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QR Codes: A Case of its Level of Adoption in Portugal

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ABSTRACT

The choice of this work arises from the interest in the topics of entrepreneurship and technology transfer toward launching more innovative products/services. It focuses on delivering a technology, QR code, which brings more innovation to a product especially with the current growth of mobile activities. Then, with the help of a strategic plan, it evaluates the level of potential acceptation and adoption of the proposed service and of widespread use of QRs in Portugal. Thus, an interactive prototype of the supporting platform is described and used for its validation with users. Most participants in this project know the technology and consider the idea interesting and promising. They even suggest add-ons such as more video functions and a higher variety of events and/or resources for combination. However, through a deeper analysis, aspects related with effective use of the service, eventual payment, and explaining how it works reveal lower enthusiasm. Thus, although there is a promising scenario for its implementation in the Portuguese market, training aimed at effectively knowing and using QR-code technology must evolve. Given the challenges of today's society, the future application of this product/service shall pass through an innovation accelerator program to launch a business model that can deal with several trends such as quick and contactless use of specialized information or resources for activities in the areas of tourism, banking, health, etc.

KEYWORDS

Entrepreneurship, Innovation, Technology Transfer, QR Code, Prototype, Mobility

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1. Introduction

The motivation behind this project is due to the interest in the areas of entrepreneurship/ innovation and technology transfer. After selecting the theme, as well as the technology to support the innovation of the underlying product, we chose to apply QR code technology. QR means quick response, which is represented by a bar code. This designation stems from the ability of quick interpretation by mobile devices. Given the related potential and creativity, we decided to go ahead with a business idea. However, the focus of this work is on the presentation and validation of its prototype.

There is an increasing number of innovation accelerator programs to support this kind of ideas based on new or emerging technologies. Usually, these programs have practical or entrepreneurial goals (Sá & Lee, 2012). Thus, this work has both sides: describing the prototype of a business project and doing investigation for a research/academic purpose. It also fills a gap because there are several studies about QR code, but rather focused on technical aspects (Booba, Shindeb, Rathodc & Gaikwadd, 2014; Moisoiu, Negrău, Győrödi, Győrödi & Pecherle, 2014) or purchase intention (Hossain, Zhou & Rahman, 2018) than on a business idea/plan.

1.1 Objectives and Research Question

This work, based on a business idea, aims to approach a stage of development that ought to support the future launch of a start-up company. This project is related to the innovative offer of a product/service, which culminates with the presentation of a prototype of a platform for sending messages in videos through QR code, called *Send and Surprise*.

In order to achieve this goal, this study will analyze some of the topics that should guide prototyping according to the market, which make up the strategic plan of the project. This will give understanding and motivation to know if there are conditions for its adoption and use. Then, this project culminates with the validation of the proposed product/service, firstly presented through an interactive prototype.

Thus, the research question to be considered is: *Which age group most uses QR codes and at what 'level'?*

A study that also validated a QR code app-based idea is from Pal and Jha (2017), but it is related to personal marketing for professional job seekers. Hossain et al. (2018) also examined the impact of QR codes on purchase intention and customer satisfaction, however without a concrete business plan and resulting prototype for launching and nurturing a new service based on it.

2. Related Work

This project has to do with the creation of opportunities, given the increasing use of wireless devices connected to the internet and the variety of associated applications (Kumar et al., 2020). In opportunity entrepreneurship (discovery of a business opportunity), the entrepreneur is, above all, an expert observer. Always attentive to the needs and desires of the contemporary consumer, which include more intangible aspects (sensory, interactive, dynamic, informal). Upon realizing the lack of a certain product, he decides to conceive and implement it. Identifying good opportunities is not a simple task. It is noted that this profile has prior knowledge about the market, even if not in-depth (Leite & Oliveira, 2007).

On the other hand, Pessoa (2005) defines three types of entrepreneurs: corporate entrepreneur (intra-entrepreneur); start-up entrepreneur (creates new businesses/companies); and social entrepreneur (creates enterprises with a social mission). Corporate entrepreneurship involves a process of identifying, developing, and implementing new opportunities within the existing company. The start-up entrepreneur aims to give rise to a new business. He analyzes the scenario and, when faced with an opportunity, presents a new enterprise. His challenges are clear: supplying an existing demand, to which has not been given attention; seeking competitive differentials in an existing market; beating the competition; wining customers; and achieving the profitability and productivity necessary to maintain the enterprise.

Finally, another type of entrepreneur is the technological one. His profile is normally characterized by familiarity with the academic world, by a search for business opportunities in the digital and knowledge economy, by a technical culture that leads him to riskily invest in niche markets with a low survival rate (Lodi, 2000; Belo et al., 2014).

The QR Code is the main technology to be applied in the proposed prototype. Therefore, it is necessary to deepen this subject and its variants to better understand the service.

2.1 Exploring QR Code

The adoption of technology implies many advantages for companies and people, such as: cost reduction, availability, timeliness, usefulness, and ease of use. At the end of each decade, a new technology propels us into the next era. The quick response code (QR) has revolutionized the code barrier. It is an interesting technological breakthrough, which has transformed the way consumers interact with sellers, service providers and other consumers.

The QR code activates tags and directs them to links that can open web pages, videos, text messages, among other resources. This technology was invented by the Japanese company Denso-Wave, a Toyota subsidiary, in 1994. The main goal was to facilitate the process of cataloging automobile components. It consists of high-density bidimensional graphical images, like barcodes composed of digital squares instead of bars. The compounds of those squares come together to create codes that, in turn, host the data that will be verified by mobile devices (Bashir, Naik & Madhavaiah, 2013).

QR code reader applications (apps), downloadable on mobile communication devices (mobile phones, tablets, etc.) require the action of a built-in camera to decode the data. This technology allows integrate such apps with other systems or objects. QR codes are barcodes that connect us quickly from physical objects to the digital world (Bashir et al., 2013). The use of QR code is free of any license as it is an open source, defined and published as an ISO standard in 2010. Then, in 2011, the QR code became commercial for the first time in the telecommunications' sector. Today, it has gained great popularity due to mobile technology, a decisive support for its proliferation. With this technology and its mobile use, the opportunities for technology transfer are also enormous.

In the beginning, the main objective was a code to be quickly interpreted by reading equipment. But after some time, other companies began to explore different ways of using QRs so that their commercial use became widespread all over the world. These codes are changing the way we interact with people and products (magazines, books, ads, events). QR codes have also changed the way content is created and delivered (Jharotia, 2018). They provide a new *channel* for direct sales rewarding the advertising investments.

2.2 QR Code and Applications

The use of QR code is increasing globally, due to its greater popularity around the world, particularly in China, Korea, Japan and the USA (Tarjan, Senk, Kovac & Horvat, 2011; Shin, Jung & Chang, 2012). In the year 2019 about 2.7 billion people used smartphones and an estimated 90% of the population will access high-speed internet in 2020. Smartphone updates have also added QR code scanning capabilities to the camera app, so these codes become an integral part of daily life.

Even the latest android smartphones have made QR code scanning a native feature. Inspired by China, South Korea has also witnessed an impressive growth in the number of QR scans. India and US markets have also adopted QR to make payments and turn shopping into a unique experience (Beaconstac, 2019).

Alipay, a leader in online and mobile payments, whose digital 'wallet' is used by millions of people, has partnered with 6 European operators to promote the interoperability of digital payments based on QR codes. Pagaqui has the exclusive use of the system in Portugal, whose project also involves the Spanish service Momopocket, the Austrian Bluecode, the Norwegian Vipps and the Finnish ePassi and Pivo that will adopt a QR code format compatible with Alipay.

The possible uses of QRs are almost infinite, as this technology is present in our daily lives in the most diverse services/products (Shin et al., 2012). Due to its versatility, it is used in several fields such as: online banking, customer service management, medical assistance, assistance for the disabled, security applications (with different types of encryption). It can be integrated in print ads, products, smooth surfaces, etc. Another form of QR, widely used, is in invoices and other documents for paying products/services, in which the user is directed to his digital invoice for immediate payment (figure 1).

Figure 1. QR-based Invoice

Source: Edicom (2021)

Futuristic stores and supermarkets that operate without staff and queues, as Amazon Go and Apple Store, also use QR codes. Before entering the store, the buyer needs to create an account and then download the app, creating a personal QR (like a digital signature). Thus, when entering the store, an electronic check-in is performed which identifies the personal QR and then automatically pays the products purchased.

2.3 QR as a Digital Marketing Tool

With QR codes marketers can better understand which campaigns are performing well, based on the number of checks (Beaconstac, 2019). URLs (website addresses) are often long, obscure and difficult to remember. That is why more companies are adopting this technology of quick recognition, due to its easiness in how people interact with digital content (Marketing charts, 2012). Whether QRs will be here in the long run is unknown, but for now it is a highly effective and valuable interactive tool. Tracking analyses, monitoring campaigns, analyzing scans based on date, time, location and device used helps to adjust the codes of various campaigns. Exporting and integrating those analyses within Google Analytics also allows to create other useful measures and innovate the campaigns/projects.

Dynamic QRs (figure 2) are another great variant of this technology, as they offer versatility to edit the linked URLs according to business requirements, even after printing and distributing them. Dynamic (or smart) QR codes allow managers to vary campaigns at different times of the day and different days. This helps campaigns to adapt to seasonal launching, special campaigns, festive offers, and seasonal products, without changing the QR code in the printed material.

Figure 2. Dynamic QR Code *vs*. Static

Source: Beaconstac (2022)

Based on these aspects, next section deals with the transition of the proposed idea to become a real enterprise. In this transition, the role of a strategic plan focusing on the prototype of an interactive platform is highlighted.

3. Research Framework

After the theoretical bases described in the previous section, regarding several aspects that served as basis for the idealization of this project, it is essential to consider the main steps to support the business idea. The ultimate goal is to create an innovative service underlying the launch of a start-up company.

The phase that must precede the launch of a product/service is the so-called strategic plan which, due to its importance, is required by any interested mentor or investor. Its main stages of development, within the scope of the purposed idea, are:

1. Market analysis and characterization
2. Proposed product/service
3. Target audience
4. Competition analysis and future trends
5. Idea presentation questionnaire
6. Prototype of the idea/project
7. Prototype validation interview
8. Product implementation
9. Promotion and publicity

The following section (and sub-sections) focus on the description of the proposed product/service, the idea-presentation survey to evaluate familiarity with QR codes, the prototype of the product, and the interview carried out for its validation.

4. Methodology

This project, *Send and Surprise*, intends to be a start-up in the area of new technologies, with a differentiating purpose in the interaction with customers through message sending (in video) among other possibilities (Agapito & Quelhas Brito, 2020). It allows an interaction between the offline/traditional (invitations, cards, gifts, etc.) and the online/contemporary (videos, digital platform, QR code, smartphone) on an individual and personalized way. Emotional/affective issues are aggregated factors as another differential side of this idea.

4.1 The Proposed Product/Service

A simple message sent, either digitally (through a chat app) or by letter/printed card, is forgotten in time. But through the suggested platform, the message is delivered in the form of a video, using a QR-code tag embedded in a chosen card or gift. This has a printed QR, which can be visualized anywhere at any time, through the camera of a mobile device with web access. In addition to the object received (a carrier of a special message from a special person) it will provide a sense of affection and closeness to whom receive it, even if distant.

To do it, you must access the *Send and Surprise* website and view (or download) the prepared video, where a QR-code is generated which can be printed on an object (or other items) of choice, available on the same website. The following figure illustrates the steps and processes involved.

Figure 3. Sequence of the Proposed App and Service

Source: Own Elaboration

An original aspect is the goal of *Send and Surprise* which is not sending ordinary messages/ videos, as those we often send and receive through Youtube. These are special messages regarding events, special occasions with a high degree of personalization and creativity. It is expected that the videos sent will be made from the sender's own mobile phone, in an informal and simple way. However, in other cases the video should be professionally produced if the event requires it.

4.2 Idea Presentation Questionnaire

To test the feasibility and acceptance of the idea, an online survey was applied using Google forms with multiple choice questions. These are related to familiarity and adoption degree of QR code and the proposed service. Having been available for 15 days, we obtained a total of 56 responses whose data are discussed. Thus, 55 respondents *recognize* the use of QRs on different surfaces in their daily lives (only 1 person gave a negative answer).

Asking whether the respondents *know* well *this type of code*, 54 respondents said yes. However, knowing it does not necessarily mean that they dominate its functioning. Thus, 49 participants answered they *know how a QR code works* and 7 gave a negative answer. Regarding its *effective use*, 50 respondents answered positively, while 6 have not used it yet.

In these 50 participants, who had already used a QR code, 25 did it 1 to 5 times; 16 did it 5 to 10 times,

and 9 did it 10 to 15 times. The number of respondents who *considered* this technology *easy to use* was 49, while 7 considered the opposite.

About 34 respondents *consider interesting to send an object with a message*, using a QR code, while 19 said perhaps, and 3 do not find it interesting yet. In the question *about receiving this kind of object*, 37 participants find it interesting, 15 answered perhaps, and 4 gave a negative response. Half of the sample used (28) would *recommend this app* to friends, 24 may recommend it, and only 4 would not recommend it.

In this survey, an open non-mandatory question was also added: "Regarding this idea, which other resource(s), in addition to objects or messages, would you consider relevant to include in this app?". Among the answers obtained, some more pertinent are: sending an invitation that integrates Google maps to add geo-location; advertising links associated to the object sent; photos' inclusion; gift cards; codified documents (such as payable invoices); and collective messages.

It should be noted that the data collected result from a convenience sample, not representative of the population, and therefore non-probabilistic and occasional. Thus, the data obtained apply only to it, but are useful to generate a knowledge base for the app development as it helps to define its scope and added value.

4.3 Idea/Project Prototyping

In computing, a prototype is a software model or pattern. In this first prototype of the proposed idea, an architecture based on screens (or 'scenes') could be defined: an initial scene; intermediate scene(s), and final scene. For each of these scenes, specific routines are defined. We emphasize that the display of each scene is generic. Briefly, the application is organized as follows:

Initial interface: this is the first scene to be displayed when starting the application. There we can view the options available. Among the options, we can select the one we want and start it. When finished, it returns to the initial interface. In this step, there is an explanatory video about the platform's operation, an icon for login/sign up;

Intermediate interface1: in this scene, the user can upload his video to the platform;

Intermediate interface2: in this step, after the video has been sent, the user can watch it on the platform. If there are no errors, it proceeds to the next scene - 'generate QR code';

Intermediate interface3: in this phase, after the QR is generated, it is up to the user choose from among the objects available on the platform so that his choice is sent to the recipient;

Intermediate interface4: in this scene, the user will have a first image (preview) of how the chosen object will look and function with the printed QR. Then, it is necessary to fill in the 'Surprise' shipping address. Certainly more items can be chosen (in the interface3), to avoid repeating the process for sending each item.

4.4 Prototype Validation Interview

The interview has the main objective of knowing the opinion related with *Send and Surprise* application, especially to evaluate its prototype. It was an individualized interview, to 5 users from the sample, in order to validate the functionality and clarity of the prototype.

The tests were carried out informally and in parallel with the development. Such tests focused basically on the interactivity of the application, verifying if the functionalities defined were executing as planned. To obtain this feedback, six open questions were applied whose results are summarized below. Here are highlight the general responses:

1. Are the layout and user interface of *Send and Surprise* friendly?

The respondents answered yes, but they suggested other color combination. They also proposed to change the font used.

2. Is it easy to navigate/interact with *Send and Surprise*?

All answered yes, as they did not find difficulties in this interaction.

3. Does *Send and Surprise* offer the products/services you need?

Although they do not perceive the proposed service as essential, most of them answered yes. However, some respondents have suggested to include other options as items, such as: chocolates, t-shirts, etc.

4. Would you like to create the video directly in the platform?

They generally answered yes if there exists the function of video edition.

5. Would you like to associate photos (besides videos)?

The participants of this experimental sub-sample answered yes, but some mentioned the inclusion of videos assembled in power-point style.

6. Are you comfortable with the service supported by this platform?

Although these participants had not used something similar before, they said they feel comfortable using the proposed platform and imagine its use in several events.

5. Discussion of Results

Due to new challenges, accelerated by the covid-19 pandemic, people have increased the use of mobile internet and apps in their daily life (Dennison, Morrison, Conway & Yardley, 2013; Hui, Inman, Huang & Suher, 2013; Datta & Nwankpa, 2021). Therefore, the main objective of this work is to present an idea of a platform for sending video messages, through a QR-code tag. Before presenting it, it was necessary to review some theoretical concepts related to the creation and development of a platform for a start-up. These concepts include entrepreneurship, innovation, technology transfer, marketing and QR technology, discussed in order to sustain the empirical part of this project.

Data on the use of smartphones/e-commerce in Portugal justify market demand for the type of product/service here proposed. To guide its implementation into a first prototype, some steps of the strategic plan were considered. Namely within the scope of QR-code technology, a survey was applied in order to capture the familiarity with it and the acceptance/adoption of the idea. Then, an interactive prototype of the service was presented and an interview to some survey participants could give insight about it. The resulting answers help to outline further changes or innovations.

Regarding the survey there is familiarity about QR codes, having been used by most respondents at least 1 to 5 times in the last year. It is considered an easy-to-use technology by the majority of them. However, this interaction still occurs through conventional means such as product package, concert invitation and invoice payment. Regarding the service offered, it is considered interesting to send or receive messages by QR-code. However, only 6 respondents are willing to pay for the application.

Finally, regarding the interview for prototype validation, the participants find it easy to understand and interact. However, in the layout, they propose a change in color patterns and fonts for a more friendly navigation.

Deepening the data obtained in the light of the research question - *Which age group most uses QR codes and at what 'level'?* - the participants who use QR the most, and find it easy to use and useful, are aged

between 26 and 35 years old. In regard to *'at what level'*, the variables (questions) such as if they would like to send an object with it, or if they know how it works, had a lower percentage of positive (yes) answers. The outputs from SPSS (statistical software used in this analysis), such as bivariate correlations (table 1), also show lower values for these two variables (questions 6 and 10 - table 1) comparing to those related with frequency of use and ease of use (questions 8 and 9). This can reveal that more knowledge on this technology and its potential is needed.

Table 1. Bivariate Correlations Obtained

Correlations

		9 - Is the QR Code technology easy to use?	10 - Would it be interesting to be able to send an object with a message via QR code?	8 - In the las 12 months, how many times have you used technology QR Code?	7 - Have you used QR Code technology? (If not used, go to question 10)	6 - Do you know how a QR Code works?	4 - Is the image shown familiar to you?	5 -Do you know a QR Code?	Female	Male
9 - Is the QR Code technology easy to use?	Pearson Correlation	1	-,015	,576**	-,734**	-,129	,053	,066	,226	-,226
	Sig. (2-tailed)		,912	<,001	<,001	,339	,695	,628	,091	,091
	N	57	57	57	57	57	57	57	57	57
10 - Would it be interesting to be able to send an object with a message via QR code?	Pearson Correlation	-,015	1	-,173	,093	-,033	,097	-,022	-,100	,100
	Sig. (2-tailed)	,912		,197	,491	,810	,475	,869	,461	,461
	N	57	57	57	57	57	57	57	57	57
8 - In the las 12 months, how many times have you used technology QR Code?	Pearson Correlation	,576**	-,173	1	-,917**	-,254	-,245	-,175	,166	-,166
	Sig. (2-tailed)	<,001	,197		<,001	,056	,066	,194	,219	,219
	N	57	57	57	57	57	57	57	57	57
7 - Have you used QR Code technology? (If not used, go to question 10)	Pearson Correlation	-,734**	,093	-,917**	1	,394**	,219	,151	-,199	,199
	Sig. (2-tailed)	<,001	,491	<,001		,002	,101	,262	,138	,138
	N	57	57	57	57	57	57	57	57	57
6 - Do you know how a QR Code works?	Pearson Correlation	-,129	-,033	-,254	,394**	1	,245	,431**	-,166	,166
	Sig. (2-tailed)	,339	,810	,056	,002		,066	<,001	,218	,218
	N	57	57	57	57	57	57	57	57	57
4 - Is the image shown familiar to you?	Pearson Correlation	,053	,097	-,245	,219	,245	1	,809**	-,157	,157
	Sig. (2-tailed)	,695	,475	,066	,101	,066		<,001	,244	,244
	N	57	57	57	57	57	57	57	57	57
5 -Do you know a QR Code?	Pearson Correlation	,066	-,022	-,175	,151	,431**	,809**	1	-,194	,194
	Sig. (2-tailed)	,628	,869	,194	,262	<,001	<,001		,148	,148
	N	57	57	57	57	57	57	57	57	57
Female	Pearson Correlation	,226	-,100	,166	-,199	-,166	-,157	-,194	1	-1,000**
	Sig. (2-tailed)	,091	,461	,219	,138	,218	,244	,148		,000
	N	57	57	57	57	57	57	57	57	57
Male	Pearson Correlation	-,226	,100	-,166	,199	,166	,157	,194	-1,000**	1
	Sig. (2-tailed)	,091	,461	,219	,138	,218	,244	,148	,000	
	N	57	57	57	57	57	57	57	57	57

Source: Own Elaboration

Thus, there is a promising scenario for the implementation of an e-service like *Send and Surprise* in the Portuguese market. Nevertheless, training aimed at promoting the effective use of QR-code technology must evolve. Then, the level of adoption of this and other similar platforms will increase.

6. Conclusion

QR code technology has been commonly used to store and transfer information of various kinds. It became a popular means of information storage and exchange, and then can be found almost everywhere. People and companies use them to store and distribute information from restaurants, retail, and packaging ever since their advent in the 90s. Now they are popular as contactless/virtual means of exchange and brand awareness, much-needed these days. They are efficient and easy to use. However, the literature review on the subject reveals a lack of studies about their effective use and potential for business model innovation. That is where this work particularly contributes with its proposed approach.

6.1 Practical Implications

This study acknowledges a promising scenario for the implementation of this kind of e-services in the Portuguese market. Nevertheless, training aimed at promoting the effective use of QR-code technology must evolve, since the analysis captured a lack of mastery of this technology what can be related to some of the security and privacy risks around its use.

An interesting result is that the surveyed users are sensitive to more video functions and a more friendly layout what can reflect the need of more visual accessible content, a trend also acknowledged in social networks and digital marketing and commerce. All these aspects are important to consider in future projects, such as the trends in terms of smart tourism systems and smart cities whose roots can lie in this and other technologies.

6.2 Managerial Implications

Some management implications (or recommendations) are thus related to the need to train key workers in this technology and its potential, in order to follow up growing trends such as BYOD (Bring your own device) at work or enhanced e-commerce. Another implication is that this study, through the design of its idea, business plan and prototype, paved the way for a type of innovation in the business model itself.

6.3 Limitations and Future Work

Several goals underlying the development of *Send and Surprise* platform-prototype were achieved. However, there are still issues that can be tested and developed to enrich it. In the future, we intend to extend the horizon of the proposed platform as a mobile app namely on Android, iOS and Windows Phone.

Currently the main function of the platform is to send video messages by QR-code activation, but we intend that it also allows sending, along with video, sponsored links creating other return sources for the business. Also, its interaction with geo-location resources can complement messages for many events. Additionally, we intend to add more languages to the platform's interface in order to broaden its geographical scope. Over time, adding the users' database to the experience acquired with the platform, other products/services may be implemented such as: documents to pay by the generated QR, invitations to social networks through a QR, etc.

Given the challenges of modern society, other possibilities to consider relate to its application to quick requests for information and/or resources for critical activities (especially in tourism, health, etc.). Moreover, since it allows a virtual exchange of information, the associated risks (malware attacks, bugs, among other) are often overlooked and forgotten. These are issues we intend to address in the *Send and Surprise* platform and resulting start-up, to be submitted to an innovation accelerator program where managers, IT specialists and investors participate.

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