



## **Title**

Machine Learning and Artificial Intelligence for Operations Management

## **Background**

Machine Learning and Artificial Intelligence are spreading nowadays in many different industries and contexts. However, real applications and benefits in Operations management field are still scarce and limited in companies. Some researches, for example, have been directed in the investigation of Artificial Neural Network in the Production Planning and Control area with the benefit of improving due date predictions and thus delivery related performances.

Other researches have been directed in the application of machine learning algorithm to predict and prevent machine failures with the benefit of scraps reduction – enhancing the sustainability - and cost savings.

Some others have been investigating the application of machine learning to better predict bottlenecks of production lines with the aim to improve lead times and customer satisfaction.

## **Objective**

Explore the literature to identify possible applications of machine learning and Artificial intelligence in Operations management and test the proposed methodology in a simulated environment.

## **Research methodology**

Literature Review – Machine learning/Artificial Neural Networks - Simulation



## Title

Worker Training in unbalanced lines

## Background

Most research on make-to-order shops assumes capacity to be reasonably fixed in space. However, in practice workers are often flexible and can be shifted from one station to another. In other words, workers are assigned to an overlapping range of stations, something called baton-zone bumping in Protzman et al. (2016). While it is obvious that techniques as baton-zone bumping are most effective if all workers are equally efficient at all stations, it is often not desirable to rely on such a highly skilled work force. Using a heterogenous workforce, instead of a homogenous, can provide significant reduction in training need and costs for companies. However, existing literature does not explain which is the optimum way to allocate workers in a flow shop line considering different workers proficiency. The aim of this research is to investigate different efficiency matrices derived from the literature (i.e. bowl phenomenon) to provide guidance to managers on how to train their workers to improve shop floor performances. How to allocate workers with different skills and efficiency in a flow shop line to have the best performances?

## Objective

Explore the literature to identify different matrix designs, such as baton zone and bowl phenomenon and assess, via simulation, performances of the different designs in a pure flow shop with high variety in demand and processing times.

## Research methodology

Simulation (Python programming language or SIMIO simulation software)



## **Title**

Production Planning and Control in MTO and services companies

## **Subtitle**

A way to reduce workload imbalances: labour's flexibility

## **Background**

Nowadays the importance and implementation of production planning and control techniques in non-repetitive manufacturing companies and services companies is increasing to foster companies' performances. Indeed, there is a change of needs due to higher customization in industries, particularly small and medium sized companies and services companies. Due to uncertainty in demand, there is lot of variation in the process which is amplified from downstream to upstream. Several methods and techniques are applied to mitigate this variation. As stated by (Stevenson et al., 2005) "Workload Control is the most appropriate planning and control technique approach for make to order companies, both for general job shop and for general flow shop production". Workload Control is a planning and control technique concept developed for high-variety job shops and it allows to regulate the inflow of work to the system and, at the same time, uses capacity adjustments to regulate the outflow of work from the system. However, the application of this technique is also feasible in services companies.

## **Objective**

Investigation of capacity adjustment's methods and how they can be effectively carry out and managed, with a focus on the increasing importance of employee' flexibility and efficiency for academics and practitioners, accordingly to "making people before making products" envisaged by Lean management culture.

## **Research methodology**

Simulation (Python programming language or SIMIO simulation software)



## **Title**

Production Planning and Control in MTO and services companies

## **Subtitle**

Capacity Adjustments methods and Order Review and Release integration

## **Background**

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## **Objective**

Investigation and analysis, via simulation, of workload control's mechanisms (Input and Output) with the aim to assess how companies can benefit from the complementary effects of the output and input control mechanisms.

## **Research methodology**

Simulation (Python programming language or SIMIO simulation software)



## **Title**

Labor Flexibility & Human-Centric Workload Control in the Industry 5.0 Era – Part 1

## **Background**

The workforce is often the most flexible resource for managing capacity in manufacturing companies. Workers can work at different stations and be reallocated when needed. Workforce flexibility may be attained through employee cross-training or by adopting adaptable work schedules, including the strategic use of overtime. Overtime defined as the time workers work beyond their regular or scheduled working time is often used in production systems to address short-term capacity problems, to deal with demand variability, to manage uncertainty in production time, and to meet orders due dates. Despite its widespread use in practice, overtime as a capacity adjustment mechanism has been relatively overlooked in academic research.

Kingsman & Hendry (2002) discovered that overtime could significantly reduce manufacturing lead times compared to worker reallocation. However, there are potential drawbacks, such as operational inefficiencies when some workers are idle during others' overtime periods. Overtime can be applied to all workers or a subset of workers.

## **Objective**

Decide between Overtime and Labor Flexibility decision with heterogeneous workforce

## **Research methodology**

Literature review/Modelling/Discrete Event Simulation/Python



## **Title**

Labor Flexibility & Human-Centric Workload Control in the Industry 5.0 Era – Part 2

## **Background**

The workforce is often the most flexible resource for managing capacity in manufacturing companies. Workers can work at different stations and be reallocated when needed. Workforce flexibility may be attained through employee cross-training or by adopting adaptable work schedules, including the strategic use of overtime. Overtime defined as the time workers work beyond their regular or scheduled working time is often used in production systems to address short-term capacity problems, to deal with demand variability, to manage uncertainty in production time, and to meet orders due dates. Despite its widespread use in practice, overtime as a capacity adjustment mechanism has been relatively overlooked in academic research.

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## **Objective**

Developing Human-Centric Workload Control in manufacturing flow shops

## **Research methodology**

Literature review/Modelling/Discrete Event Simulation/Python



## Title

Labor Flexibility & Human-Centric Workload Control in the Industry 5.0 Era – Part 3

## Background

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## Objective

How labor flexibility can mitigate worker absenteeism?

## Research methodology

Literature review/Modelling/Discrete Event Simulation/Python



## Title

Study of Walking Worker Strategies Considering Bottleneck Operations and Batching Processes

## Background

Manufacturing and service systems often involve workers who move between stations to perform tasks, inspect materials, or support automated processes. These walking workers play a critical role in maintaining production flow, especially in labor-intensive industries, warehouses, and hybrid automated-manual systems. Their efficiency may be highly influenced by system characteristics such as bottleneck operations and batching processes, impacting throughput, cycle time, and worker utilization.

Despite growing attention to flexible manufacturing with walking workers, limited research explicitly analyzes the interplay between walking worker strategies, bottleneck constraints, and batch processes. This study aims to close this gap by developing and evaluating strategies for walking worker allocation and movement under such conditions.

## Research Question(s)

How do walking worker strategies influence throughput in systems dominated by bottleneck operations and batching processes?

What batching policies (fixed-size, dynamic) best complement walking worker allocation strategies?

## Research methodology

literature review, discrete-event simulation (DES)

## Software

<https://www.simio.com/>



## Title

Integrating Demand Driven MRP and Workload Control for Enhanced Manufacturing System Performance

## Background

In today's volatile and complex manufacturing environments, companies face increasing pressure to improve responsiveness, reduce delivery times, and enhance overall operational efficiency. Traditional Material Requirements Planning (MRP) systems, while foundational, often struggle to cope with demand variability and can lead to the "bullwhip effect," resulting in inventory imbalances and poor customer service. Demand-Driven Material Requirements Planning (DDMRP), a more recent approach, aims to address these limitations by strategically decoupling the supply chain and using demand-driven buffers to improve flow and reduce lead times.

On the other hand, effective Workload Control (WLC) mechanisms are crucial for managing capacity constraints and ensuring smooth production flow within the shop floor. By regulating the release of jobs into the production system, WLC aims to prevent overloading, reduce work-in-progress (WIP), and improve due-date performance.

While both DDMRP and WLC offer significant benefits independently, their synergistic potential remains largely unexplored. This research proposes investigating the integration of DDMRP principles with various WLC strategies to understand how they interact and influence overall manufacturing system performance. Discrete Event Simulation (DES) will be employed as the primary research methodology to model and analyze the dynamic behavior of these integrated systems under different operational conditions.

## Research Question(s)

How does the integration of DDMRP principles with different Workload Control strategies impact key manufacturing performance metrics (e.g., throughput time, inventory levels, on-time delivery, resource utilization, etc.)?

## Research methodology

literature review, discrete-event simulation (DES)

## Software

<https://www.simio.com/>

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Integrating Demand Driven MRP and Workload Control for Enhanced Manufacturing System Performance

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## Research Question(s)

What are the critical factors and interactions between DDMRP parameters (e.g., buffer sizing, penetration time) and WLC parameters (e.g., release rate, workload norm) that influence the performance of the integrated system?

## Research methodology

literature review, discrete-event simulation (DES)

## Software

<https://www.simio.com/>

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## Research Question(s)

Under what operational conditions (e.g., demand variability, capacity constraints, product mix) do the integration of DDMRP and specific WLC strategies yield the most significant performance improvements?

## Research methodology

literature review, discrete-event simulation (DES)

## Software

<https://www.simio.com/>

## Title

Discrete Event Simulation and AI for Workload Control in Manufacturing Systems

## Background

Modern manufacturing systems are increasingly complex, characterized by high product variety, fluctuating demands, and complex workflows. Workload Control (WLC) has emerged as a key production planning and control concept, particularly suited for make-to-order (MTO) environments. WLC aims to balance workload and capacity by controlling the release of jobs to the shop floor, improving delivery performance, and thus competitiveness.

Discrete Event Simulation (DES) has been widely used to model, analyze, and evaluate WLC systems due to its ability to capture system dynamics over time. Meanwhile, Artificial Intelligence (AI), particularly machine learning and heuristic optimization, presents new opportunities to enhance WLC by enabling adaptive, data-driven, and predictive decision-making.

This research aims to integrate DES and AI techniques to develop a hybrid, intelligent system for workload control that improves responsiveness, efficiency, and robustness in complex production environments.

## Objective

To develop an integrated framework combining DES and AI for adaptive and intelligent workload control in manufacturing systems.

## Research methodology

literature review, discrete-event simulation (DES) potentially in Python