Smart Health Workflows: Integrating FHIR Standard with BPMN Process Models

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***Abstract*—Interoperability in healthcare remains a critical challenge, requiring not only standardized data models for consistent information exchange but also uniform process semantics to ensure coordinated care delivery. This paper examines the integration of HL7 Fast Healthcare Interoperability Resources (FHIR) and Business Process Model and Notation (BPMN) standards by mapping FHIR Workflow resources into BPMN elements. Aligning clinical semantics with executable logic enables transparent, automated, and interoperable workflows. A remote patient monitoring scenario demonstrates enhanced care coordination, process automation, and decision support.**

***Index Terms*—healthcare, FHIR, BPMN, configurability, interoperability, automation.**

I. Introduction

In recent years, efforts in healthcare digitalization have focused on telemedicine and remote monitoring, aiming to improve accessibility and efficiency in the delivery of medical services. However, the digital transformation of healthcare systems presents critical challenges. Among them, *interoperability* is essential to enable the exchange and accurate interpretation of medical data, and *configurability* is also crucial for designing effective solutions tailored to system setups, especially in case of different patient-specific conditions [1]. In this context, the adoption of standardized frameworks addresses the need for both syntactic and semantic interoperability, while facilitating collaboration across heterogeneous systems. This enables the development of innovative solutions that can transparently support personalized and context-aware healthcare processes.

Two well-established standards offer a promising solution. FHIR provides a modular and extensible framework for representing and exchanging clinical data [2]. BPMN is a standard for the formal representation of business processes, widely adopted in domains requiring automation, coordination, and human-machine interaction [3].

The integration of these standards can enable solutions to automate personalized therapeutic plans. BPMN allows to define processes executed by specific engines. FHIR, in particular the Workflow module, enables the definition of therapeutic plans as a set of interconnected actions, ensuring correct interpretation.

Several works have explored integration of FHIR and BPMN as a strategy to automate and formalize clinical workflows. Among the most notable contributions, Helm et al. [4] propose an automated transformation approach that leverages graph-based nature of both BPMN process and FHIR PlanDefinition resources. A more recent and comprehensive approach is proposed by Beckmann et al. [5], who define a bidirectional transformation between BPMN process and FHIR PlanDefinition, supporting various BPMN elements and preserving semantic equivalence.

However, they also highlight limitations in their approach, such as the lack of support for decision logic and merging elements, and the impossibility of representing loops due to hierarchical constraints in FHIR. Furthermore, both works primarily focus on the definition of process models in BPMN and FHIR, but do not address the relationship between process instances and FHIR resources resulting from the execution of these plans. This runtime perspective is essential for enabling seamless coordination, monitoring, and integration of healthcare workflows in real-world scenario.

In this work, we propose a novel approach to enable clinical process automation through FHIR and BPMN integration. Our framework goes beyond existing efforts that focus only on process definition by also addressing process execution. We present this framework embedded within an architecture for remote patient monitoring.

II. Methodology

Our approach addresses the limitations identified in existing works. In particular, we distinguish the definition of therapeutic plans from the instance for a certain patient, both at clinical and process level. FHIR Workflow module enables the specification of how actions are coordinated for the execution of clinical plans. It is based on the Definition, Request, and Event patterns, each represented by corresponding categories of FHIR resources. Definition Pattern resources describe what could happen, independently of a specific patient or timing. Request Pattern resources express the intent to perform an action. Event Pattern resources represent something that has happened, potentially as the result of a Request.

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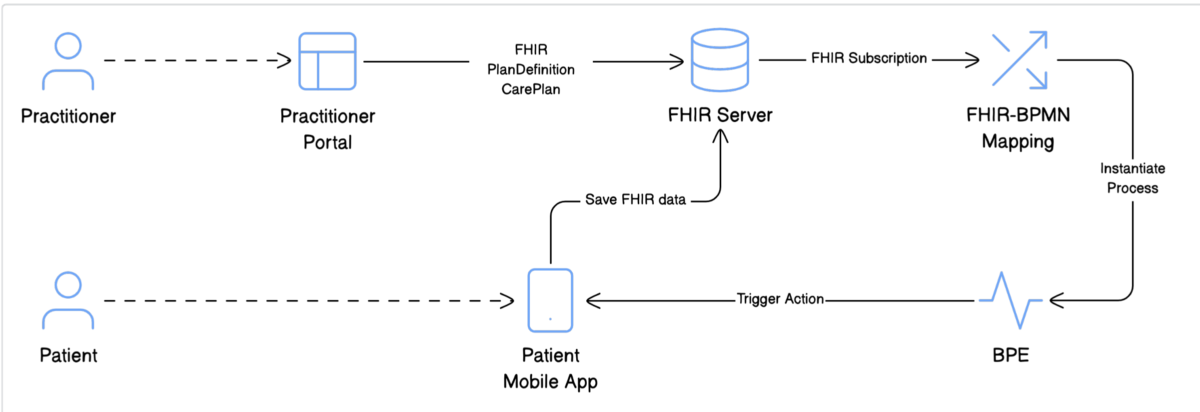

Fig. 1. Architectural schema of the proposed solution

As part of the definition mapping, FHIR Workflow Definition resources, such as PlanDefinition and ActivityDefinition, are mapped to corresponding BPMN elements. This process builds upon the BPMN-based Ontology (BBO) proposed by Annane et al. [6], which serves as a coordination point for the FHIR formatting rules and transformation mapping into BPMN elements. In this approach, each action defined in the FHIR PlanDefinition resource is associated with a specific BPMN element through its representation in the ontology. At the same time, each ontology element establishes a set of semantic and structural rules that must be satisfied to ensure that the mapping between the PlanDefinition action and the BPMN element is consistent and meaningful.

In the instance mapping phase, FHIR Workflow Request and Event resources are linked to the execution of a BPMN process within a Business Process Engine (BPE). On the FHIR side, a clinical plan defined through a PlanDefinition can be instantiated into a Request resource to represent that the plan has been assigned to a specific patient. In the presented approach, the FHIR CarePlan resource is exploited as Request resource, which lists the actions to be performed, tracks their progress, and records their outcomes through Event resources. On the BPE side, the corresponding BPMN process is executed, and a mapping is maintained between the BPMN process definition, the PlanDefinition, and the CarePlan resources.

III. Architecture

A key aspect of our work is the integration of the proposed framework within a real-world architecture for remote patient monitoring. As shown in Figure 1, the architecture has a dedicated component that handles mapping from clinical guidelines to executable processes and synchronizes their execution. It serves as a bridge between the FHIR server, which manages clinical data, and the BPE, which runs care processes. A web-based portal is provided for practitioners, allowing to define therapeutic plans and access patient data. On the patient side, a mobile application supports the execution of prescribed actions. When a clinician defines a new therapeutic plan, the system is notified via a FHIR Subscription. At that point, the mapping component generates a corresponding BPMN process definition from the PlanDefinition resource. When a plan is assigned to a specific patient, the component enriches the BPMN process definition with patient-specific input data extracted from the corresponding CarePlan resource and deploys it for execution within the BPE. The process instance interacts with the patient's mobile app to guide the patient through the required actions defined in the plan. The mobile app, communicates with the process running in the BPE, allowing the publication of flow control messages, if necessary. Action outcomes are sent to the FHIR server, where they are stored and made available for clinical evaluation.

IV. Conclusion and Future Work

In this abstract we presented our approach to integrate the FHIR and BPMN standards for enabling the automated execution of clinical care plans. While the initial results are promising, certain limitations must still be addressed. These include improving the completeness of the mapping between FHIR definitions and BPMN constructs, validating the correctness of the generated process models, and implementing appropriate fault-handling mechanisms to deal with process execution failures within the BPE.

Future work will also explore security aspects of the proposed framework, as well as the potential to extend the system with self-adaptive capabilities. By leveraging advanced BPMN constructs and runtime features of process engines, the system could adapt to evolving clinical conditions or system-level changes in real time, enhancing its robustness and clinical relevance.

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