Development of an Offline First application for SVS data entry with integrated Business Intelligence System.

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Abstract: In civil construction, a quality sector is vital due to the high volume of services and their interdependence, which can lead to significant errors. Quality monitoring involves numerous conferences, resulting in extensive paperwork, printing, staff, and time, leading to substantial expenses often overlooked in the budget. A computerized and portable system can greatly assist in reducing the time, materials, and costs associated with these conferences. This study aims to showcase the benefits of an application for filling out service verification sheets (SVS) and adapting a computerized quality monitoring system. The results revealed various advantages, as well as challenges encountered during the demo implementation, ultimately providing enhanced efficiency and data security.

Keywords: Constructions; Power BI; Application; Service Verification Sheet

Desenvolvimento de um aplicativo Offline First de preenchimento de FVS com parte integrada a um Sistema de Business Intelligence

Resumo: Em uma obra de construção civil, um setor de qualidade é essencial devido à quantidade de serviços realizados e à interdependência entre eles, que pode resultar em erros acumulados graves. No entanto, o acompanhamento da qualidade requer muitas conferências, planilhas, impressões, funcionários e tempo, o que gera altos custos adicionais, muitas vezes não considerados no orçamento. Este estudo busca demonstrar as melhorias que um aplicativo pode trazer para o preenchimento da ficha de verificação de serviço (FVS) em uma obra, assim como a adaptação de um sistema de acompanhamento da qualidade informatizado.Os resultados mostraram diversas vantagens, além de desafios enfrentados durante a implementação da demonstração, que também proporcionou agilidade e segurança nos dados.

Palavras-chave: Obra*;* Ficha de verificação de serviço (FVS)*;* Construção Civil**;** Power BI*;* Aplicativo*;*

1. INTRODUCTION

According to Mattos (2010), companies are beginning to understand that investing in process management and control is inevitable to define indicators such as deadlines, costs, profits, return on investment, and cash flow. Deficiencies in these areas are among the main causes of poor project quality due to rework, waste, and corrective maintenance. Therefore, it is essential for a quality management system to be seen increasingly as an agent of preventive measures rather than solely relying on corrective actions based on non-conformities.

Furthermore, companies that standardize quality processes and invest in technology development, aiming for continuous improvement, tend to gain more reliability and credibility with customers, and consequently, market advantages.

Therefore, despite the extreme relevance of adopting a robust and concise quality management system, it is also known that it often requires numerous monitoring services. The use of technology is important as a facilitator in the pursuit of rational use of time and manpower. Information technology contributes to centralized data storage, allowing for data analysis to support decision-making associated with the use of mobile devices, enabling users to be more efficient in their activities.

Fernandes (2004) states that an indicator should primarily aim at demonstrating a specific situation that needs to be analyzed with measurable data, enabling control of both internal and external processes related to production. Thus, the use of Business Intelligence (BI) tools, according to Barbieri (2001), in conjunction with other systems, has provided greater flexibility in organizational management, as it makes information more scalable and accessible. He defines BI as a conceptual "umbrella" that encompasses data capture, information, and knowledge through modeling and structuring of information.

In the construction industry, Oliveira et al. (2008) discuss the significant efforts required to include quality processes in recent years. This is because the construction industry is often perceived as a traditionalist industry, resistant to modernization, characterized by the use of unskilled labor, and varying levels of quality in products and services that directly impact the final outcome.

According to ISO 9001:2015, organisations in the construction industry must strive to achieve compliance with product and service requirements while retaining all documented information related to their processes. In line with this, and complying with item 8.6 of ISO 9001:2015, there are Service Verification Sheets (SVS) in the construction industry. These documents are used to verify if the services performed during the construction stages of a project comply with technical and quality standards. As a result, parameters need to be defined from the initial phase of the construction project to the final details, as SVS serve to approve or identify execution issues, as well as indicate necessary improvements to achieve the planned outcome.

According to Machado (2013), there is a need for constant organization in records to ensure data traceability. However, in construction companies in general, SVS are often done on paper and physically filed or scanned for storage on the network, in Excel, or in some type of system developed within the company. Given this, it is evident that relying on highly manual processes is challenging, as they are labor-intensive, prone to errors due to the high volume of data, resulting in rework, and do not achieve the desired efficiency and data analysis.

Neto et al. (2013) state that mobile devices such as tablets and smartphones serve as simplifiers. Additionally, Sauble (2015) discusses the Offline-first movement, which advocates that applications should be prepared for scenarios without internet access. Therefore, it is evident that without the use of technology for filling out SVS, real-time information feedback is not possible. This requires the optimization of systems to enable efficient data collection and processing.

For this study case, the company Civil Construtora was chosen, and the quality control processes related to the Verification Service Sheets (SVS) were analyzed. Currently, the company uses Sharepoint, a web-based collaboration platform by Microsoft, as a data centralizer. However, Sharepoint requires internet access, and its

mobile version tends to have errors. Furthermore, the way the database was structured makes it difficult to use automated Business Intelligence (BI) tools.

Therefore, the main objective of this project is to develop an offline-first application using computational resources, aiming to bring benefits to Civil Construtora. It is expected that the application will allow saving filled-out information offline and synchronizing it with the quality control system. Subsequently, it will enable a proper integration of processes with the existing BI system.

2. METHODOLOGY

As a methodological approach, this project was carried out within Civil Construtora and began with the field research stage to identify the problem. Subsequently, the construction and testing of the application, as well as the automation of the existing BI, were conducted, as detailed below:

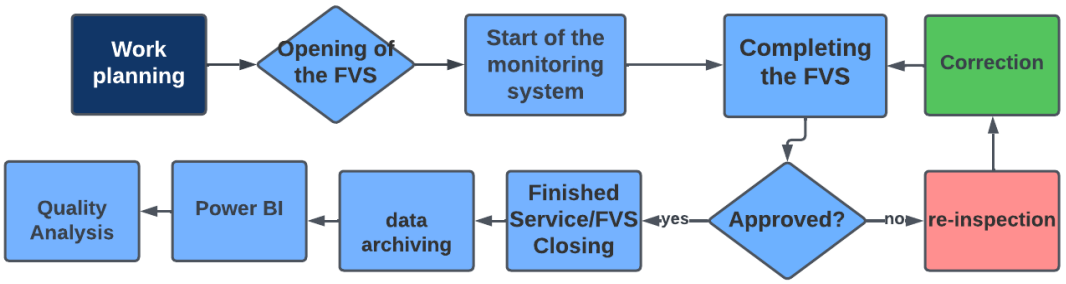
2.1 Field Research Stages

In an effort to identify existing manual processes in verification services, a questionnaire was administered to employees working on construction sites at the mentioned company. The majority of respondents highlighted the burdensome nature of the processes related to filling out the SVS forms. These tasks involved printing the form from Sharepoint or using a blank sheet of paper, conducting daily verifications of services in the field, and returning to the office to manually enter the information into the system. The quality department then analyzed the completed SVS forms weekly from all construction sites, adding further time demands to both departments.

The questionnaire included a question regarding suggestions for optimizing or improving the SVS process. A significant percentage of respondents recommended the development of an application as they expressed dissatisfaction with the current approach. During interviews, a supervisor responsible for reviews emphasized the shortcomings of the SVS, stating that it lacks effectiveness and the engineer lacks control over the process, making it challenging to provide adequate support. The current manual review process requires hours of work, sometimes spanning the entire day. The supervisor believed that digitizing the process and implementing a user-friendly mobile interface would result in a more efficient and practical data entry solution in the field.

The employees' opinions and overall dissatisfaction with the manual process underscored the necessity of developing an application to enhance the efficiency and usability of SVS. A major challenge faced in using applications at construction sites is the synchronization with the internet, primarily due to unstable or nonexistent internet connections. To gain deeper insights, site visits were conducted in collaboration with the company's technology manager to observe the SVS filling out process, identify patterns, and understand the various realities involved. It was noted that the current process had experienced failures and inefficiencies. To thoroughly analyze the current process, a flowchart was created to understand its entire logic. The flowchart was validated by the quality management system and users, revealing that what may seem like a simple process in theory is, in practice, manual and burdensome.

Figure 1. Process Flow



Source: Author's own creation

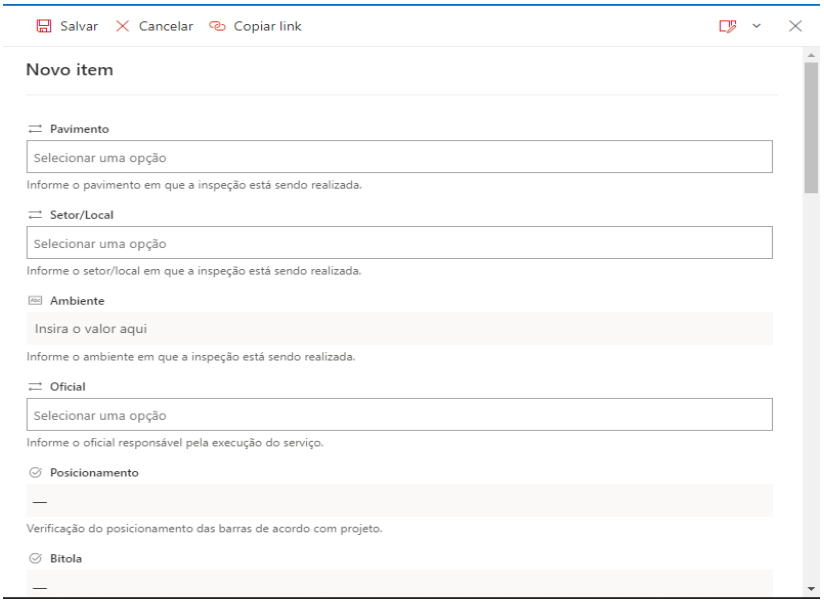
As depicted in Figure 1, each construction project has its own planning that must be followed throughout the construction process by the Production Engineering and the respective technical team. They are consulted to determine when and at which stage the SVS (Service Verification System) should be filled out. Figure 1 provides a visualization of the information flow and activities involved in completing the SVS, aiding in the understanding of the process.

During the opening of the SVS, specific criteria for each service are verified based on their execution time, and it is checked whether they are approved or not. If a service is not approved, it goes through a reinspection process, and a solution to the problem must be indicated. Once the verifications are completed, the quality management system receives this data for further analysis through Power BI tool.

2.2 Action Research

For controlled services, the company uses the Sharepoint software as storage and control. For each of the verified services, the instructions provide a brief guidance on how the service should be executed, the sequence of steps, and the expected outcomes. It is the responsibility of the supervisor to know which tools to use, the execution processes, and the expected results at the end of the process. Each work instruction is linked to a Service Verification Form, as shown in the example (Figure 2).

Figure 2: Example of a Service Verification Form linked to a work instruction.



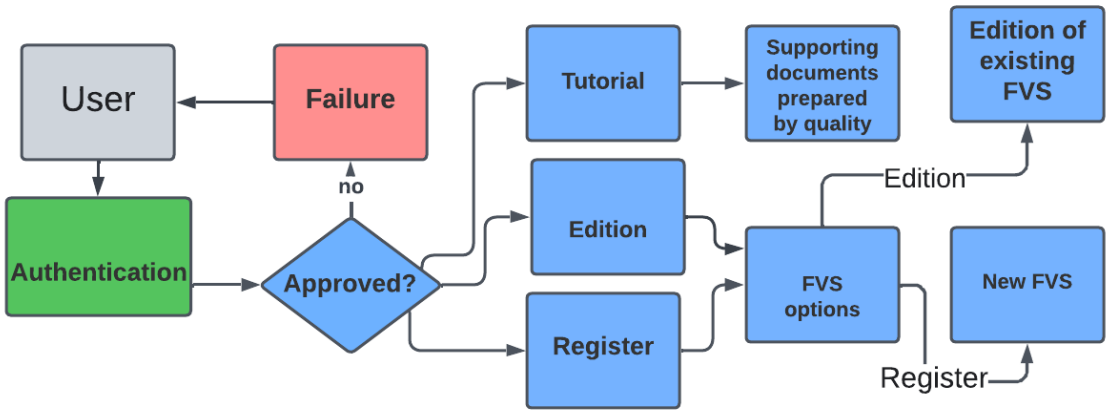
Source: Sharepoint Civil Group

2.3 App Demo

After the applied research, the development of a user-friendly demo began, aiming to establish a standard for all construction projects. The demo underwent validation by the company's quality management system and sought to address supervisors' difficulties in filling out forms. The suggestions provided by users for implementation include a help tab for filling out the SVS, optimization of fillable fields, information about the person responsible for filling out the SVS, responsive filling for mobile and tablet devices, offline functionality, a user-friendly interface, inclusion of videos and images to aid verification, a tab for generating reports with fields for image registration, observations, and an option to email the report, and automation of the manager's dashboard on the computer using Business Intelligence (BI). To better understand the screens and system requirements, a basic flow for the project was created (Figure 3).

The development of the proposed application involved the use of three main tools: Android Studio environment, a mobile emulator, and a database. Initially, Visual Studio Code with JavaScript language was utilized as the integrated development environment to build software for Android and iOS platforms (expo). The choice of free software was a predetermined parameter to ensure cost efficiency in the system's construction. Android SDK emulator from the Visual Studio Code facilitated the simulation of a mobile device, allowing the creation of the application through libraries, emulators, and code. Firebase, a publicly available tool, was used as the database system, supporting storage and exchange of information for the application's computerized creation. The prototype construction took into account recommendations from Civil Construtora's quality management system.

Figure 3. Application flow.



Source: Author's own creation

The Expo tool played a crucial role in providing a collection of widgets used as programming elements rendered and transformed into interface objects. The library used in the application's development, based on React Native, offered default design customization for the Android system, with compatibility for iOS due to the framework's internal architecture. Custom components were created for some screens to achieve distinct layout customizations from the standard library, adapting the same pattern to both platforms.

To expedite the process of obtaining reports, a demo was designed to display only necessary fields with a brief verification summary. This facilitated the consultation of forms through the Power BI computer program. Power BI served as a centralized data platform, showcasing the number of approved, not approved, and reinspected services, along with providing indicator analysis. This approach enabled the identification of potential errors and their reasons, aiding in the prevention of future construction project issues.

3. RESULTS AND DISCUSSION

The transformation of the filling process into an application is complex, requiring creativity and mastery of the variables of the tools. The development of digital versions of protocols, forms, and guides is a challenge, both due to the properties of the chosen digital device (screen size, keyboard, processing performance) and the differences in data usage in the new format, always considering the opinions of the stakeholders who, in this work, demanded a large font size due to the high brightness present at construction sites on sunny days.

Upon starting the demo, there is a company presentation screen, and upon passing through it, the user authentication is performed, which is done according to the Civil Group's database, only allowing users with the company's domain (@civil.com.br) and who are registered in the employee system.

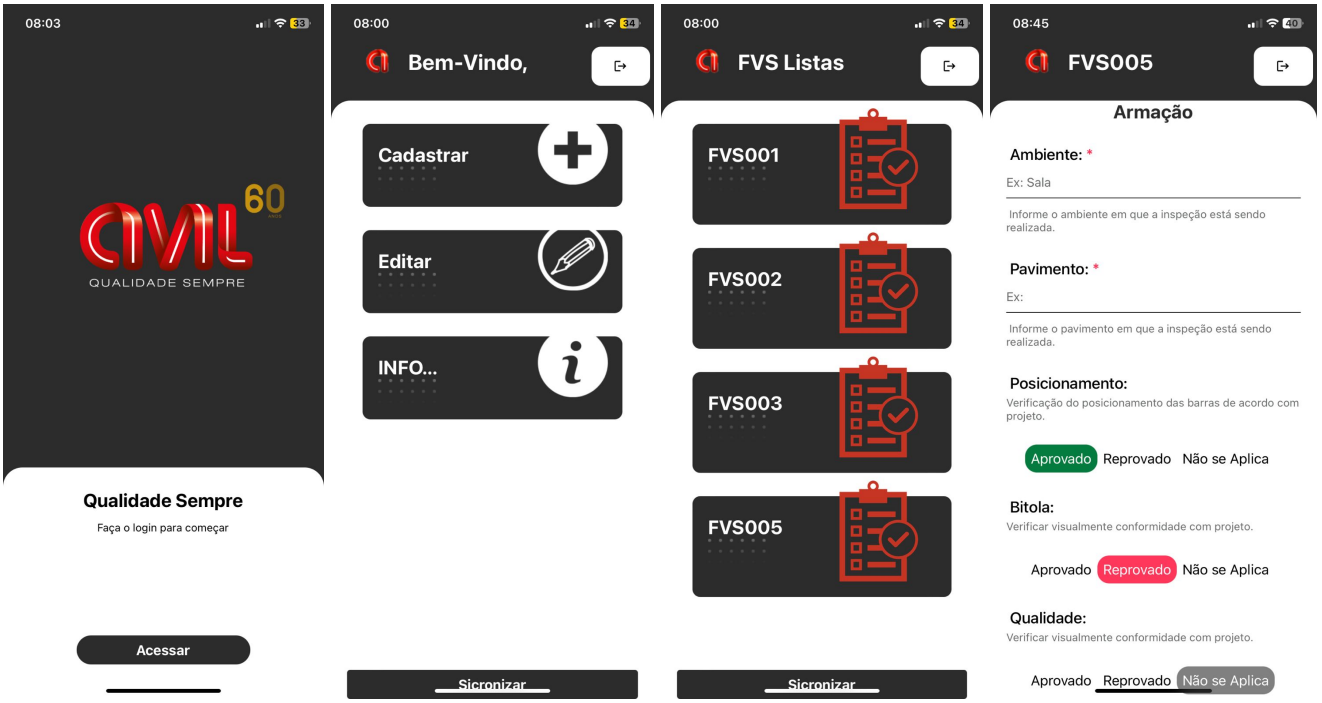
The application presents three accessible tabs after the authentication screen: "Register," "Edit," and "Information," with a synchronization button that allows sending data when the mobile device has an internet connection. Users can seamlessly navigate through the process of form registration and editing, and can also access essential support documents within the "Information" tab. For visual reference, please refer to Figure 4 showcasing the initial screens of the application.

After accessing "Cadastrar" (Register), the "FVS Listas" (List of SVS) (Figure 4) screen is displayed, where data for each form can be added. After filling in the verification data, upon pressing the "Salvar" (Save) button at the bottom of the screen, the data is sent to the manager's dashboard. In case there is no internet connection, there is a "Sincronizar" (Synchronize) button on the main screen, as seen in Figure 4.

The demo version, developed in collaboration with the Quality Management department, has been evaluated as capable of speeding up the filling out process, often essential to ensure prompt and accurate care by the team.

The relationships established between the project documents and support in services have been integrated into the application interface, with its main connections to planning and diagnostic generation. This allows for greater agility and accuracy in verifications, making the information available to the site engineer in real time.

Figure 4: Demo



Source: Own authorship.

Based on the feedback gathered through interviews with operators at each visited construction site, where they spent a day using the application on-site, it is evident that the results have been positive. One operator expressed their impression, stating, "I am impressed with the improvement that the application has brought to our work. Previously, we had to deal with time-consuming manual processes prone to errors. Now, with the user-friendly interface and seamless functionality of the application, everything has become more efficient and easier to manage. Additionally, the built-in support features in the application are truly valuable as we have quick access to important information. I believe that productivity stands to gain significantly from utilizing this digital solution."

These insights gathered directly from the operators during their hands-on experience reinforce the positive impact of the application on their work processes. The user-friendly interface, improved efficiency, and valuable support features mentioned by the operators further validate the effectiveness of the application in meeting their operational needs and improving productivity.

This quote from an operator at one of Grupo Civil's construction sites emphasizes the support for the application and its ability to improve work processes. Based on feedback from three different operators from various construction sites, they highlighted the user-friendliness, efficiency in task execution, and availability of useful resources. As one of the operators expressed, "I can't imagine work without this application anymore. Goodbye endless paperwork and slow processes. I'm excited to be able to use this digital solution throughout the entire construction site. I can't wait to experience all the efficiency and convenience it provides!"

4. CONCLUSION

Integrating information systems in the civil construction industry yields several benefits, particularly in improving management efficiency. The developed demo version

of the application has shown great potential in enhancing usability, functionality, and reliability, making it a valuable tool for construction site employees. The application aids in identifying non-conformities and potential risks in the project, enabling engineers to guide the team in adopting preventive measures to enhance service quality, reduce complications, and increase productivity.

Investments in technology and knowledge are essential for enhancing safety in forms, benefiting both the construction sector and its employees. The research focused on the development of an Offline First application for SVS filling, integrated with a Business Intelligence System. The findings showcased the practical advantages of such an application, maximizing the team's skills and competencies for day-to-day construction activities, and aiming to achieve productivity gains with improved quality.

The use of information and communication technologies in the construction industry is on the rise, facilitating the structuring and analysis of data through technology and automatic data cataloging. As a result, clear data visualization enables the verification of whether established goals have been met. The study suggests that future updates could include automation and integration of other quality control processes within the company, leading to a single platform for quality management system checks, ultimately improving user experience and sector efficiency.

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