

A Work Project presented as part of the requirements for the Award of a Master's degree in
Business Analytics from the Nova School of Business and Economics.

Reducing waste generated by international students' mobility

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developing a data-centric low-code application

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Abstract

International student mobility is on the rise. Even though international exchange programs foster intercultural development, some contend that the environmental impact must be considered more. This work project focuses on one piece of the complex puzzle: overconsumption. In line with SDG 12, we propose an application called Repurpose, aimed at effectively repurposing everyday items new international students buy but would otherwise throw away at the end of their curriculum. The application is tailored to the global Gen Z audience, leveraging AI for convenient experiences and considering the time gap when international students leave and arrive. Due to its scalable SaaS nature and considerate business model, the app has the chance to grow into a critical application for international students worldwide.

Keywords

Entrepreneurship, Innovation, Low-Code, Mobile, and Product Development

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List of Abbreviations

IPCC	Intergovernmental Panel on Climate Change
UN	United Nations
UNDP	United Nations Development Program
SDG	Sustainable Development Goals
LCDP	Low-Code Development Platform
IT	Information Technology
CRM	Customer Relationship Management
ERP	Enterprise Resource Planning
AWS	Amazon Web Services
IaaS	Infrastructure-as-a-Service
MB	Multibanco
QR	Quick Response
NOVA SBE	Universidade Nova de Lisboa – School of Business and Economics
GTM	Go-to-Market
U Lisboa	Universidade de Lisboa
ESN	Erasmus Student Network
ETL	Extract, Transform, Load
UI	User Interface

List of Abbreviations

UX	User Expérience
IP	Intellectual Property
API	Application Programming Interface
SQL	Structured Query Language
CNN	Convolutional Neural Network
SSD	Single Shot Detector
YOLO	You only look once
IOU	Intersection over Union
VGG	Visual Geometry Group
SPP	Spatial Pyramid Pooling
ASPP	Atrous Spatial Pyramid Pooling
RFP	Receptive Field Block
FPN	Feature Pyramid Network
ASFF	Adaptively Spatial Feature Fusion
BBox	Bounding Box
MSE	Mean Square Error
BI	Business Intelligence
CO2	Carbon dioxide

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1. Introduction

Having an international experience while completing tertiary education is an experience that affects the student's personal and professional development. It allows the new generation to discover new cultures, perspectives, and lifestyles. In addition, learning about other places' cultures continues to be very appealing and beneficial to people, nations, and our global society. It changes their perspectives on different subjects and brings them closer to knowing exactly how they want to build their professional career and what they want to be in the future.

Even though international exchange programs foster intercultural development, some contend that such programs' environmental impact needs to be considered more (Shields 2019). Shields assesses travel-related emissions and changes that result from a student's consumption (e.g., energy use, food) while studying abroad.

International education indirectly contributes to climate change as aviation contributes around 3.5% to climate change, based on the Intergovernmental Panel on Climate Change (IPCC), the intergovernmental body of the United Nations (Schmidt 2019). There is an ongoing discussion about substituting international students' mobility with online education, but virtual education will not deliver the same experience as an actual exchange program. Ideally, global citizenship is fostered with international education by promoting tolerance and intercultural understanding when attempting to address global problems like climate catastrophe.

International student mobility has grown from 2 million in 2000 to 6 million students in 2020 globally (UIS 2022). More than 300.000 students study, train, or volunteer each semester under the Erasmus+ umbrella (European Commission 2019). The number of students has increased by around 10.000 in Lisbon from 2020 to 2022, reaching more than 128.000 (Pordata 2022).

The United Nations Development Program (UNDP) founded the sustainable development goals (SDG) in 2015. It is a program composed of 17 goals that aim to improve the life quality of human beings on different levels and focuses. Goal number 12 focuses on sustainable consumption and production (DESA 2022). The main idea is to find a method to meet human needs while also considering nature; how we can protect natural resources so that future generations may use them.

Because of these rising numbers of international students and in line with SDG 12, we propose an application called Repurpose, aimed at effectively repurposing everyday items new students buy but would otherwise throw away at the end of their curriculum. As such, we are trying to avoid a significant waste generation at scale with peaks twice per year - at the end of each semester.

The application is the result of months of low-code development and aims to be implemented in different student cities across the globe. It leverages a marketplace model with a key stakeholder: the drop-off location – often a university or campus.

1.1 Goals

In this project, we aim to develop a solution that can help reduce the carbon footprint of international students. Our contribution will focus on responsible consumption. The primary objective is to create an online marketplace that allows the repurposing of typical student items (furniture, stationery, decoration, electronics, kitchen utilities, etc.) by new international students coming in after others have left. This will help reduce waste and make it easier for students to obtain the necessary things when moving to a new location.

Additionally, our solution aims to improve the overall student mobility experience by simplifying acquiring and transferring items. We aim to create a solution that promotes sustainability and convenience for international students.

1.2 Challenges

This section will cover the challenges we have identified when trying to find a fitting solution for the problem.

1.2.1 Bridging the time gap

One of the critical challenges is the often non-overlapping stays of incoming and outgoing international students. In other words, it is pretty standard that an international student leaves the country before the arrival of the new exchange student. The solution should consider this time gap between the two streams of students – entering or leaving a city. This gap is usually around two months (e.g., December and January or July and August).

1.2.2 User convenience

Finding a solution that is easy to use and convenient is essential, especially when targeting a younger audience, such as international students. These students often have busy schedules and may not have much time to spend on complex tasks. As such, a solution that is straightforward and easy to navigate can be highly beneficial.

The target audience of international students is likely to be familiar with using online platforms and apps. This means that if a potential solution is an app, it must be easy to use to appeal to this demographic. To achieve this, the app should be designed with simplicity and ease of use in mind, with a user-friendly interface and clear instructions that make it easy for students to browse, search, and buy or sell items. Additionally, the app should be designed to be flexible

and adaptable, allowing students to customize their experience and tailor it to their specific needs and preferences. This could include personalized recommendations or object detection to deliver a better user experience and outshine comparing platforms.

1.2.3 Safe and secure Communication and Transactions

Ensuring safe and secure communication and transactions between students is critical to the solution. This requires the implementation of a reliable and secure communication channel that can handle sensitive data with care. Any errors or misconfigurations could result in the loss of money for the students, so careful control and monitoring of the transaction flow is essential to prevent fraud and protect users.

1.2.4 Scalability

One essential requirement of our solution is that it should be scalable and adapt and grow as needed to support international students in cities worldwide. To achieve this, the solution will need to be designed and built with scalability in mind, using robust and flexible technology that can support a wide range of users and transactions. This means that the potential solution should not be limited to a single location or restricted by the number of users. Instead, it should be able to support a large and growing user base across a range of areas.

1.2.5 Technology Stack

Nowadays, complex problems often require solutions leveraging technology. On the one hand, considering investing in cutting-edge technology is a smart way to differentiate the business from other possible competitors; yet this comes at a cost. Implementing this technology necessitates using resources such as time, skills, and money.

It is worth exploring various app development options outside the traditional coding paradigms to develop something functional and entirely usable in a limited timeframe. This is a significant factor, as the requirements for conventional app development usually include fluency in one or more programming languages.

1.2.6 Business model

A sustainable solution comes with a sustainable business model. A solution that adds value while also generating money allows growth and expansion. Coming up with a business model that is fair and appealing to potential customers is a difficult task. The challenge here is to generate money from trading secondhand products while simultaneously meeting the user's willingness to pay.

1.3 Document structure

In chapter 1, we give a vision of the context of this thesis. We also present the goals and the challenges of our research. Chapter 2 will introduce the business idea of Repurpose, a secondhand marketplace for international students. In chapter 3, we investigate whether low-code programs could assist us in our mission. Then, we map the ideal customer journey on our app in chapter 4. Chapter 5 outlines the business plan comprising benchmarking, revenue discussion, and a go-to-market strategy. Technical implementations can be found in chapter 6. The impact is studied in chapter 7. Chapter 8 summarizes early user feedback. Future work and a general conclusion are outlined in chapter 9.

2. Ideation

Starting from the challenges identified above, we gained insight into potential solutions, detailed in section **Error! Reference source not found..** Combining these insights gave rise to a business idea discussed in section **Error! Reference source not found.,** which should be developed using a mobile app addressed in section **Error! Reference source not found..**

2.1 Tackling Challenges

The challenges listed above required us to make specific decisions, which combined allowed us to narrow down on a single concrete solution. The time gap, for example, showed the need for physical drop-off locations to store items that can be picked up later. The need for communications, transactions, and scalability led us to rely on a digital solution. Convenience could be achieved by providing a mobile-first experience for international students.

2.2 Repurpose Approach

The solution would be a niche online marketplace tailored towards international students, where the goods of a person moving can be advertised. These can then be repurposed by someone who arrives in the same city later and can buy items in advance. In the meantime, a middleman like a university or a volunteer can store these goods and be eligible for a commission. The items listed will be spread across six categories for the beginning: decoration, outdoor, bedroom, furniture, electronics, and cooking. The number of categories can later be adjusted.

This digital product idea, named Repurpose, is very scalable by nature, as the same technology can be embedded into every major student city worldwide.

2.3 A Mobile Application

Mobile applications are beneficial for reaching and engaging with Generation Z students. This generation, also known as Gen Z, is highly reliant on their mobile devices and is used to accessing information and communicating through apps. Therefore, ideally, Repurpose should be a mobile application available on Android and iOS.

You can find the application via the QR code below.



3. Customer journey model on Repurpose

3.1 User types

Before diving into the journey, note that there are three main user types in our solution: (1) core users that are sellers and buyers, (2) drop-off buddies, and lastly (3) admins. Each user type has its screens and permissions associated. The seller and buyer have access to the listings, the creation of listings, and buying options. Drop-off buddies can manage their inventory and approve or decline new goods at their drop-off location. The admin verifies payments and can intervene when malicious behavior on the platform is reported.

3.2 Sign up and log in

The user experience starts by either signing up or logging in, depending on whether it is a new or existing user. If the student is a new user, they need to create an account by filling in a list of fields such as email, username, password, and university. This information will help us in the future to personalize Repurpose journey for a better user experience.

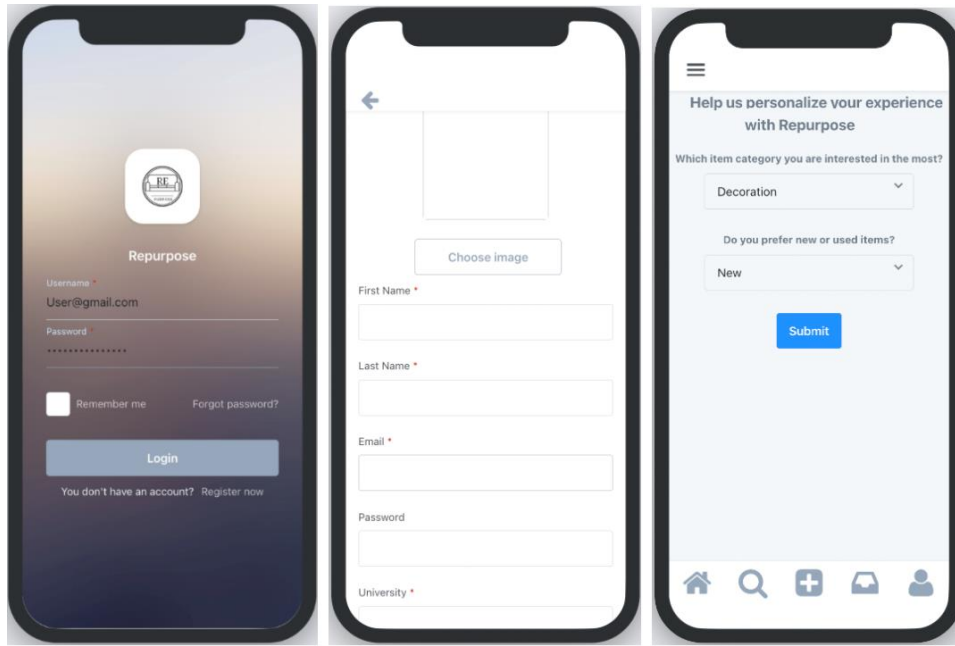


Figure 1: Repurpose Login Screen

To ensure that the information inserted is in the correct format, we have implemented different string-searching algorithms called regular expressions to ensure that we have good-quality data. The same algorithm was implemented on the password to ensure that the user has chosen a strong password that is not easy to hack. Once the student is signed up for the first time, they can personalize the home screen by choosing their preferences regarding the product category and condition. After setting up their preferences, the sorting of the listings will change by prioritizing the user's interests.

3.3 Listing Creation amplified Object Recognition

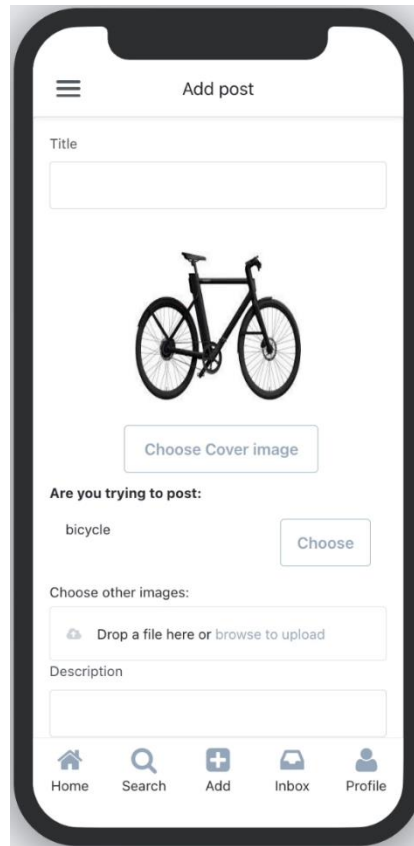


Figure 2: A Listing in Repurpose

Students interested in selling products can quickly post their items by filling in a list of inputs related to the product category, condition, price, and overall description. To improve the user experience of Repurpose, an object recognition feature was integrated to speed up the listing process by auto-filling some of the information related to the item detected within the photo uploaded by the student. The user also can upload multiple images related to the product to highlight all related details.

After setting the price, the user can choose between selling the product in person or via the drop-off option. When selecting “in person”, the buyer and the seller need to meet in presence. The seller hands the sold item to the buyer in exchange for the specified price. When done

through the drop-off option, the seller needs to drop off the product in a location that they can select according to their location. Once the selling preferences have been chosen, the listing can be submitted.

3.4 Drop-off Buddy Approval

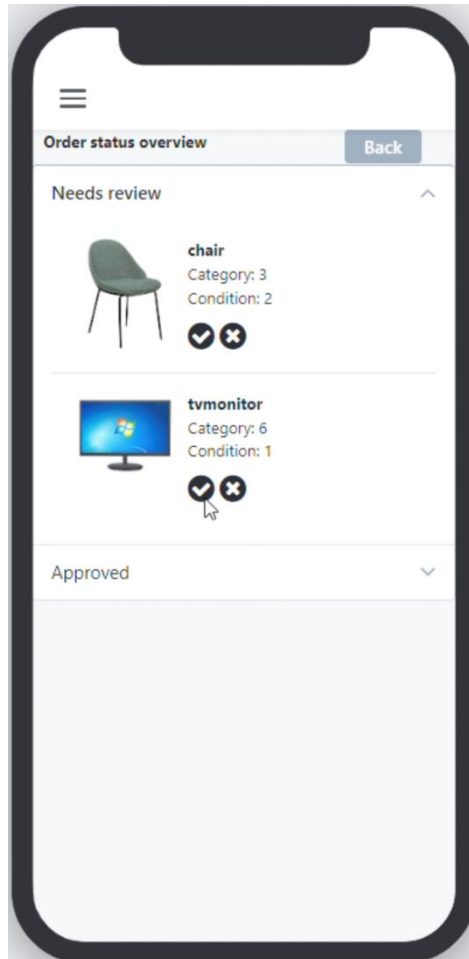


Figure 3: Drop-off Buddy Approval Overview

If the seller chooses the in-person selling preference, the product will be posted directly to the home screen. When selecting the drop-off selling preference, the student needs to wait for the drop-off buddy acceptance. The latter requires to log in to their account and check the item's

description and photos to decide whether they have sufficient space to store it. Once the drop-off buddy accepts the listing, the item will be made available for sale publicly.

In the case of refusal by the drop-off buddy, they need to specify the reason and submit it. The seller will get a notification about the rejection, possibly changing the drop-off location to a newly available location or changing the selling preference to in-person selling.

3.5 Wishlist and Buying

The first step of any student interested in buying a secondhand item is to start checking the home screen where all products will be available. The user can check the product by clicking on its pictures for more details. All product details are displayed with additional photos. The search screen can help filter the items listed by category and condition if they have a clearer idea of what to look for.

If a student is interested but hesitant to buy one of the products listed, they can add it to their wish list, consequently saving the listing for later in a separate folder to be found in the profile. The wish list can be modified, and the user can add and remove any product.

Once the student has decided to buy an article, by pressing the “Buy” button, a popup screen will appear to confirm the article and its price. At that moment, the student needs to confirm the details displayed to proceed to the payment screen. The article will be reserved for the user for three days at this stage. The product will not be available for sale during these days, and the student needs to finish the payment process. If the payment process is not concluded within the deadline, the product will be available again for sale.

At the moment, repurpose does not support in-app transactions. The payment needs to be made outside the application, where the student has a list of payment methods they can use, like bank transfer, Revolut, or MB way. More payment methods will be available in the future.

Once the payment is made, the student must upload and submit the payment proof. This can be a bank statement of the transaction or a screenshot of, e.g., a PayPal transaction. What is essential is that the transaction amount, the transaction receiver, and the transaction titular must be visible in the payment proof file. The student needs to wait for the admin to check the payment proof. Meanwhile, he/they can check the payment status in their inbox screen where the listing is displayed with the payment status “in progress.”

3.6 Payment Validation

The administrator needs to check the payment proof uploaded by the buyer, and he can accept or reject the uploaded file. In case of rejection, the buyer must produce another payment proof within the three days deadline. If the payment proof gets accepted, a QR-code will be generated for the buyer to pick up the goods at the drop-off location. The payment status on the buyer’s inbox screen will be updated, and the QR code will be added here too.

3.7 Final steps

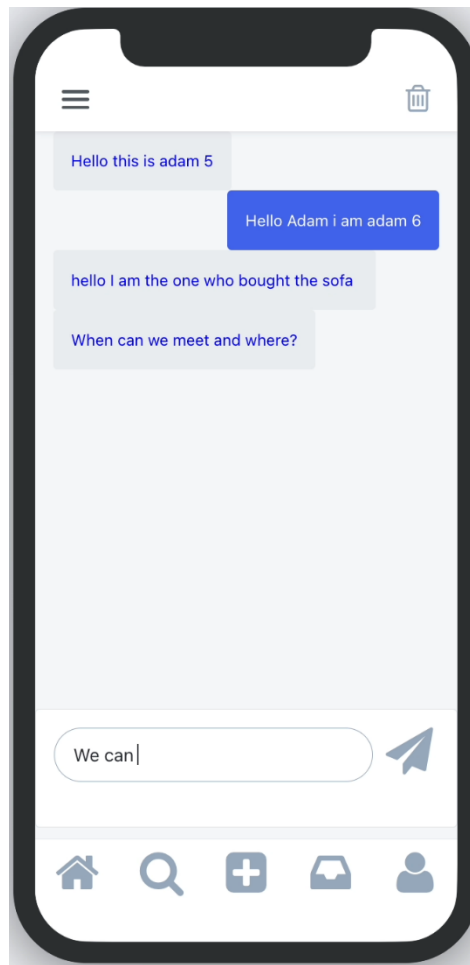


Figure 4: User Chat with Admin

If the product is sold in person, the buyer and seller can chat with each other to arrange a pickup time and place.

If the bought item is stored in a storage location, the exact location of the pickup will be shared. When arriving at the storage location, the buyer can show the drop-off buddy his QR-Code. This is also a safety feature to prevent fraudulent people from showing up at storage spaces. After the buddy scans the code from the buyer, the transaction is completed.

4. Business plan

4.1 Competitive Landscape

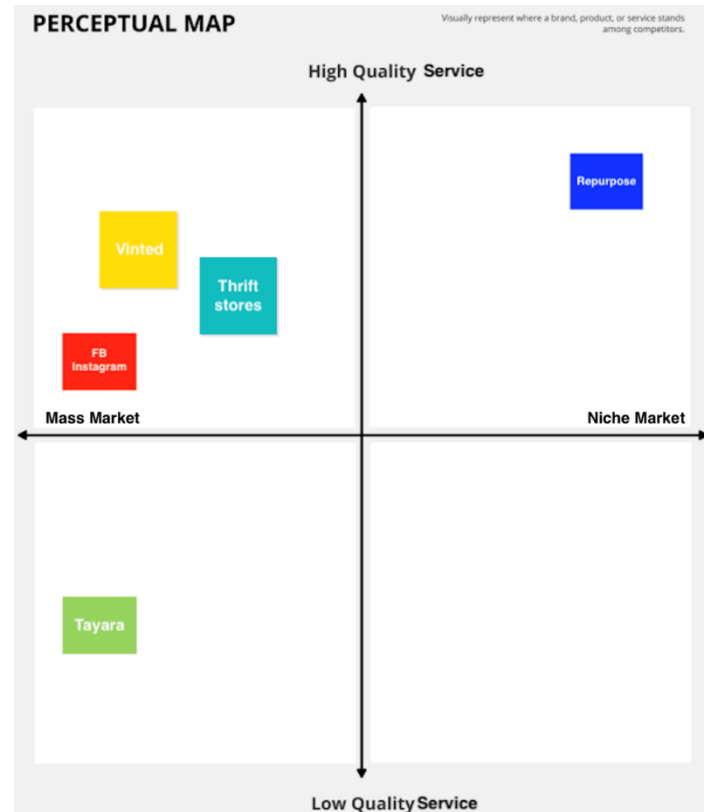


Figure 5: Perceptual Map Classification of Repurpose and Competitors

Benchmarking compares a company's operations or procedures to other firms, startups in the same sector, or even the greater competitive environment. Any service, product, or process may benefit from a benchmarking plan. This plan is used to learn, by comparison, assessing whether there are better approaches, better technologies that can be used, alternative cost-cutting techniques, which are targeted, and if you share the same potential customers, interesting ways to strengthen customer loyalty or more effective methods of increasing profits. (Eloquens 2020).

Determining which factors are most relevant for the benchmarking analysis is essential. This includes understanding the unique characteristics of a company's business operations, clients,

and services to identify significant comparison areas. Common points of comparison among organizations may include factors such as the product or service offered, the scale of the business, the delivery style, the target market segment, and more. Understanding a company's specific features and what sets it apart makes it possible to establish a definite competitive advantage (Starr 2017).

We will evaluate the following two factors: The level of market segmentation (Niche market vs. Mass market) and the service quality level.

4.1.1 Specific Applications

An interesting competitor in the same space is the mobile app "Vinted." Vinted specializes in secondhand clothing and allows users to buy or sell items. It currently operates in sixteen countries, including Portugal. As a previous user, Vinted targets a mass market where everyone interested in buying/selling secondhand clothes can be a potential user. Its service quality is also considered good since its mobile application includes customer support features and its buying experience is well organized to avoid fraud.

On a national level, several mobile apps and platforms offer similar services, such as "Tayara," a Tunisian app that covers a wide range of product categories and does not have a specific target market. Tayara is also targeting the mass market, but its service quality is low since the trading process has no security measures, which makes its users prone to fraud.

Some other companies in the same space as Vinted and Tayara include Depop, ThredUp, and Poshmark. Depop is a popular app for buying and selling secondhand clothing, particularly among younger users. ThredUp is a fashion resale website that offers a wide range of secondhand clothing and accessories. Poshmark is another app-based platform for buying and selling secondhand clothing, focusing on high-end and designer items. These competitors

demonstrate the potential for success in the secondhand marketplace and can provide valuable insights for the development of Repurpose.

4.1.2 Social Media

Social media channels, such as Facebook and Instagram, are commonly used for buying and selling secondhand items because they provide a large and easily accessible audience. These platforms allow users to easily create listings and promote their items to a wide range of potential buyers. Additionally, social media channels often have built-in features, such as hashtags and search functions, which make it easy for users to discover and find items that are relevant to their interests. Overall, the widespread use of social media for buying and selling secondhand items makes it an essential consideration for any company operating in this space.

WhatsApp groups are also one of the very well-known ways of selling and buying products within small communities like dormitories, schools, and students from the same bachelor's or master's program. For example, NOVA SBE students use a WhatsApp group to sell and buy secondhand items.

4.1.3 Amazon

Amazon is a crucial player in the e-commerce market and should be considered in the development of Repurpose. Amazon's vast selection of products, convenient shopping experience, and widespread customer trust make it a significant competitor in the online marketplace. Furthermore, Amazon has several features, such as Amazon Marketplace and Amazon Prime, specifically designed to facilitate the buying and selling secondhand items. Therefore, understanding Amazon's offerings and approach to the secondhand market can provide valuable insights for the development of Repurpose.

4.1.4 Thrift stores

Thrift shops, also known as charity shops or secondhand stores, are a vital consideration in the development of Repurpose. Thrift shops offer a physical location where customers can browse and purchase secondhand items, providing an alternative to online-only platforms. Additionally, thrift shops often have a loyal customer base and a reputation for offering good value and supporting charitable causes. Therefore, understanding the appeal and advantages of thrift shops can provide valuable insights for the development of Repurpose and help to differentiate the app from competitors. Thrift shops target something other than the mass market since their customer base depends on the shop's physical location. Adding to that, their service quality is variable depending on after sales support level of each location.

4.1.5 The competitive Edge of Repurpose

Repurpose has several competitive advantages, including its creators' understanding of the needs and preferences of international students. The app's focus on this specific market will enhance the user experience and make it easier for users to find what they want. Additionally, the creators' connections to networks such as Erasmus+ and NOVA SBE will help accelerate the commercial launch and reach potential users more quickly.

The competitive advantages stated will allow the Repurpose application to be positioned on the top right of the perceptual map (Figure 6) with increased quality service thanks to its admin support and high exclusivity through its niche targeting.

4.2 Revenue model

In this section, we will discuss the financial aspects of the app in more detail. A revenue model must be implemented to support ongoing development and hosting costs. Additionally, the compensation for drop-off buddies must also be considered.

4.2.1 Commissions

We plan to take a 5% commission on all transactions made through the drop-off feature, with 2% going to the drop-off buddy and the remaining 3% going to Repurpose. This would provide a steady stream of income that scales with the volume of transactions on the platform.

4.2.2 Subscriptions

In addition to the commission-based model, we also plan to offer a Repurpose Premium option for buyers and sellers. This premium version will include a notification system that alerts users when items matching their search terms are listed. For sellers, the Premium version will reduce the commission rate to 2%, making it more appealing for those with many items to sell, such as at the end of a semester.

4.3 Go-to-market Strategy

A go-to-market (GTM) strategy is a plan that outlines the actions and approaches a company will take to bring a new product or service to market and achieve its business goals. The GTM strategy typically includes various activities, such as market research, product development, pricing and positioning, distribution, sales and marketing, and customer support. Such a strategy aims to help a company effectively launch and promote its products or services in a way that maximizes its value and appeal to the target market, ultimately leading to increased sales and revenue.

4.3.1 Product-market fit Validation in Lisbon, Portugal

While specific data on the total number of international students in Lisbon is not available, it is known that the University of Lisbon (U Lisboa) and NOVA University Lisbon each have a significant number of international students. U Lisboa welcomes over 9,000, and NOVA

University Lisbon welcomes over 3,000 each year (ULisboa 2022; Universidade NOVA de Lisboa 2022). The high number of international students at these universities makes Lisbon a prime location to launch an app geared toward this demographic.

Before launching in any city, various drop-off locations need to be created. An initial starting point for this would be Nova SBE, the academic institution where the authors of this thesis are currently studying. We count on them because it is a school that encourages its students to create value from innovative products. More than 60% of the campus are international students from more than 70 countries (Exchange from Nova SBE - Exchange Programs | Nova SBE, n.d.). The Repurpose application aligns with the school's vision of encouraging entrepreneurship as a mindset the new generation should adopt.

As the product or service becomes more successful, additional drop-off locations can be added to other campuses and universities in the city to increase exposure. The financial support from the stimulus should assist in the expansion.

Once validation has been achieved, the next step is to expand the product to other cities and countries. This can be accomplished through the use of networks and partnerships. In the following section, we will discuss some of the networks that can assist in this process.

4.3.2 Partnerships for Growth

The GTM strategy could also include targeted marketing and outreach efforts to promote the app to international students and encourage adoption. This could consist of partnerships locally with student organizations and cultural associations, as well as targeted advertising on social media and other relevant platforms.

Moreover, the Erasmus program is one of the major exchange enablers. It was one of the primary causes, if not the leading cause, behind the increase in the number of exchange students from inside and outside Europe and between continents like Africa, Asia, and America. A collaboration with the Erasmus program could increase the Repurpose market share, expand its user base by accessing a critical number of new potential users and support our product branding in Portugal in the short term. The application could be used worldwide in the long term, which also fits our expansion strategy.

The Repurpose platform has the potential to operate not only in Portugal but also at different universities around the world. With the help of the Erasmus program, the Erasmus Student Network (ESN) around the world, and the Nova SBE school's bilateral agreements with other universities in 50 different countries (NOVA SBE 2022), the Repurpose application will have the ability to expand worldwide.

Overall, a phased launch and targeted marketing efforts can effectively introduce the app to international students and drive adoption and engagement.

5. Technical Implementation

5.1 Business Intelligence Application in Repurpose

In today's business environment, organizations must make data-driven decisions. Dr. Dan Power defined the earliest form of using data to support decision-making as a decision support system (DSS) as an "interactive computer-based system or subsystem intended to help decision makers use communications technologies, data, documents and models to identify and solve problems, complete decision process tasks and make decisions" (Power 2007). Nowadays, a more popular term is Business intelligence (BI), a broader term incorporating decision support systems. Business Intelligence is an asset that all significant companies strive to develop and foster. This applies to large and medium-sized organizations and small companies like startups, as paying more attention to business intelligence influences company performance (Caseiro and Coelho 2019). One way to translate business intelligence into a real-world application like repurpose is a dashboard (Eckerson 2010). A dashboard can be used to get an overview of activities and transactions concerning your business. With the flood of data generated by each transaction concluded in e-commerce, every post made on social media, or every message sent in messenger applications, dashboards can give users an excellent overview of all relevant information. Often it is not only data generated from these activities being depicted on dashboards but also metadata (Cahyadi and Prananto 2015).

All the data generated needs to be transformed into easily readable information to provide value to the company. In OutSystems, there are also several tools to display data and to design admin dashboards, which is explained in part 1.3

Even early startups can benefit from business intelligence as much as large businesses. BI can help small businesses to understand their operations and markets better and to make more

informed decisions about how to grow and improve. By providing small businesses with data-driven insights, BI can help them identify new opportunities, optimize their operations, and use their resources better. In today's competitive business environment, access to accurate, up-to-date information is critical for any business, regardless of size.

5.1.1 Definitions

5.1.1.1 Business Intelligence

Business intelligence is the strategies, processes, applications, data, products, technologies, and technical architectures used to support the collection, analysis, presentation, and dissemination of business information (Dedić & Stanier, 2016). This definition is an extended definition of Avzine et al. (2005), which defined business intelligence as "about how to capture, access, understand, analyze and turn one of the most valuable assets of an enterprise - raw data - into actionable information to improve business performance".

5.1.1.2 Dashboard

The terms dashboard, performance dashboard, executive dashboard, and admin dashboard are often used interchangeably, even though there might be differences when looking at these terms in detail. For example, when looking for a definition of a performance dashboard, it is described as a visual reporting and management tool that both entrepreneurs and managers use to establish the effectiveness of particular business metrics, like employee performance, customer satisfaction, and marketing campaigns (Indeed, 2022). While at the same time, when looking at the same term in an IT companies environment, they would instead describe a performance management dashboard as a tool that "enables users to effectively manage key processes within an organization's business communication system by consolidating metrics needed for monitoring, diagnostics, and reporting. It provides the necessary insights so IT can optimize the system's performance, prevents issues, and troubleshoot effectively."

An executive dashboard is a computer interface that displays the key performance indicators (KPIs) that corporate officers need to effectively run an enterprise (Sutner 2018). Executives often base their decision-making on data they obtain through aggregated spreadsheets or holistic overviews of dashboards. A company's executives need to access information other than admins, specifically, the information needed to make strategic company decisions. Because of that, an executive dashboard can also be called a "strategic dashboard."

Therefore, a unique definition is not to be found, as the definition always differs depending on the author's background or the platform's industry. When looking at the contents of a dashboard, it is easier to say. According to Sutner (2018), a dashboard typically contains multiple data visualizations to give business users a combined view of relevant KPIs and trends for operational decision-making and strategic planning. Other notable features of dashboards are their support for interactivity and a customizable interface (Sutner, 2018).

Even though the functions of dashboards can be deducted from the definitions above, (Eckerson 2010) split the functions into three main groups: monitoring business processes, analyzing root causes of problems, and managing people and processes to improve decisions.

5.1.2 Types of Dashboards

The content of a dashboard depends on what industry it is used for because the underlying data or information might be completely different. Besides the difference in data, distinct roles might also have preferences in what they wish to see and what information should not be displayed. On geckoboard.com, one can see different examples of such dashboards:



Figure 6: Marketing-Dashboard

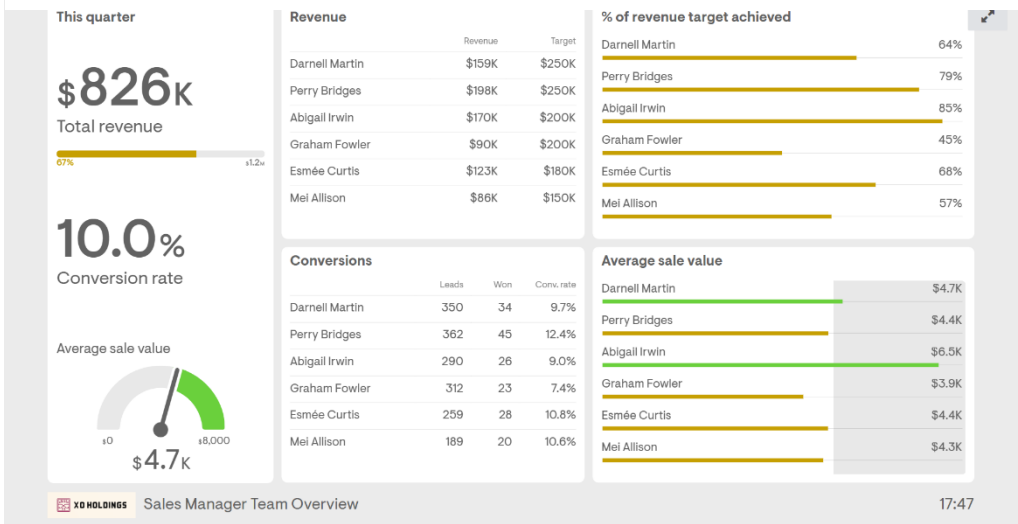


Figure 7: Sales Dashboard

In Figure 11, a typical dashboard for a marketing admin is shown. Here we can also observe the different building blocks of a dashboard. For one, we have numbers (e.g., number of searches), and for another, we have graphs (e.g., number of searches this year). Other valuable

information for the marketing department is the section on how the advertising budget is utilized and the demographic breakdown per country.

In Figure 12, one can see an example of a dashboard for a sales manager. The information displayed here is this quarter's total revenue, the current conversion rate, and data on single sales team members. What is important here is that the data displayed includes real-time data, as the dashboard gives an overview of the current situation in the sales department.

5.1.3 Building a Dashboard in OutSystems

The OutSystems Service Studio 11 provides versatile tools to build extensive business intelligence dashboards. Pie Charts, Bar Charts, Line Charts, and other options are available, as seen in Figure 1313.

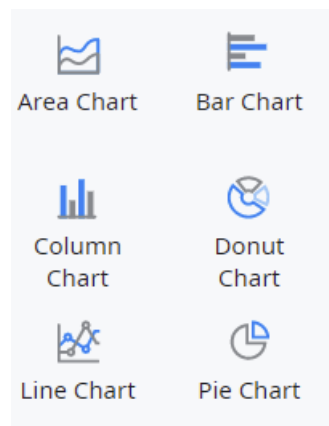


Figure 8: Chart Options in OutSystems

The charts all have customization options, ranging from whether tooltips are to be shown over coloring options to onclick-events, which can all be configured in the properties panel in OutSystems when clicking on the chart element. Further and more detailed options are available in the styles panel, where one can customize the charts even more using CSS.

The data in our application is stored in an SQL database, where it can be easily accessed from tools in OutSystems. Queries are based on clickable settings, which makes it easy to obtain data directly and bring it in a usable form.

Aggregates can be used in queries to fill charts by groups, group counts, labels, etc. Several dashboard templates are available in any application, which can be used and further customized to fit an individual application.

The screenshot shows the 'Properties' tab for a 'Charts\DonutChart' widget. The interface is divided into two main sections: 'Properties' and 'Events'. The 'Properties' section includes fields for 'Name', 'Source Block' (set to 'Charts\DonutChart'), 'SourceDataPointList' (set to 'GetListingsByCategory.List'), and a 'Mapping to DataPoint' section with dropdowns for 'Label' (set to 'Label'), 'Value' (set to 'Count'), 'DataSeriesName', 'Tooltip', and 'Color'. Below these are 'Height', 'LegendPositionId', 'ChartFormat', 'Clickable' (set to 'True'), and 'AdvancedFormat'. The 'Events' section includes 'Event' (set to 'OnClick'), 'Handler' (set to 'DonutChart1OnClick'), 'CategoryFilter' (set to 'TextToIdentifier(DataPoint.Label)'), and '(New Argument)'. The 'Styles' tab is also visible but not selected.

Figure 9: Settings and Configurations for a Donut Chart in OutSystems

There are also google maps building blocks available for location data to show one or more on a draggable or static map. All of these functionalities build a valuable toolset to build a dashboard. Interactivity can be offered through determining on-Click-events, and customizability is given through the programmer's side but not through the user's view. When defined, the data used for display is live data, which is extremely useful when the admin wishes to get live updates about ongoing operations.

Even when wanting to connect to databases outside of the application, OutSystems allows making server calls and SQL queries to obtain data, which can then be displayed with the dashboard tools. For the Repurpose app, we will display the data generated within the app itself and not use external sources.

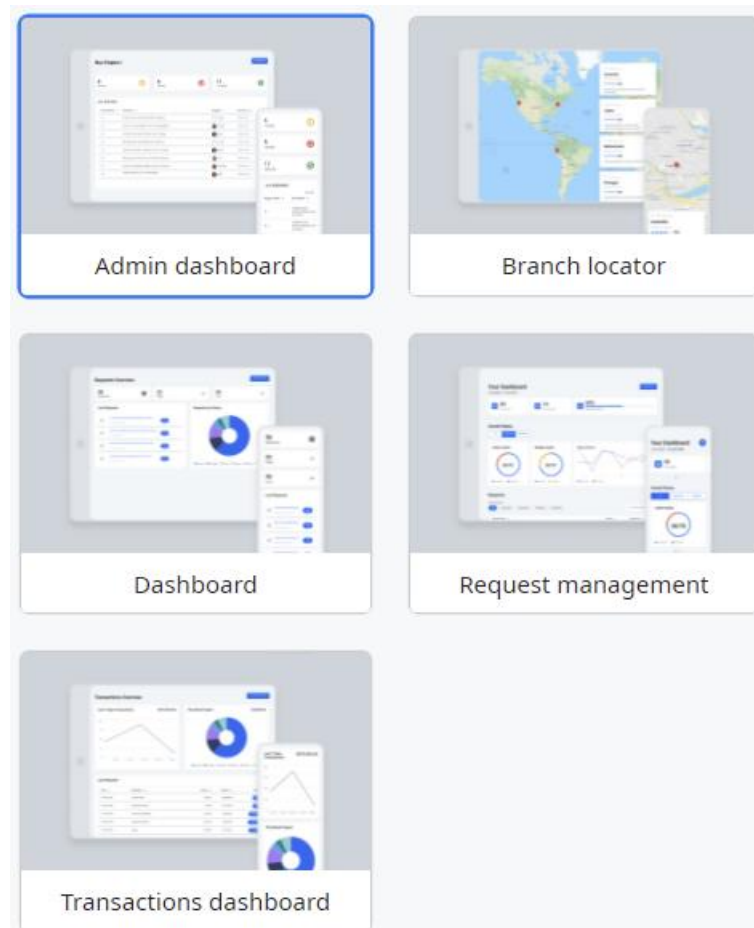


Figure 10: Dashboard Templates in OutSystems

5.1.3.1 Limitations

OutSystems gives the user many tools, even when designing admin dashboards. Still, the learning curve is steeper than visualization tools such as tableau. Further, the ease of use in business intelligence is not as effortless as dedicated tools, which is not a surprise, as OutSystems is not a dedicated Data Visualization or Business Intelligence tool.

5.1.4 Business Intelligence in Repurpose

For the application Repurpose, business intelligence is also vital for different user groups. Admins must always be informed of current events, while users might be more interested in their purchasing statistics and history. The app will include a dashboard for each user group to offer all user groups a business intelligence overview.

5.1.4.1 Admins / Executives

The admin is the role with the most permissions and responsibility. In his role, the admin has two functions. Firstly, to deal with eventual problems. He needs to ensure a smooth flow of transactions. Secondly, his function as an executive. He needs to make strategic decisions for the further development of the application, marketing decisions, and general management of the company. Therefore, he is the user who needs an overview of current events the most.

Primarily, the admin needs statistical information on platform usage. Therefore, a count of all registered users on the platform must be given. Further, it might be essential to give the count of all active listings, as they are also a good indicator of traffic on the platform. Other pieces of information that might be relevant stem from the data model. Just looking at the attributes of the "listing" entity gives a lot of information that an admin might need when wanting an overview. Relevant information might include the number of listings per category, the average price of listing per category, the number of listings per drop-off location, the number of reported listings, etc.

What is further significant is that the dashboard is interactive. Interactivity in a dashboard means hovering over or clicking on information has a visible effect. This can be opening a new page with filtered examples or giving more information about a data point when hovering. In OutSystems, this can be quickly done by defining server actions with the "onclick" attribute of different elements. Another aspect one needs to consider when designing a dashboard is the reactive web design aspect. For the admin dashboard, building one tailored to users at a full-screen web browser might be feasible, as an admin might sit on a laptop or desktop computer and not use a phone for administrative tasks.

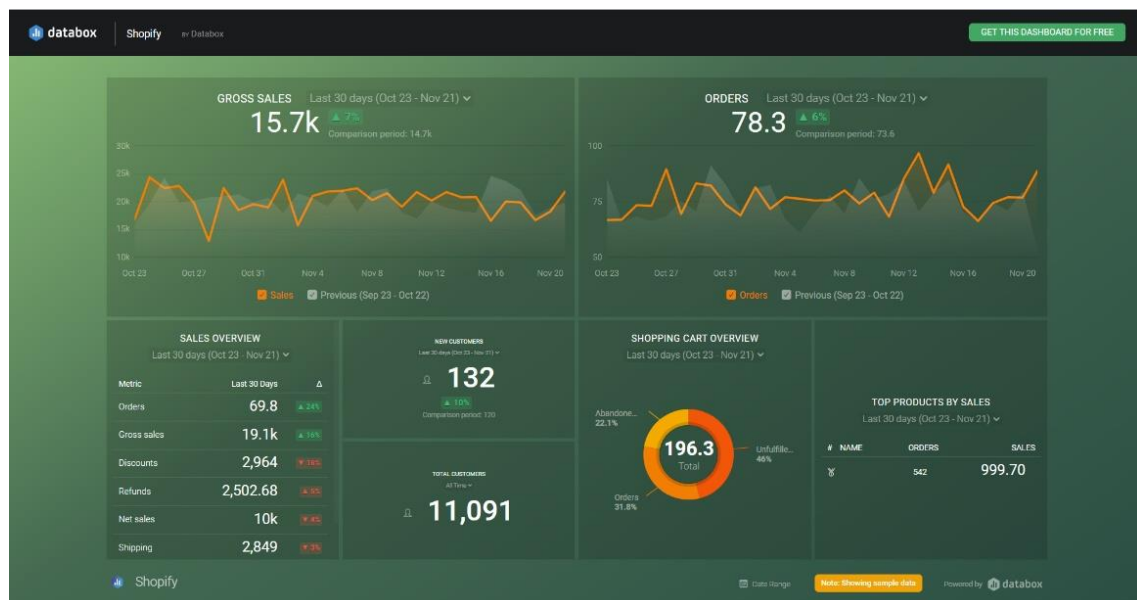


Figure 11: E-Commerce Dashboard

To get a frame of reference, Figure 3 shows an e-commerce dashboard used for a Shopify online shop. Prominent metrics on this dashboard include sales performance in the last 30 days, both gross sales and order numbers. Other indicators are a pie chart that shows an overview of shopping cart statuses, so how many purchases have been abandoned and how many are still unfulfilled, as well as an overview of new customers this month and total customers on the platform.

In the case of our application, the executives should receive information about company performance, e.g., transactions completed, the current status of transactions, the total number of listings, etc.

After looking at other dashboards, we designed the following dashboard as a first draft, which will provide all necessary information in a visually pleasing way.

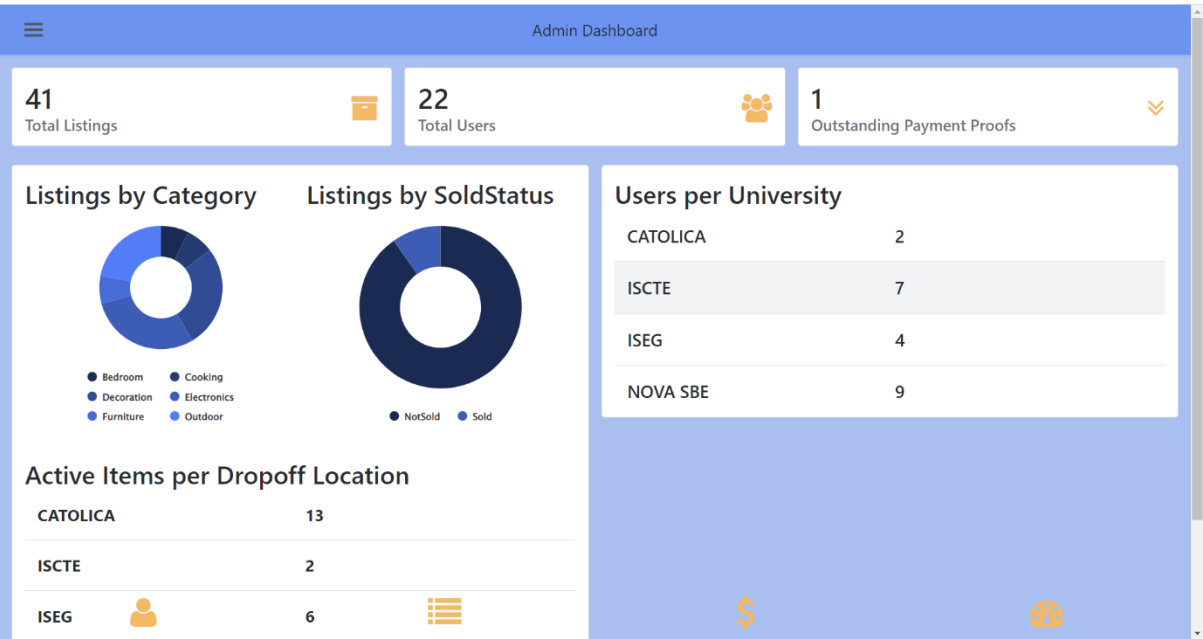


Figure 12: First Draft of Admin Dashboard in OutSystems

In the top bar, the admin can see general metrics about the platform. These are the total number of active listings, the total number of registered users, and the number of payment proofs that are pending. With just one click on any of those metrics, the admin will get a more detailed view of, e.g., the listings or the users. In the left half of the screen, the admin gets an overview of the total number of active listings by category and the number of listings by whether they have already been sold. Further below in the left column, there is a list of the sum of items that are available per Drop-off location. The admin has a quick menu in the bottom bar to switch between detailed user view, listing view, pending payment proofs, and the dashboard itself.

5.1.4.2 Students

Students pose as the primary user group in Repurpose. They can buy and sell items, create listings, report, and upload payment proofs.

The main activity of this group is looking for products and buying them, which is why a dashboard with key performance indicators and statistical information might be interesting, but not necessarily practical. As a buyer, a dashboard might not be as relevant as one for other user groups. Still, information that this group might care about is the total sum of items bought on the platform, the total number of listings per category, or the current status of the items one has bought. The other function of a student user is to sell items. Their primary interest may be to get an instant overview of the current status of the products they sell.

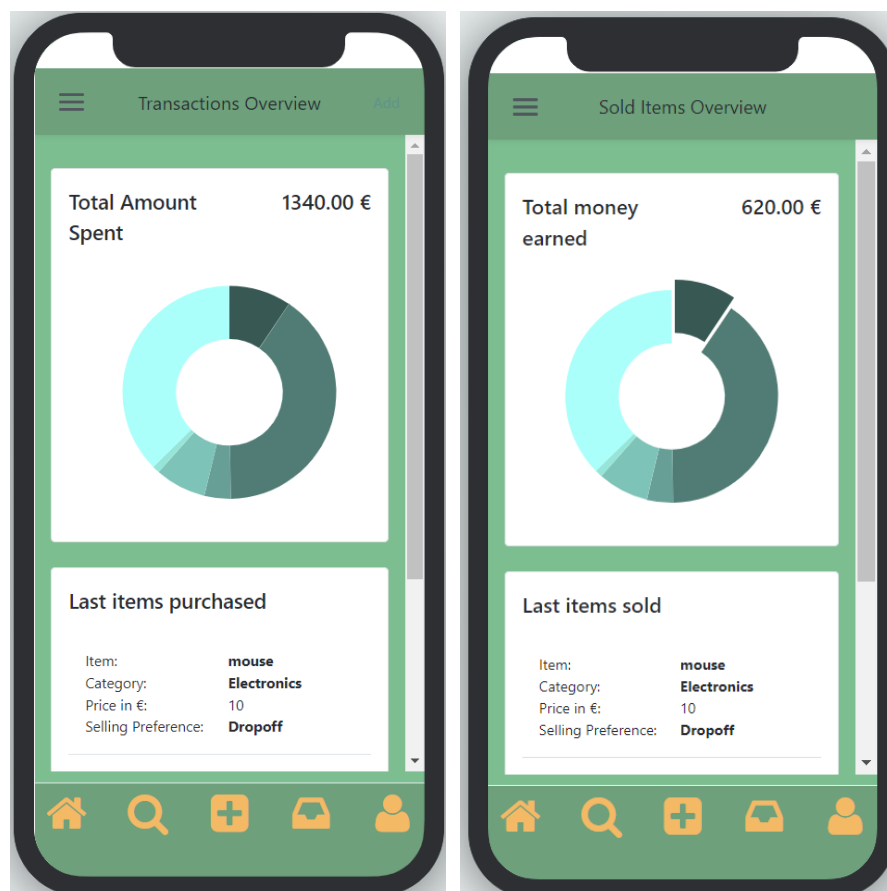


Figure 13: Dashboards for Users that are buying (left) and selling (right)

5.1.4.3 Buddies

Buddies hold the role of administering their own storage space. Therefore, it might be helpful to give them a summary of the current status of the products they are storing. It is questionable whether the best information for them is a tabular panel or a panel with diagrams. Both options will be explored in the application and evaluated for feedback.

With the buddy dashboard shown in Figure 19, the drop-off buddy can get all information that might be important to him. In the top bar, the buddy has a list of all of his drop-off locations

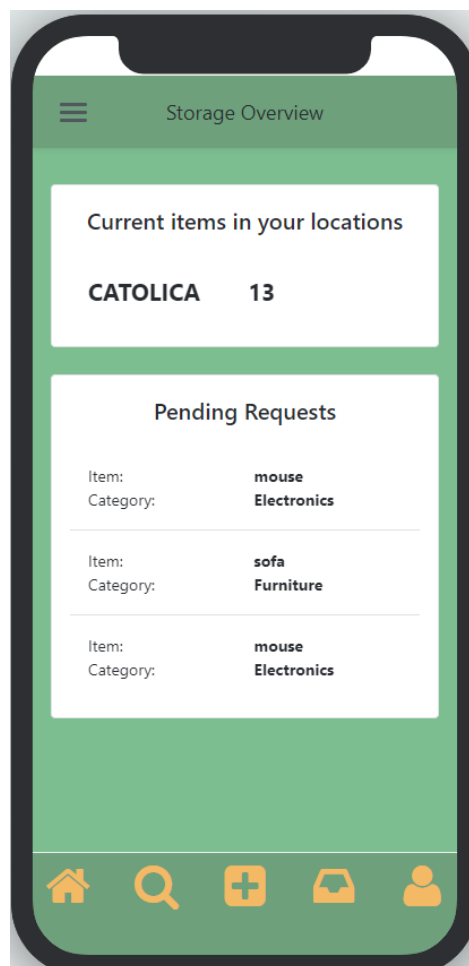


Figure 14: Dashboard for Drop-Off Buddies

with the number of items that are currently in storage there. Below that, the buddy sees all the pending requests to his location, which he can review in detail by just pressing on the request. In the following screen, he can easily accept or reject the request.

6. Impact

Repurpose's vision is to inspire and empower the new generation to make more environmentally-friendly decisions. We are committed to driving positive change toward a healthier, more sustainable environment. As a community, we are dedicated to promoting small initiatives and actions that can significantly impact us. We believe that working together can create a brighter and more sustainable future for all.

6.1 Emissions

It primarily tries to reduce students' carbon footprint and CO₂ consumption by encouraging them to adopt the reusability concept giving items a new life. This will cut down energy and resources used for producing new products and consequently scale down future waste.

For example, a study was made on the secondhand concept within the fashion industry. One of the interesting findings is that fast fashion production generates 20% of the world's wastewater and 10% of the world's carbon emissions, which is higher than the total emissions of international flights and marine shipping (Okafor 2022). More precisely, and as an example, a cotton t-shirt requires around 713 gallons (2,700 liters) of water to be made (Astoul 2021). Also, we should mention that only 15% of worn textiles are recycled, with the remaining 85% ending up in landfills or burnt. And most objects require a considerable amount of time to decompose in landfills, possibly hundreds of years (Astoul 2021). This demonstrates even more how our actions harm the ecosystem.

6.2 Financial impact

Additionally, this concept will help students save money and generate profit for the drop-off buddy. In other words, we have designed an economic cycle where everyone benefits without

harming the environment. By promoting sustainable practices and encouraging the reuse of goods, we aim to create a win-win situation for all involved. According to many resellers' pricing strategies, products in perfect condition are priced at 70% of their original price. In comparison, items that are used and have seen better days are priced at 30% of their original price (Stephenson 2005). According to Erasmus plus program, the average installation cost for an exchange student is 1000€ (Public Health in Disasters 2022). Based on these numbers, an exchange student that buys most of the items/products needed during his exchange experience through repurpose application can save at least 500 €.

7. Early user feedback

Incorporating user feedback from a diverse group of users can help ensure that the Repurpose mobile application caters to the needs and preferences of a wide range of users. This can lead to a more successful and well-received product. Additionally, gathering feedback from different perspectives and points of view can provide valuable insights that can help improve the functionality and usability of the application. We collected this feedback through Nova School of Business and Economics live demos. This approach allowed us to observe the user's journey within the application.

The goal was to get more insight into the UX in different use cases: account creation, selling, and buying. For each scenario, we focus on the time spent, whether the user will ask for help and the specific suggestions for improvement.

7.1 Perceived Strengths of the app

Firstly, the object detection feature was well-received by most participants, who found it exciting and innovative. Many were interested in how the AI technology behind the feature worked. Participants also appreciated that using the object detection feature reduced the time required to post an item, as many fields were automatically filled.

In addition to the object detection feature, participants appreciated the ability to quickly contact the help center and make inquiries or report suspicious items for sale. They also liked the option to message the seller after purchasing an item and arrange a meeting to exchange the product.

7.2 Current Weaknesses

Participants mentioned several areas for improvement in the application. Many suggested that the app's aesthetic design could be more colorful and engaging to encourage users to spend

more time using it. Some participants found the login process too lengthy, and others had trouble using the object detection feature, which didn't always correctly identify items. Additionally, some users felt that the available drop-off locations were limited, and others wanted a broader range of categories to choose from. Finally, many participants expressed concerns about the manual payment verification process and its ability to scale up as the number of users grows.

8. Conclusions

In this work project, we proposed a way to reduce waste generated by international students. The solution is a mobile app developed in the OutSystems low-code environment that is scalable and can be implemented in student cities worldwide.

While the fundamentals of the application and its business model are built, future work is necessary to (1) grow on and (2) satisfy user needs. Growth can be achieved by implementing a sound go-to-market strategy. While we did not discuss it in detail in our text, we laid out a roadmap for further development efforts:

1. Improve the aesthetic design of the application by defining a unified theme for the user interface.
2. Develop a marketing strategy to attract more drop-off buddies quickly, focusing on social media platforms like Facebook and Instagram and starting talks with institutional partners like Erasmus+.
3. Expand the list of categories to include new categories based on the specific needs of different schools and countries.
4. Implement a more flexible monetization process that considers factors such as the product's size, the product, the condition of the product, and the user's subscription type.
5. Rethink the payment process and consider implementing an AI system to verify payment proofs automatically.
6. Prepare a list of must-have items for international students based on their geographical location to facilitate their integration into the local lifestyle.
7. Analyze data collected through the application to understand users' needs and personalize their experience within the app.

These objectives will help Repurpose grow and expand while offering a high-quality user experience.

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Appendix

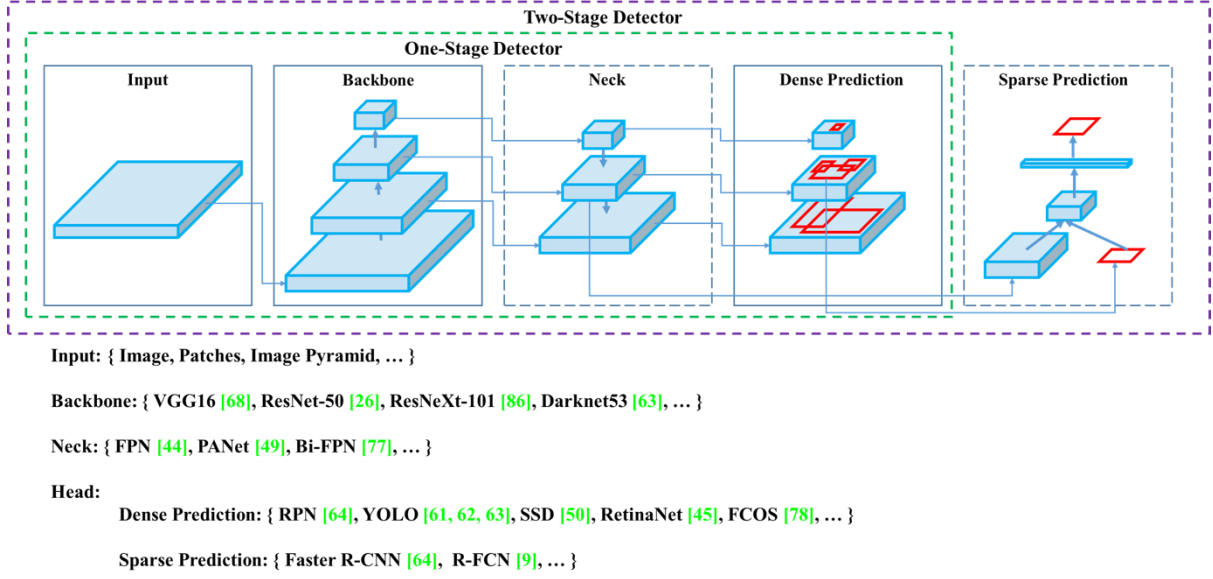


Figure A: YOLO architecture



Figure B: UbiOps implementation

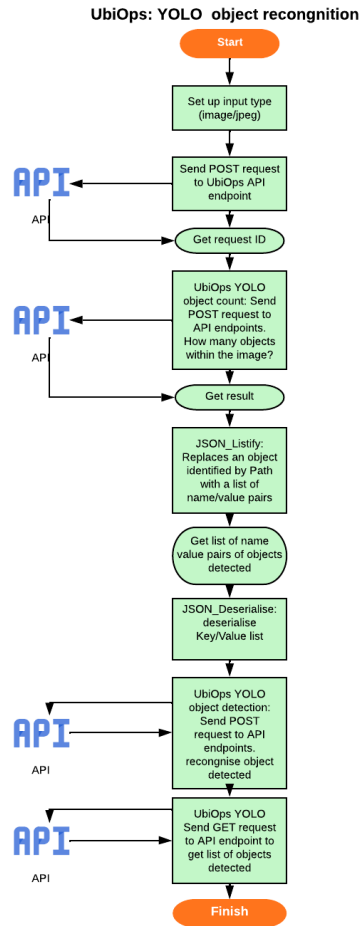


Figure C: Object detection process

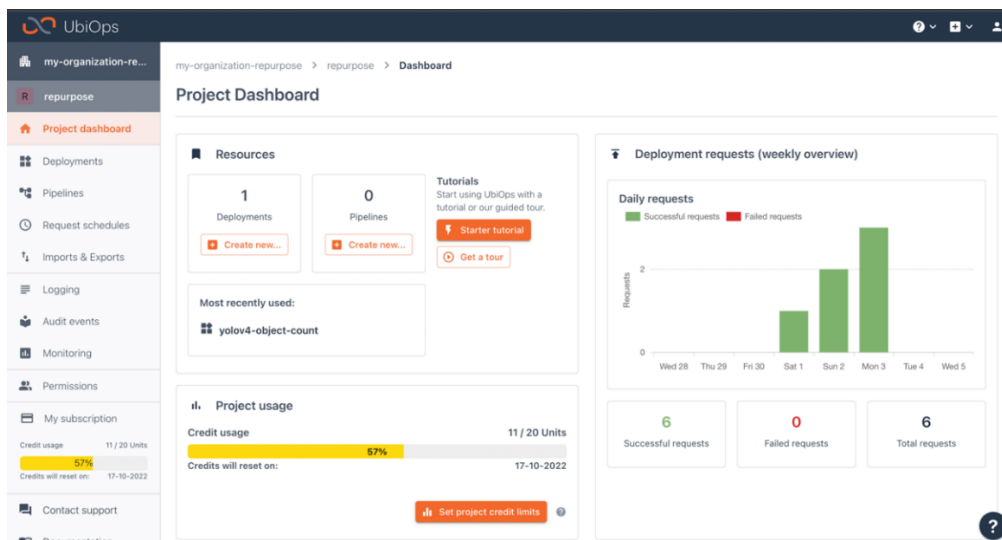


Figure D: UbiOps Project dashboard