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Monetics: A Web-based Tool for Personal Bank Statement and Financial Health Analysis

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Abstract

Effective personal financial management is important for individual well-being. Leading to the widespread importance of financial literacy to better understand financial health. Emotional factors also influence decision-making, complicating the space further. With the rise of digital banks, there come the rise of a need for digital personal finance management. Where people prefer paper-based methods, a new digital era has arisen. Current digital tools that range from spreadsheets to applications like Mint fail to cater to users' needs in one way or another. People's temporal behaviour is also observed along with the importance of accurate financial nudges and the effect of initial novelty with current solutions that result in users halting their use after a period. This dissertation presents Monetics, a web-based tool that aims to cater to the user's temporal nature and provide a solution that doesn't overwhelm this. To meet this aim, Monetics is developed with features like statement upload, automated categorisation of transactions with manual fall-back, analytics dashboard, and AI-integrated chatbot. The approach and design of this tool are presented with user-based evaluation to evaluate the effectiveness of this tool against the problem identified. Based on the evaluation results, Monetics is effective only to an extent with some limitations. The user study is conducted on 4 participants, and data evaluated show key findings in their temporal nature along with their observations and suggestions for Monetics.

Acknowledgements

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I certify that the work presented in the dissertation is my own unless referenced.

Signature 

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1 Introduction

1.1 Introduction

Managing personal finances has always been a crucial part of an adult's life. Personal finances play a direct role in our day-to-day expenses and long-term decisions. Which is why how we manage our money becomes ever so important to live a comfortable life. It has also been observed that what one may think of as people making rational financial decisions is no longer the case, and emotionality now plays a big role in this. (Kaye *et al.,*2014) Emotionality significantly influences financial decisions, and this suggests that financial education may not be enough to reduce financial vulnerability amongst people (Dibb et al., 2020).

Financial Literacy is a skill that every person must equip themselves with. This is a skill that has the power to impact a person's mental well-being as well as their savings over time. Although a must-know skill, Financial Literacy is often neglected in the education industry and not taught to students, causing a scarcity in this area, causing costly consequences for people at a personal level as well as societal problems down the line. (Versal *et al.,* 2023; Chen and Volpe, 1998)

Analysing your financial health and understanding your finances is a must and has always been. To track this, people often adopt budgeting to help manage their day-to-day spendings and employ other tracking techniques to keep tabs on their transactions. The digitalisation of banks with transactions and other financial laws has forced people towards prioritising going online. Furthermore, users have had a shift in recent years being less dependent on physical methods of personal finance management and have moved to the digital methods. This might be due to their personal liking or due to them being unable to manage their finances anymore since many banks have gone digital. These factors have resulted in the need for digitalisation of analysing one's financial health and wealth. (Lewis and Perry, 2019)

Currently, people adopt various techniques to keep track of their money, ranging from the old-school physical ways adopted from their parents to digital methods such as tracking on spreadsheets or choosing to go towards a simpler solution of various software applications and websites that manage your finances for you. (Kaye *et al.,* 2014; Lewis and Perry, 2019)

Digitally, spreadsheets provide the greatest level of user freedom, customisability, and data security assurance. This level of manual work does not entice everybody, though. Furthermore, there do come some hindrances from banks and institutions as downloading

financial metadata is a cumbersome and often impossible process; this negatively affects the user's reasoning to adopt this method. (Kaye *et al.,* 2014; Lewis and Perry, 2019)

On the other hand, there are mobile applications and websites like Snoop and Mint.com that provide the automation and simplicity for a user. Not only that, properly used financial nudges with these applications can help users save in the short-term and long-term. However, the disadvantages faced with applications include concerns about data security and a perceived lack of freedom and control in usage. (Lewis and Perry, 2019; Kaye et al., 2014)

Aside from the various advantages and disadvantages of the current solutions. It can be observed that the existing solutions do not account for the temporal nature of how people manage their finances. They want to look at their finances only when they see alarms and red flags and go back to their regular life after adjusting. The current digital solutions, be it spreadsheets or applications/websites, do not allow the users to do that. The users also have a heightened chance of being overwhelmed by the excessive financial nudge that is fed by applications and websites, and this results in them completely neglecting their personal finances. (Lee, 2019; Snow and Vyas, 2015; Kaye *et al.,* 2014; Lewis and Perry, 2019)

This dissertation proposes the development of a web-based solution called Monetics. Based on preserving simplicity and acting as a financial nudge for users, allowing them to analyse their financial health, whilst keeping their temporal nature in mind. This solution caters to users that would prefer sticking to their spreadsheet method and use this tool as a pre-loader for their sheets work. This solution also acts as a substitute to current websites and applications that may overwhelm users, by allowing them to use this whenever they feel concerned about their personal finances (catering to their temporality). The security concern that came with applications is also negated as this does not require any data storage and works with bank transactions on the go. Understanding the problems, features such as automatic categorisation of bank statements with an option to manually categorise, an analytical dashboard view to view financial health, export capabilities to extract financial metadata, and a financial nudge inducing artificial intelligence chatbot for uploaded bank statements, have been incorporated into the tool.

1.2 Aims and Objectives

The aim of this project is to address the limitations of current personal finance management tools, which often struggle to cater to users' temporal behaviour and may overwhelm them. By developing Monetics, I am creating a web-based tool that provides upload of statements, an analytics dashboard, integrating automated transactions categorisation with a fallback manual option, export capabilities to extract financial metadata, and an AI-based chatbot that provides contextual financial nudges.

1. Through the research of literature relevant to the role of financial literacy in personal well-being, financial health, current budgeting methods, and the temporal nature of people in personal finance management, demonstrate the need for a personal bank statement analysis tool to address the aim of the dissertation.
2. Define a structured analysis and design approach for the development of the tool, along with identifying ways in which the solution can be developed and evaluated.
3. Formulate requirements and design for the web-based tool based on the problem areas identified.
4. Develop a web-based tool as a solution that provides a statement analytics dashboard, integrating automated transactions categorisation with a fallback manual option, export capabilities to extract financial metadata, and an AI-based chatbot that provides contextual financial nudges.
5. Design and run an anonymised user study to evaluate the web-based tool, gaining analysable feedback on the effectiveness of the tool's features and understanding users' personal financial management preferences, along with categorisation accuracy.
6. Apply appropriate project management methodology of mixed Agile-Waterfall and use the tool Jira as required to track progress, manage risks, and manage timely completion.
7. Draw conclusions to the effectiveness of the proposed solution based on the user feedback to compare it with the assumed results from a literature review and provide evidence to whether the solution attempts to solve the problem stated.

1.3 Project Approach

We undertake this project with the approach of identifying a problem through research, formulating requirements based on existing limitations, designing our system, developing it, and ending it with a user evaluation. The project's approach is structured in this way to focus on developing a prototype solution that can be evaluated by users to compare their response and feedback directly

against the research done. Documentation happens throughout the phases, and the final step is to conclude on the findings and effectiveness of what we developed.

This project will follow a structured approach, using a mix of Agile and Scrum methodologies to ensure an adaptive development process. Some phases are visited at random intervals depending on the need, hence why the adaptive approach.

1.4 Dissertation Outline

The flowchart in Figure 1 shows how the chapters in this dissertation aim to address each objective alongside the overall motive of each chapter and their output.

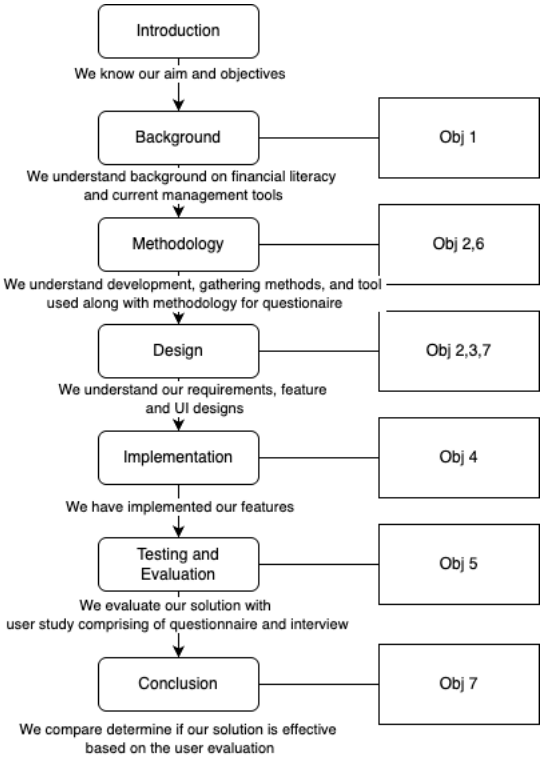

Figure 1 - Dissertation Outline Flowchart

2 Background

2.1 Financial Literacy

Financial literacy comes at the core of personal finance, and various research conducted in this field proves its importance overall. Research by Hogarth, Hilgert, and Schuchardt (2002) highlights the importance of financial education and financial knowledge, which ultimately also means financial literacy through their study. The overall objective of financial literacy is to ensure that every person is well able to make the right financial decisions through appropriate financial knowledge and skills (Hira, 1995). Not to mention, there is also a positive link between individual well-being and higher financial literacy where, people encounter a long-term growth in their savings-growth over time (Sekita, Kakkar and Ogaki, 2022).

The importance of financial literacy is evident; however, it is also important to see the state of financial literacy education in the industry, understanding the shortcomings of current methods.

2.1.1 Current State

There have been various studies conducted into looking at the current state of literacy amongst the population. In the survey conducted by Chen (1998) for 924 college students to understand their level of financial literacy, a low financial knowledge was observed amongst the participants, where only 53% of questions in the survey were answered correctly. From this result, it was understood that the current state of financial literacy amongst college students meant that these people will be unable to make informed financial decisions in the future.

After looking at the lack of financial knowledge observed amongst people, the need for financial education is highlighted. Before that, we need to know how people learn about personal financial management. Research by Hogarth (2002) conducted a questionnaire-based study and obtained information from 1,004 consumers. This survey asked questions ranging from financial product ownership to financial behaviours; however, only financial behavior responses are important to this research. Based on the responses, it is understood that people gain financial literacy from different sources. It can be through educational courses in school and outside, or it can be through personal experiences, friends, and family members. It was observed that ‘Consumers who used proactive as well as reactive methods to learn about financial management topics were less likely to be lost and bad money managers and more likely to be very good’ (Hogarth, 2002:21).

2.1.2 Financial Literacy in Higher Education

Studies into the effectiveness of financial literacy education courses amongst high school students proved more negative than positive. Findings showed that these courses showed no significant improvement in the literacy levels of students that took it versus those that didn't. (Mandel, 2009). This demonstrates the shortcomings of the current education system in trying to educate students financially. There could be various reasons for this not being effective. The methods adopted to teach these courses may be a problem; otherwise, this may not even be entirely the problem of the teaching, but rather, that the students are too young to be directly benefiting from these courses at their age as they are not yet financially independent, so they don't understand the importance of financial literacy and hence fail to learn about it.

Research by Peng (2007) was conducted with a wider audience including both high school and college students. The study was sought to see "the effect of high school level and college level personal finance course on financial literacy" (Peng, 2007:282) and the results indicated that personal finance courses in college proved beneficial to financial literacy improvements as compared to high school courses.

This helps us understand why the effectivity of financial literacy education lacked in high school students and why it is more beneficial to educated adults higher levels of studies.

2.1.3 Scope for alternate solution

Personal finance understanding is lacking amongst working adults and there is scope for financial tools to help them better understand their finances (Chen, 2006). Considering the various pitfalls and discrepancies with education course-based method, additionally, that it only caters to the proactive audience (school learning), there needs to be solutions that increase the financial literacy of people without the help of educational courses.

2.2 Personal Finance

Personal Finance varies from the term household finance, which was coined by Campbell (2006) in a way that it highlights its focus on finance at a personal level rather than looking at a societal level as with household finance. This field of personal finance allows for further research of studies related at both practical and theoretical levels. Personal Finance comprises tools such as financial statements, cash flow management, and various other types of planning. (Schuchardt, 2007). We

can clearly understand from this that personal finance covers various fields of studies such as economics, finance, management, and requires critical thinking in planning. (Hira, 2008).

Personal Finance needs to be managed well, and that requires adequate financial knowledge. Looking back at research by Hogarth (2002), which studies the relationship between financial literacy and money management ability of people, there was an alarmingly high number of money managers based in the survey that were "lost"; these were 37% of the sample participants, where the categories had consisted of "lost", "bad", "good", & "very good". This number of "lost" money managers highlights poor financial decisions.

2.3 Managing personal finances

2.3.1 Money Management

Money Management becomes a day-to-day part of an adult's life, whether it is managing for short-term spending or for long-term spending. Both are important for solid financial health. Our personal finances, how much we save from our salary, what we spend on, how much we owe, directly affect our daily habits. As a person's income increases, so does their need to manage their money in a financially smart way. Furthermore, it is observed that emotionality plays a role in how people deal with their finances, often more so than our rationality. All of this makes money management very much a social problem (Kaye, 2014). This emotionality can blend in with the reactive nature of people as observed in a study conducted by Hogarth (2002) where people had tendencies to manage their money management decisions based on their personal experience and family. Not only people's financial decisions, but their money management methods also trickle down to them through their family and personal preferences.

2.3.2 Paper systems

Budgeting from its origin has always involved paper form in one way or another, be it maintaining written records of expenses, or calendars with money expenses written all over. The use of paper systems, i.e offline methods, is evident in the study conducted by Snow (2015) and Kaye (2014). Participants in these studies have found paper systems to be their comfort-zone. They found it coherent and robust, and allowed them to keep track of their expenses.

2.3.3 Digital Era

With the current increase of banks and financial organisations going digital, there has come an increasing need for money management to also come up with digital solutions. This has various

advantages, as financial data being stored digitally gives greater scope for automation and better analyses as compared to paper-based management (Lewis, 2019). Although the paper-based methods based on the above research appear to be most preferred by people, digital money management tools as an alternative prove more beneficial for the future (Kaye, 2014).

Digitally, people can use spreadsheets to manage their personal expenses, or they can use websites/apps.

2.4 Digital Tools

2.4.1 Spreadsheets

Spreadsheets can be considered the bridge between paper systems and digital apps. Although still being digital, this is because spreadsheets are extremely manual and allow for high customisability of financial records keeping. Studies conducted in research by Lewis (2019) and Kaye (2014) into the money management habits of people show that out of the people in their study, some had their own spreadsheets to manage their finances. One individual kept an extremely detailed spreadsheet managing their finances, in contrast to another one, who had a very simple spreadsheet to calculate their spendings (Kaye, 2014). This demonstrates the customisability and benefits of spreadsheets. There are, however, difficulties with maintaining a spreadsheet for financial records, as people must manually update their records with new payments since bank accounts do not allow them to import their payments meta data directly into the spreadsheet. There is an apparent problem here with online banking institutions not providing necessary methods to extract personal payments metadata for users, raising various concerns about the current state of online data keeping where big companies are able to easily take users' data however it is not the same when users try to extract their own data from companies (Lewis, 2019).

2.4.2 Applications

Applications exist, such as mobile applications and websites, that attempt to provide users with a better financial management experience. However, there are still questions about the effectiveness of these solutions. This can be seen in the research by (Snow, 2015), where they studied 15 families to show a misalignment between people's budgeting behaviors and those supported by current apps. One website mentioned is Mint; it provides tracking, summarising, automated categorisation, goal-setting features, and the ability to link users to bank institutions (Mint, 2024). However, as per research by Kaye (2014), it was found that in their study, 2 participants had used Mint but gave it up due to security concerns, and one of them even had frustrations with the feature

that automatically categorised expenses. In a study conducted by Lewis (2019), a participant even wanted to return to having paper receipts to view her spendings because of the overwhelming real-time notifications she was receiving after every transaction; she had to turn this off and revert to end-of-the-day summaries. We can start to see the downsides of applications like Mint: people fear the safety of letting these apps store their data, and they also don't prefer the over-automation being done for them, not to mention the overload of information. Inaccurate automation might be the reason for their dislike, or it might be that they prefer their manual habits to an extent which seems to have been replaced here with an over-optimised financial system.

2.5 Digital Tendencies of users in finance

2.5.1 Temporal Nature of Users

Personal budgeting is observed to be a highly temporal activity amongst users. In a study, only 7 out of 15 participants kept a continuous formalised record of expenditure on paper or computer, they would stop once a specific goal was reached (Snow, 2015). The temporality effect might be the reason why many people hesitate to move digital and stick to paper systems still, because they get the freedom to decide when they want to manage their personal finances.

2.5.2 Novelty Effect

In the research presented by Snow (2015), it was found that out of 15 participants, 5 had used a budgeting app but stopped using it after a short period of time. This can be because apps do not cater to the temporality of users and keep forcing them to interact with the app, resulting in frustration and eventual stoppage of use. To promote the novelty of a solution to persist, it is important to acknowledge that users only would want to use the app when needed and as a tool rather than a manager. There can be a few other ways to improve the ability of an app to retain users, such as having visual clarity using a dashboard and providing quick overview.

2.5.3 Financial Touch

Most people prefer to use their own senses to keep track of their state of finances. This implies that people do not want to be constantly looking at their financial records; they'd prefer an occasional glimpse rather than to make sure nothing was out of the ordinary in their spendings. This would mean looking at their bank transactions occasionally. We see this in a study by Kaye (2014) where 8 out of 14 people checked their balance daily or several times a week, where they look for anomalies and outliers. This behavior can be classed as Financial Touch.

2.5.4 Financial Nudge

People often need motivations to achieve their personal financial goals. Digitally, there are ways to attempt to introduce these motivations amongst users by giving them negative reinforcement whenever deviation in personal spending or a financial goal is noticed. This motivation-inducing notification is known as a Financial Nudge. A financial nudge can be induced, for example, by giving notifications to a user when they have overspent for the day, allowing them to make corrections. However, it is important to keep in mind that overuse of financial nudges can lead to negative results where the person overreacts and stops paying attention to their financial health entirely (Lee, 2019). This behavior can be apparent in people where they get overwhelmed by these nudges and disable the nudge-inducing feature (Lewis, 2019).

3 Methodology

3.1 Development Methodology

To develop my web-based tool, Monetics, I had to adopt a specific methodology. Based on the type of project and my understanding, I decided to go with development in a mix of Iterative and Waterfall methodology, see Figure 2. The waterfall like phases of my project involved a series of step from Problem Research to requirements gathering, to design (Royce, 1987). What followed was an Iterative development in a somewhat Agile way with the objective of developing in cycles prioritising important features where in the end of every cycle would be a presentable product also known as a Minimum Viable Product (MVP) (Beck et al., 2001; Boehm, 1988; Fitzgerald and Stol, 2017). The only difference here compared to pure Agile was that User feedback would come at the very end of the cycle once the iterative development loop has been exited.

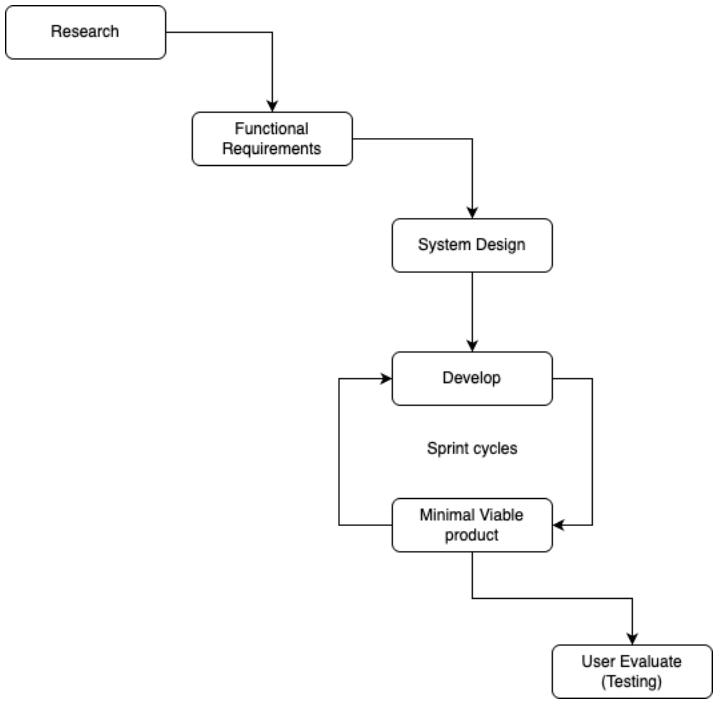

Figure 2 - Monetics Development Methodology

3.2 Research & Requirements Gathering

The requirements' gathering phase was conducted after background research and iterative review of personal finance & current digital budgeting tools. To understand the problem in better detail, Google Scholar was used to search based on keywords such related to personal finance, money management, and digital budgeting tools. Based on the research into relevant studies prior, scope for solution was identified and those were then formulated into functional requirements to move a step closer to development.

3.3 Tools

Software management tool Jira was used to manage the development of this tool. Alternatives existed here like Trello & other kanban boards; however, Jira was selected due to wider range of features it offers and personal experiences with the tool.

A product backlog was maintained here with the list of user stories categorised by core Features as Epics. The user stories were originally formulated from the Functional requirements initially created in the Research & Requirements gathering process. Furthermore, the timeline page and kanban board was used here to better manage the development process using user story cards. See Figure 3 and Figure 4.Table 2

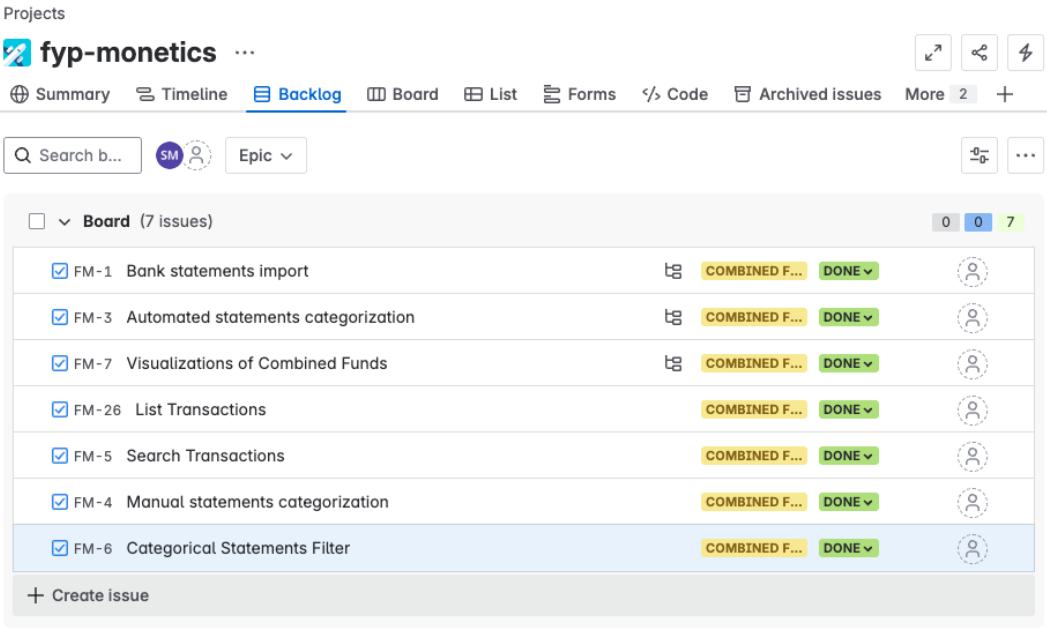

Figure 3 - Product Backlog in Jira

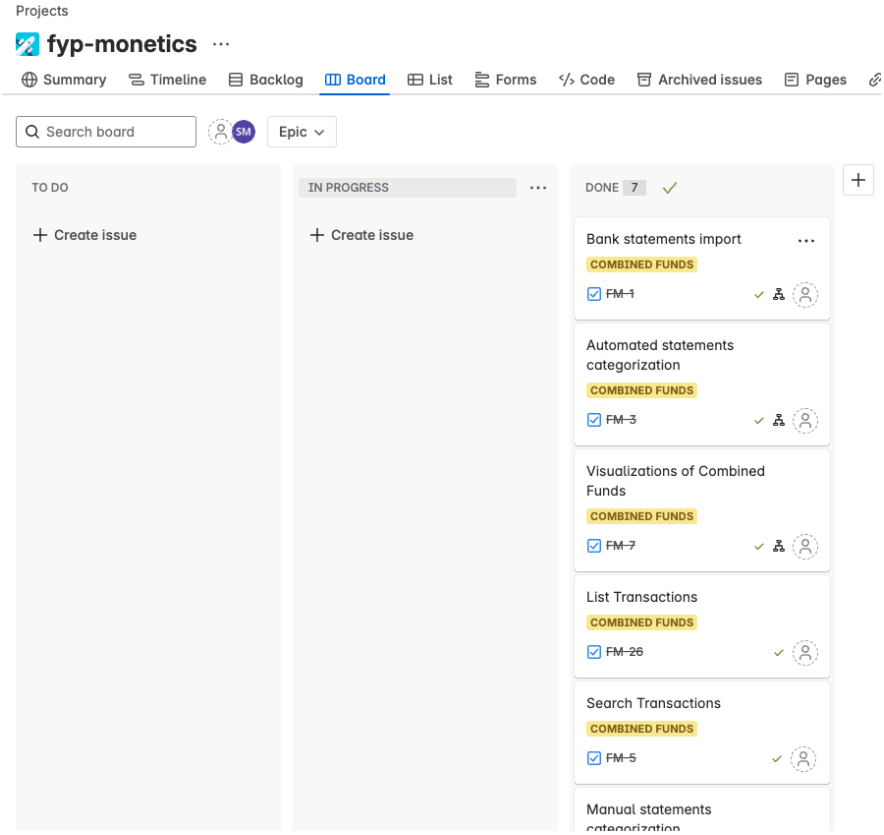

Figure 4 - User Stories via Kanban Board in Jira

Github website & its' desktop software was used to implement the tool, and all code is stored in a repository there. This tool really allowed simple & efficient development through the help of its' branching feature. For coding the frontend infrastructure, Visual Studio Code was used, whereas, for the backend, IntelliJ was used as an Integrated Development Environment for Java.

3.4 Questionnaire

Understanding the effectiveness of the solution developed required direct user feedback and user test of the web-tool, this was done through a solution user testing interview, and a 12-question questionnaire survey consisting of qualitative and quantitative questions. The questionnaire was created with two objectives in mind.

1. To evaluate the effectiveness of the web-based tool in attempting to provide personal bank statements and financial health analysis.
2. To cross-verify the notions of user behaviour observed in researched studies based on their personal finance preferences.

The questionnaire survey procedure required recruitment of individuals above the age of 18, this was done through word-of-mouth search amongst connections. Invitations were sent to 10 people, out of which 4 had responded and agreed to the survey. These participants whose details are anonymous, were recruited from financial, corporate, education, & household backgrounds. All ethics requirements were followed (see Ethics Pro-forma). The interview itself was recorded for evidence & note making purposes for understanding scope of improvements, however only the questionnaire results will be directly used in evaluation of this project.

4 Design

4.1 Introduction

This specifies the design process of my solution. The gaps in existing problems researched in Background chapter 2 is addressed with this solution.

In the Background chapter 2, we gained an understanding of financial literacy and personal finance tools along with current issues regarding literacy and personal finance management tools. There exist great number of decision makers making poor financial decisions as per 2.2 (Hogarth, 2002), this is amplified since personal finance management requires critical thinking skills (Hira, 2008). Looking into current digital tools, we saw various negatives and room for improvements, see Table 1 for details.

ID	Tool Type	Tool downside	Read more (Source)
1.A	Spreadsheet	Inability to extract financial metadata required and upload it to a sheet, due to financial	Chapter 2.4.1 (Lewis, 2019)

		institutions imposing restrictions on personal data collections.	
1.B	Spreadsheet	Extremely manual and may not be suitable to everybody. Commitment issues occur and overwhelms user.	Chapter 2.4.1(Lewis ,2019) & Novelty effect 2.5.2 (Snow, 2015)
2.A	Applications	Too much automation, for example, Automated categorisation that apps offer causes annoyance for users.	Chapter 2.4.2 (Lewis, 2019)
2.B	Applications	Security concerns with apps storing personal financial data.	Chapter 2.4.2 (Lewis, 2019)
2.C	Applications	Overwhelming financial nudges (notifications) resulting in negative behaviour.	Chapter 2.4.2 (Lewis, 2019), 2.5.4 (Lee, 2019) (Lewis, 2019)

Table 1 - Disadvantages of Existing Tools

Based on the apparent downsides with current digital personal finance tools in Table 1, my proposed solution, Monetics is put forward for implementation. I have named my tool Monetics, which is named after the combination of words "Money" and "Analytics". The aim is to create a web-based tool that provides a statement analytics dashboard, integrating automated transactions categorisation, and an AI based chatbot that provides contextual financial nudges.

4.2 Functional Requirements

Proceeding with the design of our solution, Table 2 contains the list of Functional requirements for Monetics. This "problem addressed" column in the table refers to Table 1. Each functional requirement aims to address one or more problem from the table. Problem 2.B is addressed by storing no data in the backend and minimal in runtime at frontend, more explanation in section 4.5.

FRID	Functional Requirement	Feature	Problem Addressed (See table ())
1	The system should allow users to upload monthly bank statements for Starling bank in CSV format.	Bank Statement Upload	1.A
2	The system should automatically categorise individual transactions using rule-based algorithm.	Automatic Categorisation	1.B & 2.A

3	The system should display a sparkline chart showing net balance growth over days along with total income.	Analytics Dashboard	2.C
4	The system should display a sparkline chart showing cumulative spending over days along with total spending.	Analytics Dashboard	2.C
5	The system should display a sparkline chart showing daily transactions over days along with total transaction.	Analytics Dashboard	2.C
6	The system should display a combined line chart of income and expenses over time.	Analytics Dashboard	2.C
7	The system should display a combined bar chat of individual categories spendings by week.	Analytics Dashboard	2.C
8	The system should display a pie chart of category wise spending along with total spending.	Analytics Dashboard	2.C
9	The system should allow export of the analytics dashboard in PDF report.	Data Export	1.A
10	The system should list all transactions from uploaded bank statement.	Manual Categorisation	1.B & 2.A
11	The system should allow the user to manually change categorised transactions from uploaded statement.	Manual Categorisation	1.B & 2.A
12	The system should allow export of updated bank statement in CSV format.	Data Export	1.A
13	The system shall integrate an AI chatbot with uploaded statement context.	AI Chatbot	2.C

Table 2 - Software Functional Requirements

4.3 System Architecture

Figure 5 shows the architecture design of the Monetics system.

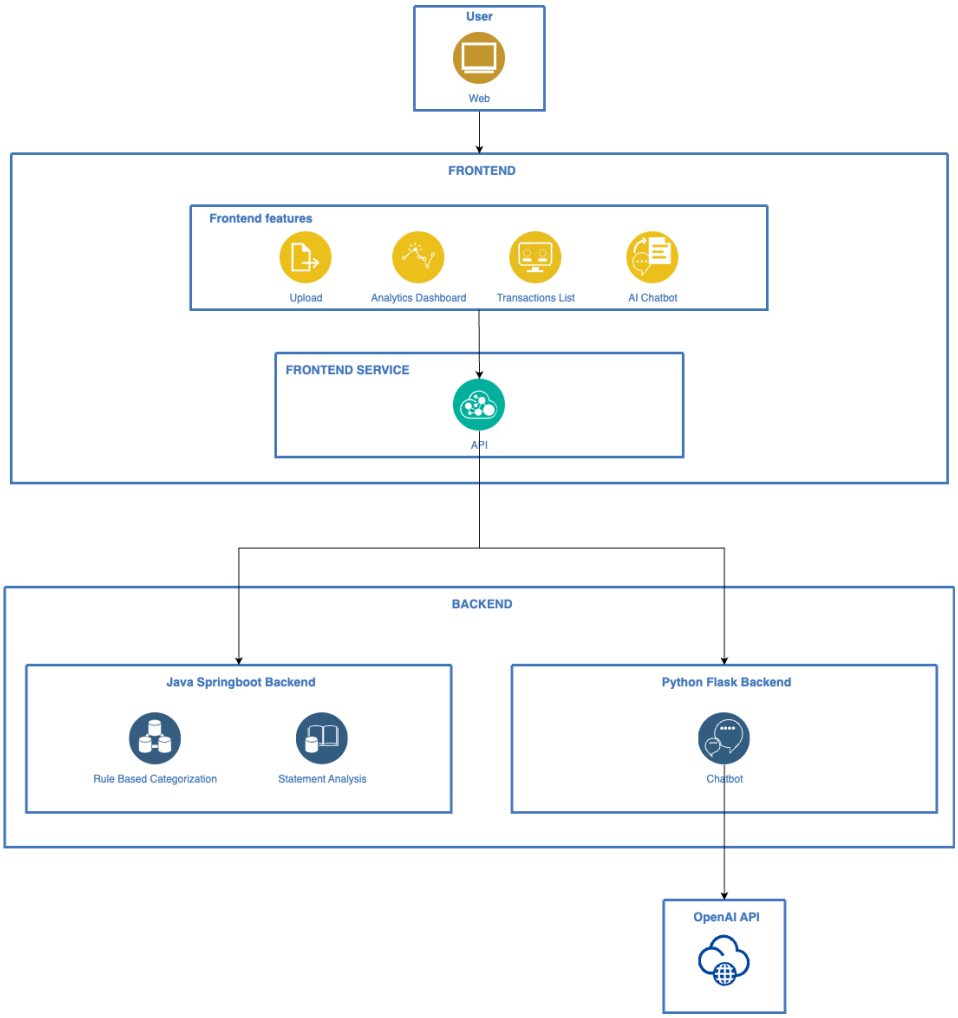

Figure 5 - High Level System Architecture

4.4 Core Features Design

4.4.1 Bank Statement Upload

Not all banks provide the same type of metadata in bank statements as noticed in study by Lewis (2019) where a participant raised concern regarding difficulties in extracting financial metadata. Understanding this concern, there is a limitation in designing a feature for uploading statements from any bank. Hence why, FRID 1 in Table 2 specifically looks at statements from Starling Bank, which is an online bank, they provide CSV format bank statements (Starling Bank, 2024). Our reason for using a CSV file format (fully known as Comma-Seperated-Values) as it allows for efficient data exchange and data handling capabilities which is what we require in our solution (Mitlöhner et al., 2016).

The user uploads their bank statement in .csv format, this will be sent to the backend via an API where the statement is parsed into a list data type for it to be categorised and sent back to the user. I used session storage in the frontend to have client-side storage of this data. See Figure 6.

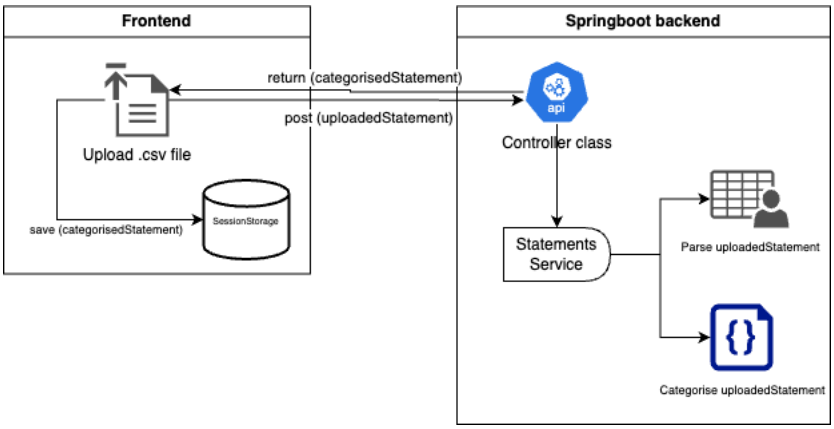

Figure 6 - Bank Statement Upload Flowchart

4.4.2 Automatic & Manual categorisation

Rule-based classification is used for the categorisation of bank transactions. Other alternative existed in artificial intelligence techniques such as deep-neural network and Bayesian model (Kowsari et al., 2019). However, due to notice of concerns with over-automation of tools in research by Lewis (2019) and mentioned in 2.A Table 1, it was decided to stick to Rule-based and add a manual categorisation fallback option for users giving them their freedom in finance management. This feature design covers FR2, FR10, and FR11 from Table 2 - Software Functional Requirements. The classification method aims to look at the subject and type of transaction to categories via word matching (See Figure 7).

Date	Counter Party	Reference	Type	Amount (GBP)	Balance (GBP)	Notes
01/01/2025	Starling Bank	December Interest Earned	DEPOSIT INTEREST	0.21	38.91	
01/01/2025	Amazon Fresh	Amazon Fresh	CARD SUBSCRIPTION	-4.02	34.89	
01/01/2025	TfL	TFL TRAVEL CH	APPLE PAY	-1.80	33.09	
02/01/2025	TfL	TFL TRAVEL CH	APPLE PAY	-1.80	31.29	
03/01/2025	Sender A	jan	FASTER PAYMENT	200.00	231.29	

Figure 7 - Bank Statement Image

Figure 8 flowchart shows how the statement is meant to be looked at using rule-based classification. This the updated statement returned from the backend is saved in session storage (Figure 6) and contains the updated object with each transaction categorised. All transactions are classified by one of the categories and if no keyword is matched for a transaction, it is categorised

as ‘Miscellaneous’. The updated statement with categories assigned can be manually changed by users using the Transactions Page (FRID 11 Table 2) aiming to fix the problem addressed in 2.A of Table 1.

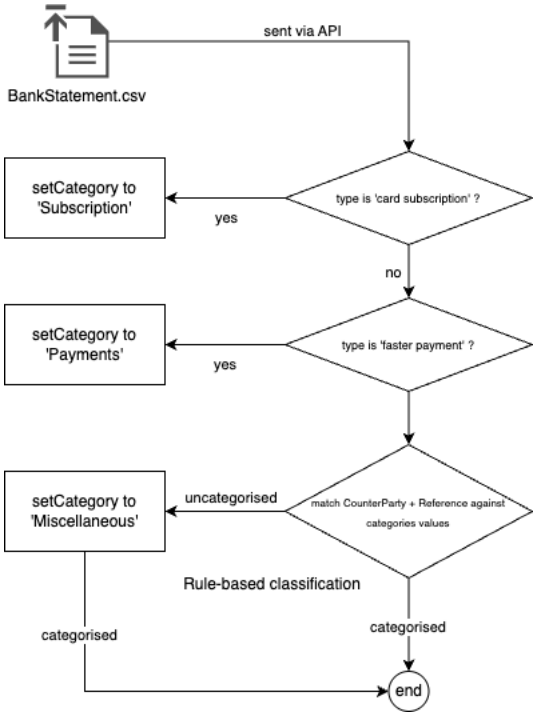

Figure 8 - Automated Categorisation Feature Design

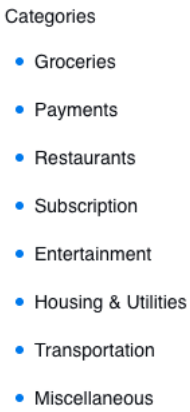

Figure 9 - List of editable categories

4.4.3 Analytics Dashboard

The graphs as mentioned in FRID 3 to 8 in Table 2 aim to provide users a summarised simplistic dashboard for users addressing the problem 2.C from Table 1, where users get overwhelmed too quickly due to unnecessary nudges resulting in the initial novelty of these solutions to wear off (Snow, 2015). The analytics page will use the statement stored in session storage and send it to the

backend where various metrics will be calculated for FRID 3 to 8, see Figure 10 for the flowchart of this.

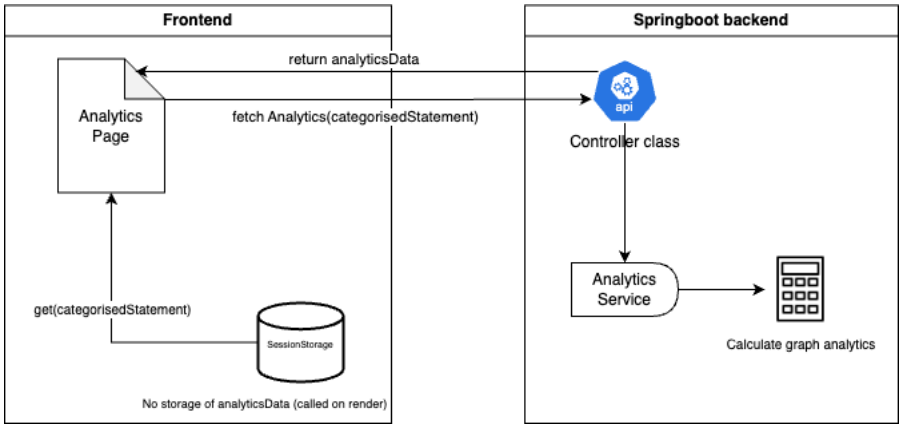

Figure 10 - Analytics Dashboard Flowchart

4.4.4 AI Chatbot

The design for the chatbot feature which meets FRID 13 (Table 2) requires integrating an external AI model, for this model I decided to pick the GPT-4o mini model which provided me a cost-efficient method that I can use to prompt statement and questions to (OpenAI, 2024). The chatbot is what the user will interact with on the frontend and their prompts, i.e. questions will be sent to the backend where it is wrapped with a role assignment with the prompt instructing the GPT-4o mini model to act as an assistant that answers questions about bank statement. See Figure 11.

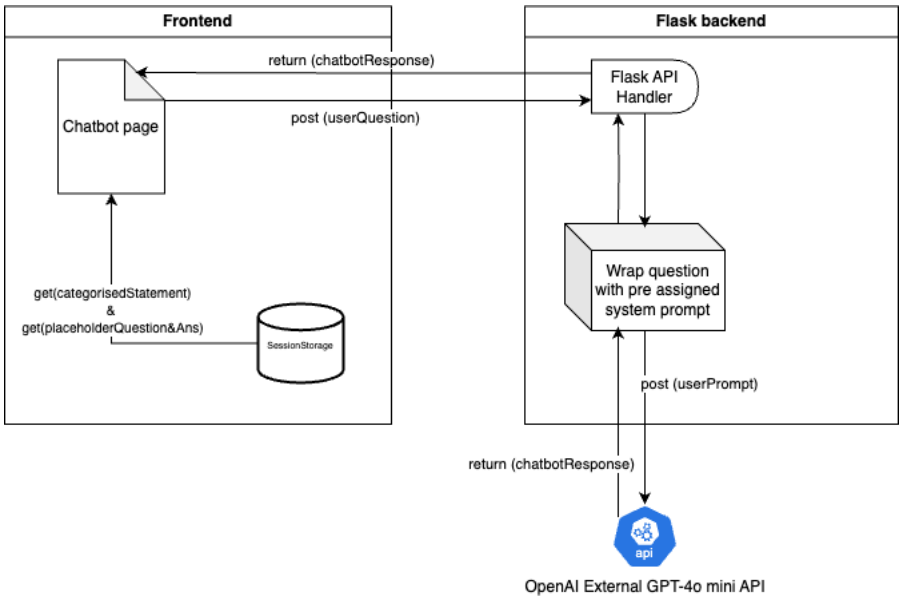

Figure 11 - Chatbot Prompt Flowchart

4.5 Security & Privacy Concerns

Understanding the concerns shared in 2.B (Table 1) regarding user security, users don't feel safe storing personal financial data and there needs to be a solution designed with attempt to store least amount of data as possible on server-side to satisfy client (Lewis, 2019). Session storage is not the safest method for storage of personal data; however, this method was picked as the design for this tool does not require any login credentials from the users or storage in the backend so storing in session storage for temporary use by users as they operate the tool is adopted. Session storage still manages to be a better option over local storage in this case as local storage allows cross-site accessing of data which is even more dangerous (West and S. Monisha Pulimood, 2012). An outlier apart from these two, might be the use of HTML5 Filesystem API which goes entirely client-sided in storage by storing data directly into the system files of the user, meaning no storage on web. This method however is not available on every browser due to security concern and is unorthodox (Bidelman, 2011).

The chatbot which is integrated with GPT-4o mini model which is a public model that collects user data. Understanding the following, this model is only adopted as part of this study to create a possible solution, so we understand users' effectiveness of it. All data fed to this model is replicate sample data for the purpose of the study (OpenAI, 2024).

4.6 Temporal User Interaction Design

Importance of temporality is highlighted throughout the background review and this design chapter. For that reason, Figure 12 shows the analytics dashboard wireframe design that is made for simplicity and a coherent overview in mind (Lee, 2019).

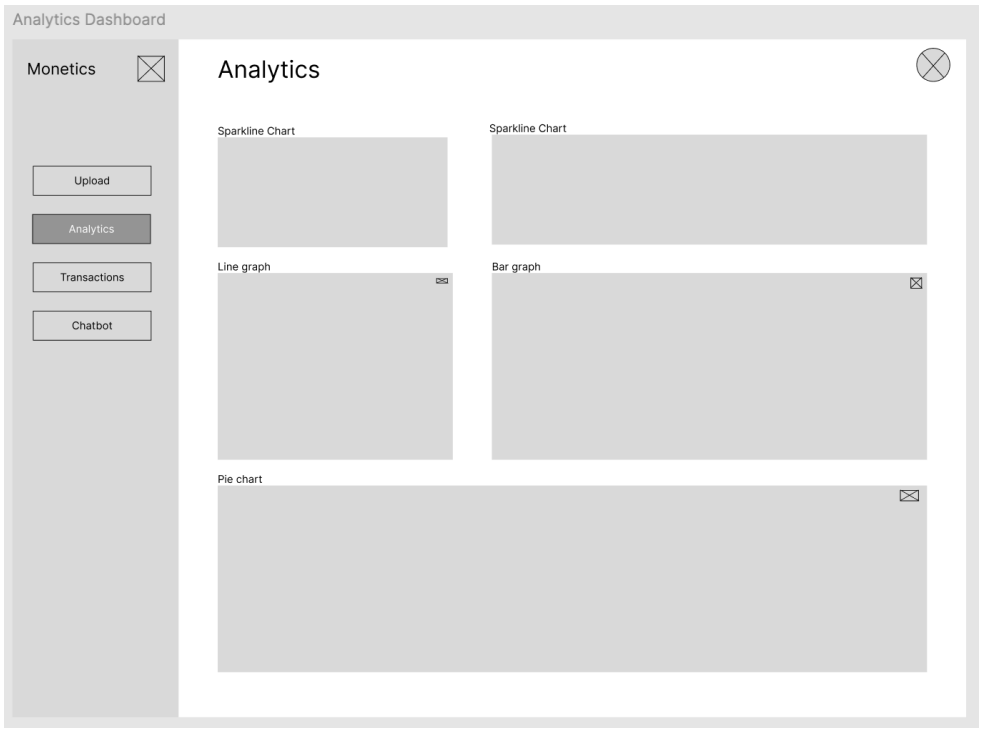

Figure 12 - Analytics Dashboard Wireframe

5 Implementation

5.1 Introduction

Core features from the formulated requirements in Table 2 are implemented in this chapter, this is done by creating a full-stack solution with React in frontend and a mix of Springboot and Flask in the backend. See Table 3 for full list of frameworks and libraries used.

The decision to use Python flask as a backend separately for open AI integration was due to the ease of setting up a flask backend for it. Also, for further improvements with the chatbot to incorporate own model, Python is preferred so I decided to use this. Allowing different backends will help me to go down the serverless route much easier and containerise if needed in the future. (Raúl Garreta and Moncecchi, 2013; Rajan, 2018)

ID	Layer	Frameworks and Libraries
1	Frontend	React.js
2		Material-UI (MUI)
3		React Router
4		Axios
5		Papaparse
6		Day.js
7	Backend	Spring Boot (Java)
8		Flask (Python)
9		Maven
10		Multipart File Handling
11		REST API
12	State Management	Session Storage

Table 3 - Monetics Frameworks and Libraries

I have adopted the use of Monorepo architecture for my code structure, this was done as I was working alone on this project and didn't require this tool to expand further in the future. Also, since my implementation does not have any hosting requirements, it was simpler to run all components as a Monorepo rather than using a Polyrepo (Brito, Terra and Valente, 2018; Fryer, 2023). There exists 2 backends, one that is Springboot Java and other that is Python Flask backend. The

frontend folder was for React js library, this folder contains the frontend for the solution that the user interacts with. See Figure 13.Figure 13 - Monetics File Structure

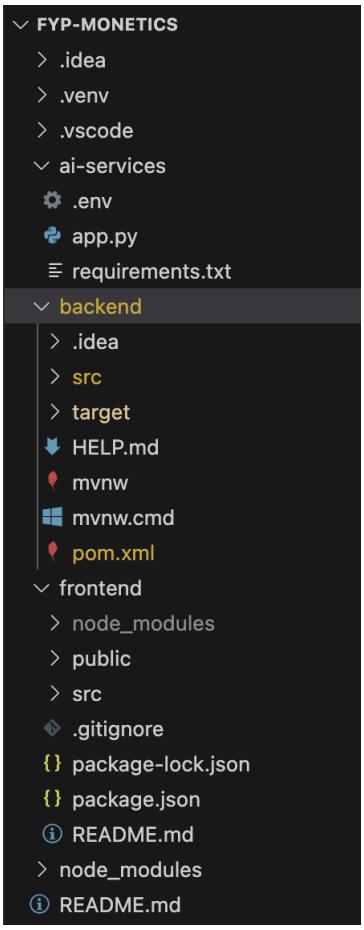

Figure 13 - Monetics File Structure

5.2 Core Features

5.2.1 Bank Statement Upload

The objective of this feature is to allow user to upload a bank statement of monthly duration. Their upload on the frontend is sent to the back end and the data is processed sending back analysable metadata.

1. Frontend (React)

To achieve this, I created a “CsvUploader.jsx” file that would contain the frontend operations for this feature. You upload a bank statement, this would trigger a change function that would call the “handleFileChange” function, See Figure 14 for a look at this function. I’ve used Papa.parse as my tool to parse the uploaded csv file.

```
const handleFileChange = (event) => {
    const selectedFile = event.target.files[0];
    setFile(selectedFile);

    if (selectedFile) {
        Papa.parse(selectedFile, { // Parsing the uploaded bank statement into CSV
            complete: (results) => {
                console.log('Parsed CSV data:', results.data);
            },
            header: true,
        });

        handleStatementUpload(selectedFile);
    }
};
```

Figure 14 - Code Snippet for "handleFileChange" function

The function “handleStatementUpload” see Figure 15 , converts the sent file into a FormData format, this is done as this file format type is used in the backend to interpret our CSV file. Along with the upload, this function acts as the initiation for creation of session storage items containing our uploaded statement which is returned from the “uploadStatement” api function we call. We also prepopulate a sample question and answer for our chatbot, the reason and functioning of this will be further explained in section 5.3.5.

```
const handleStatementUpload = async (fileToUpload) => {
    if (!fileToUpload) {
        setError('Please select a file'); // Provide feedback to no file selected
        return;
    }

    const formData = new FormData();
    formData.append('file', fileToUpload); // Conversion for api backend acceptance

    setIsLoading(true);
    setError('');

    try {
        const data = await uploadStatement(formData); // API service call for upload
        onUploadSuccess(data);
        sessionStorage.setItem('uploadedStatements', JSON.stringify(data)); // Session storage initialisation
        sessionStorage.setItem('chatbotQuestion', 'What can you do?');
        sessionStorage.setItem('chatbotAnswer', chatbotAnswer);
    } catch (err) {
        setError(err.message);
    } finally {
        setIsLoading(false);
    }
};
```

Figure 15 - Code snippet for "handleStatementUpload" function

The statement on conversion to different file type, is sent to our frontend api services file where our api function exists. Function “uploadStatement” as seen Figure 16 sends our api post request using axios. The “localhost:8080/api” is the main url of the backend onto which the exact api address is added.

```
const api = axios.create({
    baseURL: 'http://localhost:8080/api',
});

export const uploadStatement = async (formData) => {
    try {
        const response = await api.post('/statements/upload', formData, {
            headers: {
                'Content-Type': 'multipart/form-data',
            },
        });
        return response.data;
    } catch (err) {
        console.error('Upload error:', err);
        console.error('Error response:', err.response);
        throw new Error(err.response?.data || err.message || 'Failed to upload file. Please try again.');
    }
};
```

Figure 16 - Code snippet for "uploadStatement" function

2. Backend (Spring boot)

In the springboot backend contains, a StatementController.java that uses REST API to handle APIs. This controller checks the multipart nature of the sent file and sends it further to our StatementService.java file. In our statements service we parse our multipart encapsulated csv file through a CsvParserService (see Figure 17) and convert it into a List type and set it identical to our columns in the bank statement. This parser service does error handling to check for invalid date format, which is important to check for as date values are directly checked in categorisation for calculating analytic numbers based on length of the month.

```
    for (CSVRecord record : csvParser) {
        logger.debug("Processing record: {}", record);
        Transaction transaction = new Transaction();

        if (record.isSet( name: "Date") && !record.get("Date").isEmpty()) {
            try {
                transaction.setDate(LocalDate.parse(record.get("Date"), DATE_FORMATTER));
            } catch (DateTimeParseException e) {
                logger.error("Invalid date format in record: {}", record.get("Date"), e);
                throw new InvalidFileException("Invalid date format: " + record.get("Date"), e);
            }
        } else {
            transaction.setDate(null);
        }

        transaction.setCounterParty(record.isSet( name: "Counter Party") ? record.get("Counter Party") : "");
        transaction.setReference(record.isSet( name: "Reference") ? record.get("Reference") : "");
        transaction.setType(record.isSet( name: "Type") ? record.get("Type") : "");
        transaction.setAmount(record.isSet( name: "Amount (GBP)") ? Double.parseDouble(record.get("Amount (GBP)")) : 0.0);
        transaction.setBalance(record.isSet( name: "Balance (GBP)") ? Double.parseDouble(record.get("Balance (GBP)")) : 0.0);
        transaction.setNotes(record.isSet( name: "Notes") ? record.get("Notes") : "");
        transaction.setSpendingCategory("");
        transactions.add(transaction);
    }
} catch (Exception e) {
    logger.error("Error parsing CSV file: {}", e.getMessage(), e);
    throw new InvalidFileException("Invalid CSV file format: " + e.getMessage(), e);
}
```

Figure 17 - Code snippet of CsvParser service (Backend)

5.2.2 Automatic Categorisation

The objective is to automate the categorisation of uploaded bank statement transactions for the user. To achieve this, rule-based algorithm was adopted in the backend.

The list of transactions parsed in our backend is sent to CategorisationService where the categorisation done. In this categorisation method, 2 layers are incorporated. We first check to see the payment type, if it appears to be a card subscription we automatically assign it the subscription category, same is done for if payment type is a faster payment, we assign it as payment category. For the remaining cases, we check keywords in payment text and try to match it with our list (Check Figure 18 and Figure 19).

```
private static final Map<String, List<String>> CATEGORY_RULES = Map.of( 1 usage
        k1: "Groceries", List.of("tesco", "fresh", "supermarket", "morrisons"),
        k2: "Entertainment", List.of("cine", "netflix", "spotify", "ice skating"),
        k3: "Transportation", List.of("tfl", "travel", "train"),
        k4: "Restaurants", List.of("pizza", "domino", "udon", "pret", "subway", "rice and curry"),
        k5: "Housing & Utilities", List.of()
);
```

Figure 18 - Code snippet of categories

```
    private String determineCategory(String type, String counterParty, String reference) {
        // RULE 1: Check type priority
        if ("CARD SUBSCRIPTION".equalsIgnoreCase(type)) {
            return "Subscription";
        } else if ("FASTER PAYMENT".equalsIgnoreCase(type)) {
            return "Payments";
        }

        // RULE 2: Match counterParty & reference against category rules
        String combinedText = (counterParty + " " + reference).toLowerCase();
        String matchedCategory = CATEGORY_RULES.entrySet().stream() Stream<Entry<...>>
                .filter( Entry<String, List<...>> entry -> entry.getValue().stream()
                        .anyMatch( String keyword -> combinedText.contains(keyword)))
                .map(Map.Entry::getKey) Stream<String>
                .findFirst() Optional<String>
                .orElse( other: null);

        // RULE 3: Default uncat if none matches
        return matchedCategory != null ? matchedCategory : "Miscellaneous";
    }
}
```

Figure 19 - Code snippet of rule-based categorisation logic

After this categorisation, the new transactions list is sent back to the user via the original Api call in Figure 6. This list is stored in session storage allowing it to be used in other pages as well, the data stored here

5.2.3 Manual Categorisation

The objective of manual categorisation is to allow users to manually change the automated categorising done through the rule-based algorithm and adjust based on their user preference.

To implement this feature, it was important for the user to view their entire updated list of transactions after upload. For this, we created a transactions page in the frontend and used Material UI's data grid component to render our transactions

The transactions page fetches our stored uploadedStatements and renders the table. During the row and columns generation, I enable the “spendingCategory” column to be editable by the users showing a dropdown containing categories to select from, Figure 20.The manually editable categories list can be seen in Figure 9.

```
editable: key === 'spendingCategory',
...(key === 'spendingCategory' && {
  type: 'singleSelect',
  valueOptions: spendingCategories,
  renderEditCell: (params) => (
    <Select
      value={params.value}
      onChange={(event) => {
        params.api.setEditCellValue({
          id: params.id,
          field: params.field,
          value: event.target.value,
        });
      }}
      fullWidth
      native
    >
      {spendingCategories.map((category) => (
        <option key={category} value={category}>
          {category}
        </option>
      ))}
    </Select>
  ),
```

Figure 20 - Code snippet of manual categorisation

On change of any transactions category, the session storage is automatically updated with the new statements list based on the new changes by user. This is done to help with export of data later (5.3.6) and to keep the chatbot informed on updated statement (5.3.5).

5.2.4 Analytics Dashboard

All the calculation data for the render was done in the backend allowing the frontend to only display the graphics. An API call is made from our API service in the frontend via axios similar to what we did in Figure 10. This call is sent for the “/api/analytics/calculate” address located in the AnalyticsController class. The AnalyticsService class contains the calculation logic for the statement analytics, all calculations are done here based on the AnalyticsData.java model class. See fig for the keys

```
private List<Double> netBalanceGrowth;  2 usages
private double netBalancePercentageChange;  2 usages
private String netBalanceTrend;  2 usages

private List<Double> cumulativeSpending;  2 usages
private double cumulativeSpendingPercentageChange;  2 usages
private String cumulativeSpendingTrend;  2 usages

private List<Integer> dailyTransactions;  2 usages
private double dailyTransactionsPercentageChange;  2 usages
private String dailyTransactionsTrend;  2 usages

private Map<String, List<Double>> incomeVsExpense;  2 usages
private Map<String, Map<Integer, Double>> weeklySpendingByCategory;  2 usages
private Map<String, Double> overallSpendingByCategory;  2 usages

private Map<String, Double> percentageContributionByCategory;  2 usages

private DateInfo date;  2 usages
```

Figure 21 - Code snippet of the analytics variables

To see an example of what these values look like when returned to the frontend variable, refer to Figure 22. These values are not stored in session storage and the calculations are done every time the Api is called.

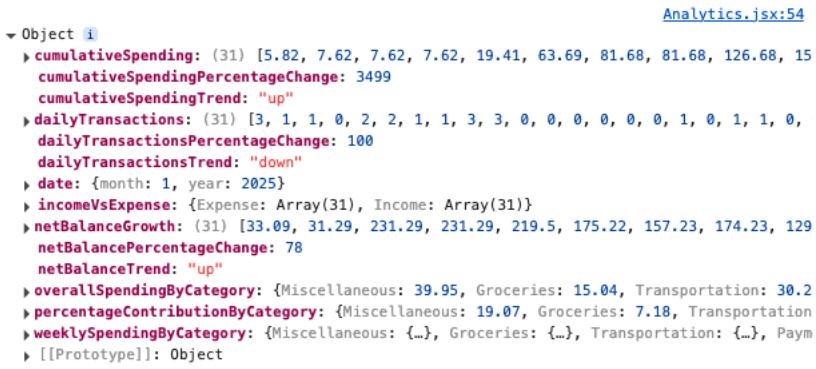

Figure 22 - Console log of analyticsData

To understand how these variables map to the Functional Requirements analytical features, refer to Table 4.

Variable name	**Feature addressed (based on table())**
netBalanceGrowth, netBalancePercentageChange, netBalancePercentageChange	FRID 3
cumulativeSpending, cumulativeSpendingPercentageChange, cumulativePercentageTrend	FRID 4
dailyTransactions, dailyTransactionsPercentageChange, dailyTransactionsTrend	FRID 5

incomeVsExpense	FRID 6
weeklySpendingByCategory	FRID 7
overallSpendingByCategory, percentageContributionByCategory	FRID 8

Table 4 - Analytics variables and their addressed features

The variables above that are a part of analyticsData are all calculated together.

Analytics calculation overview:

1) Transactions are first sorted by date, then the month and year is extracted from the first transaction.
2) Daily tracking is initialised for the day-by-day calculation data in variables (see table ())
3) Each transaction is processed to update dailySpending, dailyTransactionCount, and incomeVsExpense (dailyIncome & dailyExpense).
4) netBalanceGrowth is calculated by carrying the last known balance and logging it.
5) cumulativeSpending is calculated by adding up dailySpending values from 3)
6) The variable incomeVsExpense is calculated by simultaneously adding up variables from 3) in expense and spending per day and assigning them to this nested list.
7) For weeklySpendingByCategory, I set the max limit of weeks existing to 5 and based on after filling the weekly sets with data if the final week was empty, I would remove it.
8) For overallSpendingByCategory, I grouped the transactions by category and added the spendings that way.
9) percentageContributionByCategory involved taking the individual category spending and dividing it by the total expenses and converting that into percentage.

5.2.5 AI Chatbot integration

The frontend for the chatbot was a page specifically for this feature. On loading of this page, the pre-loaded question and answer from statement upload (5.3.1 section) is rendered. To allow user input, I coded the text input box, and a send button wraps the user's question along with the current bank statement and send it to the python backend API, refer to Figure 23.The chatbot page also has a handleQuestionChange function to update the question variable whenever a new question is inputted, this along with the chatbot answer is also stored in session storage allowing user's previous question and answer to always display on change of tabs.

```
const handleAskQuestion = async () => {
    if (!question.trim()) {
        alert('Please enter a question.');
        return;
    }

    try {
        const response = await axios.post('http://127.0.0.1:5000/ask', {
            bank_statement: bankStatement,
            question: question,
        });
        const newAnswer = response.data.answer;
        setAnswer(newAnswer);
        sessionStorage.setItem('chatbotAnswer', newAnswer);
    } catch (error) {
        console.error('Error fetching data:', error);
        setAnswer('An error occurred while fetching the answer.');
        sessionStorage.setItem('chatbotAnswer', 'An error occurred while fetching the answer.');
    }
};
```

Figure 23 - Code snippet of handleAskQuestion

Backend in python framework Flask was created to establish connection to the OpenAI GPT 4.0 turbo API. See Figure 24

```
client = OpenAI(api_key=os.getenv("OPENAI_API_KEY"))

@app.route('/ask', methods=['POST'])
def ask_question():
    data = request.json
    bank_statement = data.get("bank_statement")
    question = data.get("question")

    if not bank_statement or not question:
        return jsonify({"error": "Both 'bank_statement' and 'question' are required."}), 400

    prompt = f"Bank Statement:\n{bank_statement}\n\nQuestion: {question}\n\nAnswer:"

    try:
        response = client.chat.completions.create(
            model="gpt-4o-mini",
            messages=[
                {"role": "system", "content": "You are a helpful assistant that answers questions about bank statements."},
                {"role": "user", "content": prompt}
            ]
        )

        answer = response.choices[0].message.content.strip()

        return jsonify({"answer": answer})

    except Exception as e:
        return jsonify({"error": str(e)}), 500
```

Figure 24 - Code snippet of chatbot integration backend

5.2.6 Data Export

Analytics dashboard and list of transactions are both exportable. For the analytics dashboard, I used jsPDF which is a library for creating PDF format print of webpage. This allowed me to set my PDF sizing and width to fix it and allow it to look like this .Refer to Figure 25to see the handleExportPDF function.

```
const handleExportPDF = async () => {
  const input = document.getElementById('analytics-grid');
  const canvas = await html2canvas(input, { scale: 2 });
  const imgData = canvas.toDataURL('image/png');
  const pdf = new jsPDF('p', 'mm', 'a4');
  const imgProps = pdf.getImageProperties(imgData);
  const pdfWidth = pdf.internal.pageSize.getWidth();
  const pdfHeight = (imgProps.height * pdfWidth) / imgProps.width;
  pdf.addImage(imgData, 'PNG', 0, 0, pdfWidth, pdfHeight);
  pdf.save('analytics-report.pdf');
};
```

Figure 25 - Code snippet of handleExportPDF for PDF file

Similar export function was used in the transactions page however here instead of PDF, a csv format is required identical to what user uploaded in the beginning. So, I used the in built react saveAs function after unparsing the statement from session storage resulting in download of the csv that now has the list of transactions with categorised column added. See Figure 26 for code.

```
export default function TransactionsGrid() {
    const handleExport = () => {
        const uploadedStatements = JSON.parse(sessionStorage.getItem('uploadedStatements')) || [];
        if (uploadedStatements.length === 0) {
            return;
        }
        const csv = Papa.unparse(uploadedStatements, {
            header: true,
        });
        const blob = new Blob([csv], { type: 'text/csv;charset=utf-8;' });
        saveAs(blob, 'monetics-statements.csv');
    };
```

Figure 26 - Code snippet of handleExport for CSV file

5.3 Challenges Faced

There exist inconsistencies between the bank statements of different banks, making it difficult to implement a solution that allows upload of any bank statement.

Furthermore, the use of rule-based algorithm in automated categorisation although works at a basic level to provide users a basic categorisation by key-word matching, could incorrectly categorise with increase of keyword variances.

There was also difficulty faced in restricting the chatbot's data knowledge to prevent users from asking it non-bank statement related questions. Attempt was made to prompt the chatbot to not respond to irrelevant questions asked but it was unable to do so.

5.4 Alternative Approaches

Automated categorisation could have been developed via using a Natural Language Processing (NLP) model with the help of transformer like BERT to analyse the transactions and categorise it, but it might have been overkill and computationally heavy (Kowsari et al., 2019).

Both Spring boot and Flask backend in an alternative approach, could have been moved serverless with tool like google or Microsoft assisting here.

6 Testing and Evaluation

As a part of the aim as stated in our Introduction chapter, the aim of this project was to address the limitations of current personal finance management tools, which often struggle to cater to users' temporal behaviour and may overwhelm them. By addressing these limitations, we had designed our solution and implemented our design as seen in the Implementation chapter. This chapter will systematically attempt to evaluate whether Monetics solves the problems mentioned in Table 1 - Disadvantages of Existing Tools.

6.1 Evaluation Methodology

Based on the study of existing literature pertaining to personal finance and budgeting tools, we come with the following core questions that helps us understand the effectivity of our solution.

1) Does Monetics successfully cater to the temporal nature of people's personal finance management, and avoid overwhelming them?
2) Can automated categorisation of bank statements be implemented through rule-based method achieving a level of accuracy whilst allowed user freedom?
3) Can a dashboard for bank statement analysis provide better financial overview experience for a user catering to their temporality and act as a financial touch?
4) Does Artificial Intelligence integrated into chatbot enhance their experience in the analysis of a bank statement, acting as a positive financial nudge?

6.2 User Evaluation

Our user study which collected data from 4 participants via notes taken from tool demo interview and user filled questionnaire allowed us to gain user feedback on Monetics and its' features along with their personal finance management preferences. The questionnaire conducted via Microsoft Forms (source) comprised of 10 quantitative and qualitative questions (excluding consent form questions), see Table 5 for the list of questions. Notes taken from the user feedback demo interview are summarised in key notes, (see Appendix).

(qno) Number	Question	Type

1	Do you use any tool currently to see your personal finances or budget?	Quantitative (Yes/No)
2	Name the tool, is there a reason why you prefer the tool over the others? Provide a reason for your preference?	Qualitative (Answer)
3	What are your thoughts on the possibility of people being temporal when it comes to personal finance and that they only care to look at their finances on occasional basis rather than regularly? State your personal experience.	Qualitative (Answer)
4	How intuitive did you find the navigation within the app?	Quantitative (1-10 Likert Scale)
5	Were there any features or functions that were particularly helpful or enjoyable?	Quantitative (Multiple Selection)
6	Did you encounter any bugs or issues while using the app?	Quantitative (Yes/No/Maybe)
7	Does the automated categorisation feature prove useful to you?	Quantitative (Yes/No/Maybe)
8	Does the analytics dashboard allow you to gain a conclusive understanding of your financial health?	Quantitative (Yes/No/Maybe)
9	Does the AI chatbot provide you with information in a unique way that otherwise would have been difficult to grasp out of a regular bank statement?	Quantitative (Yes/No/Maybe)

10	What improvements or additional features would you like to see in the app?	Qualitative (Answer)

Table 5 - User Evaluation Survey Questionnaire

6.2.1 Participants Current Usage

Based on the response from the survey, for question 1 from Table 5, only 1 of the 4 participants currently use a tool to see their personal finances, meaning **75%** of the participants do not use any tool whatsoever, see Figure 27.

Figure 27 – Personal finance tool usage amongst participants (Pie Chart)

Alternatively, one of the participants during the solution demo interview mentioned using spreadsheets in the past but having stopped doing so since, 'I used to do it in the past where I would use it for consolidating multiple banks into one file, but not anymore. The use of spreadsheet as an alternative to digital solution is clarified here, as it is in research by Kaye (2014) and Lewis (2019).

6.2.2 Intuitiveness of solution

Looking at the effectivity and usefulness of the solution, it is important to understand whether users find tool intuitive which means easy to use and understand (source). Survey results from question 4 in Table 5, show the rating given by each participant. Calculating the mean (average) of the results, we find the average to be **7.75 rating**.

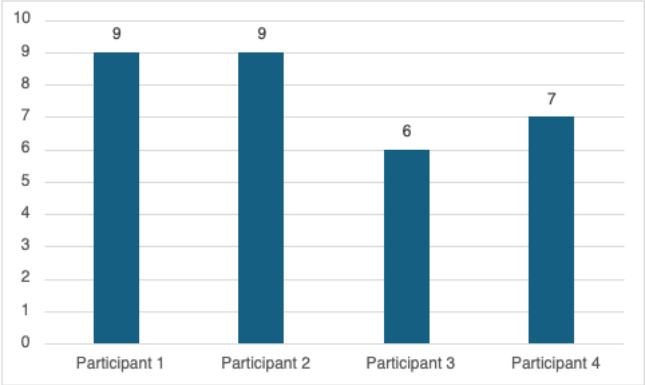

Figure 28 - Intuitiveness Score amongst participants (Bar Chart)

In the demo, when showing participant 1 the sample bank statement in contrast to the analytics dashboard they mentioned it being “a much more easier to read format”. Participant 3 said the dashboard was “easier to take in” allowing her to “do it (analyse) in 5 minutes and move on with my day”. Participant 4 highlighted the ease of not having to “context switch or go to another page”, these observations support our understanding of the importance of providing via overview and simplification (Snow, 2015).

6.2.3 Feature Usefulness

The usefulness of core features implemented based on Functional Requirements Table 2 were also asked in the questionnaire using question 5 in Table 5 through multiple choice selection. Based on the user results, only the Analytics Dashboard and AI Chatbot feature were found to be useful to 100% of participants. The remaining features like upload, categorisation & data export were not useful to 25-50% of participants, see Figure 29.

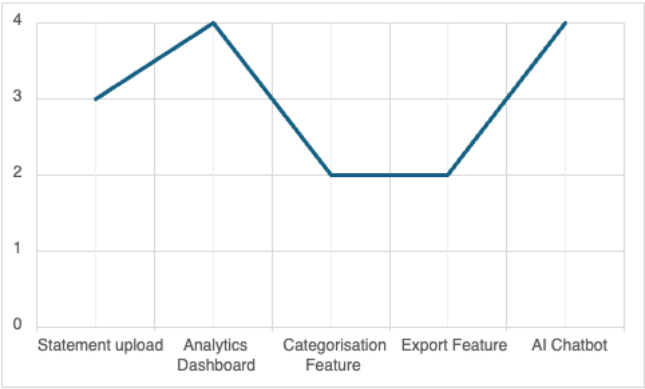

Figure 29 - Feature usefulness amongst participants (Line chart)

To further investigate why some participants may not have found categorisation and export feature not as useful, we look at participant notes from the interview. Participant 3, whilst using the tool, mentioned regarding manual categorisation being unnecessary for them and that they "personally wouldn't use it as much". From the response, and the fact that they preferred the analytics page much more, it could be interpreted that they're a type of user that prefer automation and easy to use methods such as apps over manual transactions viewing method that is similar with spreadsheets.

Questions 7 to 9 in Table 5 help getting direct feedback on three main features and allow in validation of our evaluation core questions, categorisation, analytics dashboard, and AI chatbot. All participants found these 3 features useful in fulfilling their respective aims, apart from 1 participant for question 9 who responded with "Maybe" as their answer.

6.2.4 Observed User Behaviour

Our background review into digital tendencies of users (See Chapter 2.5) needed to be validated and cross-checked through this user study, so question 3 Table 5 allows us to get users' personal thoughts on whether they are temporal with their personal finances (Snow, 2015). Looking at responses from survey, one survey response stated:

"I only look through my spendings at the end of the month, or twice a month because it is hard for me to keep track of the income coming in and expenses going out on weekly basis, it is difficult to constantly document all my transactions on Excel, or mentally calculate using the bank app."

Other participants mentioned somewhat similar points like only managing their finances when they get major payments and that too financial checking would get them fatigued. These personal opinions although from a small number of participants, all point at their apparent frustration and shortcomings with finance management.

6.2.5 User Feedback

Feedback provided via the survey questions 6 (quantitative) and 10 (qualitative) in Table 5 helped in understanding the presence of bugs encountered by participants and note any suggestions they may have for the tool. Based on the results, **2 out of 4** participants said they encountered bugs on the website. During the demo, one participant had pointed this out with the chatbot where there was no visual indication for them of their question search going through, this resulted in them spamming the button thinking their result wasn't sending and caused overloading of the chatbot

responses in return. User feedback from survey responses has been summarised as key points in Table 6.

No	User Feedback
1	Improve colour coding and visual graphics.
2	Implement budget page to budget for the coming month
3	Implement clickable categories on transactions page to filter transactions
4	Implement feature to upload multiple bank statements to view combined transactions
5	Improve features on AI chatbot for accessibility

Table 6 - User Feedback Summarise

7 Conclusions

This research aimed to identify the effect of temporality amongst users and the limitations of current personal finance management tools. Based on the solution implemented as a web-based tool to assist users in analysis of their bank statement, we get to evaluate the effectiveness of this tool using user study and find that the tool can address the limitations to some extent.

Understanding the limitations, I have created a solution to cater to users' temporality and prevent overwhelming them; this can be observed in our user evaluation where users have mentioned positive things about the mentioning of the ease of use and simplicity of the solution. To help further solidify these feelings of the users, they were even presented with during the demo, a sample bank statement to observe where all of them found it tasking to look at; in contrast, they were later shown the analytics dashboard to which when asked about the use and simplicity their sentiments were very different from that of the sample bank statement. Apart from the emotional views of the users, their quantitative results were also collected from the user survey where an overall rating of 7.75 was given for the intuitiveness of the website (Figure 28); this implied that users found this tool simplistic, opposing the overwhelming argument. Furthermore, looking at our literature review, we find downsides of current tools (Table 1) where apps have too many automations for user liking and overwhelming negative nudges; to find a solution to this, I developed an analytics dashboard and AI-integrated chatbot, which participants have found to be simplistic and gave positive feedback. Although I have created all of this, some users found the answers given by the chatbot to be a bit overwhelming to read and technical for their liking; they preferred a more summarised answer which becomes a limitation and requires better improvements.

The method to evaluate user study for this tool required finding participants that were from specific demographics, that differed from each other. This was to see if the tool catered better for people from different backgrounds. To look at a recent graduate, current student, finance professional, and corporate background individual, for example, allowed me to evaluate better. However, it is also important to see the limitations behind the current evaluation method, which had only 4 participants. Since even if each participant is from a different background to provide rich varying opinions, it is still not enough as a person from each background may have different opinions, so it is better to have more participants for a study like this. I would have increased my pool of participants from each professional background to better assess if most of that demographic finds the tool useful or not. Throughout the user study evaluation, which acted as a core evaluation method for the entire solution, all ethical processes were adhered to.

The bank statement upload, being sort of a prerequisite feature, did end up having limitations where it was only possible to upload monthly statements from a single bank, in our case Starling. This was due to difficulties in trying to accept different banks' statements due to differences in financial metadata. Since this solution is a demo with a core focus to see if it can focus on temporality and reduce the overwhelming nature of finance amongst, the limitation has been acknowledged and put aside for future projects.

The reasoning behind developing an analytics dashboard was after looking at the existing literature where gaps were identified in people wanting a more comprehensive overview of their financial health. Current tools like spreadsheets are too manual for them, and apps are too overwhelming for them. We see this in our user evaluation as well where only 1 out of the 4 participants has used a financial tool to manage their finances. The aim of the analytics dashboard also ties in with our problem and solution Monetics where the target is to make this feature as simplistic and overview-type as possible to promote the temporality of users allowing them to use this whenever they want with no over-automation. Users have reacted positively to this feature as mentioned before where all 4 of the participants found this feature useful. Although, some feedback from users mentioned improvements needed in visual colours with the dashboard where the colours of the pie chart and bar chart graphs were similar resulting in slight limitations.

For the automated categorisation feature, we used rule-based classification to categorise our bank statement categorisation which was initially formulated for the reason of finding an alternative or rather a support tool for spreadsheet users where their data can be categorised for better analysis using export features. User evaluation by interview notes found that participants did encounter some miscategorised transactions which implied the need to technically test the categorisation accuracy, however this was not possible, and just to allow a fallback option in implementation manual categorisation was implemented where users can override the transactions and categorise wherever needed. This allows them freedom and doesn't force them to automate.

To conclude my work, I would like to highlight that my solution based on the above-mentioned reasons has satisfied my set aims and objectives **to some extent** and not fully, based on limitations and reasons discussed wherever applicable.

7.1 Future Work

This project leaves scope for future work. This can be done on various aspects, like feature additions, evaluation methods, and a thorough study with more participants. From our user

suggestions in Table 6, we can identify scope for improving the visual look for Monetics, implementing a budget page for future months, and adding a feature to upload multiple bank statements to view combined transactions. Also, based on our limitations identified above in each of the aims and objectives, we can find improvements in how we automate our classification, perhaps allowing for a project that can include better algorithms.

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Appendix A Personal Reflection (Compulsory)

A.1 Reflection on Project

This project really allowed me to understand more about the personal finance field, enabling me to use this acquired knowledge to possibly try to implement the points mentioned in future works chapter on my own. Understanding how to conduct user studies via questionnaire and interview really allowed me acquire evaluation skills. In the project, problems were encountered specifically in evaluation, where I felt that it was difficult to showcase many metrics specific to my collected data due to its' small participants size.

Google scholar really helped me to find the research articles I needed in my research phase. I was able to find some important articles at Brunel library as well.

A.2 Personal Reflection

I would have decided to conduct a similar user study but at earlier stages to better solidify my background research and formulate better requirements from that. I would also switch to a simpler tool for project management like Trello as I found that a lot of the tools that Jira offered was not necessary for me to use during my project. Moreover, I would have done more technical evaluations using code tests to help further demonstrate code soundness of my solution. I believe that these things would really help me have had a better project overall.

Appendix B Ethics Documentation (Compulsory)

B.1 Ethics Pro-forma

Research Ethics Supervisor Pro forma

This form should be completed in collaboration with your supervisee. Please ensure you have familiarised yourself with the University Research Ethics Process prior to supporting students. For more information please see the Research Ethics and Integrity webpages. For further information and guidance, please contact the central Research Ethics team via email to res-ethics@brunel.ac.uk

You can select to receive a copy of your submission for your own records once you have completed the form before pressing 'submit'. Please note this pro forma is for central auditing purposes only, we do not provide confirmation of ethical approval via this form.

Supervisor

Please complete the following:

1. Student First Name *

Suryaansh

2. Student Surname *

Maithani

3. Student Number *

2249998

4. Module Name *

Final Year Project

5. Module Code *

CS3072/CS3605

6. Submission deadline *

4/11/2025

7. Please provide the BREO reference ID for the approved Module Application relevant to this student's research proposal (if applicable): *

48594-MA-Oct/2024- 52961-3

8. Please provide a brief description of the proposed low risk research (including research method(s), intended participants and recruitment method) *

User Feedback & Effectiveness User Study for 'Monetics: a web-based tool for personal bank statement & financial health analysis'.

The method to capture data here involves an online interview to user test the solution followed by an anonymised questionnaire involving a series of quantitative and qualitative questions pertaining to the monetics solution and the problem as a whole. This research would allow the student to evaluate the effectiveness of the solution against the project aim.

Prior to the questionnaire, an informal interview is to be conducted online with each participant where they demo the website and talk aloud their thoughts as they go through, the call would be recorded for evidence and note-making purposes which would be evaluated in the dissertation along with the questionnaire results maintaining anonymity.

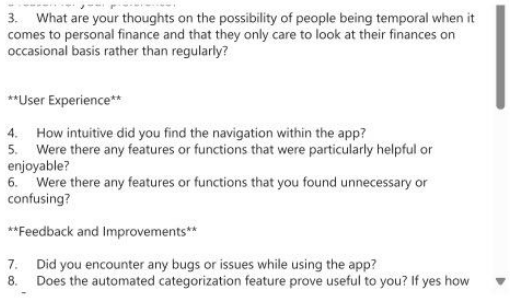
The number of participants here would range from 3-10 depending on the availability and all ethics requirements would be met prior to the interview & questionnaires. The recruitment method to get participants for this research involves anyone over the age of 18 through social media platforms like Facebook and Linkedin.

These are the tasks participants will have to complete;
- Using the App demo through online interview, (the website will be setup on my machine for the participants to access and demo):
1. Be asked to try uploading an already provided mock bank statement given to them and
2. analyse spendings on the analytics dashboard
3. try manually changing categories of certain transactions after being asked to filter them in a certain manner.
4. Exporting the updated transactions list as well as the analytics dashboard
5. ask specific questions about it to the chatbot. This is done as a user test to see if the flow is graspable to the participant.
6. Speak aloud their observations whilst performing the task requested above. These observations will be taken notes of for website improvement purposes.

- The questionnaire would be given to them right after the product demo:
1. They will answer 13 questions by filling the questionnaire and their submission will be anonymised .
2. These questions will be related to the User Experience after the demo, Feedback and improvements to the tool, and Personal Finance tool preferences that they have

Questionnaire Questions:

Personal Finance
1. Do you use any tool currently to see your personal finances or budget? If yes, which?
2. Is there a reason why you prefer the above method over the others? Provide a reason for your preference?



3. What are your thoughts on the possibility of people being temporal when it comes to personal finance and that they only care to look at their finances on occasional basis rather than regularly?

User Experience

4. How intuitive did you find the navigation within the app?
5. Were there any features or functions that were particularly helpful or enjoyable?
6. Were there any features or functions that you found unnecessary or confusing?

Feedback and Improvements

7. Did you encounter any bugs or issues while using the app?
8. Does the automated categorization feature prove useful to you? If yes how

9. Are you satisfied the proposed research falls under BUL's stated risk categories and the parameters of the approved Module Application?
You can view the Research ethics risk categories here - https://www.staff.brunel.ac.uk/research-ethics-risk-categories
*

- (•) Yes
- ( ) No

Supervisor Confirmation

Please read the following statement

- I confirm I have met with the student and discussed the research proposal in full.
- I confirm that I consider the proposed research is low-risk in nature and permissible under the parameters of the approved Module Application.
- I confirm that I have advised the student on the ethical aspects of the study design and their responsibilities when conducting research.
- I confirm that the student has been advised to read the University's Code of Research Ethics, the BUL research Risk Categories and other relevant documentation.
- I confirm that the student has the skills to carry out the research.
- I confirm that if the research involves human participants, the necessary documentation (Participant Information Sheet, consent forms etc.) have been checked and completed appropriately.
- I confirm that if the research involves human participants, the procedures for recruitment and obtaining informed consent are appropriate.

10. Please provide your Brunel email below to confirm you have read and agree to the above conditions *

Theodora Koulouri

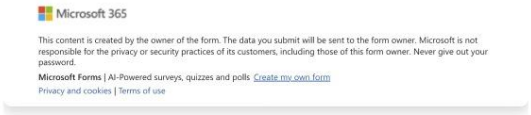
Student Declaration (to be completed by the supervisor on behalf of the student)

Please review the following statements

- I confirm I have met with my supervisor and discussed my research proposal in full.
- I confirm that the research will be undertaken in accordance with the Brunel University London Code of Research Ethics and the Brunel University London Research Integrity Code.
- I confirm that my proposed research is low-risk in nature according to the risk categories set by the University.
- I agree to notify my supervisor before implementing any changes to the agreed protocol/methods.
- I understand that if at a later date I decide to change my research study, this confirmation may no longer be valid.
- I understand that I may conduct my study only as agreed with my supervisor, and that any research activity of a medium or high-risk nature without the necessary approval may result in disciplinary procedures.

11. Please provide your Brunel email below to confirm your student has read and agreed to the above conditions *

theodora.koulouri@brunel.ac.uk


Microsoft 365
This content is created by the owner of the form. The data you submit will be sent to the form owner. Microsoft is not responsible for the privacy or security practices of its customers, including those of this form owner. Never give out your password.
Microsoft Forms | AI-Powered surveys, quizzes and polls Create my own form
Privacy and cookies | Terms of use

Appendix C Video Demonstration (Compulsory)

C.1 Link to the video

This is a YouTube unlisted link that demonstrates how my tool works alongside commentary to help explain the functioning.

https://youtu.be/lcAQr5SzPMo

Appendix D Other Appendices

D.1 Notes taken from User Testing Interview (Recorded for evidence)

1. **Is looking at bank statements hard?**
   - Participant 1; "I don't think its hard but I do think its inconvenient" "The table provides detailed everyday information, I do find it is hard to work with"
   - Participant 2; "Yeah, if there was something similar I would have liked it"
   - Participant 3; "Will have to sit down to fully analyse this" "I have but its quite like a tasking process so I prefer not to do it"
   - Participant 4; "Yes but briefly because they are so long its very difficult to analyse" "You can check day in day off sometimes to keep a track"
2. **What do you think of the analytics dashboard in contrast to the bank statement?**
   - Participant 1; "I think it's the bank statement but in a much more easier to read format"
   - Participant 2; "It would be helping me in better money management if I have this kind of an analysis so that's why I find it useful and its also showing the balance growth so it tells me that there's a surplus also and what is that amount of surplus so either I can plan to save that surplus or invest that surplus or carry it forward for another dynamic. This would help me review my expenses to see if there's anything I can cutdown to increase my surplus. I like the categorisation, it would help me to make a mental picture of how my financial health is and just by looking at it I can figure out which are the areas of the work and where I can go casual, I don't really need to look at the statement to analyse and even by looking at the particular statement I don't think I can get this picture and by having this particular tool I think it has helped me to have a broader idea"
   - Participant 3; "Easier to take in" "Let me just do it in 5 minutes and move on with my day"
   - Participant 4; "This is quite good, Like on a single page you can see all the things" "I don't have to context switch or go to another page"
3. **Analytics**
   - Participant 1; "I like this, because I can see how much I am making as well as I am spending, which is not something you can find on your bank statement or the app that you use for banking because I can only see how much money I got out of my account but I can't differentiate between income and spendings so I find this very helpful"
   - Participant 2; "I can create a folder for monthly report to see how it has grown or increased which you can't see just by statements"
   - Participant 3; "Quite quick with the way it gave me the entire analytics, normally I would expect a loading period before this" Likes the income vs expenses graph
   - Participant 4; Spend by week is good not available in other app, Analytics export use "Sometimes I like to keep physical copies on a monthly statement just to compare" "I can put 12 statements and have a view of the year"
4. **Export**
   - Participant 1; PDF exporting feature "I like that there's a pdf exporting option because that way it is easier to share."
   - Participant 2; Export feature of csv, "usually statements you get in csv files, but this kind of categorisation nd understanding your spending in better way, I am a financial planner I use budgeting while planning financial goals for my clients, if they had something like this they wouldn't have to manually check each transactions and see, automatically when we do the budget they can look at the category wise in this csv file and use it. They don't have to do the manual work anymore and this would be a good addition"
5. **Feedback**
   - Participant 1; Clicked grocery view to change category on transactions page, chatbot; "Able to answer questions but I would answer to be given first"
   - Participant 2;
     - "Mentioned daily transactions " maybe average can be done there or it can be changed to monthly" need up fix,
     - Clicking on individual category in graph should lead to transactions
     - Clicked button expecting something, clicked those can get color coded, also mentioned in different colour codings. Click on category to shortlist those and show those.
     - "In next version, could beautify it, working on visuals might help"
   - Participant 3;
     - Found it slightly difficult to see where the weekly spending for specific category is due to no hover
     - Chatbot; searched multiple times and it kept researching (bug fix)
     - Wants her answer summary to show at the top first.
   - Participant 4;
     - Feedback; colours different for bar chart and other chart
     - Asked if it can upload multiple bank statements and consolidate that.
6. **Other**
   - Participant 1;
     - **Overall spending + Line chart thoughts**"I like how there is an overall spending and the growth just so I can see my spending pattern and whether it is healthy or not"
     - **Thoughts on pie chart** "I like how easy this is to understand, do believe it is easier to understand than the bar chart solely because I am a little bit bad with numbers and identifying things."
     - **Thoughts on pie chart** "I love that I have this for visual reference but also this for more detailed reference right below"
     - **Overall navigation** "Overall it's really easy to understand I don't have any trouble navigating through the website.
     - **Manual categorisation** "Easy to change categories for sure"
   - Participant 2;
     - Chatbot, "Overall experience is good and is giving me that" "Any beginner person would like to know how their spending is going and where they can make changes so to that extent definitely this is good"
   - Participant 3;
     - Manual categorisation; "Personally wouldn't use it as much" And like analytics page better "Currently how my lifestyle is I would prefer fast"
   - Participant 4;
     - "There are features within some of the apps but they show you some sort of a categorisation but you have to do it in every app separately"
     - **Spreadsheet use** "I used to do it in the past where I would use it for consolidating multiple banks into one file, but not anymore"
     - **Would you want to use this tool on a regular basis as a long term solution** "Quite interesting because, when you're doing financials you want to do it on a web app rather than a mobile phone so I think the web app looks quite good"
     - "Very helpful for my major banks from where most of my transactions happens, I may have a different bank where I do the savings, so If I could bring all of the together, it could analyse a lot of things for me" "I might be using some other bank for my equity investments and dividends coming in, so it can give me a very rich overall financial statement"