DEVELOPING A MOBILE APPLICATION THAT ENABLES CONSUMERS TO REDUCE THEIR GROCERY EXPENDITURES IN PORTUGAL: THE BUSINESS CASE OF SUPERPOUPA

Adriano Villa Bascón – Building a User-Centric Front-End using OutSystems

By

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1.1.1 Abstract

This report investigates the potential of using a newly developed mobile app, SuperPoupa, to assist Portuguese consumers in mitigating the financial burden posed by increasing food prices caused by global events. Surveys have determined a willingness to adopt SuperPoupa into consumers' grocery habits, showing signs for an entrepreneurial opportunity. Core to the competitive edge of SuperPoupa is the self-build price-optimization algorithm to find the cheapest grocery basket. The report demonstrates the technical architecture and development process of the app's front- and back-end. Further deployment, research and development is necessary to evaluate the viability of SuperPoupa on larger scales.

Keywords:
Minimum Viable Product, Low-Code Mobile App Development, Back-End & Algorithm Development, Smart Grocery List App,

TABLE OF CONTENTS

1.1.2 List of Figures

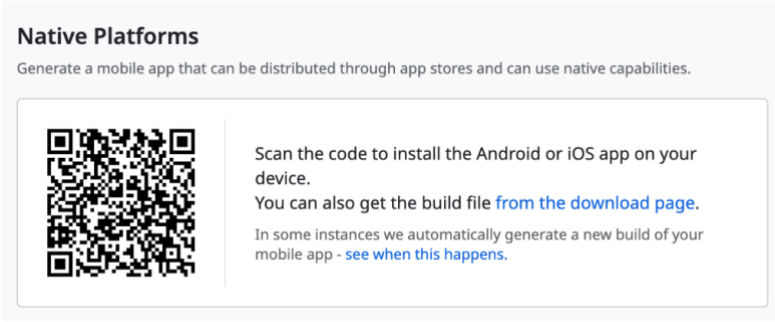
1.1.3 List of Abbreviations

Abbreviation	Definition
API	Application Programming Interface
CAGR	Compound Annual Growth Rate
COVID-19	Coronavirus Disease 2019
E.g.	Example Given
Et al.	Et Alia (and others)
Ibid.	Ibidem (of the same place)
i.e.	id est (that is)
IBM	International Business Machines
LCNC	Low-Code and No-Code
MVP	Minimum Viable Product
SPSS	Statistical Package for the Social Sciences

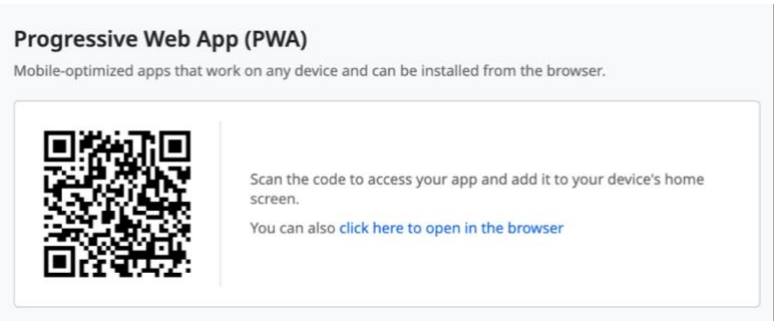
UI	User Interface
UX	User Experience

1.1.4 Access to SuperPoupa

For accessing and testing the mobile application using Android OS scan the QR code below. You will then be forwarded to a screen that allows you to install an .apk file on your device.



For accessing and testing the mobile application using iOS scan the QR code below. A new browser tab will open on your device. You can either use the app there or add it to your home screen.



Once the app is opened, you will need to register to access all its functions. After the registration has taken place, you will proceed to the login screen. Once logged in you should be able to see the start screen from which you can use all current features of SuperPoupa.

The currently available categories to search for are: *Água; Azeite; Banana; Batata; Brócolos; Carne de Vaca; Cebola; Cerveja; Couve Flor; Curgete; Cogumelos; Frango; Kiwi; Leite; Limão; Maçã; Manteiga; Manteiga de Amendoim; Ovos; Papel Higiénico; Pepino; Pimento; Tomate*

Following this link, a screen recording on how to use the application can be watched for further instructions: https://drive.google.com/file/d/1555EepgHTmhWkf1txrG5Hs9kc-re-KaW/view

EXECUTIVE SUMMARY (GROUP PART)

The global food crisis, characterized by rising food prices and disruptions to supply chains, has sparked growing concerns. These developments have contributed to a cost-of-living crisis in Europe, where stagnant wages and rising costs for essential goods and services have left many households struggling to afford their basic needs. In response to the below-displayed problem statement, this report demonstrates the potential for and the development process of a mobile application that allows consumers to find the best value-for-money grocery items and how this presents a viable business opportunity.

"Currently, consumers in Portugal experience an unprecedented spike in food prices due to inflation, leading to an increased loss of their net real income."

The literature revealed that COVID-19 and the war in Ukraine in rapid succession weighed heavily on global food production. Consequently, Portugal's food inflation reached 18,9%, equalling Europe's average, representing the fastest rise on record. As 97% of Europeans saw their grocery bills increase more rapidly, it created a new market of both lower- and middle-class households who, in response, are forced to reduce discretionary spending and prioritize essential products' price-quality ratio. Moreover, the lingering energy crises and Portugal's recent extreme weather conditions question the notion of food prices levelling out soon. As such, many believe that the identified market and the number of Portuguese households facing acute food insecurity will continue to increase over time.

The quantitative analysis of the Portuguese market showed that 93% of consumers feel the recent price surges impacted their spending potential. Additionally, 85% indicated their already conscious and directed effort to compare grocery prices before purchasing. As two-thirds of these consumers use their mobile devices to do so, the threshold for incorporating a

mobile solution into daily life was lowered. Also, participants who did not compare prices blamed this on the absence of effective solutions allowing them to, although 79% indicated their willingness to adopt such a solution, should it be available. As such, an opportunity presented itself with a digital application that would help the growing market identify the best value-for-money groceries.

This application, which was named SuperPoupa, limited users' product choice to categories (e.g., Milk) and subcategories (e.g., Skimmed Milk) when creating their shopping list, whereafter it would locate the cheapest items across Portugal's various supermarkets. The resulting list is what was coined "the cheapest path". This simplified two-step list-building approach played into the fact that many consumers now disregard the brand and opt for the best price-quality ratios. The solution's development was split into two sections: the back end, including the algorithm's programming in Python and the data model's architectural design, and the front end, including basic wireframe modelling and translating these into high-fidelity functional interfaces using OutSystems.

The resulting Minimum Viable Product, or MVP, was field-tested by 27 users. The findings suggest that inflation adversely affects consumers and reveals their positive attitude towards using SuperPoupa, due to its simplicity and potential for significant time and money savings. The approach taken by SuperPoupa thereby offers an entrepreneurial opportunity to provide real value to consumers in Portugal. In the future, introducing new features could further expand the target audience, address sustainability, health, and ethical considerations, and protect the application's ability to solidify its roots in the Portuguese grocery application market. However, further research and widespread implementation of SuperPoupa will be necessary to evaluate its potential and financial viability fully.

2 INTRODUCTION (GROUP PART)

2.1 Contextual Background

Concerns about a potential food crisis have been spreading worldwide over the past two years as global food prices have risen to alarming levels (Vos et al. 2022). The accumulation of multiple economic shocks, combined with extreme weather events, has disrupted global supply chains, exacerbating existing price trends and resulting in a European "cost-of-living crisis" (Tetlow 2022; Patrick and Pybus 2022). This crisis places millions of households under financial strain as prices for essential necessities spike while nominal wages remain stagnant not adjusting to the inflationary price environment (Ibid.). Moreover, due to lingering energy crises, the rising disparity is predicted to widen as time progresses (World Economic Forum 2022). Given that lower-income households spend as much as one-third of their disposable income on groceries (Wesley and Peterson 2022) the role of groceries in the development of living standards has become increasingly important: rising food prices have already caused the global number of people facing acute food insecurity to more than double to 345 million since 2019 (World Food Programme 2022). The ongoing deterioration of economic conditions in Europe suggests that living standards are likely to be further negatively impacted, emphasizing the necessity of prompt implementation of solutions (Patrick and Pybus 2022).

Information transparency– referring to the degree of visibility and accessibility of information (Zhu 2002) – delivered through technological advancements could provide support to consumers by allowing them to make more informed decisions, potentially lessening the financial strain caused by the cost-of-living crisis. Thus, this report investigates the potential of a mobile application, hereafter referred to as *SuperPoupa*, to assist consumers in Portugal in mitigating the effects of escalating food prices. Based on extracting price-data from three major

supermarket-chains in Portugal (*Continente, Pingo Doce, Intermarché)* SuperPoupa allows consumers to get the cheapest product combination of an inserted shopping list using a price-optimizing algorithm developed for this project. The application is therefore the proposed solution to the increasing challenges various households will prospectively face with the emerging new economic climate.

2.2 Problem definition

This report examines the difficulties posed by the current economic situation to customers and investigates how the implementation of a mobile application can enable customers to identify best value-for-money grocery items, thus helping them to adjust to the new economic environment. As such, a problem statement based on the "Five-W" methodology (Jia et al. 2016) helped to form a definition acting as a focal point for the research process and solution design of this work project.

"Currently (*when),* consumers (*who*) in Portugal (*where*) experience an unprecedented spike in food prices due to inflation (*why*), leading to an increased loss of their net real income (*what*)."

2.3 Objectives and Structure of this Report

As touched upon, this report aims to demonstrate that the identified problem gives way to a viable business opportunity. Thus, it begins by macro-analysing the influence of recent geopolitical prior events on the food industry. Then, it further supports the hypothesis that recent food inflation has caused many consumers to adjust their spending habits to mitigate its effects.

Secondly, the report will investigate the business opportunity that has arisen from the current gaps in the market and the shift in the economic climate. This section will introduce the

proposed solution SuperPoupa: a mobile application that allows consumers to get the best value-for-money grocery items. This report narrowed its focus on critical elements of the application's business model by drawing on insights gathered from the consumer survey in accordance with or contrasting literature findings. Accordingly, it provides a comprehensive overview of the solution's technical and conceptual development processes, including the instruments used. Lastly, while testing the application's first iteration, later called Minimum Viable Product (MVP), a product evaluation tool will assess how effectively users perceived the suggested solution to address the overarching problem. The report's conclusion will list its key findings and provide a prognosis for the future.

3 ANALYSIS AND DIAGNOSIS (GROUP PART)

3.1 Literature Study

It is essential to cast a view of the recent past to assess how cascading geopolitical events shaped the current economic climate surrounding the identified problem. The following section therefore explores how COVID-19 disrupted the global economy and analyses how the war on Ukraine prevented a post-pandemic economic recovery. The effects of resulting global inflationary trends on the Portuguese food industry will be analysed. Finally, the effects of the rising food prices and the behavioural response to it of both lower- and middle-class households will be covered.

3.1.1 Economic Sentiment Influenced by COVID-19 and the War in Ukraine

COVID-19 sent shock waves through the world economy, causing the past century's largest global economic crisis (WorldBank 2022). It did so by disrupting supply chains and crippling industries; thus, millions were left without employment (Dua et al. 2020). As is often the case, lower-income households were stuck hardest (CBPP 2021). Besides mortality rates,

these households disproportionally experienced food and housing insecurity due to supply-demand imbalances considering their limited budget to compete with other consumers (Parker et al. 2020).

As soon as the pandemic halted and governments alleviated peoples' and businesses' restrictions, governments and industries attempted to curb the pandemic's economic fallout (Hanselman 2022). They identified and supported initiatives that drove the economic recovery, promoted domestic spending, and protected local businesses from foreign competitors (Ibid.). Even so, the pandemic had positive repercussions. For instance, the virtual space of transactions and communication flourished into a novel economic asset, especially in third-world countries (Shang et al. 2021). Additionally, the pandemic forcibly drove entire industries, such as e-learning, logistics, and entertainment, to new levels of efficiency (Jensen 2020).

However, before the economy had time to think in future terms, Russia invaded Ukraine in February of this year (Kirby 2022). The invasion prevented a fragile post-pandemic economy from recovering and added to the supply shocks that had already struck the global supply chain (United Nations 2022). On an industry level, the war's effects propagated far and wide through trade, commodity markets, and financial relationships (Gourinchas 2022). Concerning the food industry, Russia and Ukraine exported about 30% of the world's wheat and 20% of the world's corn (Nelson 2022), reducing supplies significantly (Green 2022). So far in 2022, their prices jumped 37% and 21%, respectively, after already rising more than a fifth in 2021 (Al Jazeera 2022). As a result, households that struggled to come by during the pandemic were now faced with soaring food and energy prices (Smith and Bailie 2022).

Consequently, according to the International Monetary Fund and the United Nations, many will experience 2023 as a recession (Ward-Glenton 2022). While sizeable, they expect these effects not to be large enough to completely derail global recovery from the pandemic

(Ibid.). Historically, however, central reserves associate these two events' increased geopolitical risk with accelerated inflationary shifts worldwide (Caldara et al. 2022).

3.1.2 The Effect of Inflation on the Food Industry

Portugal's current annual inflation rate is projected to increase to 10.2% in 2022, whilst general food prices jumped 18.9%, representing peaks since May 1992 and June 1990, respectively (Trading Economics 2022). Moreover, although Brussels predicts the inflation rate to go down in 2023 (Euronews 2022a), the lingering energy crisis is expected to keep eroding Portuguese households' purchasing power and weigh heavily on food production and, thus, consumption (Ibid.). To make matters worse, Portuguese farmers recently experienced more severe and frequent droughts and extreme weather scenarios (Euronews 2022b), as well as surging prices of fertilizer, of which Russia exports one-third globally (Smith and Bailie 2022). These compounding hurdles facing the food industry's supply chain challenge the notion that food prices will decrease or even level out any time soon. In turn, it raises the question of how one can genuinely expect inflation rates to restore, given the food industry's supposed central role (Wallace 2022).

That said, it is interesting to consider the disparity in how social and economic turbulence affects different facets of society. It is well-established that low-income consumers are hit hardest for reasons discussed previously (Parker et al. 2020; Smith and Bailie 2022). Looking at the supply side, however, corporations seem to tell a much different story (Schweizer 2022). When faced with inflation, they have the luxury of choosing between different approaches that mitigate their exposure to financial risk (Ibid.). First, they can shield consumers and take a hit on their margins. Second, they can pass through and evenly share the pain with customers. Alternatively, they put an additional markup above and beyond the cost increase rate, padding their margins at customers' expense (Ibid.). Unfortunately for the customer, companies often

choose the latter, with half of consumer price inflation caused by this profit-driven approach (Bivens 2022).

As a result, market leaders are breaking year-over-year profit records in numerous industries. For example, Cargill, a commodity conglomerate, saw their most profitable year in 2021 (Ezell-Thomas 2022), while Coca-Cola, Hershey's, PepsiCo, and Mondelez, surpassed earnings estimates between 7% and 16% (Schweizer 2022). Also, when comparing recent price and wage increases, there is little to no evidence of a correlation between the acceleration in price inflation and wage growth in said industries (Schweitzer and Khattar 2022). Even so, three-quarters of middle-class households claim their wages are falling behind inflation (Uhl 2022). The Bureau of Labor Statistics affirms this claim in documenting inflation outpacing nominal wage growth for 18 months straight (Richter 2022).

Meanwhile, this year, the average CEO-to-worker pay ratio was 324 to 1, an increase of 23% from 2019, which doubled the inflation rate (Schweizer 2022). However, the above makes it seem as if corporations rationalize from an opportunistic point of view, perceiving recent crises as chances to line their pockets. Hence, instead of using their vast wealth and resources to shield their clientele from adversity, they proactively pass the largest burden to those with the most difficulty dealing with it (Bivens 2022).

3.1.3 The Effect of Food Inflation on Middle-Class Households

Where most have seen their grocery bills increase, those not severely affected often cannot fathom the burden this poses for low-income households. The reason is simple. Low-income families spend a much more significant chunk of their disposable income on food than the median household. On average, middle-class families spend 12% of their disposable income on food, whilst with low-income households, this number can be as high as 27% (Soll 2022). This discrepancy can be explained by a significant shift in spending patterns in the 20th century

(Chao and Utgoff 2006). During the 1900s, life's necessities, including food, were relatively much more expensive compared to today, leaving little room for expenditure on additional goods and services (Ibid.). On average, families spent 54% of their income on food and clothing in 1901, which dropped to a mere 14.2% in 2020 (Bureau of Labor Statistics 2022). This sharp decline led to a massive reshuffling of middle-class budgets, carrying over large chunks to transportation, insurance, and discretionary spendings such as eating out, vacations, and entertainment (Soll 2022).

For now, the data from McKinsey's latest European Consumer Survey carried out this October indicate that households are gradually reversing this process. As 97% of people experience their groceries becoming increasingly expensive (Bazzoni et al. 2022), "consumer pessimism is at an all-time high in Europe, with rising prices the number-one worry" (World Economic Forum 2022). Both are not entirely out of the ordinary, as Portugal's earlier mentioned 18,9% food inflation equals Europe's average, which is the fastest rise on record (Alderman 2022). More than 80% of consumers indicate to have altered their grocery shopping behaviour, and value for money and promotions seems fundamental to those changes (Bazzoni et al. 2022). As such, consumers' strategies include looking diligently for items on sale and, most of all, trading down – that is, they buy the store brand (Vardhini 2020). Every category except fruit and vegetables, meat and fish, and alcohol has seen more than half of European consumers switching to those cheaper store brands (Bazzoni et al. 2022). Even so, almost one-third have entirely switched to alternative stores, often in the form of discount retailers (World Economic Forum 2022). Regarding discretionary expenditure, cinemas in Germany, France, Italy, Spain and the UK saw a drop in revenue to 59% below pre-pandemic levels in September and October (Palmer 2022). Although not to this extent, numerous industries have experienced

similar trends, as two-thirds of consumers indicate to cut out jewellery, apparel, and consumer electronics expenditure in the coming season (Bazzoni et al. 2022).

3.1.4 The Effect of Food Inflation on Low-Income Households

Nonetheless, where middle-class families grew into this position from which concessions could be made, the 20th-century wealth redistribution mainly left low-income families behind. As they kept devoting most of their income to food and shelter (Soll 2022), these households still possess little to no discretionary spending to cut back on to free up funds for food (Gennetian et al. 2021). Therefore, as a last resort, over a third of European consumers, including half of the millennials, withdrew money from savings to cover their expenses in the last three months (Bazzoni et al. 2022). Even prior to the recent turmoil, in 2020, 9.8% of the Portuguese population had already experienced food insecurity (Aguiar et al. 2022). In layman's terms, this can be defined as being without reliable access to sufficient, affordable, and nutritious food (Bahn and Bahn 2021). This uncertainty has a toll on people beyond 'merely' insufficient funds. A study at Sacred Heart University, Connecticut, found that food insecurity causes people to consume less protein and vegetables and rely more on sugary and fatty foods (Solis-Moreira 2022).

One explanation is that as inflation gradually pushes more expensive healthy produce out of reach, highly processed foods become an attractive alternative since they are more affordable and have a longer shelf life (Drexel University 2022). As such, health professionals fear prolonged inflation given that these products increase the risk of diet-related diseases in the long run (Fu 2022). Furthermore, in association with the consumption of these unhealthy products, a United States national study found that the mental strain caused by food insecurity is linked to a 257% higher risk of anxiety and a 253% higher risk of depression amongst low-income households (Fang et al. 2021).

Including Portugal, the global number of those facing acute food insecurity has soared from 135 million to 345 million since the pandemic's start (World Food Program 2022). Moreover, given the risk of food prices rising even further through climate change and the continuation of war, the number of people facing such physical and mental hardship is prone to increase (IGD 2022). Therefore, a tool that allows these consumers to save money on grocery expenditures and prevent or alleviate food insecurity could be relevant. However, such drastic changes are challenging to implement within rigid food corporations, especially considering that, in this case, some seem to be at the core of the problem (Soll 2022). Accordingly, the following section will explore the feasibility and necessity of a solution from the consumer's perspective as food prices continue to rise in Portugal (Donn 2022).

3.2 Empirical Research

Developers create mobile applications to provide users with an improved and more engaging way of accessing information, services, and products (Kim et al. 2013). Thus, placing users at the center of an application's development processes is a crucial principle of mobile application design (Uddin 2022). Such user-centricity involves understanding users' needs, preferences, and behaviours and designing products and services that meet those needs (Ibid.). Therefore, companies must strive to uncover and comprehend these data for the application to provide perceptible value (Ibid.).

Customer surveys are helpful in this process, as they provide insights into areas the app development team may need to explore. Thus, to understand customers' perception of Portugal's grocery industry, a survey was conducted as part of this project. This survey investigated various aspects of a potential solution to combating rising grocery prices through a mobile application. These include participants' perceptions of price increases on grocery items and the current usage of technology to optimize their shopping routine. As the overarching problem

was now clearly defined, the survey's secondary focus was on the needs and expectations of users arising from this problem. These included participants' willingness to incorporate new tools into their shopping routine, preferred features they would like to see in the said tool, and willingness to pay for such services. These findings provided a lens through which the application's business model was conceived and allowed to pinpoint different use cases with varying demographic-& socioeconomic backgrounds. The latter enabled a deliberate and user-oriented application development process.

3.2.1 Research Instrument

The survey was undertaken from the 9th of November until the 9th of December 2022 and included 31 questions designed to gain insight into customers' needs and areas of difficulty. The survey was published in both English and Portuguese to improve its reach in Portugal. Although the sample size of 74 responses does not provide statistically significant results, the findings are an essential indicator for ensuring user-centricity in app development. The following demographic statements about the survey participants represent the consecutive findings.

The survey participants were predominantly female (71%), and the majority were aged between 25 and 34 (48%). A vast share of participants was from Portugal (39%), Germany (36%), and other European and non-European countries. Most participants were full-time employed (47%), while the other more significant portion were students (37%).

3.2.2 The Perception of Inflation and Its Effect on the Reduction of Real Net Income

Question four to six explored participant’s perception of the current economic situation. The results showed that 62% of participants felt that their budget for covering basic needs was adequate, but 86% reported feeling an increase in prices and the impact of inflation on their spending potential. In the Portuguese sample, 92% reported a decrease in disposable income

due to inflation, with 36% specifically citing rising grocery prices as a major concern. These findings suggest that solutions to reduce grocery spending could be beneficial for consumers.

3.2.3 Users' Willingness to Adapt New Technologies for Reduced Grocery Spending

Question 10-13 and their associated follow-up questions explored participants' shopping habits and their pre-existing use of technology-based tools to improve their shopping experience. The results showed that 49% of respondents compared prices before making a purchase, with a majority of these being Portuguese participants (85%). These results suggest a potential need for technology-based solutions in the market, as all respondents cited the lack of convenient solutions as the reason for not comparing prices.

Furthermore, 79% of respondents indicated that they would be receptive to such solutions, with the majority expressing their interest in an application that helps them save money. However, 21% were unwilling to use such an application, citing concerns about engagement, time and effort investment, and loyalty to a single supermarket. All in all, these findings suggest that the Portuguese market may be particularly receptive to the proposed solution, as there is a lack of existing solutions and a potential competitive advantage in addressing this void.

3.2.4 Assessing User's desired Features and their Willingness-To-Pay for it

The survey's final section explored participants' preferences for additional features in a proposed mobile application and their willingness to pay for such a product. The results showed that 32% of international respondents were interested in a virtual piggy bank, while 36% of Portuguese respondents preferred the ability to turn loyalty points into coupons at supermarkets. These findings suggest that forming strategic partnerships with retailers could be beneficial for the success of the proposed application.

Further, although 59% of participants showed a willingness to pay for the application, the remaining 41% cited a need for more trust in the promised savings. In addition, reluctance to pay could also stem from the paradoxical implications of paying for a solution whose sole purpose is to help consumers save money. To address these concerns, the offering of a trial period and incorporating advertising revenue instead of charging users directly may need to be considered. Together, these findings provided important insights into potential revenue models and user adoption barriers.

4 SOLUTION DEVELOPMENT (GROUP PART)

Considering the time constraints of the work project, the goal was to develop SuperPoupa in its most rudimentary yet functional form, otherwise known as MVP. This product has enough features to attract early-adopters and allows developers to collect feedback and validate learnings about customer interaction with minimum effort (Münch et al. 2013). Further, it allows to optimize the solution's core function and enriches it with additional functionalities without spoiling resources down the line (Lenarduzzi and Taibi 2016). This section will lay out the MVP's entire development process split into two prime sections: back-end and front-end development. Each stage and chapters within will highlight its importance, what best practices were applied and how this was done, any limitations that were encountered, and any other relevant findings. All findings are supported with relevant graphics so the reader can visualize the progress made between each stage.

To develop SuperPoupa, investigating all possible solutions to technical problems and architectural design questions has a crucial initial step. It required taking into account all variables and constraints to meet the development objectives while creating a sustainable and scalable home for SuperPoupa. Best practices of agile development and software engineering

were implemented wherever possible to construct the necessary self-build technical components, including a data model foundational to the external database with scraped supermarket data, as well as an Application Programming Interface (API) containing SuperPoupa's "Cheapest Path" algorithm to communicate between the front-end and back-end. The back-end was conceptualized prior to the front-end and thus is presented first.

4.1 Front-End Development (Group Part)

In alignment with the project objectives, identified user needs and technical requirements, as well as the back-end architecture and data model, the next step was to translate these elements into an end product by building a user-centric front-end. Front-end development aims to design and construct the user interfaces of applications and webpages in a clear, simple, and fast-to-use manner (Codesido 2009). The front-end of an app combines all design elements with the functionalities of the app and allows the user to interact with it. It is the layer of design that is visible to the user and, therefore, a critical factor in creating a positive user experience.

4.1.1 Technical Landscape for Building Mobile Apps

Traditionally, the development of an application's front-end traditionally materializes through programming languages such as Java, a popular choice for Android OS, and Objective-C or Swift, frequently used for iOS (Fireart 2022). However, the methods used to construct applications have been limited to those with the skills to write computer code. Luckily, this has seen a change since so-called low-code and no-code (LCNC) solutions gained widespread popularity by lowering the barriers to who can develop an application. For SuperPoupa, use of LCNC technologies was made by working with the OutSystems development platform. Hereby, a functioning app could be built in less than 100 days by a team of non-developers.

4.1.1.1 LCNC Technologies

LCNC is a software development approach that allows developers and non-developers, otherwise known as citizen developers, to create software applications with little to no traditional programming. This technology lets users quickly build and deploy sophisticated applications by offering graphical user interfaces (GUI) instead of requiring classical coding interfaces. Next to the GUI, LCNC tools also consist of a library of pre-built components, screen templates and tools that allow users to drag and drop components to build screens and complex functionalities. The first versions of this technology can be dated back to Apple's HyperCard in 1998 or Microsoft's Visual Basic in 1991 (Tozzi 2021; IvyPanda 2022). Since then, various tools have been released for enterprise and personal use.

Albeit simplifying the development process, low-code solutions still require some knowledge about traditional programming compared to purely no-code solutions (Tariq 2021). However, with more and more powerful solutions being offered, boundaries between these two are blurred, which is why they are often referred to as Low-Code/No-Code Solutions (Hurlburt 2021). Their widespread adoption of this technology enables organizations to greatly accelerate the development process, quickly building, deploying, and maintaining applications while reducing deployment and maintenance expenses (Elshan, Dick-haut, and Ebel 2023). A 2022 Forrester report states that large organizations can benefit from a return on investment of 506% within six months by implementing OutSystems (Forrester 2022).

4.1.1.2 The OutSystems Development Platform

OutSystems is a low-code development platform that enables developers to create, manage and deploy enterprise web- and mobile applications using a graphical user interface. OutSystems offers five main components: The platform server, Integration Studio, Service Center, LifeTime, and Service Studio. The OutSystems Platform Server is a multi-tier server

architecture that provides the infrastructure for developing and running the applications and services built within OutSystems (OutSystems n.d. a). Integration Studio extends OutSystems' functionalities by offering to connect with various external tools and software solutions. This was used this to integrate the external database. Service Center is a platform server management application that helps monitor and administrates an app's server. For this project, Service Center was used to monitor the communication protocols between OutSystems and the Flask API. While Service Center manages a single environment with its corresponding modules, roles, and settings, LifeTime is not environment specific. LifeTime helps manage several environments, security settings, and infrastructure on a higher level (OutSystems 2020). Lastly, Service Studio is the visual development environment in which the development and deployment of OutSystems Apps happen. Service Studio offers a powerful and easy-to-use GUI with all the features needed to build the front-end of SuperPoupa, including complex workflows.

4.1.1.3 Traditional vs. LCNC Front-End Development

Low-code front-end development and traditional front-end development possess the same objective of creating a seamless und user-centric experience. However, the methodology utilized in each case varies significantly. Low-code systems typically include an already existing infrastructure. In Service Studio's case, this infrastructure comprises the Processes, Interface, Logic, and Data tabs within the GUI. Additionally, Service Studio provides the capability to implement modular blocks that can be effortlessly inserted and employed across multiple screens. Moreover, the visual elements, including screens, blocks, and widgets that, in sum, make up the interfaces, are organized into hierarchical widget trees. This allows developers to find the respective elements when needed quickly. Within the four primary tabs, elements are already organized into corresponding folders in which new elements can be added. This improves the speed at which components can be found and relationships understood.

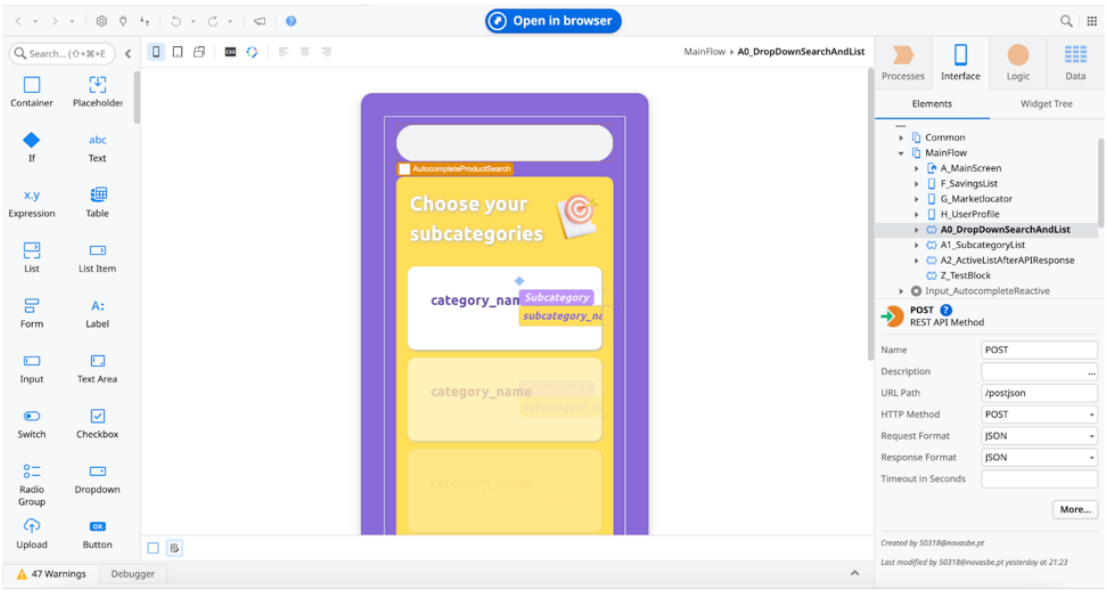
Furthermore, design aspects such as global styles for buttons, colours, backgrounds, or fonts are also already centrally organized by OutSystems enabling users to make changes that affect the entire application without having to adjust single elements. In traditional front-end development, the developing team must set up all these structures and relations from scratch. The bigger an application, the more complex the code becomes and the more critical a proper structure is. This not only takes time but is much more prone to errors.

Service Studio facilitates accelerated development, testing, and debugging – the process of identifying and rectifying errors in the application. To prevent bugs from happening in the first place, OutSystems constantly runs error checks in the background while using building components and logics in the GUI. These errors can include parsing errors, data type errors, missing values, etc. All these are errors that, in some way or another, disturb the general logic of the application. Therefore, if such errors occur, OutSystems notes them within the error console and does not allow the app to be published unless the errors have been removed. This dramatically reduces the risk of publishing a faulty app. With the 1-click publish process of OutSystems, apps can be continuously and rapidly tested even after minor changes have taken effect. In the testing environment, all features of the app that are functional on a web or mobile browser can be tested. This helps to find design- or layout discrepancies and functional errors quickly. If a flaw in the execution of the features, otherwise known as a bug, has been encountered, users can pin down the problem using the debugger. This tool provides an interactive, step-by-step debugging console that allows developers to trace, analyse, and debug an application's action flows. By allowing developers to check the values of variables and view the results of all operations, the root of bugs can be found at an increased speed.

Figure 1 - Service Studio Graphical User Interface

4.1.1.4 Limitations of the Front-End Development with OutSystems

With all this being said, OutSystems may not be suitable for all users or situations. Despite the presence of a well-developed framework, Service Studio remains challenging to comprehend due to its intricate nature, necessitating a significant amount of time to become familiar with the system. OutSystems is aimed at enterprises and IT professionals rather than non-developers, meaning that a comprehensive knowledge of development terms and concepts such as variables, loops, attributes, events, actions, relational databases, CSS styles and HTML structures is necessary to use the low-code platform.



Furthermore, many learning resources and feature documentation requires some understanding of development. This strategy by OutSystems also reflects on their pricing structure. While popular no-code apps such as Bubble (Bubble n.d.) or Flutterflow (FlutterFlow n.d.) start at 25$/month and 30$/month, respectively, for a paid plan, OutSystems' cheapest paid plan starts at over 1,500$/month (OutSystems n.d. b). These considerations must be made by individuals or smaller companies when thinking about developing with OutSystems. Luckily, Nova SBE allowed to build SuperPoupa using the university environment within OutSystems.

4.1.2 Main Feature Development of SuperPoupa (Adriano Villa Bascón)

Using the Figma wireframes as guidance for the development within OutSystems, the decision was made to work in an agile fashion that comprised two-week cycles of goal setting and iterating. It was concluded that this is the right approach to stay flexible and adjust goals when-ever needed. Goals were mainly tied to features, blocks, or screens that were planned. Each of those was based on user stories and narratives which have been agreed on beforehand.

4.1.2.1 Working Style and Frameworks

User Narratives

In web development, user narratives, also known as user stories, are simple descriptions of a feature told from the user's perspective. They are used to inform the development of a website or web application and to extract what features potential users would benefit from an application. More extended versions (Figure 12) involve details about the potential user persona and can imply many potential features. From them, shorter, more precise user narratives can be distilled. Shorter versions usually focus on one specific benefit of a feature (Figure 13).

Figure 2 - Longer Versions of SuperPoupa's User Narratives

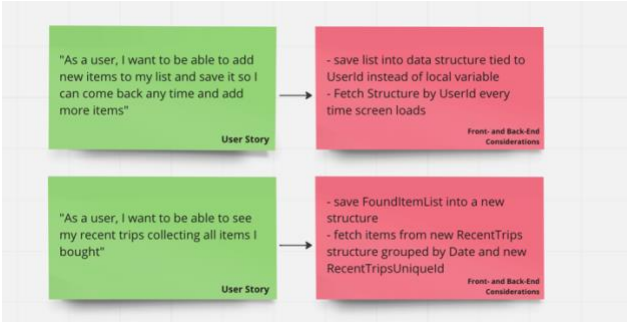


Figure 3 - Shorter Versions of SuperPoupa's User Narratives

Specific implications for the back-end and front-end development can then be drawn from it. Furthermore, user narratives help prioritise features by turning abstract technical descriptions of features into comprehensible and relatable descriptions.

For SuperPoupa, first versions were more extended versions of user narratives about various potential users' perspectives. From there, shorter versions have been extracted that could directly be translated into to-dos. Then, with the overall goal of the app and the user narratives in mind, the features planned have been sorted into two dimensions: *Impact on overall functionality and user experience* as well as *workload*, defined by the amount of time and level of difficulty to build. The two dimensions were further separated into four quadrants and assigned the features, accordingly, as shown in Figure 14. This helped to break features down into levels of priority.

1. High priority - implement these features as soon as possible. These features are characterised by their high contribution to the app's overall goal and low barrier of implementation.

2. Medium priority - implement when higher priority features are done or on hold. These features are still essential for the app's overall goal, but an MVP could work without them.

3. Low priority - implement these features only if resources allow. These features can add value to the user experience or app performance but are not essential to them.

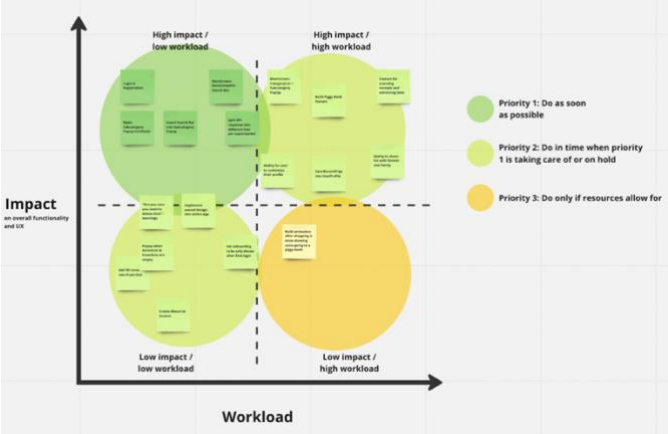


Figure 4 - Prioritization Quadrant for SuperPoupa's Features

Thanks to user narratives' simplistic nature, the value of features can be better communicated to various individuals within an organization. Based on the same user story, developers can build features, designers can build user experiences, marketers can layout campaigns, writers can create slogans, and managers can make relevant decisions. Basing the development process on user narratives was, therefore, a crucial project component given that this project is both technical and entrepreneurial.

Two-week Iteration Cycles

Execution of the plan was conducted in intervals of two weeks. Initially, the vision of the product contained a multitude of features and screens. Reorganizing the features and screens into the prioritization quadrant enabled adaptation to the potentiality of the limited timeframe. Subsequently, the primary functionalities that were deemed of the greatest value were emphasized. This included registration, a log-in function, and the main screen where the app's primary function, the set-up of the grocery list, would take place. The iterative nature of the agile technique enabled high levels of adaptability and the capacity to swiftly alter objectives when necessary. Combined with the speed with which OutSystems facilitates the process of constructing, publishing, and assessing applications, it was possible to continually

refine ideas and adjust objectives if required. Development of SuperPoupa's Features

Analysis of the survey results revealed that an application should be developed which possesses features that facilitate the user's adoption of it. Subsequently, user narratives and a prioritization quadrant were utilized to identify the key features that must be incorporated into the minimal viable product (MVP) of SuperPoupa.

4.1.2.2 Priority-One Features

Registration and Login

The initial two features featured were the registration and login screens. OutSystems offers a login screen with every new project, containing the mandatory workflows. Thereby, the registration was built upon a template with some modifications. This enabled a significant saving of time and effort, which could be utilized on other important, non-existent features. SuperPoupa's main feature could be used without the need for signing in; however, later features necessitated the use of a distinct user identifier. These features included the capacity to store a list without it being erased upon closure of the app, a user profile displaying a username and email address, and the capability for a user to view their past trips saved in their profile.

Dropdown Autocomplete Bar

A central element of the grocery list set-up is the auto-complete dropdown search bar that anticipates what a user is looking for based on the characters that have been typed in. From a user perspective, it is crucial to quickly find the desired categories to add to the list without scrolling through a long list of categories. This ability is not only convenient but essential for quickly setting up a grocery list, which plays into SuperPoupa's main value proposition. Luckily, OutSystems offers a widget called "Input Autocomplete". This helped quickly establish the feature. As can be seen in figure 15, the dropdown autocomplete search bar was,

thereby, the first feature that was built. This element fetches its list of options (items) from the integrated database's 'categories' entity. Therefore, users only need to start typing the main category (e.g. 'Tom') and then be shown all the corresponding options (e.g., 'Toma-to paste', 'Canned tomatoes, etc.). Once a dropdown item is clicked, it is added to a list that appears below. This can be repeated as many times as needed. Furthermore, main categories can be added to the list more than once, as each category needs to be specified with a subcategory. This allows users to add two or more subcategories within the same main category, e.g., "Gouda Cheese" and "Brie Cheese".

Interactive List with Subcategory Picker

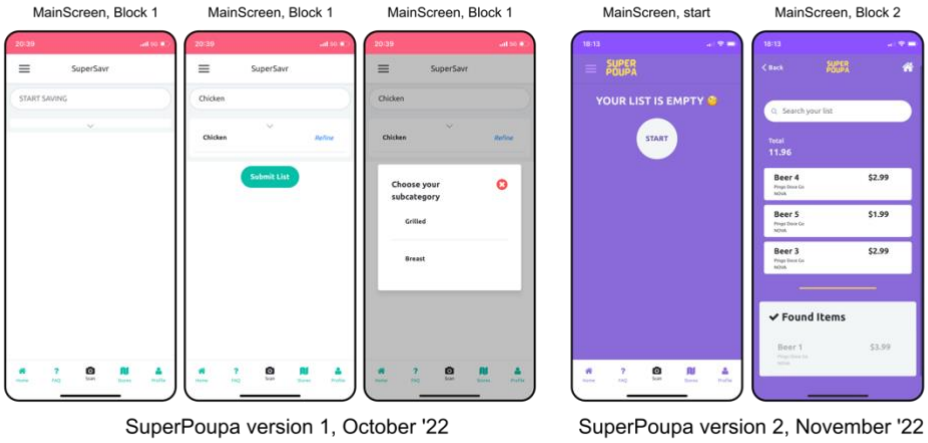


Figure 5 - SuperPoupa's First and Second Version

The second element of the list-building block is the interactive list widget below the dropdown autocomplete search bar in which selected items are collected. As mentioned above, this list consists of the items the user has chosen from the dropdown. Once clicked, a new list item, or row, is added to the list. This new list item first contains only the chosen main category (e.g., “Cheese”). It then requires further specification by adding a subcategory using the subcategory picker. Having to choose a subcategory is a necessity for the algorithm to work. It narrows down the range of entries (or products) that need to be searched upon within the

database. However, it also helps users be more specific about what they want to buy. Without further specification, the result for, e.g., the cheapest cheese could stretch from slices of gouda to cream cheese. In chocolate, the results could stretch from chocolate bars to hot chocolate powder. Therefore, it was clear that although the goal is to make the list-building effort as minimal as possible, no value can be generated if the user cannot further specify their needs. A third step to further specify might need to be considered at later stages. The argument remains, however, that consumers who are sensitive to price may benefit more from the time and money saving offered by SuperPoupa, compared to the time that would be required to create a thorough list.

Once the subcategory button is clicked, a pop-up window will appear on the screen. This pop-up holds all the subcategories a user can choose within the clicked category. The user can then select one subcategory, which will trigger the pop-up to close and the subcategory picker to be replaced by the chosen subcategory. This needs to be repeated for many category-list items on the screen. The list can be submitted only when a subcategory has replaced all subcategory pickers. If the user wishes to change a subcategory, the chosen subcategory must be clicked again. This will reopen the pop-up, and another subcategory can be chosen to replace the first one. Does the user try to submit before all categories are assigned a subcategory, an error message will be shown. Therefore, it is crucial that the user is only able to submit the list once all the information needed by the algorithm is present.

Furthermore, by swiping from right to left on category list items, entries can be deleted from the list. Unless the user submits the finished list, that list will stay intact for as long as it is not deleted or submitted. From a user experience point of view, not resetting the list is crucial as new ideas on what to buy can occur at any time. Therefore, the user can keep adding new items to the list until he or she is ready to submit the list and go grocery shopping. This list is saved into a data entity in OutSystems. Whenever the user is logged in, this entity is fetched, filtered by the corresponding UserId, and shown on the main screen. The development of this feature necessitated the restriction of full use of the app to only registered users. Figure 16 shows SuperPoupa's latest version.

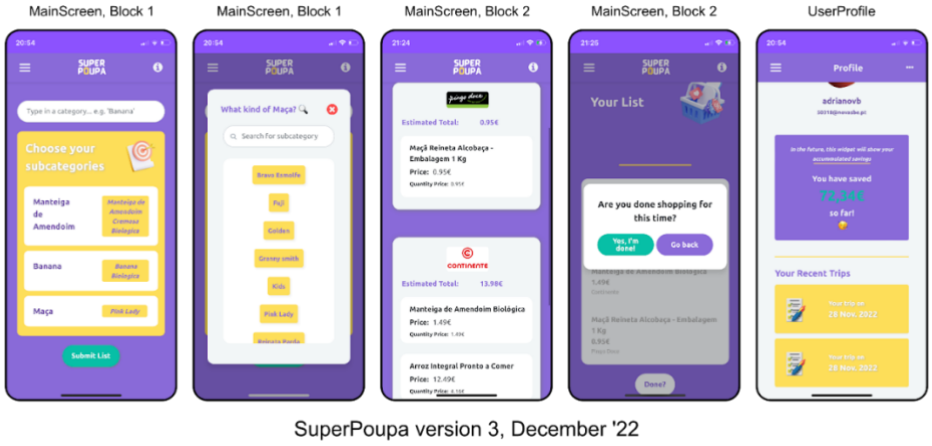


Figure 6 - SuperPoupa's Current Version. From Left to Right: Dropdown Search Bar and Category List, Subcategory Pop-Up, API List Split by Supermarket, Finish Shopping Pop-Up, Profile with Recent Trips

API Reponse, ActiveList & FoundList

This feature is what SuperPoupa is about: getting a price-optimized list of products and where to get them based on a list of categories that is fast and easy to assemble. Because the functionality for this feature was built outside of OutSystems, the approach to assembling this feature was different. Until then, all application features were built in OutSystems using actions, otherwise known as workflows or action flows. These include the workflows needed to log in,

register, search for items, select them, open pop-ups, and select subcategories. The distinction of this feature required the understanding of the concept behind APIs, how to build one, and how to connect OutSystems and a python script through an API. The challenge on the OutSystems side was building an action flow that gathers the information from the grocery list, triggers an API call, submits the information, obtains an answer by the python script, and then displays that information in a new list. The solution for this involves two separate blocks built into one screen. Block 1 contains all the required features before submitting the list via API. Block 2 displays the final shopping lists after retrieving the correct products from the external database using an SQL query. Figure 19 shows the action flows from start to end in a simplified visual.

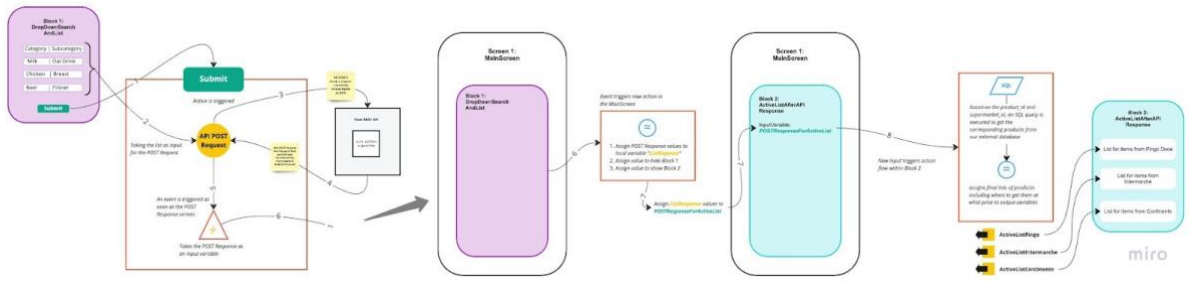


Figure 9 - Process Flow Between Block 1, Flask API, and Block 2

The upper section of Block 2 consists of the final grocery list containing the specific products separated into supermarkets where they can be found at a given price. Each active list also displays a total sum for the products in that list. This sum adjusts to items being deleted. An item can either be deleted by swiping it from right to left or marked as found by swiping left to right. If an item is marked as found, it gets removed from the active list and displayed in a list below called *FoundList*. This list gathers all found items regardless of the supermarket they were located. If an item has been moved down by accident, the same left-to-right swipe

action will move it back to its original list. Once no items are left in any of the active lists, a button appears below the FoundList. This button allows the user to finish the trip and save the items in the FoundList into a new data entity called *RecentTrips*.

4.1.2.3 Priority-Two Features

Recent Trips

Having constructed the features within the priority-one quadrant, features in the priority-two quadrant were addressed. This feature had a substantial workload with a moderate impact. Nevertheless, at the point when the decision was made to develop this feature, sufficient experience with OutSystems was attained in order to create it quickly and effortlessly. Recent Trips are defined as the FoundList that a user submits after finishing a grocery run. The items submitted are filtered by the UserId as well as a unique identifier per trip. Those trips are fetched and displayed in a list whenever a user visits the user profile. Each row consists of a finished trip with the corresponding date on which the trip was made. Once a row is clicked, a pop-up window opens up. This pop-up contains all the items, their prices, as well as the total sum and the date from the trip that has been selected. This can be repeated for all trips in the user's history.

4.1.2.4 Feature Pipeline and Future Outlook

It was previously noted that the pipeline of features for SuperPoupa was extensive. Not all features within the prioritization quadrant were achievable given the scope of the thesis. Nevertheless, features were gathered which were not presently feasible but are highly promising for future development.

4.1.2.5 Choosing Between the Cheapest Path and One-Stop Trips

First, users can opt for the cheapest list possible, the current default setting. This list is purely optimized by price and what was earlier referred to as the "cheapest path". It will,

therefore, most likely result in several lists, one for each supermarket, that offer the cheapest products for the desired categories. If, by coincidence, all products in the desired categories have the lowest price within one store, the cheapest list equals the cheapest One-Stop Trip.

Second, they can opt for the cheapest One-Stop Trip. This list will show all products within the desired categories within one supermarket at the lowest price. However, as a result, this is not necessarily the overall cheapest path.

Third, users can get the cheapest list for the closest One-Stop Trip. As such, further options for One-Stop Trips will be offered ranked by the proximity to the user's location. This, too, can be the cheapest One-Stop Trip or the cheapest path while being the closest store, as neither is mutually exclusive.

Local Stores & Store Selection

By now, the lists are constructed by optimizing price and location. To be able to offer more lists and a more individualized experience beyond this, a feature for store selection will be implemented. Users can share their location or set an address as their desired location. From there, they can leave all stores selected by default or pick stores they want to exclude from the results. This would allow users to exclude stores they dislike and do not have access to because there might not be parking spots, but also, e.g., exclude all non-organic stores. Of course, this could impede the availability of the cheapest path; however, it could still be the most cost-effective list for a user's specifications, which could be even more beneficial for specific shoppers.

User Preferences for Groceries

On top of store preferences, another possibility for individualizing the experience will be introduced. With the User Preferences feature, users can filter all products considered by the algorithm by personal preferences such as "Organic", "Plant-Based", "Gluten-Free", and "Nutri

Score Rating". This might seem like a nice-to-have but could potentially attract new groups of users who do not depend on saving on groceries but, when given the possibility, will still look for the cheapest option within their preferences. Users would select this when performing the onboarding. From there on, they have the same interface to build a categories/subcategories list, but the algorithm will already know which products to include or not include.

Favorite Items

Further personalization can be achieved by enabling users to mark categories, subcategories, and specific products as favourites. The benefit of this feature is twofold. First, users will find their favourite items easier within the search. Has a user, e.g., marked "Cherry tomatoes" as a favourite, that item will be shown on top of all others when typing "tomatoes" into the main search or "cherry" into the subcategory search for tomatoes. This speeds up the list-building process even further. Second, by gathering this information, personalized recommendations can later on be made to users. A future home screen version could then, e.g., display when favoured products or products within favoured categories are on sale. A history of what users prefer and favourite also helps further improve the product for various target groups. Historical data on prices would also allow users to understand the price histories of their favourite items.

Coupons

The survey results suggest that the option to exchange points gathered by using the app for coupons to redeem at supermarkets may be an important factor in appealing to Portuguese users. Implementing this feature would allow for a more concrete demonstration of the advantages that SuperPoupa provides, thus making the app's value more tangible. However, given the complexity of the technical implementation and the need for collaboration with supermarkets, this feature is likely to remain a distant prospect for the foreseeable future.

Re-Submit Recent Trips

Another option to simplify the usage of SuperPoupa is to offer users the option to re-submit the exact categorical specification of a recently completed trip. This could help users who e.g., do weekly shopping, in which most of the items are the same, to have an even faster and easier experience using SuperPoupa.

Shared lists

Introducing a collaborative list-sharing feature will be a crucial element of SuperPoupa. This technology will enable families, housemates, friends, colleagues, and other groups to organize and carry out assignments. Numerous grocery list applications have already implemented this functionality (Brown 2020), and its presence is likely to be a significant factor in how users choose among the available apps.

Create various lists for different occasions

This proposed feature would enable users to efficiently manage their shopping lists by allowing them to save and work on multiple lists. This is beneficial for users who need to purchase items for multiple purposes, such as personal and business-related items, and for those who need to make multiple trips to the store for different occasions, such as weekly grocery trips and dinner parties.

Piggy Bank & Savings Account

Some users reported a reluctance towards paying for SuperPoupa. Therefore, generated savings must somehow be made more tangible to users. A *Piggy Bank* feature will allow users to collect the savings they have made into their profile. This works by adding savings to an accumulated savings account whenever a user submits a FoundList. This will allow users to track how much money they have saved over time using SuperPoupa. This feature is crucial for emphasizing the value of SuperPoupa. However, a challenge that must be confronted when

attempting to quantify the savings achieved through this feature is determining the benchmark that will be used for comparison. This benchmark will be essential for determining the true magnitude of the savings customers can expect.

Thus far, the savings quantified by SuperPoupa have only been represented digitally on the application's user interface and are purely hypothetical. Whether or not these savings are actually generated is beyond the reach of SuperPoupa. An add-on to the Piggy Bank feature could address the issue by enabling the transfer of money from bank accounts, credit cards, or PayPal accounts into SuperPoupa. By doing so, users would be further aided in saving money. Existing fintech applications such as Revolut feature dedicated vaults to which users can add money in order to save up for specific goals (Revolut, n.d.). From the user's point of view, this feature has the potential to create meaningful cost reductions. From the business perspective, however, this may represent a vast financial cash flow opportunity if a sufficient number of users can generate significant savings saved within SuperPoupa, always considering that users would retain the ability to withdraw savings whenever they wanted.

Creating Lists that is Optimized by Budget

This feature's development takes place later than the aforementioned ones due to its technical complexity. The idea here is that users can add a budget for a list they can spend. Then, the algorithm, once it has enough information about their shopping habits, will automatically create a grocery list for them, considering the budget restrictions and balancing dietary needs. The algorithm, of course, would need to know the users so well as to consider the history of purchases and make predictions based on it. This is why it likely will be one of the most complicated to deploy features.

Nevertheless, if deployed and working correctly, this feature would be the most advantageous feature for consumers with a highly restricted budget. While the current list-

building algorithm optimizes individual prices, lists can still cost more than a consumer is willing or even able to spend. However, if a user can set a fixed budget of, e.g., 50€ for the following grocery list, personal finances become easier to plan.

5 EVALUATION OF SUPERPOUPA'S IMPACT POTENTIAL (GROUP PART)

SuperPoupa aims to provide easily accessible and quickly implementable mobile solutions that are effective in reducing costs for consumers and combatting the effects of rising food prices. While its reach is broad, SuperPoupa is particularly well-suited for vulnerable households who are struggling to maintain their accustomed level of consumption. With the savings that SuperPoupa can enable, these consumers can gain greater autonomy over their grocery expenditures and new financial potential to address other areas affected by the cost-living-crisis. The cost-living-crisis has had a ripple effect on various aspects of life, with households facing budget constraints being unable to put their surplus into savings accounts. SuperPoupa's presence in this economic landscape is marked by its ability to provide the generated savings to cover other household expenses, hence for many users, saving is a necessity to stay afloat in the face of the rising costs of living.

SuperPoupa's influence is not solely limited to optimizing households' budgets; research has indicated that inflation can have a far-reaching effect on people's mental and physical health (Pappas 2022; Drexel University 2022). Specifically, the uncertainty caused by inflation can contribute to depression and other mental health issues, whereas opting for cheaper, yet less healthy, grocery items can have serious physical health implications. Therefore, it is important to consider the potential effect of the solution on these levels to gain a full understanding of its wide-reaching impact. The provision of resources and freedom of choice to customers can have

beneficial impacts on households' physical and mental health, as well as restoring their sense of human dignity. An assessment of the true impact of SuperPoupa can only be conducted after its implementation in a real-world context, and the establishment of a clear method for measuring how it affects consumer spending and their lives. Despite lacking empirical evidence, the likely causal link between the adoption of SuperPoupa and financial relief for consumers can be preliminarily identified at this point.

6 CONCLUSION (GROUP CONTRIBUTION)

This thesis aims to examine the impact of current inflation rates on consumer grocery spending and assess the potential of a new mobile application, SuperPoupa, to alleviate its effects. The literature review and surveys show that consumers are adversely affected by rising food prices and are willing to adopt solutions to mitigate the financial strain. The findings suggest that the current climate will likely encourage even more users to seek assistance through these solutions. Furthermore, the surveys reveal a positive attitude towards adopting such solutions, particularly SuperPoupa, due to its simplicity and potential for significant time and money savings compared to other solutions. The approach taken by SuperPoupa offers an entrepreneurial opportunity to provide real value to consumers in Portugal in mitigating the effects of the cost-of-living crisis in the most convenient manner currently available.

In the future, introducing new features could provide further value propositions to a larger target audience looking for ways to reduce their grocery expenditures while prioritizing sustainability, health, and ethical considerations. In the long term, SuperPoupa has the potential to reduce the financial burden associated with rising food prices and address unhealthy and unsustainable dietary behaviours caused by a lack of resources and information asymmetry. However, due to the time constraints of this project, a comprehensive examination of the potential cost-saving outcomes achievable through the use of SuperPoupa could not be

conducted. From here on, it is necessary to refine the solution and ensure its adoption by a sufficient number of users in order to make meaningful conclusions. The concept and impact of SuperPoupa are to be further validated. Once supportive evidence for achieving SuperPoupa's objectives has been established, it will be essential to assess its financial viability, as this will inform decisions concerning the revenue model. In conclusion, SuperPoupa has the potential to address a current issue affecting consumers in Portugal, although further research and widespread implementation of SuperPoupa will be necessary to validate this claim.

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