

Basic Concepts of Information Systems

Leila Zemmouchi-Ghomari

Abstract

This chapter covers the basic concepts of the information systems (IS) field to prepare the reader to quickly approach the book's other chapters: the Definition of information, the notion of system, and, more particularly, information systems. We also discuss the typology of IS according to the managerial level and decision-making in the IS. Furthermore, we describe information systems applications covering functional areas and focusing on the execution of business processes across the enterprise, including all management levels. We briefly discuss the aspects related to IS security that ensure the protection and integrity of information. We continue our exploration by presenting several metrics, mainly financial, to assess the added value of IS in companies. Next, we present a brief description of a very fashionable approach to make the information system evolve in all coherence, which is the urbanization of IS. We conclude this chapter with some IS challenges focusing on the leading causes of IS implementation's failure and success.

Keywords: information, system, information system, IS typology, Decision-making, IS applications, IS security, IS evaluation, IS evolution, and IS challenges

1. Introduction

According to Russell Ackoff [1], a systems theorist and professor of organizational change, the content of the human mind can be classified into three categories:

1. **Data** represents a fact or an event statement unrelated to other things. Data is generally used regarding hard facts. This can be a mathematical symbol or text used to identify, describe, or represent something like temperature or a person. The data simply exists and has no meaning beyond its existence (in itself). It can exist in any form, usable or not. The data exists in different formats, such as text, image, sound, or even video.
2. **Information** is data combined with meaning. Information embodies the understanding of a relationship as the relationship between cause and effect [2]. Ex: The temperature dropped 15 degrees, then it started to rain. A temperature reading of 100 can have different meanings when combined with the term Fahrenheit or with the term Celsius. More semantics can be added if more context for the temperature read is added, such as the fact that this temperature concerns a liquid or a gas or the seasonal norm of 20°. In other words, information is data that has meaning through relational connection. According to Ackoff, information is useful data; it provides answers to the questions: "who," "what," "where," and "when."

3. **Knowledge** can be seen as information combined with experience, context, and interpretation. Knowledge constitutes an additional semantic level derived from information via a process. Sometimes this process is observational. Ack-off defines it as applying data and information; knowledge provides answers to the question “how” For example, what happens in cold weather for aircraft managers? Observational knowledge engineers interpret cold by its impact, which is the ice that can form on an aircraft by reducing aerodynamic thrust and potentially hampering the performance of its control surfaces [2].

IF temperature < = 0° C THEN cold = true;

Cold IF == right THEN notify personnel to remove ice from aircraft.

Indeed, knowledge is the appropriate collection of information such that it intends to be useful. Knowledge is a deterministic process. Memorization of information leads to knowledge. Knowledge represents a pattern and provides a high level of predictability regarding what is being described or will happen next.

Ex: If the humidity is very high and the temperature drops drastically, the atmosphere is unlikely to hold the humidity so that it rains.

This knowledge has a useful meaning, but its integration in a context will infer new knowledge. For example, a student memorizes or accumulates knowledge of the multiplication Table. A student can answer 2×2 because this knowledge is in the multiplication table. Nevertheless, when asked for 1267×300 , he cannot answer correctly because he cannot dip into the multiplication table. To answer such a question correctly requires a real cognitive and analytical capacity that exists in the next level ... comprehension. In computer jargon, most of the applications we use (modeling, simulation, etc.) use stored knowledge.

2. System definition

The system is an aggregated “whole” where each component interacts with at least one other component of the system. The components or parts of a system can be real or abstract.

All system components work toward a standard system goal. A system can contain several subsystems. It can be connected to other systems.

A system is a collection of elements or components that interact to achieve goals. The elements themselves and the relationships between them determine how the system works. Systems have inputs, processing mechanisms, outputs, and feedback mechanisms. A system processes the input to create the output [3].

- Input is the activity of collecting and capturing data.
- Processing involves the transformation of inputs into outputs such as computation, for example.
- Output is about producing useful information, usually in the form of documents and reports. The output of one system can become the input of another system. For example, the output of a system, which processes sales orders, can be used as input to a customer’s billing system. Computers typically produce output to printers and display to screens. The output can also be reports and documents written by hand or produced manually.
- Finally, feedback or feedback is information from the system used to modify inputs or treatments as needed.

3. Information system definition

An information system (IS) is a set of interrelated components that collect, manipulate, store and disseminate information and provide a feedback mechanism to achieve a goal. The feedback mechanism helps organizations achieve their goals by increasing profits, improving customer service [3], and supporting decision-making and control in organizations [4].

Companies use information systems to increase revenues and reduce costs.

In organizations, information systems are structured around four essential elements, proposed in the 1960s by Harold Leavitt (**Figure 1**). The pattern is known as the “Leavitt Diamond.”

1. **Technology:** The IT (Information Technology) of an IS includes the hardware, software, and telecommunications equipment used to capture, process, store and disseminate information. Today, most IS are IT-based because modern IT enables efficient operations execution and effective management in all sizes.
2. **Task:** activities necessary for the production of a good or service. These activities are supported by the flow of material, information, and knowledge between the different participants.
3. **Person:** The people component of an information system encompasses all the people directly involved in the system. These people include the managers who define the goals of the system, the users, and the developers.
4. **Structure:** The organizational structure and information systems component refers to the relationship between individuals people components. Thus, it encompasses hierarchical structures, relationships, and systems for evaluating people.

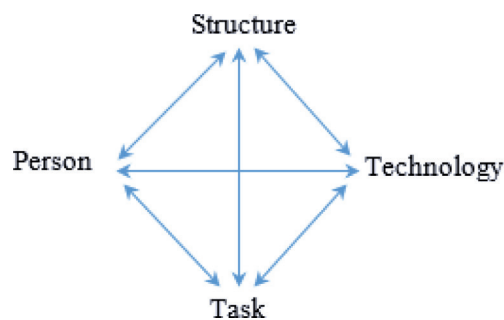


Figure 1.
Leavitt's diamond: A socio-technical view of IS.

4. Typology of information systems

A company has systems to support the different managerial levels. These systems include transaction processing systems, management information systems, decision support systems, and dedicated business intelligence systems.

Companies use information systems so that accurate and up-to-date information is available when needed [5].

Within the same organization, executives at different hierarchy levels have very different information requirements, and different types of information systems

have evolved to meet their needs. A common approach for examining the types of information systems used within organizations is to classify them according to their roles at different organizational structure levels, and this approach is called a vertical approach. Indeed, the organization is considered a management pyramid at four levels (**Figure 2**):

- **On the lowest level**, staff perform routine day-to-day operations such as selling goods and issuing payment receipts.
- **Operational management** in which managers are responsible for overseeing transaction control and deal with issues that may arise.
- **Tactical management**, which has the prerogative of making decisions on budgets, setting objectives, identifying trends, and planning short-term business activities.
- **Strategic management** is responsible for defining its long-term objectives and positioning concerning its competitors or its industry.

4.1 Transaction processing system (TPS)

At the operational level, managers need systems that keep track of the organization for necessary activities and operations, such as sales and material flow in a factory. A transaction processing system is a computer system that performs and records the routine (daily) operations necessary for managing affairs, such as keeping employee records, payroll, shipping merchandise, keeping records, accounting and treasury.

At this level, the primary purpose of systems is to answer routine questions and monitor transactions flow through the organization.

At the operational level, tasks, resources, and objectives are predefined and highly structured. The decision to grant credit to a customer, for example, is made

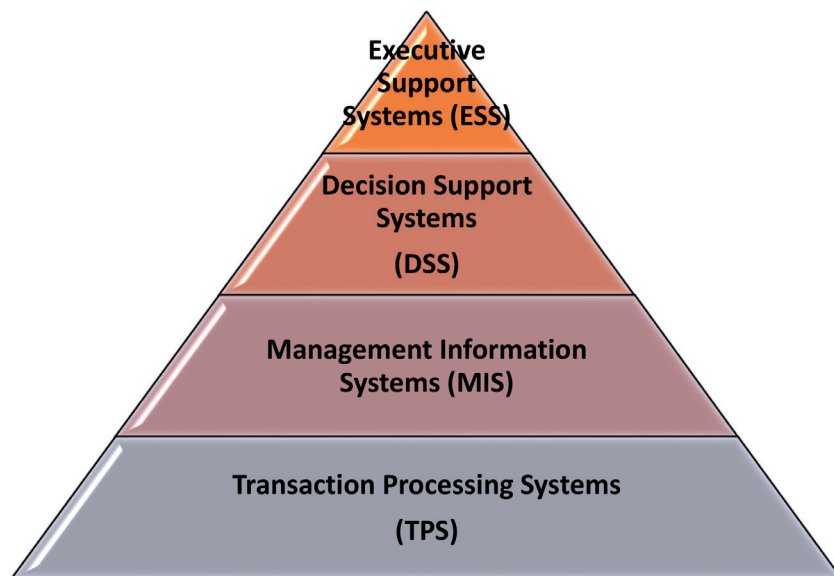


Figure 2.
Information Systems types according to managerial level.

by a primary supervisor according to predefined criteria. All that needs to be determined is whether the client meets the criteria.

4.2 Management information systems (MIS)

Middle managers need systems to help with oversight, control, decision making, and administrative activities. The main question that this type of system must answer is: is everything working correctly?

Its role is to summarize and report on essential business operations using data provided by transaction processing systems. Primary transaction data is synthesized and aggregated, and it is usually presented in reports produced regularly.

4.3 Decision support systems (DSS)

DSS supports decision-making for unusual and rapidly evolving issues, for which there are no fully predefined procedures. This type of system attempts to answer questions such as: What would impact production schedules if we were to double sales for December? What would the level of Return on investment be if the plant schedule were delayed by more than six months?

While DSSs use internal information from TPS and MIS systems, they also leverage external sources, such as stock quotes or competitor product prices. These systems use a variety of models to analyze the data. The system can answer questions such as: Considering customer's delivery schedule and the freight rate offered, which vessel should be assigned, and what fill rate to maximize profits? What is the optimum speed at which a vessel can maximize profit while meeting its delivery schedule?

4.4 Executive support system (ESS)

ESS helps top management make decisions. They address exceptional decisions requiring judgment, assessment, and a holistic view of the business situation because there is no procedure to be followed to resolve a given issue at this level.

ESS uses graphics and data from many sources through an interface that senior managers easily understand. ESS is designed to integrate data from the external environment, such as new taxes or competitor data, and integrate aggregate data from MIS and DSS. ESSs filter, synthesize and track critical data. Particular attention is given to displaying this data because it contributes to the rapid assimilation of these top management figures. Increasingly, these systems include business intelligence analysis tools to identify key trends and forecasts.

5. Decision making and information systems

Decision-making in companies is often associated with top management. Today, employees at the operational level are also responsible for individual decisions since information systems make information available at all company levels.

So decisions are made at all levels of the company.

Although some of these decisions are common, routine, and frequent, the value of improving any single decision may be small, but improving hundreds or even thousands of "small" decisions can add value to the business.

Not all situations that require decisions are the same. While some decisions result in actions that significantly impact the organization and its future, others are much less important and play a relatively minor role. A decision's impact is a criterion

that can differentiate between decision situations and the degree of the decision's structuring. Many situations are very structured, with well-defined entrances and exits. For example, it is relatively easy to determine the amount of an employee's pay if we have the appropriate input data (for example, the number of hours worked and their hourly wage rate), and all the rules of relevant decision (for example, if the hours worked during a week are more than 40, then the overtime must be calculated), and so on. In this type of situation, it is relatively easy to develop information systems that can be used to help (or even automate) the decision.

In contrast, some decision situations are very complex and unstructured, where no specific decision rules can be easily identified. As an example, consider the following task: "Design a new vehicle that is a convertible (with a retractable hardtop), has a high safety rating, and is esthetically pleasing to a reasonably broad audience. No predefined solution to this task finalizing a design will involve many compromises and require considerable knowledge and expertise.

Examples of Types of decisions, according to managerial level, are presented in **Table 1**.

Generally speaking, structured decisions are more common at lower levels of the organization, while unstructured problems are more common at higher business levels.

The more structured the decision, the easier it is to automate. If it is possible to derive an algorithm that can be used to make an efficient decision and the input data to the algorithm can be obtained at a reasonable cost, it generally makes sense to automate the decision.

Davenport and Harris [6] proposed a framework for the categorization of applications used for decision automation. Most of the systems they describe include some expert systems, often combined with DSS and/or EIS aspects. The categories they provided include Solution Configuration, Optimization of Performance, Routing or Segmentation of Decisions, Business Regulatory Compliance, Fraud Detection, Dynamic Forecasting, and Operational Control.

Many business decision situations are not very structured, and therefore cannot (or should not) be fully automated.

5.1 A particular type of decision support system: geographic information systems

Data visualization tools allow users to see patterns and relationships in large amounts of data that would be difficult to discern if the data had been presented in tabular form, for example.

Geographic Information Systems (GIS) helps decision-makers visualize issues requiring knowledge about people's geographic distribution or other resources. GIS software links the location data of points, lines, and areas on a map. Some GIS have modeling capabilities to modify data and simulate the impact of these modifications. For example, GIS could help the government calculate response times to natural disasters and other emergencies or help banks identify the best replacement for installing new branches or ATMs of tickets.

Geographic (or geospatial) information refers not only to things that exist (or are being planned) on specific locations on the Earth's surface but also to events such as traffic congestion, flooding, and other events such as an open-air festival [7].

Its scope and granularity characterize this information:

- Location, extent, and coverage are essential aspects of geographic information.
- Granularity, for example, geometric information, can be concise or fuzzy depending on the application.

Decision level	Characteristics of decisions	Examples of decisions
Top Management	Unstructured	Decide whether or not to come into the market
		Approve the budget allocated to capital
		Decide on long-term goals
Intermediate management	Semi-structured	Design a marketing plan
		Develop a departmental budget
		Design a website for the company
Operational management	Structured	Determine the overtime hours
		Determine the rules for stock replenishment
		Grant credit to customers
		Offer special offers to customers

Table 1.
Types of decisions according to managerial level.

GIS is used to capture, store, analyze, and visualize data that describes part of the Earth's surface, technical and administrative entities, and the results of geosciences, economics, and ecological applications.

- It is a computer system with a database observing the spatial distribution of objects, activities, or events described by points, lines, or surfaces.
- It is a comprehensive collection of tools for capturing, storing, extracting, transforming, and visualizing real-world spatial data for applications.
- It is an information system containing all the data of the territory, the atmosphere, the surface of the Earth, and the lithosphere, allowing the systematic capture, the update, the manipulation, and the analysis of these data standardized reference framework.
- It is a decision support system that integrates spatial data into a problem-solving environment.

Other definitions of GIS exist depending on the point of view of application [7], a GIS can be considered as

- A collection of spatial data with storage and retrieval functions
- A collection of algorithmic and functional tools
- A set of hardware and software components necessary for processing geospatial data
- A particular type of information technology
- A gold mine for answers to geospatial questions
- A model of spatial relations and spatial recognition.

Typically, a GIS provides functions for the storage and retrieval, interrogation and visualization, transformation, geometric and thematic analysis of information.

Indeed, geographic/geospatial information is ubiquitous, as seen on mobile devices such as cell phones, maps, satellite images, positioning and routing services, and even 3D simulations, gaining popularity from increasingly essential segments of the consumers.

Technological advances in recent years have transformed classical GIS into new forms of geospatial analysis tools, namely:

- Web-based and service-oriented approaches have led to a client–server architecture.
- Mobile technology has made GIS ubiquitous in smartphones, tablets, and laptops (opening up new markets).

6. Information systems applications

IS applications cover functional areas and focus on the execution of business processes across the enterprise, including all management levels.

There are several categories of business applications: Enterprise Resource Planning (ERP), Supply Chain Management systems (SCM), Customer Relationship Management systems (CRM), electronic commerce or e-commerce, Knowledge Management systems or KM, and Business Intelligence or BI. The categories of business applications dealt with in this section cover all managerial levels since KMS are mainly intended for top management (ESS), SCMs, CRMs, and BI for mid-level management (MIS and DSS), ERP and e-commerce dedicated to the transactional level (TPS or basic or operational).

However, it is useful to specify that some ERP systems, such as the global giant SAP, offer versions of its software package covering these different categories, including SCM and CRM.

6.1 ERP, Enterprise resource planning

ERPs allow business processes related to production, finance and accounting, sales and marketing, and human resources to be integrated into a single software system. Information that was previously fragmented across many different systems is integrated into a single system with a single, comprehensive database that multiple business stakeholders can use.

An ERP system centralizes an organization's data, and the processes it applies are the processes that the organization must adopt [8]. When an ERP provider designs a module, it must implement the rules of the associated business processes. ERP systems apply best management practices. In other words, when an organization implements ERP, it also improves its management as part of ERP integration. For many organizations, implementing an ERP system is an excellent opportunity to improve their business practices and upgrade their software simultaneously. Nevertheless, integrating an ERP represents a real challenge: Are the processes integrated into the ERP better than those currently used? Furthermore, if the integration is booming, and the organization operates the same as its competitors, how do you differentiate yourself?

ERPs are configurable according to the specificities of each organization. For organizations that want to continue using their processes or even design new ones, ERP systems provide means for customizing these processes. However, the

burden of maintenance falls on the organizations themselves in the case of ERP customization.

Organizations will need to consider the following decision carefully: should they accept the best practice processes embedded in the ERP system or develop their processes? If the choice is ERP, process customization should only concern processes essential to its competitive advantage.

6.2 E-commerce, electronic commerce

Electronic commerce is playing an increasingly important role in organizations with their customers.

E-commerce enables market expansion with minimal capital investment, improves the supply and marketing of products and services. Nevertheless, there is still a need for universally accepted standards to ensure the quality and security of information and sufficient telecommunications bandwidth.

The three main categories of e-commerce are Business-to-Consumer (B2C), Business-to-Business (B2B), and Consumer-to-Consumer (C2C).

- Business-to-Consumer (B2C) e-commerce involves the retailing of products and services to individual customers. Amazon, which sells books, software, and music to individual consumers, is an example of B2C e-commerce.
- Business-to-Business (B2B), e-commerce involves the sale of goods and services between businesses. The ChemConnect website for buying and selling chemicals and plastics is an example of B2B e-commerce.
- Consumer-to-Consumer (C2C), this type of e-commerce involves consumers selling directly to consumers. For example, eBay, the giant web-based auction site, allows individuals to sell their products to other consumers by auctioning their goods, either to the highest bidder or through a fixed price.

6.3 SCM, Information systems for supply chain management

Information systems for the management of the supply chain or SCM make it possible to manage its suppliers' relations. These systems help suppliers and distributors share information about orders, production, inventory levels, and delivery of products and services so that they can source, produce and deliver goods and services efficiently.

The ultimate goal is to get the right amount of products from their suppliers at a lower cost and time. Additionally, these systems improve profitability by enabling managers to optimize scheduling decisions for procurement, production, and distribution.

Anomalies in the supply chain, such as parts shortages, underutilized storage areas, prolonged storage of finished products, or high transportation cost, are caused by inaccurate or premature information. For example, manufacturers may stock an excessive amount of parts because they do not know precisely the dates of upcoming deliveries from suppliers. Alternatively, conversely, the manufacturer may order a small number of raw materials because they do not have precise information about their needs. These supply chain inefficiencies squander up to 25 percent of the company's operating costs.

If a manufacturer has precise information on the exact number of units of the product demanded by customers, on what date, and its exact production rate, it would be possible to implement a successful strategy called "just in time"

(just-in-time strategy). Raw materials would be received precisely when production needed them, and finished products would be shipped off the assembly line with no need for storage.

However, there are always uncertainties in a supply chain because many events cannot be predicted, such as late deliveries from suppliers, defective parts or non-conforming raw materials, or even breakdowns in the production process. To cope with these kinds of contingencies and keep their customers happy, manufacturers often deal with these uncertainties by stocking more materials or products than they need. The safety stock acts as a buffer against probable supply chain anomalies. While managing excess inventory is expensive, a low stock fill rate is also costly because orders can be canceled.

6.4 CRM, Information systems for customer relationship management

CRM aims to manage customer relationships by coordinating all business processes that deal with customers' sales and marketing. The goal is to optimize revenue, customer satisfaction, and customer loyalty. This collected information helps companies identify, attract and retain the most profitable customers, and provide better service to existing customers and increase sales.

The CRM captures and integrates the data of the company's customers. It consolidates data, analyzes it, and distributes the results to different systems and customer touchpoints throughout the company. A point of contact (touchpoint, contact point) is a means of interaction with the customer, such as telephone, e-mail, customer service, conventional mail, website, or even a sales store, by retail.

Well-designed CRM systems provide a single view of the company's customers, which is useful for improving sales and customer service quality. Such systems also provide customers with a single view of the business regardless of their contact point or usage.

CRM systems provide data and analytical tools to answer these types of questions: "What is the value of a customer to the business" "Who are the most loyal customers?" "Who are the most profitable customers" and "What products are profitable customers buying?"

Businesses use the answers to these questions to acquire new customers, improve service quality, support existing customers, tailor offerings to customer preferences, and deliver escalating services to retain profitable customers.

6.5 KM, knowledge management

Some companies perform better than others because they know how to create, produce, and deliver products and services. This business knowledge is difficult to emulate, is unique, and can be leveraged and deliver long-term strategic benefits. Knowledge Management Systems or KMS enable organizations to manage processes better to collect and apply knowledge and expertise. These systems collect all the relevant knowledge and experiences in the company and make them available to everyone to improve business processes and decision management.

Knowledge management systems can take many different forms, but the primary goals are: 1) facilitating communication between knowledge workers within an organization, and 2) to make explicit the expertise of a few and make it available to many.

Consider an international consulting firm, for example. The company employs thousands of consultants across many countries. The consultancy team in Spain may be trying to resolve a client's problem, very similar to a consultancy team in Singapore that has already been solved. Rather than reinventing the solution,

it would be much more useful for the Spain team to use the Singapore team's knowledge.

One way to remedy this situation is to store case histories from which employees worldwide can access (via the Internet) and search for cases (using a search engine) according to their respective needs. If the case documentation is of good quality (accurate, timely, complete), the consultants will share and benefit from each other's experiences, and the knowledge gained.

Unfortunately, it is often difficult to get employees to contribute meaningfully to the knowledge base (as they are probably more concerned with moving forward on their next engagements with customers rather than documenting their past experiences). For such systems to have any chance of success, the work organization must change, such as establishing a reward system for cases captured and well documented.

6.6 BI, business intelligence

The term Business Intelligence (BI) is generally used to describe a type of information system designed to help decision-makers learn about trends and identify relationships in large volumes of data. Typically, BI software is used in conjunction with large databases or data warehouses. While the specific capabilities of BI systems vary, most can be used for specialized reporting (e.g., aggregated data relating to multiple dimensions), ad-hoc queries, and trend analysis.

As with knowledge management systems, the value of business intelligence systems can be hampered in several ways. The quality of the data that is captured and stored is not guaranteed. Besides, the database (or data warehouse) may lack essential data (for example, ice cream sales are likely to correlate with temperature; without the temperature information, it may be difficult to identify why it is. There has been an increase or decrease in sales of ice cream). A third challenge is the lack of mastery of data analysts over the context of the organization's operations, even if they are proficient in BI software. In contrast, a manager has mastery of the organization but does not know how to use BI software. As a result, it is common to have a team (a manager associated with a data analyst) to get the most information (and/or knowledge) from a business intelligence system.

7. Information systems security

Unlike physical assets, the information does not necessarily disappear when it has been stolen. If an organization holds confidential information such as a new manufacturing process, it may be uploaded by an unauthorized person and remain available to the organization.

Exposing information to unauthorized personnel constitutes a breach of confidentiality.

Another type of system failure happens when the integrity of information is no longer guaranteed. In other words, rather than unauthorized exposure of information, there are unauthorized changes of information. A corporate website containing documentation on how to configure or repair its products could suffer severe financial harm if an intruder could change instructions, leading to customers misconfigure or even ruin the purchased product.

Finally, the denial of access to information or the unavailability of information represents another type of information failure. For example, if a doctor is prevented from accessing a patient's test results, the patient may suffer needlessly or even die. A commercial website could lose significant sales if its website were down for an extended period.

Understanding the potential causes of system failure enables appropriate action to be taken to avoid them. There are a wide variety of potential threats to an organization's information systems.

Human threats are the most complicated to manage because they include a wide variety of behaviors. To illustrate how the level of detail can vary, some relevant subcategories include:

- Accidental behavior by members of the organization, technical support staff, and customers of the organization
- Malicious behavior by someone inside or outside the organization
- Other categories of threats include:
 - A natural event: flood, fire, tornado, ice storm, earthquake, pandemic flu
 - Environmental elements: chemical spill, gas line explosion.
 - Technical Threat: Hardware or software failure
 - Operational Threat: a faulty process that unintentionally compromises the confidentiality, integrity, or availability of information. For example, an operational procedure that allows application programmers to upgrade software without test or notification system operators can result in prolonged outages.

It is possible to categorize the various checks intended to avoid a failure, such as:

1. Management controls management processes that identify system requirements such as confidentiality, integrity, and availability of information and provide for various management controls to ensure that these requirements are met.
2. Operational controls: include the day-to-day processes associated with the provision of information services.
3. Technical controls: concern the technical capacities integrated into the IT infrastructure to support the increased confidentiality, integrity, and availability of information services.

A widely cited Gartner research report concludes that “people directly cause 80% of downtime in critical application services. The remaining 20% are caused by technological failures, environmental failure or a natural disaster”.

Often, these failures are the result of software modifications such as adding new features or misconfiguring servers or network devices.

IT professionals should ensure that system changes are prioritized and tested and that all interested parties are notified of proposed changes.

8. Information systems assessment

Perceptible benefits can be quantified and assigned a monetary value. Imperceptible benefits, such as more efficient customer service or improved decision making, cannot be immediately quantified but can lead to quantifiable long-term gain [4].

System performance can be measured in different ways.

8.1 Efficiency

Efficiency is often referred to as “doing the things right” or doing things right. Efficiency can be defined as the ratio of output to input. In other words, a company is more efficient if it produces more with the same amount of resources or if it produces the same amount of output with a lower investment of resources, or - even better - produces more with less input. In other words, the company achieves improvements in terms of efficiency by reducing the waste of resources while maximizing Productivity.

Each time an item is sold or ordered, the manager updates the quantity of the item sold in the inventory system. The manager needs to check the sales to determine which items have been sold the most and restocked. This considerably reduces the manager's time to manage his stock (limit input to achieve the same output). So efficiency is a measure of what is produced divided by what is consumed [3].

8.2 Effectiveness

Effectiveness is measured based on the degree achieved in achieving system objectives. It can be calculated by dividing the objectives achieved by the total of the objectives set.

Effectiveness is denoted as “doing the right thing” or doing the things necessary or right. It is possible to define effectiveness as an organization's ability to achieve its stated goals and objectives. Typically, a business more significant is the one that makes the best decisions and can carry them out.

For example, to better meet its various customers' needs, an organization may create or improve its products and services founded on data collected from them and information accumulated from sales activities. In other words, information systems help organizations better understand their customers and deliver the products and services that customers desire. Collecting customer data on an individual basis will help the organization provide them with personalized service.

The manager can also ask customers what kind of products and services customers would like to buy in the future, trying to anticipate their needs. With the information gathered, the manager will order the customers' products and stop ordering unpopular products.

In what follows, we present several formulas established to measure efficiency and effectiveness resulting from the information systems use. Indeed, the impact of an information system on an organization can be assessed using financial measures.

8.3 Financial measures of managerial performance

When the information system is implemented, management will certainly want to assess whether the system has succeeded in achieving its objectives. Often this assessment is challenging to achieve. The business can use financial metrics such as Productivity, Return On Investment (ROI), net present value, and other performance metrics explained in the following:

8.3.1 Return on investment

Return on investment, denoted as a Return rate, is a financial ratio that measures the amount gained or lost compared to the amount initially invested.

An information system with a positive return on investment indicates that this system can improve its efficiency.

The advantage of using Return on investment is that it is possible to quantify the costs and benefits of introducing an information system. Therefore, it is possible to use this metric to compare different systems and see which systems can help the organization be more efficient and/or more effective.

8.3.2 Productivity

Developing information systems that measure Productivity and control is a crucial element for most organizations. Productivity is a measure of produced output divided by required input. A higher production level for a given entry-level means greater Productivity; a lower output level for a given entry-level means lower Productivity. Values assigned to productivity levels are not always based on hours worked. Productivity may be based on the number of raw materials used, the quality obtained, or the time to produce the goods or services. According to other parameters and with other organizations in the same industry, Productivity's value has to mean only compared to other Productivity periods.

8.3.3 Profit growth

Another measure of the SI value is the increase in profit or the growth in realized profits. For example, a mail-order company installs an order processing system that generates 7 percent growth in profits over the previous year.

8.3.4 Market share

Market share is the percentage of sales of a product or service relative to the overall market. If installing a new online catalog increases sales, it could help increase the company's market share by, for example, 20 percent.

8.3.5 Customer satisfaction

Although customer satisfaction is difficult to quantify, many companies measure their information systems performance based on internal and external feedback. Some companies use surveys and questionnaires to determine whether investments have resulted in increased customer satisfaction.

8.3.6 Total cost of ownership

Another way to measure the value of information systems has been developed by the Gartner Group and is called the Total Cost of Ownership (TCO). This approach allocates the total costs between acquiring the technology, technical support, and administrative costs. Other costs are added to the TCO, namely: retooling and training costs. TCO can help develop a more accurate estimate of total costs for systems ranging from small computers to large mainframe systems.

9. Information systems evolution

The evolution of information technologies leads to the reflection on new approaches that set up more flexible, more scalable architectures to meet its agility needs. The urbanization of information systems is one such approach.

9.1 Definition of the urbanization of information systems

The company's information system's urbanization is an IT discipline consisting of developing its information system to guarantee its consistency with its objectives and business. By taking into account its external and internal constraints while taking advantage of the opportunities of the IT state of the art.

This discipline is based on a series of concepts modeled on those of the urbanization of human habitat (organization of cities, territory), concepts that have been reused in IT to formalize or model the information system.

Town planning defines rules and a coherent, stable, and modular framework, to which the various stakeholders refer for any investment decision relating to the management of the information system.

In other words, to urbanize is to lead the information systems' continuous transformation to simplify it and ensure its consistency.

The challenges of urbanization consist of managing complexity, communicating and federating work, considering organizational constraints, and guiding technological choices.

9.2 Stages of urbanization

9.2.1 Definition of objectives

Define and frame the objectives of the project, define the scope, develop the schedule.

9.2.2 Analysis of the existing situation

Carry out the inventory, organize the work, and present the deliverables. More precisely, list the assets and map the different layers (business, functional, application, and technical):

- Business Architecture

Identify "business processes": Who does what and why? The description of the processes is done with BPMN, EPC formalisms, etc. This step is tricky and may require the use of exploration methods. However, it does improve the overall understanding and increase the possibilities for optimization

- Functional architecture

Identify the "functional block": What do we need to carry out the business processes? Here, we are based on a classic division into zones (exchanges, core business, reference data, production data, support activities, management). This step's difficulty lies in choosing the right level of detail and remaining consistent with business processes. However, it provides a hierarchical presentation and makes it easier to break down the work.

- Application Architecture

Identify the applications: How to achieve the functionalities? This step is based on a classic N-Tiers division. However, it is not easy to provide value and solutions compared to functional architecture. This stage lays the foundations for the realization (major technological choices, etc.).

- System Architecture

Identify the technical components: With what and where the applications work, it is based on a classic division into technical areas (security, storage, etc.). It is not easy to make the connection between applications and servers. This step brings concrete and structuring and is essential to assess the cost of the system.

9.2.3 Identification of the target IS

Impact on the different layers, consideration of constraints (human, material, etc.), design of costed scenarios, and arbitration of the choice of a target.

9.2.4 Development of the trajectory

How to organize the work, frame and then refine the budgets, design and plan projects, define the support strategy, set up an organization, contributions, roles, and responsibilities of actors.

At the end of this process, a Land Use Plan (LUP) is defined. It is a report consisting of:

- Summaries of the orientations chosen as well as the justifications for the options selected.
- A definition of areas, neighborhoods, and blocks.
- Existing and target maps (process, functional, application, and technical mapping).
- Additional documents (interview reports, list of people and organizational entities, etc.)

The goal is to identify the gaps between the existing and the principles of urbanization and establish changes by describing the actions and their corresponding cost.

In practice, the urbanization process is very cumbersome to implement. On the one hand, it requires the participation of many actors in the organization, and on the other hand, the analysis is very long. As a result, needs to change, and LUP is no longer necessarily suitable.

10. Information systems challenges

The reasons for a successful or unsuccessful IS implementation are complex and contested by different stakeholders and from the various perspectives involved. Developers tend to focus on the system's technical validity in terms of execution, operation, and evolution. Other qualities are often considered, such as security, maintainability, scalability, stability, and availability. All of these criteria are considered to be signs of successful IS Development.

The failure of an IS can be defined as: either the system put in place does not meet the user's expectations or does not function properly. The reasons for failure are as divergent as the projects.

The perspective of project management, on the other hand, tends to focus on the consumption of resources. The project delivered with the initial budget and within the allotted time is considered a successful project. Nelson [9] analyzed 99 SI projects and identified 36 classic errors. He categorized these errors into four categories: process, people, product, and technology. The last category concerns the factors leading to IS failures based on the misuse of modern technologies.

The seminal article by DeLone and McLean [10] suggested that IS success should be the preeminent dependent variable for the IS domain. These researchers proposed a taxonomy of six interdependent variables to define the IS' success as the system's quality, the quality of information, the IS, user satisfaction, individual impact, and organizational impact.

One of the significant extensions to this proposition is the dimension of the IT department's quality of service [11].

Either way, the use of the system is seen as a sign of its success. The IS use level is incorporated into most IS success models [11, 12]. These models show the complexity of measuring user satisfaction because, even in the same organization, some user groups may be more or less enthusiastic than others to use the new information system.

In the current global context of the covid pandemic, it appears clear that information systems that integrate web and mobile technologies can positively contribute to the monitoring of contaminated cases and therefore minimize the risks of contamination provided that users adhere to this movement for the benefit of all [13]. A truly global, rapid, and efficient decision-making process is enabled by the integration of information systems from distributed sources [14].

11. Conclusion

To conclude this introductory chapter, we present its key ideas:

- Levels of information are data, information, and knowledge.
- The system is an aggregated “whole” where each component interacts with at least one other system component to achieve a goal.
- An information system can be defined as a set of interconnected components that gather, process, store and dispense information to support decision making and control in an organization. An IS can be seen as a socio-technical system. The technical part includes the technology and the processes, while the social part includes the people and the structure.
- The role of information systems is to solve an organization's problems concerning its information needs
- A company has systems to support the different managerial levels: transaction processing systems, management information systems, decision support systems, and systems dedicated to business intelligence.
- Decisions can be operational or strategic.
- There are several categories of business applications: enterprise resource planning, supply chain management systems, customer relationship management systems, knowledge management systems, and business intelligence.


- Among the failures that can affect IS a violation of confidentiality, integrity, and availability of information.
- The controls intended to avoid the IS's security failures include management controls, operational controls, and technical controls.
- The information system's performance can be measured according to efficiency, effectiveness, Return on investment, Productivity, customer satisfaction, etc.
- Urbanizing an information system means directing its continuous transformation to guarantee its consistency
- The reasons for a successful or unsuccessful implementation of an IS are complex and contested by the various stakeholders and from the various perspectives involved.

Author details

Leila Zemmouchi-Ghomari
National Superior School of Technology, Algiers, Algeria

*Address all correspondence to: leila.ghomari@enst.dz

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