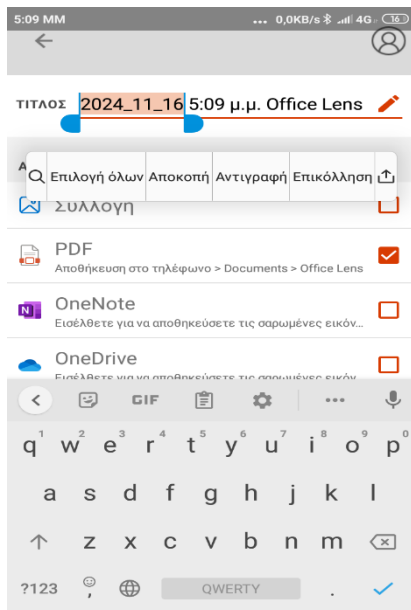


Image 15 Scanned file save menu

The predefined name has whitespaces, so when the user selects it to erase it, only one word is selected and then he has to drag the selectors to select it all. So, the following actions are taken:

M: The save menu opens

H: Focuses his attention on the name

P: Moves his fingers to the file name

2T: Press and hold on the name. Because the default name has whitespaces, only one word is selected

D: Dragging the right selector to select the entire name

H: Focuses his attention on the delete button on the keyboard of the selected name

P: Moves his fingers

T: Presses delete of selected name

M: He's thinking of a new name (myfile)

6T: Types myfile

T: Clicks ok for the name

Finally, the user chooses to save it in PDF format. So, the actions are as follows:

M: Thinking about the desired storage option

H: He focuses his attention on storage options.

P: Moves his fingers

T: Deselects save to gallery

T: Selects save to PDF

M: He's thinking about how to move forward

T: Presses save

The actions needed to scan a three-page document are summarized in Table 2.

| Operator | Times applied | Time Required (sec) |
|----------|---------------|--------------------------|
| M | 9 | $9 \times 1.35 = 12.15$ |
| H | 10 | $10 \times 0.4 = 4$ |
| P | 8 | $8 \times 0.34 = 2.72$ |
| T | 19 | $19 \times 0.73 = 13.87$ |
| D | 1 | 0.44 |

Table 2 Time required to scan with the Microsoft Lens app a file of three pages

Therefore, the user needs a total of $12.15 + 4 + 2.72 + 13.87 + 0.44 = 33.18$ sec to scan a three-page document.

If we assume that he is concentrated when scanning and his attention is not easily distracted, then the distraction coefficient is 6%. Therefore, the required time is

$$T = 1.06 \times 33.18 = 35.17 \text{ sec}$$

In conclusion, the time theoretically calculated with the GLM model is 35.17 seconds. In fact, we did experiments to scan three pages with the application and noticed that it takes about that long which means that the correctness of our calculations is confirmed. Finally, the process of calculating the scanning time will be repeated for the application that we will design to compare the results.

User Based Evaluation

For user based evaluation we will use the thinking aloud protocol, which is formative assessment, and the questionnaire method, which is inferential. Specifically, we'll use the User Experience Questionnaire (UEQ) to assess whether typical users find the Microsoft Lens app well-designed. In fact, the questionnaire is provided free of charge online along with results analysis tools (Hinderks et al. 2018).

1. User Experience Questionnaire

Our survey involved $N=10$ typical users. Specifically, we asked them to scan three pages using the Microsoft Lens app and then answer the questionnaire shown in image 16. In fact, the questionnaire was created and shared online using the Google Forms tool.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | |
|--------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------------------|----|
| ενοχλητικό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | απολαυστικό | 1 |
| δυσνόητο | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | κατανοητό | 2 |
| δημιουργικό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | αναποτελεσματικό | 3 |
| εύκολο στη μάθηση | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | δύσκολο στη μάθηση | 4 |
| πολύτιμο | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | υποδεέστερο | 5 |
| βαρετό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | συναρπαστικό | 6 |
| αδιάφορο | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | ενδιαφέρον | 7 |
| απρόβλεπτο | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | προβλέψιμο | 8 |
| γρήγορο | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | αργό | 9 |
| εφευρετικό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | συμβατικό | 10 |
| παρελκυστικό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | υποστηρικτικό | 11 |
| καλό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | κακό | 12 |
| περίπλοκο | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | εύκολο | 13 |
| αντιπαθητικό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | συμπαθητικό | 14 |
| συνηθισμένο | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | πρωτοπόρο | 15 |
| δυσάρεστο | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | ευχάριστο | 16 |
| ασφαλές | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | ανασφαλές | 17 |
| ενθαρρυντικό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | αποθαρρυντικό | 18 |
| ανταποκρίνεται στις προσδοκίες | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | δεν ανταποκρίνεται στις προσδοκίες | 19 |
| ανεπαρκές | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | επαρκές | 20 |
| σαφές | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | μπερδεμένο | 21 |
| μη πρακτικό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | πρακτικό | 22 |
| οργανωμένο | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | ανοργάνωτο | 23 |
| ελκυστικό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | απωθητικό | 24 |
| φιλικό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | εχθρικό | 25 |
| συντηρητικό | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | καινοτόμο | 26 |

Image 16 User Experience Questionnaire in Greek.

This questionnaire consists of 26 pairs of characteristics, one of each pair has a positive connotation and the other a negative one. In fact, the position to the right or left where the positive answer appears changes from question to question to avoid answers that are all towards one end of the scale, e.g. all positive. The questions in the questionnaire are divided into six groups that measure Attractiveness, Clarity-Understanding, Efficiency, Reliability, Stimulation-Interest and Innovation. Also, the questions are on a 7-point scale corresponding to scores from -3 for maximum negative answer to +3 for maximum positive. For each category, we calculate the average of user responses, standard deviation, and 95% confidence intervals. In fact, a score in a category greater than 0.8 corresponds to a positive rating, scores from -0.8 to +0.8 in average and scores less than -0.8 in negative (Hinderks et al. 2018).

The results of the statistical processing of user responses are shown in the table below.

| Category | Average | Standard deviation | 95% Confidence Interval | |
|----------------|---------|--------------------|-------------------------|-------|
| Attractiveness | -0,400 | 0,48 | -0,828 | 0,028 |
| Clarity | 0,450 | 2,11 | -0,450 | 1,350 |
| Efficiency | 0,150 | 0,41 | -0,245 | 0,545 |
| Reliability | -0,100 | 1,20 | -0,778 | 0,578 |
| Stimulation | -0,375 | 1,78 | -1,202 | 0,452 |
| Innovation | -0,125 | 0,89 | -0,710 | 0,460 |

Table 3 User rating results

We observe that all categories have an average value in the interval $[-0.8, +0.8]$ corresponding to an average evaluation. This means that users on average found the app neither nicely designed nor badly designed. Also, standard deviation tells us how likely a response is to differ from the mean value (a small standard deviation means that all answers are very close to the mean). The largest standard deviation is observed in Clarity, which means that some users found the app easy and understandable and others did not. However, users agree that in the categories Attractiveness and Efficiency the product is evaluated averagely since the standard deviation is small and the average value is also small, just -0.4 and 0.15 respectively. These statistics have been calculated with the tools provided on the questionnaire creators' website (Hinderks et al. 2018).

These results are visualized in the graph below.

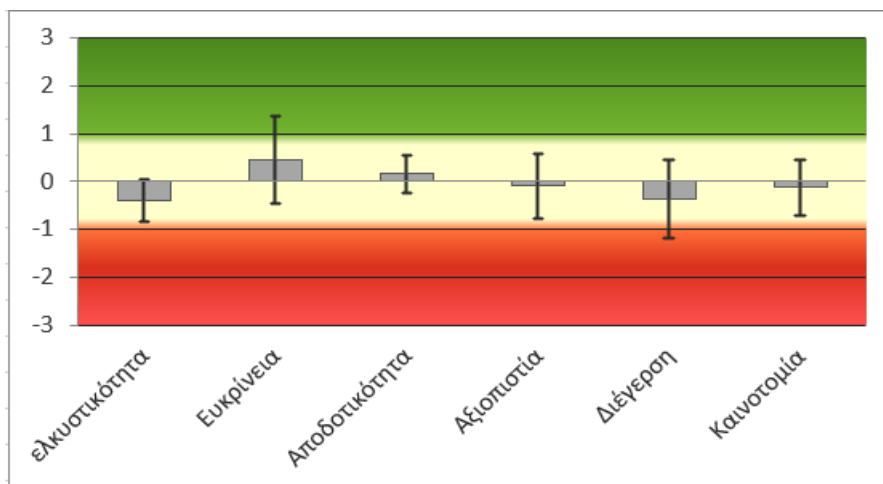


Image 17 Average price and variance in each category (text in Greek).

Also, the creators of the UEQ questionnaire allow to compare the results of our own evaluation with a database containing about 470 evaluations of various technology applications in which more than 21000 people participated. The comparison of the current evaluation against the ratings of other applications is shown in Image 18

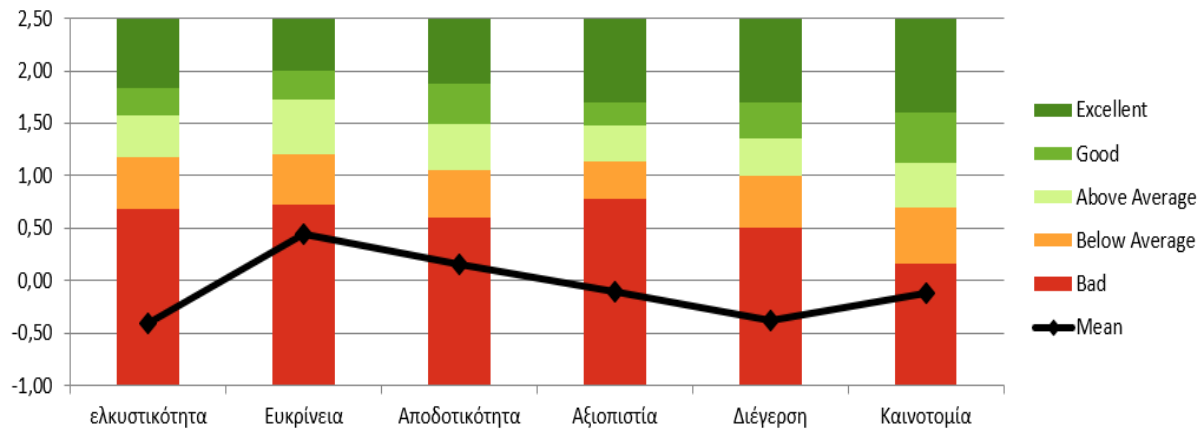


Image 18 Microsoft Lens app rating against other app ratings.

In fact, we observe that in all categories the application is considered poorly designed, i.e. it belongs to the 25% of the worst ratings. Of course, this does not correspond to reality since the above comparison is made in a wide range of applications and not only in scanning applications. The results that correspond most correctly to reality are those shown in Image 17 and show that on average users considered the application to be averagely designed.

Therefore, our User Experience Questionnaire evaluation method confirmed that users think the app can be improved. In order to understand what made the app difficult to use, we will use afterwards the think aloud protocol.

2. Thinking aloud Protocol

In the Thinking aloud protocol, users spontaneously externalize their thoughts during the use of the system (Nielsen, 2012). In this way we can understand where they faced difficulties and when unexpected things happened.

Specifically for our application we asked users to scan 3 pages and save them in PDF format. While they were using the app, they would externalize their thoughts to us and we would record them. The comments we received are shown in Table 4.

| User | Comments | When did they say it? |
|------|--------------------------|---|
| 1 | This square is annoying. | When they saw the red box while scanning (image 6). |
| | Now what do I do? | When the application after the first photo automatically transferred them to the overview menu but they wanted to scan more photos (problem D in heuristic evaluation). |

| | | |
|---|---|--|
| 2 | The red box is interesting. | When they saw the red box while scanning (image 6). |
| 3 | The margins change very quickly. | When they saw the red box while scanning (image 6). |
| | Where do I click to finish scanning? | When they wanted to stop scanning (red circle picture 6) |
| 4 | The filters are understandable. | When they tried to add filters, the icons explaining the filters were very helpful. |
| | How does page reordering work? | When they tried to change the order of the pages in the program, the absence of instructions made it difficult for the user. |
| | The red box moves a lot. | When they saw the red box while scanning (image 6). |
| 5 | The choices are very understandable. | When they saw the different photo shooting options and different image modification tools. |
| | Filters improve resolution. | When they added a filter to a slightly blurry image, to make it read better |
| | The page does not fit well. | When they saw the result of the red box after photographing the page. |
| 6 | The process is very simple. | After completing the scanning process, they commented on the simplicity and immediacy of the process. |
| | Inability to upload more than one file. | When they tried to send 2 files at once, it was not enabled by the application. |
| 7 | Very minimalist and simple application. | About the display of the whole app. |
| | Strange place for the delete button. | When he saw the delete button in image editing. |
| | The red box moves sharply. | When they saw the red box while scanning (image 6). |

Table 4. User comments using the speaking subject method.

We notice that users agree with the problem highlighted by the heuristic evaluation that the app automatically takes them to the overview menu after the first photo, even though they may want to scan other documents. Also, some users didn't like the red box while others did. In addition, one user had trouble figuring out what to do to stop scanning. Therefore, these problems must be addressed when redesigning the application.

6) Design

Based on the results of the analysis and the errors we found during the evaluation by both experts and users, we will design a new scanning application. In fact, the application we analyzed in phase A, Microsoft Lens, is from Microsoft, and that's why we assume that we are designing a new scanning application for Microsoft. Initially, both team members made wireframes on paper in order to find the design that we think meets best the requirements of our application. Afterwards, the design and prototyping will be done with [Figma \(www.figma.com\)](https://www.figma.com), which allows both team members to collaborate and edit the designs simultaneously.

We first made three sketches for the scanning screen, each of which has its own advantages and disadvantages. One member of the team made the first and third design and the other the second.

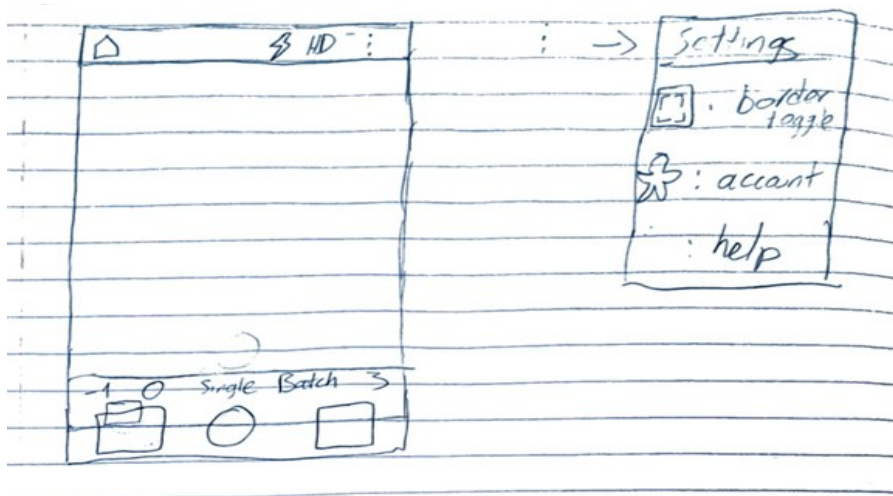


Image 19 Wireframe 1

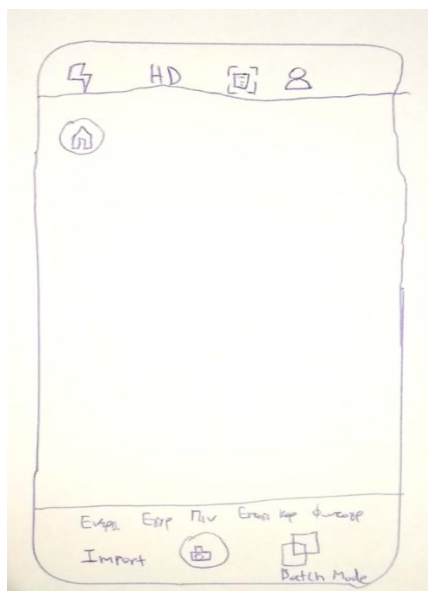


Image 20 Wireframe 2

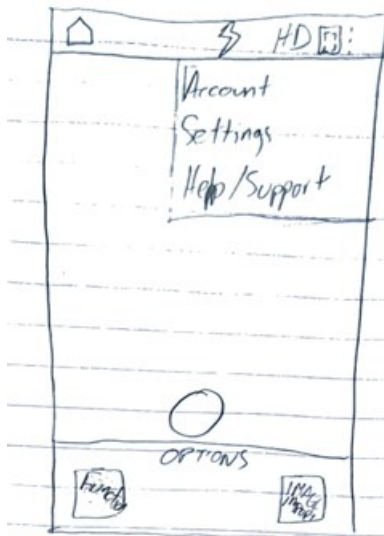
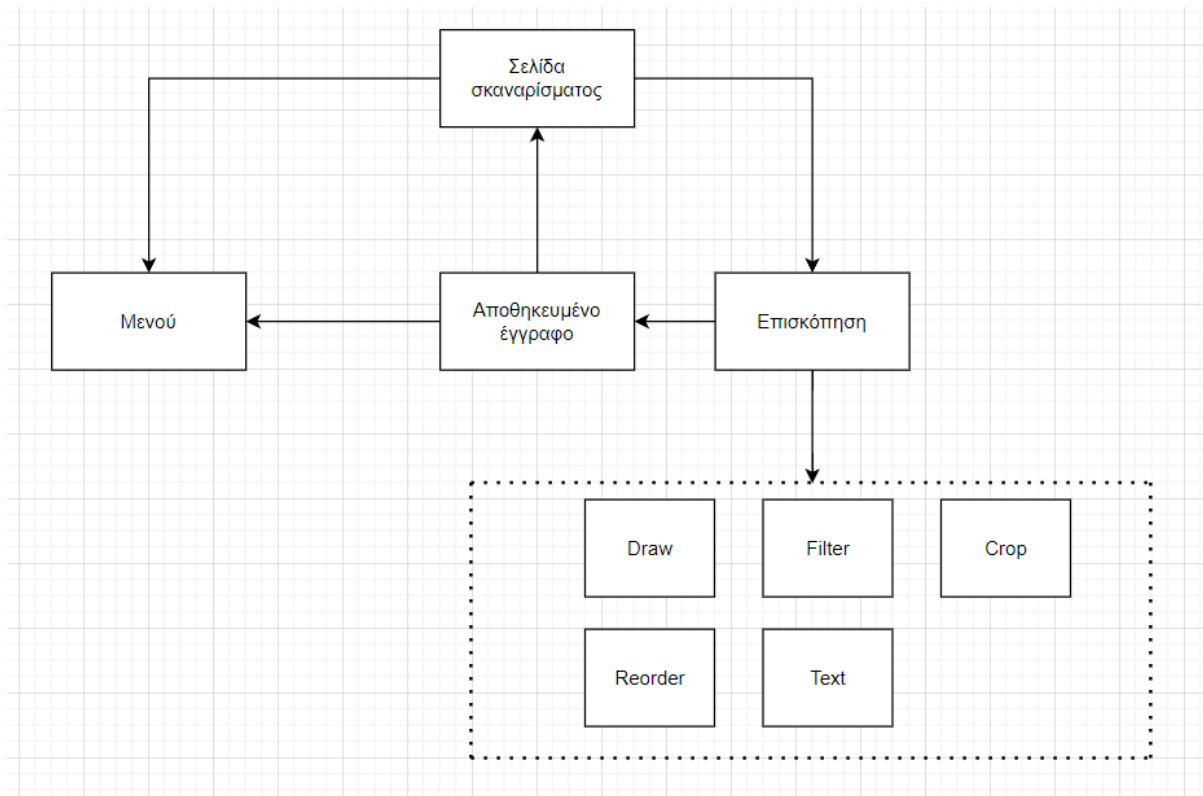


Image 21 Wireframe 3

Wireframe 2 has a circle with a camera icon as a photo button, while the other two designs have only a white circle. In wireframe 3, the photo button is outside the options box, while in wireframe 1 it is inside it. Also, in wireframe 2 there is a separate "Batch Mode" button that indicates that someone wants to scan a document with multiple pages, while in wireframes 1 and 3 this feature is found along with the options. The options are the same as in the Microsoft Lens app, that is, there is an option for whiteboard, for business card, for files and for pictures.

Eventually, we decided to have a separate button for "Batch Mode" and not to place it with the other options, because regardless of what someone wants to scan (file, business card, etc.) they may need to take a lot of photos, so they will want to choose the "Batch Mode" option. If the user has not selected "Batch Mode", then he wants to scan only one page so he is automatically transferred to the overview after scanning the first page. However, if the user has selected "Batch Mode", then he continues to scan and is not transferred to the overview page. This solves problem D) that we found during the heuristic evaluation and has been reported to us by several users in the thinking aloud protocol as well. Also, for aesthetic reasons we decided that the button for the photo shoot should be within the box with the options and all icons should be within the top panel.

In fact, the navigation map of our application is shown below.



Shape 1 Navigation map (in Greek).

When the user opens the application, they are on the scanning screen, where they can scan a document. From this page the user can go directly to the application home where all documents are stored. Also, when the scan is completed, the user is taken to the overview, where he will see if the photos are good and he may edit them. If he wants to add a photo or change it, he can of course return to the scanning page (transitions are bidirectional, arrows describe the order in which the user will usually visit the pages). On the overview page, the user must be able to edit the image, apply specific filters, change margins, rearrange images, add text, or draw. After completing the review, the user will save the document and will be transferred on another page where he will see the saved document. Additionally, after saving the document, the user will be able to return to the scanning screen to add another photo or to the main menu to see all the documents saved.

Below, we present mock-ups and some individual features for each page. Moreover, we have created working prototypes with all the details about the functions and the transitions and they are available at this link <https://www.figma.com/proto/DEWXOaiI9v0SIVEOiWMIV3/Scanner-App?node-id=0-1&t=IKaZQpYARTGxII1s-1>

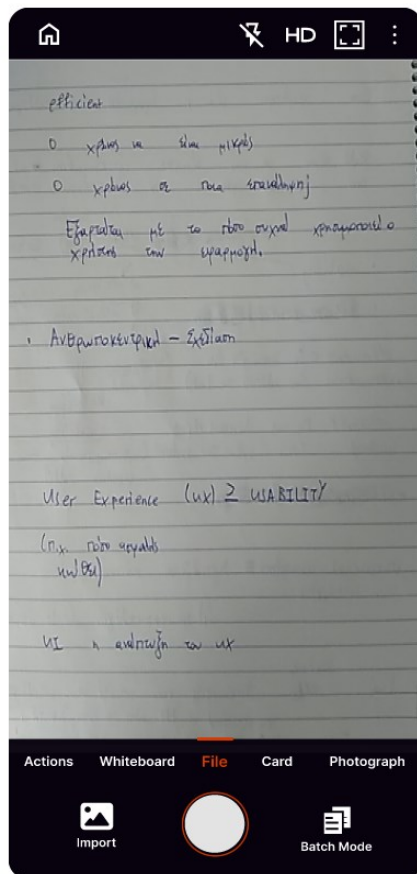


Image 22 Home scan screen

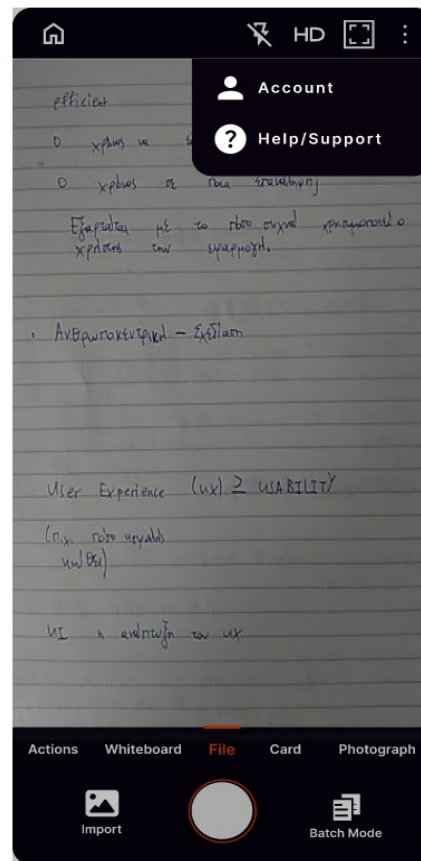


Image 23 Settings

The user can choose whether he wants to scan a file, a card, a white board or take a photo. They can also choose another action, such as QR scan or OCR, with the actions button. Action options are implemented in the prototype, but we did not include them here so as not to fill the report with identical pages that are not very important.

At the top of the screen, the user has the options to go home (where all the files are located), change the flash, the resolution of the image, and whether or not to show the frame that the camera has focused. Also, with the colons icon, they have access to help/support and their account. Everything is fully implemented in the original. Image 23 shows the dropdown with settings.

The user selects Batch Mode as explained above to scan documents with more than one page. If he has selected Batch Mode, then when he takes a picture the page becomes as shown in image 24.

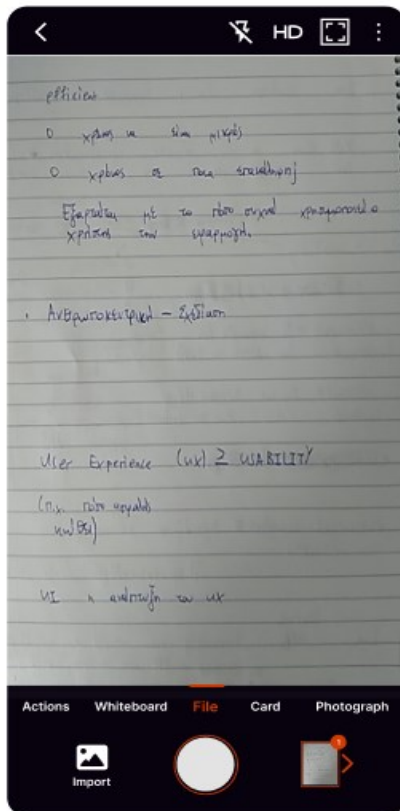


Image 24 Batch Mode Scan

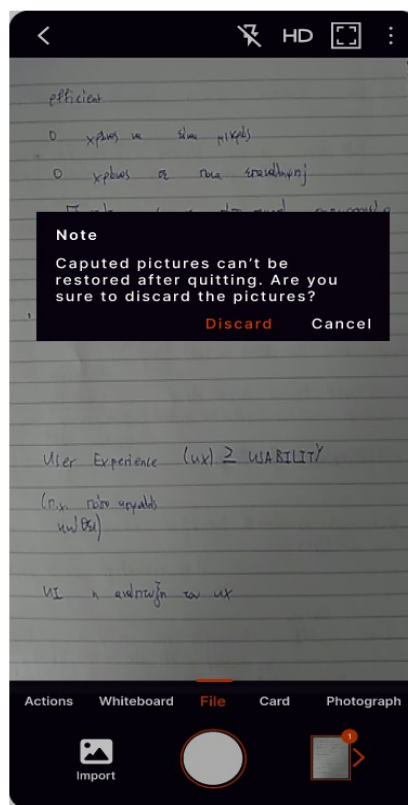


Image 25 Cancel scan

At the top left of the page, there is an arrow that can be clicked by the user to cancel the scan, as shown in image 25.

In fact, in image 23 where the settings are shown, the account exists because we assume that we are building an application for Microsoft, so the user will be able to log in to access Word, Powerpoint, PDF, etc. By clicking on the account icon, the user is taken to the page in image 26.

Then, by pressing Sign up or Login, he is transferred to Microsoft's predefined login page, which is the same for all microsoft applications and therefore we have not designed it. Also, help/support in image 23 would be determined by the company.

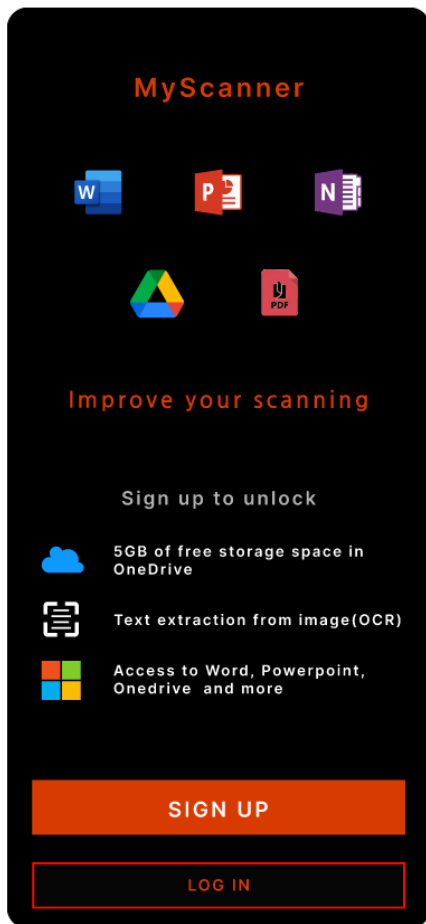


Image 26 Login and Sign up

If the user has not selected Batch Mode, when scanning the first photo he is automatically transferred to the overview in image 27 and if he has selected Batch Mode, when he wants to move to the overview he presses the picture area located at the bottom of image 24.

In the overview the user can rename the file, view all the photos and modify them. In the [prototype](#) we have made, all transitions work exactly as they would do on a real mobile. In fact, by pressing the More button, the user has access to all the options shown in image 28.

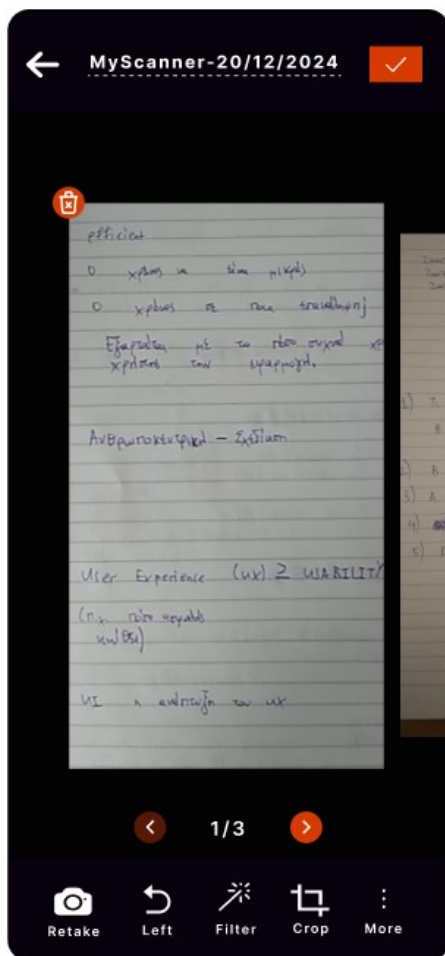


Image 27 Overview

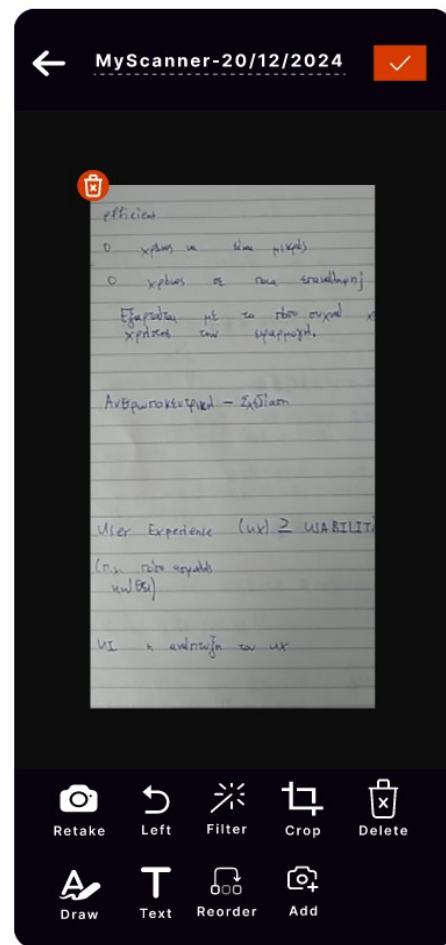


Image 28 Modification options

The retake option solves problem B) described during heuristic evaluation and is useful in case someone wants to quickly replace a photo that may be blurry with a new one. Left rotates the photo, filter allows you to select filters, crop changes margins, delete erases the photo, draw is for painting on the photo, text is for entering text and reorder is for rearrangement. Finally, add allows adding a photo. These functions are shown in the images below, 29-35. In fact, when the user has selected a function to modify an image, he is transferred to a slightly different page, where the title of the document has been replaced with the function and the other functions are not visible. Also, at the top left there is an X button to go back without saving the change, and the red tick button saves the change and takes the user back to the overview.

Note that the images in this report may be slightly different in size due to pasting and different sizes, but in the original they are all the same size.

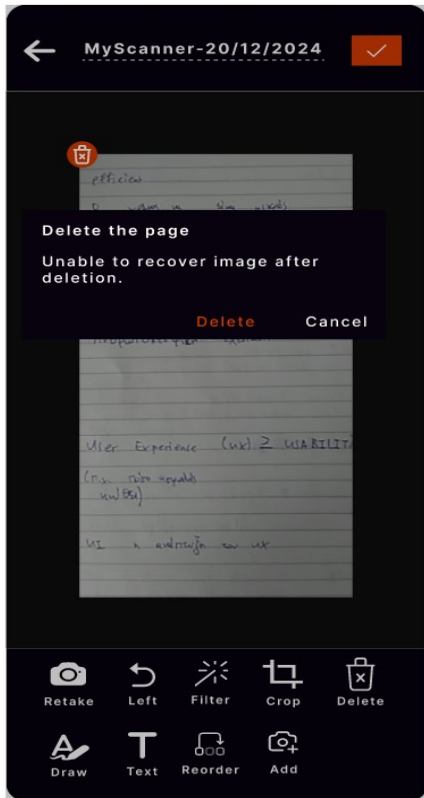


Image 29 Delete

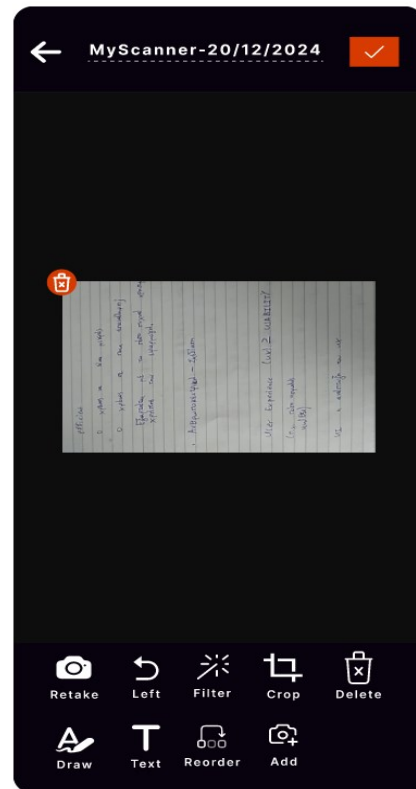


Image 30 Left

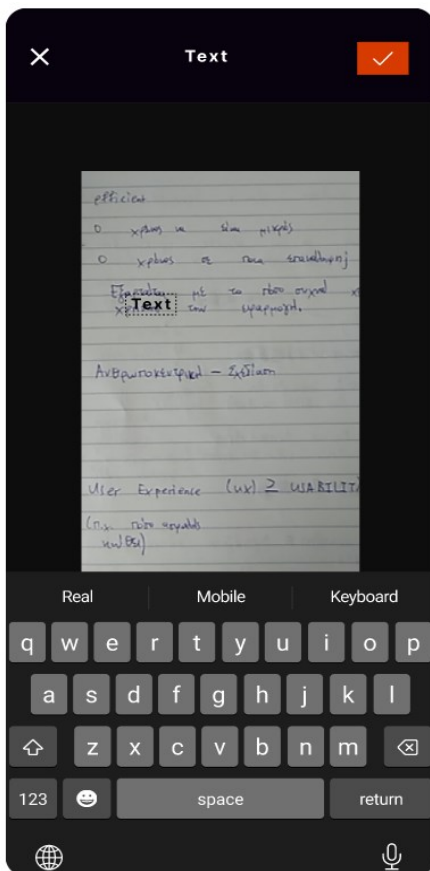


Image 31 Text

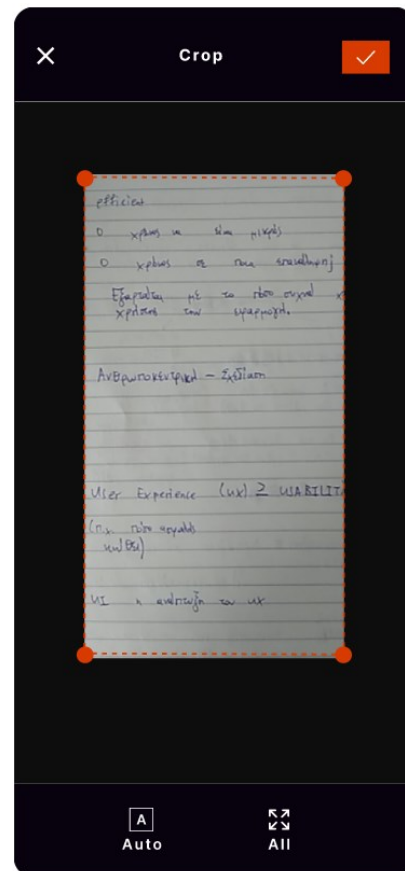


Image 32 Crop

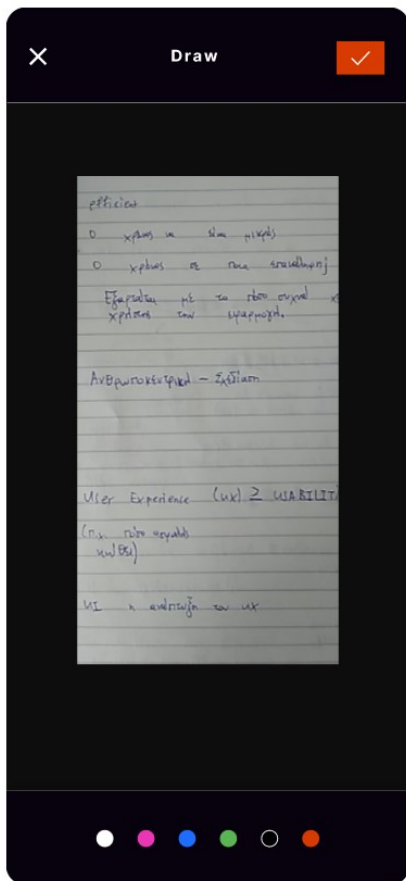


Image 33 Draw

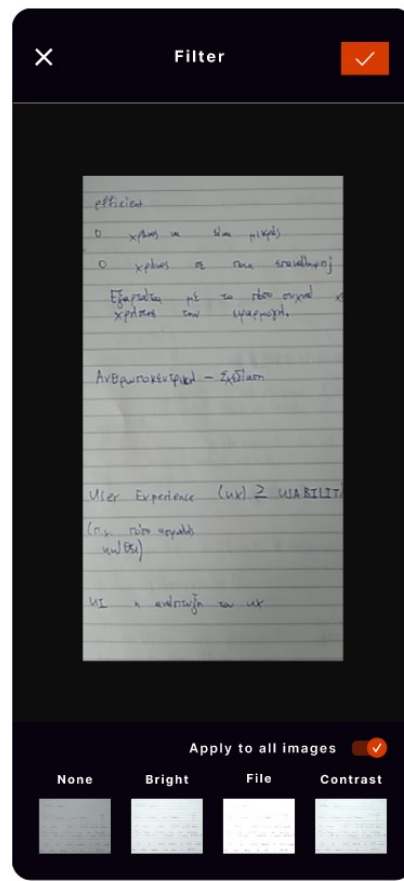


Image 34 Filter

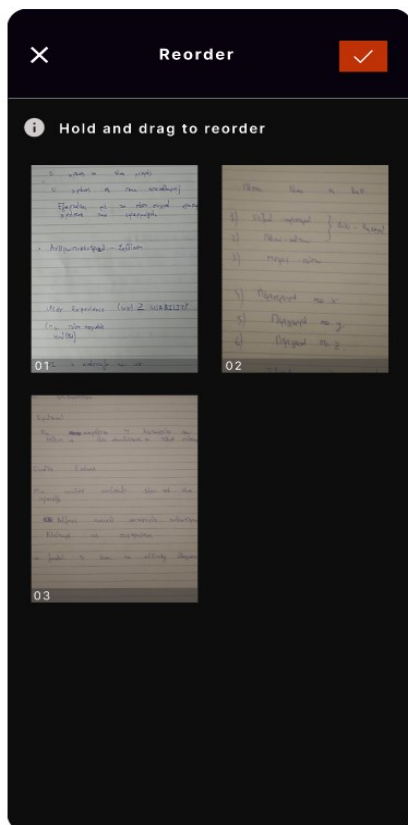


Image 35 Reorder

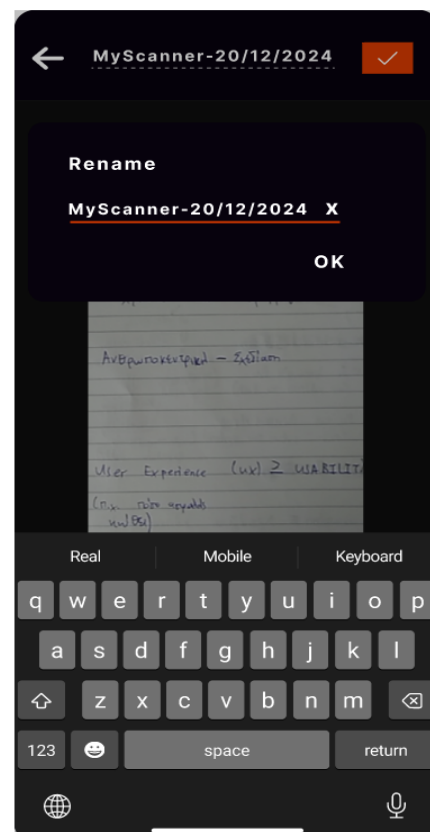


Image 36 Rename

When the user has finished the review, in order to save the photos, he presses the red button next to the title, so the following dropdown appears, to choose in which format he wishes to save his file. For example, they can choose OneDrive and save their file directly to the cloud without having it on their phone.

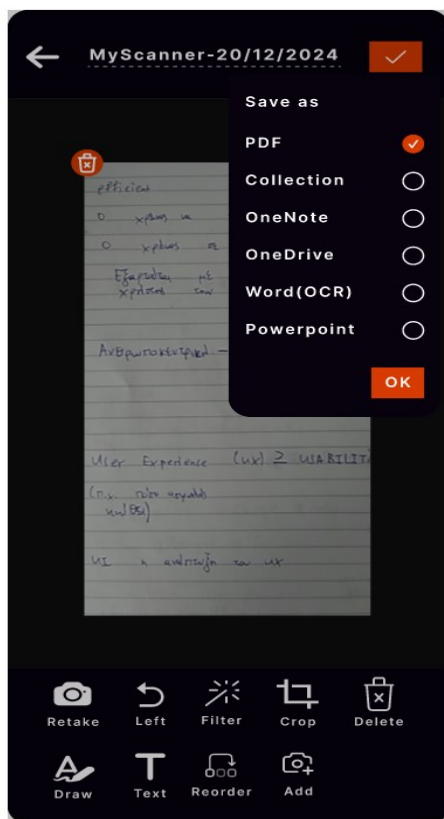


Image 37 Choice of storage format

Moreover, when the user clicks ok, he is transferred to the page in image 38.



Image 38 Saved file overview.

On this page the user can share the file, rename it, edit it and enter a password to protect the file.

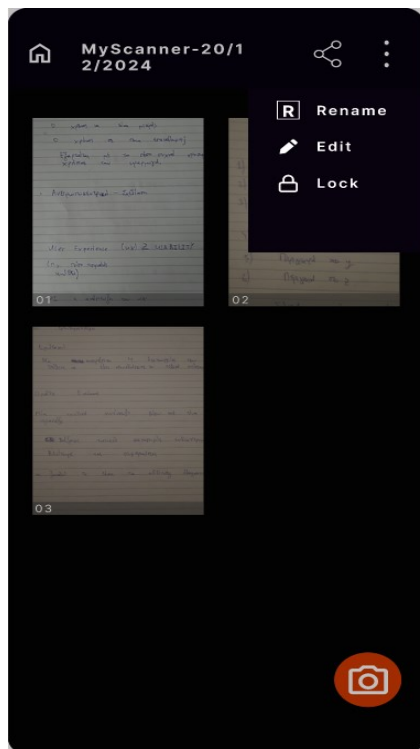


Image 39 Settings

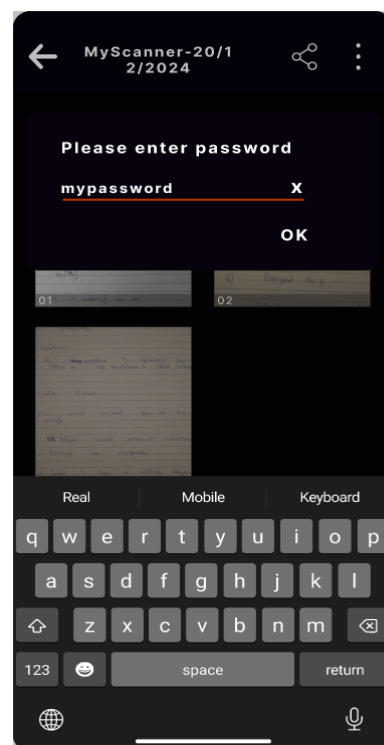


Image 40 Lock

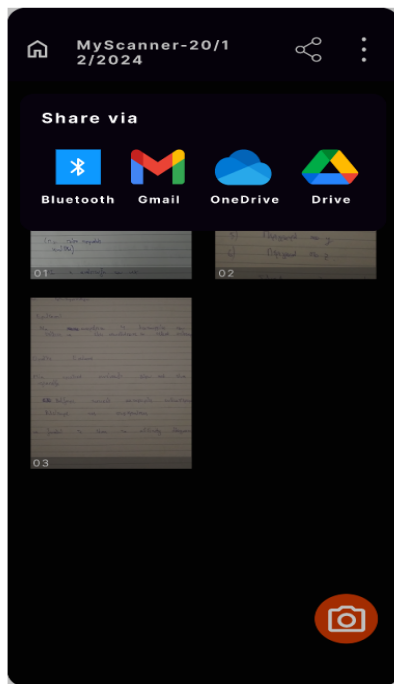


Image 41 Sharing

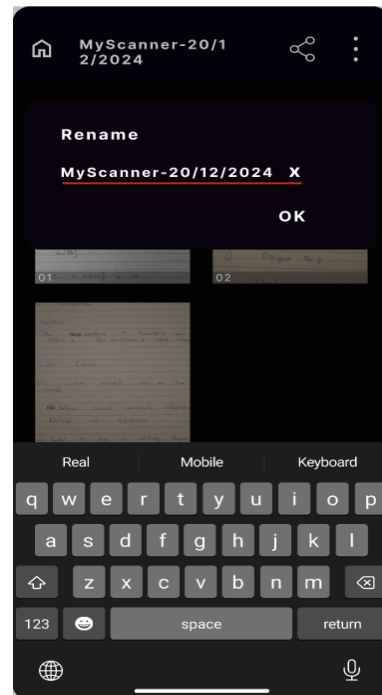


Image 42 Rename

In addition, individual pages of the document can be selected. Each page can be shared, saved to the phone's gallery or moved to a different document scanned by the app.



Image 43 Select a subpage.



Image 44 Moving specific pages to another document

Finally, if the user clicks on the home icon of image 38, he is transferred to the main menu of the application, where he sees all saved documents. For each document, he sees basic information such as the title, date saved, and number of pages.



Image 45 Main application menu

They can also search for a document or sort them according to various criteria



Image 46 Sorting documents

Finally, the user can select a document and modify it.

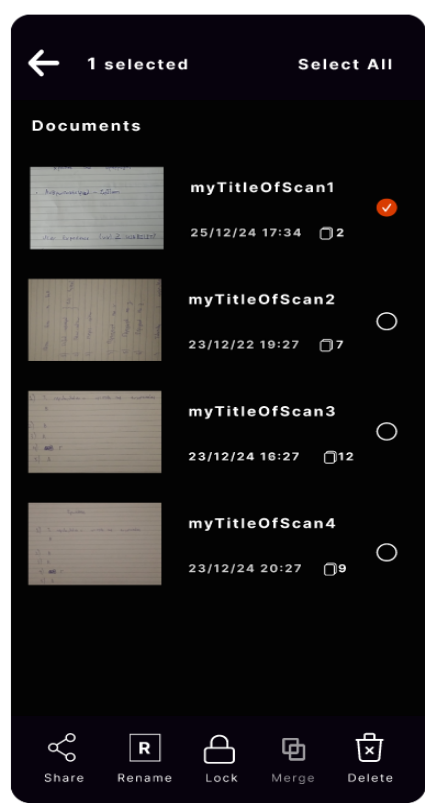


Image 47 Document modification

7) Feedback and redesign

The next step after creating the initial prototype of the app was to evaluate the prototype with typical users. This was carried out according to cooperative evaluation, through which users work as co-evaluators with experts (Monk et al., 1993). This method was chosen, as the prototype was not a complete functional application, so the intervention of our team members was necessary to avoid and resolve issues.

During this process, each user expressed positive and negative comments about the prototype. The team member asked questions such as "What do you think of this page/feature?", "Does the system react as you would expect?", "Is there a feature or option missing that you would find necessary?", "Is it something you don't understand?", and finally the team members asked for a general opinion on the app. Specifically, this evaluation was carried out by 4 different people and the results are shown in the following table.

| User | Positive comments | Negative comments |
|----------|--|---|
| 1 | The photo shoot page and file menu were very easy to understand and easy to use. | I would like icons on the file save page. |
| | Changing page order seems very simple and understandable to me. | I would like to be able to read the file I created, as it would look from a text-reading application. |
| 2 | I like the file search option. | What does "collection" mean? |
| | I like the tools and options within them. | I expected to see the final result in text rather than pages. |
| | | I would like the icon to change color when flash is activated. |
| 3 | I like that it doesn't have icons on the image while I'm shooting. | I would like a back button to login/register account. |
| | It is interesting to transfer a page to another file. | Why edit is hidden in the file review. |
| | I like the simplicity of the pages. | I'd like a preview of the file before I send it. |
| 4 | I like the options in the tools. | I would like icons in the file type selection. |
| | The pages are easy to understand. | He didn't realize he was on the file's overview page |

| | | |
|--|-------------------------------------|--|
| | I like that I can choose file type. | |
|--|-------------------------------------|--|

Table 5. User feedback on the prototype with the cooperative evaluation method.

Most changes to the design and appearance of the app were well received by the review, but it is evident that there were still minor issues that needed to be resolved. Specifically, all users had minor problems or wishes from the final file overview page. That is why the following changes have been made. Initially, all the options during the final review that had already been implemented are shown directly at the bottom of the screen. At the same time, the switch between reading mode and page display mode is implemented by adding a corresponding button at the top right of the screen. The original design is shown in images 38 and 39, while the modified version is shown in images 48 and 49.

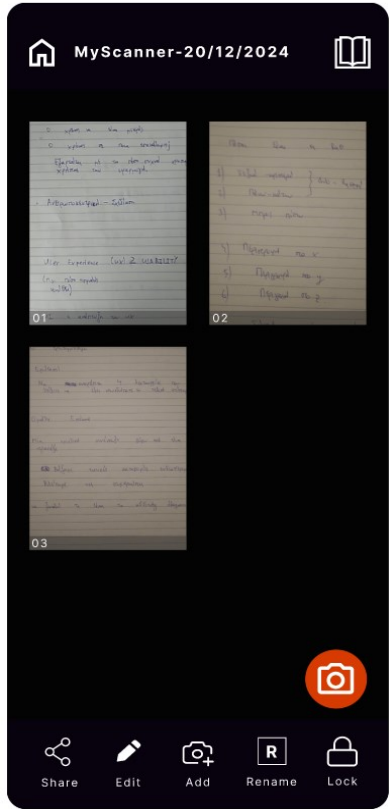


Image 48 Page display mode

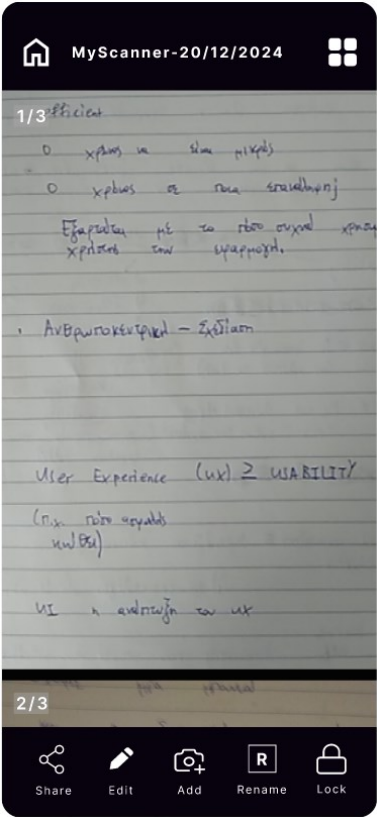


Image 49 Reading mode

The other functions of the overview page work in the same way with the only difference being the place where the sharing window appears, which is shown in image 50.

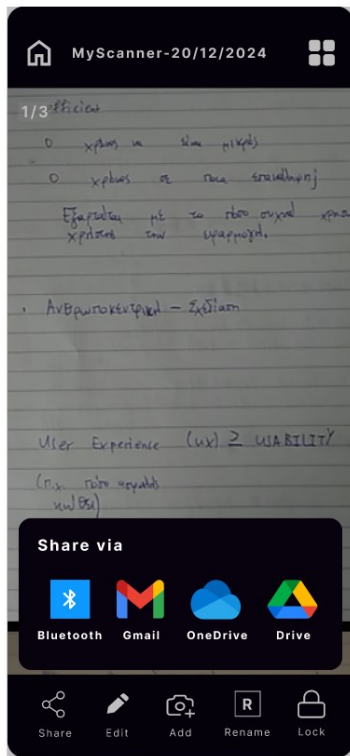


Image 50 Final sharing

The next modification was to add icons to the file type selection page and change the name "Collection" to "Gallery". The final result is shown in image 51.

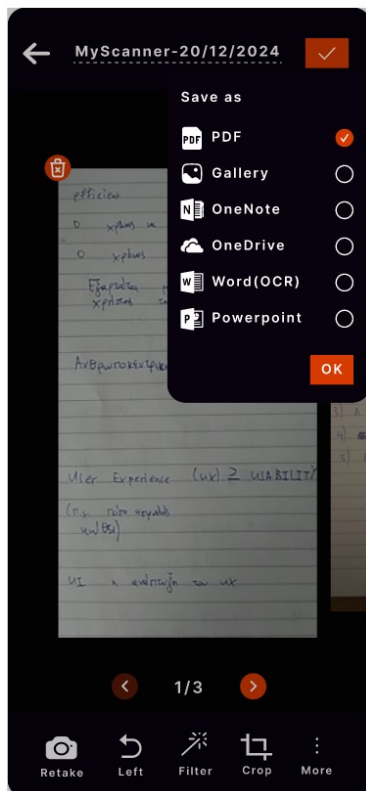


Image 51 Choice of storage format

Finally, minor modifications were made to the account page and the photo shoot page. A back button has been added to the account page, as shown in image 52. In the photo shoot the only change was to add orange color to the flash icon when it is enabled and the change is shown in image 53.

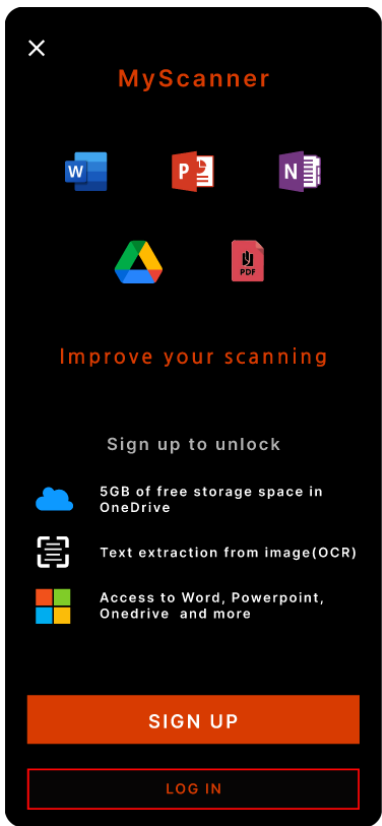


Image 52 Final account window

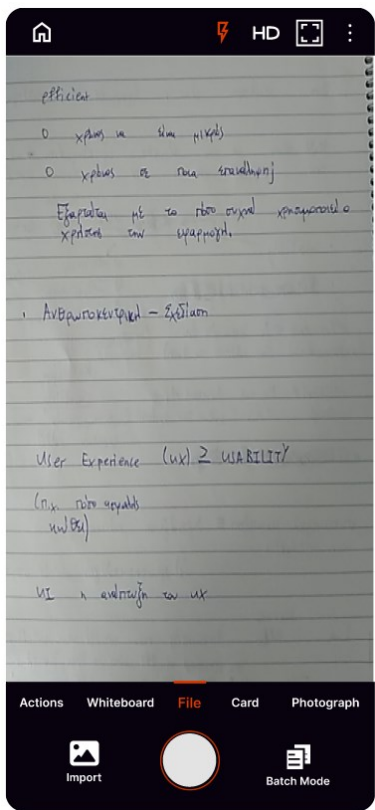


Image 53 Final flash mode

8) Comparison

To compare our design to the original, we will apply the GLM method to calculate the time for the user to scan a document. Next, we will compare the times of the initial application with ours.

The process we will study concerns again a user who scans 3 photos with the default dimensions and options and saves the file as PDF with name "myfile".

Initially, the user opens the application and scans 3 pages (image 22). In fact, an experienced user knows that he must first press Batch Mode and then take a photo, so he does not need to think (M) to make this move. These steps correspond to the following elementary actions of the GLM model:

M: Open scan image (image 53)

H: Focus attention on the button for Batch Mode

P: Finger movement

T: Press Batch Mode button

H: Focus attention on the photo shoot button

P: Move fingers to the photo shoot button

T: Press photo shoot button to scan the first page.

H: Focus attention on the photo area to take the 2nd photo (the user looks at the image he will shoot)

H: Refocuses on the photo shoot button

T: Press the photo shoot button for the 2nd photo

H: Focuses his attention on the photo shoot area to take the 3rd photo

H: Refocuses on the photo shoot button

T: Press the photo shoot button for the 3rd photo

M: Think about how to go to the overview.

H: Focus attention on the picture folder (bottom right of image 24)

P: Move fingers

T: Press button

The user is then taken to the overview menu of image 27 and wishes to change the predefined name and rename the file to "myfile" and save the document. So it takes the following actions:

M: The overview menu appears

H: Focus on the title

P: Move fingers

T: Tap title

M: Open the menu shown in image 42

H: Focus on x

P: Move fingers

T: Press x and delete title

M: Think of a new name (myfile)

6T: Type myfile

M: Think about how to move forward

H: Focus on ok

P: Move fingers

T: Click ok for the name

Then the user presses the red button with the tick, at which point opens the menu of image 51 and the user selects ok. These correspond to the following actions.

M: The overview menu appears

H: Focus attention on the red tick button

P: Move fingers

T: Press the red button

M: Opens the dropdown for the format option and checks that the default option is already in pdf.

H: His attention is focused on ok

P: Move fingers

T: Press ok

The actions needed to scan a three-page document are summarized in Table 6.

| Operator | Count | Time Required (sec) |
|----------|-------|---------------------|
| M | 8 | $8*1.35=10.8$ |
| H | 12 | $12*0.4=4.8$ |
| P | 8 | $8*0.34=2.72$ |
| T | 16 | $16*0.73=11.68$ |

Table 6 Time required for scanning with myScanner app

Therefore, the user needs a total of $10.8 + 4.8 + 2.72 + 11.68 = 30$ sec to scan a three-page document.

If we assume that he is concentrated when scanning and his attention is not easily distracted, then the distraction coefficient is 6%. Therefore, the required time is

$$T = 1.06 * 30 = 31.8 \text{ sec}$$

In conclusion, the time for a user to scan three pages with our application is 31.8 sec while with the original application is 35.17 sec. Therefore, each scan saves every user about $35.17 - 31.8 \approx 3.4$ sec which is very important for an application like Microsoft Lens, which has been downloaded by about 50,000,000 people. In fact, if we assumed that each user uses the application once a month, then each month the new design would save $50,000,000 * 3 = 150,000,000$ seconds ≈ 1700 days ≈ 5 years.

9) Conclusions

In this paper we used human-centered design methods and performed user analysis to understand and define typical users. Afterwards we did task analysis to understand exactly what tasks a user does with a scanning application. Moreover, we did requirement analysis and defined the functional and non-functional requirements of the application.

Additionally we evaluated Microsoft Lens app with both expert and user based evaluation methods. For the formative assessment of the application we did user based evaluation using the think aloud protocol and expert based evaluation using heuristic evaluation. For the conclusive evaluation of the application, the method of questionnaires was used for users, namely the User Experience questionnaire. For expert evaluation, the conclusive assessment was made using the KLM method. Both formative evaluation by users and experts highlighted significant usability issues. Also, the questionnaire method showed that typical users who participated in the evaluation of the application considered the app averagely designed, i.e. neither very well nor very bad designed.

Afterwards, we analyzed the received feedback and in combination with the requirements that were defined during requirement analysis we redesigned the application in figma to effectively address all the problems that were observed. In fact, we created detailed prototypes showing all the individual functions of the application and the way the user will interact with it. Additionally, the prototypes were re-evaluated with user based methods and the issues observed have been corrected.

Finally, we compared the time to do a standard 3-page scan with the original application and ours, and found that the time required with our own application is about 3 seconds less. This time saving is very important for an app like Microsoft Lens that is used by millions of users every month.

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