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Mobile Dashboard to Improve Real Estate Agent Productivity

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October, 2021

TECNOLOGIAS
E ARQUITETURA

Department of Information Science and Technology

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Acknowledgments

The realization and conclusion of this work is like a long journey, in which it was only possible to reach its destination with the contribution of several indispensable people. Thus, I express my gratitude to the people who, directly or indirectly, contributed to the final presentation of this thesis.

First of all, I must thank my advisor, Professor Dr. Rúben Pereira, for all the patience, commitment and practical sense with which he always guided me in this work. Thank you so much for correcting me when necessary without ever demotivating me.

I express my gratitude to João Antão, for all his patience and availability contributing to this work. Above all, thank you for joining me on this journey.

To my parents for all the support they have given me since the beginning of this challenge, and for having often believed in me more than I did.

To my girlfriend for always walking beside me. For her patience, comprehension and help during the preparation of this dissertation. For always showing me a smile, even when she sacrificed days, nights, weekends and holidays, all for the realization of this study.

To all my friends, for their support, encouragement and trust.

To ISCTE-IUL and the entire community that involves this great institution, which formed me throughout my academic journey.

Finally, my deep and heartfelt thank you to all the people who contributed to the realization of this dissertation.

Resumo

A atividade das Imobiliárias é a compra e venda ou arrendamento de bens como pedaços de terra ou casas, entre outros, os quais frequentemente atuam como intermediários entre o vendedor e o comprador. Para que os agentes consigam ajudar com as melhores opções de compra a um potencial comprador, precisam de possuir um sistema que consiga reunir todas as informações necessárias sobre as necessidades ao comprador e sobre as ofertas disponíveis, de forma a alcançarem a melhor correspondência possível.

De forma a aglomerar todos estes dados e a torná-los facilmente legíveis, os agentes imobiliários já têm à sua disposição uma aplicação móvel de *Customer Relationship Management* (CRM), a fim de ajudar a gerir a relação com os clientes, auxiliando-os a encontrar o que procuram. Ainda assim, necessitam de uma solução que providencie indicadores de desempenho chave (KPI's).

A tese centra-se no problema que se prende com o facto de estas organizações terem muitos dados e precisarem de acedê-los de forma simples e rápida.

A pesquisa consiste no desenvolvimento de dashboards para uma aplicação movel de CRM, de forma a visualizar os dados reunidos numa organização imobiliária, ao nível da venda e produtividade, com o objetivo de apoiar os agentes nas suas funções do dia a dia. A metodologia adotada para contruir e avaliar os resultados foi a Design Science Research (DSR).

Verificou-se que este segmento necessita de mais estudo e que os dashboards sobre estas temáticas assistem ao nível da monotorização e análise.

Palavras-Chave: Customer Relationship Management; CRM; Aplicações Moveis; Dashboards; Imobiliário.

Abstract

The activity of real estate agents in the context of sales, purchase or lease of goods, such as pieces of land or houses, among others, often act as intermediaries between the seller and the buyer. For agents to be able to provide a potential buyer with best purchase options, they need to have a system that can gather all the necessary information about the buyer's needs as well as the available offers, so as to achieve the best correspondence possible.

To aggregate all these data and make them easily readable, real estate agents already have a mobile Customer Relationship Management (CRM) application at their disposal, in order to help them manage the relationship with clients and to find what they are looking for. Notwithstanding, they still need a solution that provides key performance indicators (KPI's).

The thesis focuses on the problem these organizations present due to the possession of a lot of data and the need to access it simply and quickly.

The research consists of the development of dashboards for a mobile CRM application to visualize the data gathered in a real estate organization in terms of sales and productivity, in order to support agents in their day-to-day functions. The methodology adopted to build and evaluate the results was Design Science Research (DSR).

It was found that this segment needs more studies and that dashboards on these themes provide assistance in terms of monitoring and analysis.

Keywords: Customer Relationship Management; CRM; Mobile Application; Dashboards; Real Estate.

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List of Acronyms and Glossary

BI	-	Business Intelligence
Bok	-	Body of Knowledge
CBS	-	Cost Break-down Structure
CRM	-	Customer Relationship Management
DSR	-	Design Science Research
EDD	-	Enterprise Digital Dashboard
ERP	-	Enterprise Resource Planning
IS	-	Information Systems
IT	-	Information Technology
KPIs	-	Key Performance Indicators
PPSC	-	Promissory Purchase and Sale Contracts
PRE	-	Public Real Estate
PREM	-	Public Real Estate Management
RE	-	Real Estate
REMC	-	Real Estate Mediation Contracts
SLR	-	Systematic Literature Review
UI	-	User Interface
UX	-	User Experience
WBS	-	Work Break- down Structure

Chapter 1: Introduction

Over the years, a large number of organizations are becoming more and more computerized, which is leading to the spread of Information Technology (IT) within all the sectors in organizations, supporting their daily activities [1]. Organizations like Real Estate (RE) have been investing in IT platforms to provide better judgment and decisions [2].

RE consists of the propriety of land and buildings along with its natural resources. It also can be referred to as the role of purchasing, selling, and renting [3]. RE agents are responsible for selling or renting properties. IT can help them improve their work, consequently benefiting their organization [4].

RE organizations work with many data related to houses, lands, offices, and buildings for rent or sale. Plus, RE agents must deal with several customers (potential buyers) to help them fulfill their needs and goals. IT systems can already assist organizations, such as Customer Relationship Management (CRM) [4]. These systems enable RE companies to get closer to their clients with many of them referencing the good experience with it [3].

A CRM is a process and technology to improve the relationship between the organization and its customers and generate knowledge about the customer to later be reused [3]. CRM systems are not only accessible from desktops but they are also mobile. Since RE agents work in the field, this creates the need to access customer information everywhere, thus mobile solutions are advisable. Therefore, field agents get access to the information and share it more quickly, which may lead to cost-saving [4].

Nowadays there is a thirst for knowledge, and this leads to a greater amount of data. Some of these data are not usable or difficult to understand from a non-specialist point of view. IT can synthesize the important information and show it in a way that a non-specialist person can understand it [5]. Organizations need solutions that can provide updated information and summarize it in a way that a non-specialist person can understand and acknowledge it quickly [2].

Dashboards are an important tool to display brief information. They are concise and easy to understand, and allow for a smooth access and understanding of a large amount of data, improving decision making or management [6]. With the use of dashboards, the performance improves and this improvement is recognized organically [7].

Based on the previous paragraphs, this study aims to develop and tune a mobile CRM dashboard to assist RE agents in everyday tasks, allowing them to have access to information in a simplified way.

The remaining document is organized in this way: in the second chapter, State of the Art, is presents the Theoretical background of CRM, Dashboards, and some best practices of data visualization. This chapter also includes Relational Work information. In the third chapter, Research Methodology, the methodology used in the research is explained. The fourth chapter the presents the proposal and the results of the interactions are shown. The research summary can be found the fifth chapter, where the data obtained by the research will also be presented. The last chapter, the sixth, is the conclusion, which presents the main findings of the research, research limitations, lessons and future work.

Chapter 2: State of the Art

2.1. Theoretical Background

2.1.1. CRM

CRM is a set of guidelines, procedures, processes, and strategies to help organizations track all interactions with the client [8]. CRM is used to attract potentially profitable customers and improve and maintain a relationship with them [8], [9].

CRM allows for the creation of customer profiles, which, by analyzing all the saved information, provide a better perception of the client's needs, leading to customer satisfaction and a better customer experience [10]. All knowledge comes from records, emails, and calls, which are dynamically linked, creating structured data to support in decision-making and increased profitability [11].

CRM is about maintaining long-last relationships between the organization and customers. This relationship is based on trust from both sides, and it is crucial that the organization knows its customers, which is gained through CRM monitoring of several businesses, such as marketing, sales, operations and services, among others [8].

CRM Systems can be divided into three different types: collaborative, operational and analytical [12]. For instance, Operational CRM focuses on storing and integrating important customer information obtained from distinct data sources, and show it to the organization during the analysis. Analytic CRM is a continuation of Operational CRM, helping to complement the information the organization already has about the customer. Last but not least, with Collaborative CRM each collaborator works with each other to improve the services [11].

2.1.2. Dashboards

Dashboards started to be referenced as a board on the front of vehicles, being used to inform the driver about potentials malfunctions in the vehicle operation [13]. Today, dashboards are widely used to display critical information to users.

Humans cannot process great amounts of data to extract knowledge, and dashboards help with that limitation since they can aggregate the important information and present it in a more simple and interactive way [14]. They are powerful information panels, helping users conduct their decisions in the best possible way [13], [15].

There are several ways to present information through dashboards, depending on the purpose and the type of business: strategic, tactical and operational [16]. For instance, strategic dashboards focus on management and give an overview of the performance indicators, carrying out an analysis on how organizations are going and where they stand to face the established objectives. Tactical dashboards have the aim to give one prospection of the operations according to defined goals. Last but not least, operational dashboards are monitored by operators so they can see how the work is going and present what is wrong Siene as quickly as possible [16].

Dashboards are commonly used with Data Visualization, both being effective in what concerns information transmission. Data Visualization is the process of creating one perceivable image in a human mind, using a combination of visual elements, such as variables like color, positions and things that can be visualized (a person, the universe, wind, air hierarchy, relationships) in an interactive data exploration and respective graphic representation [17]. Both represent information in a visual form in a quick and easy way, the main difference being the amount of data they analyze. Data Visualization deals with most of the data available and Dashboard deals with a subset of that information, trying to transmit its big picture.

2.1.3. **Best Practices of Data Visualization**

One of the most important works published in the area of information graphics is *Semiology of Graphics* [18]. First published in French in 1967, Bertin's work opens the way for exploratory data analysis and information visualization. He was a cartographer by profession and developed an insightful theory of graphics based on his perception. Bertin's work inspired research in the field of information graphics and he also participated in the studies of cognition and perception [19]. For Bertin, the purposes of graphic representation were to communicate and analyze information. He mentions that to maximize the extraction of user information, graphic messages should be simplified and memorable. The first stage of human processing of information is vision, with graphic information being subject to six retinal variables [18].

- Size is applied to the graphic as points, lines and areas, and it describes a variation between dimensions. It is important to note that it is dissociative, in other words, it will overshadow any other retinal variable with which it is consolidated.
- Value describes the value between two objects on a surface. An order exists inside value variation, from the first to the second disorder, producing a graphic that is not appropriate for visual interpretation.
- Texture is the number of subjects in a certain area, like circles squares or lines. This type of graphics requires special attention because it can bring uncomfortable visual sensations.

- Color refers to the change between identical areas with the same value. It is necessary to take special attention to colors because they can create confusion in the user's mind, as they are similar, but one has data and the other does not.
- Orientation is a visual pattern created by many parallel signs building the perception of an orientation variation. Designers can't play too much with variations on orientation because they must be easily recognizable categories.
- Shape describes the change in the appearance of objects of equal-sized areas. It can have different forms such as circles, squares, triangles and others, which makes them much easier to distinguish.

All these variables express variations in a graphic and are frequently discussed in psychology to better define how humans work as well as to comprehend depth perception so as to transmit information more easily and effectively. These variables are tools for designers to create two-dimensional graphics. Therefore, understanding how to manipulate them is very important [20].

2.2. Related Work

For the related work, the used methodology was the Systematic Literature Review (SLR). This approach is set to identify, evaluate and synthesize the existence of completed and published work by researchers.

2.2.1. Outlining Systematic Literature Review

This SLR focus on finding literature contributions regarding dashboards for the RE. The research was carried out using the results from some of the principal databases:

- IEEE Xplore Digital Library (https://ieeexplore.ieee.org/);
- Web of Science (https://apps.webofknowledge.com/);
- ScienceDirect (https://www.sciencedirect.com/);
- ACM (https://dl.acm.org/);
- Scopus (https://www.scopus.com/).

Keywords used for the external search consisted of: "CRM AND Real Estate", "CRM AND mobile AND Real Estate", "Dashboard AND Real Estate", "CRM AND Dashboard AND Real Estate", "CRM AND Dashboard", and "CRM AND Mobile AND Dashboard". They are basically word junctions of all keywords, aiming to find works similar to this study. Then some filters were applied (Table 1).

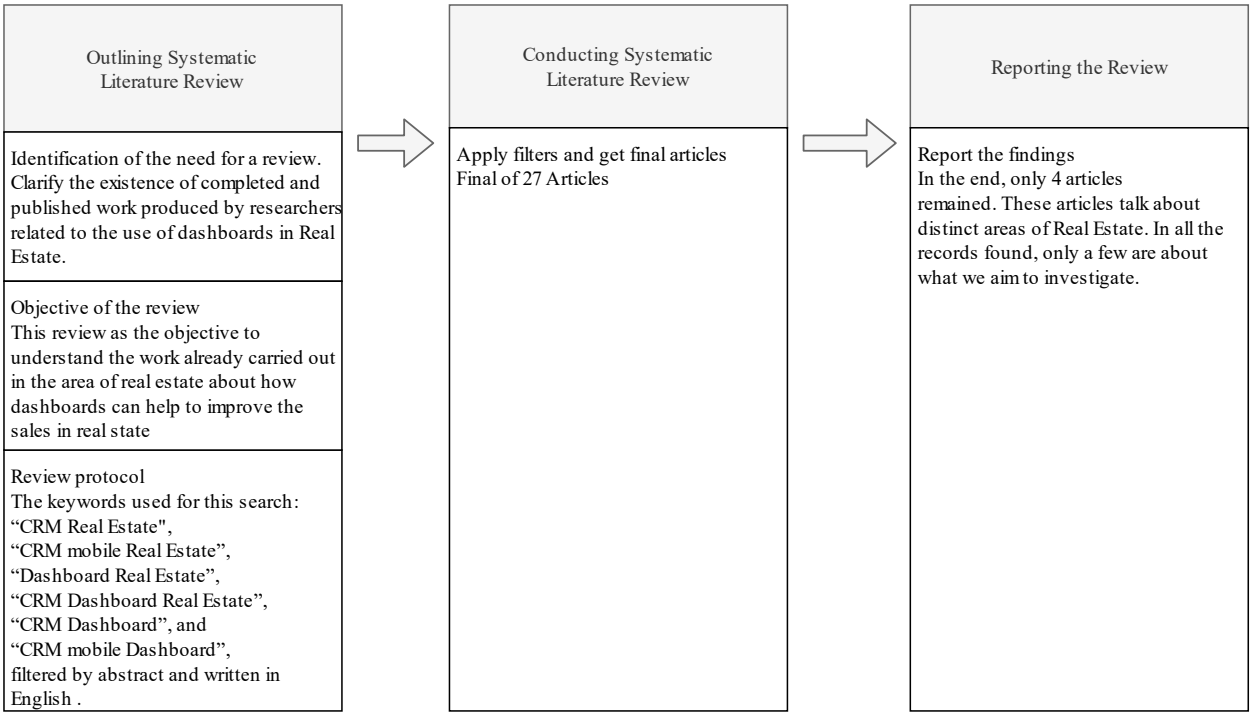


Figure 1 – Systematic literature review stages.

Table 1 – Filtration set-up

Filter	Description
1st filter	Search for articles where keywords were found in the abstract.
2nd filter	Consider only articles in English.
3rd filter	Exclude the duplicated articles.

2.2.2. **Conducting the Systematic Literature Review**

Following the SLR methodology, a survey was carried out in libraries and databases, resulting in a total of 2400 articles gathered. From that list, using abstract as the first filter, 2352 articles were discarded. The next filter was language, so only articles in English were considered. For that reason, 7 articles were removed from the previous filter, and, among those remaining articles, 14 were duplicated. This means only 27 articles remained to be analyzed (Table 2), as presented in Figure 2.

The first step was to analyze the articles according to the industry they related to. The purpose was to understand the relationship they might have with the RE or if they might be related to the key technologies that this study abords, like CRM, Mobile and Dashboard. This information is presented in a tabular format (Table 3). Unfortunately, 11 articles were not available for free, being identified as "not available", so we ended up disregarding them for this study. This left us with 8 articles focused on the RE industry and 8 about other industries, such as Construction and Health.

Table 2 – Filtration process

Data Base	No filter	1st filter	2nd filter	3rd filter
ieeexplore	6	4	4	3
web of science	26	16	12	9
ACM	393	0	0	0
scopus	762	27	24	15
sciencedirect (Elsevier)	1213	1	1	0
Total	2400	48	41	27

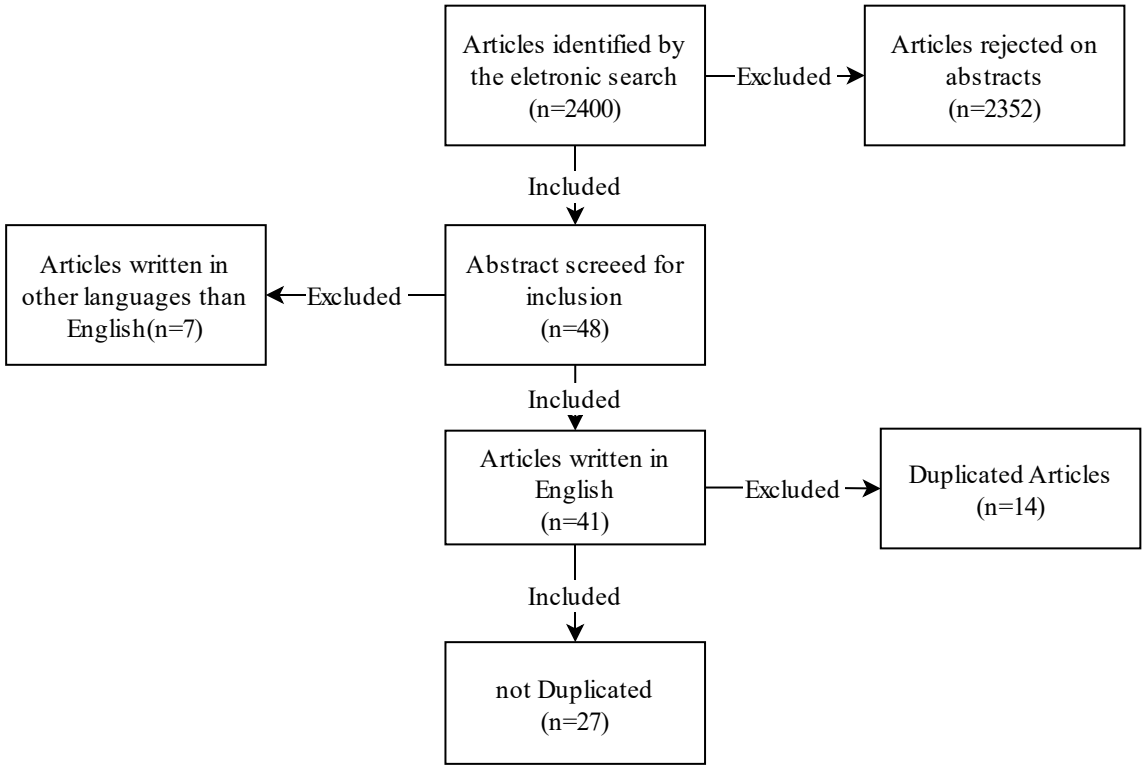


Figure 2 – Flow of all SLR selection processes

2.2.1. **Reporting the Review**

To structure all the information gathered from the literature, we started by analyzing the industries not related to RE. This analysis is displayed in Table 4. The topics are very disparate and only two are related to dashboards. Next, we introduce a summary concerning what is investigated in each study.

The authors in [21] verified that there is a lot of diabetes self-management apps that gather a lot of data. This paper tries to understand how well these applications can translate the collected data into information to the user, in a way that they can understand it. They try to demonstrate that future mobile apps will need to take advantage of automation and connected sensors and increase processing power and User Interface (UI) usability and dashboards.

Table 3 – Articles found by key technologies

Industry	References	Real Estate	Mobile	Dashboard	CRM
Construction	[22]	✓	-	✓	-
Health	[21]	-	✓	-	-
	[23]	-	-	-	-
Not specified	[24]	-	-	✓	-
	[25]	-	-	-	-
	[26]	-	-	-	-
	[27]	-	-	-	-
	[28]	-	-	✓	-
Real Estate	[11]	✓	-	-	✓
	[4]	✓	✓	-	✓
	[29]	✓	-	-	-
	[30]	✓	-	-	-
	[31]	✓	-	-	✓
	[32]	✓	-	-	✓
	[3]	✓	-	-	✓
	[33]	✓	-	✓	-

Furthermore, those authors found 13 participants of different ages, females and males, who used different applications. Then they start to interview each one of the participants and gather their inputs about their diabetes applications. In the end, they verified that there is still a large gap between data collection and a better decision-making process.

S. Lafia, J. Xiao, T. Hervey, and W. Kuhn [27] wanted to track voice commands used in virtual assistants services and use them in Geographic Information Systems. This would provide the users with public information about one's location, like transportation and accommodation, and examine the benefit from geospatial data. The proposal is a conceptual model to help users organize and provide a patch to get to that location. The voice assistants following this proposed framework, would organise contents based on information provided for the user on their spatial concepts, suggesting data and operations.

In the development of accommodation area [22], dashboards are used to view the progress, give information about the construction and its associated costs. In this study, a model was created to allow for the consumption of information through several databases. These connections help to get the data for posterior data visualization in a web-based application.

Table 4 – Articles found concerning other industries and respective results.

Industry	References	Results	CRM Features	Metrics
Health	[21]	The way information is presented to users is very important for them to be able to understand it.	NA	NA
	[23]	Dashboards help to better understand when a lot of information is obtained and they also help to understand which path the data is taking, making it possible to try to understand where the data will be.	NA	NA
Construction	[22]	Dashboards contribute to faster and better decision-making	NA	S-curves show portfolio progress to assess the overall situation of company projects in a summarized way; interactive color map based on the progress of each project; The layout concerning the progress of activities is the last dashboard in the report, showing the status of each activity;
Not specified	[26]	It is not necessary to be a good programmer to create a mobile application that stands out from the rest; however, it is essential to have a good presentation of the information, making it clear and noticeable.	NA	NA
	[27]	There is a lot of public information that can be used in different ways.	NA	NA
	[25]	It is necessary to improve how organizations are structured, in such a way that the consultation of information is more accurate.	NA	NA
	[24]	These reseat confirmed the necessity to evaluate Business Intelligence (BI) competencies and the constant need to continually improve them so as to achieve better decision support environments.	NA	NA
	[28]	A dashboard must make decision-making easier and better, allowing access to information in real time and highlighting critical events.	NA	Revenues by SBURevenues target vs. actual by SBURevenue forecast by SBUSales volumes by SBUProduction volumes by SBUTop dealers by SBU Profit margins by SBU

This web-based application grants visualization of interactive dashboards of progress layout from each level of Work Breakdown Structure (WBS)/Cost Break-down Structure (CBS), and the state of each project. This article was applied in a real case and as a result, the dashboards produced were willing to:

- Show an overall situation of the company's progress with a map with all projects' localization;
- Show an S-curve for contact and projects;
- Show the progress of the projects;
- Show the status of activities in progress.

The developed model supports monitoring performance, allowing to make decisions more thoroughly, which leads to better business decisions through the dashboards. The analysis is quickly, allowing to take action on time. Through the Oracle database, it was possible to update information and make it immediately available to users.

The authors in [26] show how to create new apps that can differentiate out from the ones that already exist in the stores. The authors of this book already released successful apps and give some examples and tips about how to get to that level.

To create this special application, there is little need for coding since user experience (UX) is more important. This book starts to talk about presenting data and how to use Apple's UI to take advantage of their usability. The next stages are about presenting and navigating through large amounts of data; how to integrate with native applications, such as the address book and the camera; how to manage presenting lots of information over the dashboard and how to create the balance between simplicity, beauty and features. In the end, programming capabilities can give a beautiful final touch to the application.

F. Fouad [25] suggested a structure model that defines and characterizes and implementation level of the corporate and clarifies why it is utilized to select and control supervisors choices based on the following factors: characterize an organization relationship; explain how the internal tools are used to screen and control implementation management choices; impact on the key choices of implementation; perceive how corporate framework encourages moral choices; understand how governance instrument goes about as a restriction on top-level supervisors choices.

TOGAF, COBIT can be presented as an individualistic governance framework with little maturity of the corporate operational environment, to improve IT. Most of the framework work in the governance, like TOGAF, COBIT, ITSM, BSC, ITIL, SOA, should try to adjust IT to business goals.

[24] identified that most organizations lack experience in Business Intelligence (BI) when they implement their systems like Enterprise Resource Planning (ERP), CRM, and Supply Chain Management (SCM). This ends up in systems that can be improved. This study proposes a tool to evaluate BI competencies of enterprise systems.

This tool will analyze the enterprise systems in six factors "Analytical and Intelligent Decision-support'', ''Providing Related Experimentation and Integration with Environmental Information'' ''Optimization and Recommended Model'', ''Reasoning'' ''Enhanced Decision-making Tools'', ''Stakeholder Satisfaction'' and then present the results in dashboards. For this study, a survey was carried out to CIOs (Chief Information Officers), IT Managers, and IT Project Managers in a total of 185 answers. At the end of the study, the authors concluded that the organization can make better decisions for designing, selecting, evaluating, and buying enterprise systems, which will create a better decision-support environment.

J. Ganesh and S. Anand [28] discuss a solution based on Web services in Enterprise Digital Dashboard (EDD). They explain the solution already implemented and propose a reference architecture for it. EDD offers business decision-makers a unique view with monitored metrics that are easy to understand and, improving the efficiency and effectiveness of these decision-makers, they present the following characteristics:

- Facilitate Faster and improved decision making;
- Enhance sense and response capability for the enterprise;
- Improved enterprise agility.

There are also challenges, such as different data types, technologies, locations, ownerships, and data structures. Some of the issues and challenges that were identified in the solution already implemented constituted an incomplete view of the data. The proposed architecture needs to address the following issues:

- Provide a composite view of data;
- Develop shared data services that can retrieve information for a set of related applications;
- Design service contracts based on the needs;
- Provide information on demand;
- Enforce data security;
- Provide a service layer that guarantees data consistency across all systems.

Addressing these issues, the new service will contribute to cost reduction, make business applications flexible, bring transparency to the model application, provide unified data usage and patterns across applications.

We will now take a closer look into RE industries (Table 5). The themes are very different and only one talks about dashboards. Next, we present a summary of the article's intentions.

[4] investigates how mobile applications can better control customer processes and if it is a profitable implementation. This study analyses the existent ERP of a RE company and then compares it with a new implementation that supports mobile application, in order to understand the benefits of the transition to mobile.

Some functions in the app were the following: taking photos of documentation directly in the form; signatures; adding notes to the form; searching for forms and user profiles; geo-localization function to store this information in the form; forms can be converted to PDF and sent e.g. by e-mail; online and an offline mode; and fields that can be stored with catalogs, also hierarchically. As shown in the study, a comparison between the previous state and the one after the introduction of the application concludes that the use of mobile applications is not an expensive option but can optimize and accelerate business processes.

Customers generate profit in RE. Although keeping a healthy relationship with customers is no easy task, ICRM can help us achieve that goal. [11] created a CRM with multiple information sources and information types, obtaining information from the customer throw records, calls, and emails. All of this information dynamically linked provides the current state of the customer. When is identified a customer status is appraised as neutral, it is necessary to identify marketing strategies that have been successful in previous similar cases to this identified customer to use in this case.

The authors recommend some strategies to improve customer services:

- Make predictions on resource planning based on how long a particular defect category takes to fix;
- Make predictions on which defects tend to occur together;
- Identify the most commonly occurring sub-category of defects in a building;
- Obtain insights for identifying the reasons why it is taking a long time to resolve a case.

Table 5 – Articles found of RE industries and its results

References	Results	CRM Features	Metrics
[4]	Mobile applications help representative salespeople a lot because they get access to updated information and react accordingly.	Take photos of documentation directly in the form; Signatures; Add notes to the form; Search for forms and users profiles; Geo-localization function to store this information in the form; Forms can be converted to PDF and sent e.g. by e-mail; Online and offline mode; fields in the form can be stored with catalogs, also hierarchically;	NA
[11]	CRM helps to improve and strengthen the relationship with customers	Create tickets	NA
[32]	CRM is a tool that can make full use of network marketing	NA	NA
[30]	It is important to have good customer relationship management to be able to listen to customers and meet their expectations	NA	NA
[3]	CRM is important to identify customers' behavior and preferences and, with this information, generate long and profitable relationships	Assists in the preparation of the agreement keeps the customer posted about the project Coordinates site visits and respond to all queries. Assists the customer in obtaining a home loan. Assists the customer in documentation registration.	NA
[29]	Through a good visualization of data on time, it is possible to make important decisions to reduce costs and make the institution's operations more effective.	NA	NA
[31]	To build a CRM, it is very important to first understand the needs of the target audience, so as to provide better satisfaction	NA	NA
[33]	Dashboards are a great tool for transmitting knowledge to different types of people.	NA	Real-time Environmental data dashboard in Hong KongHousing densities Dashboard in the City of Saratoga Springs, UT, United StatesProperty development Explorer dashboard in the City of Yakima, WA, United StatesProperty panel in the City of Los Angeles, United StatesLondon City DashboardDublin City Dashboard.

H. Zhou, X. Zhou, Z. Wang and X. Zhang [32] identify its multiple problems in the network marketing of RE enterprises and propose a CRM to help with these problems. First, they analyze the main principles of RE website construction: establishing a corporate image; optimizing enterprise internal management; improving enterprise sales potential; and improving added value. Then, they gather the principal points for an implementation of RE enterprise network marketing, such as determination of marketing goal, determination of target customers, the establishment of the network planning and overall strategy, establishment of appropriate feedback mechanisms, risk prevention in RE online trading.

Lastly, they identify the differences between a network marketing using a web site and one using CRM: data segmentation; improving the management of the whole marketing process; product lifecycle management; improving customer service system and customer satisfaction; and full unified custom management.

The problem identified in [30] was the increase of luxury housing in the market, making the purpose of this study a way to innovate business solutions based on E-commerce of e-catalog ontology. There are two conceptual methods for Ontology Structure based on E-catalog. The first is related to a common criterion and the other is about quantifying the relationship between concepts of trust. The authors found little data because the concepts are not quantifiable or reliable. This study proposes an automatic ontology, based on online research, that takes the approach to marketing ontology in luxury homes in order to find the connection between ontology and quantifying the relationship of messages.

P. S. Sarathy and S. Patro [3] approached customers to understand how they could improve their service. This way, they found that customers wanted their doubts and queries to be replied almost immediately. So, they decided to create a team to handle customers and a CRM to better describe the products and help to discuss financial and technical specifications. In the CRM some important data were collected about the customer, such as contacts, special dates purchase history, and occupational details. With this information, is possible to better understand customers' needs in order to develop long-term loyal and profitable relationships, and also understand customers' behavior and preferences. CRM helps to establish a relationship with clients and also to gain their loyalty in the long term and, as a result, this CRM model was implemented in other RE companies.

J. E. Mather [29] proposes a way to find the best relation between occupancy and the cost to get the best revenue possible. With the increase of the occupancy and the reduction of the accommodation costs, they improved their metrics and developed dashboards to help enhance the occupancy plans with better approaches to analyses and data collection. Initially, all the data was dispersed over several sources, which meant aggregate all the information, normalize it, and making the data readable, which cause difficulties such as time consumption. These difficulties highlighted the need to create a central database, communicating and storing the information of the different systems.

High-level occupancy planning can be divided into a few steps: identification of sub-profiles for analyses, review of demand drives and possible RE initiatives, supply-demand comparisons, performance metrics, and plan development. When all these steps are analyzed, it is possible to understand the business and its gaps. Then the study used the simulation method of Monte Carlo to assess the plans developed. At the end of the simulations, a High-level occupancy was proposed to be put into practice.

The important key factors affecting customer relationship management in real estate were study by [31], making 425 questionnaires to persons that have bought a house or flat in the last two-year or intending to buy in the upcoming years. Various factors were identified and discussed as key factors that affect customer relationship management as "communication facilitations", "basic amenities facilitations", "service and support facilitation" and "deliverables facilitations".

From this list of factors, the most important factor identified was "basic amenities facilitations". These nine variables were loaded as:

- Sample flat;
- Neat and clean builder office with the proper sitting arrangement;
- An appealing interior and exterior decorations;
- Scouting during the visit;
- Arrangement of tea/coffee/refreshment;
- Proper amenities availability;
- Kids entertainment and playing area;
- Dummy/map of projects;
- Arrangement of safety and security.
- RE players should focus on "basic amenities facilitations” once is the most dominating factor that affects the CRM in the real estate sector.

Was identified a lack of data and information by [34] on public real estate (PRE) has a common problem in asset management performance until recently. The objective of this study is to define a conceptual framework for a city dashboard to support Public real estate management (PREM). For a city, dashboard is understood as knowledge, managerial, and participatory tool that can collect, map and catalog, and update and share property data.

This study uses dashboards because they play a key role in the assessment of the performance and offers a great opportunity to deal with structural problems as the deficit in terms of knowledge, transparency, and strategy.

In the end, they propose a conceptual framework to develop a city dashboard for PREM. The approach proposed innovation as a process and an instrument for providing knowledge to different types of users.

In this analysis is possible to extract some interesting information at this point. This way, only 5 articles talk about CRM and only four about dashboard, so we had to leave behind 7 articles hat mention these keys but in which they are not the focus. Of these four focused in dashboards, three do not focus on the industry of RE and the one that is about RE is about better control of smart cities, differering from our focus, which is selling or renting houses or land.

With the information analyzed from the SLR, it is possible to note that little evidence exists about mobile dashboards for RE. This reveals a gap in the RE industry, which this research intends to explore.

Chapter 3: Research Methodology

Design Science Research (DSR) is the research methodology adopted for this research. This methodology is used when the main objective of the research is to broaden the limits of human and organizational abilities in creating new outputs [35]. In this research, DSR methodology is used to design, construct and assess the dashboard that will be created. Considering other archetypes of research, DSR allows for the possibility of creating real value once the outputs are developed [36]. This approach shall include three components: conceptual principles which allow defining the DSR, practical pules to impersonate the DSR, and procedures to execute and control the research [36]. The DSR Methodology application can be seen in Figure 3.

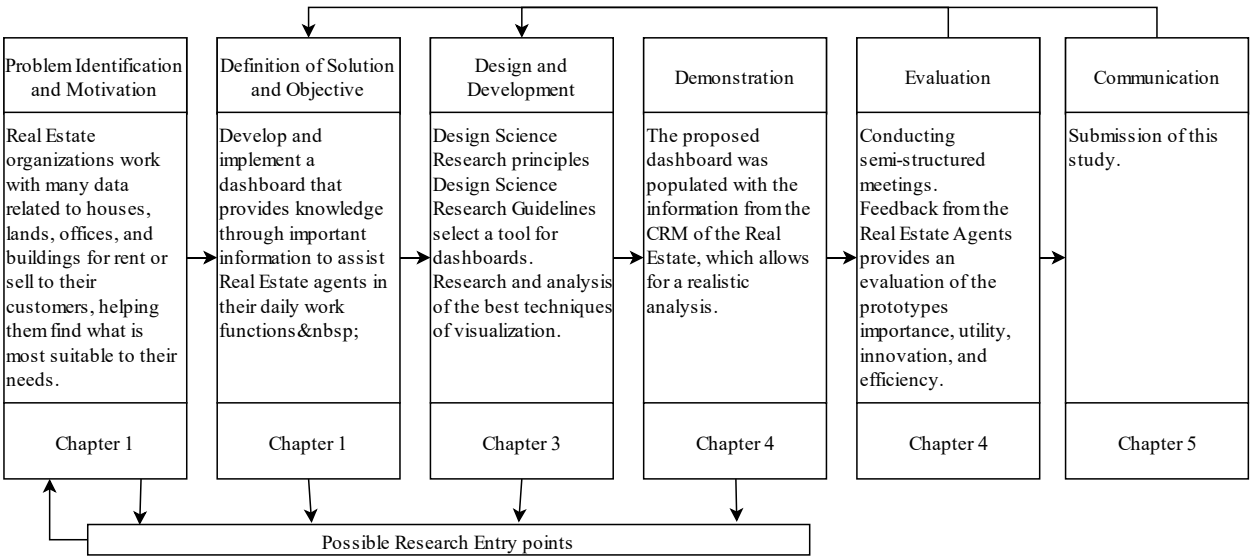


Figure 3 – DSRM Process Model Followed

DSR principles are based on Information Systems (IS), which have the objective of increasing organization efficiency [37]. Based on this, the authors follow the principles:

- Abstraction – The research consists of the development of dashboards to make information available quickly and easily to any real estate agent, through a mobile application. The indicators are from a Real State Agency in Portugal;
- Originality - The artifact is not in the body of knowledge (BoK);
- Justification – The justification for the panels is based on the evaluation by the proposed methods. Conducting a qualitative interview with real estate agents and their inputs made ir possible to add great value to this artifact;

- Benefit - The development of dashboards allows consulting information about properties or clients, so the latter make the right decisions on time. This added value can help improve organizational performance.

These principles alone do not explain the applicability and added value of design science, so we also follow the DSR guidelines proposed by Hevner [35]. Table 6 shows the DSR guidelines for this research.

Table 6 – Design Science Research Guidelines

Guideline 1: Design as an Artefact
The artifact proposed by the research is a dashboard of organization indicators and production
Guideline 2: Problem Relevance
Need to have a dashboard on production that allows the analysis of each geographic zone.
Guideline 3: Design Evaluation
Semi-structured interviews. Evaluated by interviewees who will use dashboards, which provides greater credibility.
Guideline 4: Research Contributions
A new artifact is not present in the body of knowledge.
Guideline 5: Research Rigor
The procedures and principles of DSR were taken into consideration so as to increase the credibility of the artifact and the contribution of the research. Charts color's guidelines by Stephen Few. Gestalt theory recognized that we organize visual perception.
Guideline 6: Design as a Search Process
The result obtained is the fasted access to information. Combination of visualization's best practices for prototype development.
Guideline 7: Communication of Research
Submission and publication of this study in ISCTE repository.

The use of colors in a dashboard is one of the common strategies for achieving user satisfaction. According to the literature [38], there are nine rules that should be followed in order to facilitate the interpretation of information by the user. These rules are listed in Table 7.

Table 7 – Rules for Using in Charts [38]

Rule	Description of rules
Rule 1	If you want different objects of the same color in a table or graph to look the same, make sure that the background of the color that surrounds them is consistent.
Rule 2	To give highlight to a table or a graph, use a background color that contrasts sufficiently with the object.
Rule 3	Use color only when needed to serve a particular communication goal.
Rule 4	Use different colors in different data or meaning
Rule 5	Use soft colors to information, leaving the shining to highlight information that requires greater attention.
Rule 6	When using color to a sequential range of quantitative values, use a small set of colors and vary it is intensity from darker to brighter in high values.
Rule 7	Non-data components of tables and graphs should be displayed just visibly enough to perform their role, in order not to distract attention from the data.
Rule 8	Some of the people that are colorblind cannot distinguish red from green. To guarantee that they can distinguish groups of data, one must be avoid the combination of red and green in the same display.
Rule 9	Avoid using visual effects in graphs.

The principles of Gestalt's visual perception help to understand the visual characteristics that assist us in grouping objects together. With this, is possible to understand the elements that are crucial and the ones that are not. In Table 8, one can see the six principles of Gestalt Theory of visual perception coaches.

The evaluation of the artifact will follow the Research methodology evaluation of Semi-structured interviews, which are a usual method for qualitative research [39]. Here one will evaluate the dashboards in terms of positive and negative aspects, as well as improvements of the proposed dashboards.

During the evaluation phase of the proposal, RE agents were interviewed (Table 9). The interviews allow us to understand the positive and negative aspects of the artifact after each improvement.

The answers to these questions are structured in Table 10, with four columns and tree rows that represent the pros, cons, and proposed improvements sections. The first column represents the following section: pros are the positive aspects identified by the interviewees, cons are the negative aspects identified by the interviewees, and the proposed improvements are proposed by the interviewees or even by the author. The ID column is the identifier of each aspect concerning the sections. The third column presents the synthesis of the points obtained from the interviews. In the fourth column one can the complete idea of each point can be found.

Table 8 – The Gestalt principles of visual perception

Principles	Description of the principles
Proximity	Close objects turn to be identified as groups due to their closeness.
Similarity	Objects with visual shapes, colors or sizes in common are perceived as belonging to a group.
Enclosure	Objects with visual shapes, colors, or sizes in common are perceived as being related or part of the same group.
Closure	Graphs with closed regular forms turn to be naturally perceived.
Continuity	An object is aligned with another seem to belong to the same group transmitting the feeling of continuation from one to another.
Connection	When objects are connected in some way like a line they become a part of the same group.

Table 9 – Key Evaluation Questions

Questions
What are the negative aspects of the proposed dashboard?
What are the positive aspects of the proposed dashboard?
What improvement proposals do you intend to make, regarding the proposed dashboard?

After each evaluation of the iteration, a table gives rise to a new one, with pros, cons and proposed improvements found during the iteration.

Table 11 represents the structure of Tables 13, 15 ,17, 19 and 21. This table main focus is to help analyze the proposed improvements in terms of type (visualization, information and navigation), if they were implemented or not, who suggested the improvement (author or interviewee) and the image of the implementation if the improvement was implemented.

Table 10 – The Prototype Evaluation table structure

	ID	Interviewee synthesis	Interviewee Opinions
Pros	-	-	-
Cons	-	-	-
Proposed Improvements	-	-	-

Table 11 – Improvements table structure

PI	Proposed improvement	Type improvement	Implemented?	Who suggested?	Figure
-	-	-	-	-	-

Chapter 4: Proposal

The proposed CRM dashboard is related to a PhD thesis [40], that studies the mobile CRM system applied to the RE industry. This study aims to give continuity to it, focusing on dashboards and data presentation, and understanding what information should be presented to the user and how.

Five semi-structured interviews with RE agents were performed to validate the proposed dashboard through an iterative DSR process. Each interview resulted in a DSR iteration that helped validate, consolidate and improve the dashboard.

The first three interviewees participated in the previous work [40] and the other ones were referrals from direct contacts. The criteria for the interviewees were for them to have at least one or more years of experience in RE industry as agents, and that each iteration was from different companies/regions. In table 12 there is a list of interviewees who contributed to this process.

Iteration one and three had both two interviewees, who are co-workers, giving their contribution at the exact same time.

The interviews were carried out remotely since they occurred during the Covid pandemic. On average, each interview took 40 minutes and was divided into two phases: the first part consisted of the dashboard presentation and navigation. This was performed using a shared screen and allowing the interviewees to navigate through the dashboard; the second part consisted of the questionnaire response phase. The questions of this questionnaire are presented in Table 9 and in Appendix A.

Table 12 – Data of the interviewees

DSR Iteration	Gender	Age	Role	Years of experience	Graduation
1	Male	48	Chief Executive Officer	20	Bachelor
	Female	50	Chief Executive Officer	20	Master
2	Male	35	Consultant	7	High school
3	Male	30	Consultant	4,5	High school
	Female	29	Consultant	1,5	Master
4	Male	43	Consultant	1	High school
5	Male	31	Consultant	5	Postgraduate

4.1. First DSR Iteration

Five iterations were performed to improve the prototype, following the DSR methodology.

This section provides details about the phases of each iteration: proposal, demonstration and evaluation. Using fictitious data, an environment closer to real data was created to present a dashboard that can be related to an interviewee's experience.

4.1.1. **Proposed Dashboard**

The development of the panel was divided into several steps, distributed in the next phases. The first is about finding what the user wants to see, and how, in a dashboard; the second is the application process of creating the dashboard; the last one concerns the development of the dashboard.

4.1.1.1. Research and Analysis

To propose some dashboard was needed to know what the main metrics are, that is what the professions want to see, to understand their performance allowing to improve decision support.
The KPIs used in the proposed dashboard were obtained from a previous work [40], and are as follows:

- Number of Leads;
- Number of Sales;
- Number of Fundraising;
- Number of Scriptures;
- Number of Proposals;
- Number of Presentation of Services;
- Number of real estate mediation contracts (REMC);
- Number of promissory purchase and sale contracts (PPSC);
- Prospecting time by day;
- Billing Information by day.

4.1.1.2. Application Design

During the application design, a use case diagram was created. Figure 4, one that allows the user to manage his data, to add data and check that information later whenever needed. There is an area capable of synthesizing all the information related to leads, sales, fundraising, scriptures, proposals, presentation of Services, mediation contracts, promissory purchase and sale contracts, time prospecting and invoicing in only one place.

For each role represented in the use, an Activity diagram was created to depict the behavior of each role in Appendix B. First, in Figure 18, there is a diagram regarding the data management, where it is possible for the user to introduce data correctly in the database. Next, in Figure 19, it is shown that the user will have access to a list of data and they can select one record to see all of its details. Finally, in Figure 20, all the data is gathered on only one screen and there is a summary of all the information.

4.1.1.3. Development

Application mockups were designed and made. Appendix C shows the first draft of how to group the information and colors used. The graphic choices were made to show the required information using some guidelines.

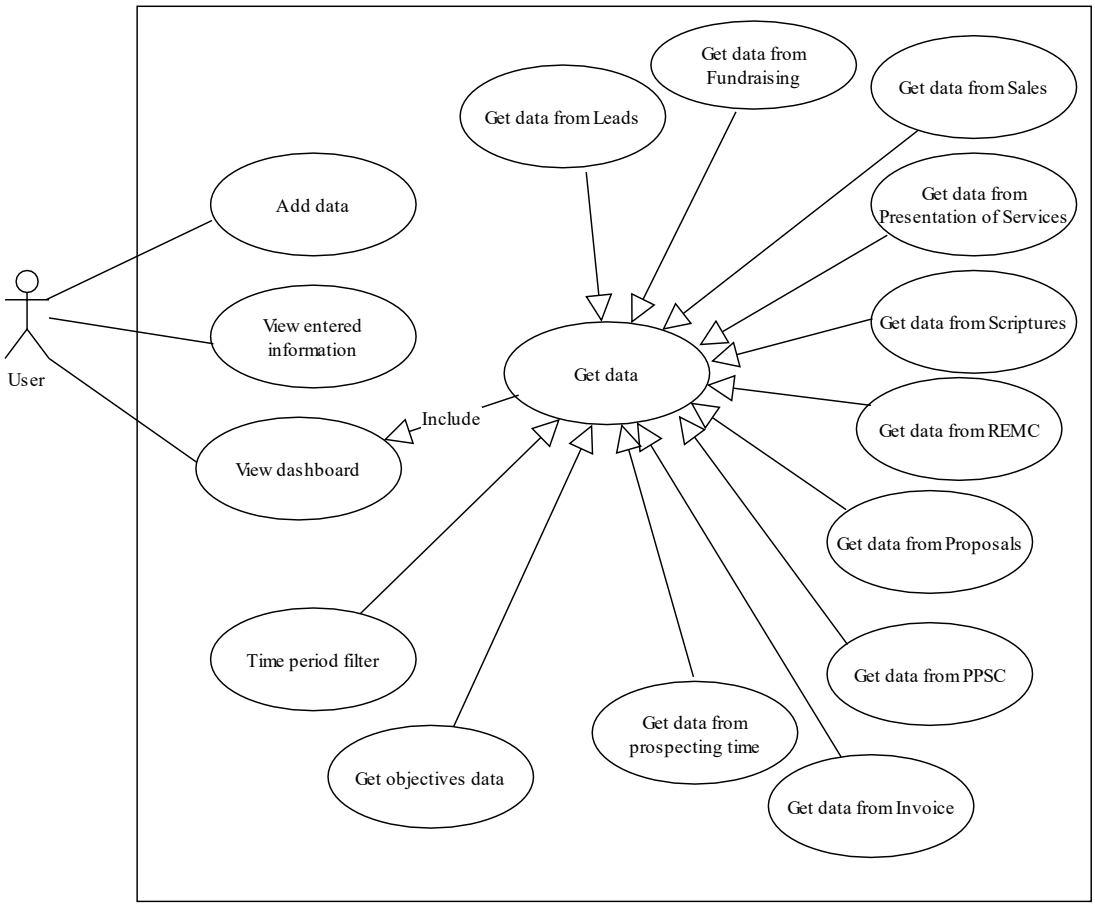


Figure 4 – Application Use Case Diagram

The use of colors can be an advantage to create a good dashboard, as they facilitate the process of understanding the information. To obtain a good dashboard, it is necessary to take into consideration some good colors practices, which are presented and explained in books such as [41][42].

Gestalt's principles help to understand how visual elements are essential to the transmission of information and the ones that need some improvement. Some authors explore these principles in their works [41][42][43].

For the first iteration, a mobile application was created using Flutter, a Dart framework that allows for cross-platform programming, making the application compatible with both android and iOS operating systems. For storage, all the data generated by the application was used in the Firebase.

The dashboard contains all the sales information regarding the sales cycle of a property. The data contained in it is fictitious, an environment was manipulated transmitting the idea that the interviewees were seeing their results.

4.1.2. **Demonstration**

The panel presentation serves to present the artifact in terms of usability, navigability, and the way information is presented, which allows for a better examination of KPIs. Table 9 presents the concerns obtained during the interviews and which contributed to the improvement of the artifact.

The proposed dashboard in Figure 5 and 6 is divided into four parts. Firstly, there are the main counters, so as to get a quick idea of the global performance of risings and sales. In the next section, there is one pie chart with more counters and with more detail of the sales process. In my proposal, it is a pie chart because all four counters should have similar values, as when they are too different it means that the one with a smaller size needs more attention. The third section is where the users can understand the time that they have spent in prospecting during the month. Finally, in the invoicing group, it is possible to see the goal marks for the year and the received incoming.

The dashboard is idealized following the lights from Gestalt principles (Proximity, Similarity, Enclosure, Closure, Continuity and Connection) and the color rules, with more focus on rule four and five, using soft colors and separating the different objects by different colors. The main purpose is to create something easy to read, by providing useful information for decision-makers.

4.1.3. **Evaluation**

Table 13 presents the feedback obtains from the first interview/ presentation performed through Zoom. In this interview/ presentation, it was validated whether the gathered KPIs to make were the right ones and the feedback obtained was: two positive aspects, three negative aspect, and four improvement proposals. The positive aspects are related to how the information is available and how easy it is to understand it, which enables quick and accurate access to information.



Figure 5 – Dashboard perspective – 1st Iteration



Figure 6 – Dashboard perspective scrolled down – 1st Iteration

The negative aspects are associated with improvements, allowing management to see the work of the people above them in the hieratical structure, help the user understand the data responsible for the values presented in the items of the dashboard, and to help understand the time spent in prospecting by turning visible the values of the chart. Also, in improvement proposals, there is the suggestion to show the number of leads distinguished by lead type, so as to help understand what is generating more leads.

4.2. Second DSR Iteration

At the end of the first iteration, an analysis of the feedback collected from the interviewees is presented in Table 13. A presentation and some explanations were carried out, regarding all raised topics during the interview.

4.2.1. **Proposal**

The improvements proposed in the first interview are synthesized in Table 14, enabling a new perception of them. All improvements proposed were suggested by the interviewees and all four of them were implemented.

Table 13 – Evaluation of the prototype – 1st Iteration

	ID	Stakeholder synthesis	Stakeholder Opinions
Pros	P1.1	Information easy to understand	The proposed dashboard has the advantage of being able to view information about all business phases and validate how we are facing the proposed objectives.
	P1.2	The way in which the information is made available was well-conceived	The way of displaying information is well-accomplished. The color and the way of showing the information are easy to understand
Cons	C1.1	The supervisor cannot see information about his/her team	Management or commercial management cannot see information from consultants
	C1.2	Prospection of time is not explicit about its numerical greatness	It is not clear if the prospecting time refers to hours, minutes, or days
	C1.3	Difficult to understand which records gave rise to the information presented	It is not possible to understand what information gave origin to the data presented in the dashboard.
Proposed Improvements	PI1.1	View the number of leads in their different types	Be able to visualize the separation of prospecting leads from buying customers leads
	PI1.2	Allow the supervisor to see information agglomerated with that of his team	Allow the supervisor to see your team's information, allowing to understand its evolution
	PI1.3	Prospection of time to have information of the quantity used	Prospection of time chart showing the information on each bar of the represented value and the associated metric.
	PI1.4	Allow to drill down	Provide a way to understand what information is entered behind the numbers presented

Table 14 – Implemented Improvements – 1st Iteration

PI	Proposed improvement	Type improvement	Implemented?	Who suggested?	Figure
PI1.1	View the number of leads in their different types	Information	Yes	Interviewees	7
PI1.2	Allow the supervisor to see information agglomerated with that of his/her team	Information	Yes	Interviewees	8, 9
PI1.3	Prospection of time, so as to have information of the quantity used	Visualization	Yes	Interviewees	8
PI1.4	Allow to drill down	Navigation	Yes	Interviewees	-

4.2.2. **Demonstration**

In Figure 7, it is possible to check the implementation of PI1.1. This implementation is shown to the user in the form of a popup, making it possible to consult the total number of records that exist in the system of leads, the leads from prospecting, and the leads from buyer clients. This pop up appears when the user clicks in the leads number.

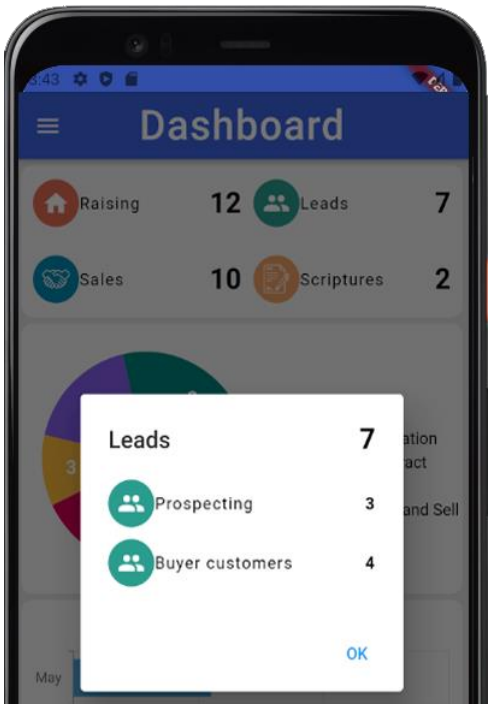


Figure 7 – Dashboard perspective deferments types of leads – 2nd Iteration

The implementation of PI1.2 aims to allow the supervisor user to have a view of their data and another one with their data and the data of the ones above them in the hieratical structure. In Figure 8, it is possible to see a dashboard with the user data, and in Figure 9 a dashboard with the information of their team.

PI1.3 is related to the prospecting time chart. In this chart, at the end of each column the corresponding value was added. This change can be seen in Figure 8.

PI1.4 was a change made in all objects of the dashboard, making all elements clickable, allowing the user to click in an element to see the list of data, which contributes to what is represented in the dashboard.

4.2.3. **Evaluation**

After the second interview, the result was two positives, two negative aspects, and five improvement proposals shown in Table 15. The positive aspects are related to the disposition of the information and the colors used, which were similar to the ones used in the notes of the interviewee.

The negative aspects are related to allow the user to select the period during which they want to see the dashboard, to see the numbers in the invoicing chart. To the interviewee, the commercial life is related to numbers, this leads him to find it is essential to see the exact number associated with each element of the chart.

Some proposed improvements are associated with the negative aspects and the others are to divide the total numbers of sales in shared and full. This change is similar to the previously proposed in the first iteration, but this time it is a different group, and the other one is a view to the agenda that helps the user understand how the latter is, helping them remember their important tasks.



Figure 8 – Dashboard perspective of a consultant – 2nd Iteration



Figure 9 – Dashboard perspective of a supervisor – 2nd Iteration

Table 15 – Evaluation of the prototype – 2nd Iteration

	ID	Stakeholder synthesis	Stakeholder Opinions
Pros	P2.1	"Dashboard has a good layout"	The proposed dashboard has a good layout
	P2.2	"Good choice of colors"	The colors used in the dashboard are the same used in agent notes
Cons	C2.1	It is not possible to distinguish this year's data from the one from the previous year	There is no option to see information in a determined period. It would be interesting to be able to compare this year's data with last year's data.
	C2.2	Invoicing numbers are not directly showing the chart	It will be better to show the value of the invoices to easily see the values that were accomplished by a specific month
Proposed Improvements	PI2.1	Filter dashboard data in time	Allow the user the possibility to change the date period of the data shown in the dashboard by adding the choice between this year, last year, a trimester, or a data range.
	PI2.2	Invoicing chart turn numbers visible, like time prospection	Invoicing char turn numbers visible like prospecting time. Turn this chart in a bar chart like time prospection to see the values of each bar of invoicing and objective
	PI2.3	Divide the sales by shared or full sale	Distinguish the sales by shared or full sale to understand if the goods are entirely to the commercial or if he will split them with someone.
	PI2.4	Have a chart of objectives by raising.	Have more information related to objectives, such as fundraising objectives
	PI2.5	The application has an agenda	Have a way to know the tasks and appointments for the day and set them as completed. In the end, it would be important to understand the number of interactions and appointments of the month

4.3. Third DSR Iteration

With the analysis of the second interviewee's feedback, a reflection of the improvement proposals was made concerning their implementation. Throughout this section explanations and images will be presented through the implemented proposals.

4.3.1. **Proposal**

The third iteration was implemented. Three out of four suggested improvements by the interviewee are represented in Table 16. In the next section, 4.3.2 Evaluation, we explain the suggestions that were implemented and the ones that were not.

Table 16 – Implemented Improvements – 2nd Iteration

PI	Proposed improvement	Type of improvement	Implemented?	Who suggested?	Figure
PI2.1	Filter dashboard data in time	Visualization	Yes	Autor	10
PI2.2	Invoicing char turn numbers visible like prospecting time	Visualization	Yes	Interviewees	11
PI2.3	Divide the sales into shared or full sale	Visualization	Yes	Interviewees	12
PI2.4	Get objectives by raising	Visualization	No	Interviewees	-
PI2.5	The application has an agenda	Information	No	Interviewees	-

4.3.2. **Demonstration**

PI2.1 brings the possibility to filter the data by last year, this year, this year trimester, and a custom date range. To get this option, the user only needs to click on the filter icon on the upper right corner of the screen, as can be seen in Figure 10.

The suggestion of PI2.2 brought some difficulties during the construction of this chart because when all the values of the bar are displayed, the number was to close to each other starting to be unreadable, so was enabled a function in the chart to show the values when the user presses the column object. This led to two options: leave the original chart with the option to see the results or continue with the column chart Figure 11, these choices were decided to leave this choice to the next iteration.

PI2.3 implementation is similar to the proposed in PI1.1. It is shown to the user in the form of a popup, with which it is possible to check the total number of records in the sales system, distinguishing the sales made by the same consultant that raised the house and sold it and the ones that only sold it. This pop-up can be seen in Figure 12.



Figure 10 – Dashboard perspective time filter – 3rd Iteration

The last two suggestions were not implemented. PI2.4 was interesting. The idea of creating objectives for the existent objects does not look like a necessity that follows a line defined by the originals KPIs and the previous interview, so it was decided to check this proposal in the next interview.

The suggestion P2.5 was quite interesting and reminded us of the essential task of the day. Nevertheless, this is a function provided by the CRM system. Since it already has these characteristics, we decided not to apply this suggestion in order to avoid duplicate functionality.



Figure 11 – Dashboard perspective of Invoice charts – 3rd Iteration

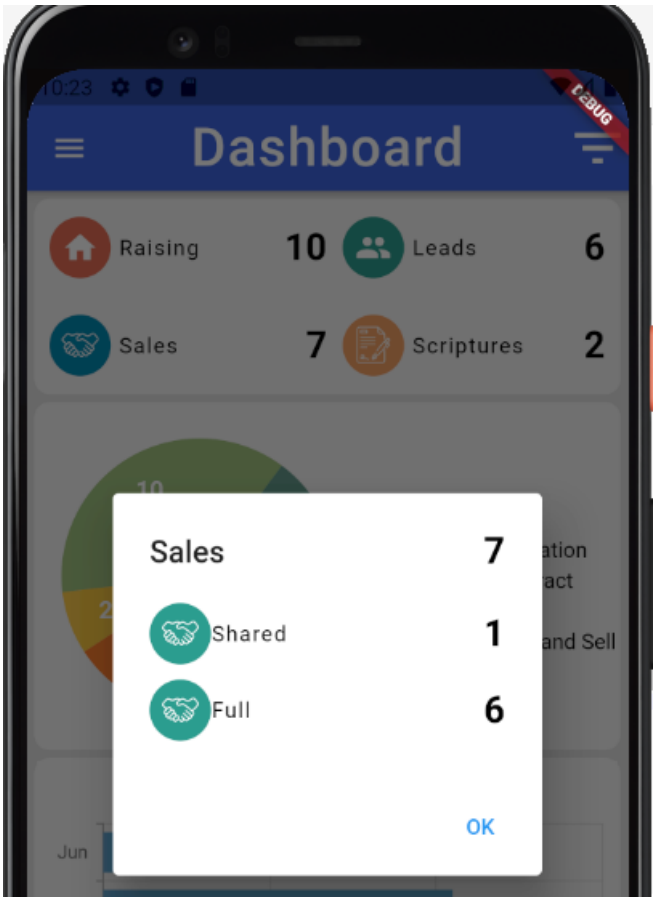


Figure 12 – Dashboard perspective of sales counters – 3rd Iteration

4.3.3. **Evaluation**

During the third interview, two proposals of improvement from the 2nd interview were validated: PI2.3 resulted in a merge of the two present invoice charts and added one more information to it, represented in a new proposal improvement. PI2.4 was concluded that the information proposed, the creation of a new chart with objectives by raising was not essential to the interviewees.

After the third interview, the result was two positive aspects, two negative aspects, and four suggestions of improvement, as can be seen in Table 17. The positive aspects were related to how the information is available and the helpful chart of prospecting time.

The negative aspects are related to adding more lead types to complete the list and improving the invoicing chart to transmit more information.

Some proposed improvements are associated with the negative aspects and the orders are to add a success rate and to introduce some gamification, by assigning points to each consultant.

Table 17 – Evaluation of the prototype – 3rd Iteration

	ID	Stakeholder synthesis	Stakeholder Opinions
Pros	P3.1	Information easy to understand	The proposed dashboard has the advantage of being able to provide information about all business phases.
	P3.2	The prospecting chart is very useful	The time prospection chart allows to understand if the time spent in prospecting is producing raisings or not.
Cons	C3.1	Lack of leads types	Not all of the lead types are represented.
	C3.2	The invoicing chart can be unfair	The invoicing chart does not represent all the work done in the month in order to achieve the objective.
Proposed Improvements	PI3.1	Have a new indicator for a success rate	Have a new indicator for a success rate, which is the relation between house raising vs house sale.
	PI3.2	Add new types for Leads	Add new types for Leads as references, site, and social network
	PI3.3	Add sales information to invoicing chart	Add sales information to invoicing chart, allowing to gain a forecast to possible earnings in future.
	PI3.4	Show consultants classification points	Add a way that makes is possible for a commercial manager or for the board to understand which the best consultant is, based on a points system that attributes points per task.

4.4. Fourth DSR Iteration

With the analysis of the third interviewee's feedback, some points were clarified and improved. Throughout this section, it will be possible to see the improvements of the implemented proposals.

4.4.1. Proposal

In the fourth iteration all four suggested improvements by the interviewees were implemented, being represented in Table 18. In the next section, 4.4.2 Evaluation, we explain the suggestions that were implemented and the ones that were not.

Table 18 – Implemented Improvements – 3rd Iteration

PI	Proposed improvement	Type improvement	Implemented?	Who suggested?	Figure
PI3.1	Have a new indicator for a success rate	Visualization	Yes	Interviewees	13
PI3.2	Add new types for Leads	Information	Yes	Interviewees	14
PI3.3	Add sales information to invoicing chart	Visualization	Yes	Interviewees	15
PI3.4	Show consultants classification points	Information	Yes	Interviewees	16

4.4.2. Demonstration

PI3.1 shows the success rate on a scale from zero to five, the rate is calculated with the raised houses and the sold ones. If the consultant sold all their houses, this will be represented with a rate of five, as can be seen in Figure 13.



Figure 13 – Dashboard perspective of Success Rate – 4th Iteration

PI3.2 is a complement of PI1.1. Initially, PI1.1 only shows leads from prospecting and leads from buyers whit this proposal, with this complement, the lead types available turn to be dynamically filled with information in the organization.

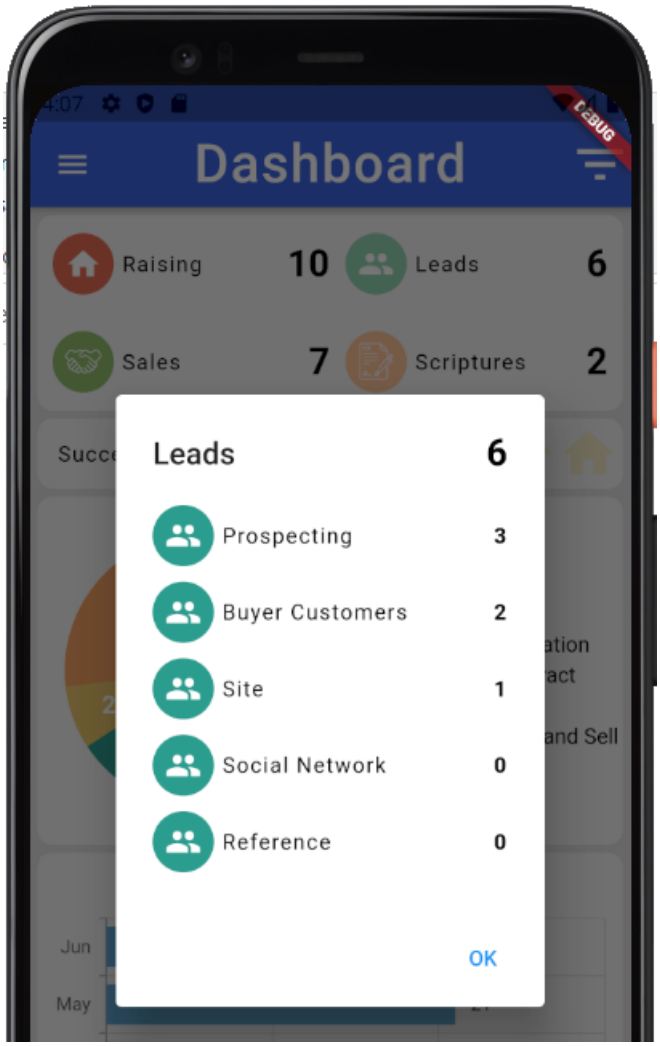


Figure 14 – Dashboard perspective of Lead Types – 4th Iteration

PI3.3 is also the continuation of PI2.3. The invoice chart was changed into two bars with the values of the invoices and the forecast. This way, it is possible to see the invoices issued and the ones that programmed to the future, and an additional line with the proposed objective for the month, visible in Figure 15.

The last suggestion, PI3.4, brings the idea of gamification only visible to the users supervisors', are given points to the consultants, such as one point for raising, one point for sales and an additional two points if it was a full sell (the sale of a house raised by the same consultant). These values are represented in Figure 16, through a column chart. The user with the biggest bar is the one with more points and with the best performance.



Figure 15 – Dashboard perspective of Invoicing Chart – 4th Iteration



Figure 16 – Dashboard perspective of Points Rate – 4th Iteration

4.4.3. **Evaluation**

After the fourth interview, the result was three positive aspects, one negative, and three suggestions for improvement according to Table 19

The positive aspects in the fourth interview are related to information visualization, and the prospecting chart was highlighted again as a great tool, as it allows the consultants to understand if the time spent in prospection is working or not. The negative aspect is associated with PI3.4. The interviewee indicated the need to attribute more points to raising than to sales, because it is more difficult to raise than to sell.

One of the three improvement proposals is associated with the negative aspects and the others are related with adding the information of tax retention, informing if the consultant is losing leads or houses, or if the clients keep the consultant until the end of the process.

4.5. Fifth DSR Iteration

In the fifth iteration, a few improvements were made in the application since the previous iteration. The proposed improvement was analyzed in terms of performance and applicability. The result is given in section 4.5.2.

4.5.1. **Proposal**

In the fifth iteration all tree suggested improvements by the interviewees were implemented, and are represented in Table 20. In the next section, 4.5.2 Evaluation, we explain the implemented suggestions.

4.5.2. **Demonstration**

Proposal PI4.1 where a change similar to PI3.4. With this change, the score attribution changed to two points for raising, one point for sell, and an additional two points if it was a full sell. The change consisted in attributing more points to the consultants that raised houses than the ones who sold them. This change makes the point attribution more fair.

PI4.2 tries to understand if the leads are focused in profit or if they stay in leads and do not go forward in the sales process. Figure 17 located below to the leads retention taxes. This verifies if the leads turn into a sale or not, zero being “no sales are made” and five means “all the leads turn into a sale”.

Table 19 – Evaluation- Evaluation of the prototype – 4th Iteration

	ID	Stakeholder synthesis	Stakeholder Opinions
Pros	P4.1	All information is summarized	With the proposed dashboard, it is possible to see all information quickly.
	P4.2	The prospecting chart is very useful	Prospecting time chart allows to understand if the time spent in prospection is producing risings or not
	P4.3	The information is well-presented	The way of displaying information is well-accomplished. The color and the way of showing the information make it easy to understand
Cons	C4.1	Bad distribution of points in users' ratings	The user rating chart gives empowerment to users to get more raisings than the ones that sell
Proposed Improvements	PI4.1	Change rating points attribution	Give more points to users that get raisings
	PI4.2	Tax retention of leads	Having a new indicator of tax retention of leads enables users to understand if the lead chooses to stick with the user until the end or not.
	PI4.3	Tax retention taxes of raisings	Have a new indicator of retention raisings so as to understand if the consultant is losing ratings for not being able to sell them

Table 20 – Implemented Improvements – 4th Iteration

PI	Proposed improvement	Type of improvement	Implemented?	Who suggested?	Figure
PI4.1	Change rating points attribution	Information	Yes	Interviewees	16
PI4.2	Tax retention of leads	Information	Yes	Interviewees	17
PI4.3	Tax retention of raisings	Information	Yes	Interviewees	17

The PI4.3 is similar to the previous point; each mediation contract was a finish date when this contract expires the consultant loses the house this indicator transmits to the consultant if he is losing houses or not where zero is all houses are with an expired contract and five all houses are with valid contracts. Is possible to see this indicator in Figure 17.



Figure 17 – Dashboard perspective of the Retention Rate – 5th Iteration

4.5.3. Evaluation

After the fifth interview, the result was three positive aspects, one negative aspect, and two improvement suggestions, as can be seen in Table 21.

The positive aspects are related, once more, with the visualization of information and a new chart about the ratings, which can bring some fun to the consultants.

The negative aspect is related to the fact that it was not possible to see the next tasks of the consultant's agenda.

In the fifth iteration, proposals were not made. PI5.1 is related to PI2.5, which is explained in section 4.3.2., and PI5.2 is associated with the commission that the consultants retrieve from the house sale. This value can be different within an organization or even a business, as this value can change regularly, so we decided to that consultants should be the ones who introduced the correct value in the application, since only they know what the commission is.

4.6. DSR Iteration System

Table 22 represents all improvement proposals obtained from the interviews. From a total of 18 proposals, 17 were suggested by the interviewee and one by the author. Of the 18 proposals, 14 were implemented and the remaining four were registered for future improvements.

The code of the application was produced as the iterations went on without any architectural planning about it. Been developed as the need calls for it, only following a modular architecture distinguishing the components like screens, data modeling, and database access.

The main difficulties encountered were learning a new code language, making the connection to the database, understanding how to retrieve all the necessary data from the database, and finding the right colors for the application and the dashboards.

The source code of each iteration can be found here https://github.com/mjffe/dash_app/tree/main/dash_app.

Table 21 – Evaluation- Evaluation of the prototype – 5th Iteration

	ID	Stakeholder's synthesis	Stakeholder's Opinions
Pros	P5.1	All information is summarized	With the proposed dashboard, it is possible to see all information quickly.
	P5.2	The information is well-presented	The way of displaying information is well-accomplished. The color and the way of showing the information make it easier to understand
	P5.3	Rates can give some fun to the users.	The ratings give a view to the team leader of how their team is performing, adding some good rivalry by checking the user that obtains more points.
Cons	C5.1	Is not possible to see the main task that is pending for the day	Allow the users to see the next task that they have on the agenda, helping them not to forget some appointment or something similar.
Proposed Improvements	PI5.1	See the next main task that is pending for the day	Have a way to allow the users to see the next task that they have on the agenda, helping them not to forget some appointment or something similar.
	PI5.2	Invoicing reflects the actual revenue based on the last year of sales	The invoice chart reflects the actual percentage of revenue. This percentage is calculated based on the total amount of sales between some ranges that use different percentages of revenue.

Table 22 – Proposed improvement prototype by iterations

PI	Proposed improvement	Type	Implemented?	Who suggested?	Figure
	Iteration 1				
PI1.1	View the number of leads in their different types	Information	Yes	Interviewees	6
PI1.2	Allow the supervisor to see information agglomerated with that of their team	Information	Yes	Interviewees	7,8
PI1.3	Time prospection so as to have information of the quantity used	Visualization	Yes	Interviewees	7
PI1.4	Allow drill down	Navigation	Yes	Interviewees	-
	Iteration 2				
PI2.1	Filter dashboard data in time	Visualization	Yes	Autor	9
PI2.2	Invoicing chart turns numbers visible, such as prospecting time	Visualization	Yes	Interviewees	10
PI2.3	Divide the sales into shared or full sale	Visualization	Yes	Interviewees	11
PI2.4	Have objectives by raising	Visualization	No	Interviewees	-
PI2.5	The application has an agenda	Information	No	Interviewees	-
	Iteration 3				
PI3.1	Have a new indicator for a success rate	Visualization	Yes	Interviewees	12
PI3.2	Add new types for Leads	Information	Yes	Interviewees	13
PI3.3	Add sales information to invoicing chart	Visualization	Yes	Interviewees	14
PI3.4	Show consultants classification points	Information	Yes	Interviewees	15
	Iteration 4				
PI4.1	Change rating points attribution	Information	Yes	Interviewees	15
PI4.2	Tax retention of leads	Information	Yes	Interviewees	16
PI4.3	Tax retention of raisings	Information	Yes	Interviewees	16
	Iteration 5				
PI5.1	See the next main task that is pending for the day	Information	No	Interviewees	-
PI5.2	Invoicing reflects the actual revenue based on the last year of sales	Information	No	Interviewees	-

Chapter 5: Conclusion and Future Work

This research aimed to build a complete mobile dashboard for RE CRM's, based on expert's feedback. This application has the purpose of assisting RE agents in everyday tasks, allowing them to have access to information in a simplified way. During the interviews, the interviewees were interested in this proposal, because most of them had to create their own mechanisms to cover their needs in daily activities due to shortages of applications focused on their available needs. Through the related work study using the SLR methodology, it was possible to confirm that there is little evidence about mobile dashboards for RE, which reveals a gap in the RE industry explored in this research.

In order to try to reach our goal, we used the DSR methodology, which helped to design and construct the dashboard and add value to it, with five remote interviews that contributed to the creation of the dashboard. The main objectives of these interviews were to share the proposed dashboard with the agents, to know the difficulties that the agents have, how the proposed dashboard can help them, or simply why they thought it would be good to improve it.

At the end of the interviews, a very simple mobile application was created, allowing the users to manage their data and see a dashboard with all information synthesized in the system. This mobile CRM dashboard was accessed by professionals through screen share, allowing them to move freely through the application and receiving their positive feedback. Some interviewees mentioned that in other to obtain some indicators provided by the proposed dashboard, they have to export a list of data and then work with it to obtain the same information.

5.1. Contributions

This research contributes with the creation of a dashboard that can transmit to the RE agent a full state of their sales cycle and provide the possibility to analyze the information simplified in the dashboard. Also, the presented dashboard allows the analysis of KPIs, which will enable a better knowledge of the organizational status.

As an interviewee stated, "Sales agents live on the numbers", they use numbers in their presentations to highlight their work and add value to themselves. With the proposed dashboard, one can get this number directly from it, without having to extract the data into Excel, to relate the date and finally make the calculation to get to the numbers or percentage wanted.

Besides the numbers, in presentations, the proposed dashboard also helps to show information about the KPIs, so RE agents can check how they are performing according to their objectives and try to understand what they are doing better and the parts that need more attention in order to improve the numbers. An example of this report for some interviewees, is the prospecting time chart, with which it is possible for the agent to understand if the time spent in prospection was worth it.

The proposed dashboard also helps RE agent s to achieve success rates and the retention rates help the agents to understand if they are selling the houses raised, if they are losing them by the contract end or if the leads do not continue the process with the agents. All of these indicators are useful for RE agents to understand if they are making the sell and not losing business by losing contracts or leads.

On top of all of these tools, to help the team leader and the higher management, it is possible to get access to one chart that represents the performance of consultants. This allows getting some good rivalry between them by adding some competition to the team or to notice that someone is having fewer points. This could also work as an alert that something is going on with this consultant, prompting the management to iterate closer with him in order to try to figure out what is happening.

This study also contributes to the scientific community by submitting for publishing in a scientific journal at AMC Transactions on Management Information Systems with more information about the journal in Figure 18. The paper submitted can be found here [44].



Figure 18 – Journal Information

5.2. Limitations

This study does not use real data to fill the dashboards. Also, the current pandemic forced the interactions to be performed through virtual ways.

Another limitation was the fact that the interviewees only had access to the application during the interview. This way, they could only interact with the application during the interview, not being able to validate the application during their daily lives

5.3. Future Work

Every day there is a new need that leads to new improvements following the functionalities suggested by the interviewees and that were not implemented, like the connection between the agenda and the dashboard, which could be helpful as a reminder of the next task/appointment.

The agents feel the need to have automated processes to gain more time for other activities, focusing on the sale cycle of the property, which means that, in the future, the application should allow this to happen.

It is also important to validate the mockup presented due to its usability, using techniques like card sorting or tree testing. Not to forget about the performance and UI/UX of the application, both should be validated and improved in order to making it an intuitive and easy-to-use application for Android and iOS users. Applying all the good practices in the realization of a mobile CRM can be fundamental for the RE agent's experience.

Furthermore, this study should be carried out without the limitations of the current pandemic, and with some real data provided by agents during their day-to-day work.

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Appendices

Appendix A – Questionnaire answered by interviewees

Question	What is your gender?
1	Male
	Female
2	Male
3	Male
	Female
4	Male
5	Male
Question	How old are you ?
1	48
	50
2	35
3	30
	29
4	43
5	31
Question	What is your role in the company?
1	Board
	Board
2	Consultant
3	Consultant
	Consultant
4	Consultant
5	Consultant
Question	How many years of experience do you have in the field?
1	20
	20
2	7
3	4,5

	1,5
4	1
5	5
Question	What is your education?
1	Graduation
	Master
2	Secondary
3	Secondary
	Master
4	Secondary
5	Postgraduate

Appendix B – Activity diagram

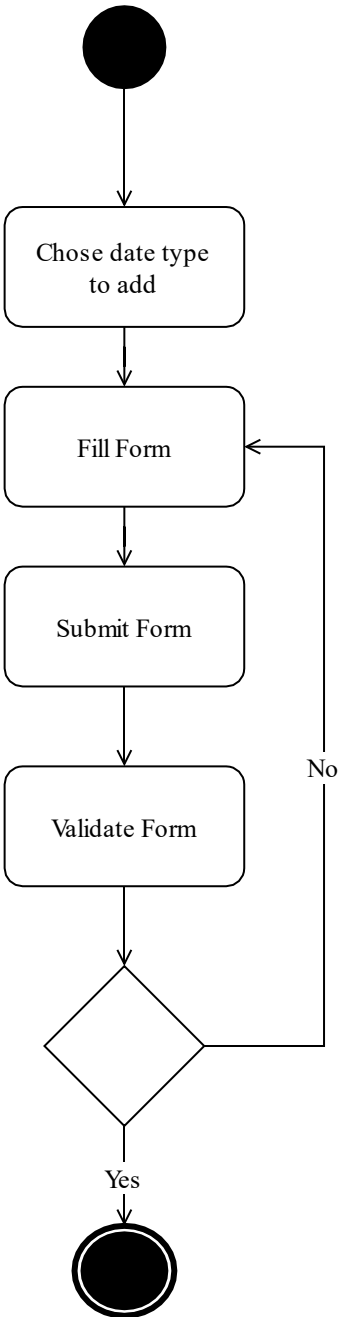


Figure 19 – Activity diagram for add new data

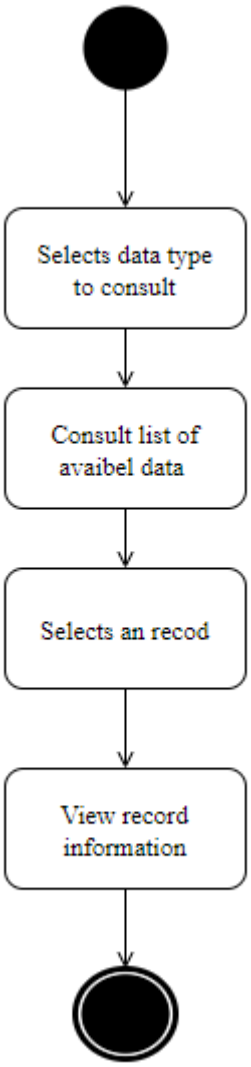


Figure 20 – Activity diagram for view data

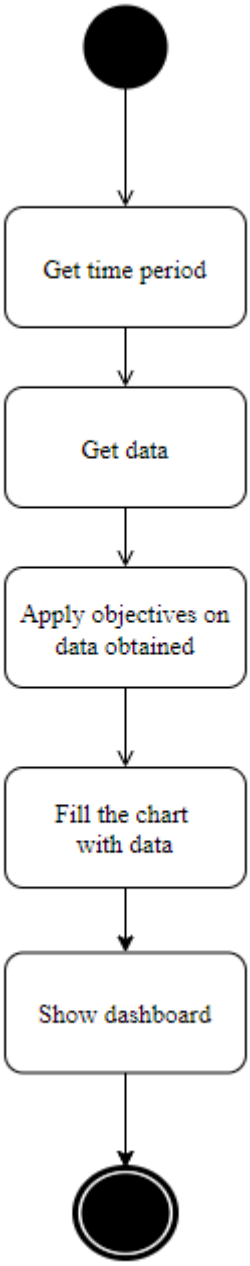


Figure 21 – Activity diagram for view a dashboard

Appendix C – Application mockups

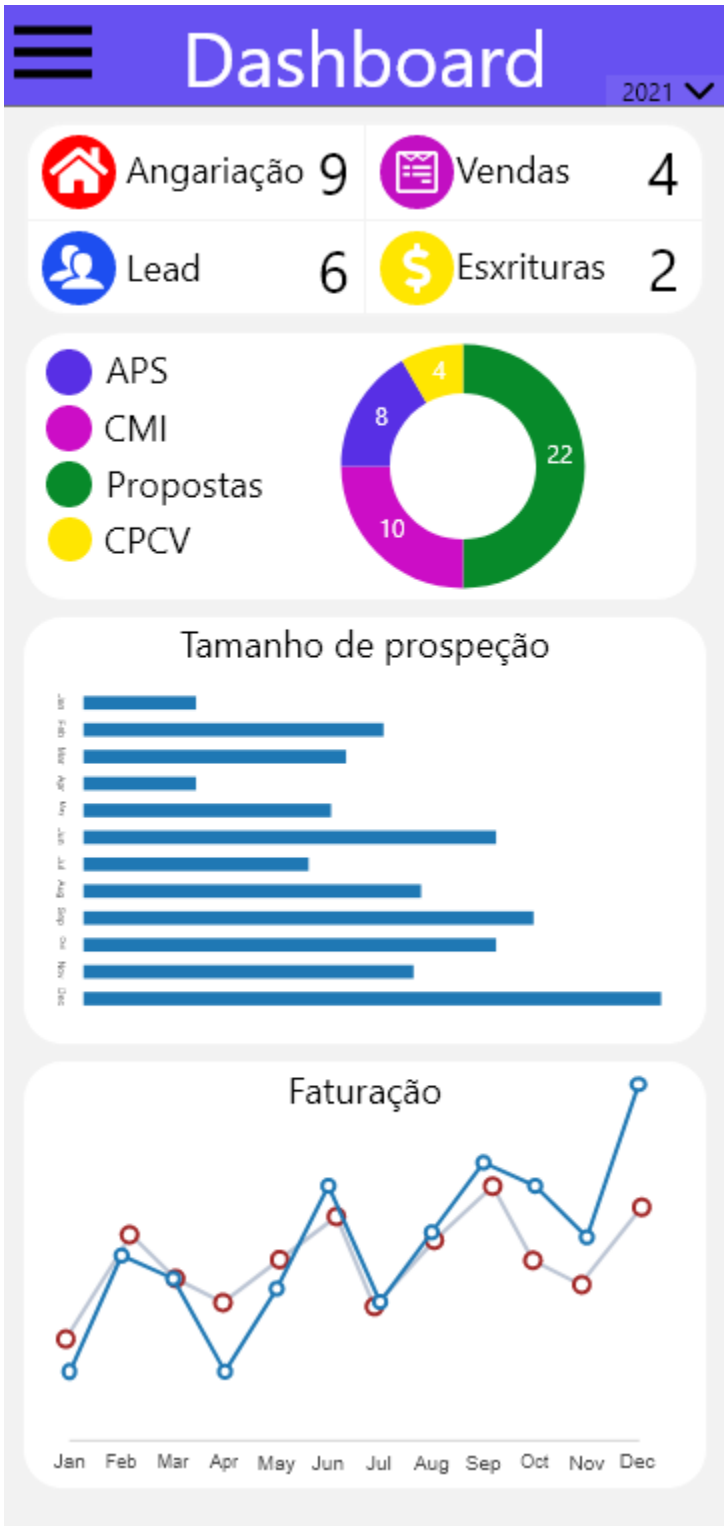


Figure 22 – Mockup dashboard

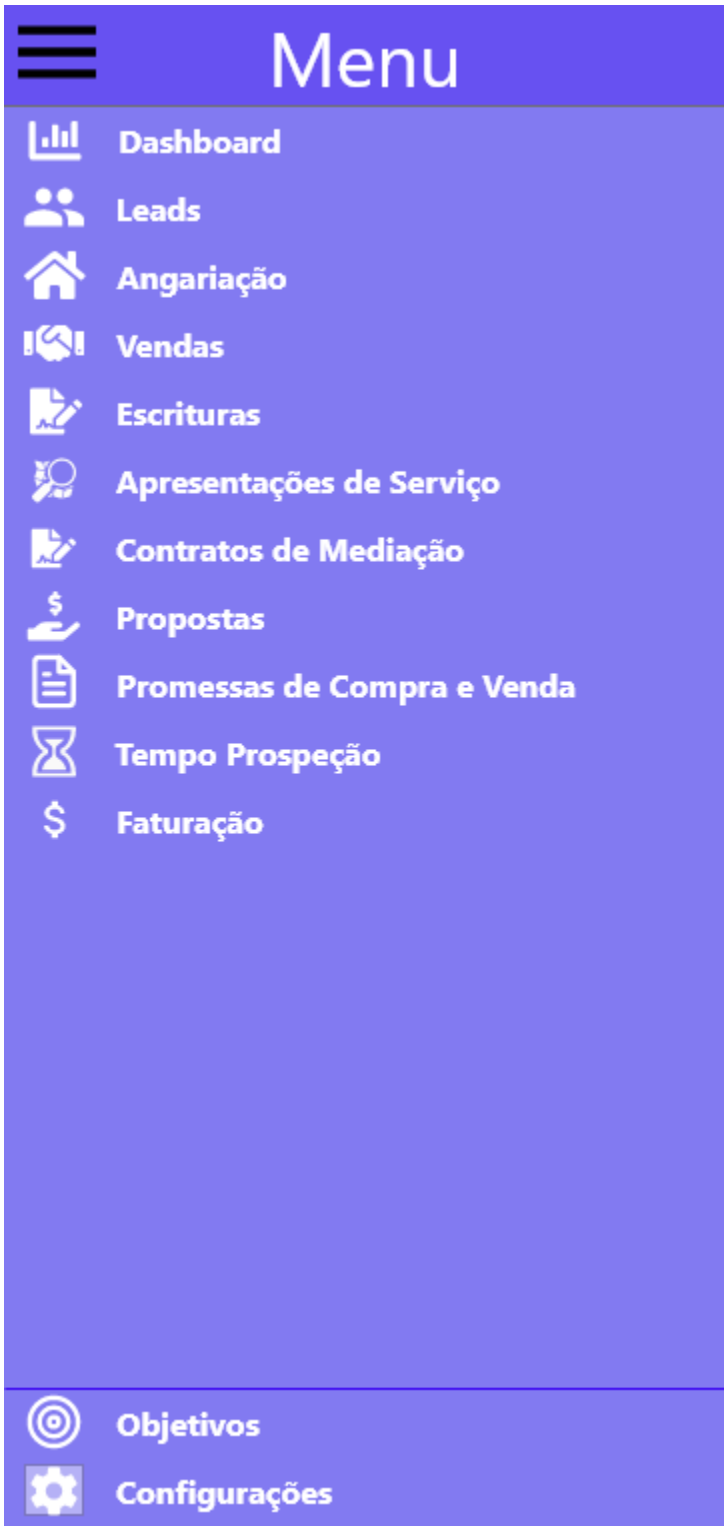


Figure 23 – Mockup menu



Figure 24 – Mockup list of data



Figure 25 – Mockup data form