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Jan Trąbka [1]

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APPLICATION OF BUSINESS PROCESS MANAGEMENT AND ENTERPRISE CONTENT MANAGEMENT TECHNOLOGIES IN SUPPORTING QUALITY MANAGEMENT SYSTEMS – CASE STUDY

Abstract: *Extensive literature and numerous reports from business practices have shown how important the role of IT/IS is in implementing and maintaining quality management systems (QMS). The entire class of IT systems supporting quality assurance in enterprises is called quality management support systems (QMSS). The aim of this paper is to show the key role that business process management (BPM) and enterprise content management (ECM) technologies can play in modern QMSS. The article presents a case study of building QMSS based on an integrated BPM/ECM platform. The subject of the analysis is a large nationwide network of medical laboratories, possessing number of certified ISO quality systems. The analysis presents a several-year project of defining and implementing quality processes and building a digital repository of quality documents. The conclusion of the work is to show that the combination of BPM and ECM technologies can bring integration and flexibility to building quality processes and provide orchestrations of these processes.*

Keywords: *quality management system, quality management support system/software, business process management, enterprise content management*

1. Introduction

As a result of progressive globalisation, growing competitiveness is forcing companies to take new and even more effective approaches to quality management (Flynn et al., 2015). The natural way to improve the quality of the values that are generated for the customer and the efficiency of the entire organisation is to implement standardised quality management systems (QMS) such as ISO 9000. An additional benefit in competitive markets is the possibility of certifying the applications of quality management systems. Obtaining certifications improves the perception of a company on the market and, in some situations, is a critical requirement that is set by customers. Research has shown the growing number of ISO 9000-certification processes in recent years (Kharub & Sharma, 2018). However, implementing and maintaining QMS is not an easy task (Črv & Markič, 2023); it can encounter many barriers in an organisation and, at the same time, is a very time-consuming and cost-intensive process. The most commonly cited of these barriers have been bureaucracy, the lack of guidance by top management, the demands on one's time and resources, and the reactions

[1] Corresponding author: Jan Trąbka
Email: jan.trabka@uek.krakow.pl

of employees (Kakouris & Sfakianaki, 2018). Kaziliūnas (2010) listed critical factors for the success of implementing and maintaining a certified ISO 9000 system: the continuous improvement of processes, people, and systems, the reward system, teamwork, the measurement of performance, and communication. Other authors have added additional factors to the above, e.g. an understanding of ISO itself (Ab Wahid & Corner, 2009). Black (2016) identified seven main reasons for the lack of effectiveness (called "failures") of QMS. The most important of these were the following:

- lack of proper training,
- lack of communication,
- inability to integrate cross-functional interactions.

The general objective of this article will be to demonstrate (based on a case study) that an implementation of IS based on modern business process management (BPM) and enterprise content management (ECM) technologies can significantly contribute to reducing the risk of QMS implementation failure in terms of the reasons that were indicated by the cited authors above.

Numerous literature items and reports from business practices have shown how important the role of IT/IS is in implementing and maintaining QMS. In Khanam et al. (2013), the authors examined the role of IT in total quality management (TQM) in an extensive literature review, indicating the growing number of publications that have discussed the positive role of IT in quality management. Kharub (2019) identified a model of critical success factors for implementing IT-based QMS. In Cao and Alyousuf (2025), the authors indicated that the Internet of Things (IoT), business intelligence (BI), cloud computing, and distributed systems have a significant impact on the success of QMS.

There is also a reverse relationship between QMS and IT/IS in which standardised quality systems significantly improve the efficiency of IT companies and the entire ICT industry (Stefanovic et al., 2010).

The entire class of IT systems that support quality assurance in enterprises has been called quality management support systems/software (QMSS). These systems provide transactional and feedback information, facilitate communication, and accelerate the implementation of the changes that result from quality management. QMSS was created and has been implemented for many years. Due to the increasingly dynamic development of technology and IT systems in recent years, QMSS must also be modified to use the new opportunities that are provided by IT/IS.

Over the last two decades, a key role has been played by the concept of process – both in quality management methods and other modern management methods such as BPM (Stojic et al., 2024). Currently, the concept of process also dominates the IT/IS field. A parallel and important trend in IT has become the implementation of content management methods in an organisation – enterprise content management (ECM).

Specifying the general objective of the work, the use of BPM and ECM methods and techniques in creating QMSS that will better contribute to breaking down the barriers to implementing quality management systems in terms of communication, sharing quality information, and integrating quality processes with other processes of an organisation was examined. This paper poses two specific research questions:

RQ1: *Can ECM-based QMSS have any impact on improving the communication and distribution of quality information?*

RQ2: *Can BPM-based QMSS ensure the broad integration of quality processes with other cross-functional processes of an organisation?*

The subject of the analysis was a large nationwide network of medical laboratories that had a number of certified ISO quality systems. The analysis concerned a several-year project of defining and implementing QMSS – in particular, handling quality processes and building a quality content

repository based on ECM/BPM platforms.

The article has the following structure: the introduction is followed by the second section, which presents BPM and ECM methods and technologies that can be used to build QMSS. This will be followed by a section that describes the case study as the research methodology that was used in the work. The case description consists of an organisation's profile and assumptions of the project of building QMSS. The main characteristics of the undertaken action in the case study are divided into three parts: the first part presents the evolutionary digitisation of documents and quality content, the second part describes the implementation of quality processes using BPM technology, and the third part focuses on the orchestration of the processes, which was achieved thanks to BPM in the area of complaint handling. The discussion of the work includes answers to the research questions and other conclusions that were reached during the observations. In addition, the aspect of IT/IS cost optimisation in quality management is also discussed. The summary presents considerations about further technologies that should be included in IT/IS while supporting quality management.

2. Theoretical and Technological Frameworks

2.1. BPM Technologies

Business process management is a systematic, cyclical, and structured activity where the process changes occur step-by-step (Elzinga et al., 1995). The set of steps of the process management cycle were presented by Dumas et al. (2018, p. 6) in their proposed definition: "*BPM is a set of methods, techniques, and tools for identifying, discovering, analysing, redesigning, executing, and monitoring business processes in order to optimise their performance*". Is the basic theoretical framework of process management called "BPM Lifecycle". Information technologies have become the basis for the effective implementations of business processes from the very beginning of their existence (from the 1990s) in science and practice. Van der Aalst (2009) introduced the term for the entire class of process-aware information system (PAIS). Initially, this group included integrated systems of the manufacturing resource planning (MRPII)/enterprise resource planning (ERP) class. According to van der Aalst, they were insufficient to fully support process management and cyclical process management due to their lack of flexibility. Their modifications required time-consuming and cost-intensive programming work. He pointed to the need to create more technologically open and flexible systems, the domain of which would be the designs of processes by users and their quick launch within an organisation. This idea was implemented by the workflow management system (WfMS) and defined by the Workflow Management Coalition (2025). The basic feature of WfMS is the ability for a user to define a process (usually, in a graphical modelling tool), which will then be executed by the process engine in the form of tasks that are distributed to subsequent implementers or other IT systems (orchestration). In addition to the process modeller and the process engine, other components of WfMS are a process repository (used to store the history of all of the tasks that are performed) and a task list (used to display the tasks to the user for execution). A diagram of the workflow components is presented in Figure 1. WfMS systems provided the flexibility required to implement a process approach; however, they needed to be significantly expanded to effectively support a BPM lifecycle; on their bases, business process management systems (BPMSs) were created. The following elements were added to the components that were known from WfMS:

- simulations processes,
- operational monitoring and controlling processes,
- possibility of close integration with other organisational systems,

- ability to control processes performed fragmentarily by other organisational systems (process orchestration and choreography),
- rule engines.

"*BPMS is a system supporting the design, analysis, implementation, and monitoring of business processes based on explicit process models"* (Dumas et al., 2018). In the development of BPMS, the standard process modelling language business process model and notation (BPMN) plays a vital role. The first version of the standard was published in 2004. (Object Management Group, 2007). This language is used for a graphical presentation of the process and is a tool for analysis and communication among people managing processes. At the same time, it is an "executable" language, i.e. it allows for the direct control of the process engines of BPMS systems. Currently, most BPMS tools use BPMN.

2.2. ECM Technologies

The concept of enterprise content management was proposed by the Association for Intelligent Information Management (AIIM) in 2000. The ECM concept has evolved over the years under the influence of changes in methods and, above all, in information technology. The current version of the definition is as follows: "*it is a dynamic combination of strategies, methods, and tools used to capture, manage, store, preserve, and deliver information supporting key organisational processes through its entire lifecycle*" (AIIM, 2025). Previous versions emphasised and clarified the concept of "content", indicating that it is unstructured information, in any electronic or traditional form, that is processed anywhere in an organisation (Trąbka, 2013). Over the years, the ECM technology area has combined technologies for managing various forms of unstructured information. This conglomerate consists of following technologies: document image processing (DIP), electronic document management systems (EDMS), electronic records management systems (ERMS), digital asset management (DAM), web content management systems (WCMS), social content, and content workflow. The description of the evolution of ECM technology together with a broader characteristic of its individual elements can be found in the work of Trąbka (2024). Analysing the structure of the latest ECMS, their main component is the content repository, which is a metadata database of stored content/documents. Each set of metadata is connected to the source file in any form, which is stored in an encrypted form in a specially created catalogue structure. For efficient content search, ECMS has indexing services and extensive sets of library services: versioning, check-in/check-out, collaborative document work, audit trails, tagging, cataloguing, full-text search, record management, and content/document process handling.

It is worth noting that the last-mentioned technology – content workflow – is the basic BPM technology (see the previous subsection). This idea has a practical significance, because, both technologies are treated synergistically (as is shown in the next subsection); this led to the creations of integrated ECM/BPM platforms.

2.3. Integrated ECM/BPM Platforms

Despite the fact that ECM and BPM are separate IT areas, there is an increasing debate about the need to combine these approaches in terms of the technology (Mendes & Bax, 2018). The cited authors listed several serious disadvantages of separately developing ECM and BPM initiatives in an organisation. The lack of an integration of these approaches leads to a significant reduction in the potential of change management in the organisation. In the described situation where separate ECM and BPM teams conducted independent work on optimising the organisation's processes, the phenomena of duplicating goals, resources, and competencies may occur.

These phenomena lead to the creation of partially overlapping/duplicating and redundant solutions. These solutions can lead to storing the same contents in different IT systems – the lack of a single source of truth (SSOT) in the organisation. From a technical point of view, the lack of integration between BPM and ECM solutions excessively complicates the corporate IT architecture and generates unnecessary costs of implementing and maintaining separate solutions. The trend towards creating integrated ECM/BPM platforms is also visible in the market, where suppliers such as IBM, Microsoft, Oracle, and Hyland offer cooperating components that support contents and processes. It is worth emphasising that the type of process called content-/document-centric (which is characterised by focusing on the creation, management, and distribution of contents and documents) is dominant in some areas of the company's operations. The area of quality processes that are described in this article is the best example of content-/document-centric processes.

The basic idea of the ECM/BPM platform concept is the combination of components that support contents (ECM) and processes (BPM).

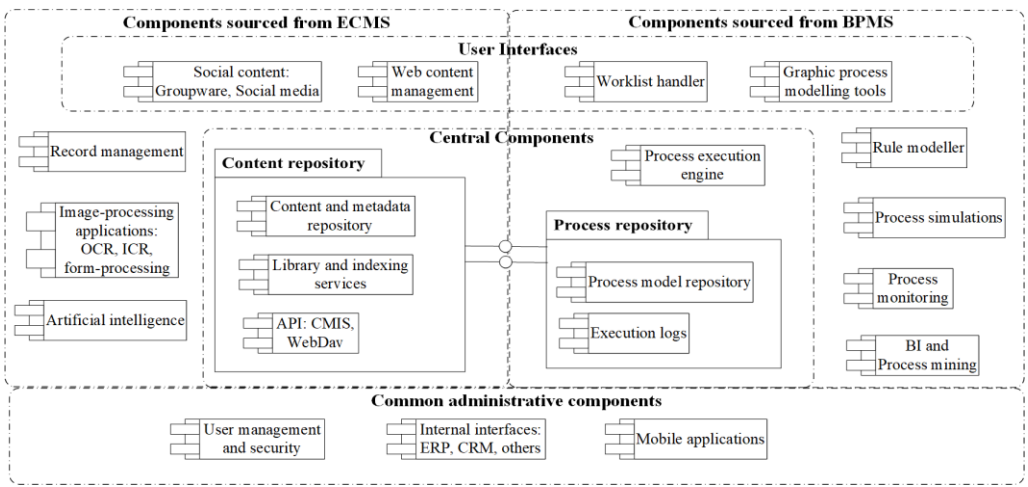

Figure 1. Integrated ECM/BPM platform (component diagram) – based on (Trąbka, 2024)

The basic assumption of the proposed structure is to connect the components that support content (ECM) and processes (BPM), which have existed independently thus far. The proposed structure of the ECM/BPM platform components is presented in Figure 1. The proposed structure is divided into two main parts: components that have been sourced from both BPMS and ECMS. The central element of the ECM/BPM platform are the components that support workflow processes: the process execution engine, and the process repository. The processes that are carried out by these components will create the content and store it in the next central component – the content repository. Both of the central components have efficient bidirectional interfaces (based on microservices). The Worklist handler component is responsible for displaying the user's tasks that resulted from the active processes on their screen. When combined with the web content management technology and social content support. This component would constitute the main user interface of the ECM/BPM platform (marked as the User Interfaces group in Figure 1); the remaining components and additional services that are included in the platform come from both technologies, but the microservices technology allows for their free sharing. A detailed description of the ECM/BPM

platform concept and its individual components can be found in Trąbka (2024).

3. Research Methodology

In order to answer the research questions that have been posed in this work, the author used a qualitative research approach – primarily, a case study methodology, which provides tools for examining complex phenomena in their real and full environmental context. This was designed as a descriptive case study, which offers a rich and nuanced understanding of a situation according to Yin (2018). This type of case study is particularly useful for building theories and exploring complex situations where a deep understanding of a specific case is paramount. In this article, the author described a several-year project of building an IT system in a large organisation in the medical industry. The main interest focused on the motivation for undertaking the project, the strategic decisions that were made during it, and their accuracy (which was assessed after completing the system).

A characteristic feature of case study research is the use of multiple data sources – a strategy that also increases the credibility of data and results (Patton, 1990). In this case study, the author broadly used participant observation, as he was directly involved in the project that was described above. In addition to the observations, the implementation documentation, created process models, and screenshots that presented the system were also used.

4. Case Study Characteristics

The company that was the subject of the case study is a network of diagnostic laboratories that operate throughout Poland; it consists of more than 150 diagnostic laboratories and over 1000 collection points. The company employs more than 5000 employees. As a medical company, it has several certified quality systems: a quality management system PN-EN ISO 9001:2015 (Polski Komitet Normalizacyjny, 2016), a medical quality and competence system for laboratory activities PN EN ISO 15189:2013 (Polski Komitet Normalizacyjny, 2013) and PN-EN ISO/IEC 17025:2018 (Polski Komitet Normalizacyjny, 2018), and an information security management system PN-EN ISO/IEC 27001:2023-08 (Polskie Komitet Normalizacyjny, 2023). These management systems played an important role in defining the requirements for the digitalisation project of the document flow system. The quality information for all of the standards that were indicated above consisted of more than 150,000 documents. The company has a very extensive organisational structure that consists of more than 1500 units that are located throughout the country. In the financial and administrative area (incoming correspondence only), these units process tens of thousands of documents per month. Apart from the mentioned financial and quality areas, the remaining areas that were covered by the project were the HR processes and the legal areas. Taking the above organisational parameters and the complexity of the processes into account, it became obvious that the management board undertook a project to build an "electronic circulation of documents and matters" – the aim of which was to digitalise and automate the processes in the areas that were indicated above. After almost a year of searching for and selecting a platform and supplier, it was decided to use an open-source ECM system from Alfresco (currently, Hyland) with an integrated Alfresco BPM Activiti component. The adopted solution was to use a universal platform for the gradual handling of processes in the individual areas of the project. The process areas were implemented one after another in order to minimise the technological risk and to gradually accustom the staff to the new tool and work methods. Firstly, the financial and correspondence area was initiated; then, the quality area was designated for implementation. Each area was an independent stage of the project; each consisted of a system analysis,

implementation, final testing, and launch. The average implementation time of a single area was two years. In the following sections of the paper, the focus was only on the digitalisation of the quality area. The created solution was called QMSS, which was built on the ECM/BPM platform.

5. Undertaken Actions

5.1. Quality Content – Evolution

Partial Digitisation

The initial situation that was described in the previous section (in particular, the large number of quality documents that were processed in the organisation) resulted not only from the number of standardised QMS that were used but mainly from the fact that the quality documents were officially stored in "paper" form. The official form meant that only paper documents were allowed for circulation and audits. An additional reason for such a large number of documents was the very extensive organisational and location structure of the company. Each laboratory unit (more than 150 in total) is in a completely different location in the largest Polish cities. The same applies to collection points; of these, there are currently more than 1000 (which are also scattered throughout Poland). Each of the above-mentioned organisational units had its own document repositories that were stored in paper form in a physical location. The source quality documents were created by quality specialists in electronic form (MS Word text editor files). Due to the lack of a publicly accessible central repository, however, the documents were then distributed and printed in units where they were stored in paper form (in physical rooms and document cabinets). This approach radically increased the labour and cost intensity of distributing and updating the documents as well as increased the risk of outdated documents appearing in circulation.

The documentation of quality systems is not only procedures and instructions that are created centrally but also many documents that are created on-site in the laboratory units (quality records, corrective and preventive action cards, etc.). In this respect, the paper form of storing documents did not allow for their easy central control by quality specialists. The first step in the method towards digitising the collections of the quality documents was to use shared space on network drives and create a tree-like directory structure. This solution limited the number of copies of the documents that were stored locally or sent by e-mail systems. However, this solution presented many disadvantages, including the following:

- no search mechanisms,
- no information about relationships between files (e.g. main document and attachments),
- no interface for accessing document content (document browser),
- security and permissions problems in large network structure.

Due to the above-mentioned problems, this stage of the digitisation was called partial digitisation.

Quality Content Repository

The main assumption of the project that is described in this paper was to create a central quality content repository (QCR) on the technological basis of the ECM/BPM platform. As mentioned earlier, the qualitative area was only one of the elements of the project of digitising many areas of the analysed organisation's activity. The ECM/BPM platform from Alfresco that was selected for the creation of QMSS has a central content repository with a set of library services (see Sub-section 2.2). A diagram of the components and the content services of the ECM/BPM Alfresco platform is presented in Figure 2.

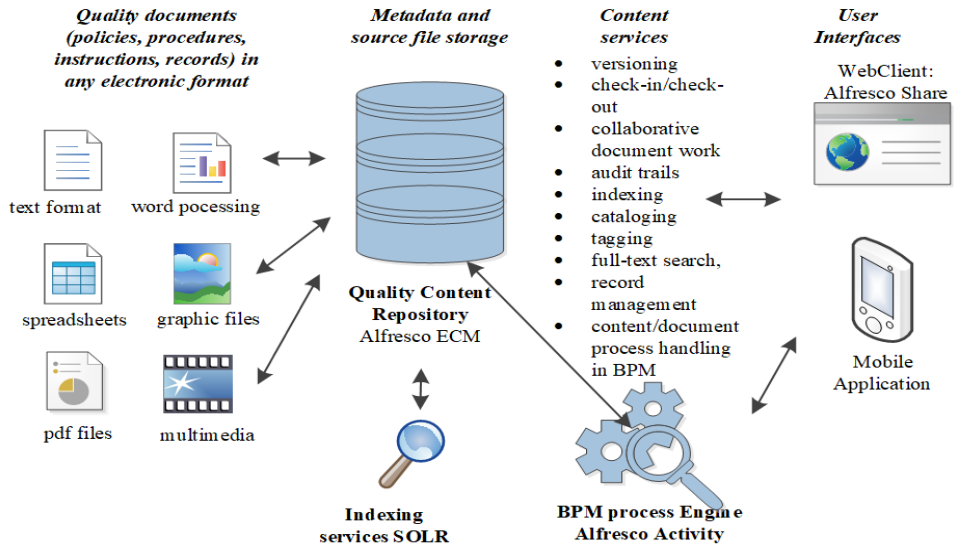

Figure 2. Quality content repository built on ECM/BPM platform

At the same time, the ECM/BPM platform had a web access application called Alfresco Share. The access application could be expanded by using native Alfresco programming components, JavaScript, and CSS. Based on these technologies, the platform provider created a dedicated module called "Quality"; in this module, sets of forms for entering data about documents is possible, along with the possibility of managing them in the form of a register (Figure 3).

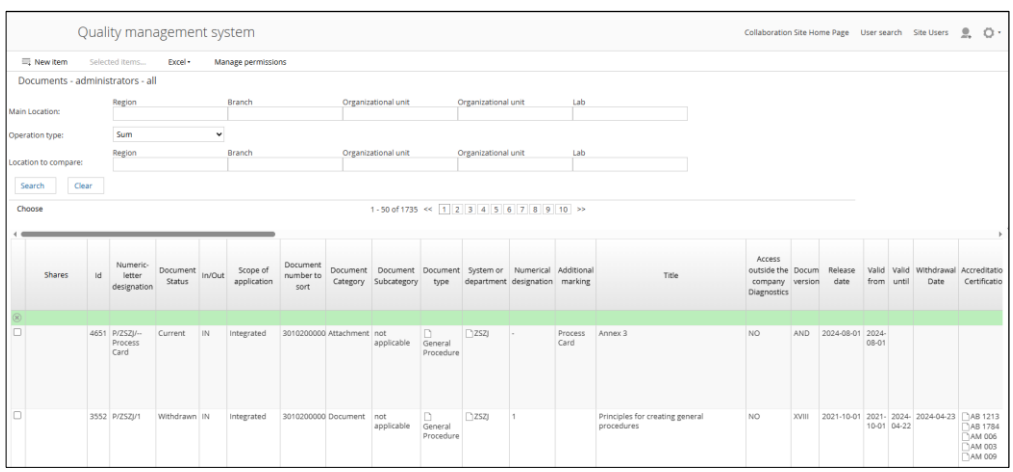

Figure 3. Register of quality document – QMSS form

At this point, it is worth defining the concept of the quality content that is stored in the repository – these are sets of metadata about the quality documents that are stored in the database (e.g. policies, systems, procedures, instructions, records, audit reports, etc.); these are linked to the original source files and stored in a special encrypted structure of folders and files (which is also part of the repository). Documents can take practically

any electronic format, such as text, word processing documents, graphic files, pdf files, spreadsheets, sound files, and multimedia. The set of standard metadata about a document can be extended based on content models depending on the defined document types. Content searching in the repository can be performed using individual attributes that are described in the metadata (Figure 3). The ECM/BPM platform also provides full-text search capabilities directly from the text of the documents. Efficient full-text searches are possible thanks to the SOLR indexing service; this indexes all original files, while graphic files (such as pdfs) are processed in the optical character recognition (OCR) service (which recognises the text layer before placing the document in the repository). Thanks to this, graphic files can also be searched for in full text by their contents.

Versioning is a very useful service in the processing of qualitative documents. Subsequent versions (created automatically) build a history of document creation and modification with the possibility of restoring older versions and comparing them with each other.

In terms of authorisations to access to the content that is stored in QCR, an "Organisational Structure" module was created in the discussed project. This module stores information about each organisational unit and the current assignments of the individual employees to them. This module is connected to the human resource (HR) system. In the organisational structure module, it is also possible to define one's own user groups and assign defined roles to them. Thanks to this functionality, so-called distribution lists are created, which define to which group of employees a single quality document is dedicated. The distribution lists are the basis for the process of distributing quality documents in the organisation; this will be described in the next section.

Built on the Alfresco ECM, QCR meets security requirements and complies with record management standards for the central storage and sharing of documents among the several-thousand-employee organisation; additionally, it is deployed in several hundred locations throughout Poland. As mentioned earlier, user access to the contents and processes is implemented through the Alfresco share web application. User verification and authentication is ensured by direct user synchronisation with the company's central domain system. User service is provided via the secure shell (SSH) protocol. It is worth noting that Alfresco meets records management and open government compliance standards worldwide, including ISO 15489, ISO 16175, US DoD, and MoReq (Skytizens, 2025).

In summary, the creation of QCR based on ECM technology provided the basis for the full digitisation of all of the quality content. It was possible to completely eliminate the paper forms of the documents, which significantly reduced the costs and time-consuming maintenance of QMS. Quality department was given the possibility of the central distribution and control of the acceptance of procedures and instructions for use by individual employees (which was impossible until now). For the employees themselves, system access to the quality documents marked a completely new era. Each employee received current and ergonomic access to medical procedures, instructions, or even instructional films. When communicated in such a form, quality information has the chance to be used on an ongoing basis in the activities of the employees.

5.2. Quality Processes

Quality processes in medical enterprises represent an area that consists of the following detailed processes: document control, corrective and preventive action tracking, auditing, training and competence records, equipment calibration and maintenance, custom management, and supplier management (Woodcock, 2005). The

owners of these processes are managers and employees of the quality departments of an organisation. The digitisation of the above-mentioned processes will definitely increase the efficiency of these departments; above all, however, it will reduce the cost of maintaining QMS in the organisation. Quality processes should be supported by QMSS. It is worth noting that equipment calibration and maintenance processes are very often implemented by systems that are supplied directly by the manufacturers of laboratory equipment. In such a case, it is important to create interfaces between QMSS and the software of the laboratory devices.

In the discussed case study, the following processes were included in the digitalisation of the quality area:

- creating and updating quality documents,
- supervised delivery of quality documents,
- support for preventive and corrective actions,
- handling complaints,
- audit service.

The implementation of a repository that is based on ECM technology ensures the secure storage and sharing of all types of quality management system content but does not provide process support for creating, updating, and delivering documents and their supervised confirmations. The listed processes were implemented in the QMSS in the above-mentioned BPM Alfresco Activity component. This component has a characteristic structure that is consistent with WMC recommendations for workflow systems (see Sub-section 2.1). The BPM components that were used in the discussed case included process models, a process engine, and process repositories. A characteristic element of the workflow system structure is the task list, which was connected to the Alfresco Share user interface in our case. Thanks to this, the users have access to both the quality contents and the quality processes in this common environment for the ECM repository and the BPM components. Since the processes that were described in the quality area are content-/document-centric, the principle is that each document from the repository is delivered by defined and executed processes in the BPM components. The quality content repositories that were described in the previous subsection only provide access to documents, while their creation and modification are always carried out through defined processes. Such a mechanism provides a process history of each document, indicating what tasks were performed on the document (as well as when and by whom). In order to present this idea clearly, the process of creating and delivering all types of quality documents (rules, procedures, instructions, or quality records) will now be described. This is definitely the most important and most complicated process in this area. The process involves the quality department (a central quality officer and QMS specialist), the substantive and system (ensuring the compliance of the contents with the appropriate ISO standards) authors of the documents, the organisation's management, and (above all) all employees of the organisation. Employees are the internal customers and final beneficiaries of this process, as they receive the content of the document, familiarise themselves with it, and confirm its acceptance for use. It can be assumed that even several thousand users can participate in a single instance of the process. The process is very complex, which is why it is shown as a series of subprocesses at the highest level (Figure 4).

The process diagram was presented in the BPMN language, which is used in the discussed ECM/BPM platform for both the modelling and executing processes in the process engine. In the following part, selected subprocesses are presented and characterised in detail.

The process begins with the need to create or update a quality document. The QMS specialist begins the document initialization subprocess (Figure 5) by entering the document metadata (so-called document

metrics) into QMSS. Then, the appropriate document template is attached, and it is determined who will create the substantive and system content. The next important task for the QMS specialist is the creation of a distribution list, which indicates the organisational units in which the document will be valid.

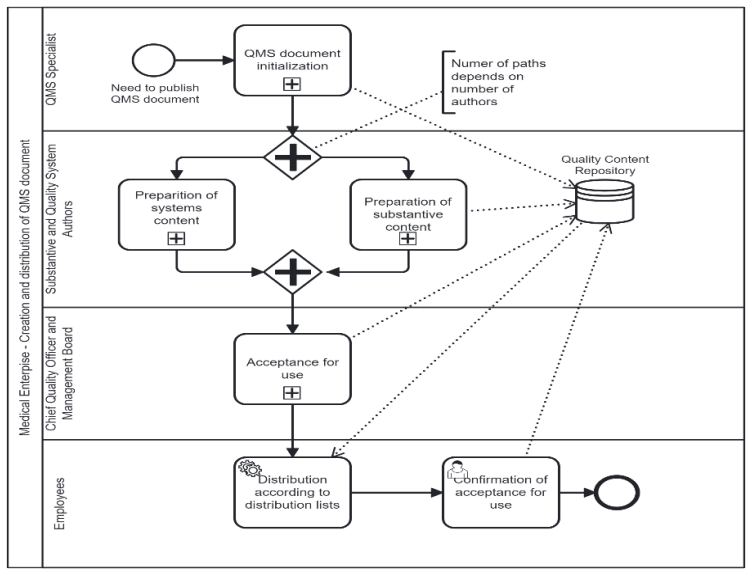

Figure 4. Creation and distribution of QMS document – BPMN diagram

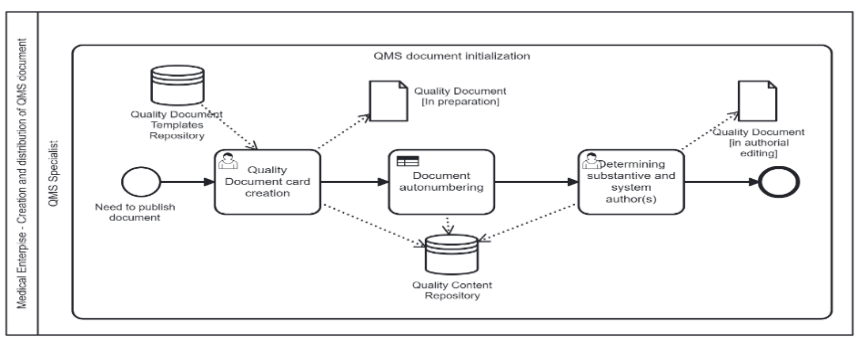

Figure 5. Subprocess QMS document initialisation – BPMN diagram

In the QMS document-initialisation subprocess, the system number of the document is automatically assigned depending on its document type. The document is saved in QCR under this number; this is the end of the subprocess. Next, QMSS starts parallel subprocesses of creating substantive and system content. The tasks from these subprocesses are directed to the authors that are indicated in the metrics (of whom there can be any number). In the diagram of the "creation and distribution of QMS document" subprocess (Figure 4), this was illustrated by the symbol of a parallel gate with a comment. The preparation of the QMS document subprocess showed the authors' work on the content of the document. The process diagram is presented in Figure 6. For this purpose, the authors use the MS Word editor; because the document is stored in QCR, however, they can use ECM services such as versioning, check-in, or check-out.

While editing the document, the authors can also add attachments in various formats. In such a case, the repository remembers the relationship between the main document and each attachment. It is important to emphasise that the ECM repository provides a mechanism for controlling simultaneous work on a document by multiple users. Thanks to its integration with Google, Microsoft, or OnlyOffice services, the ECM Alfresco repository ensures the parallel work of multiple users.

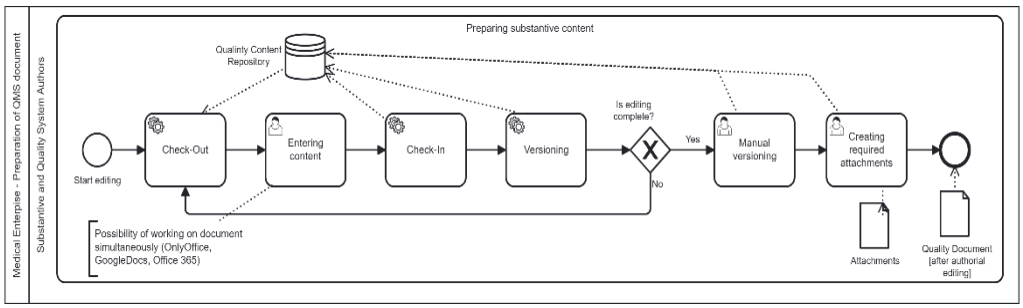

Figure 6. Subprocess preparation of QMS document – BPMN diagram

The subprocesses of all of the authors are executed in a parallel loop, which means that the system will begin further task executions only after all of the subprocesses are completed; in this case, it will begin the "acceptance to use" subprocess. The process of acceptance is performed sequentially by the people who are indicated in the initiation subprocess; these are most often the CQO and members of the organisation's management board. After its acceptance, the document is ready for distribution to the employees. The selection of specific employees (QMSS users) is performed using the organisational structure module (described in the previous subsection). The company's organisational units (indicated in the distribution list) are automatically converted into groups of specific users to whom the tasks of familiarising themselves with the document will be directed. It is worth adding that the company's organisational structure has five levels: regions, branches, laboratories, departments, and collection points. The automatic procedure creates a set of users and assigns each of them the task of familiarising themselves with the document. The user receives a task, which includes the main documents and all other attachments to this document. The user can read the content of the document on the screen, download it, or print it. The task form is presented in Figure 7.

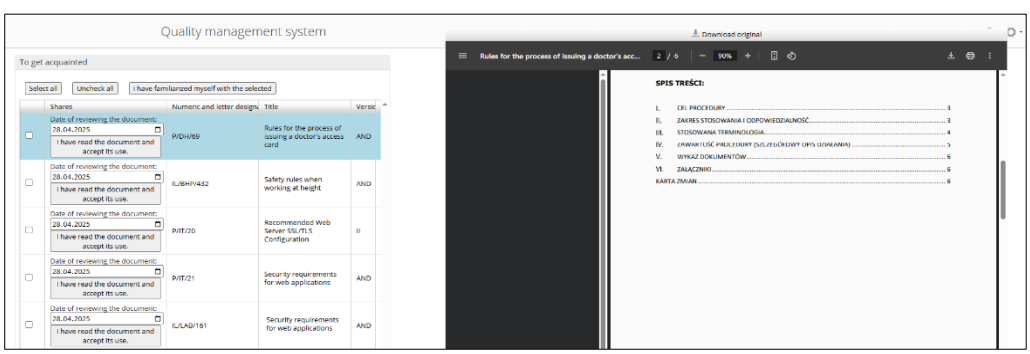

Figure 7. Task **"**Confirmation of acceptance for use" for individual employee – QMSS form

The most important element of the task is a declaration of familiarisation with the content of the document and its acceptance for use. The completion of the task by the user is recorded in QCR; on its basis, the quality department keeps records and reports, which present who familiarised themselves with a given document (and when). A matrix mapping is created in the system (the number of employees times the number of documents); from this, it is possible to report which documents an employee familiarised themselves with or which employees familiarised themselves with a given document. In a situation where an employee has not familiarised themselves with the given documents, the escalation mechanism reminds them of this necessity and subsequently informs their superior(s) and the quality department about this fact. This type of report is used by quality system auditors, who control the accredited organisational units. The preparation and implementation of the process of creating and distributing QMS documents took two years and required multiple optimisations of the entire system's performance due to the huge amount of processed data. The achieved level of digitalisation and auditability of the entire process guarantees its credibility in an organisation of such a scale as the one that was described in the case study.

5.3. Process Orchestration – Complaint Handling

The complaint process in the analysed case was very complex to digitise even though it consisted of three steps: registration, resolution, and closure (Figure 8). Its complexity came from two factors: firstly, a complaint can be reported through many channels (traditional and electronic). People who can file complaints are primarily external participants in the process (patients and medical partners), but internal participants are also file, i.e. company employees, sales representatives, and customer service employees. Secondly, a complaint must be carried out at the place where the reported problem occurred even though its consideration can be registered through many channels and from any physical location. In the first case, the complaint must be resolved at the collection point if the complaint concerns the handling of the material-collection process. In the second case, the complaint must take place in the laboratory that performed the test if its consideration concerns the test result. An additional complication is the fact that a single complaint may concern tests that are carried out in different laboratories (often, in different parts of Poland).

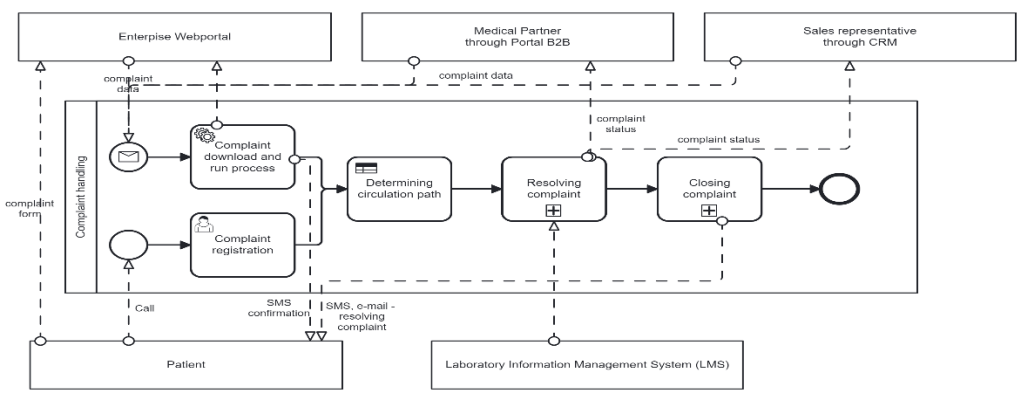

Figure 8. Complaint handling – process orchestration (BPMN diagram)

The complaint process is coordinated by the quality department. The complaint process was implemented at end because the organisation had a dedicated system that supported the complaint process up to that point. However, this system did not have the technical capabilities of exchanging data with other systems and was no longer supported by the manufacturer. These shortcomings led to the decision to replace it as part of the discussed project. Since the complaint process required communications among several systems (Figure 8), a QMSS system that was based on an open ECM/BPM platform became the optimal place for its implementation. Openness is understood as having publicly available, described, and usually free interfaces (APIs) that enable the connections of different systems.

Recently, there has been a lot of discussion about process orchestration in the context of BPMS; this is defined as the (external) coordination of various tasks and processes – both automatic and manual (Ruecker & Strauch, 2025). Orchestration improves end-to-end processes – especially when individual tasks in the process are performed by different IT systems. An example of this was the complaint process in the discussed case. The process could be initiated by a patient or a medical partner (doctors, medical centres, hospitals) who ordered tests for their patients in the network of laboratories of the analysed company. The process could also be initiated by a sales representative (an employee of the analysed company) who handled the sales process for larger entities and institutions (e.g. large hospitals, large employers, etc.). Patients could submit complaints in person, by phone at the customer service office or via a form on the organisation's main web portal. A dedicated B2B portal was created for the medical partners, where they could receive test results, order them, control settlements, and submit complaints. The B2B portal was equipped with a set of forms and procedures for this purpose. Sales representatives who take care of institutional clients use the CRM system on a daily basis.

In order to not force them to learn and operate QMSS, it was decided to create a bidirectional interface between this system and the CRM. QMSS acted as an orchestrator here in which the main subprocesses of the complaint handling were carried out. As shown in Figure 8, the complaint process has two initial events: the first event shows the transfer of data from the above-mentioned systems to QMSS, which are then automatically validated; then, the process is launched in the BPM process engine. The second event shows the filling out of the complaint form directly in the QMSS system by a call centre employee, medical employee, or quality specialist. Based on the data on the type and location of the complaint, QMSS then directs the complaint-handling tasks to dedicated people in the individual organisational units. The subprocess is intended to clarify whether the complaint is justified or not and what was done incorrectly (and where) in a given case. The employee who resolves the complaint may ask for consultations from any person in the organisation (the consultation task on the diagram). The last subprocess is the closing of the complaint by a person with appropriate authorisations (usually, the head of a laboratory or collection point). At the same time, a response is prepared for the patient, which is sent via e-mail or text message. During the complaint handling, the patient, medical partner, and sales representative are kept informed on an ongoing basis about the changing status of the complaints that they have registered. In technical terms, QMSS sends feedback via interfaces about the complaint status to the systems from which the complaint was received. An example of this process shows that a QMSS system that is based on the ECM/BPM platform can be a tool for process orchestration – especially in a situation where quality processes require communication with many other systems in the organisation.

6. Discussion

An assessment of the use of the ECM/BPM platform as a basis for building a QMSS system has shown an efficient path to the full digitisation of quality content, which is mostly an unstructured collection of information. The use of ECM technologies and services provides an efficient and secure place to store all types of content in one central repository. Employees receive ergonomic access to this information from many hardware and system platforms; this provides ongoing and time-unlimited access to information from QMS. This refutes the accusation that quality documents are "shelf" documents that no one uses because they are difficult to access. QMS requires central supervision over the creation and control of the effectiveness of delivering quality content. The presented case study showed what role BPM technologies can play in this respect, in which such processes can be freely defined and flexibly adapted to the organisational structure and procedures that function within it. Built-in BPM mechanisms provide full control over the implementations of the individual tasks that are performed by employees. The implemented solution allowed to maintain and control 2500 quality documents (from all QMS applicable in the organization) in the ECM repository, instead of over 100,000 paper documents circulating in the quality area. The system remembers all familiarizations with documents (2500 docs. x 5000 employees equals 12.5 million familiarizations). The role of QMS specialists was limited to reporting control of familiarization with documents, which in the past, despite the huge amount of work, was impossible. Savings resulting from introducing QMSS on the ECM/BPM platform led to significant savings of time and costs of maintaining QMS.

Undoubtedly, we use the technologies that are described in the work for areas of a company other than quality processes. In this aspect, a huge advantage of building a QMSS on a universal and open ECM/BPM platform was noticed. The practice that had been used in companies was to purchase ready-made systems that were dedicated to supporting quality management. Such a stand-alone QMSS must be integrated with many other organisational systems, such as ERP, CRM, or workflow/BPMS. In the discussed case study, the ECM/BPM platform was used in parallel to support financial, correspondence, HR, and legal processes. The previously mentioned processes also required interfaces to other organisational systems that were mentioned earlier. QMSS that is built on the ECM/BPM platform can share these interfaces, which will radically affect the costs of implementing and maintaining the entire solution and significantly simplify the organisation's IT infrastructure. It is worth emphasising that all ECM/BPM platforms are equipped with open interfaces based on open, available, and described protocols.

Referring directly to the second research question, the use of open platform interfaces and the possibility of process orchestration (to which BPM technologies are dedicated) allowed us to support the complaint process that ran between many functional areas and many information systems in the analysed case. Analysing the effectiveness of the complaint process, it should be noted that in the previous non-integrated system, only about 200 complaints were registered per year (the rest were handled in an uncontrolled manner, apart from QMS). In the presented solution, an average of about 4000 complaints are resolved annually.

Another observation from the analysed case is the reference to the costs of purchasing and implementing QMSS. When purchasing ready-made systems, organisations are exposed to high license fees. In an organisation with the scale of operations that is discussed in the article (more than 5000 employees, each of whom needs to have access to the system), the scale effect means that the budget for such a project becomes a barrier. Such a high budget is only intended to support one area of the company's operations – the quality area – which causes

resistance from decision-makers. ECM/BPM platforms are universal and can be used to build processes for any areas of an organisation at the same time. In the discussed case, the platform-implementation budget was spread over several areas (mentioned earlier). Due to this, the costs and effectiveness of such a project are perceived completely differently. An additional issue is the fact that the used Alfresco platform is one of the few open-source enterprise-class solutions. This aspect led to a situation where the estimated cost of implementing several process areas (including the quality area) was an order of magnitude lower than in the case of offers from other suppliers.

7. Conclusions

The conclusions from the case study confirmed that the use of the ECM/BPM platform in the implementation and maintenance of QMS improves communication, modernises the forms of information delivery, and affects the better perception and current use of quality systems. The use of ECM and BPM technologies provides technological modernity, ergonomics, and efficiency while at the same time providing economic efficiency. The above technologies are constantly developing quite dynamically; therefore, it should be expected that the QMSS that are built on their bases should also incorporate technological novelties. Looking at the future development of systems that support quality management, the use of artificial intelligence (AI) should be considered – both in content management and quality processes. In content management, the possibility of using large language models (LLM), trained on quality content, should be investigated, as these systems could provide contextual answers about specific steps of medical procedures, required test parameters, etc., without using specific documents. LLM can also support the editing and, in particular, the updating of quality documents based on the existing resources of quality repositories. In the context of the process, the application of AI can be used in the recognition and categorisation of complaints that come from various sources. Using intelligent decision tables, complaints could be automatically sent to those people who are responsible for their resolutions. The development of QMSS towards the use of artificial intelligence will be the subject of the author's next works.

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Jan Trąbka
Krakow University of
Economics,
Krakow,
Poland
jan.trabka@uek.krakow.pl
ORCID 0000-0002-7616-6379