INSTITUTO
UNIVERSITÁRIO
DE LISBOA

A Mobile CRM Development for Real Estate

João Pedro Beato Antão

Master in Telecommunications and Computer Engineering

Supervisor:
Prof. Dr. Rúben Filipe de Sousa Pereira, Assistant Professor,
Iscte – Instituto Universitário de Lisboa

Co-supervisor:
Prof. Dr. Ricardo Daniel Santos Faro Marques Ribeiro, Associate Professor,
Iscte – Instituto Universitário de Lisboa

november, 2020

iscte

TECNOLOGIAS
E ARQUITETURA

A Mobile CRM Development for Real Estate

João Pedro Beato Antão

Master in Telecommunications and Computer Engineering

Supervisor:
Prof. Dr. Rúben Filipe de Sousa Pereira, Assistant Professor,
Iscte – Instituto Universitário de Lisboa

Co-supervisor:
Prof. Dr. Ricardo Daniel Santos Faro Marques Ribeiro, Associate Professor,
Iscte – Instituto Universitário de Lisboa

november, 2020

Dedico este trabalho aos meus pais que sempre me incentivaram e me deram todas as condições para que todo o meu sucesso académico. Sem eles nada disto seria possível.

Acknowledgments

I express my gratitude to Prof. Dr. Rúben Pereira, Iscte's Assistant Professor and my supervisor, for all his availability, support and comprehension. His demanding and insightful project management combined with his high commitment to the project were key factors in the success of this dissertation.

To Prof. Dr. Ricardo Ribeiro, Iscte's Assistant Professor and my co-supervisor, I thank him for all his trust, support and constant incentives during the research. His advice, indications and experience proved crucial for the development of all the scientific contribution generated.

To all my family, and especially to my parents, Isabel and Jorge for all the support, availability and support throughout my academic career.

To my friends, who despite not being able to follow all the development of my thesis in person, have always been available and with great patience to listen to all my ventures, giving fantastic suggestions and constructive criticism. It was thanks to all their support, motivation and exchange of knowledge that it was possible to bring this whole project to a successful conclusion.

To all the real estate agents who have given their precious time to help me in this investigation, especially to Pedro Santos for all the hours of training and introduction to the operation of the sector and, above all, for his constant encouragement and support throughout the project.

To the whole team of the ISCTE-IUL's Technology Students Nucleus and to the whole team of the FISTA 20 organization, for creating constant learning conditions that allowed me to develop a more rigorous and professional project. And a special recognition to the institution and to the whole teaching and student community that involves Iscte, was really a space where I grew a lot.

To all of you I have listed my sincere "Thank you".

Resumo

Os agentes imobiliários são profissionais que necessitam de informação atualizada e precisa sobre os seus clientes para conseguirem manter relações profícuas e duradouras com cada um deles, a fim de prosperarem numa indústria tão competitiva.

A dissertação concentra-se num problema: não existe uma solução *mobile*, criada à medida das necessidades dos agentes imobiliários, capaz de melhorar o seu desempenho e otimizar os seus resultados, tornando possível investir mais tempo no trabalho da relação com o cliente e menos com tarefas de secretaria.

A importância da resolução deste problema está relacionada com a importância de otimizar trabalho e recursos numa indústria altamente abundante de informação. Através da digitalização destes serviços a produtividade e performance dos agentes imobiliários podem ser melhoradas.

A pesquisa consiste no desenvolvimento de um Costumer Relationship Management (CRM) para dispositivos móveis capaz de gerir informação sobre os clientes e parceiros de negócio de cada utilizador, que forneça serviços de agenda e ainda um sistema de informação visual capaz de mostrar os progressos do agente e outras análises estatísticas.

Todas as funcionalidades implementadas foram recolhidas através de 15 entrevistas presenciais e validadas com sete entrevistas por vídeo-conferencia. Para esta validação do artefacto seguiu-se a metodologia DSR correspondendo cada entrevista feita a uma iteração deste modelo.

Verificou-se que a solução mobile de CRM é uma mais-valia ao nível da gestão da carteira de clientes potenciando o desenvolvimento das suas relações, e ao nível da monitorização da performance dos agentes imobiliários.

Palavras-Chave: Sistemas de informação; Setor Imobiliário; Customer Relationship Management; Aplicação móvel.

Abstract

Real estate (RE) agents are professionals who need up-to-date and accurate information about their clients in order to maintain profitable and long-lasting relationships with each of them to prosper in such a competitive industry.

The research focuses on one problem: unexistance of mobile solution, adapted to the needs of RE agents, that integrates only their needed features. The creation of this allows them to improve their performance and optimize their results, making it possible to invest more time in building relationships and less in secretarial tasks.

The importance of solving this problem is related to the importance of optimizing work and resources in a highly abundant information industry. Through this service digitalization, the productivity and performance of RE agents can be improved.

The research consists in the development of a Costumer Relationship Management (CRM) for mobile devices capable of managing information about the customers and business partners of each user, which provides agenda services and also a visual information system capable of showing the progress of the agent and other statistical analysis.

All functionalities implemented were collected through 15 face-to-face interviews and validated with seven videoconference interviews. All of them were made using different specialists. For the development and evaluation of this artifact was followed the DSR methodology corresponding to each interview made to an iteration of this model.

It was verified that the mobile CRM solution is an added value in terms of customer portfolio management, enhancing the development of their relationships, and in monitoring the performance of professionals.

Keywords: Information Systems; Real Estate; Customer Relationship Management; Mobile Application

Contents

List of Tables

List of Figures

List of Acronyms

AI	-	Artificial Inteligence
CRM	-	Customer Relationship Management
DSR	-	Design Science Research
GL	-	Grey Literature
IS	-	Information System
IT	-	Information Technology
m-CRM	-	Mobile Customer Relationship Management
ML	-	Machine Learning
MLR	-	Multivocal Literature Review
RE	-	Real Estate
SLR	-	Systematic Literature Review
UI	-	User Interface
UX	-	User Experience

CHAPTER 1

Introduction

In the last decades, the growth of information technologies (IT) is evident [1] and has changed the paradigm of the global economy [2]. The use of the Internet and information systems (IS) is currently extremely relevant for companies [3] which are expected to be more agile and able to faster adapt to any changes in the market [4].

Moreover, traditional methods of collecting information are no longer able to meet the needs felt by professionals [5]. So, the implementation of IS is becoming a need even in a traditional sector as real estate (RE) [6].

After 2008, when the RE industry gained visibility due to the crisis felt in the sector [7], RE agencies tried to optimise their activities and services [8], following the example of other industries [9]. Some of the solutions found were the creation of websites to promote and advertise their properties as well as to recommend properties, helping the client to make the best decision [10]. While in the traditional RE business each agency is responsible for the business of its surrounding areas, with the implementation of these IS the offer presented is no longer geographically restricted [8] and new business opportunities emerge [11].

So, with this growth in the RE industry, coupled with a significant increase in the number of agents in the business [12], the competitiveness is increasing and more quality of service is required [13]. Since this has become an information overloaded business [8], the more knowledge and information the agents have in their possession, the more competitive and distinctive from other agents they will be able to be [14], which benefits them equally [15]. This has led to each agent being forced to be aware of all the details, from RE properties [16] to customer qualification [15] and behaviour [17].

At the end of the day, the RE agent is responsible to make clients feel satisfied with his service [18] building a strong relationship with them [19]. One of the best ways for this to happen is by implementing a CRM [20], [21]. Literature reveal, that the implementation of CRM is something essential to earn satisfaction and loyalty [22] allowing to save a customer's history and anticipate behaviors [23].

Moreover, it is important for each RE agent to have access to information from each client and place of visit on the move [24]. In this way, the implementation of a mobile CRM (m-CRM), on a smartphone, for example, is a suitable solution for a technology-

oriented agent and, at the same time, can promote more efficiency in business completion [25] and provide a bigger support for data management and processing [1].

Understanding which features RE agents consider essential to exist in an m-CRM is fundamental to be able to build a mobile application completely focused on the agent, capable of further increasing the agent's performance, facilitating its lead management and making it possible to create a more empathetic and lasting relationship. Overall the agent should be able to be more productive and more competitive within the RE industry, saving resources [26].

1.1. Objectives

Before establishing the general objective for this investigation, a set of face-to-face interviews with RE professionals was carried out.

Each interview aimed at identifying the professionals' receptivity to the new information technologies, perceiving their background and how they use their smartphones. It was also important to identify if any of the professionals had contact with any existing CRM and what their experience and feedback was.

A total of 15 interviews were conducted, each lasting an average of 25 minutes. Table 1 shows the characteristics of the sample. The interview guide is available in the Appendix E.

All the interviewees recognized that not using digital technologies means giving up competitiveness in the market and confess to be at ease with the handling of technological devices and digital tools. However, it has often been reported that the use of these devices often causes unwanted distractions, quoting one interviewee, "the mobile phone brings with it notifications about other applications such as social networks, that if we are not totally focused, we will not be able to be so productive".

Professionals in the sector see their mobile phone as an essential tool for the work, serving, among other things, the management of their customers and business partners and as an agenda.

Despite knowing the advantages inherent to the transition to digital tools, some of the interviewees are still skeptical, defending the use of a physical notepad where they point out all their commitments and tasks. They justify it because it is thanks to this method of work that they get their results and do not feel the immediate need for change - "if it works, why change?" - some said. However, if a CRM solution emerged for their

smartphones tailored to their needs, no interviewee hesitated to state that they would at least like to test the software.

Table 1 - First interviewees' data

Gender	Age	Role	Experience
Male	54	Collector and Buyer Agent	11 years
Male	46	Collector	3 years
Male	41	Team Leader	7 years
Male	43	Collector	2 years
Male	51	Branch Manager	6 years
Male	32	Buyer Agent	6 years
Female	49	Collector	3 years
Male	51	Team Leader	19 years
Female	33	Buyer Agent	2 years
Female	39	Administrative	7 years
Female	29	Marketing Manager	4 years
Female	40	Expansion Director	5 years
Male	37	Collector and Buyer Agent	7 years
Female	24	Collector	2 years
Male	52	Collector and Buyer Agent	16 years

When confronted with some CRM solutions on the market, few were the interviewees who knew the software and even less those who tried it. At the end of the interviews it was possible to understand that only four interviewees knew at least one of the applications, and only one interviewee had experience with some of them. From this RE agent it was possible to realize that there is still no application capable of managing the sales process with the same quality that can manage contacts and vice-versa, and that is visually appealing.

Based on the opinions of the interviewees, it was possible to understand some reasons why these agents do not use the CRMs presented or other tools with the same purpose. The main reasons pointed out for not using these solutions are presented in Figure 1.

Although some agents mentioned the CRM provided internally by the brand, none of them presented a positive feedback of the same revealing some flaws and dissatisfactions as well as a non-existent or not very responsive mobile component.

Considering all the information gathered in the interviews, it is possible to notice that there is still a gap felt in this dimension of the RE sector. This gap is related to the inexistence of a complete m-CRM, focused on the RE agent, able to integrate only the functionalities that they consider essential. Thus, it was established as the main objective

of this research the creation of a m-CRM that professionals consider an added value in their daily lives.

To achieve this final objective, it is necessary to outline another intermediate goal. This is related to the questioning of what will really be the fundamental and intended features by RE agents.

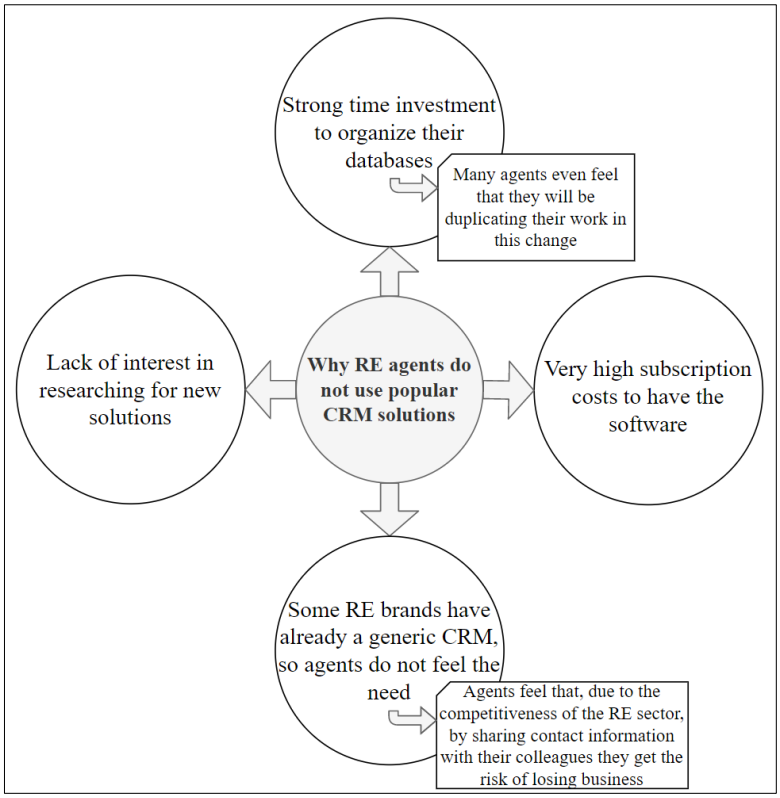


Figure 1 - Reasons why enterviewees do not use popular CRM solutions

1.2. Dissertation Structure

After this introductory chapter, the remaining of the document is organized as follows: the second chapter approaches the State of the Art. It introduces the theoretical background as well as the related work already done until now. All related work presented in this chapter was refined following the multivocal literature review methodology. In the third chapter, it is presented the research methodology used in this research. Our proposal and the results of interactions are presented in the fourth chapter. The research synthesis and where the data obtained are presented in the fifth chapter. Finally, the sixth chapter is reserved for the conclusions of this research. There are written our main findings, the limitations we found on our research, the take-home messages and the future work that can be done next.

CHAPTER 2

State of the Art

Considering the problems presented above, this chapter intends to clarify the concepts addressed and used in the industry, thus explaining its theoretical background. It also aims to demonstrate the relevance of the subject by analysing the work already done so far in this area.

2.1. Real Estate Industry

Since its inception, the RE market has been based on good interpersonal relationships and sales. Its business model translates into incentives and commissions described by complex reference models and vast sales cycles. As a result, negotiations are often complex and unique. In other words, each sale is independent of the other. It is considered a highly competitive market [27] where the rate of customer retention and, in turn, successful sales is proportional to the value of the asset and its rates of return [12].

A RE property can be defined as a space outlined by someone with the objective of exercising a certain activity in it for a period of time[28]. Each property is associated with a certain monetary value [29]. In the context of this research, the RE referenced will be mostly for housing purposes.

In this sense, intermediation plays a crucial role in RE transactions [30]. This intermediation can be defined as a group or company that acts as an agent by moderating the housing contract between two parties during the process [31].

In this business, in general, we can divide its process into three distinct phases: Information gathering, which although it occurs during the whole transaction process, is crucial in the first approaches; Negotiation, where the opinions of the two parties are considered and a monetary value of common satisfaction is reached; and, finally, the Execution phase, where a transaction takes place and there is a final agreement for the deed [32]. A RE transaction is understood as the purchase or sale of RE and its requirements vary according to the laws practiced in each country [8].

It is also important to understand the importance of the intermediary in this business. To this intermediary we give the name of RE agent and he is responsible for looking for

clients who own properties and clients who are looking to buy a property. Their role is determining since it is up to them to speed up negotiations, determine the prices of each property and manage the necessary documentation of each client to carry out the transactions [33].

The objective of these agents is clear: to sell at the highest possible value in the shortest possible time [34]. In addition to their responsibilities, from a RE agent is expected to be able to provide confidence to clients, minimize to the maximum the costs of property search, live up to the client's expectations, collect important data for each business, assist in the decision making of each client and also let them know different options, find the fair market value, assist in all logistical aspects, organize and manage the details of agreements and, finally, also act as an intermediary with other business organizations [33].

In the RE sector, it is common to find exclusivity regimes with agencies and agents. This type of contracts that clients make with the RE agency make it impossible for them to associate themselves with other agencies or to make the purchase/sale by other routes than that involving the RE agent. This not only takes away the possibility of two competing companies selling the same thing [35], but also allows the existence of a commission that must be paid to the agent after the promissory purchase and sale agreement is signed [36]. This policy allows the agent to feel more motivated to sell the assets and imposes a time limit of sale corresponding to the duration of the contract.

As it is understood so far, in this industry information is power [15]. Modern technological advances call for new information systems to facilitate the processing of this information [8].

2.2. Customer Relationship Management

A CRM is a tool where information from customers, various processes and the technology itself are aggregated to expand the relationships of a given organization with all its customers [37]; [21]. It was created to understand and meet the needs of customers [38]; [8] and is also understood as a strategy to increase customer retention by making them more loyal to the company [9]; [39], especially the most valuable ones [40]. Additionally, it can also help to reduce company costs [41]; [42]. These tools are often used in the business world because its advanced IT support facilitates the development of long-term strategies [43].

From a business perspective, this strategy brings many benefits [20] among which the increase in revenue of the company itself [42], but for this to happen it is important they know how to use CRM for their benefit [44].

According to the literature, we can define the advantages and the disadvantages of using a CRM as shown in Table 2 and Table 3, respectively.

Table 2 - Advantages of using a CRM

Advantages	Articles
Finding out who are the most profitable customers and investing the most in them.	[39]
Management of all customers data.	[39]
More sales efficiency.	[20], [38], [39]
Ensures customer satisfaction.	[20], [38], [39]
More knowledge of potential customers and buyers.	[40]
Improve customers interactions.	[39], [40]
Increasing sales base.	[39]
Improve customers satisfaction.	[20]
Better relationship between both parties.	[20], [38], [39], [40]
Improve competitiveness among the vendors.	[38]
Maintaining organisation stakeholders' interest.	[38]

Table 3 - Disadvantages of using a CRM

Disadvantages	Articles
Insufficiently defined activities.	[40]
Might lead to overload of unnecessary info for organization.	[39]
Might lead to over automation.	[39]
Weak combination with back office systems.	[39]
Raising customers' expectations.	[39], [40]
Negative customers reaction.	[40]
Isolated solutions.	[40]
Deficient CRM systems.	[40]
Cannot succeed with new data entered.	[39]

CRMs can have multiples functionalities: sales force, automation, data warehousing, data mining, decision support and reporting tools [41]. It normally depends of the objective that the CRM is used to. These objectives are related to the advantages presented as the vast majority normally are: process time saving; elevated productivity; improved data quality; cost reductions; employee satisfaction; customer retention and prospection [20]; [40].

Having a mobile device application with these characteristics can have a stronger impact than a usual CRM [45]. A mobile CRM (m-CRM) can be operated on smartphones or tablets and it allows its users to consult all the clients data and update their sales activity

[8] bringing value for the company anytime and anywhere in real time from the convenience of their mobile device [46].

2.3. Mobile Design Best Practices

Developing a mobile application is quite different from traditional software [47]. It is essential to understand well the needs of the application main target and build something customized for them [48]. Moreover, the developer should focus in developing something intuitive, comfortable and easy to use and memorize and also flexible to all kinds of user [49]. It is also important to keep in mind the user's age group as for older people it is difficult to understand many interface design changes [25].

The adoption of standardized and native designs increases user satisfaction and engagement with the app [1] and the final product should always be something that the user is pleased to open. So, to build an adequate mobile application we must be concise with the information presented on the screen and create a welcoming and interesting atmosphere. To gamify the application is in some points a solution that leads to increase a better application-user relationship [48]. The user must feel that the time spent in a mobile application is less than what he would spend doing the same task in a desktop computer. This is particularly important since in real life people often use their mobile device while moving around and/or are involved in another activities [49].

According to the literature above mentioned, these are some of the best practices in what concerns a mobile design pattern:

- **Great interaction** – users must know how to use the application to perform tasks;
- **Fast information capture** –users should be able to enter information quickly on the platform in order to increase its efficiency;
- **Navigation** – users must be able to orient themselves in the application in order to access what they want more quickly;
- **Flat design** - user interface (UI) must be visually pleasing;
- **Customized content** – each user should have personalised information regarding their needs, interests and location, for example;
- **Gamification** – leads to a more immersive application and creates healthy competition between users;
- **Widgets** – users want fast access to all the data;
- **Camera** – the application must be able to capture moments and visual information anywhere and anytime and share it with other users;

- **Support and feedback** – the users must feel that if they encounter an error there is someone who will help them and fix it for them. It is also important to share the updates released with other users.

2.4. Related Work

After an initial search to exapand the knowledge about m-CRM for RE, it was not possible to find a significant amount of academic research on this topic. Therefore, in order to understand the work that other researchers have done, a Multivocal Literature Review (MLR) was conducted.

A MLR is a systematic literature review (SLR) that adds "grey" literature (GL), such as publications from websites, videos or white papers, to scientific literature formally published in journals and conference papers [50]. By using this variety of literature review, it is expected to gain a more detailed notion of what is currently being developed and find existing gaps.

Because this is an adapted methodology of SLR it means that the guidelines suggested by Kitchenham (2004) are also used. Of these authors we adopted three steps for the MLR: (1) planning the review; (2) conducting the review; (3) reporting the review. However, these guidelines do not complete a MLR. As MLR guidelines we use the suggested Garousi, Felderer and Mäntylä (2019) standards. The procedure of this methodology is summarized in Figure 2.

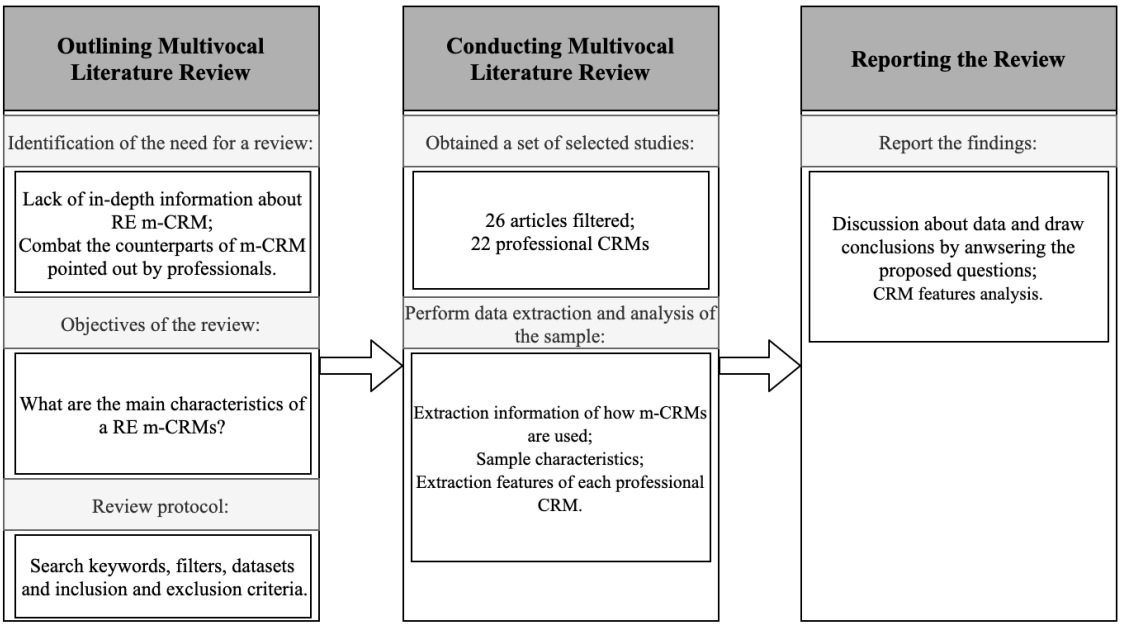


Figure 2 - MLR stages based on SLR ones

2.4.1. Outlining Multivocal Literature Review

The main goal of this research is to understand the characteristics of CRMs in mobile environments and its use by RE agents.

To this end, a set of keywords was systematically researched in different online repositories. Four large repositories were used:

- IEEE Xplore Digital Library (https://ieeexplore.ieee.org/Xplore/home.jsp);
- American Real Estate Society (https://www.aresjournals.org/);
- Emerald (https://www.emerald.com/insight/);
- Scopus (https://www.scopus.com/home.uri).

These repositories were chosen based on their coverage of themes and relevance in the digital area and, in the specific case of the American Real Estate Society, due to its high focus on scientific progress in the RE sector.

Some selection criteria were considered when selecting scientific literature. Table 4 lists the inclusion criteria and, as its opposite, the exclusion criteria.

Regarding GL, a search was made in Google search engine (www.google.com) in order to know technological solutions that resemble the artifact we want to develop.

Different keywords (presented next) with different objectives were used to carry out the survey in the different repositories using the AND and OR operators associated with the term "Real Estate" since it is the focus of this research.

Keywords: *"Real Estate" AND ("CRM" OR "Customer Relationship Management" OR "Mobile CRM" OR "Mobile Application" OR "IT Solutions" OR "Management Systems" OR "Information Systems")*.

Table 4 - Inclusion and exclusion criteria

Inclusion Criteria	Exclusion criteria	ID
Written in English	Not written in English	C1
Scientific papers in conferences or journals and books	Non-transferable documents nor Master Thesis	C2
Publication date greater than or equal to 2010	Documents with publication date less than 2010	C3
Title or abstract has keywords	Title or abstract does not have keywords	C4
Unique article	Duplicated article	C5
Meets the quality criteria	Does not meet the quality criteria	C6

At the beginning of the approach of this methodology we started by searching in each repository the keywords chosen without any filter being applied to them. Since the

different repositories have different search mechanisms, the keywords were adapted to each reality.

To apply the first filtering, the time filter was used being the C3 criteria the selection criteria applied. Then we restricted the search of the keywords only to the title or abstract of the article being used the C4 criterion. The next step was to eliminate all documents that were not written in English, as well as those that were not possible to obtain a freely or did not correspond to a scientific paper in conferences or journals and books. In this step the selection criteria used were C1, C2 and C5.

After applying these filters, it was necessary to realize if the context the document reported was framed within the development of IS for RE. This way the selection criteria C6 was applied and the quality criteria presented in Table 5 were those used for the last filtering.

Table 5 - Quality criteria used in filtering

Quality Criteria
QC1. Is the description of the article related to the research context?
QC2. Do the results found in the article add value to the description of concepts?

Since most of CRMs and mobile applications are based in information technology and digital solutions, keywords like “IT Solutions”, “Management Systems“ and “Information Systems” were used with the exploratory purpose of what was being done in the RE industry related with new technologies.

To find GL the process was simpler because it was only necessary to find the product that was intended to be compared and analyzed. As such, the only keywords used were: *“Real Estate” AND (“CRM” OR “Customer Relationship Management”)*.

2.4.2. Conducting the Multivocal Literature Review

To start with this collection, studies which featured the keyword used in each repository were identified. The first filtering was done based on the year of publication. Every document published below the year of 2010 was excluded. This allows the research to be based on recent data, only ten years old, representing what is most recently being developed and studied.

The second filter had the purpose to exclude documents based on the absence of the keywords searched in abstracts and titles. This approach allows separating the documentation related to the subject from the ones who just refer to these concepts. After

this filter application, the number of articles dropped 97,2% from the results gathered in the first filtration which reveal to be very significant.

The last filter intends to exclude from the 246 documents, 156 that focus the keywords in contexts other than what is the research main goal as well as exclude the 51 duplicate articles found and the 6 written in other languages than English. This filtering results in 26 final articles. The final list of scientific reports is presented by author in Table 29 (Appendix A). The whole filtering process is illustrated through the scheme illustrated in Figure 3. Table 6 also represents in a more expressive and exhaustive way the number of articles collected in each database at each filtering.

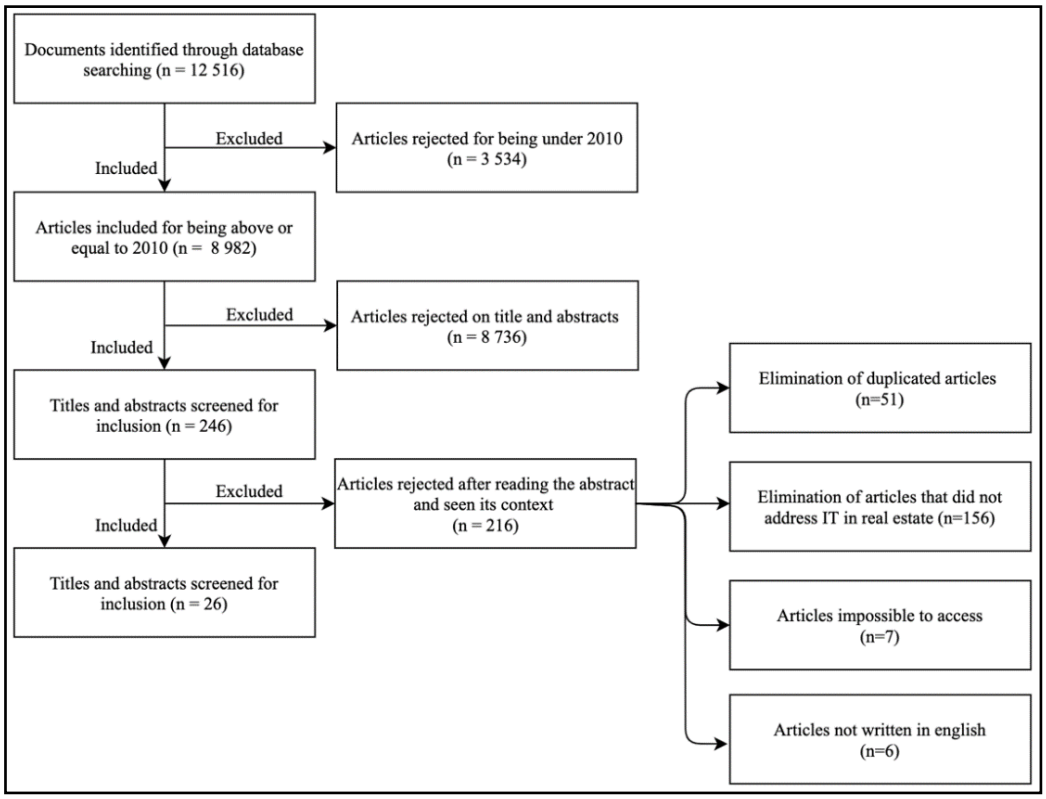


Figure 3 - Flow of all filtration process

In order to broaden the range of research, an Internet search of some existing CRMs in the international RE market was performed. The authors found 22 CRMs that are commonly used by RE agents. These are presented in Table 7.

2.4.2.1. Information Extraction Process

After the filter's application, the analysis of the articles was conducted. For each article, IT applications, technology and methodologies used, year of when the article was published, article domain and relevant information about RE were extracted.

Table 6 - Filtration process

	Keywords	No filter	1st filter	2nd filter	3rd filter
Scopus	Real Estate CRM	156	128	2	2
	Real Estate Customer Relationship Management	194	145	5	1
	Real Estate Mobile CRM	0	0	0	0
	Real Estate Mobile Application	70	67	6	1
	Real Estate IT Solutions	31	20	6	3
	Real Estate Management System	1795	1468	40	4
	Real Estate Information System	4620	3645	151	8
Emerald	Real Estate CRM	160	110	0	0
	Real Estate Customer Relationship Management	260	166	1	0
	Real Estate Mobile CRM	0	0	0	0
	Real Estate Mobile Application	75	71	1	0
	Real Estate IT Solutions	63	36	3	0
	Real Estate Management System	1414	874	8	0
	Real Estate Information System	1811	1117	4	0
American Real Estate Society	Real Estate CRM	3	1	0	0
	Real Estate Customer Relationship Management	1	0	0	0
	Real Estate Mobile CRM	0	0	0	0
	Real Estate Mobile Application	0	0	0	0
	Real Estate IT Solutions	0	0	0	0
	Real Estate Management System	35	13	0	0
	Real Estate Information System	98	44	0	0
IEEE Xplore Digital Library	Real Estate CRM	125	79	0	0
	Real Estate Customer Relationship Management	9	7	3	2
	Real Estate Mobile CRM	0	0	0	0
	Real Estate Mobile Application	190	158	3	1
	Real Estate IT Solutions	0	0	0	0
	Real Estate Management System	728	392	2	1
	Real Estate Information System	834	441	11	3
	Total	12 516	8 982	246	**26**

About GL, a survey of functionalities was made for each CRM collected, in order to identify what already exists in the existing IS. These functionalities were present in most of the explored websites. In addition, DEMO versions of the software were tested in order to rigorously prove the existing functionality.

2.4.2.2. Sample Characteristics

The dataset collected is composed of 26 articles and 22 applications. As mentioned above, as scientific literature only articles of journals and conferences have been considered. Figure 4 shows the distribution of each publication type in the sample collected. It was also analyzed the rank of the journals and its result is showed in Figure 5. These rankings are based on Scimago Journal & Country Ranks.

It is clear that journals represent the vast majority (about 61%) of all articles reviewed. Observing Figure 5 it is important to mention that 56% of the final articles are from journals Q1 and Q2 ranks, which are the predominant ranks in the resulted articles.

It is also relevant to refer that there was one article whose rank was not found so it was attributed to this article the "NA" classification.

Table 7 - CRMs analyzed

CRMs		Reference
Contactually	-	https://www.contactually.com/
CINC – Agent	-	https://www.cincpro.com/
Top Producer CRM	-	https://www.topproducer.com/top-producer-crm/
Real Geeks	-	https://www.realgeeks.com/lead-manager-crm/
Market Leader	-	https://www.marketleader.com/
Rethink CRM	-	https://rethinkcrm.com/
Realty Juggler	-	https://www.realtyjuggler.com/
Follow Up Boss	-	https://www.followupboss.com/
IXACT Contact	-	https://www.ixactcontact.com/
Lion Desk	-	https://www.liondesk.com/
Boston Logic	-	https://www.bostonlogic.com/crm/
Boom Town	-	https://boomtownroi.com/
Client Look	-	https://www.clientlook.com/
Property Base	-	https://www.propertybase.com/
Placester	-	https://placester.com/real-estate-crm-email-marketing/
Apto	-	https://www.apto.com/
Pipedrive	-	https://www.pipedrive.com/
Less Anoying CRM	-	https://www.lessannoyingcrm.com/
Referral Maker	-	https://www.buffiniandcompany.com/solutions/referral-maker-crm/
Co Star Brokage"	-	https://www.costar.com/products/costar-brokerage-applications
Apptivo CRM	-	https://www.apptivo.com/solutions/crm/
Lease Hawk	-	https://www.leasehawk.com/products

As far as the conferences are concerned, and as shown in Table 30 (Appendix B), only two proved to be in the international rank of the ERA - Excellence in Research in Australia - having assigned the rank C. In all the others the ranking was neither found nor validated.

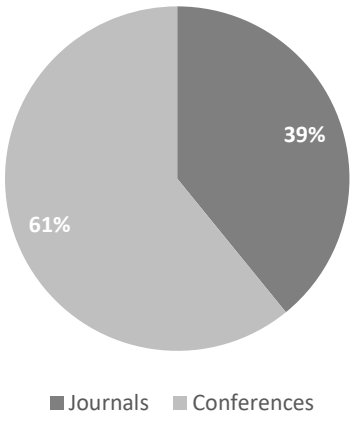


Figure 4 - Sample number of journals and conferences

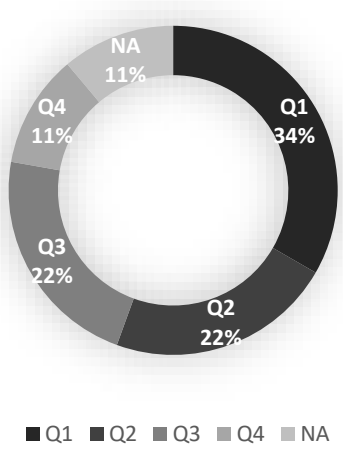


Figure 5 - Sample journals quality

Despite using data filters, is still interesting to understand the time division and evolution of these RE themes in last ten years (Table 8). It can be observed that 2019 is

the year that has most publications and most contributions gives to the dataset created.This could be justified by the evolution of e-commerce and RE platforms [53]. All data collected is presented in Table 31 (Appendix C).

Table 8 - Articles distribution by publication year

Year	Percentage [%]	Total
2019	26,66	7
2018	6,67	2
2017	10,00	3
2014	10,00	5
2013	10,00	3
2012	3,33	2
2011	6,67	1
2010	13,33	3
		26

2.4.3. Reporting the Review

The objective of this discussion is to divide the articles by main theme and to perceive which are the methodologies approached to each theme. Due to the high specificity of the software and the context to be addressed - m-CRM in the RE sector - it was expected that there would not be a strong scientific basis in the literature.

After analyzing all the scientific literature it was possible to group all its content into six different topics presented in Table 9. These results show that CRMs applied to RE and, above all, CRMs in mobile environment, do not have a solid literature base that allows us to survey which are the best practices and main features to be implemented. Rockel & Barth (2019) are the only ones mentioning the benefits that mobile CRM solutions have. Such as, allowing users to access updated information anywhere and anytime and therefore improving the rapid adaptation of each agent to customer needs.

Table 9 - Articles grouped by subject

Subject	References
Support in decision-making	[54]; [55]; [56]; [57]; [58]; [59]; [60]; [61]; [62]; [63]; [64].
E-commer Solutions	[53]; [65]; [66].
RE management systems	[67]; [68]; [61]; [69].
Other RE IS	[70]; [71]; [60]; [72]; [73]; [74]; [75].
Mobile System	[26]; [76]; [58]; [77]; [66]; [78].
Mobile CRMs	[26].

It is possible to realize that most of the scientific work published is related to the production of tools that facilitate the access to RE information by the final client, so that he can make a more conscious and correct decision. This happens either through improvements in home search systems [63] or through the implementation of some

machine learning-based models, able to predict fluctuations and accurate property price valuations in certain locations [55].

Some of the work attributed to the category of "Other RE IS" stands out for making reference to the positive aspects that the evolution of IS has from the point of view of the personal marketing of RE agents [70] , in particular by mentioning the influence it has on the personal email of the agent [75].

There are some authors who address the reasons for restrictions in the use of mobile applications by users [78] and who study the relationship of e-commerce with mobile environments [66]. As most authors study the impact of technologies on the end consumer, we realize that computer systems designed with the agent in mind are practically nonexistent.

Although all these are topics of great value, they are not directly related to m-CRM platforms or features, maintaining the relevance of the topic.

2.4.3.1. CRM Features Analysis

Figure 6 shows how often these features appear in all CRMs analyzed and reinforces the ones that are fundamental to have in a CRM to increase its effectiveness.

Table 32 (Appendix D) represents a benchmarking of 22 CRMs features. These features have been clustered in different groups according to their characteristics. Contacts integration allows the agent to have in a singular platform his contacts form the telephone and e-mail which enables them to send their clients text messages, phone calls and e-mails. In this metric is also included the user agenda and calendar so agents can use it to schedule their days as well. As it is represented in Figure 6, it is clear that this feature is the most common one since it was found in 20 CRMs. Other feature found very interesting in these platforms is team management solutions. This allows users to see dashboards and statistic values of their performance, productivity and profitability, for example, anytime. Associated with this there are some CRMs that separate users in different roles according to the company hierarchy and showing different screens accordingly as well.

The third more common feature seen is the use of pipelines. It allows users to create their goals and see their daily task list. It can be customized and can track any business process that the user wants. Within the same scenario, some platforms also had automated action plan featured, which allows the user to have their own action plan build automatically according to their ambitions and objectives. An action plan is the path that

some user must follow to make something to happen, by other words it is the automation of workflow. CRMs like *Ixact Contact*, *Follow Up Boss*, *Contactually*, *Lease Hawk* and *Apto* are the only ones to implement both features which contribute for a more efficient and automated overall process.

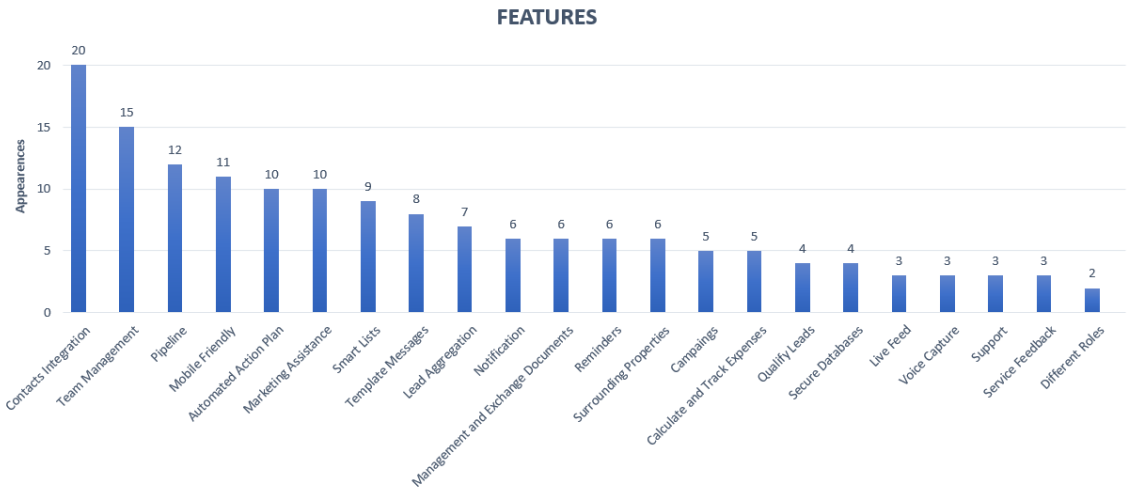


Figure 6 - Professional CRM feature appearance

The third more common feature seen is the use of pipelines. It allows users to create their goals and see their daily task list. It can be customized and can track any business process that the user wants. Within the same scenario, some platforms also had automated action plan featured, which allows the user to have their own action plan build automatically according to their ambitions and objectives. An action plan is the path that some user must follow to make something to happen, by other words it is the automation of workflow. CRMs like *Ixact Contact*, *Follow Up Boss*, *Contactually*, *Lease Hawk* and *Apto* are the only ones to implement both features which contribute for a more efficient and automated overall process.

Some platforms also have smart lists that prioritize the most relevant and most likely to buy or sell clients and lead aggregation features, which allows the expansion of customers network by gathering leads from several different web platforms into one. There were also mobile friendly CRMs which enable access to the platform on the move anywhere and anytime. Despite it might seem a usual platform characteristic, this study reveals that less than half of the CRMs had this implemented, only appearing on 10.

Another feature recognized is the marketing assistance the platform offers. This allows the user to get help with some publicity issues and brand disclosure throw the platform. Having template messages also allows the user to save time by sending the same

core message to different customers. Related to this but less used, some CRMs also enable campaigns, that is e-mails can be broadcast to many different customers increasing their reach. It is often used with the goal to promote properties. It is also important to mention that only *Ixact Contact*, *Contactually* and *Top Producer CRM* do not implement both features opting only for the template messages feature.

Notifications and reminders are also present in many platforms. The core difference between them is that the first one aims to get alerts from any updates or other notices and reminders are used to inform the user to call someone or make some task that he might forget. A usual example for reminders application in the commercial business is to call some client at his birthday. According to Table 32 (Appendix D) and despite having different meanings both are implemented in the same number of platforms. However only *Real Geeks*, *Top Producer CRM* and *Realty Juggler* have implemented both notifications and reminders in their CRM system.

Other features analyzed are the management and exchange documents throw the platform; calculate and track expenses; voice capture that allows agents to review calls made and improve from them; having secure databases; and support for listening to the user's problems and fix them, improving the quality of the platform. In addition, a few platforms implement surrounding properties knowledge which allows the agent to get to know other properties and makes it possible to collect them. There are also some features implemented to qualify leads which can be interesting to save time and collect only the most qualified customers.

At last it was also found features related to customer feedback service. It contributes to inform clients of their property results and builds the relationship between agents and clients. Live feeds that enable the agent to get information about properties and clients in his home page and social profiles appear as a solution to characterize consumers and guide the sale according to pre-built information.

Figure 7, created through the VOS Viewer software (https://www.vosviewer.com), presents the relations each feature has to each other. The diameter of the nodes of each feature varies according to the number of uses it has, the thickness of the connections varies according to the intensity of the relation between the different features. It is important to analyze the structure of the network presented since at the ends are the less relevant features and near the center are the ones with more usefulness. The size of the nodes is coherent with the results shown above.

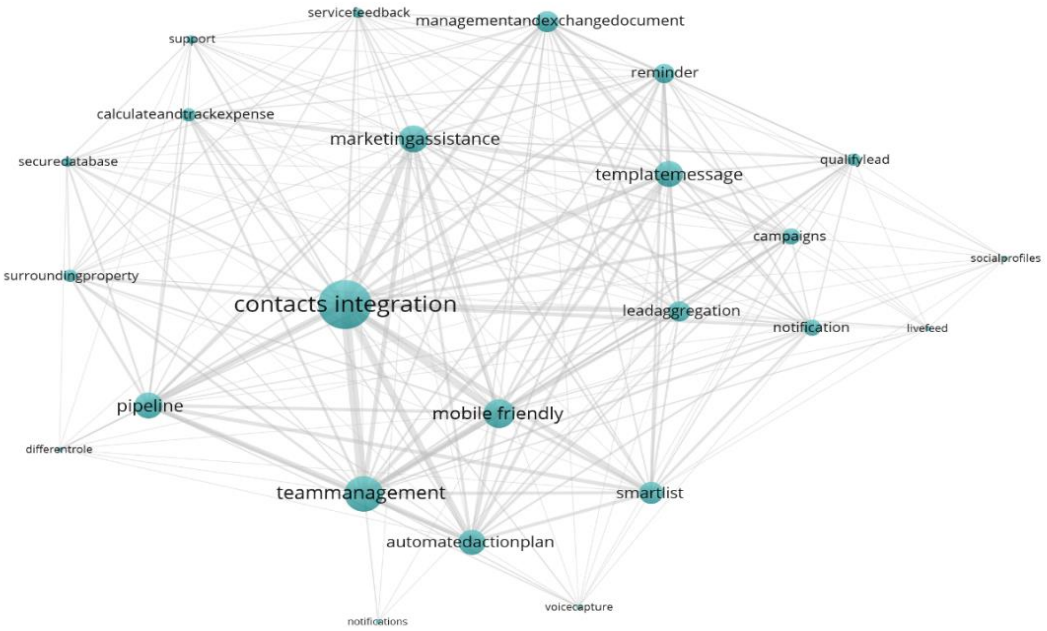


Figure 7 - Relation between different features

As already demonstrated, there are still many platforms that are not adopting this solution, creating this gap between what is advised by the literature and what is implemented in practice.

On the other hand, while in the literature there was only one reference to mobile CRM applications, in this analysis it was found that a considerable number of softwares were compatible with smartphones - 9 out of 22 CRMs - which shows that their applications still have a lot of progress to be made at a cientifical level.

CHAPTER 3

Research Methodology

The research methodology used in this research was Design Science Research (DSR). The DSR methodology applied here is based on the principle of design, construction and evaluation of the mobile application we intend to develop. It aims to solve a specific problem and can be defined as the methodical construction of artefacts that intend to meet predefined requirements [79]. This methodology approach includes three elements: conceptual principles, that help establish the DSR, practical rules for implementing the methodology and procedures for conducting and carrying out the research [80].

This methodology can be applied using six stages as it is demonstrated in Figure 4. It should start with the identification of the problems and the research motivation, then it should define the objectives of the research and the proposed solution.

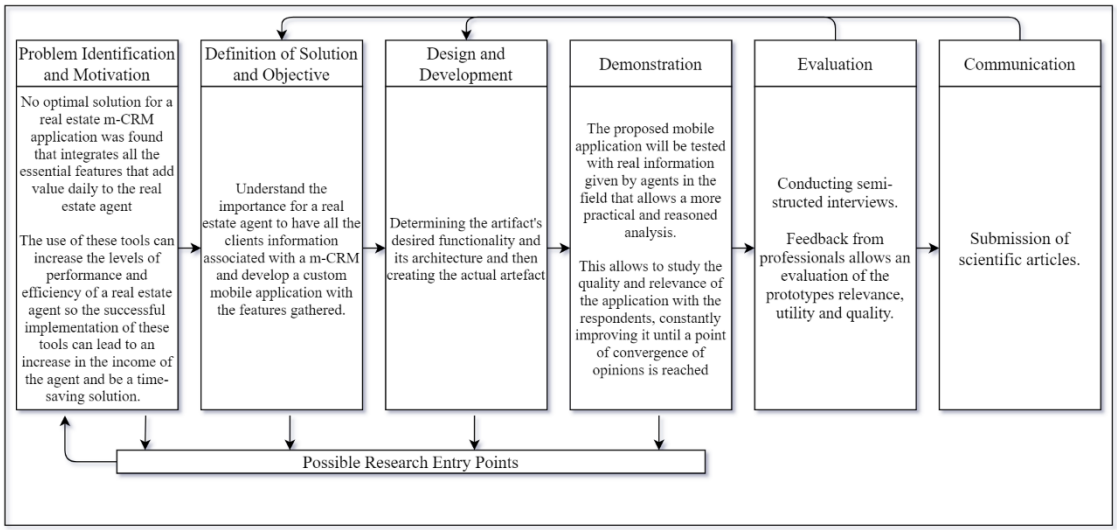


Figure 8 - DSR methodology scheme.

After that we move on to the implementation phase. As the artefact to be developed is the creation of customized mobile software, as soon as each version is completed it should be demonstrated to RE agents (fourth stage) to gather feedback and make an evaluation of the product which represents the fifth stage of the methodology. If there are improvements both in terms of requirements and functional level of the system, the DSR model can be iterated again to improve the application.

The last phase its intended to be the communication of the discoveries and the results found with the artefact produced.

CHAPTER 4

Proposal and Evaluation

In order to be able to build the idealized IS, the DSR methodology described in Chapter 3 was followed. Seven DSR iterations were performed. In order to evaluate them, one expert was interviewed for each iteration. Table 10 represents the sample of respondents used in this process. The survey design is presented in Appendix F.

Given the global pandemic crisis, this entire iterative process had to be carried out remotely. Each iterative interview took approximately 45 minutes and was achieved through a video conference via Zoom. The remote nature of this interaction meant that only users with Android operating systems could receive the .apk file, in order to install it on their own mobile devices. With iOS devices this process did not become feasible since it would be necessary for each iteration to request approval from the Apple entity and submit the application in the apple store. In these cases, the interviewer shared the screen of his smartphone live. In order to not compromise the authenticity of the test and honesty of the feedback collected in the interview, the interviewer only performed the movements that the RE agent asked for, giving him total freedom to use the application.

This phased monitoring of different professionals was done to ensure validation, consolidation and constant improvements throughout the development of the artifact, allowing it to reach a possible upper-bound (a point where all the feedback gathered was similar) where the IS was considered an ideal m-CRM.

Table 10 - Data of interviewees

Gender	Age	Role	Experience	Iteration
Male	31	Collector and Buyer Agent	4 years	First
Female	26	Collector and Buyer Agent	2 years	Second
Male	39	Team Leader	11 years	Third
Male	37	Collector and Buyer Agent	7 years	Fourth
Male	27	Collector	3 years	Fifth
Female	49	General Manager	4 years	Sixth
Male	52	Agency Director	20 years	Seventh

4.1. First DSR Iteration

In order to realize the first iteration of the DSR, the first artifact was built. For this, it was necessary to gather the fundamental functionalities of IS. These functionalities were

acquired, again from the RE professionals. The sample of agents interviewed corresponds exactly to the 15 listed in Table 1, in Section 1.2. More than raising requests, these new interviews served to understand if the functionalities found in the literature correspond to those the market needs.

4.1.1. Requirements Gathering

After identifying a list of requirements present in the literature and products already on the market, visible on Table 11, it was then important to realize whether such features were the right ones and really brought value to RE agents.

Table 11 - Features gathered in GL

ID	Features in GL
FGL.1	Contact Integration
FGL.2	Team Management
FGL.3	Pipeline
FGL.4	Mobile Friendly
FGL.5	Automated Action Plan
FGL.6	Marketing Assistance
FGL.7	Smart Lists
FGL.8	Template Messages
FGL.9	Lead Aggregation
FGL.10	Notification
FGL.11	Management and Exchange Documents
FGL.12	Reminders
FGL.13	Surrounding Properties
FGL.14	Campaigns
FGL.15	Calculate and Track Expenses
FGL.16	Qualify Leads
FGL.17	Live Feed
FGL.18	Voice capture
FGL.19	Support
FGL.20	Service Feedback
FGL.21	Different Roles

Given the opinions of the interviewees it was realized that there were some features present in GL that did not fit with what professionals understoond as essential features for a CRM. Features such as FGL.6, FGL.13, FG20 and FGL.21 were considered very interesting and could add value to the agent, but only in a context where the artifact developed is a platform that facilitates sales. Since what is being developed is not a sales focused platform these features were demeed unecessary. Other features like FGL.5, FGL.9 and FGL.14, although having received good feedback when applied to web platforms, they were not recommended when the environment became mobile. This

argument was justified by the fact that most agents perform this work in an office context, where they use their personal computer to work. As far as the FGL.4 functionality is concerned, given that the aim of the research is to develop a platform in a mobile environment, this functionality was not even considered under discussion.

Regarding the functionalities of FGL.15, FGL.17 and FGL.18, the feedback gathered was that given the description of the features, their implementation would not be opportune for the development of the artifact, mainly because it does not affect any core functionality of what the RE agents interviewed idealized as m-CRM.

Considering all the opinions of the professionals interviewed, a new and timelier list of functionalities to be implemented in an m-CRM was prepared. This new list is present in Table 12.

Table 12 - Artifact features from GL

ID	Features in GL
FGL.1	Contact Integration
FGL.2	Team Management
FGL.3	Pipeline
FGL.7	Smart Lists
FGL.8	Template Messages
FGL.10	Notification
FGL.11	Management and Exchange Documents
FGL.12	Reminders
FGL.16	Qualify Leads
FGL.19	Support

In order to start the software development project for the artifact, it became important to reduce each functionality to its essence and to understand exactly what would be needed in the system to meet the expectations of the RE agents. For this purpose, Table 13 matches the functionalities described in GL with the features found to be the most desired in the interviews as wells as base functionalities required in type of mobile applications.

This way it is understood that the functionalities desired by RE professionals are in line with those most common in existing CRMs. It is also important that the functionalities that are the most commonin different CRMs, such as the integration of contacts, for example, are understood as the main features in an m-CRM. In this way, with the realization and validation of an artifact with these functionalities, we would be able to converge exactly what is necessary and that was considered of greater value, both through literature and interviews, making the IS distinctive and unique in the RE sector.

Table 13 - Features to be implemented vs Features in GL

Features to be implemented	Features in GL
Platform registration and authentication.	--
Agenda Integration; Contact Registration; Possibility of making calls and messages.	Contact Integration
Creation of graphics; Record of the progress of the agent; Display of the evolution and objectives of the RE agent.	Team Management
Sales Funnel.	Pipeline
Smart Lists.	Smart Lists
Customization of messages	Template Messages
Notifications	Notification
Documentation Management	Management and Exchange Documents
Reminders	Reminders
Customer Qualification.	Qualify Leads
Settings; Support	Support Settings

4.1.2. Mockup and Prioritization

In order to improve the user experience (UX) of the software [25] and to allow a quick understanding of the software to be developed, storyboards were created (Figure 9).

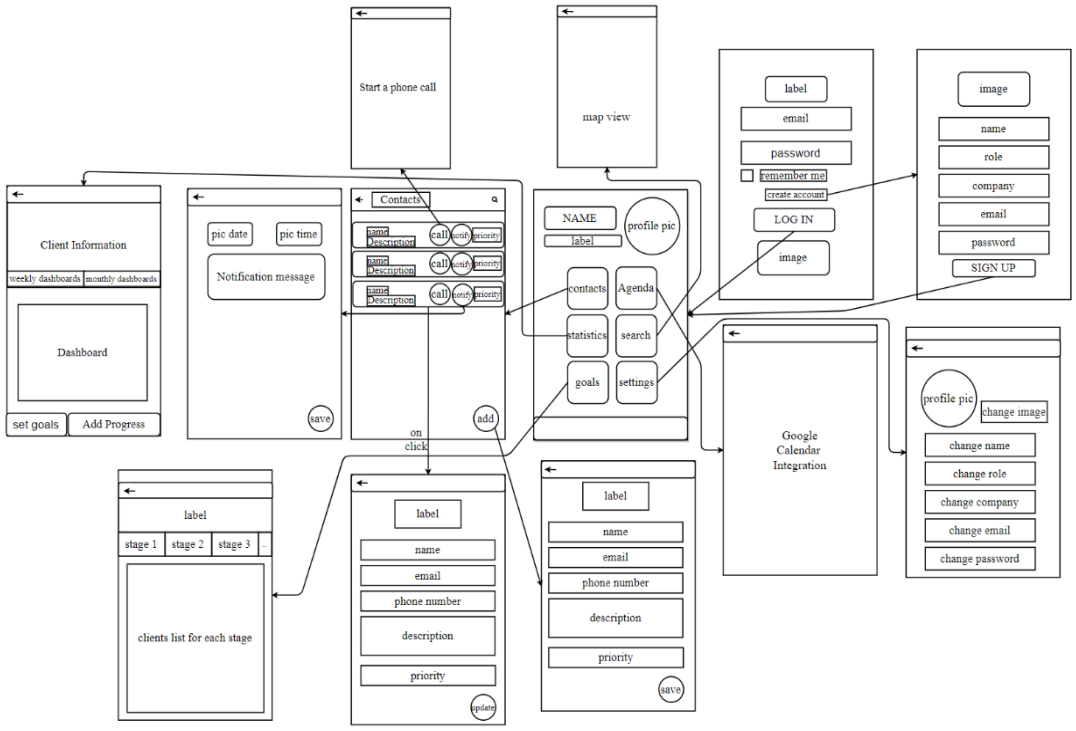


Figure 9 - Initial mockup screens for the artifact

After the interviews it was also defined which features would be most and least relevant in a mobile software, which allowed for a fast prioritization. Thus, it was also determined that the most important features would be given the most priority and vice

versa. The most important functionalities were considered, considering the insight obtained through the feedback from RE agents. The features presented in section 4.1.1 were thus distributed according to different priority orders, as shown in Table 14, with 1 being the highest priority and 10 the lowest.

Table 14 - Features prioritization

ID	Features	Priority
F1	*Contacts integration*	1
F2	*Agenda integration*	2
F3	*Smart lists*	3
F4	*Notifications and reminders*	4
F5	*Individual performance management and statistical information*	5
F6	*Client qualification*	6
F7	*Clients documentation management*	7
F8	*Clients pipeline*	8
F9	*Customizable template messages*	9
F10	*Support Settings*	10

This order was established according to two major factors: the relevance pointed out by the literature; and the importance attributed to each of them by the RE professionals interviewed.

4.1.3. Artifact Development

At the beginning of this development process, the programming language and its database were chosen. Dart was chosen as the programming language, using its most recent framework: Flutter. The use of Flutter allowed the development in multiplatforms, meaning that the application is compatible with Android and iOS operating systems. The data was stored using Firebase as back-end. The use of this free service from Google, besides being very compatible with Flutter, facilitates the authentication process with email and password; allows cloud storage through Cloud Firestore, its Storage features allows us to store images and files; enhanced the sending of push notifications through Firebase Cloud Messaging; and, among other things, also allows the creation of automatic processes through Firebase Functions.

It was also defined a primary graphical package of the application in order to enable the coherence of the software, a better user experience and facilitate the creation of the user interface. A functional authentication screen was developed capable of registering each user and an initial dashboard containing an image of the RE agent, his name and

agency. This was the starting point of the development of the first and most important features of the artifact.

In each iteration of the DSR model, in addition to the implementations the interviewees considered appropriate, the functionalities were also added according to their order of importance, defined in section 4.1.2. Table 15 intends to illustrate all stages of the development of this artefact.

It is important to mention that the last iteration served mainly to verify and validate if all the implemented suggestions were in accordance with the opinion of a bigger number of professionals, which allowed us to reach a saturation point and validate the artifact created.

Table 15 - Assignment of features by iteration

DSR Iteration	Features	ID
First Iteration	*Contacts integration*; *Agenda integration*; *Smart lists*.	F1; F2; F3
Second Iteration	First iteration feature improvement; *Notifications and reminders*; *Individual performance management and statistical information*.	F4; F5
Third Iteration	Second iteration feature improvement; *Client qualification*; *Clients documentation management*.	F6; F7
Fourth Iteration	Third iteration feature improvement; *Clients pipeline.*	F8
Fifth Iteration	Fourth iteration feature improvement; *Customizable template messages*.	F9
Sixth Iteration	Fifth iteration feature improvement; *Support Settings.*	F10
Seventh Iteration	Sixth iteration feature improvement.	-

4.1.4. Demonstration

To demonstrate the first artifact, different screens were created corresponding to the functionalities implemeted for this iteration. These screens are illustrated in Figure 10.

When opening the application, the interviewee is faced with a login screen. The credentials used in the experiments were previously created by the system administrator to optimize the collection of feedback in the interview. This form of authentication is also able to memorize the entry credentials.

After being authenticated, the interviewee had the opportunity to analyze the main menu. By clicking on the "contacts" option, the RE agent was able to see the list of contacts organized according to pre-assigned priorities and with the possibilities of connecting and preparing personalized notifications for each one. In this screen the interviewee could add a new user and edit the existing ones. After returning to the screens,

the interviewee was also able to assess the integration of the Google Calendar. The feedback from this agent is recorded in Table 16.

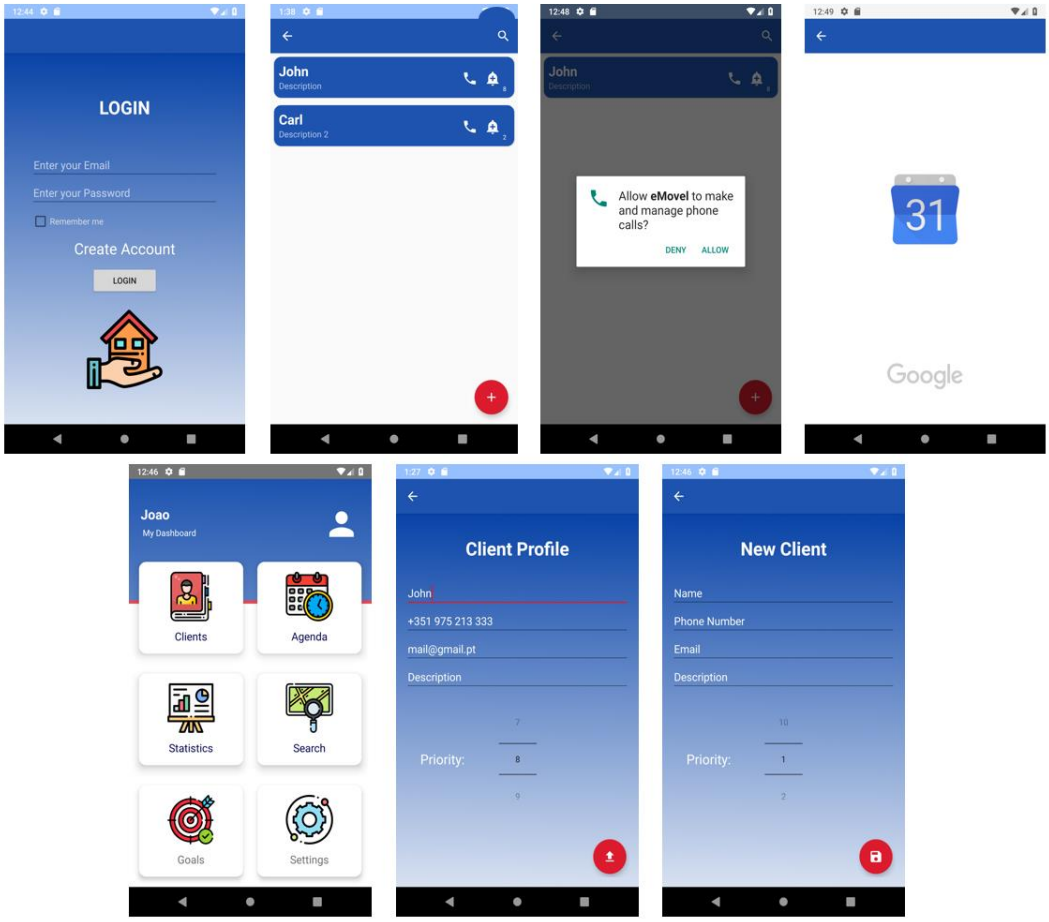


Figure 10 - First artifact iteration

4.1.5. Evaluation

After the first version of the software was completed, comprised only of the first four priority functionalities, a new interview was conducted with a RE professional. Since this interviewee owned a mobile device with android operating system, there was no problem testing the application on his phone.

After the first validation interview of the artifact, the feedback obtained was the following: three negative and one positive aspect and four proposals for improvement, as we can see in Table 16. The positive aspect is related to the ease of intuition presented by the initial screens for authentication. As negative aspects, errors were reported regarding the lack of responsiveness of the software. The RE agent considered that despite being a good addition, notifications should be interactive to streamline the process for the agent and improve their experience. It was also reported that with the vast list of customers that

can be created in medium/long term, it would be difficult to find a contact if there was no search functionality.

About the suggested improvements, these are mainly related to the interaction with the information that is displayed in the system. There were also suggestions of visual improvements relating to the responsiveness of the screens. Most of these suggestions were considered essential for the optimization of the artifact. There was only one suggestion that was considered relevant to leave on hold to assess whether the feedback in the following iterations remained the same.

Table 16 - Evaluation of the first iteration artifact

	ID	Stakeholder Synthesis	Stakeholder Opinions
Pros	P1.1	"Intuitive customer authentication."	Customer authentication was considered a very intuitive and easy to use tool which facilitates an easy access.
Cons	C1.1	"The display of the initial panel showed deformations on the cards."	Due to the version of the android device used in the test, the application had some visual inaccuracies on the cards that did not show variable size and did not become appealing.
	C1.2	"It was not possible to interact with the notification."	After receiving the notification from the client, the interviewee detected that it was not possible to click and interact with it.
	C1.3	"User is not enabled to easily find clients."	If the client list is too long it would be important to filter them out.
Proposed Improvements	PI1.1	"Adjust the formatting of the cards on the dashboard."	To make the application more aesthetic and visually appealing it is important that the cards with the different features are adjustable to the different mobile devices.
	PI1.2	"Decrease priority levels."	Levels of priority were considered exaggerated. There is no need to distinguish between 10 levels of priority. The respondent suggested something between 1 and 5 or 1 and 3 as a more realistic range of priority levels. It was also suggested that colour schemes be used according to the priority set.
	PI1.3	"Client Search."	In order to be able to guarantee the effectiveness of a client's search without wasting too much time, a search area would be very useful.

4.2. Second DSR Iteration

After analyzing all the interviews and defining the system requirements and its development priorities, the second prototype of the artifact was developed and evaluated. All the suggestions pointed out by the interviewee are displayed in Table 18 along with their justification.

Proposal

In this iteration the features have been improved so that the RE agent interviewed can validate them. Therefore, it is possible to understand if there is consistency in the feedback and suggestions for improvement. Table 17 allows us to have a synthesized view of what has been improved. As can be seen, the suggestion to decrease the priority levels assigned to each client was not implemented. This was due to the need to understand if this was a recurrent opinion among professionals.

Table 17 - Implemented improvements after first iteration

Proposed Improvement	ID	Type of Improvement	Implemented?	Suggested by
"Adjust the formatting of the cards on the dashboard."	PI1.1	Visual	Yes	Interviewee
"Decrease priority levels."	PI1.2	Information	No	Interviewee
"Client Search."	PI1.3	Information	Yes	Interviewee

Proposal

Figure 11 shows the progress made in the artifact. The cards within the startup screen have become more responsive, having lost the color of their icons in an attempt to standardize the software's graphics package. A button, with the icon of a magnifying glass, became available, which when clicked, allowed for searching of clients in the contacts list.

As a new inclusion in this second iteration notifications were added in a way that could be programmed and customized by the interviewee. The notifications are created interactively which means that the user when clicking on the notification is able to access the main panel and perform the task for which he defined the notification.

Also added were the graphs indicating the progress of the agents, having to be the user himself to define his objectives and to insert his progress daily. Through the design of the goal line it is clear for the user how close he is to achieving it. For this

implementation it was necessary to adopt a library named MPFlutterChart capable of generating the graphics.

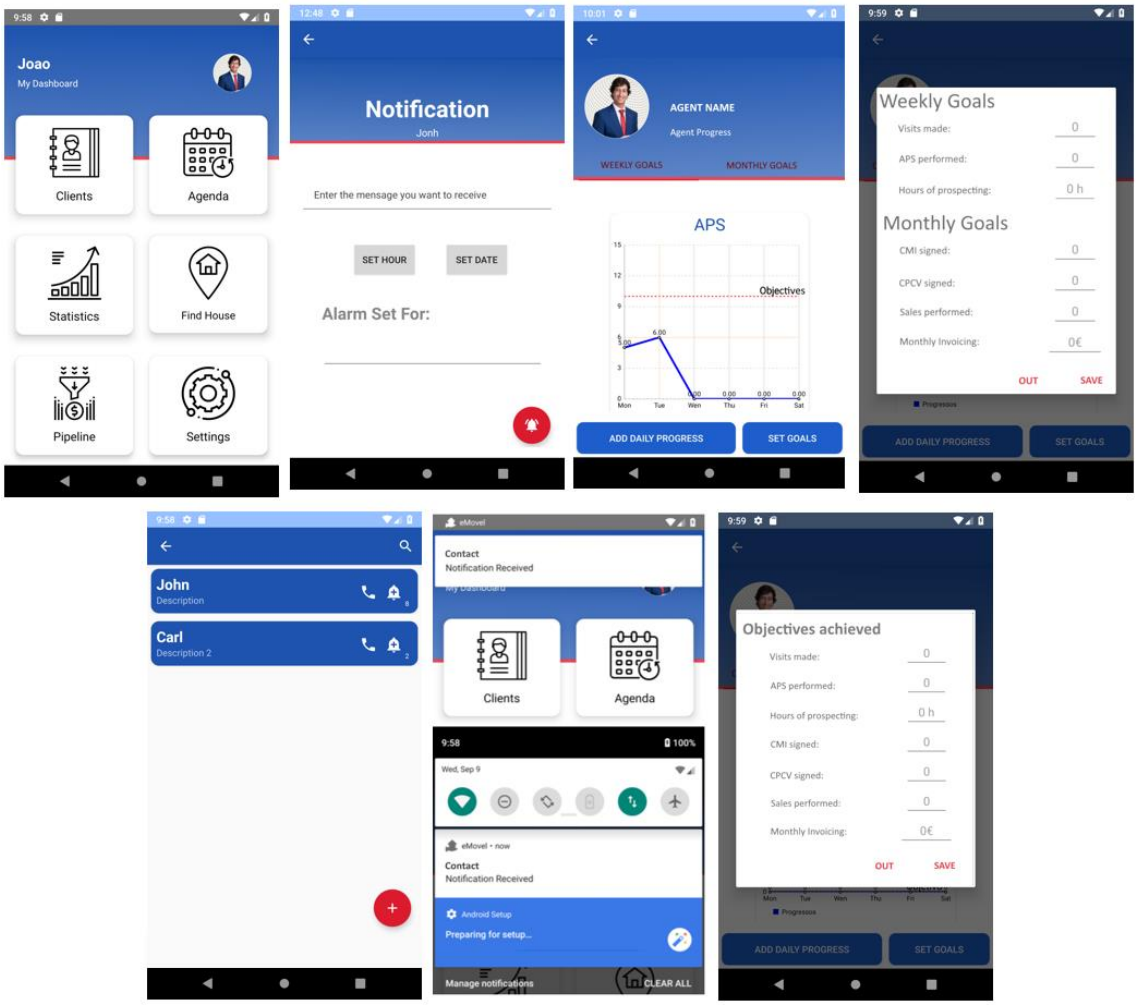


Figure 11 - Artifact from second iteration

Evaluation

After the second interview it was possible to obtain a result consistent with the feedback obtained in the first. The comments given relating to the software were more positive (five) than negative (two) which revealed that the artifact was on a good track to meet the needs of RE agents. In addition, the interviewee also left some constructive criticism in order to create a fully customised platform for the agent. Table 18 presents the description of the opinions left by the interviewee.

In this iteration it was also possible to realize that the change of the client's priority levels was something that should have been taken into account, having been changed to the third iteration.

Table 18 - Evaluation of the second iteration artifact

	ID	Stakeholder Synthesis	Stakeholder Opinions
Pros	P2.1	"Integration of the personal agenda is very valuable."	The integration of the agent's personal calendar was considered very important as it is a fundamental time management tool for the user and was very well achieved in the application.
	P2.2	"The ability to eliminate a customer is very important."	As there are many contacts in a phone book it is important to be able to delete those that no longer make sense to keep track of.
	P2.3	"Personal dashboard very intuitive."	To have the information distributed in the various segments and reachable in a very intuitive way is a very positive point. In addition, showing the agent's information as the profile photo and his name were praised details.
	P2.4	"Having the option to customize the notifications for each client is a positive point."	The existence of notifications is quite important in a universe full of information. Having the possibility of remembering specific information for each client was very welcome.
	P2.5	"Integration of the personal agenda is very valuable."	The integration of the agent's personal calendar was considered very important as it is a fundamental time management tool for the user and was very well achieved in the application.
Cons	C2.1	"A message should appear asking us to confirm the removal of the client."	It is still important to confirm this before deleting the contact as the agent can cheat or delete it without having that purpose. This functionality was not implemented, and it should have this validation.
	C2.2	"Lack of a record field for birthday dates."	Due to the relevance of contacting customers it is important to register the birthday of each and receive an alert on that day so that the user is reminded to make that contact.
Proposed Improvements	PI2.1	"Separation of the contact list according to the various types of clients."	There are mainly four types of customer: the selling customer, the buyer, the one looking for rent and the one looking to invest. As a rule, the interviewee already did this in his personal phone book by assigning a number, from 1 to 4, to the different customers he had. With the existence of each list separated by the types of customers, it was easier to find and identify each customer.
	PI2.2	"Creation in the customer profile of a field to record the anniversary date with notification associated with that event."	Knowing the customer's birthday dates is always an asset to the agent. Being able to send them a message on that special day is something that is often forgotten and makes all the difference for a more personal approach with the client. So, being able to have that record in the application and receive the reminder on the day can be a very relevant feature.
	PI2.3	"Priority allocation do not need to be so extensive."	In establishing the priority of contacts, it will be enough that the most important contacts to be followed up appear at the beginning. This means that the scale used from 1 to 10 will not be the most appropriate. A scale of 1 to 5 should be perfect for the agent to set the priority.
	PI2.4	"Follow-up notifications following the 1-30-90 method."	This method was stated by the interviewee who said it was used by the biggest American RE agents. This method advocates that the client should be contacted 1 day, 30 days and 90 days after signing the deed of the house. Having this methodology implemented in the application can add great value to it
	PI2.5	Creation of a screen with a record of calls and notes taken by the agent at the end of each customer interaction.	Due to the information overload that is inherent to the RE profession it is very difficult for agents to remember everything. But the more personal information each client has, the better the relationship they create. It would therefore be very useful if, at the end of each interaction, they could record some notes in the client's profile that could be consulted before future interactions so that nothing is forgotten.

4.3.Third DSR Iteration

After analyzing all the interviews and defining the system requirements and its development priorities, the first prototype was carried out and presented. All the points pointed out by the interviewee are exposed in Table 20 along with their justification.

Proposal

In the third iteration the user interface was updated in order to create its own visual entity because, although it is not the main focus of the development, it makes the use of the software clearer for the interviewee, making his suggestions more objective. In addition, fourth of the fifth suggestions for improvement were made in the second iteration. In Table 19 it is possible to see which improvements were implemented. The results and feedback of these implementations are in section 4.3.3 Evaluation. Once again it should be noted that the follow up notifications feature was not been implemented. This is justified by the peculiarity of the suggestion and the need to validate the suggestion of the interviewee.

Table 19 - Implemented improvements after second iteration

Proposed Improvement	ID	Type of Improvement	Implemented?	Suggested by
"Separation of the contact list according to the various types of clients."	PI2.1	Information	Yes	Interviewee
"Creation in the customer profile of a field to record the anniversary date with notification associated with that event."	PI2.2	Information	Yes	Interviewee
"Priority allocation do not need to be so extensive."	PI2.3	Information	Yes	Interviewee
"Follow-up notifications following the 1-30-90 method. "	PI2.4	Information	No	Interviewee
“Creation of a screen with a record of calls and notes taken by the agent at the end of each customer interaction.”	PI2.5	Information	Yes	Author

Demonstration

In the creation of the artifact for third iteration the maximum value allowed to set the priority of a client was changed, now from 0 to 5 as indicated in PI2.4 and PI1.2. The design of the software was also changed, namely in the screens of the client profile, in an attempt to create a different visual identity.

The implementation of PI2.2 suggestion was very important as it is a feature that allows maintaining contact with the customer over the years and is essential to ensure a lasting relationship between RE agents and their contacts.

It was interesting to realize that the professionals interviewed are consistent in the needs they feel, because the PI2.1 proposal appears almost as an anticipation of what had been raised as a requirement and was planned for this new iteration. The interviewee considers opportune the existence of filters within the list of contacts that will be possible at the time of their qualification. This reveals the importance of F6 implementation for professionals.

The suggestion PI2.5 appears as a complement to the client's information register, allowing the agent to always have in hands the last interactions he had with the contact giving the professional all the capacity to cause more impact and empathy naturally improving his relationship with the client.

The implementation of these suggestions as well as the implementation of F6 and F7 is illustrated in Figure 12.

Evaluation

After the interview, the result was three positive comments, two negative criticisms and three suggestion proposals according to Table 20. Of the suggested improvement proposals only one was related to visual aspects of the artifact, and the other two worked as improvements in the information that is exposed thus optimizing and customizing the artifact.

Following this interview all the suggestions were made, and this information is available in section 4.4.2.

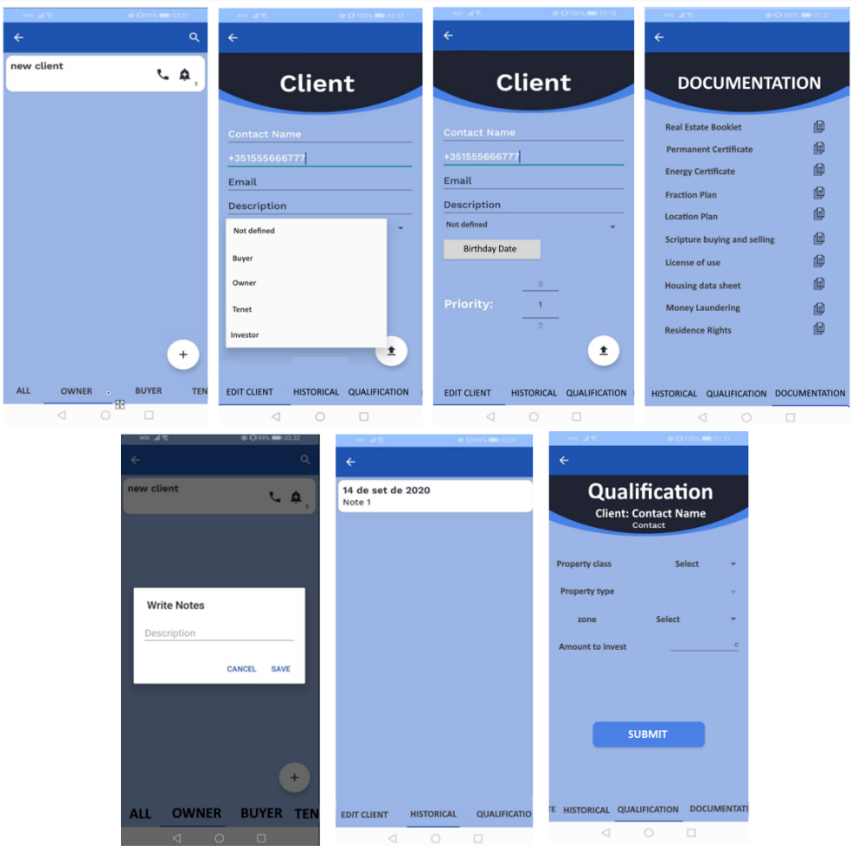


Figure 12 - Artifact improvements on the third iteration

Table 20 - Evaluation of the artifact at third iteration

	ID	Stakeholder Synthesis	Stakeholder Opinions
Pros	P3.1	"Notifications of the calendar and possibility to customize them."	For a RE agent, it is practically impossible to memorize all his commitments to all his clients. Therefore, this feature proves to be quite important so that nothing is missed during the day.
	P3.2	"Existence of notes and a history of iterations with the customer."	Given the high volume of information exchanged with the various customers, and often the large time gap between interactions quickly the user forgets the last contacts he had with each client individually. The existence of this history allows us to always know the topics covered in the past before each contact and ensure a better and more lasting relationship with each client.
	P3.3	"Intuitive dashboards."	This information is presented in a way that is easy to understand and to handle.
Cons	C3.1	"Not being able to qualify the customer."	Given the high volume of contacts that a RE consultant has, it is important to be able to qualify them in order to understand whether the contact can be turned into a lead and possible client or if he is not so interested in obtaining the user's service.
	C3.2	"Statistical analysis metrics."	The interviewee considered that the metrics analyzed would not be sufficient.
Proposed Improvements	PI3.1	"Add a checklist with the necessary documentation."	In order to proceed with the collection of documentation, it was suggested by the interviewee that these documents appear associated with a checkbox so that it is easier to manage all the missing documentation and understand which one the user already has.
	PI3.2	"Improvement of statistical analysis metrics."	The stakeholder interviewed suggested a set of metrics to analyse and display on the dashboard screen. This list included: invoicing, deeds, collections and leads generated, sales, service presentations, RE contracts, promissory contracts, proposals obtained, successful sales, prospecting time.
	PI3.3	"Definition of customer qualification metrics."	It was also suggested, based on the client qualification processes already used by the interviewed professional, what characteristics and metrics should be adopted in order to ensure an effective client qualification. These improvements included recording the type of financing the client needed and the bank to which it was associated. According to the interviewee, having this information about the client from the beginning facilitates all the interaction between all those involved, which causes a greater sense of trust in the client and in turn provides a more lasting relationship.

4.4.Fourth DSR Iteration

Once again, after the third iteration was completed, the proposals for improvement received were analyzed and considered. The result is shown in section 4.4.2.

Proposal

Following the feedback from the third iteration interview and in order to continue with the optimization of the artifact all the suggestions left by the interviewee were implemented. Table 21 summarizes the result of what was suggested and implemented between the last iteration and the current one. In addition to these improvements, the order of implementation of functionalities presented in section 4.1.2 was also continued.

Table 21 - Implemented improvements after third iteration

Proposed Improvement	ID	Type of Improvement	Implemented?	Suggested by
Add a checklist with the necessary documentation.	PI3.1	Visual	Yes	Interviewee
Improvement of statistical analysis metrics.	PI3.2	Information	Yes	Interviewee
Definition of customer qualification metrics.	PI3.3	Information	Yes	Interviewee

Demonstration

In Figure 14 it is possible to perceive the progress that the artifact had in the transition of iterations. It is noticeable the introduction of more metrics of customer qualification, as suggested in PI3.3 where it is now possible to register also what the customer of the user thinks about acquiring the property as well as the banking entity to which it is associated, adding more value to all the qualification allowed by the artifact.

It was also presented the screen and respective functionalities of the sales hopper as proposed for this iteration. This functionality allowed dragging each user's lead into the different sales process adding reminders about it at any stage to optimize the sales process.

In addition, it is possible to identify the changes that occurred in the documentation registration part. As suggested in PI3.1 the visual scheme of the screen and the usability became more effective, remaining intuitive for the user to recognize which documents he still needs from his customer and which ones already in his possession.

To complement the statistical metrics and implement the suggestion suggested in PI3.2 more dashboards were implemented, keeping the same style in a sliding window.

These dashboards had in common their scale and axes since we are talking about quantitative metrics defined by whole values. While the vertical axis meant the number of tasks generated, the horizontal axis pointed to the days when the same tasks took place. In this way it is possible to perceive the advance and progress of each metric in a time prespective. These graphics are illustrated in Figure 14. This allows the RE agents to more accurately measure their performance by recognizing where they should improve to achieve better results in their business.

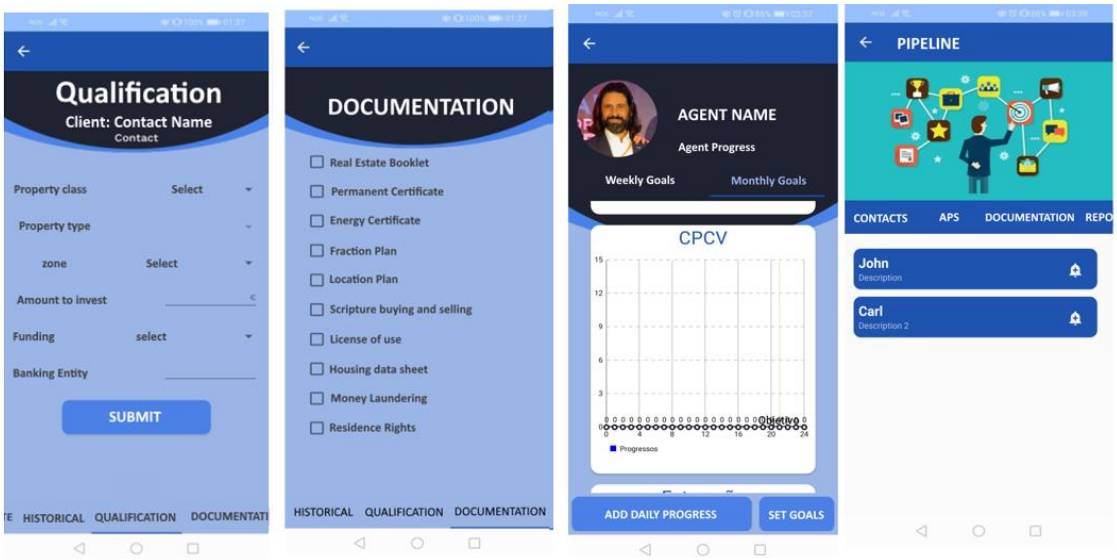


Figure 13 - Changes made in the artifact on the fourth iteration

Figure 14 - Dashboard metrics applied on the fourth iteration

Evaluation

After the demonstration of the fourth artifact created it was perceived by the interviewee that we were reaching a very interesting application from the commercial point of view. All the feedback left by the RE agent is described in Table 23. The positive comments (four) were superior to the negative aspects (two) pointed out and the interviewee also suggested an addition to the existing information. In total, four proposals for improvement were left which will be analysed in section 4.5.1.

4.5.Fifth DSR Iteration

Taking into consideration the feedback received by the RE agent interviewed on the fourth iteration, his suggestions were considered, and a more complete artefact was developed. Throughout this section the proposed and implemented improvements will be demonstrated and displayed.

Proposal

In the fifth iteration, the artefact was improved considering the proposals for improvement suggested by the subject intervened in the previous iteration. Of the proposed suggestions only one was not realized because it seemed a particularity of the interviewed RE agent, being in wait to realize if in the following iterations the same comment was mentioned. In Table 22 the accepted and unaccepted proposals are exposed, and the demonstration of the current artifact can only be found in section 4.5.2.

Table 22 – Implemented improvements at fouth iteration

Proposed Improvement	ID	Type of Improvement	Implemented?	Suggested by
“Change the scale of the dashboards.”	PI4.1	Visual	Yes	Author
“Add business partner contacts.”	PI4.2	Information	Yes	Interviewee
“Establish only the professional's annual goal and from that set their daily, weekly and monthly goals automatically.”	PI4.3	Information	No	Interviewee
“Synchronization of contacts with the user's mobile phone.”	PI4.4	Information	Yes	Interviewee

Table 23 - Evaluation of the artifact at fourth iteration

	ID	Stakeholder Synthesis	Stakeholder Opinions
Pros	P4.1	"Structure of dashboards quite accurate."	The dashboard screen presentation has been praised and recognized for resembling that usually practiced by professionals.
	P4.2	"Setting of priorities is seen as something quite interesting."	Prioritizing each customer was considered a positive thing where the user can quickly know who the hot customers are - those who are ready to do business - distinguishing them from those who are colder - who still need either documentation or financing to really be ready for the transaction.
	P4.3	"Existence of a contact history."	The existence of a history of contacts was praised as it allows the RE agent to be always aware of all the details of all interactions with each client regardless of the time spent between each contact. This allows the agent to create a more fruitful and long-lasting relationship.
	P4.4	"Possibility to make calls from the application."	The ability to integrate services such as calls is seen as essential so that the agent does not need several applications to work and can have all his work concentrated on a single platform.
Cons	C4.1	"Lack of possibility to integrate existing contacts."	Given the need to integrate services such as making calls was also felt the need to import contacts into the system's database, which allows easier adaptation to the application and saves time to the user, allowing them to maintain their efficiency without productivity losses in the beginning of the software use.
	C4.2	"Dashboards should cover annual objectives."	The interviewee warned that the main objectives of RE agents are measured on an annual rather than monthly or weekly scale. As such, he suggested applying the target of the objectives, present on the progress screen, to a larger time space.
Proposed Improvements	PI4.1	"Change the scale of the dashboards."	Despite agreeing that the dashboards were in accordance with the practices of the professionals, the interviewee also agreed that their interface should be reviewed, and their scale adjusted.
	PI4.2	"Add business partner contacts."	It was suggested that in the user contacts section, another type of contact category be created: the business partners.
	PI4.3	"Establish only the professional's annual goal and from that set their daily, weekly and monthly goals automatically."	After explaining that the objectives of the RE professionals are measured essentially by the year, the interviewee suggested that a system could be made in which the user, when giving his annual objective, the software calibrated and suggested the objectives that this user would have to achieve daily, weekly and monthly in order to achieve the objective he set himself at the end of the year.
	PI4.4	"Synchronization of contacts with the user's mobile phone."	For a full integration of the contact service it was proposed to implement the functionality of importing the user's personal contacts directly into the developed IS.

Demonstration

In the presentation of the artifact made for this iteration, changes were demonstrated, especially at the visual level to create a more accessible, simple and clean environment.

As illustrated in Figure 15, the visual environment of the dashboard screen has undergone the most changes. This happened in connection with the PI4.1 improvement proposal where the graph scales were changed to a new layout, managing to change the types of graphs used. Instead of all metrics being arranged in linear graphs, bar graphs, pie charts were created, and some metrics were still arranged in numerical format. This solution proved to be more appealing and impactful and some additional enthusiasm was noticed during the display of this screen.

Following the suggestion of improvement pointed out in PI4.2, a very precise set of types of clients capable of qualifying the real estate agent's contact in seven different categories was implemented. This change is displayed on the third screen in Figure 15 and was placed both on the registration screen of the new contact and on the editing screen of the same. To access this option the different categories of clients were arranged in a dropdown menu.

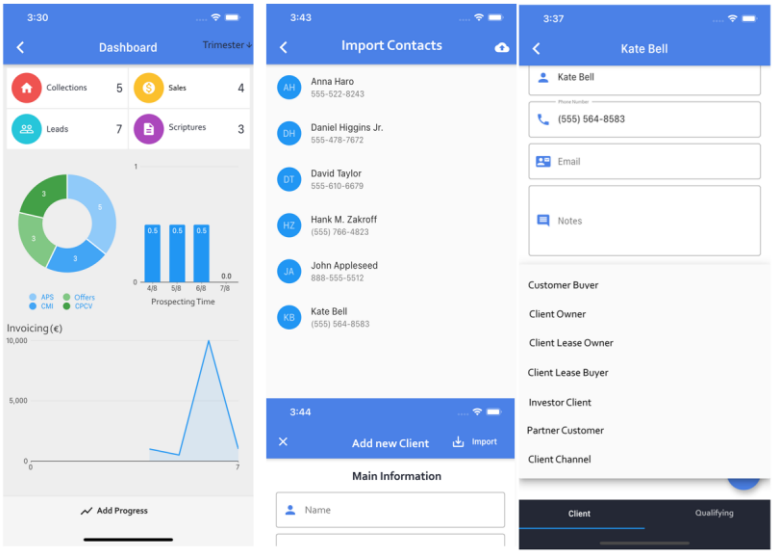


Figure 15 - Improvements made for fifth iteration

Finally, it was also implemented the importation of the contacts already existing in the user's device. This option appears on the add contacts screen and allows the real estate agent to quickly select which of his personal contacts he wants to add to his application database. This way the user can benefit from a quick initial adaptation to the software,

and it is still possible to continuously add new contacts during the whole period of use of the application.

Evaluation

After the fifth interview, the results pointed to four positive and three negative comments. Four suggestions for improvement were also suggested. All feedback was recorded in Table 24.

In this iteration the positive feedback was related to the different functionalities of client information registration which is essential about client management. While negative aspects of the artifact were pointed out critics regarding more effective and efficient ways of showing the information, as well as left some alternatives to the metrics used to measure the performance of the individual agent.

4.6. Sixth DSR Iteration

For this iteration the interviewee of the fifth iteration suggested several improvements. As it happened in the past iterations all these suggestions were analyzed and pondered in order to implement them in a more efficient way and develop good synergies with the functionalities already implemented. The results obtained are explained throughout this section.

Proposal

In the sixth iteration the whole artefact was perfected so that the interviewee could give feedback on the most completed version of the artefact. This proposal had already been implemented three of the four improvement proposals verified through the interview of the previous iteration. In addition, the settings screen was implemented where the user can make changes to their personal information as well as access some settings of the mobile application. Table 25 describes which proposals were implemented and which were left to be implemented. All the explanation of the prototype will be described later in section 4.6.2.

Table 24 - Evaluation of the artifact at fifth iteration

	ID	Stakeholder Synthesis	Stakeholder Opinions
Pros	P5.1	"Ability to record the customer's date of birth."	It was praised the fact that it is possible to record the client's birthday, emphasizing that this feature allows the development of a continuous and lasting relationship with the client.
	P5.2	"Agent's agenda is quite relevant."	The integration of the agenda has proved to be very important, as it is there that many agents point out their daily commitments and activities and being able to access it through the application is an added value.
	P5.3	"Ability to make calls from the application is a good idea."	The integration of a call controller is essential to be able to import existing contacts into the database without much initial effort and then qualify them to the user's satisfaction.
	P5.4	"Being able to qualify customers by the application is very good."	The qualification of the customers was considered very valuable because it allows in a fast and effective way to realize how directed the customer is in buying or selling RE.
Cons	C5.1	"Presentation of the application was not very professional."	One of the biggest negative points pointed out to the application was the presentation and design. The interviewee believes that to be marketed the information system needs to be improved from the point of view of UI and UX.
	C5.2	"Metrics of the visits, in the dashboards, unnecessary."	The interviewee warned that metrics of "visits" are not necessary and would not add as much value to the agent as was previously thought.
	C5.3	"Extensive presentation of the type of customers."	It was also pointed out that the presentation of the different types of contacts was too extensive. The long names were considered unnecessary as their abbreviation would serve the same purpose and make the screen cleaner.
Proposed Improvements	PI5.1	"Add some types of property that are missing."	To optimize customer qualification, it was suggested to implement other types of property that were not yet available in the system.
	PI5.2	"Add information about the client's relatives."	It was suggested to add a specific cover for additional notes, especially the information that can be obtained about the client's relatives, once again to improve the agent-client relationship.
	PI5.3	"Add a calendar focused only on contact information."	The interviewee considered that it would be quite valuable to have merely a calendar focused on customer information that alerts itself to the small details and commemorative dates of the customer in order to improve, once again, the user's achievement with his customers.
	PI5.4	"Changing customer type nomenclature"	Given the criticism exposed the extensive presentation of the names of the types of customers has been suggested that only their abbreviation is displayed to save space and make the whole screen more appealing.

Table 25 - Implemented improvements at fifth iteration

Proposed Improvement	ID	Type of Improvement	Implemented	Suggested by
“Add some types of property that are missing.”	PI5.1	Information	Yes	Author
“Add information about the client's relatives.”	PI5.2	Information	Yes	Interviewee
“Add a calendar focused only on contact information.”	PI5.3	Information	No	Interviewee
“Changing customer type nomenclature”	PI5.4	Visual	Yes	Interviewee

Demonstration

For the demonstration of the artifact in this iteration most of the advices suggested at fifth iteration was again taken into account and turned out to be very timely.

The functionality that presented the most improvements was the customer qualification. Having taken that into account, the visual aspect tended more towards a formal appearance (following the criticism C5.1 pointed out in the previous iteration). Also considered were all the possibilities of RE purchase and sale options suggested in PI5.1. Thus, through a very intuitive design, the user can choose between the type of property he is looking for, whether it is for housing or commercial use, and have the different options automatically appear, ready to be selected.

Using the same method, in case the user's client needed some type of financing, the artifact is programmed to ask the bank entity allusive to that financing. This implementation allows to guarantee a complete and intuitive customer qualification service to the user. The result of this implementation can be seen in the third image of Figure 16.

In addition to these features, to correspond to what was proposed in PI5.4, the names of the various types of customers were adjusted by abbreviations suggested by the professional interviewed in the fifth iteration. To these abbreviations were assigned some colors and then added as a tag in the contact list so that it is possible to quickly identify the type of client. PI5.4 has also been implemented to provide an exclusive space to fill in information from the client's relatives. The final status of the screens covered is illustrated in Figure 17.

Following the order of priority shown in Table 15, the settings screen was also implemented in this iteration. This screen is illustrated in Figure 18. In this screen the user has the possibility to change his information and profile picture. This way each user

has the possibility to customize his environment, thus improving the UX of the mobile application.

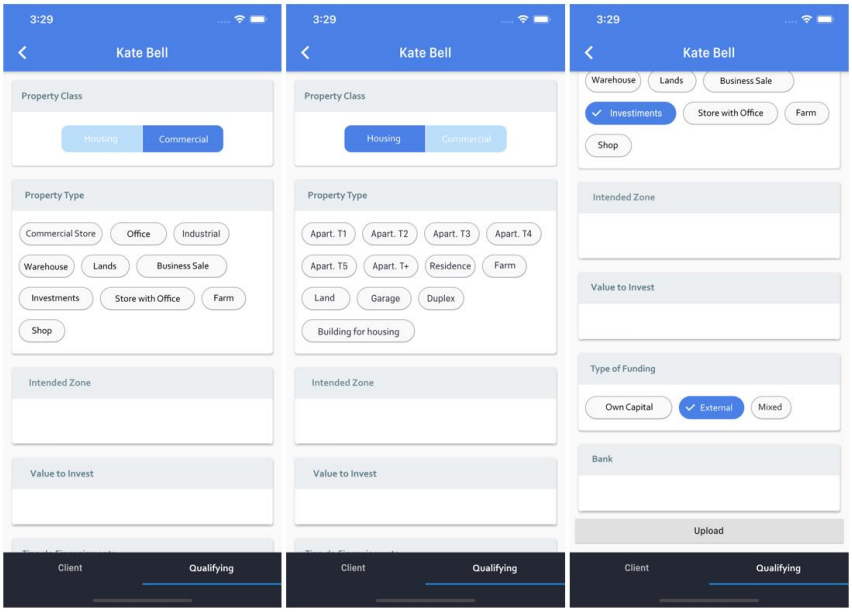


Figure 16 - Final result of qualification screen in sixth iteration

Evaluation

At the end of the sixth iteration it was possible to collect three positive and only two negative comments. Regarding the proposed suggestions, only three were counted and only two were suggested by the interviewee and the third proposed by the author himself. All the feedback gathered is explained in Table 26.

It should be noted that the positive feedback is related to stakeholder satisfaction in the functionalities presented and in the ponderous commercial advantage that the project itself sees. In addition, the UI/UX component was valued, although the interviewee felt a margin of progression in these themes. About the negative points, these were pointed out to small details that were missing and that complete the functionalities of the artifact.

Through this review we began to understand that the feedback on the developed artifact is reaching the expected common point of agreement meaning an approximation to the ideal solution.

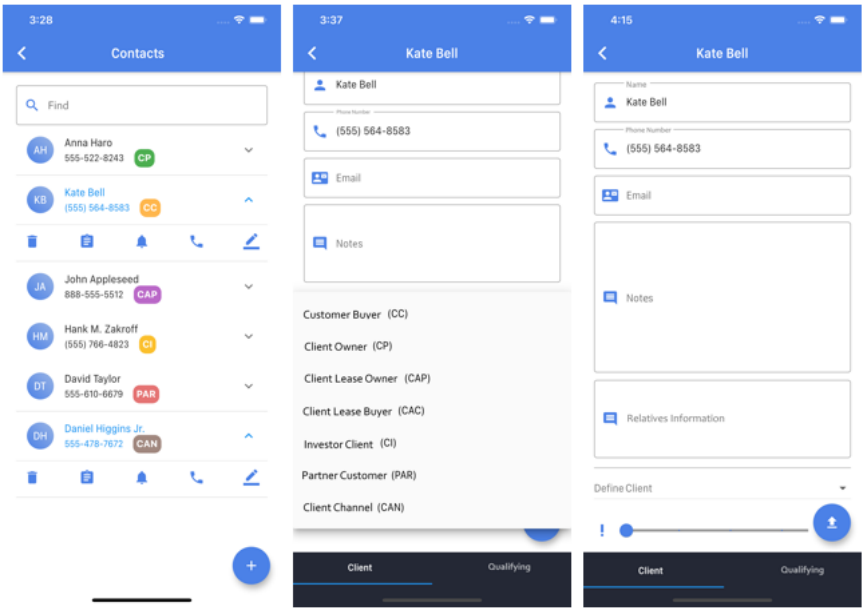


Figure 17 - Labels and tags of customers abbreviations

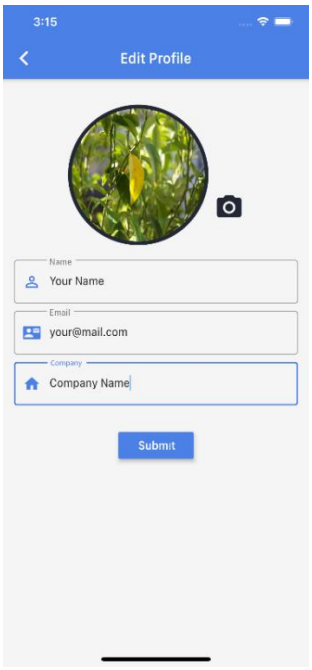


Figure 18 - Settings screen

Table 26 - Sixth iteration feedback

	ID	Stakeholder Synthesis	Stakeholder Opinions
Pros	P6.1	"Present functionalities are the essential ones."	After the presentation of the product, the stakeholder considered that customer management and agenda tools were essential and well implemented, which corresponded to what the professional had idealized at the beginning.
	P6.2	“Good disposition of dashboards and their information.”	The progress and statistics graphics screen stood out for its layout and simplicity, combined with a good way of viewing the information. As these data are quite crucial for the evaluation of the agent's performance, the stakeholder's opinion was quite positive.
	P6.3	“Intuitive and dynamic mobile application.”	The mobile application has proven to be very intuitive, dynamic and easy to access and handle which allows RE agents without any kind of experience with this type of software to quickly adapt and start using the app.
Cons	C6.1	"Lack of app interaction with the user"	The interaction with the user is very important considering that the more transparent is the usability of the application the easier the user will understand what happens and will help in the quick adaptation to the application. As examples of these interactions, it was suggested the use of toast messages when recording information.
	C6.2	"Limited document listing."	Since the required documentation is often different from customer to customer, the static listing of documents limits the agent's action.
Proposed Improvements	PI6.1	"Creating a date picker to select the birthday."	It was suggested to implement a date picker in order to create something more intuitive and practical to select the customer's birthday. This allows a greater experience for the user as well as ensuring consistency in the input and type of data present in the database.
	PI6.2	"Creating a field to record personalized documents."	By creating this field, the user can add a specific document type to the list of a particular customer. This allows greater control and management of documents needed by the RE agent.
	PI6.3	"Creation of toast messages to accompany the user."	Through the creation of these messages it becomes possible for the user to better understand the processes that the application has to run and allows greater adaptation to the software as well as the whole system becomes more user-friendly.

4.7. Seventh DSR Iteration

The final iteration aimed to validate the artifact as a whole and collect a last opinion from a real estate professional. This iteration was defined as the last one because from iterations five and six it was already possible to intercept a consistent and similar feedback on most of the screens realized. Moreover, as no additional functionality was implemented, the feedback gathered here served to consolidate the implementation and to ascertain the arrival of the already expected common point of agreement.

Proposal

In order to develop this version of the artifact and prepare it for this interview all the suggestions given by the professional interviewed in the sixth iteration were implemented. In order to synthesize what was implemented, the information was arranged in Table 27.

Table 27 - Implemented improvements at sixth

Proposed Improvement	ID	Type of Improvement	Implemented	Suggested by
"Creating a date picker to select the birthday."	PI6.1	Visual	Yes	Author
"Creating a field to record personalized documents."	PI6.2	Information	Yes	Interviewee
"Creation of toast messages to accompany the user."	PI6.3	Visual	Yes	Interviewee

Demonstration

The improvements made for this iteration are mainly related to the increase of UX and usability of the artifact. Figure 19 illustrates the additions made. As one can see the three improvements are related to dialogs or pop up messages that allow the awakening of the user's attention creating greater engagement.

The first improvement suggestion, PI6.1, was made using the date picker native widget. This means that the calendar where the user selected the birthday varies its design according to the mobile device and its operating system.

Regarding PI6.2, a text box was added with a request to the user to add the new document he wants to see added to his client list.

Finally, to create more interactions with the user were created toast messages. These are temporary messages that are intended to give feedback to the user, warning him of the success or failure of his actions. This implementation corresponds to PI6.3 progress.

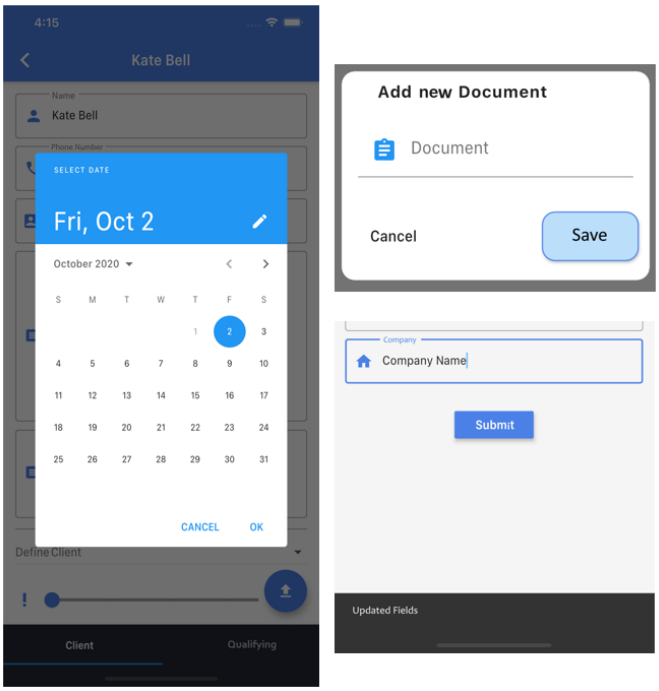


Figure 19 - Progresses made for seventh iteration

Evaluation

After the presented artifact it was possible to verify that these features really create impact, enthusiasm and satisfaction to the real estate agents. As a last iteration it was realized that opinions on the application converge to a common point, being the feedback now pointed in very similar to the one obtained in previous iterations.

4.8. DSR Synthesis

At the end of the six iterations it was possible to obtain a set of important improvement proposals that are included in Table 28. From a total of 22 suggestions for improvement, 18 were proposed by professionals and 4 by the author. Of the total of the suggestions, the majority was successfully accomplished and only three proposals remained to be implemented.

Table 28 - Proposed improvement artifact by iterations

First Iteration					
ID	**Proposed Improvement**	**Type**	**Implemented?**	**Suggested by**	**Figure**
PI1.1	"Adjust the formatting of the cards on the dashboard."	Visual	Yes	Interviewee	11
PI1.2	"Decrease priority levels."	Information	Yes	Interviewee	12
PI1.3	"Client search implementation."	Information	Yes	Interviewee	11
Second Iteration					
PI2.1	"Separation of the contact list according to the various types of clients."	Information	Yes	Interviewee	11
PI2.2	"Creation in the customer profile of a field to record the anniversary date with notification associated with that event."	Information	Yes	Interviewee	12
PI2.3	"Priority allocation do not need to be so extensive."	Information	Yes	Interviewee	12
PI2.4	"Follow-up notifications following the 1-30-90 method. "	Information	No	Interviewee	-
PI2.5	“Creation of a screen with a record of calls and notes taken by the agent at the end of each customer interaction.”	Information	Yes	Author	12
Third Iteration					
PI3.1	“Add a checklist with the necessary documentation.”	Visual	Yes	Interviewee	13
PI3.2	“Improvement of statistical analysis metrics.”	Information	Yes	Interviewee	13
PI3.3	“Definition of customer qualification metrics.”	Information	Yes	Interviewee	14
Fourth Iteration					
PI4.1	“Change the scale of the dashboards.”	Visual	Yes	Author	15
PI4.2	“Add business partner contacts.”	Information	Yes	Interviewee	15
PI4.3	“Establish only the professional's annual goal and from that set their daily, weekly and monthly goals automatically.”	Information	No	Interviewee	-
PI4.4	“Synchronization of contacts with the user's mobile phone.”	Information	Yes	Interviewee	15
Fift Iteration					
PI5.1	“Add some types of property that are missing.”	Information	Yes	Author	16
PI5.2	“Add information about the client's relatives.”	Information	Yes	Interviewee	17
PI5.3	“Add a calendar focused only on contact information.”	Information	No	Interviewee	-
PI5.4	“Changing customer type nomenclature”	Visual	Yes	Interviewee	17
Sixth Iteration					
PI6.1	"Creating a date picker to select the birthday."	Visual	Yes	Author	19
PI6.2	"Creating a field to record personalized documents."	Information	Yes	Interviewee	19
PI6.3	"Creation of toast messages to accompany the user."	Information	Yes	Interviewee	19

CHAPTER 5

Conclusions

This research aimed to build a more complete m-CRM based on experts' (RE agents) feedback. DSR was selected as the main research methodology and a set of interviews was performed to elicit requirements and to validate the proposed artifact.

At the end, a very simple and intuitive mobile application was created. This tool does not require an early large time investment and that integrates several services that were ascertained and valued by the interviewees. The m-CRM was well received and appreciated by professionals, receiving positive comments from those whishing to use it in their professional lives as RE agents. The willingness to adopt to this tool reflects the quality and relevance of the mobile application created. Plus, this m-CRM was developed for several platforms, having available versions for both iOS and Android.

Through the interviews conducted to gather requirements, it was possible to determine what the main and unavoidable features are to achieve a high-quality and valuable m-CRM. Some of the core features are contacts and agenda integration, dashboards and charts showing the agent progress and clients qualification features. All these features were described in section 4.2 and it was through them that the artifact was developed and the project was structured until the application was completed.

It was possible to conclude that the implementation of an application of this nature can allow a controlled growth of contact lists, qualified customers and portfolio customers. This IS can strengthen the relationship between the RE agent and their clients, which in turn drives the sale of RE. On the other hand, the agents felt that this is a complete solution capable of integrating various types of services. The interviewees also considered that the developed artifact is able to save the RE agents time, allowing them to focus on the growth of the emotional and empathic relationship with the client.

They also considered that the features that stood out the most were notifications and reminders as they allowed them to keep track of appointments and important dates, ensuring that the user can stay focused on their daily tasks of high profitability. In addition, the qualification feature also received many compliments for its detail, effectiveness and simplicity. All other features were also successfully implemented and had great feedback from the RE agents. All feedback can be found in a summarized form in Table 28.

At the end, it was possible to create a mobile app that the agents appreciate and feel that it adds value to their work. This way, the artifact presents itself as very promising for the maintenance of customer relationships, and in the medium-long term, these contacts can be transformed into customers again.

5.1. Contributions

5.2.1. Academic Level

With this mobile application it was possible to address a gap identified in literature. A survey and clarification of which functionalities were not feasible for the realization of an m-CRM, making the solution adapted to the professional life of the RE agent. Thanks to the constant validation of the software developed through the interviews and the rigorous monitoring of the DSR model it was possible to build a mobile application supported by a strong scientific basis.

To formally conclude the last stage of the entire DSR model, the results were communicated in a scientific journal. The article was submitted to the Journal "Information and Software Technology" - evaluated with the Q1 ranking - under the title "Requirements Gathering and Development of a Mobile Application for Real Estate agents" where it addresses the topics of obtaining requirements of the features and the creation of the application.

5.2.2. Business Level

From the point of view of the business market, through the development of this artifact it was possible to contribute with a mobile application 100% focused on the RE agent. This application concentrates the essential functionalities recognized by RE professionals, capable of adding value in their daily lives and enhancing long-term customer relations.

5.2. Limitations

Although professionals from several different agencies were interviewed, it was evident that only people within the same team had similar working methods. This means that although most of the opionions in the development of the functionalities of the presented artefact coverged, it was not tested during a considerable period, by a distinct group of professionals in order to be able to analyze its real impact. Thus, there may still be different improvement proposals throughout the testing period capable of further optimizing and validating the mobile application.

As the interviews were mostly conducted with users of devices with iOS operating systems, it was only possible for them to validate the application remotely. Although every effort was made to make the comments as authentic as possible, the authors recognize that in the case of mobile applications it is always important that they handle them without any kind of constraints for the feedback to be 100% valid.

5.3.Future Work

As proposals for future work it would be very interesting to work with the m-CRM developed in this research and increasingly mould it to a sales assistance platform for the real estate agent. In this sense the functionalities found in the interviews that were not implemented because they left the scope of a CRM would now be timely. Moreover, given the feedback constantly collected during the interviews for UI/UX improvements, the existence of a study that understands the design and good practices to have in the realization of an m-CRM can be fundamental for the real implementation of the artifact created. Taking also into account the comments of the interviewees regarding the graphics created, they should also be the object of study in order to understand with scientific rigor what makes the statistical graphics appealing, both in terms of the type of graphic used and what are the best colours for them, in order to optimize their use.

The automation of some processes concerning the management and qualification of contacts and properties is seen as having a lot of potential for association with ML and AI, in general, technologies. The existence of RE suggestions compatible with what your clients are looking for and chat bots capable of assisting the RE agent in any task, serving as an intelligent assistant, are also other timely suggestions that could create a positive impact on the work of the real estate agent, affecting the entire industry.

Appendices

Appendix A

Table 29 - List of scientific literature articles by author

Authors	Title
[53]	The Impact of Internet RE Intermediary Platform on the Real Estate Market
[54]	Using Geographic Information and Point of Interest to Estimate Missing Second-Hand Housing Price of Residential Area in Urban Space
[55]	An Intelligent Automatic Valuation System for Real Estate Based on Machine Learning
[70]	Research on Innovation of Real Estate Marketing Model Based on Mobile Internet
[71]	Factual Dimension Identification and usage for Real Estate Framework
[56]	Comparison of Expert Algorithms with Machine Learning Models for Real Estate Appraisal
[57]	Regression Model for Appraisal of Real Estate using Recurrent Neural Network and Boosting Tree
[58]	Collaborative Filtering Methods for Identifying Relevant Adverts to a Real Estate Mobile Agents
[59]	Exploiting Geographic Dependencies for Real Estate Appraisal: A Mutual Perspective of Ranking and Clustering
[67]	An Interactive Concierge for Independent Living
[68]	Public Real Estate Management System in the Procedural Approach – A Case Study of Poland and Slovakia
[60]	The Application of GIS in the Real Estate Management System
[61]	System Integration of Digital Real Estate-Management Based on Service
[65]	Business Solution for Luxury Housing Market Based on E-catalog Ontology
[64]	Driving Forces for the US Residential Housing Price: A Predictive Analysis
[62]	A Machine Learning Approach to Big Data Regression Analysis of Real Estate Prices for Inferential and Predictive Purposes
[26]	App Launch for Customer Processes of a Real Estate Company
[72]	Blockchain Technology in Commercial Real Estate Transactions
[77]	Developing a Real Estate Sales App for Mobile Devices
[73]	Information Security in the South Australian Real Estate Industry: A study of 40 Real Estate Organisations
[63]	Research and Implementation of Search Engine Based on Lucene
[66]	The Study of Behavioral Intention for Mobile Commerce: Via Integrated Model of TAM and TTF
[74]	Technology in Residential Brokerage: Showing Appointment Scheduling Services, Property Prices and Marketing Times
[78]	The Role of User Resistance in the Adoption of a Mobile Data Service
[75]	Influence of Email Marketing on Real Estate Agent Performance
[69]	Evaluating Corporate Real Estate Management Decision Support Software Solutions

Appendix B

Table 30 - Scientific literature articles by publications

Conferences and Journals	Articles
ACM International Conference Proceeding Series	[53]
2018 IEEE International Smart Cities Conference, ISC2 2018	[54]
AIIPCC '19: Proceedings of the International Conference on Artificial Intelligence, Information Processing and Cloud Computing	[55]
2018 4th International Conference on Economics, Management and Humanities Science (ECOMHS 2018)	[70]
RETech 2018 - Proceedings of the 2018 ACM Workshop on Multimedia for Real Estate Tech, Co-located with ICMR 2018	[81]
Proceedings - 2017 IEEE International Conference on Innovations in Intelligent Systems and Applications, INISTA 2017	[56]
2017 2nd IEEE International Conference on Computational Intelligence and Applications, ICCIA 2017	[57]
International Journal of u- and e-Service, Science and Technology	[58]
Proceedings of the ACM SIGKDD International Conference on Knowledge Discovery and Data Mining	[59]
2014 IEEE 3rd Global Conference on Consumer Electronics, GCCE 2014	[67]
Real Estate Management and Valuation	[68]
Advances in Intelligent Systems and Computing	[60]
Physics Procedia	[61]
BMEI 2011 - Proceedings 2011 International Conference on Business Management and Electronic Information	[65]
Built Environment Project and Asset Management	[64]
Journal of Research in Interactive Marketing	[77]
Information Management and Computer Security	[73]
Advanced Materials Research	[63]
Quality and Quantity	[66]
Journal of Real Estate Practice and Education	[74]
Cyberpsychology, Behavior, and Social Networking	[78]
American Real Estate Society Journal	[75]
Journal of Corporate Real Estate	[69]

Appendix C

Table 31 - Data and country per article

Articles	Year	Research Country	Focus
[53]	2019	China	Real Estate web platforms to reduce prices of housing transactions.
[54]	2019		Second-hand real estate values
[55]	2019		Property valuation using machine learning techniques
[70]	2018		Mobile internet to innovate real estate marketing model
[71]	2018	India	Key Performance Indicators to evaluate the best feature for classification for real estate data
[56]	2017	Poland	Algorithms based on the sales comparison to assist with property valuation
[57]	2017	Canada	Ensemble learning regression model for real estate appraisal
[58]	2014	---	Intelligent gateway that can elicit the client desires and finds highest possible matches for advertisements on the real estate market
[59]	2014		ClusRanking, a new method for ranking estates
[67]	2014	Germany	Mobile interactive sales system
[68]	2014	Poland and Slovakia	General management systems approach
[60]	2013	China	New management system proposed using geographic information system
[61]	2012		A digital real estate management system solution
[65]	2011		Intelligence recommendation model for luxury housing and knowledge ontology
[64]	2019	USA	Predicting housing prices and a model for decision making
[62]	2019	---	Analysis of big data regression under a machine learning approach, which facilitates inference and prediction regarding real estate data
[26]	2019	Germany	Mobile application review for customer processes of a real estate company
[72]	2019	Netherlands	Development of a blockchain application that can improve the real estate transaction process
[77]	2017	---	Use of a mobile app to improve sales and assist agents with marketing. Application
[73]	2014	Australia	Understanding threats, awareness and risk management standards of information in real estate
[63]	2013	Switzerland	Using Lucene as a search tool in a web page to match search queries
[66]	2013	---	Identifying the match between mobile commerce technique and individual performance
[74]	2012	---	Shows that appointment scheduling services affects transactions results and consequently the prices of the houses
[78]	2010	---	A study on mobile usage inhibitors
[75]	2010	USA	If using email as a marketing strategy has a positive impact on real estate agent’s performance
[69]	2010	USA	Real estate agents should be able to identify and evaluate the best IT solutions from a list of them

Appendix D

Table 32 - Distribuition of features from the 22 professional CRM analysed

	Contacts Integration	Team Management	Pipeline	Mobile Friendly	Automated Action Plan	Marketing Assistance	Smart Lists	Template Messages	Lead Aggregation	Reminders	Notification	Management and Exchange Documents	Surrounding Properties	Campaigns	Calculate and Track Expenses	Qualify Leads	Secure Databases	Live Feed	Voice Capture	Support	Service Feedback	Different Roles	Social Profiles
Ixact Contact	•	•	•	•	•	•	-	•	-	•	-	•	•	-	•	-	-	-	-	-	•	-	-
Follow Up Boss	•	•	•	•	•	-	•	-	•	-	-	-	-	-	-	-	-	-	-	-	-	•	-
Contactually	•	•	•	•	•	-	•	•	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-
Pipedrive	•	•	•	•	-	-	-	-	-	-	-	-	•	-	-	-	•	-	-	-	-	-	-
Lease Hawk	•	•	•	-	•	-	•	-	-	-	•	-	-	-	-	-	-	-	•	-	-	-	-
Referral Maker	•	•	•	-	-	•	-	-	-	-	-	-	-	-	•	-	-	-	-	-	-	-	-
Co Star Brokage	•	•	•	-	-	-	-	-	-	-	-	-	•	-	•	-	•	-	-	-	-	-	-
Lion Desk	•	•	•	-	-	•	-	•	•	-	-	•	-	•	-		-	-	•	-	-	-	-
Real Geeks	•	•	-	•	-	-	•	•	•	•	•	•	-	•	-	•	-	•	-	-	-	-	•
Market Leader	•	•	-	•	-	•	-	-	•	-	•	-	-	-	-		-	-	-	-	-	-	-
Boston Logic	•	•	-	•	•	•	-	•	-	-	-	-	-	•	-	•	-	-	-	-	-	-	-
Boom Town	•	•	-	•	-	•	-	-	-	-	-	-	-	-	•	•	-	-	-	-	-	-	-
Property Base	•	•	-	•	•	•	•	-	-	-	•	-	-	-	-	-	-	-	-	-	-	-	-
Placester	•	•	-	•	•	-	-	•	-	-	-	-	-	•	-	-	-	-	-	-	-	-	-
Client Look	•	-	•	•	-	•	•	-	-	-	-	-	•	-	-	-	-	-	•	•	-	-	-
Top Producer CRM	•	-	-	-	-	•	•	•	•	•	•	•	-	-	-	•	-	-	-	•	-	-	-
Realty Juggler	•	-	-	-	•	•	-	•	•	•	•	•	-	•	•	-	•	-	-	•	-	-	-
Less Anoying CRM	•	-	•	-	-	-	-	-	-	-	-	•	-	-	-	-	•	-	-	•	-	•	-
Apptivo CRM	•	-	-	-	•	-	-	-	•	-	-	-	•	-	-	-	-	-	-	-	-	-	-
Apto	•	-	•	-	•	-	•	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rethink CRM	-	•	-	-	-	-	-	-	-	-	-	-	•	-	-	-	-	•	-	-	-	-	-
Cinc Agent	-	-	•	-	-	-	•	-	-	•	--	-	-	-	-	-	-	-	-	-	-	-	-

Appendix E

Survey Design: First set of Interviews

Chamo-me João Antão e estou no último ano do Mestrado em Engenharia de Telecomunicações e Informática. Como tese de mestrado propus-me a desenvolver um sistema de informação que fizesse a diferença no setor imobiliário e que trouxesse aos seus utilizadores mais eficiência, maiores rendimentos e taxas de conversão de leads em clientes.

Nome do entrevistado: _____

Função: _____

Anos de experiência: _____

1. Background tecnológico e método de trabalho

1.1 Qual a sua relação com a tecnologia?

(Objetivo – perceber se a criação de um sistema de informação digital levanta à partida algum atrito por não ser algo tradicional. Perceber qual a relação dos agentes com ferramentas tecnológicas)

1.2 Em média quanto tempo passa ao telemóvel?

(Objetivo – perceber quão acertado é concretizar uma aplicação móvel)

1.2.1 Qual a finalidade que lhe atribui?

(Objetivo – dado que a solução será para mobilie importa perceber se o telemóvel é um aparelho utilizado frequentemente e para que fins)

1.3 Como e onde guarda todas as informações dos seus clientes?

(Objetivo – perceber se a solução mobile apresentada faz sentido e como pode ser adaptada às necessidades reais dos agentes imobiliários)

1.4 Quão confortável se sente com o seu método de trabalho?

(Objetivo – Perceber a comodidade do dia a dia de um consultor imobiliário ao gerir a sua agenda e os seus clientes)

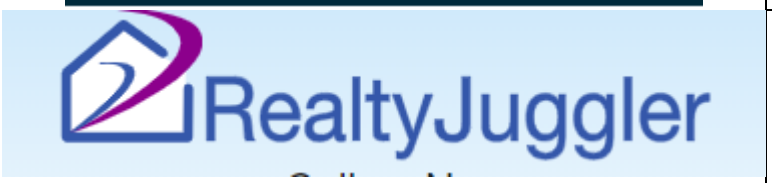
1.5 Considera eficiente o seu método de trabalho?
(Objetivo – perceber motivos para falta de eficácia e como pudemos combatê-la)

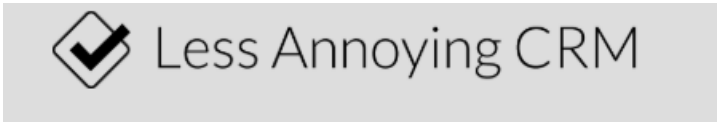
2. Reconhecimento de aplicações já existentes

2.1 Se existisse uma aplicação móvel intuitiva que o permitisse ser mais eficiente e produtivo usaria?
(Objetivo – perceber porquê aceitação da app)

2.1.1 O que o faz rejeitar sistemas informáticos deste tipo?
(Objetivo – perceber porque de rejeição da app)

2.2 Conhece ou já ouviu falar das seguintes plataformas?

Contactually		
Cinc – agent		
Top producer crm		
Real geeks		
Market leader		
Rethink crm		
Realty juggler		
Follow up boss		

Ixact contact		
Lion desk		
Boston logic		
Boom town		
Client look		
Property base		
Placester		
Apto		
Pipedrive		
Less anoying crm		

Referral maker		
Co star brokage		
Apptivo crm		
Lease hawk		

2.2.1 Caso conheça porque não utiliza?

(Objetivo – perceber se existe algum conhecimento sobre soluções semelhantes à apresentada)

Appendix F

Survey Design: Second set of Interviews

Chamo-me João Antão e estou no último ano do Mestrado em Engenharia de Telecomunicações e Informática. Como tese de mestrado propus-me a desenvolver um sistema de informação que fizesse a diferença no setor imobiliário e que trouxesse aos seus utilizadores mais eficiência, maiores rendimentos e taxas de conversão de leads em clientes.

Nome do entrevistado: _____

Função: _____

Anos de experiência: _____

1.Indique Justificando quais das seguintes funcionalidades acha relevante existirem nessa plataforma?

1.1 INTEGRAÇÃO DE CONTACTOS (mails, chamadas, mensagens e calendário)

1.2 TEAM MANAGEMENT (Gráficos de progressos, taxas de conversão, dados estatísticos…)

1.3 PIPELINE (Lista de tarefas pendentes e objetivos a cumprir)

1.4 AUTOMATED ACTION PLAN (Atribuição de tarefas e objetivos e gestão estratégica automática)

1.5 APLICAÇÃO MÓVEL (Ser adaptada para dispositivos moveis)

1.6 ASSISTÊNCIA EM MARKETING (Ajudas na divulgação de contactos e sugestões de publicidade)

1.7 SMART LISTS (Organização inteligente dos clientes conforme a relação atual – dar prioridade as tarefas mais importantes)

1.8 TEMPLATE MESSAGES (Mensagens pessoais automatizadas e customizadas)

1.9 AGREGAÇÃO DE LEADS (Leads provenientes de vários sites agregadas na plataforma)

1.10 NOTIFICAÇÕES (Alertas de follow up)

1.11 GESTÃO DE DOCUMENTOS (Ficheiros importantes à conclusão do negócio geridos pela aplicação)

1.12 REMINDERS (lembretes para melhor relação)

1.13 AREA KNOWLEDGE (Conhecimento da área envolvente)

1.14 CAMPANHAS (Campanhas de e-mail para vários clientes)

1.15 CALCULAR E ACOMPANHAR DESPESAS (Seguir os valores e números de comissões e preços a pagar e a vender)

1.16 QUALIFICAR LEADS (Saber se a Lead em questão é valida e perceber o seu potencial)

1.17 SEGURANÇA DE BASE DE DADOS (Serviços de proteção de informação)

1.18 FEED EM TEMPO REAL (Acompanhar as notícias dos clientes)

1.19 VOICE CAPTURE (Captura de voz em chamadas para evolução)

1.20 SERVIÇO DE FEEDBACK (Envio de feedback ao cliente através da plataforma)

1.21 ROLES DIFERENTES (Existirem diferentes papeis na plataforma para cada utilizador)

1.22 PERFIS SOCIAIS (existirem perfis sociais adaptados a cada cliente)

---

2. Extras

2.1 Existe mais alguma funcionalidade que acrescentaria na plataforma?

2.2 Uma aplicação deste tipo seria relevante para "enfrentar" quer <u>clientes compradores</u>, quer <u>clientes proprietários?</u>

2.3 Consegue-me recomendar algum colega para completar este estudo?

References

[1] H. D. Lubis Muharman, Sutoyo Edi, Azuddin Muna, ‘User Experience in Mobile Application Design : Utility Defined Context of Use User Experience in Mobile Application Design : Utility Defined Context of Use’, 2019.

[2] T. Lindén, T. Heikkinen, T. Ojala, H. Kukka, and M. Jurmu, ‘Web-based framework for spatiotemporal screen real estate management of interactive public displays’, *Proc. 19th Int. Conf. World Wide Web, WWW ’10*, pp. 1277–1280, 2010.

[3] and G. S. S. G. Donald Jud, Daniel T. Winkler, ‘The Impact of Information Technology on Real Estate Licensee Income’, *J. Chem. Inf. Model.*, vol. 53, no. 9, pp. 1689–1699, 2019.

[4] G. Krishnan and V. Ravindran, ‘IT service management automation and its impact to IT industry’, *ICCIDS 2017 - Int. Conf. Comput. Intell. Data Sci. Proc.*, vol. 2018-Janua, pp. 5–8, 2018.

[5] B. Jin, W. Song, K. Zhao, S. Li, and Z. Wang, ‘Cloud Infrastructure and Monitoring System for Real Estate Registration’, *Int. Conf. Geoinformatics*, vol. 2018-June, no. Figure 1, pp. 1–9, 2018.

[6] D. Warburton, ‘The role of technology in the real estate industry’, *J. Real Estate Pract. Educ. 5(1)*, no. 714, pp. 1–7, 2016.

[7] P. Hartmann, ‘Real estate markets and macroprudential policy in Europe’, *J. Money, Credit Bank.*, vol. 47, no. S1, pp. 69–80, 2015.

[8] E. Cherif, ‘Real estate services structure evolution with internet and SWOT analysis’, *Int. J. Electron. Cust. Relatsh. Manag.*, vol. 8, no. 4, p. 200, 2014.

[9] M. B. Galvão, R. C. de Carvalho, L. A. B. de Oliveira, and D. D. de Medeiros, ‘Customer loyalty approach based on CRM for SMEs’, *J. Bus. Ind. Mark.*, vol. 33, no. 5, pp. 706–716, 2018.

[10] E. M. Alrawhani, H. Basirona, and Z. Sa’ayaa, ‘Real estate recommender system using case-based reasoning approach’, *J. Telecommun. Electron. Comput. Eng.*, vol. 8, no. 2, pp. 177–182, 2016.

[11] H. Donner, K. Eriksson, and M. Steep, ‘Digital Cities: Real Estate Development Driven by

Big Data', *Gpc.Stanford.Edu*, pp. 1–22, 2017.

[12] P. J. Barwick, 'Competition in the Real Estate Brokerage Industry : A Critical Review ∗ Lack of Competition and Elevated Commission Fees', 2019.

[13] D. Zhang, P. Zhu, and Y. Ye, 'The effects of E-commerce on the demand for commercial real estate', *Cities*, vol. 51, pp. 106–120, 2016.

[14] S. Agarwal, J. He, T. F. Sing, and C. Song, 'Do real estate agents have information advantages in housing markets?', *J. financ. econ.*, vol. 134, no. 3, pp. 715–735, 2019.

[15] M. Kummerow and J. C. Lun, 'Information and communication technology in the real estate industry: Productivity, industry structure and market efficiency', *Telecomm. Policy*, vol. 29, no. 2-3 SPEC.ISS., pp. 173–190, 2005.

[16] T. Gubler and R. Cooper, 'Socially advantaged? How social affiliations influence access to valuable service professional transactions', *Strateg. Manag. J.*, vol. 40, no. 13, pp. 2287–2314, 2019.

[17] T. Bohling *et al.*, 'CRM implementation: Effectiveness issues and insights', *J. Serv. Res.*, vol. 9, no. 2, pp. 184–194, 2006.

[18] S. Gountas, J. Gountas, and F. T. Mavondo, 'Exploring the associations between standards for service delivery (organisational culture), co-worker support, self-efficacy, job satisfaction and customer orientation in the real estate industry', *Aust. J. Manag.*, vol. 39, no. 1, pp. 107–126, 2014.

[19] G. Tholen, S. J. Relly, C. Warhurst, and J. Commander, 'Higher education, graduate skills and the skills of graduates: the case of graduates as residential sales estate agents', *Br. Educ. Res. J.*, vol. 42, no. 3, pp. 508–523, 2016.

[20] J. Z. Haislip and V. J. Richardson, 'The effect of Customer Relationship Management systems on firm performance', *Int. J. Account. Inf. Syst.*, vol. 27, no. September 2016, pp. 16–29, 2017.

[21] T. Hou and A. K. D. Wong, 'Real Estate Customer Relationship Management using Data Mining Techniques', *Conf. Pap. Glob. Chinese Real Estate Congr. 2012 Annu. Conf. Macau, July 2012*, no. 852, pp. 1–6, 2012.

[22] Y. Baashar *et al.*, 'Customer relationship management systems (CRMS) in the healthcare environment: A systematic literature review', *Comput. Stand. Interfaces*, vol. 71, no. April, p. 103442, 2020.

[23] A. Rafiki, S. E. Hidayat, and D. Al Abdul Razzaq, ‘CRM and organizational performance: A survey on telecommunication companies in Kuwait’, *Int. J. Organ. Anal.*, vol. 27, no. 1, pp. 187–205, 2019.

[24] P. Awasthi and P. S. Sangle, ‘The importance of value and context for mobile CRM services in banking’, *Bus. Process Manag. J.*, vol. 19, no. 6, pp. 864–891, 2013.

[25] T. Aslam and M. Latif, ‘Impacts of Mobile UX Design on Older Adults’, *ACTA Sci. Comput. Sci.*, vol. 2, no. 1, pp. 4–10, 2020.

[26] G. Rockel and L. Barth, ‘App launch for customer processes of a real estate company’, *Int. J. Innov. Technol. Explor. Eng.*, vol. 9, no. 1, pp. 607–616, 2019.

[27] A. Varma, A. Sarma, S. Doshi, and R. Nair, ‘House Price Prediction Using Machine Learning and Neural Networks’, *Proc. Int. Conf. Inven. Commun. Comput. Technol. ICICCT 2018*, pp. 1936–1939, 2018.

[28] N. Leskinen, J. Vimpari, and S. Junnila, ‘Using real estate market fundamentals to determine the correct discount rate for decentralised energy investments’, *Sustain. Cities Soc.*, vol. 53, no. November 2019, p. 101953, 2020.

[29] D. B. Kohlhepp, ‘The Real Estate Development Matrix’, *Am. Real Estate Soc. Meet.*, p. 27, 2012.

[30] A. P. C. Chan and R. B. Abidoye, ‘Advanced Property Valuation Techniques and Valuation Accuracy: Deciphering the Artificial Neural Network Technique’, *Int. J. Real Estate L. Plan.*, vol. 2, pp. 2623–4807, 2019.

[31] J. Howells, ‘Intermediation and the role of intermediaries in innovation’, *Res. Policy*, vol. 35, no. 5, pp. 715–728, 2006.

[32] P. Buxmann and J. W. Goethe-universität, ‘INTERNET-BASED INTERMEDIARIES - THE CASE OF THE REAL ESTATE MARKET D-60054 Frankfurt am Main’, *World Wide Web Internet Web Inf. Syst.*, 1998.

[33] S. Dilek, ‘Impact of estate agents on market and the relationship with experience’, *Bus. Econ. Horizons*, vol. 10, no. 2, pp. 94–106, 2014.

[34] E. C. Rosenthal, ‘A Pricing Model for Residential Homes with Poisson Arrivals and a Sales Deadline’, *J. Real Estate Financ. Econ.*, vol. 42, no. 2, pp. 143–161, 2011.

[35] A. D. Melamed, ‘EXCLUSIVE DEALING AGREEMENTS AND OTHER

EXCLUSIONARY CONDUCT—ARE THERE UNIFYING PRINCIPLES?', *Antitrust Law J.*, vol. 73, no. 2, pp. 375–412, 2006.

[36] F. B. de Oliveira, *Direito dos Contratos - O Contrato de Mediação Imobiliária na Prática Judicial: uma abordagem jurisprudencial*. Centro de Estudos Judiciários, 2016.

[37] H. Jin, 'Research on the E-commerce Business New Pattern from Perspectives of SWOT and Customer Relationship Management', *DEStech Trans. Soc. Sci. Educ. Hum. Sci.*, no. isetem, pp. 3–7, 2016.

[38] C. Preece, H. . Chong, H. Golizadeh, and J. Rogers, 'Construction Management Technical Note challenges in construction organizations', *Int. J. Civ. Eng.*, vol. 13, no. 3, 2015.

[39] S. Jayashree, S. Shojaee, and S. Pahlavanzadeh, 'A critical analysis of Customer Relationship Management from strategic perspective', *Int. Conf. E-business, Manag. Econ.*, vol. 3, pp. 340–345, 2011.

[40] M. Hartel, R. Bulander, and M. Decker, 'A literature survey on objectives and success factors of mobile CRM projects', *Management*, 2004.

[41] Z. Soltani and N. J. Navimipour, 'Customer relationship management mechanisms: A systematic review of the state of the art literature and recommendations for future research', *Comput. Human Behav.*, vol. 61, pp. 667–688, 2016.

[42] D. Elmuti, H. Jia, and D. Gray, 'Customer relationship management strategic application and organizational effectiveness: An empirical investigation', *J. Strateg. Mark.*, vol. 17, no. 1, pp. 75–96, 2009.

[43] A. DikbaAY and K. ErcoAYkun, 'Implementability of Crm in Aec/Fm Domain: a Case Study', *Jt. Int. Conf. Comput. Decis. Mak. Civ. Build. Eng.*, pp. 3742–3752, 2006.

[44] D. W. Cockcroft, F. Faaaai, P. Nair, F. Frcpc, P. Nair, and F. Frcpc, 'Reproduced with permission of the copyright owner . Further reproduction prohibited without', *J. Allergy Clin. Immunol.*, vol. 130, no. 2, p. 556, 2012.

[45] M. Rodriguez and K. Trainor, 'A conceptual model of the drivers and outcomes of mobile CRM application adoption', *J. Res. Interact. Mark.*, vol. 10, no. 1, pp. 67–84, 2016.

[46] S. San-Martín, N. H. Jiménez, and B. López-Catalán, 'Los beneficios del CRM móvil para la empresa desde la perspectiva del marketing relacional y el modelo TOE', *Spanish J. Mark. - ESIC*, vol. 20, no. 1, pp. 18–29, 2016.

[47] A. Aldayel and K. Alnafjan, ‘Challenges and best practices for mobile application development: Review paper’, *ACM Int. Conf. Proceeding Ser.*, vol. Part F1302, pp. 41–48, 2017.

[48] Xu Taian, ‘Study on User Experience Design of Mobile Application Interfaces’, *Springer Nat. Switz. AG*, vol. 1, no. Ihiet, pp. 516–521, 2019.

[49] M. Pušnik, D. Ivanovski, and B. Šumak, ‘Patterns for improving mobile user experience’, *2017 40th Int. Conv. Inf. Commun. Technol. Electron. Microelectron. MIPRO 2017 - Proc.*, pp. 582–587, 2017.

[50] V. Garousi, M. Felderer, and M. V. Mäntylä, ‘The need for multivocal literature reviews in software engineering: complementing systematic literature reviews with grey literature’, *EASE ’16 Proc. 20th Int. Conf. Eval. Assess. Softw. Eng.*, pp. 1–6, 2016.

[51] Barbara Kitchenham, ‘Procedures for Performing Systematic Reviews’, *Jt. Tech. Rep.*, no. 1, 2004.

[52] V. Garousi, M. Felderer, and M. V. Mäntylä, ‘Guidelines for including grey literature and conducting multivocal literature reviews in software engineering’, *Inf. Softw. Technol.*, vol. 106, no. September 2018, pp. 101–121, 2019.

[53] W. Zhang, S. Chen, D. Guo, and B. Li, ‘The impact of internet real estate intermediary platform on the real estate market’, *ACM Int. Conf. Proceeding Ser.*, pp. 132–139, 2019.

[54] J. Tang, Z. Liu, Y. Wang, J. Yang, and Q. Wang, ‘Using Geographic Information and Point of Interest to Estimate Missing Second-Hand Housing Price of Residential Area in Urban Space’, *2018 IEEE Int. Smart Cities Conf. ISC2 2018*, 2019.

[55] J. Niu and P. Niu, ‘An Intelligent Automatic Valuation System for Real Estate Based on Machine Learning’, in *AIIPCC ’19: Proceedings of the International Conference on Artificial Intelligence, Information Processing and Cloud Computing*, 2019, pp. 1–6.

[56] B. Trawinski *et al.*, ‘Comparison of expert algorithms with machine learning models for real estate appraisal’, *Proc. - 2017 IEEE Int. Conf. Innov. Intell. Syst. Appl. INISTA 2017*, pp. 51–54, 2017.

[57] J. Bin *et al.*, ‘Regression model for appraisal of real estate using recurrent neural network and boosting tree’, *2017 2nd IEEE Int. Conf. Comput. Intell. Appl. ICCIA 2017*, vol. 2017-Janua, pp. 209–213, 2017.

[58] J. Fiaidhi, N. Shakeri, S. Mohammed, and T. Kim, ‘Collaborative Filtering Methods for Identifying Relevant Adverts to a Real Estate Mobile Agents’, *Int. J. u- e-Service, Sci. Technol.*, vol. 7, no. 4, pp. 171–186, 2014.

[59] Y. Fu, H. Xiong, Y. Ge, Z. Yao, Y. Zheng, and Z. H. Zhou, ‘Exploiting geographic dependencies for real estate appraisal: A mutual perspective of ranking and clustering’, *Proc. ACM SIGKDD Int. Conf. Knowl. Discov. Data Min.*, pp. 1047–1056, 2014.

[60] Q. Ru, ‘The application of GIS in the real estate management system’, *Adv. Intell. Syst. Comput.*, vol. 191 AISC, pp. 553–558, 2013.

[61] X. Li, F. Bian, and Y. Shi, ‘System Integration of Digital Real Estate-Management Based on Service’, *Phys. Procedia*, vol. 24, pp. 1012–1017, 2012.

[62] J. I. Pérez-Rave, J. C. Correa-Morales, and F. González-Echavarría, ‘A machine learning approach to big data regression analysis of real estate prices for inferential and predictive purposes’, *J. Prop. Res.*, vol. 36, no. 1, pp. 59–96, 2019.

[63] T. Q. Li and P. Wang, ‘Research and implementation of search engine based on Lucene’, *Adv. Mater. Res.*, vol. 711, pp. 582–586, 2013.

[64] A. Jafari and R. Akhavian, ‘Driving forces for the US residential housing price: a predictive analysis’, *Built Environ. Proj. Asset Manag.*, vol. 9, no. 4, pp. 515–529, 2019.

[65] X. Qiu, ‘Business solution for luxury housing market based on E-catalog ontology’, *BMEI 2011 - Proc. 2011 Int. Conf. Bus. Manag. Electron. Inf.*, vol. 4, pp. 146–150, 2011.

[66] Y. Y. Shih and C. Y. Chen, ‘The study of behavioral intention for mobile commerce: Via integrated model of TAM and TTF’, *Qual. Quant.*, vol. 47, no. 2, pp. 1009–1020, 2013.

[67] O. Arnold, L. Kirsch, and A. Schulz, ‘An interactive concierge for independent living’, *2014 IEEE 3rd Glob. Conf. Consum. Electron. GCCE 2014*, pp. 59–62, 2014.

[68] M. Gross, R. Źróbek, and D. Špirková, ‘Public Real Estate Management System in the Procedural Approach - A Case Study of Poland and Slovakia’, *Real Estate Manag. Valuat.*, vol. 22, no. 3, pp. 63–72, 2014.

[69] K. M. Gibler, R. R. Gibler, and D. Anderson, ‘Evaluating corporate real estate management decision support software solutions’, *J. Corp. Real Estate*, vol. 12, no. 2, pp. 117–134, 2010.

[70] Y. Yang, ‘Research on Innovation of Real Estate Marketing Model Based on Mobile Internet’, in *2018 4th International Conference on Economics, Management and Humanities*

Science(ECOMHS 2018) Research, 2018, no. Ecomhs, pp. 279–283.

[71] G. Kaur and H. Kaur, 'Factual dimension identification and usage for real estate framework', *Proc. - 2nd Int. Conf. Micro-Electronics Telecommun. Eng. ICMETE 2018*, pp. 23–27, 2018.

[72] H. P. Wouda and R. Opdenakker, 'Blockchain technology in commercial real estate transactions', *J. Prop. Invest. Financ.*, vol. 37, no. 6, pp. 570–579, 2019.

[73] D. Mani, K. K. R. Choo, and S. Mubarak, 'Information security in the South Australian real estate industry: A study of 40 real estate organisations', *Inf. Manag. Comput. Secur.*, vol. 22, no. 1, pp. 24–41, 2014.

[74] M. T. Allen and J. D. Benefield, 'Technology in residential brokerage: Showing appointment scheduling services, property prices, and marketing times', *J. Real Estate Pract. Educ.*, vol. 15, no. 1, pp. 1–17, 2012.

[75] T. Z. Ram N. Acharya, Albert Kagan, 'Influence Of Email Marketing on Real Estate Agent Performance', *Am. Real Estate Soc. J.*, 2010.

[76] S. Boyd, 'REFeasibility: Designing a mobile application for initiating feasibility analysis', *Pacific Rim Prop. Res. J.*, vol. 21, no. 2, pp. 179–196, 2015.

[77] Y. P. Chiu, Y. L. Lee, Y. C. Shiau, and Y. Y. Chu, 'Developing a real estate sales app for mobile devices', *ICIC Express Lett. Part B Appl.*, vol. 8, no. 1, pp. 193–200, 2017.

[78] C. Sanford and H. Oh, 'The role of user resistance in the adoption of a mobile data service', *Cyberpsychology, Behav. Soc. Netw.*, vol. 13, no. 6, pp. 663–672, 2010.

[79] J. T. Janse Van Rensburg and C. Vermaak, 'Designing a mobile application for agricultural knowledge management: A DSR approach', *ACM Int. Conf. Proceeding Ser.*, 2017.

[80] K. Peffers, T. Tuunanen, M. A. Rothenberger, and S. Chatterjee, 'A design science research methodology for information systems research', *J. Manag. Inf. Syst.*, vol. 24, no. 3, pp. 45–77, 2007.

[81] N. Kato, K. Aizawa, T. Yamasaki, and T. Ohama, 'Users' preference prediction of real estates featuring floor plan analysis using floornet', *RETech 2018 - Proc. 2018 ACM Work. Multimed. Real Estate Tech, Co-located with ICMR 2018*, pp. 7–11, 2018.