Chapter 1

Process Mining in Production Management, Intelligent Control, and Advanced KPI for Dynamic Process Optimization:
Industry 5.0 Production Processes

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ABSTRACT

The book chapter is focused on the definition of efficient models to apply to production processes. Specifically, starting to business process modelling and notation (BPMN) approach, are defined rules and methods to integrate artificial intelligence (AI) and innovative key performance indicators (KPIs) for task checkpoints implementing a dynamic and intelligent decision-making approach. The whole theoretical mechanism constitutes a decision support system (DSS) model supporting risk analyses including aspects related to organization, predictive maintenance, and the use of technologies in the era of Industry 5.0. Particular attention is addressed on methods about the efficient monitoring of production processes by means process mining (PM) workflows. Different examples are provided in the book chapter, by enhancing the aspect related to the DSS logics and implementation of logic conditions. The discussed model opens a new topic about intelligent BPMN and process engineering including AI facilities strengthening decisions in operating processes.

1. INTRODUCTION: BACKGROUND AND BPMN FRAMEWORK

Process Mining (PM) is an important research topic of management engineering concerning the implementation of Industry 5.0 production processes using self-adaptive mechatronic facilities. Possible applications are in quality control and production efficiency processes enabling automatic setting and calibration of machine parameters.

Specifically, the PM is a 'proof of concept' that is born as Industry 5.0 perspective (Massaro, 2021 a): modern industrial process workflows are characterized by Artificial Intelligence (AI) decision making phases enabling specific sub-processes. The initial concept was later expanded to Business Process Modelling and Notation (BPMN) modelling of operations of production machines (Massaro, 2022 a) and to risk assessment in industrial scenario (Massaro, 2022 c). A recent study highlights the importance and the utility of PM in industrial manufacturing processes requiring advanced mechatronic systems (Massaro, 2023). The goal of this chapter is just to provide elements about the matching between AI-based mechatronic systems and PM model execution.

PM is a particular BPMN workflow representation based on AI algorithms behaving as process decision making. The PM can be implemented to enable the entire process of automation and control. The control and the actuation processes can be performed by Decision Support Systems (DSSs) which play an important role in the automatic decision-making processes, especially when a robotic action must be performed (Massaro, 2021a). DSS workflows can be designed and integrated into process workflows embedding AI engines (Massaro, 2021b). The workflows sketch actions and working activities in operative processes. BPMN is tool adopted to design workflow modelling processes (Massaro, 2021c), and it is suitable to highlight DSSs functions in operative workflows (Massaro, 2022 a). The DSSs are modelled as a part of the whole BPMN process referred to the AI-based decision making sub-process.

1.1 BPMN Main Symbols

The main BPMN symbols useful to design a process are listed in Table 1. The symbols are classified as events, tasks and gateways. All the symbols are linked constituting workflows modelling a process or a sub-process. The workflows are contained into pools (containers of workflows dedicated to a specific actor of the system). A full process could be composed by different pools, since a simpler system could require only one pool. Different pools are graphically arranged into a sequential vertical scheme. A pool refers to a system of actors or to a software platform such as a portal addressing the actions to do by means a dropdown menu representing the phases of a process.

The digital BPMN model is the first step to digitize processes in companies oriented on digital transformation.

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