Role-based Modeling of Business Processes with RBPMN

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Abstract: Traditionally, companies use business process (BP) models to describe and design their organizational processes involving digital entities and humans. Advances in the development of Cyber-physical Systems (CPS) allow companies to expand their BPs into the physical world. While this expansion might contribute to higher degrees of automation and efficiency of an organization's BPs, it could also negatively affect the complexity of the BP models. Existing BP notations show shortcomings when modeling interactions and responsibilities within modern dynamic processes that involve digital, human, and non-human work performers. In this work, we extend the Business Process Model and Notation (BPMN 2.0) standard with a modern understanding of *Roles* to highlight responsibilities and interactions of entities performing work in BPs. We apply the proposed extension–*RBPMN*–to BPs in a smart factory context. By using roles we achieve an improved expressiveness for modeling complex and context-sensitive BPs with a high degree of variability to tame complexity.

Keywords: Business Process Modeling, Role-based Modeling, Cyber-physical Systems

1 Extended Abstract

This extended abstract refers to our work published in the International Journal on Software and Systems Modeling (SoSyM) in 2024 [Sk24]. Cyber-physical systems (CPS) and Internet of Things (IoT) technologies introduce new types of non-human performers of work to be considered in an organization's business processes (BPs). Autonomous machines, robots and other kinds of *smart devices* may take over sophisticated tasks in BPs to facilitate their collaboration with human workers and digital services. With extending existing business process models to consider these new types of cyber-physical process performers, which are often composed of numerous sensors producing data and actuators manipulating the physical world, we have identified the following five challenges that need to be addressed by a BP modeling language to enable the modeling of modern BPs: 1) expressing different process performer types, 2) unifying stakeholder perspectives, 3) coping with BP model complexity, 4) modeling BP variability, and 5) modeling context-sensitive elements.

Following the design science research methodology, we evaluated existing BP modeling notations, most prominently the Business Process Model and Notation (BPMN 2.0) standard, regarding their capabilities of addressing these challenges. As most of the investigated languages show shortcomings in addressing all of these five challenges, we decided to

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extend BPMN 2.0 following a systematic extension process with a modern understanding of the *Role* concept [Kü17]. We consider roles to be beneficial here because of their relational, behavioral, and context-sensitive nature. The main benefits of using roles in software engineering are an increase of 1) flexibility and expressiveness to model interactions among objects and entities; 2) context-awareness and context-dependent behavior; and 3) dynamic adaptability of structural and behavioral models to cope with complexity [Kü17].

RBPMN extends the meta-model of BPMN 2.0 in a standard-conform manner with elements from the Compartment Role Object Model (CROM [Kü17]) and new role elements and role relationships. The concrete syntax of the new elements is depicted in Fig. 1. To demonstrate the novel modeling concepts we use processes from the smart manufacturing domain based on a model smart factory [Ma20]. Apart from specifying the interactions and responsibilities of process performers over time more clearly and flexibly, we are also able to show the advantages of using a role-based modeling approach to adapt the BP model complexity based on different levels of context perceptions (e.g., depending on the availability of sensor data). The evaluation of RBPMN based on workflow patterns, ontology representation, role features, and process variability frameworks confirms its expressiveness to effectively model the flexibility and context-sensitivity of BPs in dynamic and complex settings (e.g., CPS). As an extension of BPMN 2.0, RBPMN introduces role-specific constructs and context-aware modeling capabilities to facilitate the modeling of modern business processes.

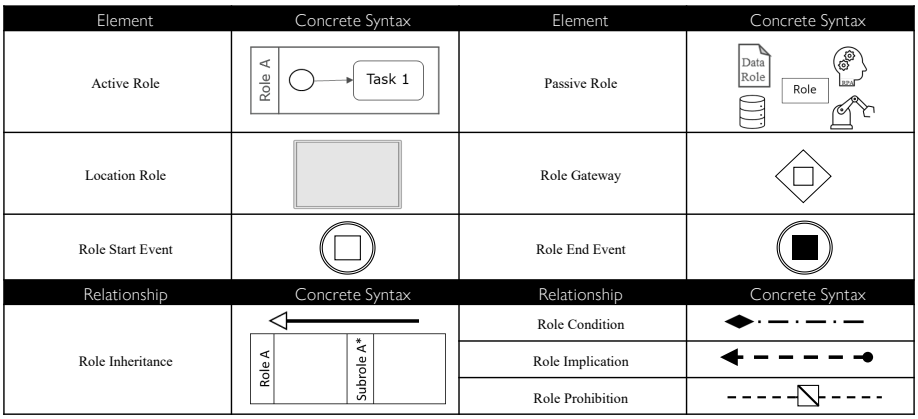

Fig. 1: Concrete Syntax of RBPMN as Extension of BPMN 2.0

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