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The Enabling Technologies for Digitalization in the Chemical Process Industry

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Highlights

- **Identified** and **categorized** the enabling technologies for digitalization.
- Identified the **problem domains** and **development aspects** that characterize the chemical process industry.
- Selected the technologies **most essential** to bridging the gap between problem and solution.
- Provided **case studies** to cast a spotlight on the use of **state-of-the-art technologies**.

Introduction

The chemical process industry is facing critical **problems** including:

- **Skills shortage** in the labour market.
- Reaching **its sustainability goals** in the face of changing climate realities.
- **Transitioning** from existing feedstock and energy sources to alternative, more sustainable ones.

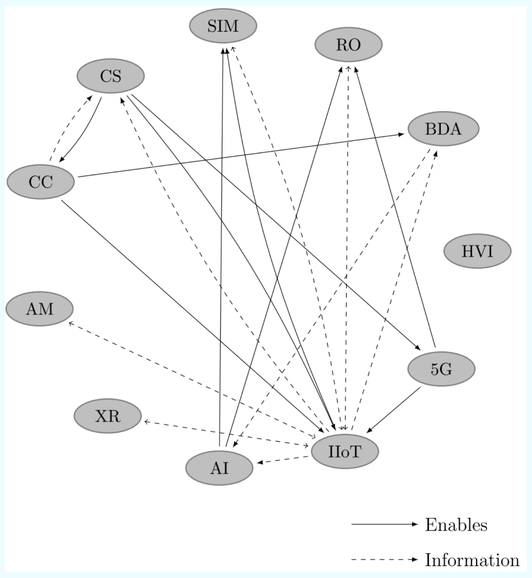
In this work, we answer:

- Which digital technologies can be implemented in the industry to solve these problems?

Enabling Technologies

Identified **eleven technologies** that enable digitalization [1]:

- Big Data and Analytics (BDA)
- Autonomous Robots (RO)
- Simulation (SIM)
- Cloud Computing (CC)
- Additive Manufacturing (AM)
- Extended Reality (XR)
- Artificial Intelligence (AI)
- Industrial Internet of Things (IIoT)
- Cybersecurity (CS)
- 5G
- Horizontal and Vertical Integration (HVI)



Problem Domains and Development Aspects

Problem domains are the areas within a chemical plant from which problems come from. We identified four:

- Maintenance
- Production
- Safety Management
- Supply Chain Management

Development aspects are the areas within a chemical plant that lend themselves to digitalization. We identified six:

- Assets
- People
- Feedstock
- Energy
- Spare Parts
- Site

With the help from domain experts, we constructed a **digitalization matrix** identifying the development aspects that lend themselves to digitalization to solve problems coming from the four domains.

	Maintenance	Production	Safety management	Supply chain management
Assets	✓	✓	✓	✓
People	✓	✓	✓	
Feedstock		✓		✓
Energy		✓		✓
Spare Parts	✓			
Site	✓	✓	✓	✓

Digital Solutions to Industry Problems

We descried the opportunities for digitalization by identifying **use cases** of specific technologies being deploy on development aspects to solve issues arising in the problem domains.

Problemdomain	Developmentaspect	BDA	RO	SIM	CC	AM	XR	AI	IIoT	CS	5G	HVI
Maintenance	Assets	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
	People	✓			✓		✓	✓		✓	✓	✓
	Spare Parts					✓						
	Site	✓	✓		✓		✓	✓		✓	✓	✓
Production	Assets	✓		✓	✓	✓		✓	✓	✓	✓	✓
	People	✓			✓		✓	✓		✓	✓	✓
	Feedstock	✓		✓				✓				
	Energy	✓		✓				✓				
	Site	✓	✓		✓			✓		✓	✓	✓
Safety	Assets	✓		✓	✓		✓	✓	✓	✓	✓	✓
	People				✓	✓	✓			✓	✓	
	Site	✓	✓		✓		✓	✓		✓	✓	✓
Supply Chain Management	Assets	✓		✓	✓			✓	✓	✓	✓	✓
	Feedstock	✓		✓				✓				
	Energy	✓		✓				✓				
	Site	✓			✓			✓	✓	✓		

Evaluation

We surveyed industry experts to gain a better understanding into the **technology acceptance** of the identified technologies [2]. The results are summarized as.

	Top 3	Bottom 3
Usefulness	Artificial Intelligence Simulation Big Data and Analytics	Additive Manufacturing Autonomous Robots Extended Reality
Ease of Implementation	Cloud Computing 5G Cybersecurity	Autonomous Robots Artificial Intelligence Extended Reality
Intent of Use	Simulation Big Data and Analytics Artificial Intelligence	Additive Manufacturing Autonomous Robots Extended Reality

References

[1] Ortiz, Jesús Hamilton. "Industry 4.0: Current status and future trends." (2020).

[2] Davis, Fred D. "Perceived usefulness, perceived ease of use, and user acceptance of information technology." *MIS quarterly* (1989): 319-340.

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