RPER SOFTWARE - A SOCIAL MANAGEMENT TOOL FOR RAPID PARTICIPATORY EMANCIPATORY RESEARCH: PLANNING, DESIGN AND IMPLEMENTATION

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ABSTRACT

Theoretical framework: This study is grounded in Social Management, a paradigm that focuses on society’s deliberative process for public decisions. It also employs the Rapid Participatory and Emancipatory Research (RPER) method, an adaptation of rapid and participatory appraisals, to apply social management in rural contexts.

Research objectives: Identify the requirements, plan, design, assess the complexity, and implement a system to support the RPER application.

Methodology: The waterfall model for software development lifecycle was used to carry out the system’s planning. The discipline of Business Process Management (BPM) was necessary for the requirements mapping and the Function Point Analysis (FPA) technique to measure the software complexity from a user perspective.

Results: The RPER application process was fully mapped, and several features that could be implemented for the software were uncovered. These functionalities address practically all the steps involved in the method’s application. In addition, the software measurement was completed, and 542 function points were found. After this, the design for the graphical user interface was then created. Finally, the software was developed using technologies such as Express for building the back-end RESTful API with Node.js, React library to create the front-end’s componentized user interface, TypeScript as the main programming language and PostgreSQL as the relational database.

Originality: It is notable that some software has already been used to try and promote social participation in public matters. However, studies specific to the use of information and communication technology (ICT) to resolve social issues, and, at the same time, dealing specifically with participatory techniques are non-existent. There is an overflow of software tools designed to support quantitative research in the agriculture field, yet there remains a notable deficiency in software tailored to assist qualitative research and practices.

Theoretical and practical contributions: The use of a web system on participatory approaches can bring advantages. In the theoretical side, this research might provide insights into these methods’ evolution. It will also provide a foundational framework for understanding the intersection of ICT and participatory techniques, paving the way for future research in this area. Some other more practical benefits include the wider distribution and dissemination of results, data transparency, the unification or centralization of the research made using the methods, the organization of data, the possibility of automation on report generation, better communication and collaboration between team members, and data safety with periodic backups. Nonetheless, the software could serve as a platform for preparing new researchers with help and tips section for each of the methods’ techniques.

Keywords: Agricultural Information Systems, Rural Community Engagement, Information Technology, Participatory Software Design, Social Management.

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RESUMO

Estrutura teórica: Este estudo é fundamentado na Gestão Social, um paradigma que se concentra no processo deliberativo da sociedade para as decisões públicas. Também emprega o método de Pesquisa Rápida Participativa e Emancipatória (RPER), uma adaptação de avaliações rápidas e participativas, para aplicar a gestão social em contextos rurais.

Objetivos da pesquisa: Identificar os requisitos, planejar, projetar, avaliar a complexidade e implementar um sistema para dar suporte à aplicação RPER.

Metodologia: O modelo em cascata para o ciclo de vida do desenvolvimento de software foi utilizado para realizar o planejamento do sistema. A disciplina de BPM (Business Process Management, gerenciamento de processos de negócios) era necessária para o mapeamento de requisitos e para a técnica de FPA (Function Point Analysis, análise de ponto de função) a fim de medir a complexidade do software a partir da perspectiva do usuário.

Resultados: O processo de aplicação do RPER foi totalmente mapeado, e vários recursos que poderiam ser implementados para o software foram descobertos. Estas funcionalidades abordam praticamente todas as etapas envolvidas na aplicação do método. Além disso, a medição do software foi concluída e foram encontrados 542 pontos de função. Depois disso, o design da interface gráfica do usuário foi criado. Finalmente, o software foi desenvolvido usando tecnologias como Express para a construção da API RESTful back-end com Node.js, biblioteca React para criar a interface de usuário componentizada do front-end, TypeScript como a linguagem de programação principal e PostgreSQL como o banco de dados relacional.

Originalidade: É notável que alguns softwares já tenham sido usados para tentar promover a participação social em assuntos públicos. No entanto, não existem estudos específicos sobre o uso das tecnologias da informação e comunicação (TIC) para resolver questões sociais e, ao mesmo tempo, lidar especificamente com técnicas participativas. Há um excesso de ferramentas de software projetadas para apoiar a pesquisa quantitativa no campo da agricultura, mas ainda há uma deficiência notável em software adaptado para ajudar a pesquisa e práticas qualitativas.

Contribuições teóricas e práticas: O uso de um sistema web sobre abordagens participativas pode trazer vantagens. Teoricamente, essa pesquisa pode fornecer ideias sobre a evolução desses métodos. Proporcionará também um quadro fundamental para a compreensão da interseção entre as TIC e as técnicas participativas, abrindo caminho para a investigação futura nesta área. Outros benefícios mais práticos incluem a distribuição e a disseminação mais amplas dos resultados, a transparência dos dados, a unificação ou centralização da pesquisa feita usando os métodos, a organização dos dados, a possibilidade de automação na geração de relatórios, melhor comunicação e colaboração entre os membros da equipe e segurança de dados com backups periódicos. No entanto, o software pode servir como plataforma para preparar novos pesquisadores com seção de ajuda e dicas para cada uma das técnicas dos métodos.


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1 INTRODUCTION

Social Management is a relatively a new paradigm that focuses on society's deliberative process for public decisions. This paradigm is committed to the promotion of the common good. It is conceptualized as a dialogical management action focused on the public interest (Cançado, Pereira, Tenório, 2015, p.101) and its main categories are the well-understood public interest
(Tocqueville, 2003), the public sphere (Habermas, 1991), and social emancipation (Freire, 1985). The paradigm itself is similar to the concept of deliberative governance developed by Dryzek (2010) and his collaborators. Deliberative action incorporates policies and institutional measures to promote the common good.

Araújo (2012) describes Social Management as a multi-paradigmatic and polysemic field, suggesting that it's still evolving and highlighting its multidisciplinary nature. On the other hand, Cançado (2011) and Cançado, Pereira, and Tenório (2015) strongly argue that Social Management has made substantial progress over the years. They emphasize its well-established theoretical foundations and to validate its standing as a genuine science, they compare its maturity to the standards set by renowned scholars like Popper, Kuhn, Lakatos, and others. Through this comparison, they show that Social Management indeed fits the characteristics of a recognized scientific field. Social Management's concept remains open at some degree of interpretation due to academic debates that shape its evolution. Despite this, a central theme present is its emphasis on participation and adherence to Weber's (2017) ideal type suggesting a guiding path characterized by transparent, inclusive, intelligible, dialogical, coercion-free, and emancipatory collective decision-making.

A fitting example to elucidate the application of Social Management concepts is in the agriculture field. The famous Hardin's "Tragedy of the Commons" dilemma (Hardin, 1968) suggests that individuals, acting in their own self-interest, will inevitably overuse shared resources, leading to depletion or ruin. In the context of agriculture, this might manifest as depleting water resources, over-farming, or over-grazing, resulting in land degradation. Ostrom (1990) offers a more nuanced perspective, arguing that communities can, and often do, develop cooperative mechanisms to manage and sustain common resources effectively. Ostrom's principles, such as clearly defined boundaries, collective choice arrangements, and effective monitoring, could be applied to rural agricultural settings to prevent over-exploitation and ensure sustainable use.

Implementing such principles requires a holistic approach, and this is where a method of Social Management can be employed. The Rapid Participatory and Emancipatory Research (RPER; Pereira, 2017; Teixeira, Alcântara, Garcia & Pereira, 2019) consists of intervention techniques that allow qualitative and quantitative information to be obtained from a collectivity in a short period. This information is then used to identify problems, their causes, and possible solutions, with the goal of promoting social change and sustainable development. The RPER method has been the foundation of several empirical studies, some of which focus on agricultural communities and water related issues in different countries and regions (Teixeira, Cruz, Machado, & Pereira, 2020; Teixeira et al., 2019; Pereira, 2017; Alcântara, Pereira, & Vieira, 2018; Teixeira Cruz, 2017; Pereira, 2001; Teixeira, Marques, & Pereira, 2017; Pereira, & Little, 1998). As stated by Pereira (2017, pg. 76), this method was tailor-made to systematically address the intricate realities of social groups like rural land reform settlements, associations, and agriculture related cooperatives, for example. The RPER represents a progressive evolution from the classic Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) methods, merging foundational principles from both and focusing on critical theory and participatory strategies to apply the concepts of Social Management.

Information and communication technology (ICT) has been used to try and promote social participation in public matters by enhancing societal well-being with platforms that empower communities to address challenges and participate directly in public decision-making processes (MySociety, 2013; Walravens, 2015; Peña-López, 2017; Felizardo, Pereira, & Silva, 2019). However, to the best of our knowledge, studies specific to the use of ICT to resolve social issues, that support participatory techniques, especially in the agriculture domain, are non-existent. In agricultural research, there is a strong trend toward developing software and hardware tools for quantitative application and research. For example, tools have been
developed for high-throughput phenotyping and seed quality testing (Tu et al., 2023), as well as for identifying soil-constrained areas in row crop fields (Orton, McClymont, Page, Menzies, & Dang, 2022). Hyper spectral imaging-based plant phenotyping is another area of focus (ElManawy, Sun, Abdalla, Zhu, & Cen, 2022), and the examples are many (Kim, 2021; Pacciofetti, Córdoba, & Balzarini, 2020; Jacquin et al., 2019; Álvarez, Oliva, & Valera, 2012; Zapa et al., 2012). Despite showing significant advancements with all these tools for the agriculture field, there remains a glaring deficiency in software solutions specifically tailored to assist qualitative research and participation methods.

The use of a web system on participatory approaches, particularly the one proposed on this work, can bring several advantages. From a theoretical perspective, it not only provides insights into the evolution of these participatory methods, but also establishes a foundational framework that bridges the gap between ICT and participatory techniques, setting the stage for subsequent research in this domain. Practical benefits include the wider distribution and dissemination of results, data transparency, the unification or centralization of the research made using the methods, the organization of data, the possibility of automation on report generation for faster feedback for the community, better communication and collaboration between team members, and data safety with periodic backups. Nonetheless, the software could serve as a platform for preparing new researchers with help and tips section for each of the methods’ techniques.

The primary objective of this work is to identify the requirements, plan, design, assess the complexity, and implement a system to support the Rapid Participatory and Emancipatory Research (RPER). The software can receive input from users, deal with separate roles like project coordinators, team members and visitors and generate automated report documents. All the technologies used for implementing the software are open-source and freely available, including the software itself, which is in a public repository of a cloud-based service for version control. In this manuscript, we bring the theoretical framework and development process of the software, discuss functionality and utilization strategies, and propose potential directions for subsequent research in this field.

2 THEORETICAL FRAMEWORK

2.1 Social Management

Even though the term social management's first appearance in the social sciences field was in the 1960s (Porket, 1967), as reported by Felizardo et al. (2021), the most recognizable reference came from the text of Rovida (1985), which deals with self-managed experiences in the Spanish civil war (Cançado, Tenório, & Pereira, 2011; Tenório, 2012). Nonetheless, in Rovida's (1985) text, social management appears with the meaning of proletarian democracy for locals. However, the term is also used to describe the management of collective farms in the communist Soviet Union, also known as Sovkhoz.

According to Cançado (2011), the main references on the Social Management concept construction are the works of Tenório (2008a, 2008b, 2010, 2012), França Filho (2003, 2008), Fischer (2002), Fischer and Melo (2003, 2006), Boullosa (2009), and Boullosa and Schommer (2008, 2009). In this list, it is also important to include the own work of Cançado (2011), the book entitled "Social Management, the epistemology of a paradigm" from Cançado, Pereira, and Tenório (2015) and, more recently, Tenório and Araújo (2021) alongside Davel, Xavier, and Cançado (2020). Academic work in social management are extensive and involves a set of scientific articles, books, dissertations, thesis, and other bibliographic materials that are being produced in different education and research institutions with different theoretical approaches and empirical studies, thus, controversies arose in the field.
As an example of this kind of dispute, Araújo (2012) defends the concept of Social Management as multi-paradigmatic, polysemic, and a field under construction. He states that it is a field of knowledge in a preliminary stage in which the multidisciplinary character prevails. On the other hand, Cançado (2011) and Cançado, Pereira, and Tenório (2015) argue that Social Management has already achieved much progress and has a consistent theoretical body approaching its first paradigm, or in other words, with specific theoretical foundations. In order to demonstrate that Social Management passes the criteria to be accepted as a science, the authors compare the maturity of Social Management with the criteria proposed by Popper, Kuhn, Lakatos, Feyerabend, Chalmers, Boaventura de Souza Santos and, Pedro Demo. This way, attempting to prove scientifically that social management is a field of knowledge that could be characterized as a science. The academic debate about the divergences is still in progress, as can be observed in the works of Araújo (2012), Cançado (2013), and Tenório and Araújo (2021), for example.

As recently stated by Tenório and Araújo (2021), social management arises, in opposition to strategic management, trying to achieve a fairer society. A society that is democratically articulated in the management of its interests, other than the interests of the market. It is, therefore, the opposition to strategic management as it, according to Tenório (1998), tries to replace technobureaucratic, monological management with participatory and dialogical management, one that the decision-making process is exercised amongst different social subjects. The distinctions between these management approaches are highlighted by other numerous scholarly works (Pimentel, 2014; Cançado, Villela, & Sausen, 2016; Tenório & Araújo, 2021; do Carmo et al., 2023). In social management, the decision-making authority is shared among the participants in the action using a dialogical managerial process. This seminal concept by Tenório (1998) is one of the most cited in the literature on this subject and it assumes Habermas' (1984, 1987) communicative action and the deliberative democracy concept as its analytical premises.

Tenorio and Araujo (2021) stated that despite the concept of social management being already on the agenda of the South American academy for quite some time, its understanding is not unanimous, and the concept is still not fully known. Notwithstanding, the authors insist that social management, since the early 1990s, has been an opposition and alternative to strategic management. Thus, it is a schism, a heterodox perspective against the mainstream, a concept of resistance not taken as an end in itself or as a goal of politics, but as a beginning and as a possibility, as the relationship between oppression and resistance, with no appeal to the sense of maximum agency of the modern subject.

The concept of social management is not fully formed and continues to evolve, with the existing academic debates shaping its progression and refinement. However, there is a common and convergent point in every work, social management is based on participation. In addition, it has flexible delimitation, and it is based on the ideal Weberian type (Weber, 2017). This means that it has a path to be followed as a guide, but the end possibly will not be fully achieved. This path, however, is conducted by some characteristics in collective decision-making with the characteristics being: no coercion, maximum transparency, intelligibility, dialogicity, aiming at emancipation.

2.2 Rapid Participatory Emancipatory Research (RPER)

To accurately appraise the reality of an organization, a rural community, small groups, or a collectivity from the perspective of Social Management, in relation to organizational change and sustainable development, it is necessary to use participatory methods based on dialogical processes of transformation of reality. It was with this aim in mind that the Rapid Rural Appraisal (RRA) emerged, and by 1979 it had its own thematic workshop and conference
(Barnett, 1979; Workshop on Rapid Rural Appraisal, 1979; Conference on Rapid Rural Appraisal, 1979). After some time, Chambers (1981) provided one of the foundational expositions on RRA, elucidating the method’s rationale and repertoire, emphasizing its significance in obtaining reliable data swiftly and efficiently. However, as the decade unfolded, there was an increasing awareness of the necessity for a more collaborative approach. This thought led to the evolution of RRA into the Participatory Rural Appraisal (PRA) in the late 1980s. This approach prioritized the active involvement of local communities in the research process, ensuring their voices and insights were central to the findings. In a seminal work, Chambers (1994) traced the origins and practices of PRA, highlighting the transformative shift from the more observational RRA to the inclusive and collaborative nature of PRA. This evolution underscored the realization that sustainable and impactful development necessitates the active engagement of the communities it seeks to benefit.

The RPER was established on the foundational principles of both RRA and PRA methods. It integrates the tenets of critical theory, predominantly from the Habermasian communicative action theory (Habermas, 1984, 1987), and is also deeply influenced by Paulo Freire's approach to dialogical education (Freire, 2018). Thus, RPER became a path for the application of Social Management theory (Teixeira et al., 2019). According to the method's creator, Pereira (2017), RPER is not entirely characterized as an action-research, it has the presence of an interdisciplinary team, external to the collectivity and uses participatory techniques, although, it uses such methods in the research process and in the construction of inter-subjectivities. According to the author, in the RPER, the main role of the interdisciplinary team is to guide participants to identify their own problems, their causes, and possible solutions, recognizing their demands within a principle of dialogical otherness. Thus, the participatory approach of this method is based on the knowledge, aspirations, and creative capacity of the participants, in addition to the involvement of other social actors. Therefore, in the methodological process of the RPER, a dialogical communicative action occurs and causes the commitment between the social actors involved. This gives the research a characteristic of a participatory development process. In addition to that, the interdisciplinary characteristics of the external team enable dialogic interaction with participants in correspondence to various aspects of their socio-economic, political, cultural, and environmental reality. That makes it possible for the participants to capture, understand, register, and communicate properly about different problems.

In general terms, the objectives of the RPER are focused on the basis of a process where the awareness of the participants allows them to move from a situation of dependency (also known as tutorial) to a sustained and emancipated situation as mentioned in the dialogical education perspective by Freire (2018). The main objectives of the method are: 1) to identify and analyze the participants' generated themes to motivate them methodologically to problematize their own reality, establishing their priorities and evaluating the actions that they themselves can carry out with those that would be the responsibility of local, state, or federal institutions; 2) to collect information of qualitative and quantitative natures in order to develop action strategies for the participants; and 3) to identify structural or potential organizational limitations of the participants (Pereira, 2017).

RPER is used to instrumentalize the concept of Social Management. It has as its methodological assumption the participation of the community that will experience the research process in conjunction with the interdisciplinary team. It is an approach and intervention methodology that is not in a tutorial format but one that has the capacity to promote participation and commitment from those involved. More details and information on the stages of the RPER will be explained in the Results and Discussion section of this work since they are part of the software requisites analysis and implementation.
3 METHODOLOGY

In order to carry out the implementation of the software, a development lifecycle model was used, which is a structure that contains processes, activities, and tasks related to the development, operation, and maintenance of a software product, covering the life of the system, from the definition of its requirements to the end of its use (ISO/IEC/IEEE 12207, 2017). However, there is no absolute consensus on software development lifecycle models, but traditional models are sequential and include models such as waterfall, spiral, or V-shaped (Ehrler, Lovis & Blondon, 2019). For this study, the waterfall model was chosen due to its great success, simplicity, and systematic nature (Bassil, 2012; Kumar & Bhatia, 2014). Precisely because of these characteristics, the waterfall model was and still is used by many software development companies and industrial manufacturers as the main technique to plan, build and maintain their products (Munassar & Govardhan, 2010; Susilo, 2018; Firzatullah, 2021).

The waterfall model was first introduced by Benington (1956) and modified by Royce (1970). Bennington’s original waterfall model recommended that software be developed in the following stages: operational analysis, operational specification, design and coding specification, development, and testing. Anticipating that there could be difficulties and unforeseen events, Royce (1970) improved this model, where at the end of each stage, feedback would be added so that each previous stage could be revisited, he also suggested a preliminary requirements phase (Figure 1).

The model phases can be summarized as follows (Royce, 1970; Bassil, 2012):

Requirements Phase - Also known as planning, or system requirements. As with research, this initial step consists of conducting a preliminary analysis to raise the problem, the objectives, and the needs or requirements of the software to be built. The business prerequisites are recognized at this stage, and, if possible, an initial measurement of the software should already be carried out at this stage.

Analysis Phase - This phase represents a complete and comprehensive description of the behavior of the software to be developed. Here functional and non-functional requirements
are defined in more detail, including classes, their relationships, functions, software attributes, interface requirements, and database requirements.

**Design Phase** - It is the process of planning and solving problems for a software solution, including the initial visuals. In this phase, the developers define the plan for a solution that includes algorithm design, software architecture design, graphical user interface design, among others.

**Development Phase** - Refers to the realization of business requirements and design specifications in an executable program, database, website, desktop application, and/or mobile application, that is, a concrete software component will be done in this phase using programming and implementation.

**Validation and Testing Phase** - It is the process of verifying whether a software solution meets the original requirements and specifications and if it fulfills the intended objective. In addition, the testing phase is the time to perform code debugging, in which errors and system failures are sought and corrected.

**Maintenance Phase** - It is the process of modifying a software solution after delivery and deployment to refine the output, correct errors, and improve performance or quality.

The general procedure starts with the identification of the requirements and needs of the project through the authors’ experience in software development and knowledge of the RPER method. The target audience for using the software was determined as the entire interdisciplinary team responsible for applying the method. All the requirements and requisites of the process that would be affected somehow by technology to be developed are detailed in the results topic.

The discipline of Business Process Management (BPM) was used to carry out the requirements mapping. BPM includes concepts, methods, and techniques to support the representation and execution of Business Processes (Weske, 2007). The BPM approach has been increasingly applied in the business scenario in recent years (Baklizky & Fantinato, 2012) and has proven to be a powerful way of solving or contributing significantly to the solution of a series of organizational problems, allowing for the improvement of business processes and, consequently, improved results obtained (Baklizky & Fantinato, 2012). The union of business management and information technology allows for the alignment between the processes and the strategic objectives to be achieved. In business process modeling, the main objective is to produce a description of reality, for example, the way in which a business transaction is carried out to understand it and, eventually, modify it to incorporate improvements in it. Consequently, it is important to have a notation that allows the essence of the business to be modeled as clearly as possible (Rodríguez, Fernández-Medina & Piattini, 2007). This notation has the acronym BPMN and for this study two elements of the notation will be used. Basically, the activity, represented by a rectangle with rounded edges, and the sequence flow, represented by an arrow indicating the process flow. Each activity will have mapped the requirements that can be accomplished or supported by the software.

After the initial requirements mapping, the Function Point Analysis (FPA) technique was used to measure the software. This is a complete technique to measure software from the system requirements point of view, even in the early requirements planning and analysis stages. FPA is part of one of the Functional Size Measurement (FSM) methods, which was introduced by Albrecht (1979) as a method for measuring the amount of complexity and functionality in a software project. In the FPA procedure, there are a variety of transactions to be accounted for, including data received, sent, or to be processed by the system and its access to internal and external databases (Rohayani, Gaol, Soewito & Hendric, 2017). Despite accounting for these details, the analysis should only be used with the business requirements that are clear to users and is independent of technical details such as the choice of programming languages and technologies to be used.
4 RESULTS AND DISCUSSION

4.1 Functionality Planning for the RPER’s Steps

The RPER's methodological intervention process follows a script, which can be defined as shown in Figure 2 (Pereira, 2017). Almost all steps can benefit from the software implementation in different ways, the details of each step will be presented next.

Formation of the interdisciplinary team - At this stage, it is already possible to predict the need for the system to support the registration of users. Thus, a CRUD for users is needed – CRUD are the four basic operations for data manipulation, that is create, read, update, and delete data from a table in the database. In addition, there must also be a registration of roles and the association between roles to users. These roles include being a member of a RPER and coordinator, which can add or remove other users as members of the interdisciplinary RPER team.

Preparation and training of the interdisciplinary team - To help with this step, the system can have the following functionalities: a) A page with step-by-step about the RPER method described using text and graphical visualizations. b) A help button on each of the system screens with useful information about each system functionality and step.

Elaboration of the generating themes framework table to be used as a guide to the techniques that will make up the RPER - Despite not being specified in the Figure 2 scheme, this is an important part of the team preparation and we believed to be important to make sure it will be added in the system. Similar to what will happen in most steps, here the system will
allow members of a particular RPER to add content to a blank editor page, where they can work together in the same document. Also, at this page, the help link could provide examples of tables already made on past applications of the method.

*Collection and systematization of secondary information about the collectivity in focus and the historical context of the region* - Here, the system allows the upload of images, text, and table inputs from members of that particular RPER application. The content will be saved in the database and all users will have access to the same content so they can collaborate with each other to form a single document for each RPER, similar to the step right before about the generating themes.

*Direct contact and mobilization with the participating actors or community* - For this step the system has no interference and everything must be done in person or sometimes over the phone/video conferences.

*Fieldwork with the community following the methodological process using previously defined participatory techniques, including interviews.* - Especially due to the possibility of no internet connection in most places where the RPER method is applied, it will not be possible to count on having the system work in loco for most places, since it is a web-based software with integrated options between several different users at the same time. Nonetheless, the functionalities of fieldwork will be created to enable the insertion, storage, and organization of all data collected during the application, even afterward. CRUD functions for all field work activities, enable the insertion of images, tables, charts, and text obtained during each used technique. The complete list and purpose of each technique can be found in table 1. In summary the software will be able to be a place where the interdisciplinary team members could save: the information on all collective participants acquired during their presentation; data obtained during the historical mapping; inputs acquired during the transect walk; details of public and private organizations that have links with the community for the stage named Venn diagram; facts on the seasonal calendar; findings about the community daily routine habits; records about the input and output technique; whole transcripts and insights from interviews and focus groups, with guiding pre-set questions; the reality and objective matrix data; and finally, the results of the priority election step.

The RPER fieldwork phase should be carried out over a period of three to five consecutive days by an interdisciplinary team with approximately five researchers from different backgrounds. Before the fieldwork, the group of researchers must have already contacted the community where the method will be applied. It is important that everybody knows some basic information about the community, such as type, structure, who are the members and leaders, among other aspects. After that, the application team and the community should schedule a date for the fieldwork application. As mentioned, there are several techniques that can be applied during this phase. Table 1 presents a summary of field activities that can be carried out during the application and its purpose. It is important to emphasize that the method is flexible, enabling changes in the choice and organization of the participatory techniques to capture the reality experienced by the participants of any given collectivity. The system is prepared for that, where each activity can be marked as not applicable, if necessary and with optional other fieldwork field where additional fieldwork not initially predicted can be added to appear in the final report.

| Table 1 - Rapid Participatory Emancipatory Research (RPER) fieldwork stages and techniques |
| Technique name | Technique Purpose |
| Presentation of the interdisciplinary team and members of the community | Identify who the participants are (name, age, marital status, occupation, and other information). |
| Historical mapping | Draw a map of the location that represents the organization or social phenomenon in the perception of the participants. |
Transect walk | The team must walk across the map drawn in the previous step to verify on the spot the description made by them, photographing and/or filming the landscape.
---|---
Venn diagram | Identify and evaluate public and private organizations that have importance and performance in the organization in the perception of the participants.
Seasonal calendar | Arrange all the organization's activities during the previous year in a graph.
Input and output | Analyze the situation of the production system in relation to the market context that involves the economic activities developed by the organization.
Semi-structured interviews | Allow for the objective comparison of opinions while also providing an opportunity to spontaneously explore topics relevant to that collectivity member. In addition, it requires the interviewer to have prior knowledge about the interviewee and the topic to be addressed.
Focus group | It aims to obtain qualitative information on the themes that generate collectivity and have as a principle a focused, previously determined discussion.
Daily routine | Identify day-to-day activities and the division of labor in the organization while planning future activities.
Reality and objective matrix | Identify problems, their causes, and possible solutions in the perception of the participants themselves.
Priorities election | Identify the social, economic, political, and technical-productive priorities of the participants through a democratic election.
Other fieldwork | While many fieldwork techniques are already encompassed in the method, its theory clearly allows for adaptability. Depending on the collective needs, certain techniques can be included or omitted.

Source: adapted from Pereira (2017).

**Systematization, analysis, and interpretation of all information collected** - This can be used after the analysis to insert content about the data gathered and studied. On this page the team members can also insert text and figures related to the interpretation of the data.

**Elaboration of the final report** - It is important that all the information collected is inserted into the system beforehand so it can be used to enable the final report generation. At first, the system will contain a button to generate a Microsoft Word report with a pre-defined style and introduction.

Apart from the already mentioned not applicable status available for each step and fieldwork activity, the system offers three additional status options for each page: unstarted, completed, and in progress. These indicate the current stage of each step within the RPER application. These statuses serve two primary purposes in the system. First, the software features a progress bar that automatically calculates the completion percentage of the RPER application, counting steps marked as completed or not applicable. Second, the statuses guide the automated report generation. Only pages with the status completed or in progress are selected for printing to form the final document.

For the data analysis and interpretation, everything should be carried out by the interdisciplinary team members following the RPER principles, that is, using content analysis (Bardin, 1977). This analysis is considered a fundamental phase of the research process for the RPER method. It is another step where the software can facilitate and speed up the process as much of the information should be collected by now and the team members can work cooperatively and simultaneously before selecting the final report elaboration. The concept of content analysis is given by Bardin (1977) as a set of communication analysis techniques that use systematic and objective procedures to describe the message content. According to the author, content analysis follows three phases: 1) pre-analysis, 2) exploration of the material, and 3) treatment, inference, and interpretation of results. The purpose of this analysis is to reveal the meaning of the ideas and values expressed during the research process by the participants.

During the RPER, the interpretation of the participating actors' ideas and values is enriched by the discussion about the materials collected and by the triangulation of information,
which confers quality, validity, and fidelity of the information to the researched reality. Possible discrepancies between the actual situation of the community and the thematic universe in which they fit must also be analyzed, contrasting the information presented by the participants and the technical-scientific knowledge of the interdisciplinary team. Thus, the RPER seeks to explore, qualitatively and quantitatively, the generating themes, considering the whole set and attributing a "holistic" character to the information collection process during the analyses. Finally, during the data interpretation stage, it is necessary to distance the team from the place where the research was carried out to put into practice the process of critical reflection on the information collected.

Figure 3 offers a comprehensive view of the RPER application process using a BPM diagram, illustrating the software features associated with each activity. Each functionality is numbered for easy reference and to track their frequency of appearance.
Figure 3 - Business Process Management (BPM) diagram of the Rapid Participatory Emancipatory Research (RPER) intervention method process and the respective planned functionalities for the system.

Source: Prepared by the authors.
4.2 RPER Software Function Point Analysis (FPA)

Albrecht (1979) initially proposed Function Point Analysis (FPA) as a strategic approach to quantitatively assess both the complexity and functionality inherent in a software endeavor. Within the framework of FPA, it's imperative to consider an array of transactions. These encompass data that the system receives, sends, or process, as well as its interactions with both internal and external database structures (Rohayani et al., 2017).

Within the realm of software development, the foundational operations associated with data management are encapsulated by the acronym CRUD, denoting Create, Read, Update, and Delete, as already mentioned in this manuscript. When delving into function point analysis, these operations are equivalently recognized as the foundational activities for interaction with the system's Internal Logic Files (ILFs), that is, persistent data structures within a software application that store and manage the system's internal data (IFPUG, 2004).

Table 2 elucidates the desired system functionalities according to the BPM established in the previous topics and their corresponding calculated total function points. It offers a comprehensive view of each individual functionality point. Every row of the table delineates a specific functionality with its name, brief description and numerical designation which corresponds to the ones mapped using BPM shown in the previous section.

<table>
<thead>
<tr>
<th>Functionality</th>
<th>Overview</th>
<th>FP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Users CRUD</td>
<td>CRUD operations for the users, this defines the possibility of user creation in the system, update information such as name and password and update profile picture, for example.</td>
<td>19</td>
</tr>
<tr>
<td>2) Roles &amp; Users/Roles Association</td>
<td>A user is given the status of a viewer for all registered RPERs when he/she first join the system, but it is known that they can became members or even coordinate a RPER, this functionality controls this kind of association.</td>
<td>22</td>
</tr>
<tr>
<td>3) Step by Step Explanation Page</td>
<td>Just a static page that will contain information to guide current and future interdisciplinary team members on how to proceed with a RPER application.</td>
<td>3</td>
</tr>
<tr>
<td>4) Help Button “?” Pages</td>
<td>This is also a static page with information, but instead of a macro view of the applications, using this help button users can see information on each individual step of the method, including examples of past uses.</td>
<td>54</td>
</tr>
<tr>
<td>5) Text Editor with Image Handling</td>
<td>Collaborative text editor for each step of the method, so users can insert, update, delete and/or justinspect text, images, and tables for each page of the system. This is the main functionality in the whole software where users will input most of the data and information gathered.</td>
<td>360</td>
</tr>
<tr>
<td>6) Status Tracking Info</td>
<td>With four possible status option, not applicable, unstarted, completed, and in progress, each step of the application will be controlled by the team members to keep track of their progress and select what will be printed in the report.</td>
<td>57</td>
</tr>
<tr>
<td>7) Automated Report</td>
<td>With this functionality, users can generate a report document with all the information placed into the system. Initially the software will only be able to create a Microsoft Word file, but the choices could extend in the future.</td>
<td>4</td>
</tr>
<tr>
<td>8) Summary Page with Progress Bar</td>
<td>This page is a dynamic page with summarized information about the RPER, such as its avatar image, team members, and progress, monitored by evaluating the status of each step.</td>
<td>10</td>
</tr>
<tr>
<td>9) RPER CRUD</td>
<td>CRUD operations for the RPER itself, where it is possible to create the method for an application in a collectivity, choose its avatar picture and by default the coordinator will be person that initiate the RPER.</td>
<td>13</td>
</tr>
</tbody>
</table>

Total Function Points: 542

Source: Prepared by the authors.

Starting with the users CRUD functionality, this was evaluated based on several components. External Inputs (EI) for creation, updating, and deletion of users accounted for 9 points. The display of user details, categorized under External Inquiry (EQ), contributed another
3 points. Additionally, the Internal Logical Files (ILF) for user data storage added 7 points, culminating in a total of 19 function points for this segment.

To ensure there is no confusion, an EQ, worth 3 functions points, typically involves both retrieving and presenting data without significant transformation to it. External Output (EO) involves processing logic that changes the behavior or form of the data, like doing calculations before presenting it, that is why it is accounted for 4 function points each. That is the reason user details being displayed are more of an inquiry operation rather than an output operation.

Roles and users/roles association is an important functionality within the software, responsible for the management of roles to users. The processes of role assignment and removal, both categorized under EIs, together they contributed 8 points since they fall under the average complexity classification for interacting with two ILF at once. The ILFs, which holds user data and the intricate associations between specific RPER applications and their members, summed up to 14 points, 7 each. Thus, the aggregate function points for this segment amounted to 22.

EIs refer to processes in which data enters the software system from an external application or user. These inputs do not necessarily have to update the ILF, but often they do. The primary intent behind an EI is to maintain some form of ILF or to influence the behavior of the system. An EI is characterized by its complexity, which is determined by the number of data elements it manages and the number of ILFs it references. In the context of the RPER software's roles and users/roles association functionality, an EI is the process where a coordinator assigns or removes a member role to/from a user. This role will influence the system by updating the user's permissions or access rights based on it. These processes of assigning and removing roles are typical examples of EIs in the function point analysis.

The software also offers a step-by-step full explanation of the method and help pages that provide guidance for each of the 18 steps of the RPER application. In total there are 3 preparation pages, 12 fieldwork pages, and 3 more after fieldwork steps that can withhold separate information each. The viewing of unique content for these pages, classified under External Inquiries (EQ). The sum of 3 function points for each of these 18 pages, 54, plus the 3 for the step-by-step document generated a total of 57 points.

Next we have the text editor with image handling, this tool facilitates content management across all 18 steps. This functionality involves 162 points from EIs for adding, updating, and deleting content (3 operations times 3 function point times 18 different content pages). Also, the display of this content, categorized under EQ, added another 54 points, 3 for each page. The ILF, for storing this content in the database, contributed 126 points, since it uses 18 unique tables to save the content of each page. This led to an aggregate of 360 function points for this functionality.

Status tracking information enables the software to monitor and present the status of each of the 18 RPER steps. This functionality amassed 54 points from EIs dedicated to status dynamic updates and an additional 3 points from EQ used to display the current status of each step of a given method, totaling 57 points. On another functionality, a user has the option to generate the report merging the information from all the steps in a single Microsoft Word file, despite being technically challenging, this task this falls under a single EO contributing in mere 4 points to the overall function point count.

The summary page with progress bar display information on the RPER avatar’s image, team members, and roles which account for 3 points as EQ. It also enables members to update the RPER avatar photo, adding 3 points as EIs. And it calculates and presents the progress percentage for the RPER application, 4 points as an EO. All of this results in 10 function points for this segment. Lastly, the RPER Creation operation to allow the management of the RPER itself, was assessed. In this version of the software it is only possible for users to create the RPER, and all the updates possible on it were already dealt with in previous functionalities, so we only have to add the EIs for the creation operation, 3 points, the displaying of RPER details.
in the RPERs list, which falls under External Inquiries (EQ) adding 3 points, and the ILF for storing RPER data, that contributed 7 points, bringing the total for this section to 13 function points.

The RPER software, with its set of functionalities and interactions, encompasses a total of 542 function points, providing a robust measure of its complexity and underscoring the intricacies involved in its development and maintenance. The Function Point Analysis technique considers the effort required to produce the software, however, to transform this points effort into number of hours of work is very subjective. This can vary depending on the programming language chosen and the knowledge of the technicians who will produce the system, for example.

Nonetheless, expert knowledge provides a metric suggesting that in modern programming languages, one function point equates to approximately 10 hours of effort from a well-trained professional, which fits with what is indicated by other researchers. While in the past this value reached fourteen hours per point (Morris, 2001), more recent studies indicate that this value ranges from about eight to eleven hours depending on the project type, software system, application area and technology involved (Chrobot, 2011; Czarnacka, 2012). The International Software Benchmarking Standards Group (ISBSG, 2023) supports this estimate, particularly for "medium 2" size projects (spanning from 300 to 1000 function points). Consequently, completing such a system would require roughly 5420 hours of dedicated full-time work, equating to about two years and eight months. Subsequent sections compare this estimation with the actual development time spent.

### 4.3 Software Interface Prototyping and Wireframe

There are several free tools that help in the system prototyping stage. In this work we use Figma (2021), a vector graphics editor and prototyping tool which is primarily web browser based. The software is focused on graphical user interface development and user experience design, also known as UI/UX (Franco, 2021). Figma is mainly a browser-based application, but there are desktop versions available for macOS and Windows. In addition, it has vector tools for proficient illustrations and code generation. Furthermore, the software can be applied to image manipulation (Kadam, Ahirrao, & Kotecha, 2021). Figma allows the resize, crop, adjustment of colors, and filters application in images like contrast, shadows, mirror, blur, exposure, highlight, and many others.

The designed graphical interface can be visualized in Figures 4 and 5. Figure 4 shows the logo created for the software, the login screen, and the account creation screen. In Figure 5, two screens of the system are presented. The screen on the left lists all RPERs in progress or finished in the format of a product cards design, where the title of the application and a photo representing it will be highlighted. Also, on the same interface, it is possible to check the position of the search bar and the sorting functionalities. The button to add a new RPER is also present. The other screen, located on the right of figure 5, unveils an example of RPER already in progress and the menu with the mapped features accounted for in the previous sections of this work. It is also possible to see the featured image, also known as RPER avatar, other images inserted in the particular example project and the application progress based on steps already finished or underway. Each step status is listed as a graphical small circle before the step’s name. The empty circle for example indicates an unstarted step, while the full circle suggests a completed task. This design was done before any coding, however the end result of the software precisely followed this plan.
4.4 Software Back-End and Front-End Implementation

The back-end of the RPER software serves as the backbone, ensuring data integrity, security, and communication with one or multiple front-end options (e.g., Web Application, Mobile App). It functions as the foundational infrastructure where data storage, processing, and business logic reside. In our case, it also delineates a set of conventions for creating, retrieving, updating, and deleting data, thereby ensuring the seamless interplay of data and operations between the front-end and back-end systems. The most important technologies employed for this step of the software development included: Node.js, an open-source server environment, Express as the free and open-source back-end web application framework, Postgres database as the free and open-source relational database management system (RDBMS), and TypeScript as the open-source high-level programming language that builds on JavaScript.

Node.js is a multi-platform, open-source runtime environment that executes JavaScript or TypeScript both on the client-side and the server-side. This facilitates the creation of a dynamic web system even before it is relayed to the user's browser. Node.js harmonizes web application development around a singular programming language, simplifying its coding process. In recent years, Node.js has garnered significant accolades. For instance, LinkedIn's mobile application transitioned from "Ruby on Rails" to Node.js, leading to a reduction from 30 data servers to a mere three, all the while retaining the same user traffic (Paul, 2012). Other industry leaders like Netflix, PayPal, and Uber also leverage this technology (Lin & El Gebaly, 2016). In performance evaluations juxtaposing Node.js against traditional server environments, systematic tests have consistently shown it outpacing its competitors (Chitra & Satapathy, 2017). Carter (2014) further praised Node.js as a platform designed for rapid and easy system development with significant scalability for network applications.

The choice of using Express, a minimal and flexible Node.js web framework, ensured a strong foundation for building the application's programming interface (API). Express, when combined with Node.js, enabled the creation of a powerful representational state transfer API (RESTful API), which serves as the bridge between the software's front-end and its PostgreSQL database. Express is used at large companies, such as Twitter, now "X" (StackShare, 2023)

Data management and storage, is the essence of the RPER software. Given the intricate nature of participatory appraisals and the depth of data they produce, a reliable and efficient database system was paramount. PostgreSQL, a powerful open-source relational database, was the chosen database system. Given its reputation for extensibility, performance, and Structured Query Language (SQL) compliance (Makris, Tserpes, Spiliopoulos, Zissis, & Anagnostopoulos, 2021), PostgreSQL provided the necessary tools to handle the vast amounts of data that could be generated during several to come Rapid Participatory and Emancipatory Research (RPER) applications. Its atomicity, consistency, isolation, and durability compliant (ACID-compliant) nature ensures that all transactions are processed reliably, a critical factor for a research-oriented application like this. As example, due to its robustness, companies like Instagram and Spotify are using PostgreSQL in their applications (Thomson Data, 2023)

Lastly, TypeScript, a typed superset of JavaScript (Microsoft, 2023), was used as the primary programming language for the back-end and for the front-end development. It offers strong programming concepts, including classes and interfaces, facilitating the building of large-scale JavaScript projects (Wu, Sun, Gong, Chen, Liao, & Jin, 2020). Based on various studies, both JavaScript and TypeScript had emerged as leading languages for quite some time and still are (Frederickson, 2018; Stackoverflow, 2017, Stackoverflow, 2022). TypeScript's static typing feature, combined with its powerful object-oriented programming capabilities, ensured that our codebase will remain maintainable, a critical aspect for any software expected to last long and evolve over time.
For our front-end, we faced a decision between developing a mobile app or a web application. While we initially leaned towards a mobile app, we strategically pivoted to a Web Application. Web apps provide instant cross-platform access, facilitating quicker deployment and wider user engagement. Despite not being developed specifically as a mobile app, our web system was designed with responsive principles and adjusts seamlessly to various screen sizes and resolutions, ensuring optimal viewing on phones, tablets, and computers alike. The framework we chose for development of the front-end was React (Meta, 2023), a free and open-source front-end library for building user interfaces based on components, primarily developed maintained by Meta (formerly known as Facebook). This not only expedited development but also simplifies potential future transitions. As React Native, a popular tool for developing mobile apps leverages React’s core principles, it offers a smoother pathway to expand into a mobile app later, facilitating continuity and a unified user experience across platforms.

The front-end of the RPER software focuses on user experience, ensuring that data visualization, user input, and overall interaction are smooth and intuitive. The choice of React for building user interfaces laid the groundwork for a componentized and efficient front-end architecture. This modular approach allows for reusable components, enhancing the software's maintainability and scalability. Besides Typescript and React.js, other important tools were used in the front-end development, such as StyledComponents, SunEditor and Axios. We will briefly explain how these tools were used in our application.

Styled-components played a crucial role in the software’s aesthetics and user experience. This library for React and React Native allowed us to utilize tagged template literals to style components, ensuring a clean and organized code structure. This approach also eliminated the need for mapping between styles and components, reducing potential errors and simplifying the styling process while ensuring the software’s web pages were both responsive and interactive. For rich text editing capabilities, SunEditor, a lightweight yet powerful what you see is what you get (WYSIWYG) editor, was incorporated. This allowed users to generate detailed reports, documentation, and other essential research documents with ease. And finally, communication with the back-end was facilitated by Axios, a promise-based HTTP client for the browser and Node.js. Axios made it simpler to send asynchronous HTTP requests to REST endpoints, ensuring that data retrieval, posting, and other CRUD operations were handled smoothly.

All the technologies used for implementing the software are open-source and freely available, including the software itself which is in a public repository of a cloud-based service for version control. In summary, the combination of these technologies provided a robust, scalable, and user-friendly software solution, tailored specifically for the needs of RPER. Given that community participation lies at the heart of the topic, it was imperative to choose free and open-source tools. This not only echoes the principles of participatory research but also ensures that the platform remains adaptable to future needs, inviting contributions and fostering a sense of community ownership over its evolution.

The coding for the back-end and front-end started in June 2021 and was done regularly until August 2023, little over 2 years. It had the involvement of two experienced developers and one occasional third junior developer that helped with the front-end. The effort and time invested closely matched the initial projections from the function point analysis, especially considering none of the developers were dedicated full time to the project. By the time this manuscript was being drafted, both, the back-end and the front-end, had approximately eight thousand lines of code, each, in the back-end these lines were spread among basically three hundred files while in the front-end one hundred and thirty files were created, including pages and components. This amount accounts only for developed files, excluding the code from imported libraries and reused functions from external contributors.
5 CONCLUSIONS AND FUTURE WORK

This work used a professional approach to software development to create an initial version of an application in the Social Management field to enhance the capabilities of this theory, augment the RPER methodology with innovative information technology, and extend its reach. Based on the number of function points calculated, and the hours required for development, it is evident that the system is of significant size. Despite the complexity of development, it is more important to note how the software can support the RPER method application in nearly every step of the way. This will consequently benefit society and the rural communities where the research was intended to be applied.

The thorough text description, coupled with illustrative software screens, make it easier for readers to grasp the developed work, facilitating their journey from conceptual understanding to tangible insights. Due to the development methodology adopted, the waterfall model, it is possible during the maintenance of the system to revisit previous steps to make changes in the design itself or in any of the functionalities already mapped, according to the necessity.

Beyond the immediate theoretical merits of applying social management, other accomplishments are expected with the use of a web system in the RPER applications. These benefits include the distribution and dissemination of results, even more transparency, the unification or centralization of the research made using the method, the organization of data, report generation automation, and better communication and collaboration between team members. But perhaps its most profound impact lies in its potential socio-economic ramifications, particularly in the realm of rural community engagement and qualitative research enhancement in agriculture.

As future work, we recommend the continuation of this system development, maintenance, and possible adaptations like integrating artificial intelligence capabilities and adaptation to other appraisal practices. As highlighted in the results, every single technology used to build the system is openly accessible and we made sure the RPER software be the same, guaranteeing the platform's flexibility for future demands and encouraging community contributions. Some other suggestions include a frequently asked questions page where users can pose questions and specialists give their responses, integrated video lessons with tips about the techniques and application steps, and interactive questionnaire for users to gauge their proficiency and readiness to apply the method. Furthermore, it is also possible to suggest the construction of other systems using the concepts, techniques, and technologies presented in this work, especially those that bolster qualitative research in the agriculture domain, a methodology niche with a shortfall in information technology engagement.
Figure 4 - Rapid Participatory and Emancipatory Research (RPER) Software Graphical User Interface (GUI): Logo, Login, and Signup Screens.
Source: Prepared by the authors.
Figure 5 - Rapid Participatory and Emancipatory Research (RPER) Software Graphical User Interface (GUI): Listing and Example Screens. 
Source: Prepared by the authors.
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