Chapter 1: Industrial Information Systems

1. Introduction

The term "Information System" (IS) is being used more and more frequently, whether through the acronym DSI (Information Systems Department) or, for example, in the reform of the final year of the IG program, which is now called GSI (Information Systems Management). But what exactly does an Information System represent, and what is its connection to computer science and industry?

In the context of organizations whether a business or a public institution like the state the concept of a "system" is fundamental. A system can be understood as a **set of dynamically interacting elements, organized with respect to a specific goal** (as defined by Joël de Rosnay in Le Macroscope, Éditions du Seuil). To achieve this goal, the system must both respond to and regulate itself according to its surrounding environment. This adaptation to change is made possible through the exchange of information flows. These flows not only connect the system to its environment but also circulate internally, enabling the system to monitor and optimize its own functioning. Within a company, all operational activities such as purchasing, production, sales, financing, and investment generate exchanges with external partners. These exchanges take the form of **flows**, which are essential for the system's coordination and performance.

2. The different flows

In any organization, three main types of flows are involved in operational processes: physical flows, monetary flows, and information flows.

2.1 Physical flows

Refer to the transfer of goods or services. This includes the purchase of raw materials, their movement through various production workshops, employee labor, the sale of finished products, or the purchase of services. Goods are tangible items such as raw materials, semi-finished, or finished products while services involve intangible work carried out by other entities, such as cleaning or consulting services. For example, when a furniture factory buys wood, nails, and paint, these raw materials enter the production system and become part of the manufacturing process. The labor of employees, whether on the shop floor or in administrative roles, is a crucial contribution to transforming inputs into deliverables, even if it does not constitute a direct physical flow.

2.2 Monetary flows

On the other hand, represent the movement of money within and beyond the organization. These include paying suppliers, receiving payments from clients, repaying loans to banks, and paying employee wages.

2.1 Information flows

Involve the circulation of information, either internally within the organization or externally with partners. For instance, a procurement manager might ask the production manager for the quantities of materials required for manufacturing (internal flow) in order to determine what to order from suppliers. The corresponding external exchanges such as purchase orders, invoices, or delivery notes represent structured information flows that support coordination and decision-making.

The figure below illustrates the interrelation between material, information, and monetary flows within a logistics system [1].

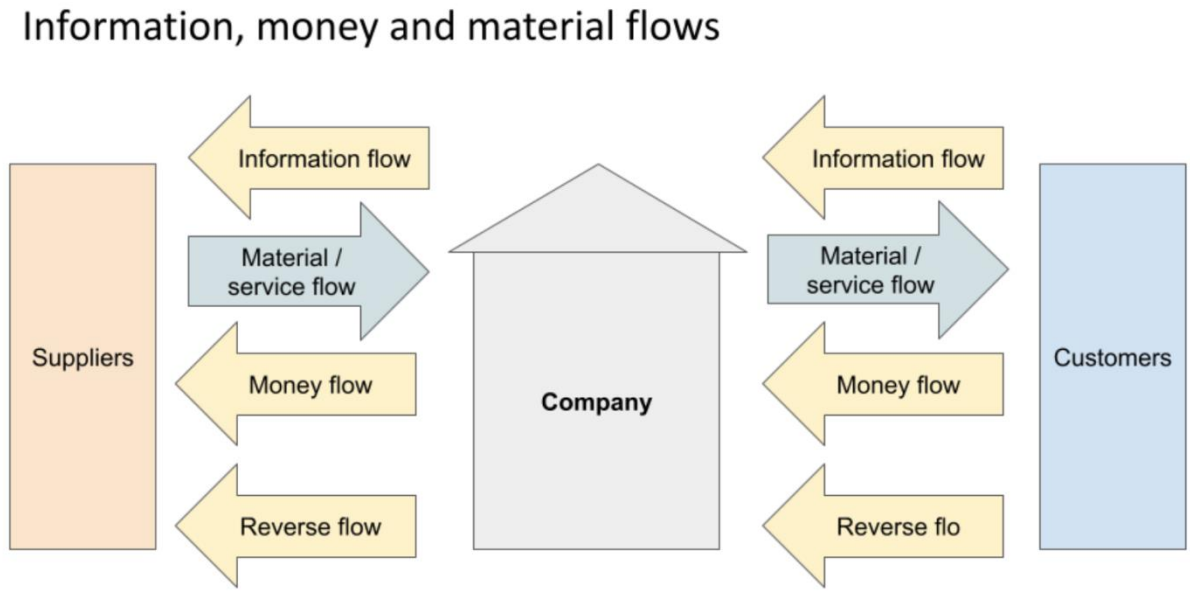

Figure 1 Information, money, and material flows in logistics.

Source: Logistiikan Maailma, https://www.logistiikanmaailma.fi/en/logistics/logistics-and-supply-chain/information-money-and-material-flow/, accessed on June 1, 2025.

3. The different subsystems within an organization:

An organization's Information System can be divided into two main subsystems: the **decision-making system** (also known as the control or management system) and the **operating system**.

The decision-making system is responsible for defining the strategic, tactical, and operational actions required to steer the organization toward its goals. It relies on data circulating through the information system to make informed decisions, such as launching a new product, entering a foreign market, or selecting the most suitable supplier. It also monitors the performance of the operating system and makes necessary adjustments such as increasing production capacity in response to market demand or reorganizing staff schedules during peak periods.

On the other hand, the **operating system** is in charge of executing the organization's core activities. This includes billing customers, paying employees, and managing inventories. It implements the directives issued by the decision-making system and, in doing so, generates operational data. This data then feeds back into the decision-making system, enabling it to evaluate performance and respond to deviations from planned objectives. The close interdependence between these two subsystems where information flows back and forth ensures that the organization remains responsive, efficient, and aligned with its strategic vision.

Within an organization, the **Information System** serves as a critical subsystem that supports the overall coordination and efficiency of operations. Its main role is to **collect, store, process, and disseminate information** essential to the organization's functioning. It gathers data from various sources internal operations, the external environment, or other internal systems and transforms raw data into meaningful insights to support decision-making. The system ensures that the right information reaches the right people at the right time. For instance, an ERP (Enterprise Resource Planning) system can track stock levels in real-time and alert managers to potential shortages, while a dashboard may display key performance indicators for executives.

The **Information System** is tightly interconnected with both the **decision-making system**, which it supports by providing reliable and timely data, and the **operating system**, which it informs and guides through instructions and operational data flows.

The **Operating System**, in contrast, is responsible for the **actual execution of activities** required to produce goods or deliver services. Its functions include transforming raw materials into finished products, delivering these products or services to customers, and carrying out all tasks defined by the decision-making system. For example, a production line manufacturing automotive parts is a core component of the operating system. This subsystem receives

instructions from the decision-making system regarding what needs to be done and provides feedback to the information system such as production volumes, machine breakdowns, or delays ensuring continuous monitoring and control of operations.

Together, these subsystems form a coherent and dynamic structure, where data, decisions, and execution are interlinked to maintain alignment with the organization's objectives.

4. Information system (IS)

To ensure effective operation, any organizational system must **store**, **process**, and **disseminate information** a function fulfilled by the **Information System (IS)**. The IS is a core component of any company or institution, enabling various stakeholders to **exchange information** and **communicate** through a combination of **human, technical, and software resources**. Its primary role is to **create, collect, store, process, and update information** in multiple formats to support decision-making and day-to-day operations.

An Information System is designed to **deliver the right information to the right person at the right time**, using the most appropriate format. It not only manages internal and external information flows within the organization but also provides the tools to compare, predict, and coordinate activities. A more operational definition sees the IS as the **sum of all information flows** within the organization, along with the **resources deployed to manage them**.

These resources include both **human and physical means** such as staff, computers, and automated systems. Although many IS functions are increasingly automated (with machines, software, and connected systems generating and processing data), **human input remains essential**, especially for tasks involving data entry, interpretation, or strategic decision-making. The IS thus plays a crucial role in ensuring that information is transformed into knowledge and action within the organization.

To process information, both computers and humans apply a set of **rules and procedures**. These may include **mathematical models, algorithms, standards, regulations, and administrative procedures**, all of which help structure how data is interpreted, transformed, and used within the organization.

4.1 The functions of an information system

Information Collection

For an organization to operate effectively, its Information System (IS) must be **fed with data** from various sources, both **internal and external**. External sources originate from the

system's environment and typically include **partners such as clients, suppliers, and public institutions**. In today's fast-changing world, organizations must be highly responsive to their external environment in order to anticipate changes and adapt accordingly. The rise of communication technologies especially the internet has greatly facilitated access to information, though it also raises challenges related to **data quality and reliability**.

Internally, the IS is fueled by **information flows generated by the organization's own activities**, such as production, human resources, and accounting. While many of these flows are formalized through well-defined procedures, others are **informal**, such as social climate indicators or undocumented know-how. These informal flows, though harder to capture and analyze, can have significant strategic value.

Relevant information must be **recorded and entered into the system**, which is often a **costly process**, especially when it requires human input. This has led to growing efforts toward **automation**, including real-time systems and digitization technologies. Although information is a **critical asset** for organizations, its acquisition and management come at a cost making **efficiency in data collection and processing a major concern** for modern businesses.

Information Storage

Once information is collected, it must be **preserved reliably over time**. Ensuring the **durability and security of storage** is a core responsibility of the Information System. Today, the **primary medium** for storing information is digital using devices such as **hard drives, CDs, DVDs**, and other electronic storage technologies. Nevertheless, **paper-based storage** still holds a significant place in many organizations, especially for the **archiving of legal or administrative documents**.

Digitally stored information is usually kept in the form of **files** or organized into **databases** to facilitate access and processing. As such, the **Database Management System (DBMS)** becomes a **central component** of any modern Information System. In order to be processed and stored in a database, information must first be **converted into data**, since computers can only handle data, not information per se. Conversely, the system must be capable of **reconstructing meaningful information** from this stored data when needed.

Information Processing

In order to be useful, information must undergo processing. While some processing tasks may still be done manually though increasingly rarely most are now automated and carried out by computer systems. The main types of processing include searching for and retrieving specific information, aggregating and consolidating data, comparing different sets of information, modifying or deleting existing data, and even generating new information through calculations or predefined rules. These operations are essential to transform raw data into meaningful insights that support decision-making and operational efficiency.

Information Dissemination

For information to be effectively used, it must **reach its intended recipient as quickly and efficiently as possible**. Various means are available to disseminate information: **paper documents, oral communication**, and most commonly today **digital media**, which ensure optimal transmission speed and broader reach. This is especially true in the era of **the Internet and interconnected information systems**, where rapid and widespread distribution of information has become both a necessity and a strategic advantage for organizations.

4.2 Qualities of an Information System

To be effective, an information system must ensure **fast and easy access to information**.
The speed and ease of access to information: A system that is too slow or overly complex can discourage users, reduce operational efficiency, and negatively impact the quality of decisions.

Therefore, it is essential to rely on **high-performance hardware and networks**, as well as **user-friendly and practical interfaces** that facilitate interaction and adoption by all stakeholders.

Reliability, Relevance, and Integrity of Information: An effective information system must ensure that the data it provides is **trustworthy and up to date**. The **timeliness of data entry**, largely dependent on human actions, plays a crucial role in maintaining data reliability. On the technical side, the system must be **available whenever needed**, with maintenance operations ideally scheduled outside working hours.

Information integrity means the system must be able to detect and respond to issues that could lead to data inconsistency. For instance, if communication is interrupted between two computers that need to synchronize their data, the system must be capable of **restoring a** coherent state across both machines to preserve data accuracy.

Security and Confidentiality of Information: Data confidentiality is a key aspect of information system security. It ensures that only authorized individuals can access sensitive information.

Confidentiality can be maintained using hardware solutions such as card readers, fingerprint scanners, or facial recognition systems. It can also rely on software mechanisms, including user authentication procedures and permission settings for files or databases.

4.3 Examples of Information Systems

In large companies, the information system is often built around an **ERP (Enterprise Resource Planning)** system, which manages most of the company's operations. In French, this is referred to as a **PGI (Progiciel de Gestion Intégré)**. An ERP ensures centralized data management and consistency across various departments, facilitating efficient coordination and decision-making. However, certain specific functions of the company may be managed by other standard or custom-built information systems, depending on the organization's unique needs and operational characteristics.

In general, within production or service-oriented companies, different types of applications can be found, such as:

Commercial Management:

CRM (Customer Relationship Management): This includes all functions related to managing customer interactions and relationships. It is referred to in French as GRC (Gestion de la Relation Client).

MIS (Marketing Information System): A system used to collect and process data to support and guide the company's marketing strategies and decisions.

Human Resource Management (HRM):

This type of application allows companies to monitor employee careers, skills, training, salaries, leave, and other HR-related activities.

Logistics:

SCM (Supply Chain Management): This includes all functions aimed at integrating suppliers and logistics into the company's information system.

Geographic Management:

GIS (Geographic Information System): A GIS allows the production of maps, plans, and the geographic localization of sites, municipalities, and other spatial entities.

The most representative applications across different levels of the company include:

Control-command systems: These systems directly manage and control industrial machines and equipment in real time.

A **control-command system** is a system that **monitors and controls an automated process**. It works in three main steps:

1) **Measure:** It collects data from the environment (via sensors, cameras, etc.).
2) **Decide:** It analyzes the information and decides what action to take (using a program, AI, etc.)
3) **Act:** It sends commands to machines (motors, robotic arms, etc.) to perform the action.

Simple example: A thermostat

-It **measures** the room temperature.

-It **decides** whether to turn the heating on or off.

-It **sends a command** to the heater to perform the action.

In an ASRS (Automated Storage and Retrieval System), the control-command system manages product movements:

-It **detects the position** of items.

-It **selects the best product** to retrieve.

-It **sends instructions** to the machines to pick and move the item.

-It's like an **automatic brain** that makes decisions and gives orders to machines!

Supervisory systems: Used to monitor and visualize production processes, often through SCADA (Supervisory Control and Data Acquisition) platforms.
A supervision system is a system that **monitors and controls an automated process in real time**. Its main role is to **display information**, **detect anomalies**, and **support operators** in decision-making.

Difference with a control-command system:

Control-command system: Automatically **makes decisions and sends commands** to machines.

Supervision system: **Displays** what's happening and allows **human operators** to interact or intervene when needed.

How does it work?

1. **Data collection:** It receives information from sensors, PLCs, machines.
2. **Display and analysis:** It shows data on a screen (graphs, alarms, status indicators).
3. **Human intervention:** The operator can adjust parameters or correct issues.

Simple example: A car dashboard

- Displays speed, fuel level, engine temperature.
- Alerts you if there's a problem (red light, alarm).
- The driver reacts (slows down, refuels, etc.).

In an **ASRS** (Automated Storage and Retrieval System):

A **supervision system** could show:

-Rack status (full/empty)

- Products in motion

-Destocking/restocking times

-Errors or failures

In short: it's the **interface between the automated system and the human operator**.

MES (Manufacturing Execution Systems): These systems bridge the gap between business planning (ERP) and factory floor operations. They monitor, track, and document the transformation of raw materials into finished goods in real time.
A **MES (Manufacturing Execution System)** is a key component of industrial information

systems, whose **main goal** is to ensure that **production operations are executed efficiently** and to **enhance manufacturing performance**.

Main Functions of a MES:

Real-time production tracking → Monitors quantities produced, machine status, and production progress.

Efficiency improvement→ Helps reduce downtime, optimize material and information flows.

Product traceability→ Records who made what, when, how useful for quality control and audits.

Quality management→ Detects defects, verifies compliance with standards, and supports corrective actions.

Performance analysis→ Calculates KPIs like **OEE** (Overall Equipment Effectiveness) to identify improvement areas.

A MES connects the **shop floor (machines, operators)** with the **management level**, providing **real-time visibility**, **control**, and **data** to make better decisions.

CAPM systems (Computer-Aided Production Management): These support the planning, scheduling, and monitoring of production activities, including inventory management and work orders.Such a program allows to plan and monitor industrial activities, closely linked with planning, procurement, manufacturing, and sometimes distribution departments.
Main functions:

Production planning→ Anticipates needs for raw materials, machinery, and human resources.

Launching manufacturing orders→ Gives the green light to start production according to the defined schedule.

Batch size management→ Determines the optimal production lot sizes to minimize costs or meet deadlines.

Supplier order placement→ Automates purchases of raw materials or components needed for production.

Progress tracking→ Monitors production progress in real-time (delays, incidents, consumption, etc.)

PDM/PLM systems (Product Data Management / Product Lifecycle Management): Often referred to in French as SGDT (Système de Gestion des Données Techniques), these systems manage all data related to product design, engineering, and lifecycle.

Note: The four processes we just discussed are **process-oriented**, meaning they focus on the **manufacturing process** itself whether it is control, supervision, or command.In contrast, the **SGDT (Technical Data Management System)** is more **product-oriented**, focusing on managing the technical data related to the product rather than the manufacturing process.

4.4 Main Needs of Information Systems Integration (SII):

Integration mechanism: There is a need for different applications to interact with each other. This mechanism of interaction or cooperation between various applications is generally called an **integration mechanism**.

Typical examples of needs that may drive the use of integration within a company include:

-An application A that periodically and/or regularly needs to access data from application B;

-An application A that requires a function provided by application B;

-Applications A and B that need to share a common set of data to avoid redundancies;

-Applications A and B that must collaborate by exchanging data;

-Applications A and B that are orchestrated by an ad hoc application to carry out a business process.

Need for Flexibility: Organizations evolve, and these changes can significantly impact the information system. These changes may originate from:

-Internal sources (e.g., changes caused by organizational restructuring, creation of new subsidiaries, or new geographical locations).

-External sources (e.g., changes caused by mergers or acquisitions of organizations).

-Evolution of Regulations: These changes can impact the information system from an external (exogenous) source for example, the transition to the Euro currency or changes in calculation rules imposed by the government or local authorities. Such evolutions often require rethinking and/or modernizing the information system.

-Evolution of the Business: These changes are mainly due to the evolution of the company's activity (for example, the production of a new product line). Such business evolutions impact business processes and consequently affect the information system.

-Evolution of Technologies: These changes are mainly due to the evolution of software products, architecture models (mainframe, client-server, multi-tier, etc.), programming paradigms (C++, Java, etc.), and IT infrastructures (J2EE, .NET). These evolutions impact information systems as they often require efforts to integrate heterogeneous technologies.

-Cost Control: This is often a requirement imposed on IT departments, which are asked to reduce and/or control their costs. This most often translates into an effort to rationalize the information system.

5. Conclusion

This first chapter laid the essential foundations regarding information systems, defining their central role in the collection, processing, storage, and dissemination of data within organizations. An information system is much more than just an IT tool; it is an organized set of human, hardware, software, and procedural resources that contribute to decision-making, activity coordination, and value creation.

More specifically, industrial information systems are distinguished by their focus on automation, control, and optimization of production processes and resource management in industrial environments. They often integrate specialized technologies such as ERP (Enterprise Resource Planning), SCADA systems, and MES (Manufacturing Execution

Systems), enabling fine synchronization between the production line, inventory management, and information flows.

In summary, mastering industrial information systems is a major strategic lever to enhance competitiveness, flexibility, and responsiveness of companies facing current technological and economic challenges.

For further study, one can refer to the classic work by Laudon and Laudon, which remains a key reference for understanding the impact of information systems in modern organizations [2].