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Case Management versus Workflow Systems in Healthcare

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Abstract
As healthcare and care management is a people-centric endeavor, the processes and workflows involved are ripe for efficiency gains. One historic business approach to streamlining processes is using workflow or business process management systems and techniques. A process is defined as a set of steps, or tasks, that are undertaken to get something done. In business, processes are typically divided into core and support processes, with core processes being the primary value creation processes while support processes are there to allow the primary processes to be complete. A similar division of healthcare processes exists involving organizational and medical treatment. Within these classifications are several subcategories of processes that tend to split along complexity and repeatability lines. Business process management has a similar division of processes, called production processes and knowledge-intensive processes. Over time, two different approaches to handling these processes have evolved: workflow management systems and adaptive or dynamic case management. Given how the split in business processes parallels the separation in health care processes, we argue that workflow and case management techniques and tools can efficiently solve similar problems in the health care domain. This paper provides a comparative analysis of the classical workflow-systems versus case-management techniques. To illustrate their specific advantages in a practical way, we demonstrate how they can or have been applied to sample processes, such as radiology, telehealth management, and care coordination.

Keywords: Case management; Workflow system; Group processes; Patient care management

Introduction

Healthcare and care management is a people-centric endeavor that requires specialized knowledge to deliver critical care to patients. In this environment, systems need to support this mission by assisting and automating work where possible while allowing the clinician and care delivery teams the autonomy and flexibility in reacting to conditions observed throughout the care delivery process.

Businesses have struggled to meet similar needs in automating processes when possible and offering flexible support to users when a strictly defined process is not feasible. Their solutions define a set of core process types based on business value creation [1], dividing work into core and support processes. Core processes represent the primary value creation work and support processes are there to allow the primary work to complete [2].

In addition to the business value-based division, a secondary breakdown of processes has centered on the repeatability, flexibility, and knowledge requirements [3]. These have resulted in the development of complementary approaches to process management that include workflow management (WfM), business process management (BPM), and adaptive case management (ACM).

Based on our research, we noticed that a similar division of processes can be applied in a health care scenario, with the processes closely aligning to both the value-based division and the secondary breakdown defined above.

In order to facilitate the development of efficient health care systems we assert that it is important to identify the specific types of processes needed in such systems and based on that to identify which techniques are best suited to which process types in healthcare. So, considering these, we have started our research from the following two research questions:

RQ1: Which are the main classes of processes existing in the healthcare, and how are these related to the general process classification criteria?

RQ2: Which are the most appropriate techniques that could be used efficiently for each kind of these processes?

In order to answer to this research questions we first identify structured classifications based on well defined criteria and then analyse which of the two main techniques (WfM) and (ACM) could be efficiently applied to the specific classes of processes.

Process Classification

In order to arrive to a process classification specific to the healthcare setting we started from the general process classification and then tried to identifiy the similarities and specific differences. In process classification, it is important to examine the key terms and techniques, as they will inform the analysis used to answer the listed research questions. This section will define the key types of processes and the techniques used in business and other areas to support these processes. Once this is complete, we can then compare them to processes found commonly in healthcare and make recommendations for which techniques to use so that the technological systems in place can better support the efficient delivery of care.

Feilers [4] defines a process as "a set of partially ordered steps intended to reach a goal." While this definition can be applied broadly, we will concentrate on processes that can be represented, tracked, and guided by software. This will allow us to describe and document process(es) that can be managed using modern process management techniques.

As mentioned in the introduction of this section, we need to start from the common types of processes from business and software literature. This will provide a baseline for comparing and classifying healthcare processes and will inform the ultimate conclusions of this work. Much of the literature has described processes as existing on a spectrum, noting the level of complexity, repeatability, or knowledge necessary to complete. These elements can be combined into a scale with repeatable and strictly defined processes at one end and non-repeatable, unstructured and knowledge intensive processes at the other.

As early as 1992, McCready [2] defined three processes classes: ad-hoc, administrative, and production. Production workflows are "highly structured and complex business processes that are governed by a series of explicit policies and procedures" where ad-hoc processes "are actives within all corporations that defy definition and thereby limit the use of policies and procedures to govern their outcome." In 1994, Earl [5] described processes similarly, creating a topology of processes spanning two axes: low to high structure and value chain target (primary to secondary).

Production and Administrative Processes

As mentioned before, processes are often classified on a spectrum of complexity and repeatability. Production processes tend to be highly repeatable, inflexible, tightly structured, and often high in volume.

Other characteristics provide additional insight into the basic classification for repeatable production processes. These include the extent to which the processes can be completed without human intervention, who or what systems are involved in completing the process, and the types of exceptions in the process.

At the most extreme, there are highly structured processes and low in flexibility [3]. As early as 2000, there were efforts to implement and move to a straight through processing (STP) paradigm. In these situations, the goal was for the "process to be conducted electronically without the need for re-keying or manual intervention" [6]. The goal of STP is to eliminate human interaction and can encompass two other definitions of production processes: transactional [7] and integration-centric processes [8]. Both definitions describe processes that are designed to integrate systems and enterprise applications. Zhu et al. describe transactional processes as often able to be accomplished without human intervention [7].

The next level is structured processes with predefined [9] or ad-hoc [3] exceptions. They still follow a predefined plan but do have the possibility of exceptions or errors in the process that require intervention and "may deviate from the predefined reference work practices and process adaptation strategies may be required" [3].

McCready and Earl also applied elements of Porter's Value Chain [1] to these processes types. The core of the value chain applies to whether a process brings value to the business, leading to the division between production or value generating, and administrative processes, that may support value creation. While these are business terms, they can apply to a healthcare scenario, as we will describe in in Healthcare Processes.

Knowledge Intensive Processing and Ad-Hoc Processes

At the other end of the spectrum exist processes that are not repeatable or heavily reliant on the implicit and explicit knowledge of the users. This distinction led researchers to focus on describing and assisting users in completing these less well-defined processes. In earlier literature, like McCready [2], these are described as ad-hoc processes and as knowledge-intensive processes in more recent literature [3].

An early reference to the term knowledge-intensive process (KiP), then described as knowledge-intensive business solutions, was in 1995 [10]. These processes rely heavily upon professional knowledge to produce intermediary services or are of competitive importance and supplied primarily to business [11]. In 2003, Papavassiliou et al. described these types of processes as "often complex in general, with many, but conceptually simple, (usually) document-centered activities" with a few judgment-based or knowledge decisions [12]. These decisions often draw from other, similar cases or other items such as regulations, operating procedures, and other information.

The more current definition of knowledge-intensive processes (KiP), sometimes known as knowledge-intensive business processes, are those whose conduct and execution are heavily dependent on knowledge workers performing various interconnected knowledge-intensive decision-making tasks. Knowledge Intensive Processes are genuinely knowledge, information, and data centric. As such, they require substantial flexibility at design- and run-time [3,13].

Evaluation Criteria

In addition to identifying the techniques and technologies available to process professionals, we also need to describe the criteria we will use to determine each technique's applicability to the health care processes. While there are several criteria sets, we chose to apply a subset of the requirements described by Lederer et al. [9], where they assembled a set of criteria and determined their applicability to several workflow- and process-based techniques. These criteria were defined in relation to software development, as such not all the criteria applied to this review. Given this, we removed criteria that were only applicable in software domain, such as IT needs, implementation methodology, and process implementation.

Based on this, the criteria we selected were: Structuring, Trend Orientation, Knowledge Intensity, Complexity, Predictability, and Flexibility. These criteria represent aspects of both the value-chain perspective and repeatability/knowledge-centricity spectrum. Table 1 shows the criteria names and their various values, assigning each value a numerical index from 1-5. These indexes are used in later tables where we apply the criteria to processes and techniques.

Table 1. Selected criteria (adapted from Lederer [9])

Criteria	1	2	3	4	5
Structuring	Structured	Structured with ad hoc exceptions	Structured with predefined exceptions	Loosely structured	Unstructured
Trend Orientation	Data-driven	Case-driven	Social-driven		
Knowledge Intensity	Knowledge-intensive	Automated / Repeatable			
Complexity	High	Medium	Low		
Predictability	High	Medium	Low		
Flexibility	High	Medium	Low		

Lederer defined each criterion with a different set of values. Some were defined on a high-medium-low scale, while others were given distinct values. For example, Structuring is given five unique values representing their level of structure, with *structured processes* having predefined logic, steps, and resources while *unstructured* have little to no predefined structure [3,9]. Closely related with the Knowledge Intensity metric, with *automated/repeatable* being closely related to *structured* cases and *knowledge-intensive* related to *loosely-structured* and *unstructured*.

Trend orientation is also given distinct values defining whether it is *data-driven* with data central to the process; *case-driven*, with knowledge central to the process; or *social-driven* with the team as central to the process.

Workflow versus Case Management

As mentioned before, business technology has evolved several techniques to support the implementation of production and support processes. These techniques are workflow management, business process management and adaptive case management.

Workflow and Business Process Management

Workflow management (WfM) describes "the computerized facilitation or automation of processes" [14] that define, control, and coordinate the execution of tasks to reach a defined goal. To achieve the goal, systems ensure that flow of work is executed efficiently by ensuring that the right work is done by the right resource at the right time [14–19]. The system should also allow for tasks and work to be completed in parallel, also increasing the efficiency of the system and its users.

Business Process Management (BPM) is considered an extension to workflow management that adds a comprehensive approach to managing and improving the efficiency and effectiveness of business processes across the enterprise [20]. BPM also involves techniques and tools to manage and automate business processes performed by people, applications, and external sources [7]. At its core, BPM adds context to the process and its execution within workflow management systems.

Adaptive Case Management

In addition to workflow management, there is an emerging area of research around applying traditional case management techniques to process management called Adaptive Case Management (ACM) [13,21], sometimes referred to as dynamic case management. This method came about as businesses and computer scientists realized that workflows and workflow systems were overly restrictive [21–23].

Modern case management started with an often-cited 1994 MIT Sloane article reviewing how organizations moved from a restrictive workflow management model to a more case-centric model [24]. Subsequent work was completed by van der Aalst [21], Hull [13,25], and Marin [23].

These collective works and body of knowledge describe ACM as the answer to how organizations move from a restrictive workflow management model to a more case-centric model [24]. This includes implementing systems and processes that, per Van der Aalst [21], avoid context tunneling

by providing all information available, decides which activities are enabled based on this information, separates work distribution from authorization, and allows workers to view and add/modify data before or after the corresponding activities have been executed. Zhu et al. further describe ACM as built around the concept of processing a case, described as a collection of information, and coordinated tasks, by knowledge or case workers [18].

Ultimately, ACM enables and guides users in achieving the goal of the process by utilizing their knowledge and reacting to the decisions made rather than enforcing a strictly defined and often inflexible series of steps.

Comparing Workflow and Case Management

As mentioned before, workflow management (WfM) and business process management (BPM) both provide a set of predefined processes and steps that need to be completed to achieve the goal. Because they rely on predefined steps known at design time, they tend to be inflexible and therefore apply well to processes with fewer exceptions, such as administrative and production processes. Most of the steps are known before implementation in each scenario and can be coded into the process.

Adaptive case management (ACM) offers an alternative to, or perhaps a superset of BPM capabilities through a more flexible set of tasks that make up the case. These tasks can be simple to-do lists or can be full-fledged workflow processes [19]. What differentiates ACM from BPM is how these tasks are invoked, with ACM starting processes based on previous decisions or information stored in the case itself. In fact, some tasks can be discretionary or optional, meaning that the user can decide whether they need to be executed or not. Advanced Case Management can offer a series of stages and milestones that can be used to chart and represent progress through the case, again, offering flexibility but accountability.

Armed with these techniques, we can now describe how the criteria described in Table 1 apply to the techniques. Table 2 shows how we apply the criteria to workflow and ACM. Again, some of this classification is borrowed from Lederer [9], though augmented with information on the techniques described above.

Table 2. Applying criteria to techniques

Criteria	Workflow / BPM	ACM
Structuring	1, 2, 3	4, 5
Trend Orientation	1, 2	2, 3
Knowledge Intensity	2	1
Complexity	2,3	1,2
Predictability	3	1
Flexibility	1	3

Healthcare Processes

This section presents a review of some common healthcare-related processes to define a baseline with which to compare the above definitions, technologies, and techniques. Our previous research found that healthcare processes are typically divided into three key types: clinical, administrative, and organizational [26,27]. The key elements of each type are also described in this section.

Clinical

We will start with clinical processes, because healthcare is, at its core, about provided patient care and addressing safety goals, such as reducing patient falls or preventing negative health outcomes, such as pressure ulcers [26,27]. Zheng describes these processes as being at the center of all clinical activities and are essential to the effective and safe delivery of patient care. They are also complex, reflecting the multifaceted nature of clinical tasks and the dependencies between them and, at the

same time, fragile and can be easily disrupted by changes in the order or methods by which clinical tasks are completed [28].

Organizational

Secondary to the core, clinical processes are organizational processes that represent secondary steps necessary to support clinical activities. These can include patient scheduling and processing lab work. It should be noted that these processes will be more well defined than the knowledge-centric clinical processes. While they may have some exceptions and can draw on worker knowledge, they will typically require less flexibility.

Administrative

Finally, there are the administrative tasks. They are directly related to the administrative processes described by McCready and Earl and are typically associated with managing the business of healthcare. Examples would be billing and equipment maintenance. These processes are often strictly defined with little to no flexibility in their implementation and execution.

Mapping to Technologies

With the key health care process types defined, we can compare them to the process types, technologies, and techniques described in the Workflow and Case Management section. This comparison aims to provide recommendations for appropriate technologies and techniques to support these activities. With the above descriptions, we have applied the criteria from Table 2 to the three health care processes described above. Our analysis listed the appropriate values for each facet as applied to that type of process. Table 3 shows the criteria as applied. After applying the criteria, we can begin to recommend techniques for solving these classes of healthcare processes.

Table 3. Applying criteria to healthcare processes

Types	Clinical	Organizational	Administrative
Structuring	4, 5	2, 3	1, 2, 3
Trend Orientation	1, 2, 3	1, 2	1
Knowledge Intensity	1	1, 2	1, 2
Complexity	1	2	2,3
Predictability	1	2, 3	2, 3
Flexibility	3	2	1

We will start with clinical processes as these are fundamental to the delivery of care. In fact, when compared to the Porter Value Chain, these are the core value generating processes in healthcare and could be considered production processes. However, they offer a challenge compared to traditional production processes in that they are highly dependent on clinician and care team knowledge, hence the high rating for Knowledge Intensity. Given this, we can describe them as flexible, often unpredictable, and supporting the healthcare process by bringing explicit medical knowledge to the point of care [26].

Organizational and administrative processes tend to be more well-defined support and back-office processes that benefit more from systems that offer support for stepwise and concrete processes. These need to support fewer exceptions and rely more on pre-definition rather than at the moment decisions. We see two ways of classification with respect to techniques: ACM- and workflow-ready processes.

To be classified as ACM-ready, we are looking for processes that need guidelines and support, but not hard and fast steps. These include the clinical process itself because ACM stores and reacts to information gathered and user decisions, in this case the clinical staff, the medical information gathered, and the knowledge they bring to the situation.

Concrete examples of these could include healthcare pathways, defined as planned process patterns that are aimed at improving process quality and resource usage [26,29]. In these scenarios, the ACM solution can track the information gathered either directly or when supporting an electronic medical record (EMR) or electronic health record (EHR) systems. This would allow for managing tasks based on information gathered and a method for assisting in the execution of orders and tracking the patient through the process stages. The solution would not dictate to the clinician the process, but rather react to their knowledge and medical judgments. Other examples include emergency response management [30] and patient navigation [31,32].

On the other side are processes that are forms of data analysis and order management. In each scenario, the goal of the process is lend themselves to traditional process management. These will have well-defined processes that can be tracked and managed directly and include many organizational and administrative processes. Examples well defined and the steps to completion would be known in advance. One example is DICOM image review [35] where the process is highly repeatable and low in the need for flexibility.

Administrative and back-office processes can be supported with workflow management. One example is medical billing, where the users gather the procedures completed and resources used to generate the appropriate bill and track it from sending to payment. These types of processes likely will not benefit from the extra flexibility within an ACM solution because they are typically highly repeatable. In a 2014 article, Villanova University describes 3 ways BPM can improve healthcare [37] and they specifically call out claims processing as "complex task that also encompasses compliance and reporting activities, and requires a smooth flow of information". These are highly-repeatable administrative processes and, as such, can be considered workflow-ready.

Examples

Szelągowski, et al, describe using BPM to support clinical pathways and patient support [33]. They describe a number of individual processes that can be automated using BPM techniques to support caring for patients with chronic diseases. The also describe reacting to data about the patient gathered from direct and electronic means. The overall process they describe is very data centric, with a strong social component via the collective care team. The processes also show a strong degree of flexibility required. Specifically, the process of consultation includes a six tasks that can be completed in any order the diagnostician deems appropriate based on their knowledge and the data at hand. "The implementation of CPs requires the empowerment of process executors to make diagnostic and therapeutic decisions in accordance with the possessed knowledge and the requirements of the clinical context of process implementation."

Similar to Szelągowski, Boudko [29] also describes implementing clinical pathways via Petri Nets, a mathematical-based model for defining workflow processes [34]. The resulting process contains a number of varying paths representing a process with a high level of complexity and unpredictability.

Both of these represent classic use cases for an ACM-ready solution as the processes and knowledge necessary will vary based on the patient, resulting in a more flexible implementation to support the care givers.

Becker, et. al described applying BPM to infection control within a hospital setting [36]. Their work involved reviewing existing, paper-based processes and implementing a BPM solution to manage the follow process after an infection is identified. When compared to the defined criteria, it shows that the process is highly structured, data driven, and highly repatable. Specifically, the two processes show only two and three branches, respectively. This would indicate that the process is well suited to a BPM/workflow based solution. Their implementation agreed with our assessment because they reported a 75% reduction in time to notification after implementing a BPM-based solution. "Furthermore, ICP spent an average of 30 % of their daily work time on screening infection reports and patient charts."

For clinical processes, we see ACM providing the most significant benefit. Because these processes are highly flexible and dynamic, they need systems that can support those activities. We believe that the case model lends itself to these needs by offering a place to store the information

about the patient and process, by allowing the system to react to the decisions and knowledge of the practitioners, and by removing the need to track external processes from the caregivers.

Table 4. Concrete processes evaluation

Criteria	Becker	Szelągowski	Boudko
Structuring	1	4	3
Trend Orientation	1	2,3	1
Knowledge Intensity	2	1	1
Complexity	3	1	1
Predictability	1	3	2-3
Flexibility	3	1	1-2

It is also important to note that an ACM solution should be seen as a support system, allowing the clinician freedom to use their knowledge and to guide the care process rather than forcing them into an inflexible, specific set of steps. While the solution can offer common ailments and procedures, guidelines or pathways, it will still need to react to and support the realities of activities conducted.

We see that BPM and BPM-hosted tasks in an ACM solution offer great value for operational and administrative processes. The goal, especially for operational processes, is to manage these on behalf of the care team. This would provide a centralized place to check the process of orders and scheduling. In addition, it can offer accountability for the completion of these critical tasks.

Based on all these the answers to the proposed reaserach questions are:

A1: Healthcare processes are divided into three main classes: clinical, organizational, and administrative. Clinical processes are the primary value generating processes in health care, so they match closely to production processes, with organizational and administrative processes providing support.

A2: It is the clinical processes that show the largest need for flexibility and knowledge centricty where organizational and administrative processes are typically more repeatable and less flexible. With that, we can conclude that the processes map best to the techniques as shown in Table 5.

Table 5. Healthcare processes mapped to techniques

Technology	Clinical	Organizational	Administrative
Workflow / BPM		X	X
ACM	X		

Conclusions

In our review of healthcare processes, we do see instances where the techniques and technologies developed to manage business processes can apply to healthcare. Specifically, we believe that these techniques can support the practitioners delivering vital care to patients.

Given the constrcuts decribed here, it is up to individual practices and institutions to determine where and how they will implement BPM and ACM practices. While the complete implementation of these techniques is beyond the scope of this paper, we recommend that institutions with no software support begin by mapping out their processes. While BPM and ACM are typically software supported, the principles of documenting the steps to complete a process can be applied in a completely human-centric environment. Simply documenting what needs to be completed can support the organization in accomplishing the core goals of the process.

For larger oragnizations that already have electronic health record systems in place, such as Epic[1] or Meditech[2], building on the process capabilities inherent in the platform can help streamline

[1] https://www.epic.com/

[2] https://ehr.meditech.com/

processes. In addition, other platform vendors' products can be implemented to provide support to both administrative and organizational processes.

Ultimately, we see the solutions described as being able to support and lessen the clinical team's workload, by providing them with increased flexibility and, perhaps more importantly, time to spend with the patients, resulting in better outcomes for all involved.

List of abbreviations

ACM: Advanced case management
BPM: Business process management
STP: Straight through processing
WfM: Workflow management

Conflict of Interest

The authors declare that they have no conflict of interest.

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