LIAISE | Cooperation, development and cross-border transfer of industrial symbiosis

Stakeholders' Engagement: Identifying, Collaborating, and Building Trust in Industrial Symbiosis Networks

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LIAISE Industrial Symbiosis Training School

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cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Stakeholders' Engagement in Industrial Symbiosis (IS)

Agenda

1. Introduction
2. What is Innovation?
3. Industrial Symbiosis (IS) vs. Circular Economy (CE)

Case Study: Kalundborg Industrial Symbiosis vs. BMW's Circular Economy Approach

Case Study: Toyota's Kanban and Zero Waste vs. BMW's Circular Economy Approach – Evolution of sustainable manufacturing

4. Stakeholder Engagement and Collaboration in IS

Workshop: Stakeholder Analysis for OneHealthDrugs Action

5. Building Trust and Cooperation in IS Networks

Case Study: SymbioCity (Sweden) – Trust-building in Industrial Symbiosis through governance and digital tools

Mini-Activity – Designing a Trust-Building Framework for Industrial Symbiosis

6. Policy, Regulation, and Digital Transformation in IS

Interactive Exercise – Designing Policy & Digital Strategies for IS

Case Study: Rotterdam Industrial Symbiosis – Government and digital solutions enabling IS success

7. Final Project Development: Crafting Actionable IS Initiatives

Case Study: Kalundborg Industrial Symbiosis – Lessons for scaling IS initiatives globally

1. Introduction to the Session

Overview of the Session

- Understanding Stakeholders' Engagement in Industrial Symbiosis (IS)
- Exploring the role of businesses, local governments, communities, and NGOs
- Learning how to build trust and collaboration for successful IS networks

Objectives & Expected Outcomes

- Gain insights into stakeholder engagement strategies
- Learn about policy frameworks and digital tools supporting IS
- Develop practical skills for IS implementation
- Participate in an interactive case study to apply concepts

2. What is Innovation?

Understanding Innovation in Industrial Symbiosis

Definition & Key Concepts

- Innovation refers to the **introduction of new methods, ideas, or products** that improve **efficiency**, **sustainability**, or **competitiveness**.

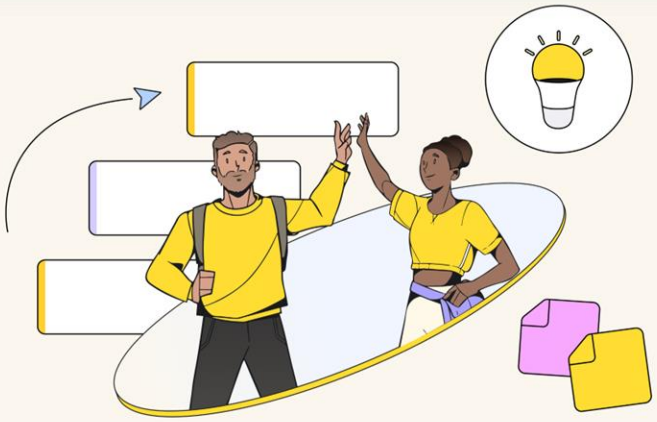
- In the context of **Industrial Symbiosis (IS)**, innovation plays a crucial role in optimizing resource flows, fostering collaboration, and implementing sustainable business models.

2. What is Innovation?

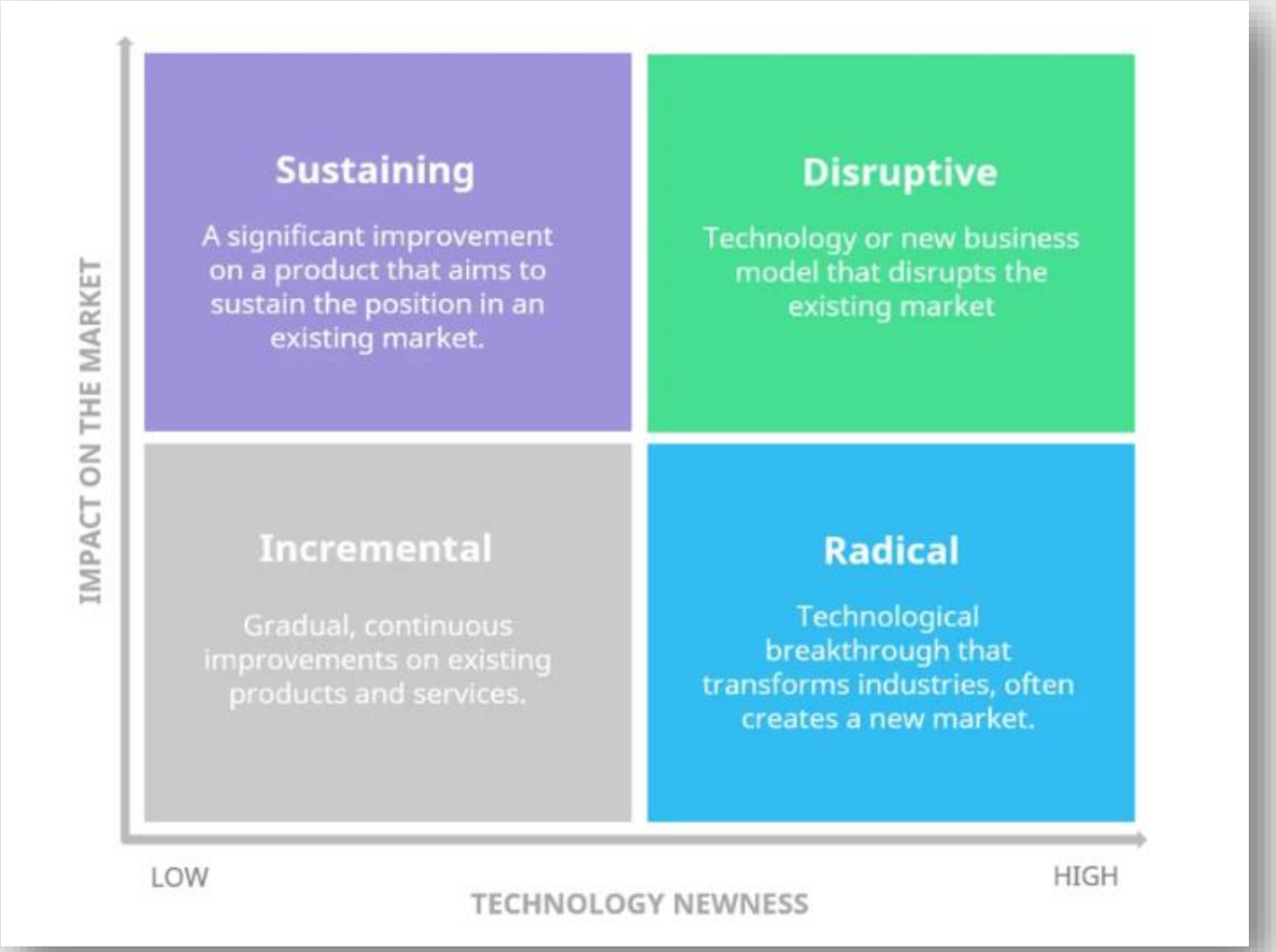
Types of Innovation

1. **Technological Innovation** – Development of new materials, processes, or tools that enhance IS efficiency (e.g., AI-driven resource tracking, blockchain for waste exchange).
2. **Business Model Innovation** – Creating new ways for industries to collaborate and exchange resources profitably.
3. **Social Innovation** – Community-driven initiatives and stakeholder engagement strategies that promote sustainability.
4. **Process Innovation** – Improvements in production or operational methods to reduce waste and enhance efficiency.

2. What is Innovation? The Innovation Matrix



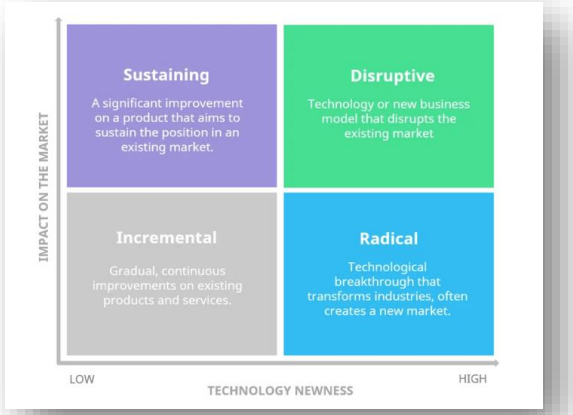
Types of Innovation and Their Impact on Industrial Symbiosis



2. What is Innovation? The Innovation Matrix

Types of Innovation and Their Impact on Industrial Symbiosis

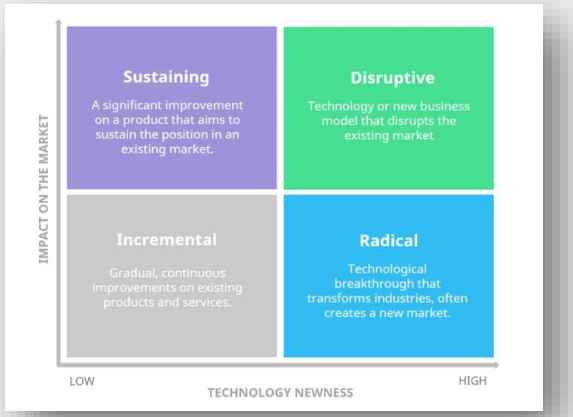
The **Innovation Matrix** helps categorize innovation based on **market impact** and **technological change**.
It is useful for understanding how industries and stakeholders can approach innovation in Industrial Symbiosis.



Type of Innovation	Market Impact	Technological Change	Example in IS
Incremental Innovation	Low	Low	Process improvements in waste heat recovery systems.
Sustaining Innovation	High	Low	Advanced water recycling techniques within industrial clusters.
Disruptive Innovation	High	High	AI-driven material flow optimization between industries.
Radical Innovation	Low	High	New bio-based materials replacing traditional industrial inputs.

2. What is Innovation? The Innovation Matrix

Types of Innovation and Their Impact on Industrial Symbiosis



Key Takeaways

- **Incremental Innovation** improves existing IS processes (e.g., better logistics for material exchange).
- **Sustaining Innovation** enhances established methods (e.g., improved energy-sharing networks).
- **Disruptive Innovation** transforms business models (e.g., digital IS platforms facilitating transactions).
- **Radical Innovation** introduces entirely new materials or techniques (e.g., biotech solutions for industrial waste).

3. Industrial Symbiosis vs. Circular Economy

Industrial Symbiosis vs. Circular Economy: Key Differences and Overlaps

Key Similarities

✓ **Resource Efficiency** – Both aim to **minimise waste** and **reuse materials** instead of discarding them.
✓ **Waste as a Resource** – In both models, **by-products and waste** are seen as **valuable inputs** for other processes.
✓ **Sustainability Focus** – They support **reducing environmental impact** by cutting down on emissions, waste, and raw material extraction.
✓ **Collaboration & Stakeholder Engagement** – Both require **cooperation between businesses, industries, and governments** to be effective.
✓ **Economic & Environmental Benefits** – They promote **cost savings, new business opportunities, and carbon footprint reduction**.

3. Industrial Symbiosis vs. Circular Economy

Industrial Symbiosis vs. Circular Economy: Key Differences and Overlaps

Key Differences

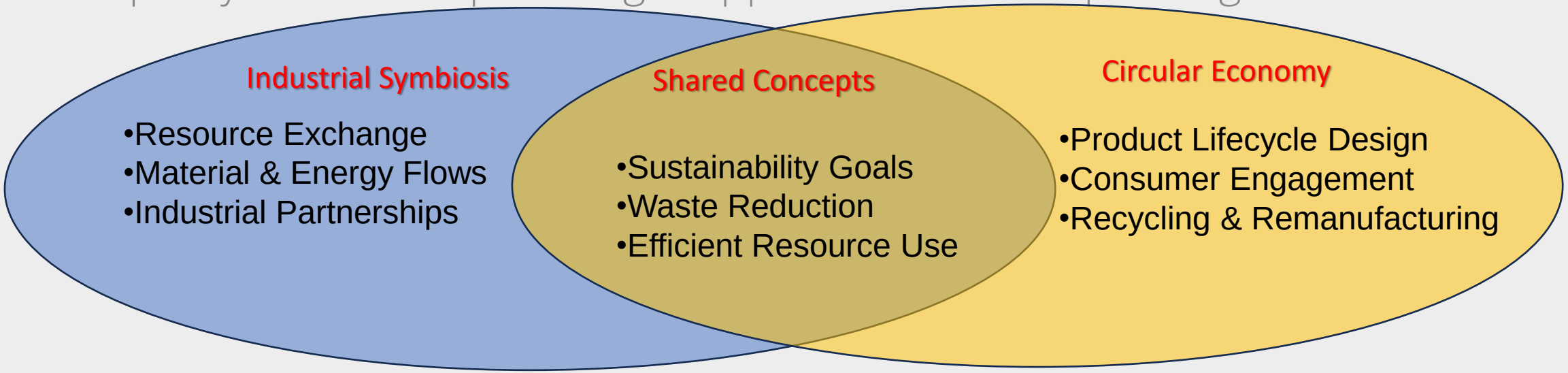
Feature	Industrial Symbiosis (IS)	Circular Economy (CE)
Focus	Inter-industry resource exchange	Entire economic system redesign
Scale	Local/Regional (industrial parks, cities, clusters)	Global (all sectors: production, consumption, waste management)
Primary Mechanism	Exchange of materials, energy, water between companies	Reduce, reuse, repair, recycle across all industries
Example	Kalundborg Symbiosis (Denmark): Industries exchange waste & energy	EU Circular Economy Action Plan: Sustainable product design & waste policies
End-of-Life Products	Focuses mainly on industrial by-products	Includes product life extension (repair, remanufacturing, recycling)
Policy Impact	Encourages collaboration between industries	Requires systemic policy changes (EPR, sustainable production rules, etc.)

3. Industrial Symbiosis vs. Circular Economy

Industrial Symbiosis vs. Circular Economy: Key Differences and Overlaps

Why Does This Matter?

- IS is a strategy within CE, but CE goes beyond IS to include product lifecycle management, consumer behaviour, and sustainable business models.
- Understanding the overlap between IS and CE helps industries and policymakers adopt the right approach for their specific goals.



3. Industry-Specific Case Studies

1. Kalundborg Symbiosis (Denmark) – The Benchmark Example

✅ **Best-known industrial symbiosis model worldwide.**
✅ **Cross-industry collaboration**: Companies exchange energy, water, and by-products.
✅ **Economic & environmental impact**: CO_2 reductions, cost savings, and circular material use.
❌ **Limitation**: Primarily driven by large industries; scalability for smaller businesses is uncertain.

2. Dunkirk Industrial Symbiosis (France) – Energy-Focused IS

✅ **Focus on waste heat recovery and CO_2 capture.**
✅ **Collaboration between energy, steel, and chemical industries.**
✅ **Government-backed model promoting circular economy principles.**
❌ **Limitation**: Heavily industry-dependent, with fewer small-to-medium enterprise (SME) collaborations.

3. Industry-Specific Case Studies

3. Ulsan Eco-Industrial Park (South Korea) – Government-Driven IS Model

✅ **Government-led initiative integrating IS principles in industrial clusters.**
✅ **More than 60 businesses share by-products, waste heat, and resources.**
✅ **Strong policy support & digital infrastructure.**
❌ **Limitation**: Highly structured and may be difficult to replicate in deregulated markets.

4. BASF Verbund (Germany) – Chemical Industry IS Model

✅ **One of the most sophisticated industrial symbiosis networks in the chemical sector.**
✅ **Highly integrated production: By-products from one chemical process serve as raw materials for another.**
✅ **Significant cost and energy savings.**
❌ **Limitation**: Focused on internal optimization within a single company rather than broad inter-industry exchanges.

3. Industry-Specific Case Study – Industrial Symbiosis in the Automotive Sector

Case Study: BMW's Circular Economy Strategy & Industrial Symbiosis

Overview

- BMW has integrated **Industrial Symbiosis (IS)** and **Circular Economy (CE)** principles to reduce waste, optimize resources, and create sustainable manufacturing processes.
- The company collaborates with **suppliers, recyclers, policymakers, and research institutions** to develop closed-loop systems for materials and energy.

3. Industry-Specific Case Study – Industrial Symbiosis in the Automotive Sector

Key Stakeholders & Their Roles in IS

1. Businesses – **BMW & Supply Chain Partners**

- Implement **closed-loop recycling systems** for aluminium, steel, and plastics.
- Reuse production waste, reducing reliance on virgin materials.
- Partner with **energy providers** to use renewable energy sources in factories.

2. Governments & Policymakers

- Provide incentives for **sustainable manufacturing** and material reuse.
- Develop **regulations for end-of-life vehicle recycling** (e.g., EU Directive on Waste Vehicles).
- Support the integration of **green energy** in automotive production.

3. Industry-Specific Case Study – Industrial Symbiosis in the Automotive Sector

Key Stakeholders & Their Roles in IS

3. Academia & Research Institutions

- Collaborate with BMW to develop **new recycling technologies** (e.g., battery recycling for electric vehicles).
- Conduct **life cycle assessments (LCA)** to optimize material use and reduce carbon footprint.
- Provide workforce training on **circular economy and IS strategies**.

4. Civil Society & Consumer Engagement

- Promote **sustainable mobility choices**, encouraging demand for recycled-content vehicles.
- Participate in **trade-in programs** for used cars, supporting IS by feeding materials back into production.
- Advocate for **stronger environmental policies** in automotive manufacturing.

3. Industry-Specific Case Study – Industrial Symbiosis in the Automotive Sector

Driving Industrial Symbiosis: Lessons from the Automotive Industry

Impact of Industrial Symbiosis in BMW's Model

Area	Outcome
Waste Reduction	99% of production waste reused or recycled.
Carbon Emissions	40% reduction in CO_2 emissions in supply chain by 2030.
Energy Efficiency	Factories powered by 100% renewable energy.
Material Reuse	50% of new BMW vehicles contain recycled or repurposed materials.

3. Industry-Specific Case Study – Industrial Symbiosis in the Automotive Sector

Lessons for Other Industries

- **Supply Chain Integration**: Strong collaboration across suppliers and recyclers ensures material circularity.
- **Government & Policy Support**: Clear regulatory frameworks encourage IS adoption.
- **Innovation & Research Partnerships**: Working with academia leads to breakthroughs in sustainable materials.
- **Consumer Awareness**: Public demand for sustainability drives business innovation.

3. Comparing BMW's Industrial Symbiosis with Toyota's Zero Waste & TQM Approach

From Total Quality Management (TQM) to Industrial Symbiosis: Evolution of Sustainable Manufacturing

BMW vs. Toyota: A Comparative Analysis

Feature	BMW – Circular Economy & Industrial Symbiosis	Toyota – Zero Waste & Total Quality Management (TQM)
Core Philosophy	Industrial Symbiosis & Circular Economy for sustainability	Continuous improvement (Kaizen) & Lean Manufacturing
Key Sustainability Strategy	Resource sharing, waste reuse, and cross-industry collaboration	Waste minimization, defect reduction, and process efficiency
Waste Management	99% of production waste is recycled or reused	Just-in-Time (JIT) manufacturing to eliminate excess inventory and waste
Carbon Footprint Reduction	40% CO_2 reduction in the supply chain by 2030	Eco-factories with **energy-efficient production lines**
Material Innovation	Use of recycled materials in vehicle production	Development of biodegradable and recyclable materials
Stakeholder Engagement	Collaboration with policymakers, academia, and supply chain partners	Internal employee engagement & supplier efficiency programs

3. Industry-Specific Case Study – Industrial Symbiosis in the Automotive Sector

Driving Industrial Symbiosis: Lessons from the Automotive Industry

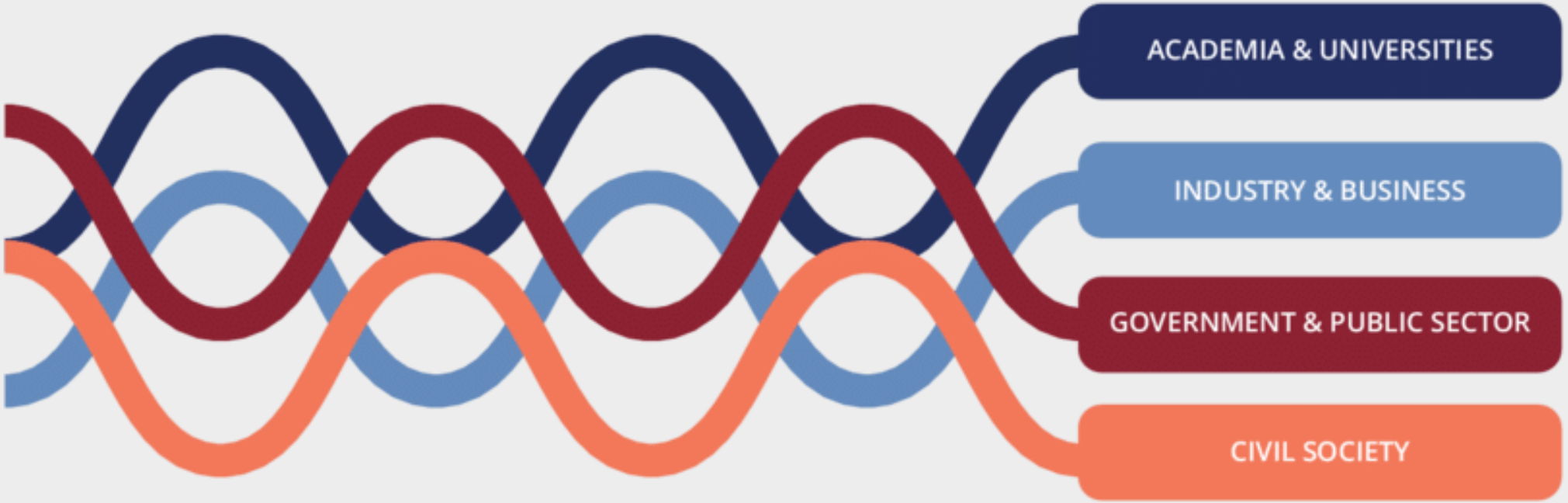
Key Takeaways

- Toyota's TQM & Zero Waste principles laid the foundation for modern sustainability strategies.
- BMW's model expands on this by integrating Industrial Symbiosis and Circular Economy principles.
- Industrial Symbiosis represents the future of sustainable manufacturing, moving from internal efficiency to cross-industry collaboration.
- The next step: Companies need policy support, digital tools, and cross-sector cooperation to make IS scalable.

4. Stakeholder Engagement in Industrial Symbiosis Networks

Identifying and Engaging Key Stakeholders in Industrial Symbiosis

The Quadruple Helix model



4. Stakeholder Engagement in Industrial Symbiosis Networks

The **Quadruple Helix** framework ensures **multi-stakeholder collaboration** in Industrial Symbiosis by integrating:

1. Businesses
    1. Industries, manufacturers, suppliers, recyclers.
    2. Drive material and energy exchanges.
    3. Implement new IS models for cost savings and sustainability.
2. Governments
    1. Policymakers, municipalities, regulatory bodies.
    2. Create incentives and policies supporting IS.
    3. Facilitate inter-industry collaborations and investments.

4. Stakeholder Engagement in Industrial Symbiosis Networks

The **Quadruple Helix** framework ensures **multi-stakeholder collaboration** in Industrial Symbiosis by integrating:

3. Academia
    1. Universities, research institutes, and think tanks.
    2. Develop new technologies, provide data, and assess IS impact.
    3. Train professionals for IS implementation.
4. Civil Society
    1. NGOs, consumer groups, and local communities.
    2. Advocate for sustainability and social responsibility.
    3. Ensure IS models align with environmental and societal needs.

4. Stakeholder Engagement in Industrial Symbiosis Networks

Industrial Symbiosis relies on collaboration between all four stakeholder groups to create sustainable and efficient resource-sharing networks.

Why is Stakeholder Engagement Important?

- Ensures **collaboration and resource-sharing** for efficient IS implementation.
- Encourages **policy alignment** and regulatory support.
- Builds **trust and transparency**, overcoming resistance to change.
- Promotes **economic and environmental benefits** for all parties involved.

4. Stakeholder Engagement

Identifying and Engaging Key Stakeholders

Workshop: Stakeholder Analysis for OneHealthDrugs Action

Workshop Agenda

1

Overview of Stakeholder Analysis Framework

- Explanation of the framework
- Objectives and importance

2

Identifying Stakeholder Groups

- Criteria for identification
- Initial suggestions and open discussion

3

Selecting Stakeholder Analysis Tools

- Overview of available tools
- Choosing the right tools for our needs

4

•Developing an Action Plan

- Steps involved in creating the action plan
- Milestones and timelines

C D E

Communication	Dissemination	Exploitation	
Reach out to society and show the **impact and benefits of EU-funded R&I activities.** Targeted communication activities must address the public policy perspective of European R&I funding by considering aspects such as (i) the benefits of transnational cooperation in a European consortium or (ii) scientific excellence or (iii) contributing to competitiveness and to solving societal challenges.	**Transfer knowledge & results** with the aim to enable others to use or reuse and take up results, thus maximising the impact of EU-funded research.	**Effectively use/reuse project results** through scientific, economic, political or societal exploitation routes aiming to turn R&I actions into concrete value and impact for society.	Objective
Inform about and **promote** the **project AND its results/ success** in a non-technical manner and through strategically planned actions – possibly engaging in a two-way exchange.	**Describe** and **ensure results available** for others to **USE or REUSE** ➡ focus on results only!	**Make concrete use/reuse** of research results (not restricted to commercial use.)	Focus
Multiple audiences beyond the project's own community incl. media and the broad public.	Audiences that may take an interest in the potential **USE/REUSE** of the results (e.g. scientific community, industrial partner, policymakers).	People/organisations including project partners themselves that make concrete use/reuse of the project results, as well as user groups outside the project.	Target Audience

Stakeholder Analysis for OneHealthDrugs Action

Theo Zacharis - **03 July 2024**

Overview of Stakeholder Analysis Framework

Stakeholders Analysis

Stakeholder analysis framework will serve as a structured approach to identify, analyse, and engage with the key stakeholders who influence and are impacted by our works. We aim to ensure that OHD stakeholder strategy aligns with our project goals and addresses the interests and concerns of all relevant parties.

Step 1
Identify Stakeholders
1

Step 2
Utilize Stakeholder Analysis Tools
2

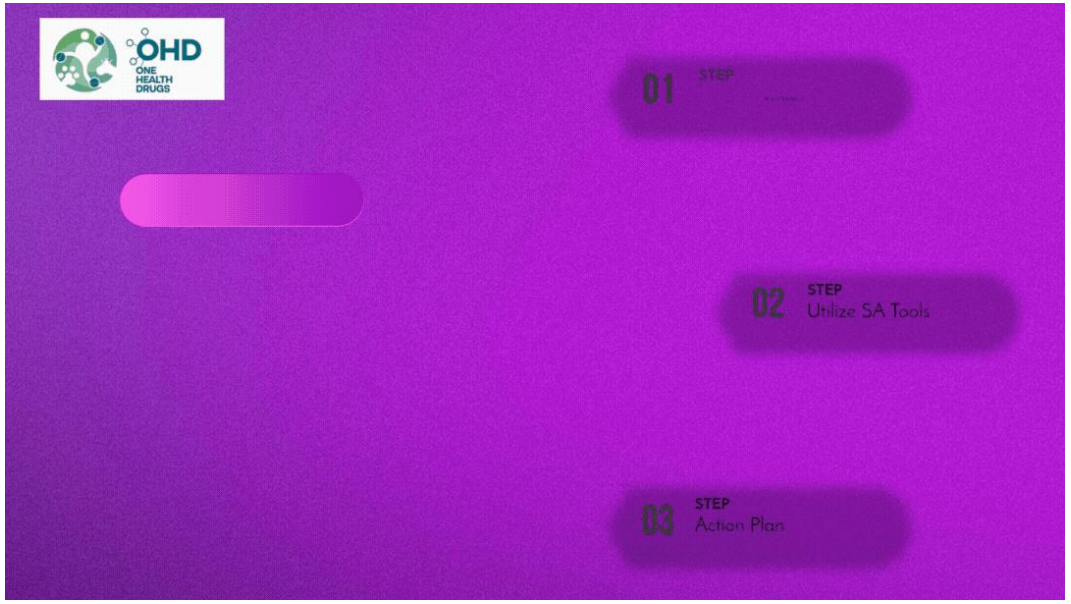
Step 3
Engagement Strategies
3

Step 4
Dissemination and Exploitation Opportunities
4

Step 5
Exploitation Strategies
5

Future Plans
Timeline and Milestones
6

Stakeholders Analysis



Overview of Stakeholder Analysis Framework

Step 1. Identify Stakeholders

Identifying Stakeholder Groups

Step 1. Identify Stakeholders

- Academic and Research Institutions
- Healthcare Providers
- Biotechnology and Pharmaceutical Companies
- Investors and Funding
- Policy Makers and Regulatory Bodies
- Patient Advocacy Groups
- Technology Developers

Stakeholders Analysis – Key Stakeholders

ACADEMIC AND RESEARCH INSTITUTIONS

- Research Excellence Centres
- Biomedical Institutes

BIOTECH AND PHARMA COMPANIES

- Drug development
- Manufacturing, and distributing new drugs and technologies.

INVESTORS AND FUNDING BODIES

- Venture Capitalists
- EU & Government grants
- Foundations & Philanthropic organizations.

REGULATORY BODIES & STANDARDS ORGANISATIONS

- European Medicines Agency (EMA)
- European Centre for Disease Prevention
- and Control (ECDC)
- European Food Safety Authority (EFSA)
- National Health Authorities **(PM)**
- Medicines and Healthcare products Regulatory Agency (MHRA) - UK
- Federal Institute for Drugs and Medical Devices (BfArM) - Germany
- French Agency for the Safety of Health Products (ANSM) - France
- Italian Medicines Agency (AIFA) - Italy
- Health Technology Assessment (HTA) Bodies

POLICY MAKERS

- European Level – Directorate-General for Health and Food Safety (DG SANTE)
- National level – Ministries
- World Health Organization (WHO)
- World Organisation for Animal Health (OIE)

HEALTHCARE PROVIDERS

- Veterinarians
- Doctors & Nurses
- Other Clinicians who will use the new technologies in clinical settings

OTHER - PATIENTS AND PATIENT ADVOCACY GROUPS, NGOS, THINK TANKS, HEALTH INSURANCE COMPANIES, TECHNOLOGY DEVELOPERS (Companies developing diagnostic tools, AI applications, and other relevant technologies.) AND IT COMPANIES, ETC

Overview of Stakeholder Analysis Framework

Step 2. Stakeholders Analysis Tools

Stakeholders Analysis Tools

Stakeholder Analysis Matrix: A table used to evaluate stakeholders based on various criteria such as interest, influence, power, and support. This helps in **prioritizing** stakeholder engagement strategies.

Power-Interest Grid: This tool plots stakeholders on a grid based on **their level of interest** in the project and their power to influence it. It helps in identifying which stakeholders need **more attention** and which can be monitored with less frequent communication.

SWOT Analysis: Sometimes adapted for stakeholder analysis by assessing the **Strengths, Weaknesses, Opportunities, and Threats** that stakeholders bring to a project.

Salience Model: This model classifies stakeholders based on three attributes: **power, legitimacy, and urgency**. It helps in understanding who should be given priority based on their attributes' combination.

Influence-Impact Grid: Similar to the Power-Interest grid, this tool helps in assessing stakeholders based on their **influence** over the project and the **impact** the project has on them.

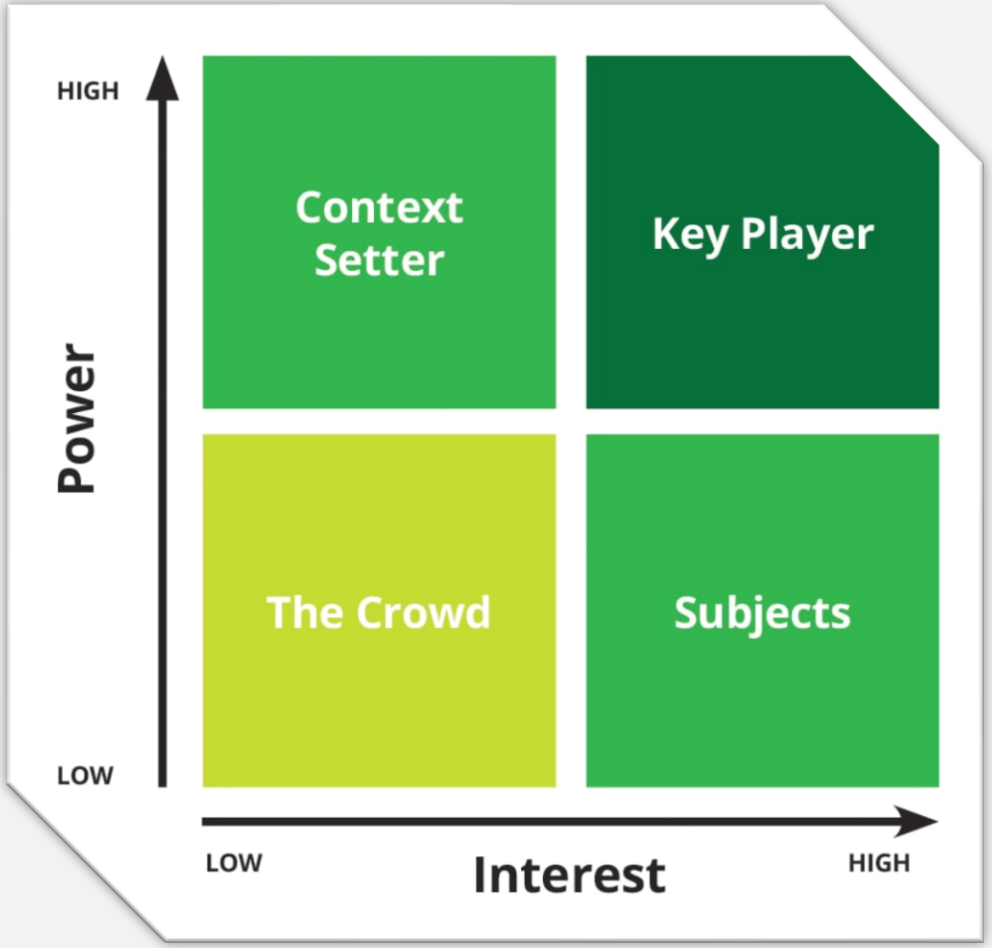
Stakeholder Engagement Assessment Matrix: This matrix helps in determining the **current level of engagement** of each stakeholder and the **desired level of engagement** to ensure project success.

Stakeholders Analysis Tools

Stakeholder Analysis Matrix

Stakeholders Analysis Tools

Power-Interest Grid

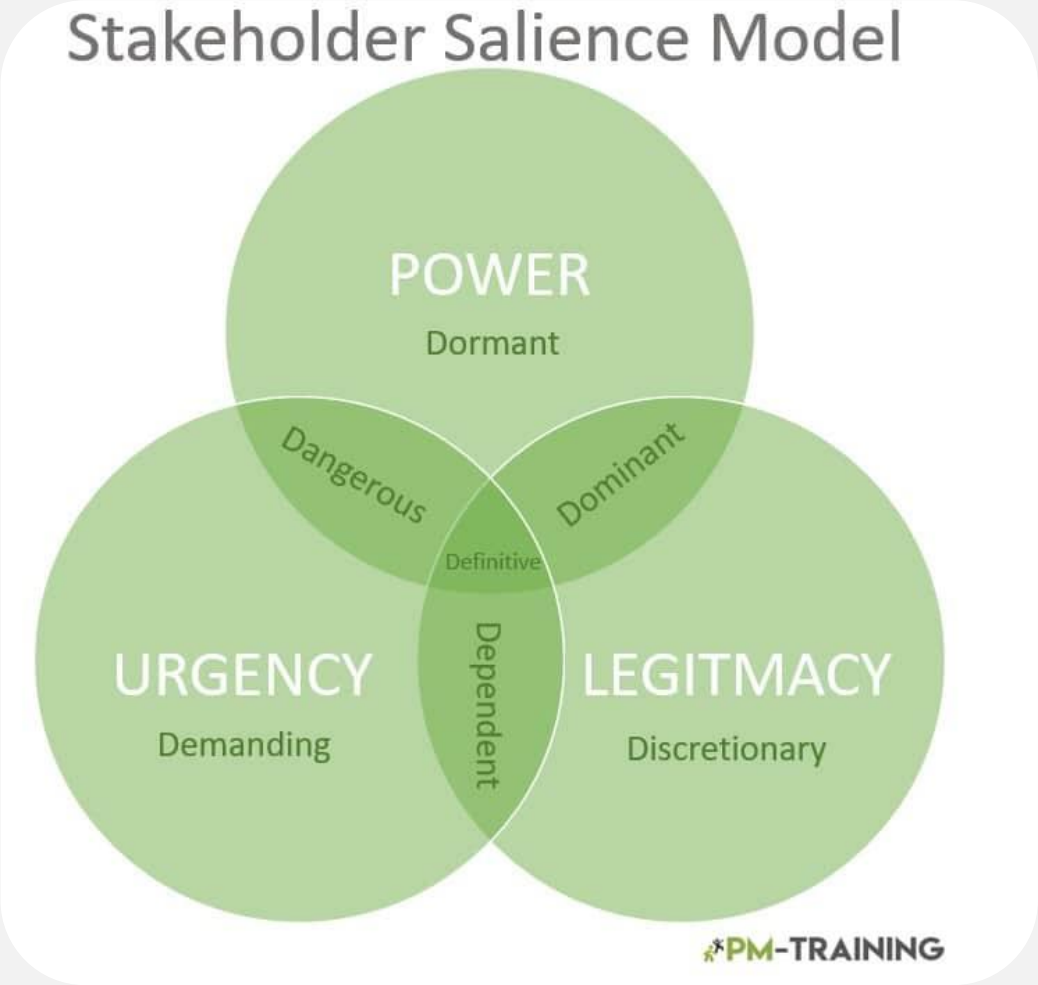


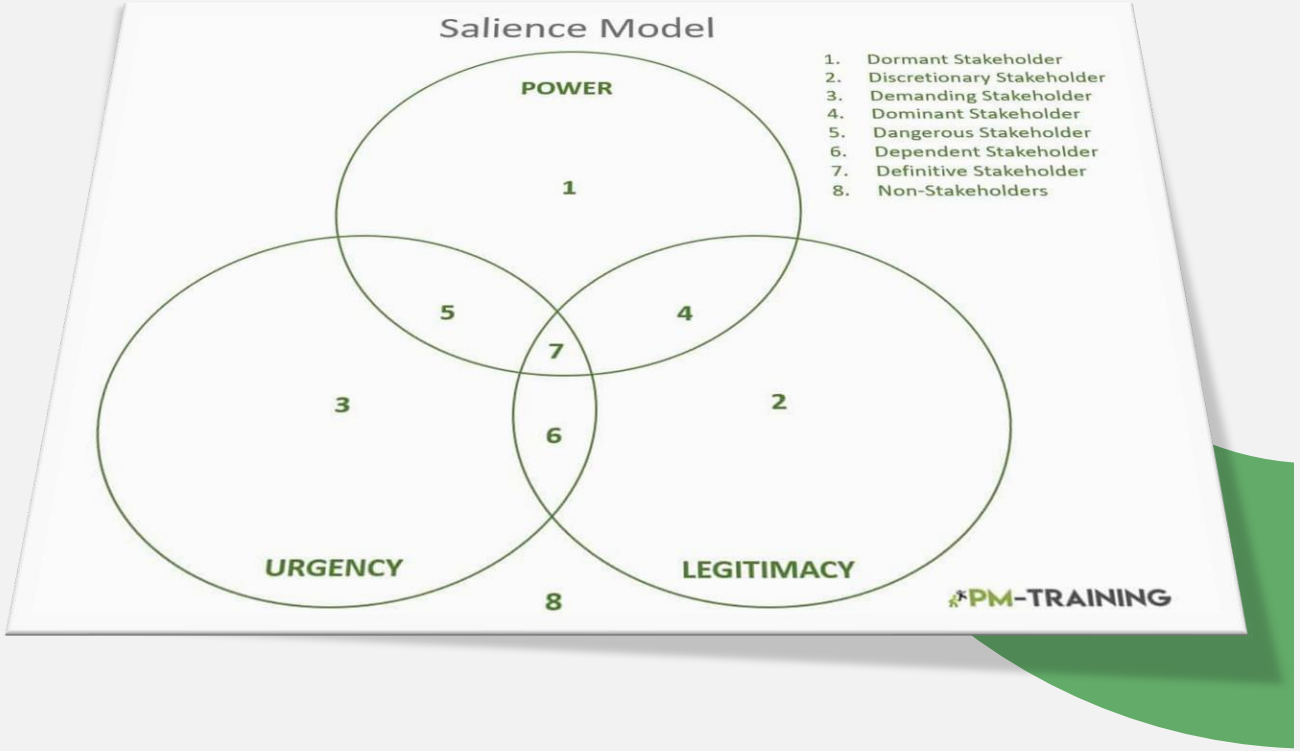
Stakeholders Analysis Tools

SWOT Analysis

Stakeholders Analysis Tools

Salience Model

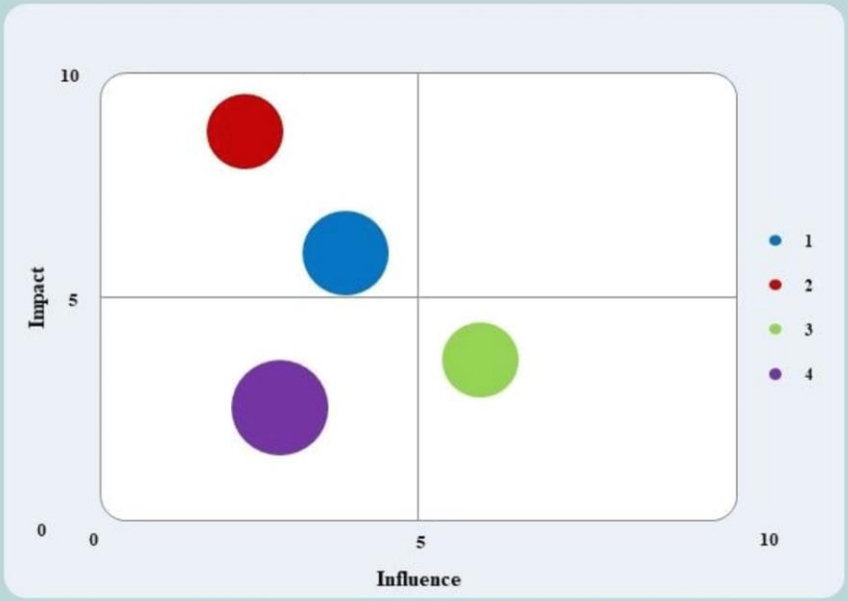




Stakeholders Analysis Tools

Influence-Impact Grid

Stakeholder prioritization based on commitment and impact



Stakeholder	Impact	Influence	Actions for effective management
	6	4	Communicate advantages
	9	3	Include in project team and use there suggestions
	4	6	Keep them informed
	3	2	No action required

Stakeholders Analysis Tools

Stakeholder Engagement Assessment Matrix

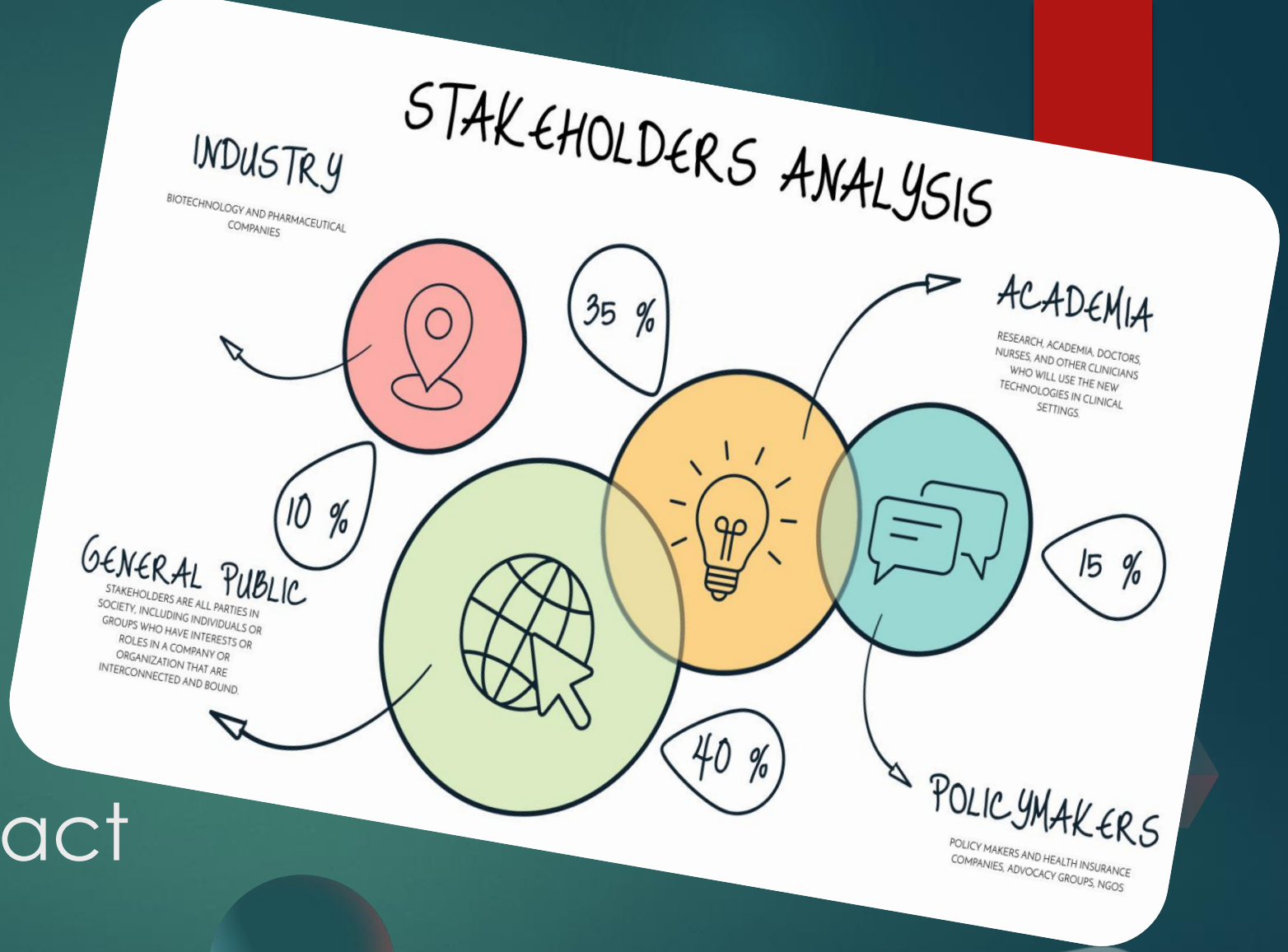
C	Current Level of Engagement
D	Desired Level of Engagement
C D	Both Current and Desired

STAKEHOLDER	Unaware	Resistant	Neutral	Supportive	Leading
Stakeholder 1	C			D	
Stakeholder 2			C D		
Stakeholder 3		C	D		
Stakeholder 4				C D	
Stakeholder 5					
Stakeholder 6					
Stakeholder 7					
Stakeholder 8					

Selecting Stakeholder Analysis Tools

Engage
Understand
Collaborate

Reaching
Stakeholders for
Breakthrough Impact



Stakeholders Analysis

Developing an Action Plan

Phase 1

Workshop on Stakeholders Analysis (SA) – Oxford, UK July 3-5

Identify Stakeholders

Academia / Research, Biotech and Pharma Companies, Healthcare Providers, Policy Makersetc.

Utilize SA Tools

Stakeholder Analysis Matrix, Power-Interest Grid, SWOT Analysis, Salience Model, Influence-Impact Grid, Stakeholder Engagement Assessment Matrix

Action Plan

Define Deliverables, Timeline & Stakeholders involvement

4. Case Studies of Stakeholder Collaboration in IS

Kalundborg Symbiosis (Denmark)

Overview:

- The **world's first large-scale industrial symbiosis** model.
- Located in **Kalundborg, Denmark**, bringing together multiple industries.
- Functions as a **self-organized collaborative network**, where waste from one company becomes a resource for another.

4. Case Studies of Stakeholder Collaboration in IS

Successful Multi-Stakeholder Collaboration in IS

Key Stakeholders & Their Roles:

1. **Businesses**: Novo Nordisk, Gyproc, Ørsted, and others exchange water, steam, and materials.
2. **Government**: Local policies encourage waste reuse and resource optimization.
3. **Academia**: Research institutions analyze symbiosis efficiency and promote further innovation.
4. **Civil Society**: Citizens benefit from lower emissions and reduced industrial waste.

Impact:

- 30% reduction in CO_2 emissions.
- 1.2 million tons of waste recycled annually.
- Lower costs & improved resource efficiency for participating industries.

4. Case Studies of Stakeholder Collaboration in IS

Case Study 2: Dunkirk Industrial Symbiosis (France)

Overview:

- Located in **northern France**, integrating **energy, steel, and chemical industries**.
- Focused on **waste heat recovery and CO_2 utilization**.


INDAVER

4. Case Studies of Stakeholder Collaboration in IS

Successful Multi-Stakeholder Collaboration in IS

Key Stakeholders & Their Roles:

1. **Businesses**: ArcelorMittal, Aluminium Dunkerque, and TotalEnergies exchange industrial by-products.
2. **Government**: Supports carbon capture and re-use policies to reduce emissions.
3. **Academia**: Helps optimize energy-sharing strategies and test new materials.
4. **Civil Society**: Ensures the model aligns with sustainable urban planning.

Impact:

- 30% reduction in industrial energy consumption.
- Waste heat from steel plants powers local buildings and greenhouses.
- CO_2 capture and reuse lowers the region's carbon footprint.

4. Case Studies of Stakeholder Collaboration in IS

Key Takeaways

- Stakeholder collaboration is essential for Industrial Symbiosis success.
- Government incentives accelerate implementation and inter-industry cooperation.
- Public engagement ensures sustainability benefits are widely recognized.
- Scaling IS requires knowledge exchange between academia and industry.

4. Case Studies of Stakeholder Collaboration in IS

Discussion Prompt

- Based on the **Kalundborg and Dunkirk case studies**, what do you think are the **biggest challenges** in getting different stakeholders to collaborate?
- How can **businesses, governments, academia, and civil society** work better together to implement Industrial Symbiosis in your region?
- What **barriers** (economic, regulatory, social) prevent organizations from adopting IS, and how can they be overcome?

4. Overcoming Stakeholder Collaboration Challenges in Industrial Symbiosis

Addressing Barriers and Strengthening Multi-Stakeholder Cooperation

What are the biggest challenges in getting different stakeholders to collaborate?

Key Challenges:

1. **Misaligned Incentives** – Businesses focus on profits, while governments prioritize regulations and sustainability.
2. **Lack of Trust** – Companies fear sharing data with competitors.
3. **Regulatory Barriers** – Policies may not be adapted to support Industrial Symbiosis models.
4. **Financial Risks** – High upfront investment costs in infrastructure and resource-sharing networks.
5. **Limited Awareness & Knowledge** – Many industries and policymakers are unaware of IS benefits.

4. Overcoming Stakeholder Collaboration Challenges in Industrial Symbiosis

Addressing Barriers and Strengthening Multi-Stakeholder Cooperation

How can businesses, governments, academia, and civil society work better together?

Suggested Strategies for Stronger IS Collaboration:

1. **Businesses** (Manufacturers, Suppliers, Recyclers)

- Establish **cross-industry agreements** to formalize waste and resource exchanges.
- Adopt **open-data platforms** to build transparency in material flows.
- Invest in **digital monitoring tools** for real-time resource tracking.

2. **Governments** (Municipalities, Policymakers, Regulatory Bodies)

- Introduce **financial incentives** (tax benefits, grants) for IS adoption.
- Develop **standardized IS policies** at national and regional levels.
- Facilitate **public-private partnerships (PPPs)** to co-fund infrastructure.

4. Overcoming Stakeholder Collaboration Challenges in Industrial Symbiosis

Addressing Barriers and Strengthening Multi-Stakeholder Cooperation

How can businesses, governments, academia, and civil society work better together?

Suggested Strategies for Stronger IS Collaboration:

3. **Academia** (Universities, Research Institutions, Think Tanks)

- Conduct **feasibility studies** to demonstrate IS benefits and risks.
- Develop **training programs and workshops** to upskill workforce on IS.
- Collaborate with businesses to **test and scale new technologies**.

4. **Civil Society** (NGOs, Local Communities, Consumer Groups)

- Advocate for **sustainable industrial policies** at local and national levels.
- Create **community-driven IS initiatives**, such as industrial waste repurposing hubs.
- Engage consumers in **circular economy awareness campaigns**.

4. Overcoming Stakeholder Collaboration Challenges in Industrial Symbiosis

Addressing Barriers and Strengthening Multi-Stakeholder Cooperation

What barriers prevent organizations from adopting IS, and how can they be overcome?

Barrier	Solution
Economic Barriers – High costs for IS infrastructure.	Offer **subsidies, grants, and tax breaks** for IS projects.
Regulatory Uncertainty – Lack of clear IS policies.	Implement **IS-friendly legislation** with clear compliance pathways.
Technological Limitations – Need for better resource tracking.	Develop **AI and blockchain-based monitoring systems.**
Lack of Stakeholder Engagement	Organize **cross-sector IS networks and advisory panels.**
Data Security Concerns	Introduce **secure digital platforms for IS collaboration.**

4. Overcoming Stakeholder Collaboration Challenges in Industrial Symbiosis

Addressing Barriers and Strengthening Multi-Stakeholder Cooperation

Key Takeaways

- **Building trust through transparency and incentives** is crucial.
- **Collaboration between industry, government, and academia** can drive innovation.
- **Regulatory and financial support** are key to scaling IS models.
- **Digital tools and data-sharing** enhance efficiency and confidence in IS networks.

4. Overcoming Stakeholder Collaboration Challenges in Industrial Symbiosis

Building Trust and Cooperation in IS Networks

Why is Trust Important in IS?

- Encourages **data sharing** for resource optimization.
- Reduces **competition concerns** and builds long-term partnerships.
- Facilitates **policy alignment** between industry and government.
- Increases **investment confidence** in shared infrastructure and technology.

Challenges in Trust & Cooperation

Challenge	Impact	Solution
Data Sharing Concerns	Companies fear exposing trade secrets.	Use **blockchain and secure data platforms** for transparency.
Regulatory Uncertainty	Companies are unsure about legal risks in waste exchange.	Governments should **clarify IS-friendly policies** and offer legal guidance.
Short-Term Thinking	Businesses prioritize immediate profits over long-term IS gains.	Introduce **financial incentives** (tax benefits, subsidies) for IS adoption.
Lack of Clear Leadership	IS networks often lack coordination among stakeholders.	Establish **governance structures** (public-private partnerships, industry consortia).

5. Building Trust and Cooperation in IS Networks

Real-World Example – Trust-Building in Industrial Symbiosis
How Industrial Symbiosis Networks Overcame Trust Barriers

Case Study: SymbioCity (Sweden) – Building Trust in IS Through Governance & Digital Tools

Overview

- SymbioCity is an **industrial symbiosis initiative** connecting industries in Sweden to **exchange waste, energy, and materials**.
- The project focuses on **reducing emissions, optimizing energy use, and reusing industrial by-products** while ensuring trust among stakeholders.

5. Building Trust and Cooperation in IS Networks

Real-World Example – Trust-Building in Industrial Symbiosis
How Industrial Symbiosis Networks Overcame Trust Barriers

How Did They Overcome Trust Barriers?

1. Governance & Coordination

1. **Public-private partnerships** ensured a neutral, trusted entity managed IS exchanges.
2. **Clear legal agreements** between businesses provided transparency in resource-sharing.

2. Data Security & Transparency

1. **Blockchain-based tracking systems** allowed secure and verifiable waste and energy transactions.
2. **AI-powered analytics** optimized material flow without exposing sensitive company data.

3. Regulatory Alignment

1. **Government subsidies & tax incentives** encouraged participation.
2. **Legal framework adjustments** removed uncertainties around waste classification and liability.

4. Economic Incentives & Long-Term Benefits

1. **Businesses saved up to 30% on raw material costs** by sourcing secondary materials.
2. **CO_2 emissions reduced by 25%**, meeting environmental targets without extra costs.

5. Building Trust and Cooperation in IS Networks

Real-World Example – Trust-Building in Industrial Symbiosis
How Industrial Symbiosis Networks Overcame Trust Barriers

Key Takeaways

- **A neutral coordinating entity** fosters long-term collaboration.
- **Technology (Blockchain & AI)** enhances trust by securing data and ensuring fair exchanges.
- **Financial and policy incentives** make IS participation attractive.
- **Regulatory clarity** removes legal uncertainties and encourages investment in IS.

5. Mini-Activity – Designing a Trust-Building Framework for Industrial Symbiosis

Creating a Strategy to Overcome Trust Barriers in IS Networks

Activity Overview

Participants will work in small groups to develop a trust-building framework for an imaginary or real IS network of their choice.

Goal:

✓ Identify key trust barriers in your Industrial Symbiosis network.

✓ Propose practical strategies to enhance collaboration.

✓ Present a short trust-building action plan.

5. Mini-Activity – Designing a Trust-Building Framework for Industrial Symbiosis

Creating a Strategy to Overcome Trust Barriers in IS Networks

Step 1: Identify a Key Trust Barrier

Each group selects **one major trust issue** from the table below or defines their own:

Barrier	Example
Lack of Transparency	Companies hesitant to share resource flow data.
Regulatory Uncertainty	No clear legal framework for IS material exchanges.
Competition Concerns	Fear of losing strategic advantage by sharing waste streams.
Short-Term Thinking	Companies prioritize short-term profits over long-term sustainability.

5. Mini-Activity – Designing a Trust-Building Framework for Industrial Symbiosis

Creating a Strategy to Overcome Trust Barriers in IS Networks

Step 2: Develop a Trust-Building Solution

Each group outlines 2-3 key actions to address their selected challenge.

Example Solutions:

✓ Lack of Transparency → Use blockchain for secure, verifiable material flow tracking.

✓ Regulatory Uncertainty → Establish a public-private advisory group to develop IS-friendly policies.

✓ Competition Concerns → Introduce a neutral IS platform where companies share data without revealing proprietary details.

✓ Short-Term Thinking → Provide financial incentives for companies that engage in IS.

5. Mini-Activity – Designing a Trust-Building Framework for Industrial Symbiosis

Creating a Strategy to Overcome Trust Barriers in IS Networks

Step 3: Present and Discuss

Each group presents their trust-building framework in 2-3 minutes.

Discussion on:

- What challenges did you face when designing your framework?
- Which stakeholders should lead the implementation?
- How can digital tools or policy changes help strengthen trust?

5. Mini-Activity – Designing a Trust-Building Framework for Industrial Symbiosis

Creating a Strategy to Overcome Trust Barriers in IS Networks

Key Takeaways

- Stakeholder trust is a major driver of IS success.
- Collaborative platforms and policy incentives encourage participation.
- Technology can provide solutions, but governance is equally important.
- A proactive approach to trust-building reduces risks and ensures long-term IS sustainability.

6. Policy, Regulation, and Digital Transformation in Industrial Symbiosis

The Role of Policy & Technology in Scaling Industrial Symbiosis

Why Do Policy & Regulation Matter?

- **Define legal frameworks** for waste and by-product exchange.
- **Encourage investment** through financial incentives.
- **Ensure environmental compliance** while promoting circular economy principles.
- **Facilitate cross-sector collaboration** between industries and policymakers.

6. Policy, Regulation, and Digital Transformation in Industrial Symbiosis

The Role of Policy & Technology in Scaling Industrial Symbiosis

Key Policy Considerations for Industrial Symbiosis

Policy Area	Impact on IS	Example
Circular Economy Legislation	Supports waste-to-resource initiatives.	EU Circular Economy Action Plan
Industrial Emissions Regulations	Ensures IS models reduce pollution.	EU Industrial Emissions Directive
Waste Classification & Reuse Laws	Allows by-products to be reclassified as secondary raw materials.	UK End-of-Waste Criteria
Financial Incentives & Tax Benefits	Encourages IS investments.	Government grants & carbon credits

6. Policy, Regulation, and Digital Transformation in Industrial Symbiosis

The Role of Policy & Technology in Scaling Industrial Symbiosis

How Digital Transformation Supports IS

✓ AI & Big Data – Optimizes resource flows and predictive analytics.

✓ Blockchain – Ensures secure, transparent tracking of material exchanges.

✓ IoT & Smart Sensors – Real-time monitoring of energy, waste, and resource use.

✓ IS Digital Marketplaces – Online platforms for resource exchange between industries.

Real-World Example: Digital Tools for IS in Action

Kalundborg Symbiosis (Denmark) uses AI-driven monitoring systems to track industrial resource exchanges and optimize symbiotic efficiency.

6. Interactive Exercise – Designing Policy & Digital Strategies for IS

How Can Policy and Technology Drive Industrial Symbiosis?

Exercise Overview

Participants will work in **small groups** to develop **an action plan** for scaling Industrial Symbiosis through policy and digital tools.

Goal:

✓ Identify key **policy gaps** preventing IS adoption.
✓ Propose **digital solutions** to enhance IS networks.
✓ Present a **short policy & technology strategy** for IS implementation.

6. Interactive Exercise – Designing Policy & Digital Strategies for IS

How Can Policy and Technology Drive Industrial Symbiosis?

Step 1: Identify a Key Policy or Regulatory Challenge

Each group selects **one major policy gap** from the table below or defines their own:

Policy Gap	Impact on IS
Unclear Waste Regulations	Companies hesitate to exchange materials due to classification issues.
Lack of Financial Incentives	Industries see no economic benefit in adopting IS.
Regulatory Barriers to Data Sharing	Companies fear legal risks in sharing resource data.
No IS-Specific Government Strategy	IS initiatives remain fragmented and uncoordinated.

6. Interactive Exercise – Designing Policy & Digital Strategies for IS

Step 2: Propose a Digital or Policy Solution

Each group outlines 2-3 key actions to address their selected challenge.

Example Solutions:

✓ Unclear Waste Regulations → Implement End-of-Waste criteria to reclassify industrial by-products.

✓ Lack of Financial Incentives → Offer tax credits and grants for IS adoption.

✓ Regulatory Barriers to Data Sharing → Introduce secure blockchain-based platforms for material tracking.

✓ No IS-Specific Strategy → Governments should create National IS Roadmaps with industry partnerships.

6. Interactive Exercise – Designing Policy & Digital Strategies for IS

How Can Policy and Technology Drive Industrial Symbiosis?

Step 3: Present and Discuss

Each group presents their **policy and technology strategy** in 2-3 minutes.

Discussion on:

- What **policy change** would have the biggest impact on IS adoption?
- How can **digital tools accelerate stakeholder collaboration**?
- How can governments and businesses **work together to remove IS barriers**?

6. Interactive Exercise – Designing Policy & Digital Strategies for IS

How Can Policy and Technology Drive Industrial Symbiosis?

Key Takeaways

- Policies should enable, not restrict, Industrial Symbiosis.
- Technology can bridge trust gaps and improve efficiency.
- Collaboration between policymakers, businesses, and researchers is essential.
- Scalable IS models require both regulatory support and digital innovation.

6. Case Study – How Policy and Digital Tools Enabled Industrial Symbiosis

The Role of Government and Technology in IS Success – Rotterdam Port (Netherlands)

Case Study: Rotterdam Industrial Symbiosis – A Government & Digital Success Story

Overview

- The **Port of Rotterdam** is one of the most advanced **Industrial Symbiosis (IS) hubs** in Europe.
- **Policy incentives, regulatory support, and digital tracking tools** have transformed it into a **circular industrial cluster**.

6. Case Study – How Policy and Digital Tools Enabled Industrial Symbiosis

The Role of Government and Technology in IS Success – Rotterdam Port (Netherlands)

Key Policy & Digital Strategies That Enabled IS in Rotterdam

Strategy	Implementation	Impact
Government-Led IS Roadmap	Dutch authorities created a **national IS strategy** for industries to follow.	Ensured **long-term IS adoption** and policy stability.
Waste Reclassification Laws	Allowed industrial by-products to be legally reused as **secondary raw materials.**	Encouraged businesses to **exchange materials instead of discarding them.**
Financial Incentives & Subsidies	Government introduced **grants & tax breaks** for industries adopting IS.	Lowered **investment risks** for businesses.
Digital IS Marketplace	AI-driven **online platform** matches waste producers with industries that need materials.	Increased **efficiency & transparency** in resource exchanges.
Real-Time Monitoring Systems	IoT sensors track **waste, emissions, and energy use** in industrial zones.	Optimized **material flows & reduced inefficiencies.**

6. Case Study – How Policy and Digital Tools Enabled Industrial Symbiosis

The Role of Government and Technology in IS Success – Rotterdam Port (Netherlands)

Key Results from Rotterdam's IS Model

- ✅ CO_2 emissions reduced by 1.2 million tons annually.
- ✅ 50+ companies actively exchanging materials & energy.
- ✅ €100 million in cost savings for participating businesses.
- ✅ Significant waste reduction through cross-industry resource sharing.

Lessons for Other Regions

Policy clarity accelerates IS adoption.

Government-backed IS incentives reduce industry reluctance.

Digital platforms simplify and scale IS networks.

A public-private approach creates long-term IS sustainability.

7. Final Project Development – Crafting Actionable IS Initiatives

Turning Industrial Symbiosis Strategies into Real-World Projects

Case Study – Kalundborg Industrial Symbiosis (Denmark)

Title: How Kalundborg Became the World's Leading Industrial Symbiosis Model

Overview of Kalundborg Symbiosis

- Established in **Denmark** in the **1970s**, it is the **world's first fully functioning industrial symbiosis network**.
- A self-organized collaboration where **by-products and waste from one company serve as resources for others**.
- **Public-private partnerships** played a key role in its long-term success.

7. Final Project Development – Crafting Actionable IS Initiatives

Turning Industrial Symbiosis Strategies into Real-World Projects

Key Stakeholders & Their Roles in IS

Stakeholder	Role in Kalundborg IS	Impact
Businesses (Novo Nordisk, Ørsted, Gyproc, etc.)	Exchange waste heat, water, and by-products across industries.	**Cost savings, increased resource efficiency, CO_2 reduction.**
Government & Regulators	Provided early incentives & legal framework for resource exchanges.	**Encouraged investment & innovation in IS.**
Academia & Research Institutions	Studied IS efficiency & trained professionals in symbiosis models.	**Improved resource optimization & knowledge-sharing.**
Local Community	Benefited from reduced industrial waste & pollution.	**Healthier environment & economic growth.**

7. Final Project Development – Crafting Actionable IS Initiatives

Turning Industrial Symbiosis Strategies into Real-World Projects

How Kalundborg Overcame Common IS Barriers

Barrier	Kalundborg's Solution
Lack of Trust Between Companies	Established **transparent, long-term agreements** for material exchange.
Regulatory Uncertainty	Worked closely with government to develop **clear IS-friendly policies.**
Financial Risks & Infrastructure Costs	Used **joint investment models** where companies co-funded infrastructure.
Data Sharing Concerns	Implemented **monitoring tools** to track material & energy exchanges securely.

7. Final Project Development – Crafting Actionable IS Initiatives

Turning Industrial Symbiosis Strategies into Real-World Projects

Impact of Kalundborg Industrial Symbiosis

✓ CO_2 emissions reduced by 635,000 tons per year.
✓ 30% reduction in water consumption across participating industries.
✓ €28 million annual cost savings through resource sharing.
✓ Increased investment in sustainable industry solutions.

Lessons for Other IS Initiatives

✓ Trust & collaboration take time – Kalundborg grew over decades.
✓ Policy & financial incentives encourage participation.
✓ Digital tracking & monitoring enhance efficiency & trust.
✓ Public-private partnerships create long-term IS success.

7. Final Project Development – Crafting Actionable IS Initiatives

Designing a Scalable Industrial Symbiosis Initiative Based on Kalundborg

Objective of the Session

Participants will **develop an Industrial Symbiosis (IS) initiative** inspired by **Kalundborg**, integrating stakeholder engagement, policy, and digital solutions.

7. Final Project Development – Crafting Actionable IS Initiatives

Designing a Scalable Industrial Symbiosis Initiative Based on Kalundborg

Step 1: Define the IS Project Scope

Each group will design a Kalundborg-style IS initiative for a different industry and location.

✓ Select an Industrial Cluster – Choose a sector & geographic region for your IS project.
✓ Identify Available Resources – What waste streams or by-products could be exchanged?
✓ Determine Key Players – What businesses and stakeholders should be involved?

Example Industrial Clusters for IS:

Sector	Example IS Opportunity
Energy & Power Plants	Waste heat recovery for district heating, like Kalundborg.
Chemical & Pharma	Wastewater and chemical by-product reuse in manufacturing.
Agriculture & Food Processing	Organic waste converted into biogas or animal feed.
Metals & Mining	Shared water treatment and mineral recovery.

7. Final Project Development – Crafting Actionable IS Initiatives

Designing a Scalable Industrial Symbiosis Initiative Based on Kalundborg

Step 2: Identify Key Stakeholders (5 min)

✓ **Businesses** – Who are the main companies involved?
✓ **Government & Regulators** – What policies affect IS adoption?
✓ **Academia & Research** – What technologies can be applied?
✓ **Local Communities & NGOs** – How can public support be ensured?

Example (Kalundborg Model Adaptation):

Stakeholder	Potential Role in IS
Industrial Partners	Exchange materials, waste heat, and energy.
Local Government	Provide regulatory support & financial incentives.
Research Institutions	Develop & test innovative IS solutions.
Community Groups & NGOs	Ensure environmental & social benefits.

7. Final Project Development – Crafting Actionable IS Initiatives

Designing a Scalable Industrial Symbiosis Initiative Based on Kalundborg

Step 3: Develop the IS Strategy (10 min)

Each group outlines **key elements** of their Kalundborg-inspired IS project:

- ✓ **Waste-to-Resource Exchange** – What materials or energy will be shared?
- ✓ **Policy & Incentives** – What government support is needed?
- ✓ **Digital Tools** – What technology (AI, blockchain, IoT) can be integrated?
- ✓ **Economic Feasibility** – How will the project be funded?

Example (Kalundborg Adaptation):

Strategy	Example Implementation
By-Product Exchange	A power plant supplies excess steam to nearby industries.
Policy Incentives	Government offers tax reductions for IS participants.
Digital Monitoring	AI-based tracking ensures optimal resource flow.
Funding Model	Industries co-invest in shared infrastructure.

6. Case Study – How Policy and Digital Tools Enabled Industrial Symbiosis

The Role of Government and Technology in IS Success – Rotterdam Port (Netherlands)

Step 4: Presentation & Discussion

Each group presents their **Kalundborg-style IS initiative in 3-5 minutes**.

Discussion on:

- What are the **biggest challenges** in implementing this project?
- How can it be **scaled beyond the pilot phase**?
- What are the **next steps for making it a reality**?

6. Case Study – How Policy and Digital Tools Enabled Industrial Symbiosis

The Role of Government and Technology in IS Success – Rotterdam Port (Netherlands)

Key Takeaways

✓ Kalundborg's success proves that IS works with the right stakeholders.
✓ Policy support & digital tools accelerate IS implementation.
✓ Scaling IS requires investment, trust, and long-term commitment.
✓ Public-private partnerships are essential for long-term sustainability.

Thank You

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