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Implementing EDRMS in public procurement: a retrofit approach

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Abstract

In public procurement, a multitude of data is used, produced, and exchanged in various ways and formats. Laws and regulations often require that the exchange of information takes place through signed and recorded documents, following specific authorization processes. On the other hand, many modern Project Management techniques rely on accurate knowledge of project data, which requires information flow to occur in a structured and digital manner. The concept of an Electronic Document and Records Management System was created for this purpose, to combine document flow and structured information flow. However, in practice, it is difficult to find ready-to-use commercial solutions, and many administrations choose to use traditional document management systems. This work aims to investigate the two requirements independently and then jointly, proposing a clean and simple approach to align them. The chosen approach envisions a two-tier system with defined functional specifications, where the first tier coincides with an existing document management system. The outcome demonstrates how to implement an Electronic Document and Records Management System by retrofitting a traditional document engine. The described approach will be tested through a case study related to a large public construction contract.

Keywords: Project Management; Information System; Public Procurement; EDRMS; Electronic Document and Records Management System.

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1. Introduction

The management of public procurement involves processing a multitude of data, which are produced, read, and reworked many times by different processes and people [1]. The data may include information about what needs to be done, timelines, authorizations, and, as part of public processes, are subject to laws and regulations that require them to be transmitted and stored in certain ways [2]. Information systems that support these processes focus on elements such as document authorization flows, visibility permissions, and protocol number assignments. These methods conflict with modern data-driven Project Management (PM) techniques that require data to be stored in a structured format [3][4][5].

The concept of an Electronic Document and Records Management System (EDRMS) was designed to reconcile these seemingly conflicting requirements and bring them together [6]. On the other hand, the technology is not mature, and there are no sources that provide precise and transparent descriptions on how to implement an ERDMS.

In this paper, we analyze the technical, legal, and organizational difficulties of implementing an EDRMS for public procurement management and propose an approach to overcome these challenges. Finally, we will demonstrate how we implemented an EDRMS following our approach in a real-world case of public construction and the benefits we found.

The remainder of this paper is organised as follows. In Section 2, a literature review is presented on EDRMS and related tools. Section 3 clearly articulates the research objective, which is to integrate a document flow with structured data within the context of public procurement. Section 4 proposes a two-layers approach. Section 5 provides an illustrative case study on a public procurement, wherein an application solution based on our approach was developed. Finally, Section 6 presents the conclusions.

2. Literature Review

The first type of publications considered in our literature review relate to application cases in which an EDRMS was attempted to be implemented, listing its benefits and challenges. Gelashvili and Pappel [7] and Pappel, Gelashvili and Pappel [8] mapped numerous studies related to the benefits and problems of implementing an EDRMS and proposed a ranking system for the maturity of an EDRMS. Yin [9] examines the implementation of an EDRMS for the New Zealand government and identifies several benefits, including improved internal records management, increased cost-effectiveness, and enhanced transparency and accountability. Mosweu, Bwalya and Mutshewa [10] examined the factors influencing the adoption and use of the document flow management system in Botswana's Department of Trade, highlighting that the reluctance of users to adopt and use EDRMS is due to negative attitudes towards computers, computer anxiety, the complexity of the systems, and incompatibility with current working practices, and suggesting that user adoption is a critical factor in the successful implementation of EDRMS in public procurement management. Wilkins, Swatman and Holt [11] emphasize the importance of involving people and processes in the implementation of EDRMS, presenting a case-study that demonstrates that a centralized approach can only work in the long term if the organization effectively manages and maintains the records and information. Sataslaatten [12] discusses about norwegian government standards for implementing an EDRMS through metadata, pointing out how the lack of standardization on the format and the data it contains can lead to problems with reading and analysis.

We then considered publications in which a similar result was intended, namely, to manage structured information from a pre-existing document system, but without implementing an EDRMS. Basile et al. [13] proposed a pipeline for information extraction by Natural Language Processing to extract information from legacy document systems. Nai et al. [14] have studied how the use of commercial software such as Apache Lucene can contribute to ex-post reorganization of documentary data from court judgments.

3. State of the Art and Problem Definition

As discussed in the introduction, there are two conflicting requirements in the management of public procurement. On the one hand, orders and information must be sent in means and formats defined by law. On the other hand, for efficiency reasons, data should be maintained in a structured format.

To illustrate this conflict, consider the example of a public construction project. When a part of the work is completed, the director of the construction company usually sends a report to the public administration. This report contains information on the progress of the work, acceptance tests performed, and payment amounts. However, instead of maintaining the data in a structured format, it is usually printed in PDF, signed, and sent via email. The administration official then enters the data into an internal computer system, analyzes it, and produces new documents in response. These new documents are based on the same data, and may require additional signatures before being re-entered into the internal document system. This process involves printing and re-writing the originally structured data numerous times, which can lead to errors and inefficiencies.

Computerizing processes with workflow management systems would be an obvious solution. However, this solution faces two challenges. Firstly, legal requirements often dictate many of the steps involved in the current process, such as entering the document in the protocol or sending a request to the manager, making it difficult to waive these steps. Finding a workflow manager that complies with the legal requirements and deals with the specific types of data in the contract can be challenging and expensive. Secondly, even if a suitable workflow manager exists, implementing a complete replacement of the current system can be difficult due to political and human reasons against change: public administrations may already have a document management system in place, and they may be hesitant to change it.

4. Proposed Approach

Our work aims to address the two limitations highlighted in the previous section by proposing a new approach. To address the conflict between legal requirements and the need for efficiency, we propose to break the problem down into two layers. Legacy applications that administrations already have should continue to manage canonical document management, while records management should occur at a higher level where documents represent the persistence layer.

To address concerns about organizational change, we propose to implement the EDRMS atomically. This means that EDRMS implementation should only occur for specific processes and documents without impacting others. This approach allows organizations to gradually adopt the new system without disrupting existing processes and systems.

Overall, our proposed approach seeks to address the limitations of current systems and provide a more efficient and effective solution for managing public procurement.

According to the maturity scale proposed by Pappel, Gelashvili and Pappel [8], our approach is placed at the fourth stage, allowing structured information to be transported and parts of decision making to be implemented by automatic rules or artificial intelligence.

4.1. Persistence Layer

The persistence layer refers to the current document management systems, also known as Protocols Engine, Document Management System (DMS), Common Data Environment (CDE), Workflow Engine (WE), which are already in use and offer different features. Some systems handle simple document storage after authentication, while others provide automatic forwarding functions and interfaces for authorization flow.

The minimum requirement for the proposed approach to make sense is that these systems have two functions: the ability to upload a document and the ability to view the list of uploaded documents. The documents contained in this layer represent the entire state of the application.

Importantly, this lower layer remains fully usable by anyone directly without going through additional layers. However, it can optionally provide functions and interfaces that optimize its use from the top layer. This means that organizations can choose to use the legacy system directly or implement additional functions and interfaces to optimize its use with the proposed approach.

Overall, the persistence layer plays a crucial role in the proposed approach by providing a foundation for records management while allowing organizations to retain their existing document management systems.

4.2. Logical Layer

We then define a second layer, called logical layer, which relies on the persistence layer. The logical layer has no state, which is completely stored in the persistence layer. This layer is the core of the proposed approach, and it allows the underlying layer to be retrofitted by inserting structured data management functions. The logical layer can be used to perform any operation, and it intervenes in two stages.

When storing on the persistence layer, instead of directly inserting a document, it is possible to switch from the logical layer: in this case it is possible, according to a standardized coding, to embed structured data within a document, and only then to load it.

When reading from the persistence layer, instead of searching for information using a document approach, it is possible to make queries consistent with the encoding used. It is the job of the logical layer to return the desired information.

With respect to the first step, no further investigation is necessary, which is worth doing on the second step. In terms of the result, this is not merely a document search by structured field, but a true implementation of a documental database. If in documents of a certain type one goes to store, for example, a certain JSON object, it will be possible to query the logical layer with JSON-queries asking for projections and aggregations on the fields of the object. The important point is that the JSON is inside the document processed according to all legal requirements. In terms of process, the logical layer chooses how to work based on the level of cooperation of the persistence layer. The crudest of implementations, which involves no cooperation, is to read all the files loaded with each query, extract their structured content, return it to a queryable base, and then query it. A system with high cooperation could instead provide a standard way to store structured information, making the logical layer, in effect, a mere carrier of information. An intermediate cooperation layer, which is what we will discuss in our case study, is the one that enables caching.

5. Case Study

This work came out of collaboration with the Building Department of a large public administration in the Turin area, engaged in a public contract in the order of hundreds of millions of euros. The administration contacted us after work had begun, when the technical contract, which also regulated information systems, were already drafted.

5.1. Context

The information system in use is a CDE, shared between the administration and the builder. It stores documents of all kinds and manages document and authorization flows. With respect to some procedures, it also manages Building Information Model (BIM) data, providing customized graphical representation utilities.

Despite having a good-quality custom system, the problem described in our paper arose: some procedures that "on paper" seemed perfectly manageable with document flows turned out to be untenable in practice. The problem first surfaced with the inspection sheets. The overall construction is subdivided with two indices, one functional and one spatial; and each "construction unit" is the intersection of these two indices (e.g., the pillar in room 22). When the operator completes construction units, the testing clerks draw up inspection sheets, in which these indices are entered. The compilation process is done at the construction site, by hand, after which the scanned sheets are uploaded to the CDE. Then, at periodic intervals, the administration pays for the work done. For each declared construction unit there is a respective inspection sheet, and that it has been successful.

Obviously, the inspection phase proved gradually more complex as the granularity of the units increased: if with building works it was dozens of items per zone, with finishing and installations the number exploded.

5.2. Implementation

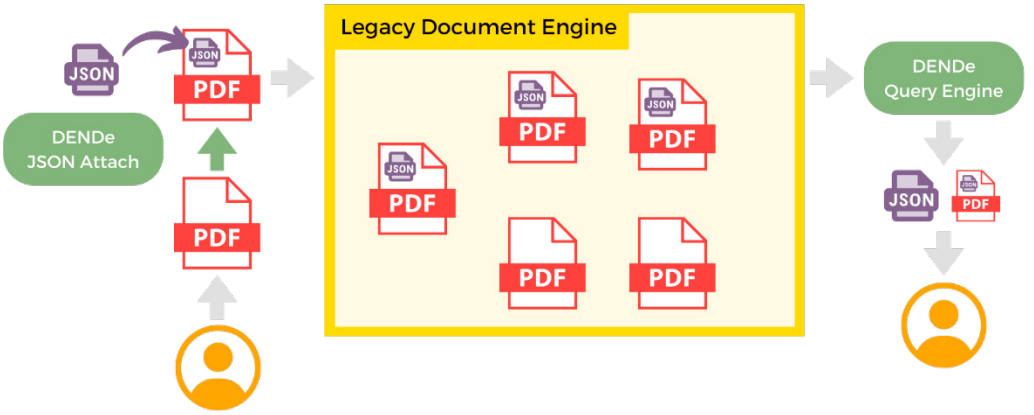

Fig. 1. DENDe overview.

Given that the builder also has a full interest in the administration carrying out the checks quickly, we therefore agreed to implement the approach described. The builder was provided with a simple interface to insert pdf metadata within the control sheets, before entering them into the CDE. In each card it is possible to insert the two indexes representing it, and a flag indicating whether the checks are all passed. A read interface has been provided to the administration, allowing them to query the CDE as if it were a document database.

The logical layer for storing and retrieving information was implemented in the DENDe (Document Engine as Nosql Database) package, which we intend to release as open-source after the testing phase is complete (Figure 1).

We conducted several preliminary tests on DENDe, involving both the contractor's staff and the contracting station staff as users. The system provided useful functions for all actors involved in the processes under consideration, and did not affect the processes carried out by other actors. It was therefore well received by all, and seems to bring good preliminary results.

6. Conclusion and Future Work

In this paper, we have analyzed the benefits of using structured data in quality management for public procurement and the main obstacles in implementing solutions that deal with them. We proposed a two-tiered approach that retrofits legacy document management systems to provide modern search and storage functions, which addresses these obstacles.

We then presented a case study of a large public construction contract where we needed to introduce structured data management without distorting the agreed document management. We implemented our approach using the DENDe software package, and we are conducting preliminary tests with users that seem to be yielding good results.

Moving forward, we plan to map the current document management systems used by the public administration in more detail and provide a better understanding of the proposed approach's architecture and how the dialogue between layers takes place. Additionally, we will report the final results of our case study.

Overall, our work demonstrates the importance of structured data in managing public procurement and provides a practical approach for implementing these functions within existing document management systems.

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