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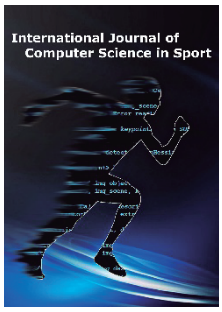

Optimizing Player Management Processes in Sports: Translating Lessons from Healthcare Process Improvements to Sports

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Abstract

Typical player management processes focus on managing an athlete's physical, physiological, psychological, technical and tactical preparation and performance. Current literature illustrates limited attempts to optimize such processes in sports. Therefore, this study aimed to analyze the application of Business Process Management (BPM) in healthcare (a service industry resembling sports) and formulate a model to optimize data driven player management processes in professional sports. A systematic review, adhering to PRISMA framework was conducted on articles extracted from seven databases, focused on using BPM to digitally optimize patient related healthcare processes. Literature reviews by authors was the main mode of healthcare process identification for BPM interventions. Interviews with process owners followed by process modelling were common modes of process discovery. Stakeholder and value-based analysis highlighted potential optimization areas. In most articles, details on process redesign strategies were not explicitly provided. New digital system developments and implementation of Business Process Management Systems were common. Optimized processes were evaluated using usability assessments and pre-post statistical analysis of key process performance indicators. However, the scientific rigor of most experiments designed for such latter evaluations were suboptimal. From the findings, a stepwise approach to optimize data driven player management processes in professional sports has been proposed.

KEYWORDS: BUSINESS PROCESS MANAGEMENT; PLAYER MANAGEMENT; SPORTS PROCESS OPTIMIZATION; SPORT INFORMATICS; PATIENT MANAGEMENT.

Introduction

Recent enhancements within computational power and miniaturization of electro-mechanical systems have allowed sports practitioners to rely more heavily on qualitative and quantitative data to manage professional athletes (Bromley, Drew, Talpey, McIntosh, & Finch, 2017; Seshadri et al., 2019). Such latter data streams aid in digitally transforming (the process of using digital technologies to generate new or optimize existing operational processes) feedback pathways within player management processes to create closed loop data driven decision making models (Schelling & Robertson, 2020; Stein et al., 2017). Literature focusing on data driven measurement and management of athletes has mainly concentrated on making direct analyzes and inferences from the available data (De Silva et al., 2018; West, Williams, Kemp, Cross, & Stokes, 2019). There are currently limited attempts to explore if the processes underpinning such analysis and inference are optimized. Additionally, less focus has been given to systematically discovering the exact qualitative and quantitative data required to support meeting specific organizational goals or objectives within player management processes. For example, research (West et al., 2019), illustrated that high speed running was the key Global Positioning System (GPS) based metric used by twelve Premiership rugby union clubs. However, between those teams, eight different methods for quantifying this metric were used. This may suggest differing organizational objectives (e.g., playing strategy, training goals) among the teams. Hence, high speed running data metric may need be collected, processed and analyzed in line with specific goals of the training program. This emphasizes the necessity for data used within each team to be aligned to its operational objectives and optimized prior to formulating inferences from them.

Among the different techniques available to optimize and align operational processes to meet organizational goals, Business Process Management (BPM) has been used extensively in different application areas (Anand, Wamba, & Gnanzou, 2013; Capgemini, 2017). The Association of Business Process Management Professionals (ABPMP) defines BPM as:

> *A disciplined approach to identify, design, execute, document, measure, monitor, and control both automated and non-automated business processes to achieve consistent, targeted results aligned with an organization's strategic goals (ABPMP, 2019).*

An intervention based on a BPM framework evolves through a lifecycle (Szelągowski, 2018). The key execution steps of the BPM lifecycles presented in literature are similar (Morais, Kazan, Pádua, & Costa, 2014). As specified below, the BPM lifecycle presented by Dumas, Rosa, Mendling, & Reijers (2018), has six key stages within its execution (p. 23) and has been adopted by many scholars for BPM interventions.

- Process identification - Formulates the process architecture, performance measures and identifies the processes requiring an optimization.
- Process discovery - The finer details on the current state (As-Is) of the identified processes are collected and modelled.
- Process analysis - The discovered processes are analyzed for issues and optimization areas.
- Process redesign - Each process is redesigned to an optimized future state (To-Be), to overcome the identified issues.
- Process implementation - The redesigned processes are implemented (mostly through automation) by managing organization change.

- Process monitoring - The effectiveness of the optimization is assessed. The cycle is repeated to discovery stage if further improvements are necessary.

As a framework, BPM is built on the fundamentals of Six Sigma (Tjahjono et al., 2010), LEAN (Bhamu & Sangwan, 2014; Zepeda-Lugo et al., 2020), Total Quality Management (TQM) (Al-Damen, 2017), operations management and information technology techniques (Dumas et al., 2018). The key attribute of BPM is to improve organizational operations by implementing process automation initiatives, whereas a framework like LEAN or Six Sigma on its own focusses on improving business performance by reducing variability and defects in processes. BPM has been used within a wide array of service industries to improve their operating processes (Anand et al., 2013) and has successfully optimized the information architecture required for process execution whilst enabling a culture for continual improvement (Cánovas-Segura et al., 2017; Grisdale & Seymour, 2011; Nikolaidou, Anagnostopoulos, & Tsalgatidou, 2008). Therefore, BPM appears to be suitable for optimizing service-oriented processes. However, although BPM optimizations are successful, they may not be the cheapest as they rely on implementations using technology. Since player management processes in sports are service oriented in nature (e.g., a strength and conditioning coach supplies knowledge as an intangible service to enhance performance of a player) and assisted by data driven information architectures, BPM appears to have the potential to improve them.

Business Process Management has not been utilized effectively within sport literature. An initial Boolean search conducted on selected databases yielded only a single article (Mullane, Chakravorti, Conway, & West, 2011) for using BPM techniques for optimizing player management processes. Therefore, to generate a framework for using BPM in sports, it was first necessary to explore BPM literature from a service industry with similarities and close interactions to sports. Among such service industries, healthcare has a close interconnection with sports and research illustrates how specific aspects of sports have been explored for potential applications in healthcare and vice versa. For instance, healthcare research has explored principles of teamwork in sports for improving interprofessional collaboration practices in healthcare settings (Bosch & Mansell, 2015; Breitbach, Reeves, & Fletcher, 2017). Conversely, research in the sports literature has explored introducing elite athlete management models where healthcare principles and practitioners (sports medicine physicians) are integrated into the coaching and performance management models (Dijkstra, Pollock, Chakraverty, & Alonso, 2014). Therefore, healthcare acts as a core operational entity within professional sport (e.g., medical departments of sporting organizations use healthcare practices during execution). Furthermore, methods such as Statistical Process Control (SPC), used extensively to manage patients in healthcare (Seim, Andersen, & Sandberg, 2006), have been proposed to manage elite athletes (Sands et al., 2019) and analyze team performance in football (Beggs & Bond Alexander, 2020). However, BPM itself has also been used substantially within healthcare to optimize patient management processes and presents a wide array of operational examples (A. D. R. Fernández, Fernández, & García, 2019). Hence, there is an opportunity to explore applications of BPM in healthcare and collate information on its possible use to optimize player management processes in sports.

Therefore, the present study initially aimed to identify the applications of Business Process Management within healthcare settings via a systematic review. The study attempted to identify different methodological approaches adopted within each stage of the BPM lifecycle in reference to the model presented by Dumas et al. (2018) with applications focused on patient related processes. Finally, we aimed to translate the findings of BPM based approaches in healthcare to sporting contexts by proposing how such methods can be used to optimize and digitally transform data driven player management processes in professional sports.

Methods

Search strategy

A literature search was conducted in line with the 2009 Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) statement (Moher et al., 2009) on PubMed, Scopus, ScienceDirect, Medline, Academic Search Complete, SPORTDiscus and IEEE Xplore databases to identify articles published from year 2000 to January 2021. Boolean operators were used to streamline the search to identify intended studies for the review. Keywords were chosen to focus the search to BPM in healthcare. Since process modelling is a pivotal aspect of the BPM strategy, specific nomenclature of modelling standards such as 'BPMN' and 'Unified Modelling Language' were included as key words. However, terms such as 'LEAN', 'Six Sigma' or 'TQM' were not included to help streamline the search to unravel articles specifically concentrating on BPM as the overall intervention framework. The specific search terms and combinations used in five databases are illustrated below (all the used search terms are available in Appendix A).

PubMed, Medline, Academic Search Complete, SPORTDiscus and IEEE Xplore

(BPMN OR "business process management" OR "value stream mapping" OR "Unified Modelling Language" OR "business process modelling") AND (health* OR clinical OR hospital OR medical)

Study selection

Titles and abstracts of the retrieved papers were independently reviewed by two authors (JR and MZ) against the specified inclusion and exclusion criteria. Articles not meeting the inclusion criteria were excluded prior to full text review. When it was unclear on the relevance of the articles based on the title and abstract, full texts were reviewed. Studies with conflicting ratings from the two authors (JR and MZ) were analyzed together after the initial screening and unanimous consensus was reached on the inclusion of such papers for full text review. Selected full text studies were further analyzed against the inclusion and exclusion criteria. A search of references within the selected studies were conducted to ensure that all relevant articles for the review were included. The overall inclusion and exclusion criteria of the articles have been stated below (selection criteria were primarily focused on identifying healthcare process optimizations which could relate to athlete management processes in sports).

Inclusion

- Articles written in English.
- BPM methodology applied to processes related to patients in healthcare settings.
- Model implementation conducted with the goal of achieving an outcome that is clearly defined.
- Examined an information flow associated with a healthcare process.
- Contained a digital intervention.
- Interventions were developed and implemented.
- Had conducted a pre-post study or usability assessment.

Exclusion

- Review and short abstract papers.
- Administrative processes not directly related to patients within healthcare settings.
- Process discovery conducted through automated methods.

- Examples where only process models were introduced.
- Interventions validated only based on simulation.
- Studies comprising of process improvements with no digital interventions.
- Impact due to the digital interventions were not assessed.

Data extraction and analysis

Data were extracted by author JR and summarized according to details on the BPM intervention location, type of process considered, overall objective of the study, participants, process identification methodology, process performance measures (the dimensions among time, cost, quality, flexibility and the defined KPI's to measure them), process discovery methodology (data gathering and modelling techniques) process analysis tools (qualitative and/or quantitative), process implementation (exact digital intervention and approach to implementation) and the implemented process monitoring strategy (methods and tools).

For process redesign stage of the lifecycle, the framework provided by Dumas et al. (2018) was used to group the redesign strategy adopted in each study to a descriptor in the process redesign orbit (p. 306).

Quality assessment

All articles with a pre-post study without a control group were assessed for quality based on the National Institute of Health (NIH) Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group (NIH, 2014). Any articles with a pre-post study comprising of a control group were analyzed for quality by using the Methodological Index for Non-Randomized Studies (MINORS) tool (Slim et al., 2003). Quality assessment of papers incorporating a usability study were conducted based on the Critical Assessment of Usability Studies Scale (CAUSS) (Silva et al., 2019). All studies were assessed for quality independently by the two authors (JR and MZ) and consensus was reached for any disagreements after discussions between them.

Results

Removal of duplicates resulted in narrowing the initially screened list of articles identified through database and reference list searching from 2237 to 1554 studies. There was 9.8% conflict between authors (JR and MZ) following initial screening of titles and abstracts. After discussions between the authors, these conflicts were resolved, and 119 studies were selected to meet the inclusion criteria for the review. A further 105 articles were removed after full text screening; 42 studies were developed based on LEAN as the core intervention framework, interventions were not implemented in 49 articles, 9 texts were only focused on process modelling, there was 1 duplicate paper and 4 articles did not conduct any assessment to determine the impact due to the interventions. The resulting 14 studies were considered for final data synthesis (Figure 1).

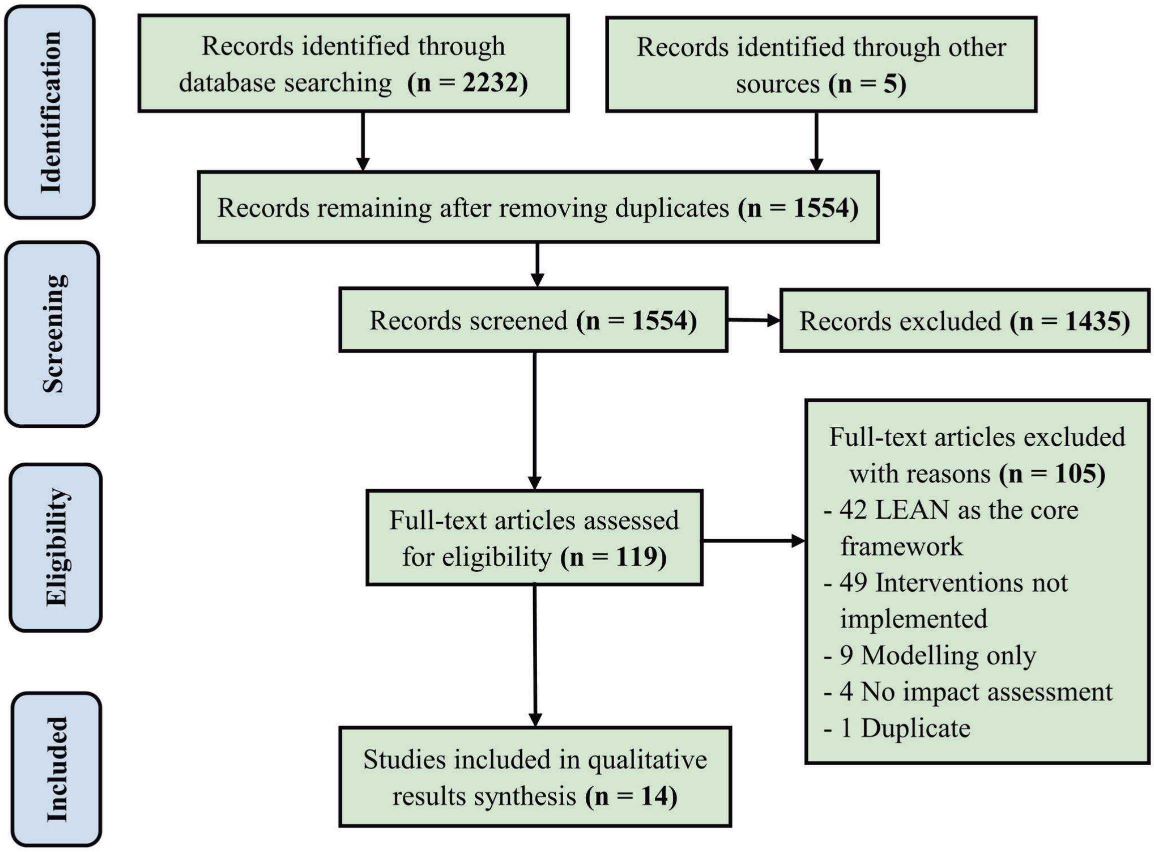

Figure 1. Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) flow diagram of systematic review.

Background of BPM interventions

As illustrated in Table 1, we present background details of the BPM implementations considered within the review.

Intervention location and specific process

Most BPM interventions (10/14) were executed in an actual healthcare facility comprising of a focused process for improvement. Authors had considered patient and physician driven processes such as disease diagnosis (A. Fernández, Fernández, Marcos-Jorquera, & Iglesias, 2020), infection control (Janiesch & Fischer, 2009), operating room planning and scheduling (Barbagallo et al., 2015) for improvement. Furthermore, specific data driven patient management processes such as retrieval of patient data related to kidney transplant (Andellini et al., 2017) and test result acknowledgment by emergency department physicians (Georgiou et al., 2016) were also considered for the implementation of digital interventions.

The processes considered for BPM interventions in healthcare have similarities to player management processes in sports. Specifically, the tasks performed by physiotherapists, doctors and strength and conditioning coaches within performance departments in team sport environments have similarities to patient data retrieval (e.g., athlete data retrieval), disease diagnosis (e.g., injury, physical and technical-tactical diagnoses of performance) and stroke rehabilitation (e.g., injury rehabilitation) healthcare processes.

Table 1. Background, intervention details and quality assessment results of the studies

ID	Study	Main Objective of the Study	Location	Participants	Target Performance Dimensions	Process Performance KPI's	Digital Intervention	Technologies Used	Assessment Type	Quality Assessment
1	(A. Fernández et al., 2020)	Early diagnosis of Chronic Obstructive Pulmonary Disease	Theoretical	Authors, doctors and patients	Time / Quality	Not defined	A decision support system integrated into the health information system	Service-oriented architecture / RESTFul services/ MySQL database / Bonita BPMS / OpenEMR electronic health record system (with mobile & web aps) / spirometer hardware input	Usability	Fair
2	(AlSalamah et al., 2012)	Improve team communication and patient care coordination in integrated care pathways	Theoretical	Authors and members of Clinical Information Unit	Flexibility / Quality	Not defined	A Workflow Management System (WfMS) set between users and currently in use health information system	Stateframe BPM system from Alia Systems Ltd	Usability	Fair
3	(Andellini et al., 2017)	Prompt retrieval of patient data and documents related to kidney transplant	Bambino Gesù Children's Hospital, Italy	A multi disciplinary team	Time / Flexibility	Average time spent per patient	A web-based application, a database, interacting with hospital clinical repository to retrieve patient data	Implemented on a BPM framework using Jamio Platform (Openwork srl) with a service-oriented architecture	Pre-post	Fair

Table 1 (Continued)

ID	Study	Main Objective of the Study	Location	Participants	Target Performance Dimensions	Process Performance KPI's	Digital Intervention	Technologies Used	Assessment Type	Quality Assessment
4	(Barbagallo et al., 2015)	Optimize Operating Room (OR) planning and scheduling	Bambino Gesù Children's Hospital, Italy	A multi disciplinary team	Cost	Number of patients scheduled for OR / OR utilization	Mathematical optimization model for OR planning	Based on an optimization algorithm previously developed by the authors	Pre-post	Poor
5	(Becker, Fischer, Janiesch, & Scherpbier, 2007)	Improve efficiency of Infection Control (IC) process	A major healthcare facility in USA	BPM service provider	Time	Time to notification	Process automation through a Workflow Management System (WfMS)	Soarian medical information system, by Siemens MED / WfMS from third party product TIBCO Staffware Process Suite	Pre-post	Poor
6	(Georgiou et al., 2016)	To examine the impact of Electronic Results Acknowledgment (eRA) in the emergency department	A metropolitan teaching hospital in Australia	Emergency physicians	Time	Number of individual acknowledgements and time per acknowledgment	Electronic Results Acknowledgment (eRA) system (an additional module to existing electronic medical record)	Message Centre, Cerner Millennium, MO, USA	Pre-post	Fair
7	(Janiesch & Fischer, 2009)	Improve efficiency of Infection Control (IC) process	A major healthcare facility in USA	BPM service provider	Time	Turnaround time	A Workflow Management System (WfMS) integrated into existing environment	Soarian medical information system by Siemens MED / WfMS from third party product TIBCO Staffware Process Suite	Pre-post	Fair

Table 1 (Continued)

ID	Study	Main Objective of the Study	Location	Participants	Target Performance Dimensions	Process Performance KPI's	Digital Intervention	Technologies Used	Assessment Type	Quality Assessment
8	(Jimenez-Molina, Gaete-Villegas, & Fuentes, 2018)	Chronic respiratory patient management and risk prediction	The Exequiel González Cortés Pediatric Hospital, Chile	Authors, 16 healthcare professionals	Quality	Not defined	A digital framework for the development of chronic disease support systems	Accelerometer / Gyroscope / PPG / temperature sensor as inputs / Node.js software running on Raspberry Pi 4.0 / Amazon S3 for data storage	Usability	Poor
9	(Krupp et al., 2017)	To reduce 30-day pediatric asthma readmissions rate	Riley Hospital for Children at Indiana University Health, USA	A group of multi disciplinary stakeholders	Quality	Asthma specific inpatient 30-day readmission rate	Asthma Admission Assessment Tool (AAAT) **only part of overall solution*	Not clearly Specified	Pre-post	Fair
10	(Brown, 2004)	To reduce turnaround time of histopathology process	Leicester Royal Infirmary, University Hospitals of Leicester, UK	A multi disciplinary team	Time	Turnaround time	Computerized reports with online correction of errors and authorization by pathologists **only part of overall solution*	Not clearly Specified	Pre-post	Poor
11	(Leu & Huang, 2011)	To optimize clinical processes in the emergency department	A mid-size regional hospital in Taiwan	A multi disciplinary team	Quality	8 different KPI's (e.g., length of stay more than 6 hours)	All processes and documents in emergency department were computerized and users can obtain data from a web-based platform	ARIS, developed by IDS Scheer in Germany	Pre-post	Fair

Table 1 (Continued)

ID	Study	Main Objective of the Study	Location	Participants	Target Performance Dimensions	Process Performance KPI's	Digital Intervention	Technologies Used	Assessment Type	Quality Assessment
12	(Ruiz-Fernández, Marcos-Jorquera, Gilart-Iglesias, Vives-Boix, & Ramírez-Navarro, 2017)	To empower patient with hypertension monitoring	Not specified	Authors, patients	Flexibility	Not defined	Distributed software system with IoT sensor inputs for patient data. web application for management and supervision by medical team	MySQL database / NodeJS + Express web services / HTTPS for security / Bonita BPMS / Apache Cordova for mobile aps / blood pressure sensor, digital scale & patient inputs / Raspberry Pi 3 with barometer inputs / Python, AngularJS web developments	Usability	Poor
13	(Ryan et al., 2016)	To optimize the perioperative process	An academic medical center in south-eastern USA	A multi-disciplinary executive team	Time	4 different KPI's (e.g., operating room turnaround time)	4 different interventions, including hospital-wide Electronic Medical Record (EMR) integration	Not clearly Specified	Pre-post	Poor
14	(Osamor et al., 2014)	To speed up tuberculosis infection screening process and provide accessibility to the public	Not specified	Authors, doctors and nurses	Time / Flexibility	Not defined	A web, rule based expert system linked with a database	Java Server Pages (JSP) / Apache Tomcat web server / Apache Derby Version 2.0 / Java NetBeans IDE	Usability	Poor

Participants

Results (8/14) indicated the formation of multidisciplinary teams during early stages of the BPM lifecycle, comprising of stakeholders relevant to the healthcare process being considered. Although, authors themselves contributed as the key participants within the BPM lifecycle in 4/14 papers, three studies (AlSalamah, Gray, & Morrey, 2012; A. Fernández et al., 2020; Osamor, Azeta, & Ajulo, 2014) from them engaged potential users as participants during latter stages of the BPM lifecycle to assess the usability of developed digital interventions.

Process performance measures

Studies in the review demonstrated the objectivity for improving a specific process performance dimension among cost, quality, time and flexibility based on a BPM intervention. In 9/14 articles (all pre-post studies), the resulting effects from the intervention were evaluated in relation to a clearly specified Key Performance Indicator (KPI).

Quality of studies

Overall, only one article (Andellini et al., 2017) among the 9/14 pre-post studies used a controlled group. And among the pre-post studies, the quality of 5/9 articles were deemed 'Fair' and the rest were 'Poor' (see Tables B and C in Appendix B). The remaining 5/14 papers consisted of a usability assessment and the quality of 2/5 of them were assessed as 'Fair' and the rest were deemed 'Poor' (see Table D in Appendix B). None of the articles were rated as 'Good' quality pre-post or usability studies.

Methodological approaches within BPM lifecycle

In reference to Figure 2, we provide information on various methods and tools adopted in the BPM lifecycle by the studies in relation to the framework presented by Dumas et al. (2018). The studies have been referenced in Figure 2 in relation to the article ID specified in Table 1.

Process Identification

Most processes (9/14) for BPM initiatives were identified solely by the authors and were justified for optimizations by conducting literature reviews to extract details on the current suboptimal operational nature of those identified processes. In 4/14 studies, processes were selected for an optimization due to current poor performances based on an expected outcome measure or due to the surfacing of issues during execution. And in the remaining article (Leu & Huang, 2011), emergency department processes were identified as core processes for a BPM initiative to support meeting departmental core goals defined as "offering immediate and high-quality medical services".

Identifying player management processes for optimization to meet specific goals/objectives of a considered sporting organization will be more applicable than selecting processes arbitrary and exploring sport literature to justify those process selections. Such an approach will help to ensure that the resources allocated to BPM initiatives directly impact player management processes truly requiring optimizations in sporting environments. However, since athlete management domains may not operate with a process-oriented mindset, it might be necessary to initially derive the process architecture of the considered sporting department/organization and select the relevant processes for optimization.

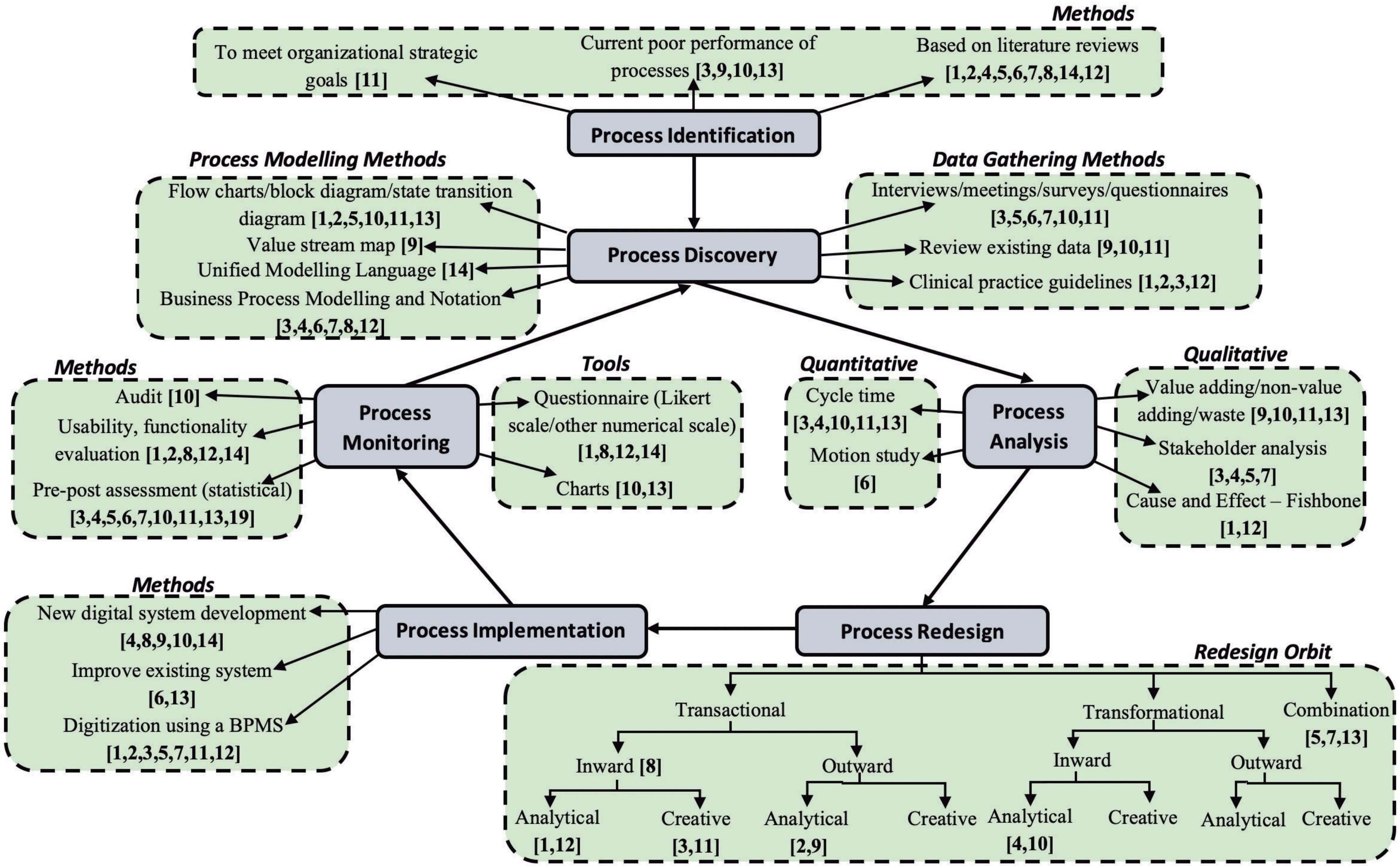

Figure 2. Methods and tools adopted within BPM lifecycle in healthcare analyzed in reference to the model by Dumas et al. (2018).

Business Process Discovery (BPD)

Data collection methods: A group of articles (6/14) conducted interviews, meetings, surveys and questionnaires with relevant stakeholders or process owners (the person responsible for managing the process) to discover the current state (As-Is) of the considered processes. Discovering details by analyzing already available data on the identified process was also of interest in 3/14 articles. Additionally, researchers examined currently available standard clinical practice guidelines in 4/14 studies when defining the As-Is state of the identified processes for optimization.

Collecting finer details on player management processes based on interviews and/or meetings may be viable in sporting contexts, since the documentation of process performance measures for player management or availability of universal guidelines elaborating the standard steps to manage players may be uncommon in sporting contexts (perhaps excluding medical departments).

Process modelling methods: After collecting information on the current state of the identified processes, authors had used basic flow charts/block diagram notation (6/14), collaboration and process diagrams in Business Process Modelling and Notation (BPMN) (6/14), use case and activity diagrams in Unified Modelling Language (UML) (1/14) and Value Stream Mapping (VSM) (1/14) to convert the collected data into process models. However, none of the studies conducted a quality assessment of the developed process models to evaluate if the models adhered to specific modelling guidelines, whether they properly translated the actual process being analyzed or if the models were practically usable.

Whilst any of the previously specified standards may be used to model player management processes, the availability of swimlanes (delineating who does what is a process) in BPMN and UML standards may suit sporting contexts. This is because the execution of player management processes generally involves the collaboration of multiple stakeholders (e.g., physiotherapists, coaches, sports scientists).

Process analysis

Qualitative process analysis methods: A set of studies (4/14) conducted value-based analysis (to determine the value generating steps and vice versa) to identify issues existing in the current state of the process. More structured qualitative analysis methods like cause-effect diagrams (Ishikawa diagrams) were also adopted to identify root causes of the unraveled process issues (2/14). However, a proportion of articles (4/14) analyzed the current state of the process based on the perceptions of its stakeholders (Stakeholder Analysis).

Quantitative process analysis methods: Quantitative dynamics of process analysis mainly concentrated on measuring the cycle time of specific tasks under consideration for optimization. Additionally, more industrial engineering oriented quantitative methods such as Work Observation Method by Activity Timing (WOMBAT) were also used to quantitatively analyze the time taken by physicians to acknowledge test results within an emergency department (Georgiou et al., 2016).

Identifying process issues from the stakeholder perspectives may be viable in sporting contexts. The scientific rigor of such analysis could be enhanced by using methods like Ishikawa diagrams to systematically identify exact root causes of the identified issues. However, value-based analysis of athlete management processes may not be applicable immediately, since further research is essential to determine how value is created to sporting organizations from player management processes.

Process redesign

The authors adopted different strategies to redesign the analyzed processes to the best future (To-Be) state. LEAN was utilized as the basis for process redesign in one study (Krupp et al., 2017). In another article (Barbagallo et al., 2015), a transformational approach to process redesign was induced, where an "out of the frame" vision for redesigning the process was described. Business process re-engineering was also introduced as a strategy for redesigning histopathology service (Brown, 2004). Ryan, Doster, Daily, & Lewis (2016) incorporated multiple redesign approaches including continuous process improvement, best practices and business process re-engineering with a Plan-Do-Study-Act (PDCA) cycle. The rest of the articles did not explicitly provide information on the exact process redesign approach used. However, as illustrated in Figure 2, the authors mapped 8/14 articles to an instance in the process redesign orbit based on the strategies described to remodel the analyzed processes. In 2/14 articles, the specific redesign strategy adopted could not be determined. Finally, the resulting processes created after process redesign were modelled from process modelling methods as the To-Be state of the process.

It may be practical to consider an inward-looking approach (redesigning from the view of host organization) to redesign athlete management processes, as more outward-looking strategies (redesigning from benchmarks set from similar better-performing organizations) will be less practical. This is because there likely exists a lack of open innovation between similar sporting organizations as every team wants to obtain a tactical advantage based on its own operating model, resulting in a closed operational structure.

Process implementation

In 7/14 studies, the redesigned processes were implemented with a Business Process Management System (BPMS), and in two of those articles (A. Fernández et al., 2020; Janiesch & Fischer, 2009), a Service Oriented Architecture (SOA) was used as a process implementation framework. Improving the existing system through modifications (2/14) was another method adopted for process implementation. However, a proportion of studies (5/14) concentrated on developing a new digital intervention. Web based and mobile driven user interfaces linked with a relational database for data storage was used in developments comprising of new digital interventions. We encourage readers to refer to Table 1 for specific details on the digitization conducted in each article and the technologies that were used to implement the optimizations.

While the specific methods to implement a redesigned player management process may depend on the nature of the optimization task, like healthcare process implementations being required to communicate with health information systems, sport process implementations may need to communicate with already available Athlete Management Systems (AMS) that are commonly used in sporting environments.

Process monitoring

Most articles (9/14) adopted a pre-post study method and evaluated specific KPI's to determine the effects created due to the BPM interventions. Five articles from the latter group of studies used statistical tests or methods to determine the significance of changes in performance KPI's due to the intervention. Furthermore, charts (bar and run charts) were incorporated to visually represent and monitor the outcomes created due to the interventions. An audit was also conducted to determine the effects generated due to a BPM intervention. In the remaining 5/14 articles, feedback was obtained from the relevant system users to assess the usability and impact due to the intervention. Questionnaires adopting Likert or similar numerical scales were deployed to quantify and monitor the effectiveness of the introduced systems from the user viewpoint. No study adopted dashboards to monitor the performance of the optimized processes or provided details on repeating the BPM lifecycle.

All the methods used for process monitoring in healthcare may be adopted to sporting environments. However, as the availability of defined process KPI's to measure performance of player management processes may be rare, specific KPI's may need to be defined first in sporting contexts to evaluate the effects from process optimizations (e.g., time to injury notification, quality of information).

Discussion

Translating findings from BPM in healthcare to sports

The main aim of the systematic review was to understand the different methods and strategies adopted in each stage of the BPM lifecycle when optimizing healthcare processes to be utilized as guidelines for introducing BPM to sports. Although the articles in the review attempted to assess the pre-post changes in a selected healthcare process due to a BPM optimization or analyze the usability and applicability of an intervention from the user viewpoint, the overall quality of the experiments designed to evaluate such outcomes were suboptimal. This was mainly because the BPM applications in healthcare settings concentrated more on elaborating the intervention itself rather than designing robust experiments to analyze the impact of such interventions on the considered processes. Therefore, it was not possible to make an overall judgement on the impact of BPM in healthcare.

While more scientifically rigorous experiments (e.g., minimizing bias in the pre-post studies, utilizing validated questionnaires for usability assessments) may help to better evaluate the overall effectiveness of BPM in healthcare, the outcomes from the quality assessment alone should not discourage sports practitioners to experiment with adopting BPM in sporting contexts. Instead, the overall results from the systematic review should encourage sport practitioners to test BPM in sporting settings and report its effectiveness for optimizing athlete management processes. Particularly, the similarities between the patient management processes considered in the review and specific player management processes in sports should provide practitioners with the confidence to experiment with BPM in sporting contexts. However, unlike in healthcare, authors introducing BPM applications to sporting environments must be mindful of designing scientifically rigorous usability and pre-post assessments to evaluate the impact of BPM in sports.

Business Process Management in healthcare

Authors acting as primary participants for BPM applications in healthcare created a situation where interventions were synthesized based only on the developer's viewpoint. In such instances, although engaging users of the developed systems to assess the interventions at later stages of the BPM lifecycle may help to reduce risks, it cannot achieve the complete benefits that are created when stakeholders interact early in the BPM lifecycle.

BPM lifecycle in healthcare

Identification of patient management processes for BPM interventions from the solitary perspectives of the authors and the justification of those choices based on literature reviews illustrated limited interaction with actual users or beneficiaries at early stages of the BPM lifecycle to determine if optimization of the considered processes truly contributed to the overall goals or objectives of an organization.

Discovering information on the identified processes based on interviews, surveys, questionnaires and meetings with process stakeholders or process owners created possibilities to discover the considered processes from actual user viewpoint. Whereas, reviewing existing data or referring to clinical practice guidelines for data collection had allowed limited opportunities for BPM intervention developers to gain a first-hand practical experience of actual execution of the identified processes.

Value-based analysis of healthcare processes was possible due to the clear definition of value pathways in healthcare settings (Marzorati & Pravettoni, 2017). This is because patients are depicted as consumers of healthcare organizations (since patients are willing to pay for the services obtained from a medical institution) (Nordgren, 2009). Therefore, value pathways in healthcare settings were defined in relation to the services provided to the patients. Additionally, stakeholder-based process analysis allowed to identify issues from the viewpoints of actual day-to-day users of the considered processes.

For process redesign, articles in the review placed less emphasis on elaborating the specific redesign approaches adopted. However, it could be specified that the primary redesign heuristic was based on task automation.

Implementing the redesigned processes from systems built on techniques like Representational State Transfer (REST), Internet of Things (IoT) and Service Oriented Architectures (SOA) assisted in achieving modern digitization requirements such as remote patient management. A key feature of the implemented digital interventions was their ability to interact with already available health information systems.

Within the process monitoring stage, the scientific rigor associated with statistical tests conducted to assess the impact of BPM interventions can be further improved as no study reported priori sample size calculations, power calculations etc. In all studies, the pre-post and usability assessments were not blinded to the system developers. None of the articles adopted a validated questionnaire in literature for usability assessments. Instead, the authors developed their own questionnaires and provided no details on validating them prior to usage.

Business Process Management for sports

The findings from the systematic review have provided guidelines to consider when implementing BPM based digital interventions in sporting contexts. Specifically, based on outcomes of the review, aligning to the BPM lifecycle presented by Dumas et al. (2018) and in reference to additional BPM literature, a stepwise approach for applying BPM to optimize and digitally transform data driven player management processes in professional sports has been proposed below and diagrammatically outlined in Figure 3.

Step 1 - Identification of data driven player management processes for optimization

- In sporting environments, it is suitable to identify player management processes for optimization to meet strategic organizational goals (e.g., game strategy, organizational culture, coaching strategy) or from specific management initiatives (e.g., an initiative to enhance the information quality for player management decision processes). This approach will help to perceive a sporting institution as a complete entity and recognize key points within its operational process which require improvements to assist in meeting the overall organizational goals. In comparison to current situations in sporting environment, where optimization projects tend to be selected with minimum analysis on how they would impact the overall organizational objectives, the proposed approach to process identification may help to create optimization solutions which would solve genuine problems in a sporting organization.

- To identify the key processes in a sporting organization requiring improvements, a portfolio (Rosemann, 2006) of all data driven player management processes could be formulated prior to process prioritization to define the process architecture of the organization and senior management (e.g., head of performance, head of coaching) can qualitatively rate the current state of each process based on the below specified criteria (Dumas et al., 2018). Player management processes with direct data interaction (e.g., planning resistance training, acute health assessment) could then be identified and prioritized based on the evaluation outcomes,
    - Strategic importance of the process.
    - Health of the process (e.g., management can rate their perception of current information quality).
    - Feasibility of the process for optimization (e.g., whether the process is associated with organizational politics).
- The prioritized player management processes for BPM interventions could be measured (KPI) in terms of time (e.g., time for soft tissue treatment), quality (e.g., quality of information for decision making), flexibility (e.g., ability to operate as normal during unexpected scenarios such as a player being tested positive for COVID-19) or cost (e.g., cost for treatment).
- Given the multidisciplinary nature of stakeholders relating to professional sport performance outcomes (e.g. physical, technical-tactical, medical and psychological), integrating key stakeholders as multidisciplinary teams at the early stages of BPM lifecycle would help to create digital interventions from viewpoints of all the actual users (Brocke et al., 2014).

Step 2 - Discovering details on identified player management processes (As-Is)

- Interviews and/or meetings with the relevant process owners (e.g., physiotherapists, coaches, player conditioning staff) of the identified processes can be conducted to collect data on their current state.
- Collected data from the interviews may be converted to current state process models using BPMN or UML and specific decision points using Decision Requirement Diagrams (DRD) (Bazhenova, Zerbato, Oliboni, & Weske, 2019) and decision tables (Calvanese et al., 2018) in Decision Modelling and Notation (DMN). For BPMN, practitioners can refer to international standards (ISO/IEC, 2013) as a guideline for this purpose.

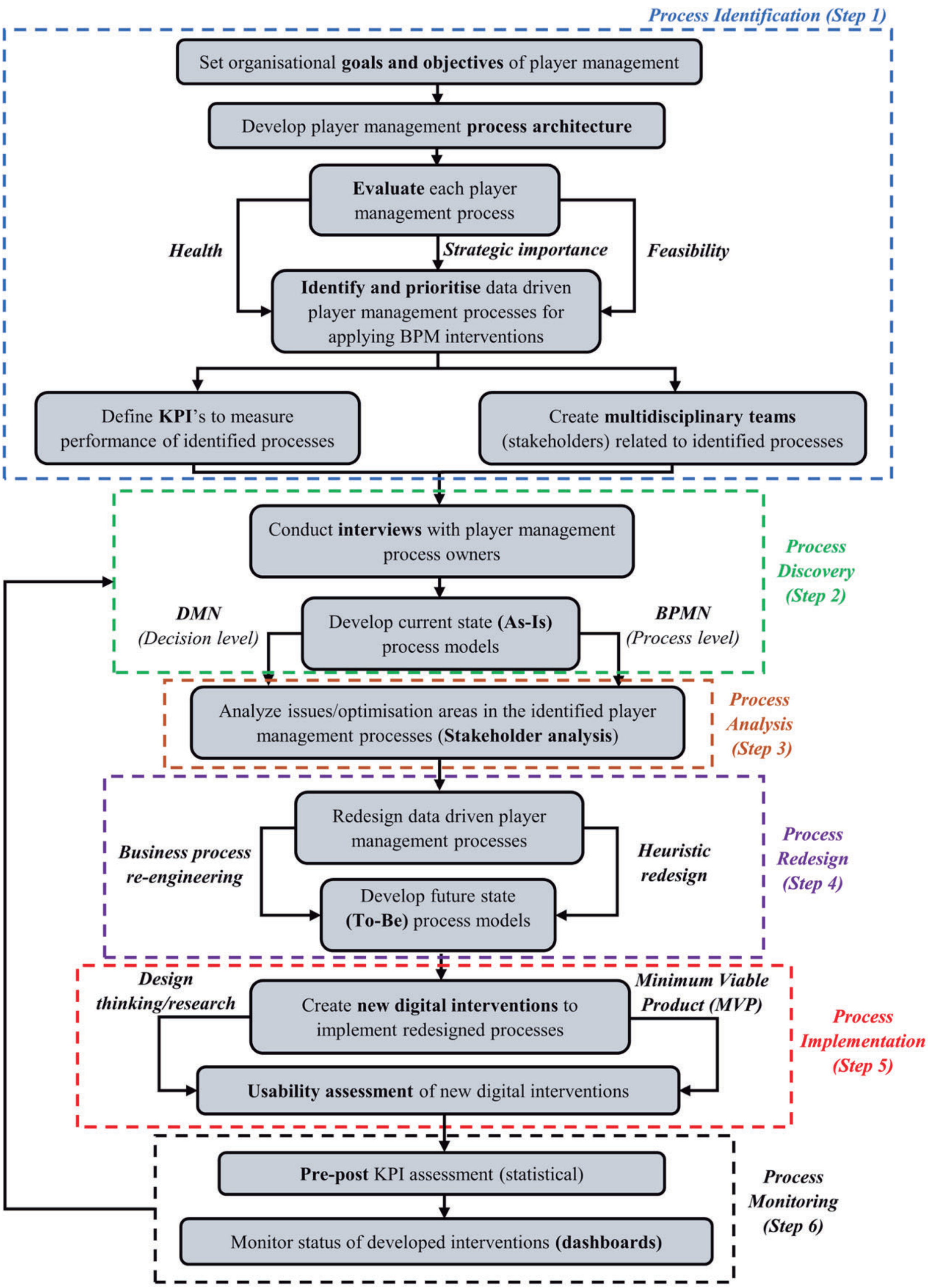

Figure 3. The pathway of proposed BPM methods for optimizing data driven player management processes in sports.

Step 3 - Analyzing As-Is state of discovered sports processes

- Any issues in the current player management processes could be identified using Stakeholder Analysis (Dumas et al., 2018). Stakeholders relevant to athlete management processes may be easily accessible during BPM project execution, knowledgeable on the process operating dynamics and fair in understanding specific requirements for optimization within the considered process. Additionally, fundamentals of LEAN could be applied to identify factors such as overburden and over processing experienced by staff (Delgado, Albernaz, & Sarmento, 2011).
- Value pathways associated with player management processes are not clearly defined in current literature. However, staff in player management processes are adding value on a player to be available at optimum performance levels (physiologically, tactically, etc.) during the game. Therefore, practitioners performing activities directly on the player for performance management (e.g., strength and conditioning coach delivering a strength session), health management (e.g., physiotherapist conducting soft tissue treatment), coaching strategy (e.g., coaches providing tactical information), etc. could be deemed value adding tasks. On the contrary, tasks not directly associated with managing the player could be categorized as non-value adding (e.g., players waiting for treatment). The authors wish to encourage the readers to explore such thoughts on value creation in sports and potentially define value pathways in player management processes in future.

Step 4 - Redesigning player management processes (To-Be)

- As discussed previously, more inward-looking redesign methods such as Heuristic Redesign (Pereira, Lapão, Scalabrin Bianchi, & Amaral, 2020) or Business Process-Reengineering (Bhaskar, 2017) may be used to redesign the player management processes to overcome the issues identified in the analysis phase.

Step 5 - Implementing redesigned sports processes

- Following design thinking/research (Blessing & Chakrabarti, 2009; Lacome, 2020) approaches to innovate new digital interventions could be a practical mode of process implementation in sports. Instead of having lengthy design stages, using concepts such as Minimum Viable Products (MVP) could shorten lead times and allow design validation with already connected stakeholders (Nguyen Duc, Khalid, Bajwa, & Lønnestad, 2019; Reis, 2011). Due to the fast-paced operational nature within professional sports, developing digital interventions on mobile or web-based platforms, coupled with databases for data storage would be more ideal. Additionally, strong attention must be given to allocate necessary security measures for data protection on digital interventions associated with athlete data (Osborne & Cunningham, 2017).
- The usability of the implemented digital interventions must be analyzed from the user viewpoint. For summative tests (to analyse how well a system performs), standard usability assessment questionnaires (Sauro & Lewis, 2016) like the System Usability Scale (SUS) (Brooke, 1995) can be used. For formative usability assessments (to identify specific issues in a system), sport practitioners could use usability evaluation

methods like Cognitive Walkthroughs (Mahatody, Sagar, & Kolski, 2010) or usability testing techniques like Think Aloud (users discussing their thoughts when interacting with a system during testing) (Alomari, Ramasamy, Kiper, & Potvin, 2020; Nielsen, 2012).

Step 6 - Process monitoring in sports

- The effects of implemented digital interventions on player management processes need to be assessed as pre-post statistical tests based on the measured KPI's.
- Strategic dashboards could be designed to visualize critical data metrices of player management processes based on statistical analysis of process evaluation KPI's (Perin et al., 2018). There exists guidelines in sports literature to support the development of such data visualization platforms (Robertson, Bartlett, & Gastin, 2016). Additionally, operational dashboards and periodical audits could also be used to determine if the introduced digital interventions operate as per the design expectations.

Conclusion

Business Process Management has great potential to optimize player management processes in sports as they are service oriented in nature and bound by information pathways. It can be concluded that techniques used in all phases of the BPM lifecycle in healthcare can be adopted to sporting contexts. However, methods for process identification, redesign and implementation stages have been reinforced based on the wider BPM literature. Additional stronger emphasis has been given to elaborate process monitoring strategies with the goal of motivating future authors to design scientifically adequate experiments to evaluate the outcomes from BPM interventions in sports.

There may be a lack of initial knowledge for the player management process owners on BPM. Hence, initial knowledge transfer sessions on BPM, in sporting environments may be necessary. Operational processes in sporting environments are less process oriented and more human focused. Therefore, player management processes are dictated by the execution strategy of the process owner rather than on clearly defined process pathways. Hence, as already experienced within healthcare (Buttigieg, Dey, & Gauci, 2016), initial challenges for adaptation of more process-oriented techniques such as BPM could be expected within sporting environments. Additionally, the review illustrated the requirement for information technology knowledge when developing digital interventions. Specific knowledge on software development, database management, hardware synchronization and modern technical domains such as Internet of Things (IoT) are highlighted within the new digital intervention developments in healthcare. Therefore, incorporating individuals with such technical skills within sporting environments will require significant emphasis for successful optimization and digital transformation of data driven player management processes based on BPM.

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Appendix A

Search terms

PubMed, Medline, Academic Search Complete, SPORTDiscus and IEEE Xplore

(BPMN OR "business process management" OR "value stream mapping" OR "Unified Modelling Language" OR "business process modelling") AND (health* OR clinical OR hospital OR medical)

Science Direct

(BPMN OR "business process management" OR "value stream mapping" OR "Unified Modelling Language" OR "business process modelling") AND (healthcare OR clinical) NOT (manufacturing)

Scopus

(BPMN OR "business process management" OR "value stream mapping" OR "Unified Modelling Language" OR "business process modelling") AND (healthcare OR clinical OR hospital OR medical) AND (patient)

Search results

Table A. Search results for each database

Database	Results
PubMed	188
IEEE Xplore	168
Scopus	444
Science Direct	1001
Medline	188
Academic Search Complete	237
SPORTDiscus	6
Other references	5
Total	**2237**

After removing duplicates, the final number of papers were reduced to **1554** papers for the analysis.

Appendix B

Complete quality assessment ratings

Table B. Results from quality assessment of all pre-post studies without a control group conducted by using National Institute of Health (NIH) Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group.

Yes	
No	
Other (CD, NA, NR)	
CD - Cannot Determine / NA - Not Applicable / NR - Not Reported	

Study	1. Was the study question or objective clearly stated?	2. Were eligibility/selection criteria for the study population prespecified and clearly described?	3. Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?	4. Were all eligible participants that met the prespecified entry criteria enrolled?	5. Was the sample size sufficiently large to provide confidence in the findings?	6. Was the test/service/intervention clearly described and delivered consistently across the study population?	7. Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across all study participants?	8. Were the people assessing the outcomes blinded to the participants' exposures/interventions?	9. Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in the analysis?	10. Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?	11. Were outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (i.e., did they use an interrupted time-series design)?	12. If the intervention was conducted at a group level (e.g., a whole hospital, a community, etc.) did the statistical analysis take into account the use of individual-level data to determine effects at the group level?	Quality Rating (Poor, Fair, Good)
(Barbagallo et al., 2015)	Y	NR	N	NR	CD	Y	Y	N	NA	NA	NR	CD	**Poor**
(Becker et al., 2007)	Y	NR	CD	NR	NR	Y	Y	N	NR	NR	NR	CD	**Poor**
(Georgiou et al., 2016)	Y	NR	Y	NR	CD	Y	Y	N	NR	Y	NR	Y	**Fair**
(Janiesch & Fischer, 2009)	Y	NR	CD	NR	CD	Y	Y	N	N	Y	NR	Y	**Fair**
(Krupp et al., 2017)	Y	Y	Y	NR	CD	Y	Y	N	NR	Y	Y	CD	**Fair**
(Leu & Huang, 2011)	Y	NR	Y	NR	CD	Y	Y	N	NR	Y	Y	Y	**Fair**
(Ryan et al., 2016)	Y	NR	Y	NR	NR	Y	Y	N	NR	NR	NR	NR	**Poor**
(Brown, 2004)	Y	NR	Y	NR	NR	Y	Y	N	NR	N	Y	NR	**Poor**

Table C. Results from quality of assessment of all pre-post studies, including the study with a control group (Andellini et al., 2017) conducted by using Methodological Index for Non-Randomized Studies (MINORS) instrument.

0	Not Reported
1	Reported but Inadequate
2	Reported and Adequate)

Study	1. A clearly stated aim	2. Inclusion of consecutive patients	3. Prospective collection of data	4. Endpoints appropriate to the aim of the study	5. Unbiased assessment of the study endpoint	6. Follow-up period appropriate to the aim of the study	7. Loss to follow up less than 5%	8. Prospective calculation of the study size	9. An adequate control group	10. Contemporary groups	11. Baseline equivalence of groups	12. Adequate statistical analyses	**Overall**
(Andellini et al., 2017)	2	0	1	2	0	0	0	0	2	2	1	2	**12/24**
(Barbagallo et al., 2015)	2	0	1	2	0	0	0	0					5/16
(Becker et al., 2007)	2	0	2	2	0	1	0	0					7/16
(Georgiou et al., 2016)	2	0	2	2	0	0	0	0					6/16
(Janiesch & Fischer, 2009)	2	0	2	2	0	1	1	0					8/16
(Krupp et al., 2017)	2	2	2	2	0	1	0	0					9/16
(Leu & Huang, 2011)	2	1	1	2	0	1	0	0					7/16
(Ryan et al., 2016)	2	0	0	2	0	2	0	0					6/16
(Brown, 2004)	2	0	0	2	0	1	0	0					5/16

Table D. Results from quality assessment of usability studies using Critical Assessment of Usability Studies Scale (CAUSS).

Yes																	
No																	
Study	1. Did the study use valid measurement instruments of usability	2. Did the study use reliable measurement instruments of usability	3. Was there coherence between the procedures used to assess usability and study aims?	4. Did the study use procedures of assessment for usability that were adequate to the development stage of the product/service?	5. Did the study use procedures of assessment for usability adequate to study participants' characteristics?	6. Did the study employ triangulation of methods for the assessment of usability?	7. Was the type of analysis adequate to the study's aims and variables measurement scale?	8. Was usability assessed using both potential users and experts?	9. Were participants who assessed the product/service usability representative of the experts' population and/or of the potential user's population?	10. Was the investigator or that conducted usability assessments adequately trained?	11. Was the investigator that conducted usability assessments external to the process of product/service development?	12. Was the usability assessment conducted in the real context or close to the real context where product/service is going to be used?	13. Was the number of participants used to assess usability adequate	14. Were the tasks that serve as the base for the usability assessment representative of the functionalities of the product/service?	15. Was the usability assessment based on continuous and prolonged use of the product/service over time?*	**Consensus Score**	**%**	**Overall**
(Fernández et al., 2020)	No	No	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes	Yes	Yes	NA	**7/14**	**50.0**	Fair
(AlSalamah et al., 2012)	No	No	Yes	Yes	Yes	Yes	No	Yes	No	No	No	Yes	No	Yes	NA	**7/14**	**50.0**	Fair
(Jimenez-Molina et al., 2018)	No	No	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes	No	Yes	NA	**5/14**	**35.7**	Poor
(Osamor et al., 2014)	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	NA	**3/14**	**21.4**	Poor
(Ruiz-Fernández et al., 2017)	No	No	Yes	Yes	Yes	No	No	No	No	No	No	Yes	No	Yes	NA	**5/14**	**35.7**	Poor