Course Book

OPERATIONAL APPLICATION SYSTEMS

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LEARNING OBJECTIVES

The course book, **Operational Application Systems**, explores the fundamental principles, objectives, and functional-content-related classification, as well as an organizational and value-added oriented integrative classification in the operational process landscape.

In addition, you will learn about application systems and their areas of implementation. This includes systems for managing and supporting general business processes, as well as for specific tasks related to the overall operational performance.

The course explains systems for enterprise resource planning, as well as systems that are used for important areas of inter-organizational value creation, such as supply chain and customer relationship management. The course book concludes by examining management information systems as an important tool for supporting operational management tasks.

UNIT 1

CATEGORIES OF OPERATIONAL APPLICATION SYSTEMS

STUDY GOALS

On completion of this unit, you will be able to ...

– understand what is meant by business application systems.
– explain how these systems can be categorized.
– analyze how application systems are integrated into the company.
– outline how the contribution of these systems works in practice.

1. CATEGORIES OF OPERATIONAL APPLICATION SYSTEMS

Introduction

We are living in a fast-paced world characterized by rapid changes. In such an environment, acting and reacting quickly in decision-making situations are essential for a competitive business. In this regard, information and communication systems can play an essential role by facilitating the decision-making process.

Correct decisions and correct actions are directly related to the knowledge available within an organization. In today's world, in which data and information are among the most important resources for performing and creating value for business, the systems that handle these resources are of strategic and essential importance for any business.

These systems enable businesses to define their strategies and goals more efficiently. However, these systems require clear planning and architecture that could help the organizations optimize their operation instead of creating more problems and obstacles.

In this unit, we will discuss the operational application system. First, we define what is an operational application system and how can these systems be classified. Then, we will see what functional inputs and parameters of application systems should be integrated to maximize the benefit for the organization. Finally, we will see how a practical implementation and contribution of such systems look in a concrete real-world scenario.

1.1 Terminology, Objectives, and Delimitation of Operational Application Systems

We start with definitions of the main terms of this course: operation, application systems, and naturally operational application systems.

An operation refers to a localized unit, both technically and organizationally, dedicated to producing goods and services. It is defined by its specific geographical context and internal structure (Dautzenberg, 2018). An application system, on the other hand, is a type of software designed to address tasks within a specific area of electronic data processing. (Lackes, 2018). In the scope of business, we refer to application systems as computer-based administrative systems, information systems (management information systems), computer-based scheduling systems, and planning systems. (Lackes, 2018). Then, we can define operational application systems as software systems offering different functionalities to support the business operation landscape in producing the intended operational output (services and products). More precisely, operational application systems are information systems (IS) that support the informational needs within the business operation, particularly in the context of decision-making and actions undertaken by the involved parties.

Information Systems

Information systems (IS) are socio-technical systems that include human and machine components (subsystems). IS enables the successful collection, structuring, processing, provision, communication, and use of data, information, and knowledge, as well as their transformation. These systems contribute value-added processes, including decision-making, coordination, management, and control. They additionally facilitate processes under specified economic criteria, such as automation, integration, and virtualization. A well-designed system is a powerful innovation tool that enables product, process, and business model innovations (Krcmar, 2015). In the following, we will be back to IS as a part of the information management system.

Information Management (IM)

We use Krcmar's reference model, which describes different levels of information management (Krcmar, 2015). In this regard, information management is considered part of corporate management to optimize the use of the information in creating value-added for a company. It includes the planning, guidance, and control of information, information systems, and information and communication technology (ICT) as the technical infrastructure.

It is important to note that information management serves to coordinate information flows within the value-added process. It is an instrument for maintaining and increasing the competitiveness of companies and their business models, which is especially important for digital transformation. In this context, the management of information and knowledge results in primarily the targeted use of information systems to make workflows and structures more effective, efficient, and faster. As we know, the functional content of the planning and design of information and application systems is directly linked to the company's operating performance. This shows the importance of these systems, not only in terms of digitization but also in terms of operational performance.

Krcmar's three-tier model

Krcmar's three-tier model of information management systems provides a comprehensive framework for understanding and effectively managing the multifaceted components of an organization’s information management systems. This model divides the information management system into three levels, where each level has its components and is at the same time connected to other levels as can be seen in the following figure.

Table 1: Information Management Model

Management tasks of the IM It governance IT strategy IT processes IT staff IT security	**Level 1: Management of economic information:** Offers, requests, and utilization
	Level 2: Management of the information systems Data, processes, and life cycles
	Level 3: ICT management Storage, processing, communication, and technology bundle

Source: Hamzeh Alavirad (2024), based on Leimeister (2015, p. 137).

Management of economic information

The focus of the economic information level is on information as a resource. It is about decisions on the information demand and the information supply, thus about the information utilization. At this level, the information management system recognizes the information needs of the organization and checks the quality, availability, and relevance of information through data modeling, information architecture, and knowledge management. The required information and its utilization by the provided information are planned, organized, and controlled in an information management planning cycle. In this context, the management system covers all essential uses within a company's divisions and subdivisions.

The management of how information is utilized is in the first line the responsibility of the company's management through the use of business decision models (Krcmar, 2015 p. 108).

Management of information systems

The task of the middle level is the management of information. Information systems refer to systems of coordinated elements of personnel, organizational, and technical nature that serve to meet information requirements. The applications are the main object at this level. Therefore, the main tasks at this level are the management of data, the process of data, and the application life cycle. This middle level in turn specifies requirements for and receives support services from ICT. The management of application development takes place at this level (Krcmar, 2015 p. 109).

Information and communication technology

At the level of information and communications technology (ICT), the focus is on storage technology, processing technology, communications technology, and technology bundles. Technology management generally refers to the deployment and management of the technology infrastructure as well as the planning of the technical customization of deployed systems in the company. At this lowest level, the physical infrastructure is provided for the application landscape at the middle level and thus for the deployment of information resources.

However, some tasks are performed at every level or that are not exclusively related to one level. They are general tasks of IM and belong to the group of management tasks of information management and are shown in the figure above across all levels. The objectives of the management tasks that affect all three levels are the definition of the governance of IM, the definition of the strategy, the associated definition of the importance of IM for the company, the management of IT processes, the management of IT personnel, IT security and IT controlling in the broader sense as the management of IM.

If we now want to derive the meaning of information systems from information management. An information system is a comprehensive network of regulated internal and external information connections, along with their technical and organizational structure, utilized for information acquisition and processing.

Information management refers to the process of collecting, storing, organizing, managing, and disseminating information within an organization or any other entity. It involves various activities aimed at ensuring that information is handled efficiently, accurately, securely, and in a manner that meets the needs of users or stakeholders. Information management involves providing timely delivery of all required and pertinent information to stakeholders in a cost-effective and rational manner. The information system serves as the conduit for decision-making and execution by management, thus serving as the foundation for the entire managerial process. The information flow occurs within the information system. (Siepermann 2018).

So, if we consider the management of information systems as a subset of information management, then the following main issues arise (Krcmar, 2015, p. 173):

- the management of the basic building blocks/subsystems of information systems,
- the design of their data and process organization,
- the support of applications from the management of ideas up to operation and replacement, and the harmonization of an entire system landscape and the infrastructure in organizations that support it.

The resulting subtasks are primarily concerned with the following areas (Krcmar, 2015, pp. 175–176):

Management of the data

This includes an adjustment according to reference models, a development of an enterprise-wide data model, the introduction of databases and the associated data security.

Process management

This includes the identification of core business processes and the business processes that support them, their modelling and optimization, and also based on standards, to ensure the economic viability of the identified process flows.

Life cycle management

This means that decisions have to be made regarding the deployment and procurement of software, including licensing considerations or cost estimates for in-house development, which are accompanied over time by questions about system replacement, migration or a fundamental system change.

System landscape and infrastructure

This is backed up by considerations of architecture specifications in connection with project planning as implementation measures that must be controlled individually or also in combination and simultaneously.

These requirements also make it clear that applications supported by information systems must support the necessary process guidance through their functionality. This depends in turn on the properties that characterize the application software packages used for this purpose. To be able to formulate these requirements in a purpose-oriented manner, the operational process landscape must be kept transparent. This aspect is primarily part of operational business process management. The management of information and application systems deals with the basic technical and functional building blocks of information and application systems, the design of their data and process organization, the life cycle of the applications they provide, and their organization within the company's performance and value creation.

Areas of Application Systems Deployment

The subtasks of the management of information and application systems mentioned in the last section have made it clear that several aspects have to be taken into account when it comes to the planning, introduction and further development of application systems. In practice, there are of course a large number of different tasks within the process design, and therefore, it is logical that, based on the business process involved, there must be different types of application systems.

In this context, we understand an operational application system "in the narrow sense to be the collection of all programs for a concrete operational application area. This includes the application software and the associated data. In the broader sense, the hardware and software system required for the use of the application software, the necessary communication facilities and - depending on the approach - also the users are additionally part of the operational application system" (Leimeister, 2015, p. 136).

We find application systems in almost all operational areas. Within service production, these can be the primary functional clusters of procurement, production and sales, but for the company as a whole, there are also secondary process contributions in accounting and human resources or in control. Moreover, the differences between business and industry mean that we have application systems with different functional orientations and information and communications technology specifications in almost all sectors and branches of the market, in both private and public administrative institutions. But as a rule, the deployment objective is always connected with the efficiency and effectiveness aspects of competition.

The system deployment is intended to optimize process performance with regard to these aspects, which in each case is performed according to the conditions that characterize the specific deployment scenario. These conditions can be clarified by criteria such as those summarized in the following table (Leimeister, 2015, p. 137), which are used to categorize application systems. However, the criteria listed in the table only represent one case, since depending on the field of application there may of course also be other conditions and requirements that can also parameterize the organizational and technical architecture of application systems.

Table 2: Criteria Structuring of Operational Application Systems

Criteria	Explanation	Examples
Type: tailored or standard software	Software can be obtained as a ready-made package or individually programmed application.	Office packages for word processing are usually standard software. ERP software such as SAP ERP usually has to be customized.
Platform: Proprietary software, Open, online/Web	The software can only work with defined systems of one provider (proprietary), with multiple systems (open), or be available online/as a web service via browser.	Proprietary: software written for Windows Open: Java programs Web service: Online Banking
Forms of use: Interactive mode, batch processing, transaction processing.	Data can be processed individually by interactive mode, by processing larger amounts of data at once, or in individual transactions.	Interactive mode: money transfer at the ATM Batch processing: Process all money transfers of one day Transaction processing: Withdraw money
Programming language: procedural, non-procedural, object-oriented	Software can be distinguished by the programming language used.	SQL, ABAP/4, Java, C++
License model: one-time license, time-based license, user-based license, hardware-based license	Software can be differentiated based on the license model.	One-time license: pay once, use forever (most of cases with annual maintenance services) Time-based license: pay for one year of use
Hardware requirements: Computing power, storage space, network, other devices like add-on cards, printers, etc.	Software can be distinguished based on hardware requirements.	High computing speed for scientific simulations
Specific devices: cash register reading device, ATM, self-service terminal.	Software can be distinguished based on required additional hardware.	A POS system requires a connection to the cash register as well as to the cash register reading device

Criteria	Explanation	Examples
Architecture: centralized, decentralized, client-server, etc.	Software can be differentiated by architecture.	Insurance companies have partially decentralized structures for the sales offices.

Source: Paul Nikodemus (2021), based on Leimeister (2015, p. 137).

A further distinction of operational information and application systems results from the allocation regarding the deadline of the functional performance of the respective support. This means that the target groups working with the system and their decision-making time frame are important. While operational application systems are more likely to have a short-term focus, management information systems are strategy-oriented, and therefore, generally have a long-term focus. In between there are the planning systems, whose user group is likely to be mainly in middle management.

The operational application systems, which mainly support day-to-day process performance in companies, can be found in almost all companies and in all organizational and information technology sizes. As the process performance differs slightly from company to company, then there are many standardized systems for this application scenario. This is not likely to be the case for strategy-related process services (management) because of the individualization of competitive support. Therefore, operational systems are very often differentiated by their function and the user group, e.g., the industry. The following tables show how this is structured (Leimeister, 2015, p. 139).

Table 3: Structuring of Operational Application Systems

	Administrative operational systems	Operational dispositive systems
Task focus	classical operational accounting of “mass data,” and management of inventories	preparation of short-term dispositive decisions
Target group	operational area of the lower level of the company	management of the lower level of the company

	Administrative operational systems	Operational dispositive systems
Example applications	activities in financial accounting, including monthly and annual financial statements (accounting, tax advisor, controlling) monthly payroll accounting in human resources (personnel processing) inventory management of stock items in trade and manufacturing industry (cashier, storekeeper, salesman, production staff) administration of accounts at banks and building associations or contracts at leasing companies and insurance companies (service employee, account manager)	calculation in cost accounting (management) Field service control and route planning in sales (sales manager) material procurement (purchaser) workshop control in production (production manager) order management in retail (store manager, team leader)

Source: Paul Nikodemus (2021), based on Leimeister (2015, p. 137).

The second table shows that industry-neutral operational application systems offer functionality that can be used in almost any company since they support cross-industry tasks.

Table 4: Industry-Neutral and Industry-Specific Operational Application Systems

Industry-neutral operational application systems	Industry-specific operational application systems
• finance and accounting • human resources • procurement and purchasing • distribution	• CAD (computer-aided design) • merchandise management system in trade • securities trading system • claims processing system

Source: Hamzeh Alavirad (2024).

One application focus of industry-specific operational systems is in manufacturing and production operations. Here, the main focus is on systems that support manufacturing processes with computing power. The basis for this is the Computer Integrated Manufacturing (CIM) concept established in the 1970s, which aims to achieve the maximum possible integration of manufacturing workflows and the business and organizational tasks that control them.

However, some of today's standard systems already mentioned for operational use can also offer many of the functionalities provided in the CIM concept. The relevant sub-functions of CIM include computer-aided design (CAD), computer-aided planning (CAP), and computer-aided manufacturing (CAM) for the technical aspects of production, as well as and production planning and control (PPC) for the organizational aspects of production (Leimeister, 2015, p. 147).

Operational planning information systems
This type of system supports management in its planning tasks.

From the perspective of information management, **operational planning information systems** are application systems that support planning processes. They are mainly found in connection with operational decision scenarios for management. Typical examples are demand, capacity and maintenance planning in manufacturing or route planning in distribution. Depending on the scope of planning, individual departments or even the entire company can be supported by integrative planning.

The planning data may already be available or may be generated by simulations or forecasts. Planning models determine the calculation rules and the temporal reference values and provide analysis procedures for analyzing the deviation. More complex mathematical models can be applied via operations research (OR), where it is also possible to consider optimization models and simulation methods. It is common for planning systems to perform extensive mathematical calculations, which may scale their information technology equipment accordingly (Leimeister, 2015, pp. 158–159).

As a rule, operational management information systems must provide senior management with the information relevant to their management processes and management functions in a suitable format.

In the context of information logistics, it could also be said that these systems must provide the right information at the right time, in the right form, and at the right place. Conceptually, these systems go back to the management information systems (MIS) that were already common in the USA in the 1960s. Together with the planning information systems, the management information systems build the management systems of a company, which is why they are also called management support systems (MSS). An executive information system (EIS) supports managers in their leadership executive information system (EIS) and decision-making work, known as the decision support system (DSS). In addition, of course, office communication applications are still used to support management in companies (Leimeister, 2015, pp. 159–161).

In addition to information systems that directly support the organizational structure in process design, there are also systems that facilitate and automate the processing of cross-sectional tasks.

These applications, which are also referred to as operational cross-sectional information systems, include the office systems already mentioned, but also applications for computer-supported group work, conference systems, workflow management systems, and document and knowledge management systems. Systems for electronic data interchange represent a more specialized application (Leimeister, 2015, pp. 163–171).

Objectives of Operational Application Systems

Operational application systems can help organizations to achieve their business goals. Undoubtedly, economic goals have the highest priority among all objectives, but there are other objectives that are in line with economic objectives such as social, ecological, and cultural goals. For example, in today's world, when we struggle with the effects of global warming, having a green image is on the agenda of every company. The strategic considerations in companies in addition to the economic parameters also have social and ecological goals in mind. We can consider the following economic objectives classes for an organization (Hansen et al., 2019, pp., 20–21):

- rationalization, with an aim to ensure a seamless and efficient day-to-day operation
- daily Information System for flexibility and responsiveness of day-to-day operation
- decision support through analyses of existing data repositories (business intelligence)
- contribution to innovation through continuous process optimization and the facilitation of new business models.

The following table shows a practical implementation of an operational application system in a retail business:

Table 5: Implementation of an Operational Application System in a Retail Business

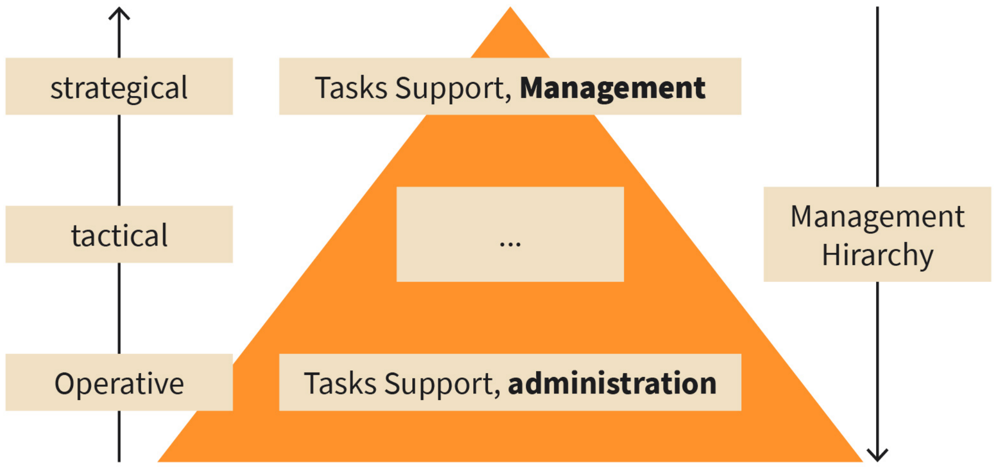
Objective	Example
Automation	Inventory management systems, barcode scanners at cash registers, automated warehousing systems, and robotic picking systems
Self-service	Shelf optimization, electronic shelf labeling, self-scanning, contactless payment with smartphone or NFC, and online shopping
Individualization	Recommendation systems, virtual and augmented reality, package tracking, purchase behavior analysis, and CRM systems
Reach out to the global market	Electronic data exchange, supply chain management systems, and social media
Exploring new markets	Responsive web design or mobile websites, and mobile shopping apps
Process tracking and exploring new markets through IoT.	Radio frequency identification (RFID) for contactless identification, control, and tracking of goods throughout the entire supply chain.

Source: Paul Nikodemus (2021), based on Hansen et al. (2019, p. 24).

1.2 Horizontal and Vertical Integration

So far, we have learned that business application systems can be categorized according to the services they provide to support task processing. Also, they can be hierarchically structured according to their objectives. For example, consider the day-to-day support provided by operational systems for administration at the low end of the management scale and the support provided by management information systems in strategic decision-making situations at the high end of the management scale. If we combine this with the deadline of decisions (operational, tactical, strategic in the sense of short-, medium-, and long-term) in classical management, we can broadly classify the application system landscapes that we've already covered.

Figure 1: Application Systems and Tasks Support



Source: Paul Nikodemus (2021), based on Hansen et al. (2019, p. 8).

This diagram makes it clear that, due to the existing process landscape, companies naturally need to have an information-functional and information-technical infrastructure for the application systems that comply with certain integration principles in their architecture to provide optimal support for the creation of services or value.

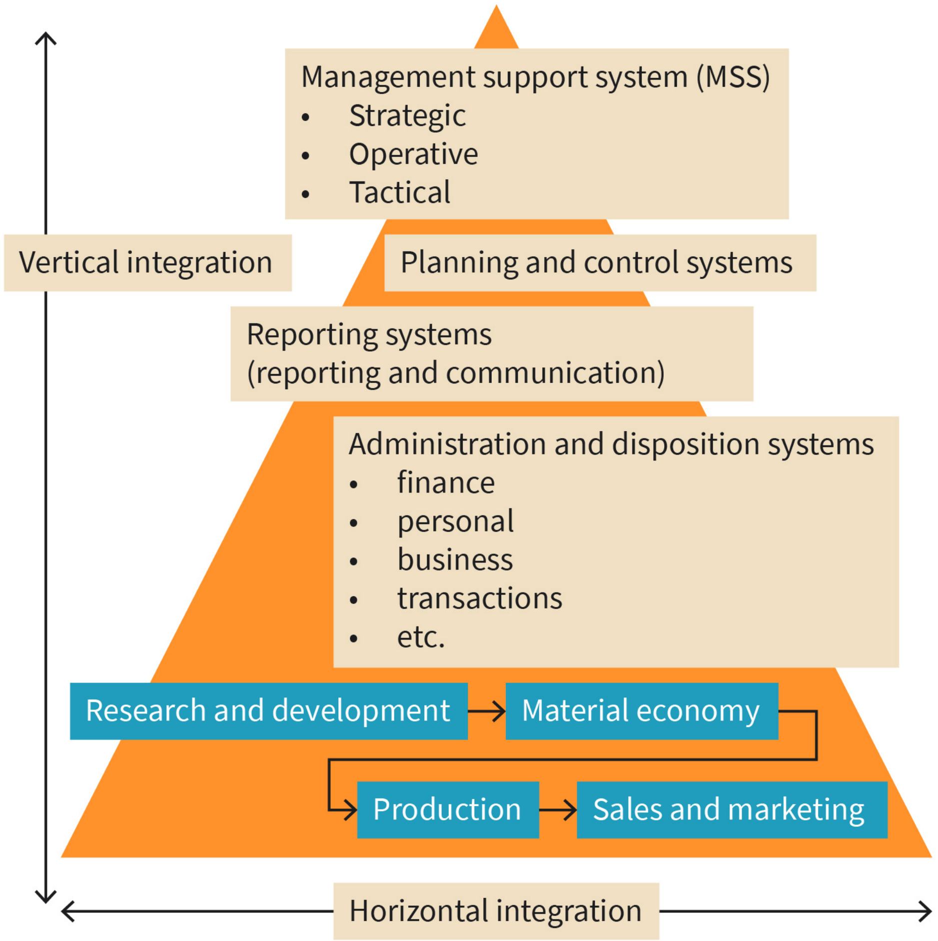
For the integration of the application systems within the whole architecture, different objects and elements can be employed as the basis for a classification principle:

- Information or data integration is achieved when several application systems use a shared database to have a redundancy-free system. This saves a considerable amount of interface effort regardless of implementation problems.
- Integration via the functional properties of application systems through functional clusters that span a common application area or support a significant part of the operational process landscape.
- Integration via the workflow sequence, as it results from the process organization on the workflow side and is subdivided into logically structured subprocesses to form a dynamic integration basis.

From these contexts, it is possible to model system integration vertically, along the organizational structure, and horizontally, along the value chain. “A horizontally integrated information system combines subsystems from different functional areas at one level. A vertically integrated information system links subsystems of the same functional area at different levels, such as a system for processing business transactions with an office information system and a management support system” (Hansen et al., 2019, p. 8).

In this definition, the total subsystems integrated via an infrastructure are understood as an information system (see also the following figure). However, the object of integration is also the data, the functions, and the processes for transaction processing.

Figure 2: Horizontal and Vertical Integration



Source: Paul Nikodemus (2021), based on Hansen et al. (2019, p. 8).

The functional integration of business application systems shown here follows the organizational structure of companies. It is extended by cross-departmental business processes that range from the supplier to the customer side, which represents the horizontal view of integration. The company as a whole can thus be understood as a process landscape supported by an overall application system, which in turn derives its information and communication technology capabilities from a technical infrastructure. Customer orientation and value creation are the competitive drivers, and efficiency and effectiveness are the design parameters. The central processes of value generation are research and development, materials management, production, and market development. These processes are supported by finance and accounting, human resources, and general administration.

Competitive positioning determines the internal process focus and also the weighting of the efficiency and effectiveness dimensions for the development of core operational competencies, while the supporting activities can also be realized via external market partners and can be outsourced (Hansen et al., 2019, pp. 8–9). Another important aspect of integration is the level of automation it achieves. The coupling of different application systems might be relatively weak, resulting in higher interface costs, but it can also be designed in such a way that operation processing can be fully automated, and the subsystems act externally as one system. For example, sales order data from sales order management can be automatically transferred to production planning or kept in the accounting system where it is synchronized with the bank accounts.

Digital transformation
This plays a more significant role because information technology requirements increase with the intensity of automation.

In the context of the **digital transformation** of industrial infrastructures, this plays a more significant role because information technology requirements increase with the intensity of automation. Intelligent sensors and embedded systems must then support system integration. As a result, complete autonomy within service production can be achieved in the form of a smart factory (SF). The Industrial Internet of Things (IIoT) is the term used to describe the technical infrastructures that make this possible. But even in the commercial application domains with sales applications, couplings may become necessary due to the introduction of new business models that only lead to acceptable processes via full automation.

1.3 Example Scenario for the Use of Operational Application Systems

Application systems in the company support the processing of tasks in the operational context in a manifold way. In relation to the goals of using application systems, it is easy to see that support for processes can range from the customer side in sales to the exchange of transaction data with suppliers.

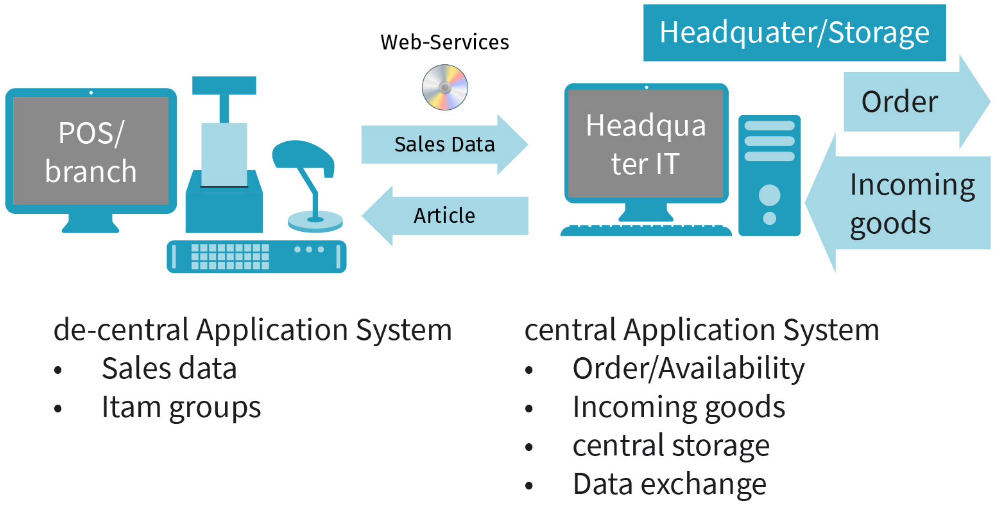
Therefore, examples of how these systems can be used vary widely, and in this section will take a look at one. As an example, we'll focus on a small retail company that operates several stores in North Rhine-Westphalia, Germany. The head office is located in a large city, and the fifteen stores are spread throughout the federal state. The core of the business includes toys for children and young people up to the age of 16. The business also offers textiles for the same target group, primarily for the sports and leisure. The following sketch shows the geographical and organizational allocation.

Figure 3: Headquarters and Branches of a Retail Business

Source: Paul Nikodemus (2021).

As the company expanded in the 1990s, the stores were equipped with intelligent check-out systems including reading equipment for labels (scanners), which could also record sales numbers by product group. This data was transmitted monthly via data storage device to the head office, which used it to organize the purchase system and the distribution of the delivered goods from the central warehouse to the sales points on the basis of the product group sales. The following figure shows this process. The head office used an application system for purchasing orders, with which the data exchange with suppliers was already able to take place electronically. The data from the stores could be read and aggregated by this system. This enabled inventory planning to be carried out for all stores altogether. The goods receipt in the central warehouse could also be controlled with the order data received from the inventory planning.

Figure 4: Process Landscape



Source: Paul Nikodemus (2021).

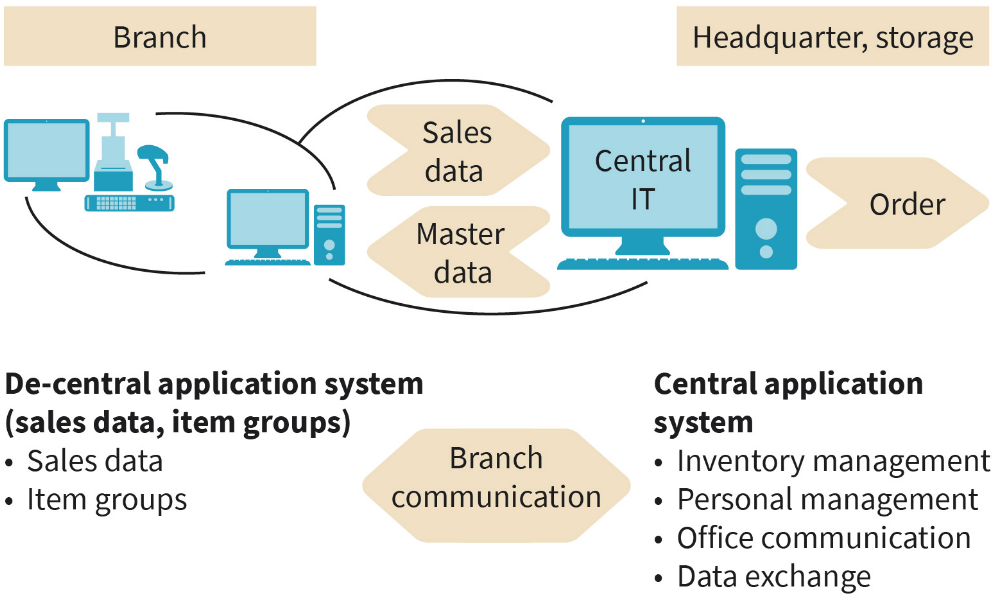
Inventory management system
a comprehensive application system in the retail sector which supports the automation of inventory management

In the 2010s, a further five stores were opened. Due to an expansion of the product range, the **inventory management system** also had to be redesigned. The Inventory planning system, which was based on product groups, was now replaced by an order processing system based on articles and points of sale. In this scenario, an integrated merchandise management system was purchased for the head quarter and also stores´ application functions. For the stores, a local network was added to connect the checkout to a local store computer. The article reference data is managed on the computer and kept up to date by the head office. With the decentralized functions of the goods management system, the stores can now carry out their own article planning once a month and report this to the head office for order processing.

On the other hand, when articles are delivered to the store, they are posted in the articles receiving area. In this way, inventories can be managed and controlled on a point-of-sale basis. The central functions of the inventory management system have been adapted to the distributed application. In addition, managers can now also use a reporting system that can provide them with detailed information on the points of sale, articles and assortment areas. The transaction data from the points of sale is stored centrally, and the reporting feature now allows evaluations to be made that also enable a short-term reaction

For example, the price corrections and discounting of seasonal goods can be done remotely from headquarters. Communication between the headquarters and the point of sale can take place at any time via the network. The inventory management system also provides functions for human resources management and point-of-sale accounting. With the simultaneous use of applications, the store is also able to communicate individually with customers at any time. In the next stage of expansion, an online store system was planned. In this way, the branch company would also like to open up new business model options and expand its value creation. The following figure shows the functional development.

Figure 5: Companywide Application



Source: Paul Nikodemus (2021).

This example shows a typical development associated with the use of application systems. The demands of competition lead to a re-evaluation of support services and new quality expectations for information processing. This leads to a migration of existing systems. For the retail business example, one can of course mention above all the developments in the network technology as drivers of innovation and migration. The successes of online retailing are also making it necessary for stationary retailers to reconsider their business models.

SUMMARY

The digitization revolution has already reached almost all industries and sectors of the economy. The focus of digital transformation is on business application systems, which are being developed, adapted and migrated with a focus on a high level of process and data integration. By using these systems, companies are primarily pursuing economic goals, but social, ecological and overall societal perspectives are also part of the motivational background.

We can address the idea of integration more concretely in connection with the coupling of different subsystems in two dimensions. On the one hand, functional integration takes place along the organizational hierarchy, and on the other hand, system services are to be integrated along

the functional relationships within the value chain via different applications. With this vertical and horizontal integration of operational application systems, we can also make the regulatory principle visually clear.

The value proposition of the information systems as functional application providers and their target group define the position of the systems in this two-dimensional classification. The system support is focused on the value chain from the supply market to the sales market end of the value chain. The users are located at almost all organizational points making a contribution in this process world.

Along the hierarchy, the systems can be classified primarily according to the deadline of the relevant decision-making situations. Here we find the everyday process supported by administration and scheduling systems, whose operative transaction behavior leads to massive data, and whose evaluation is often the basis for planning and control steps, which are also made possible by the tactically placed application systems. A good example is the information systems that support production planning and control on the applications side. The strategic concerns in the company naturally play a role primarily at the upper management levels. Here is where we find management support systems serving the decision-making departments.

However, there are also applications in companies that can be used across the whole company in terms of their performance potential. These include office communication systems, but also information systems for specific communication services or operational collaboration and knowledge management. Information management as a normative, strategic and operative functional and managerial structure and management discipline forms the backbone of the company. The application systems stand in the middle between the information management (supply and demand) of the service process landscape and the technology bundles of the infrastructure for information and communication technology. The overall objective is to optimize the use of information as a resource so that it can act as a driver of competitiveness in the company's processes.

UNIT 2

SYSTEMS FOR HANDLING BUSINESS PROCESSES

STUDY GOALS

On completion of this unit, you will be able to ...

– explain what business process management is.
– understand how this management can be supported by systems.
– outline how this is achieved by workflow management systems.
– analyze how document management systems operate in information management.

2. SYSTEMS FOR HANDLING BUSINESS PROCESSES

Introduction

As far as value creation and the necessity of using application systems that support management are concerned, business processes are the main topics for action. The use of systems for business process management as well as workflow and document management can increase the efficiency of business processes by automating repetitive tasks. Redundancies in process handling can be avoided and the resource information can be handled following the principles of an intelligent organizational structure and development. As a result, it is possible to shorten lead times and increase the quality and effectiveness of processes, as well as reduce costs.

Therefore, when it comes to designing application scenarios for process optimization, the following fundamental questions arise:

- What typical tasks and functions can we map to systems for business process management, workflow management and document management and what is the real-world performance of such application systems?
- How can the performance of these systems be characterized and distinguished from each other?

2.1 Business Process Management Systems

A business process is a series of interconnected tasks or activities performed by people, systems, or a combination of both within an organization to achieve a specific business goal. These processes typically involve the transformation of inputs (such as information, materials, or resources) into outputs (such as products, services, or information) through a defined sequence of steps. (Gartner, 2023; Schewe, 2018).

Business Process Management (BPM) refers to a systematic approach to improving and managing the processes within an organization to achieve desired business outcomes efficiently and effectively. BPM involves the design, execution, monitoring, and optimization of business processes to streamline operations, enhance productivity, and adapt to changing business needs (Siepermann, 2018a). We therefore refer to application systems that support the design of business processes as business process management systems (BPMS).

Business processes exist in all companies, regardless of whether they are state or private bodies, and also regardless of whether there is an objective to make a profit or not. Business processes can always be recognized by the fact that tasks are broken down into subtasks such that their processing can be carried out in a group of tasks.

Business processes are defined for each business individually. In principle, processes are executed to create products or provide services for each business. As a result, the quality of process execution also determines overall operational performance. The effectiveness and efficiency of business processes are consequently the characteristics with which a company can compete and succeed against its competitors. Effectiveness is primarily concerned with achieving a higher level of customer benefit, while efficiency is primarily concerned with cost-effectiveness.

Efficiency, therefore, plays a role above all when the cost aspect accounts for the competitive advantage in a price-oriented market scenario (Hansen et al., 2019, pp. 92–93). If we also consider the task-splitting aspect in the definition of business process, then “a business process is understood to be a complex workflow consisting of several functions for the completion of an operational task.” (Hansen et al., 2019, pp. 92–93). The sub-functions and activities are connected logically and chronologically, which reflects the business objective.

The split of tasks as an important objective makes it clear that this is not about isolated functions that can be arbitrarily orchestrated on the process side, but rather about a philosophy that the entire value creation should follow. We refer to this basic organizational orientation as the process orientation of operational control in companies. Therefore, in each case, there are **process owners** that we can identify in terms of responsibility and competence for the design elements of managing business processes.

Process owners
The process owner is responsible for the control, planning, organizing and optimizing of a business process.

Information systems are the medium of the functional applications that are used in the process-oriented organization and for the creation of efficiency and effectiveness as competitive advantage dimensions. With some technologies, development leaps are possible which results in entirely new business models and consequently brings more business opportunities. Their deployment is not always dependent on the size of the company, and even small companies can achieve success in relevant markets through an intelligent combination of value creation and revenue models by using application systems. Especially in recent years, the term **disruption** is synonymous with this development in the market, which is based on new and superior business models. But “the big leap” is not the only goal for a system deployment. Information systems are also used for process integration, as it is a basic prerequisite for an optimized split of tasks across functional areas.

Disruption
In contrast to simple continued development, a disruption represents a new development which requires completely new approaches.

“The importance of business process management [...] stems from the fact that, on the one hand, information-analytical methods can be used to analyze processes [...]. On the other hand, the use of information systems often offers great potential to improve organize business processes. This applies not only to business processes within a company [...], but also to processes that are cross-functional and extend beyond company boundaries” (Hansen et al., 2019, p. 96).

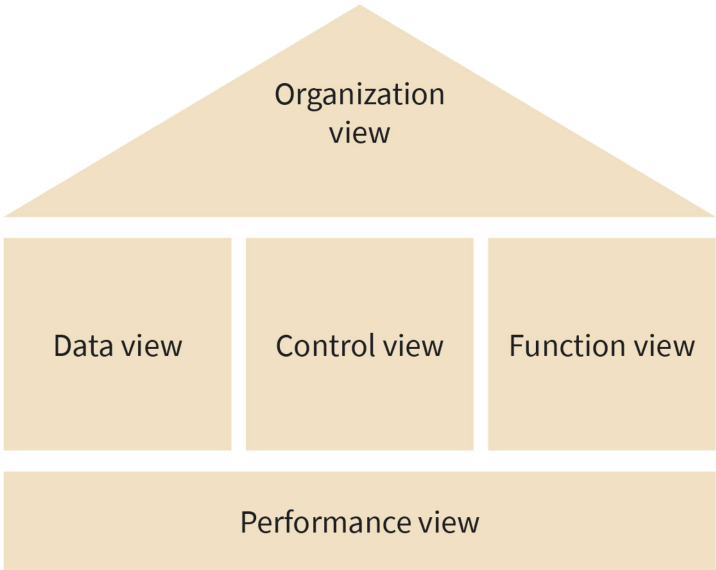
Business processes provide different views into their content elements and their characteristics:

- **Functional view**: This view focuses on the functional structure of processes and the temporal and logical relationship between the elements of the process chain.
- **Control view**: It includes all aspects of a process associated with the execution of operations and the events and rules of operation between functions that trigger them.
- **Data view**: In connection with integration performance, naturally the data view of a business process is significant since all information is described and generated in its various structures here.
- **Organizational view**: The connection to the organizational structure is realized via the organizational view, which defines the process participants as task owners or job holders, or via organizational units and operating units.
- **Performance view**: The performance view concerns mainly the product, but also intermediate and preliminary services in the functional group (Hansen et al., 2019, pp. 97–99).

Architecture of integrated information systems
The goal of AIIS is to address the relevant views of business processes.

These views can also be found in the definition for the **architecture of integrated information systems** (AIIS). In this course book, AIIS refers to various views of an information system. The methods used for this are oriented according to the business processes that are to be supported. In the framework of software development engineering and based on the problem description in the specialist department, a technical concept will first be prepared. This can then be used to develop specifications for a data processing concept, which is used to plan the technical implementation of the data processing and finally forms the basis for the implementation (Lackes, 2018).

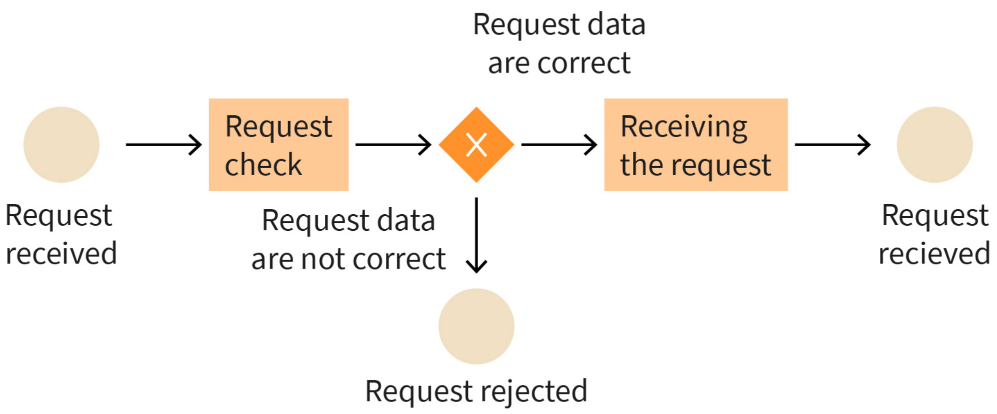
Figure 6: AIIS Views



Source: Paul Nikodemus (2021).

In the project planning of software as a medium for the functions of the application, these views are implemented as detailed as possible to ensure that the application addresses the process requirements as comprehensively as possible, (i.e., including all views). With this concept, the integration idea, as we have already described with the vertical and horizontal classification, is explicitly reflected. The following figure shows an instance of the process view and provides a small process model for an application review. The “X” junction stands for a symbol of the sequence control and indicates that the process sequence varies depending on the test result.

Figure 7: Instance of a Process View



Source: Paul Nikodemus (2021).

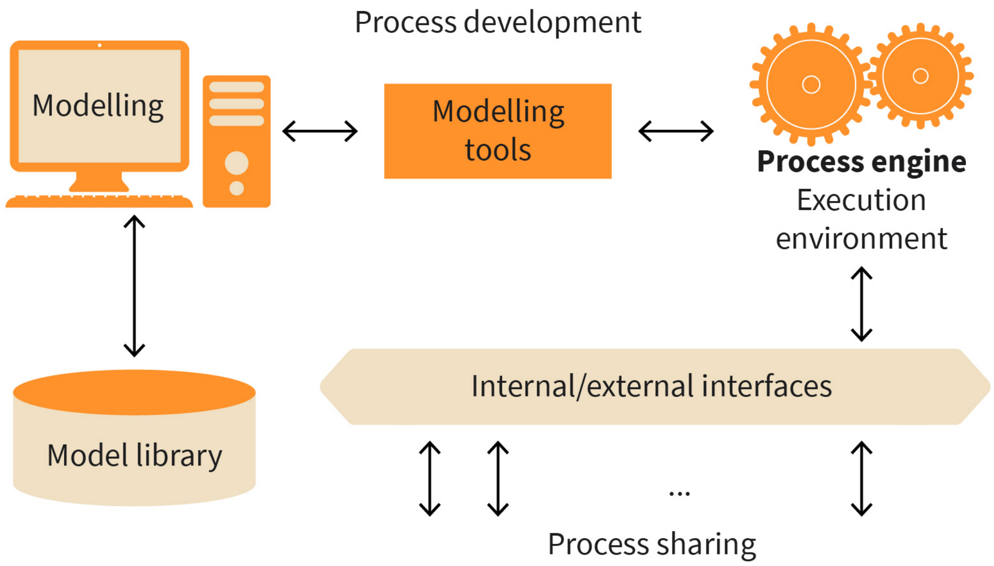
If we look at a company's process landscape, we can identify two typical tasks. Firstly, processes have to be configured, and then, they have to be controlled and coordinated. These two tasks also represent two possible dimensions of process design, the configuration task, which concerns static aspects, and the coordination task, which concerns dynamic aspects of processes. Thus, in business process management we usually encounter these two design fields, whose characteristics represent the process architecture and at the same time parameterize the architecture of information systems for business process management (BPM).

“Coordination [...] is the harmonization of activities performed by different actuators to perform a process efficiently. The actuators can be people or automated subprocesses” (Hansen et al., 2019, p. 100).

Then let us consider the architecture and content elements of business process management systems (BPMS). This family of systems is directly related to process execution (i.e., dynamics). The central element of a BPMS is a system component that supports process execution. In the following figure, this component is called the process engine.

To ensure that a process contains all required information and parameters, it must be defined as complete as possible. This is achieved using a process model and a modeling language. In practice, the business process model and notation (BPMN) method are frequently used for this purpose, which provides a syntax for graphically representing business process steps. BPMN creates the prerequisites for automated process execution through complete documentation of the information flows.

Figure 8: Business Process Management System



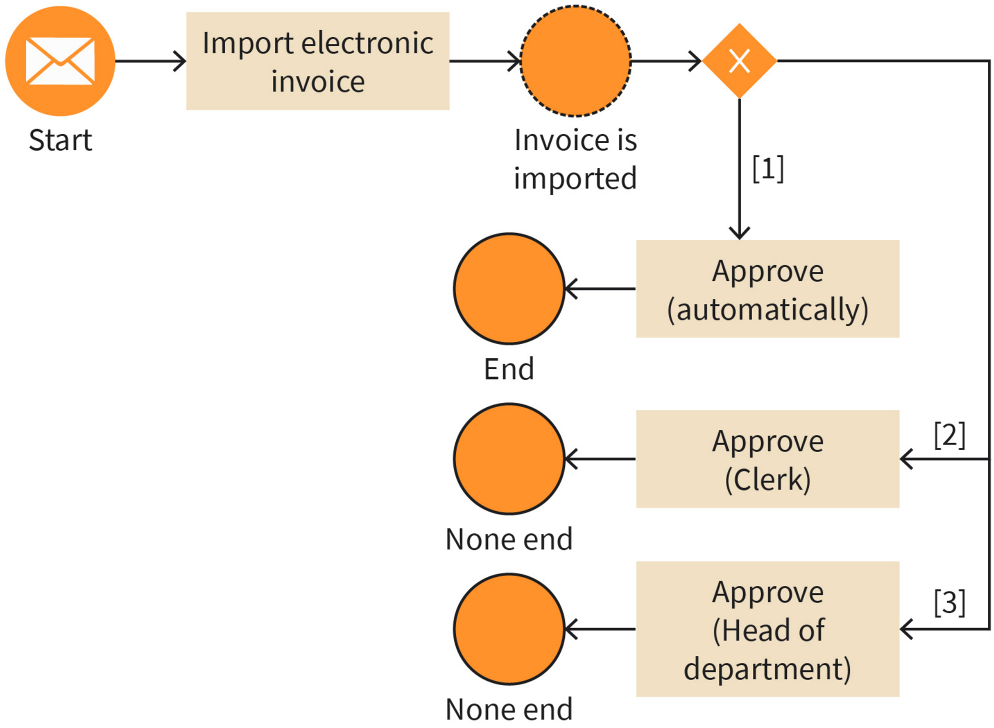
Source: Paul Nikodemus (2021).

With the modeling component, business processes will be defined and documented. The generated business process models are managed in a model library. They can be transferred to the execution environment via a connection to the process engine. Process participants can then start a runtime version of a process in this environment and the process engine works through the process steps and communicates using interfaces with internal and external entities and services that are necessary for execution. The process participants can also access, manage and visualize process data using defined interfaces and via a web portal.

Digital twin
To assist with simulation and analysis, digital twins are produced using a runtime image of the process.

Modern working environments also use the execution environment to simulate processes. For this reason, the relevant interfaces are implemented exclusively or partially for information and communication technology. By capturing and storing the relevant process movement data, a runtime image of the process environment, and a **digital twin** can be generated. Digital twins are used primarily in production and manufacturing technology and in connection with engineering development processes to virtualize processes so that they can be run and analyzed and measured. Process transaction data also plays an important role in connection with big data analysis in the industrial environment. In this field, process mining is understood as “analysis techniques that enable insights into the execution of processes based on log data. This provides insight into whether a business process is being executed as planned” (Hansen et al., 2019, pp. 125–126).

Figure 9: Example Business Process Management System



Source: Paul Nikodemus (2021), based on SoftGuide (2021).

The figure shows a typical user interface of a software tool for process modelling with a process sample according to the BPMN methodology. An ideal application for BPMS is the deployment of modern server-oriented environments. Here, web services can automatically take over the execution of sub-processes, while calls can be realized internally and externally.

Service-oriented architecture (SOA) enables a very flexible combination of independent services. A service offers one or more application functions that can be called via a software-independent interface. The combination of the services configured in this way forms a functional area that is used in business process support (see figure below). The interfaces to the services are implemented via a **service bus** that acts as a connector.

Service bus
A service bus is an IT network architecture that supports the integration of distributed services and applications.

There are significant advantages of implementing BPMS, including

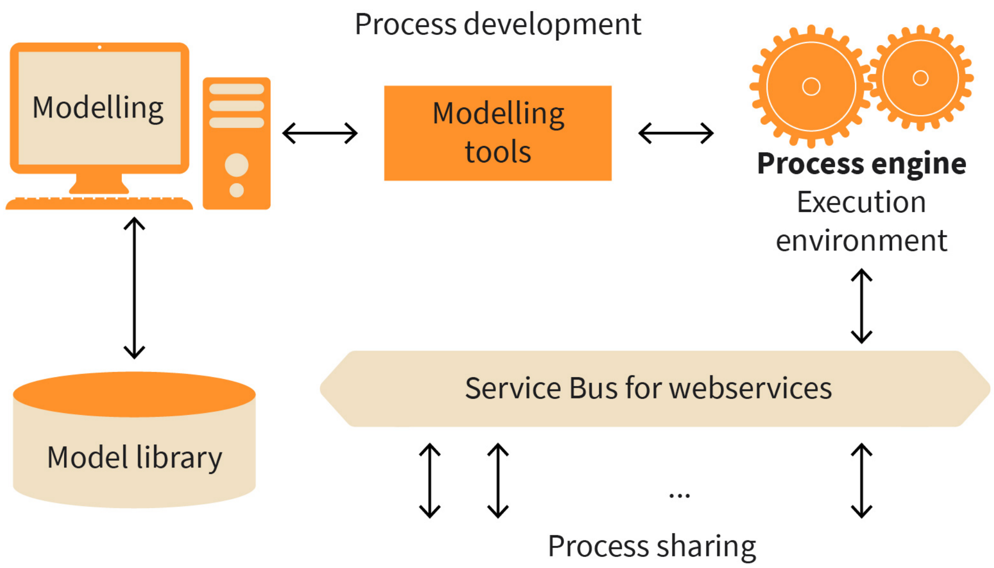
- the full modelling of the processes,
- the integration of software development environments,
- the creation of a basic architecture for an SOA,
- the adaptability of the process models in the enterprise, and
- the possibility of monitoring the processes (Allweyer, 2014, p. 29).

Also, there are some disadvantages, including

- a higher degree of overall complexity due to the interaction of different technologies,

- a potential difficulty in troubleshooting due to the complexity,
- higher demands due to the diversity of technologies,
- higher overall complexity and thus lower process flexibility,
- more difficult data integration due to the diversity of systems, and
- possible performance problems due to the large number of interfaces (Allweyer, 2014, pp. 30–31).

Figure 10: Business Process Management System Overview



Source: Paul Nikodemus (2021), based on Gadatsch (2017, p. 138).

2.2 Workflow Management Systems

In the last section, we learned that BPMSs are information systems that support the modelling, developing, execution, monitoring and supervision of business processes, with subtasks being distributed to process participants in the execution environment. In connection with the process dynamics and the coordination of the process flow, we can also speak here of a workflow, which forms the core of the system performance.

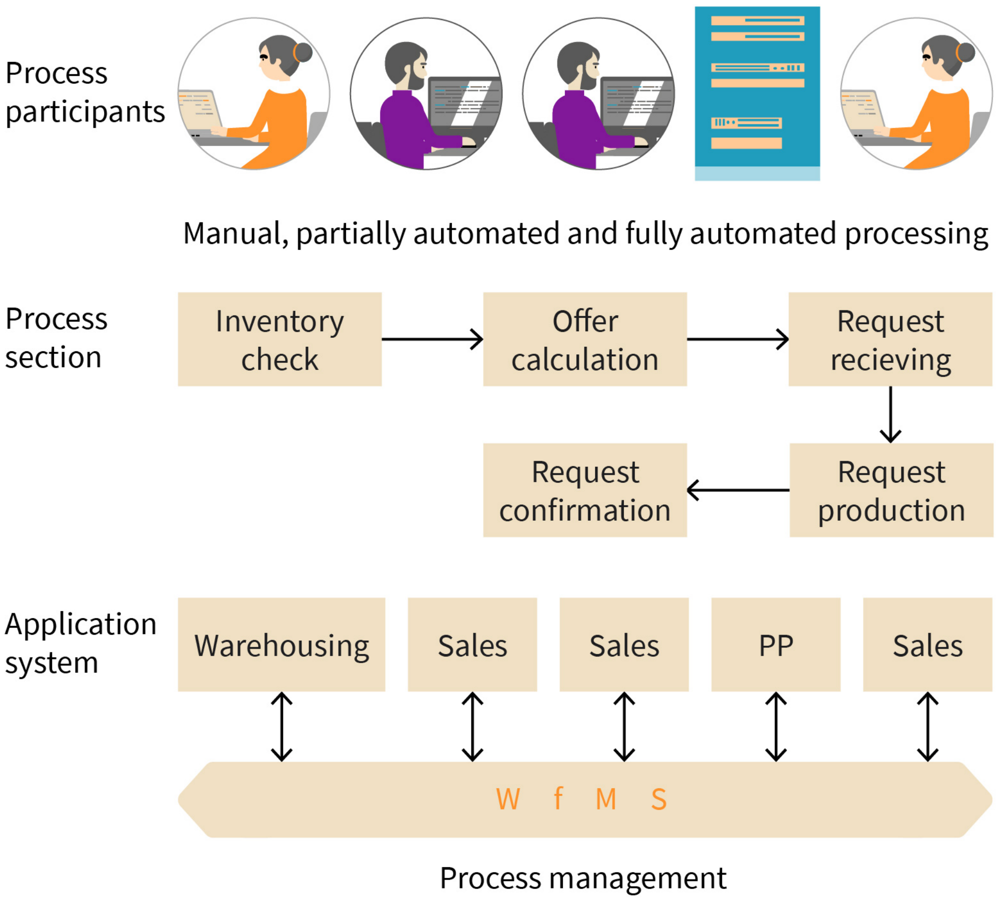
Similar to BPMS, we can refer to this system service as workflow management systems (WfMS). It's a software system designed to help manage the flow of administrative processes, ensuring transactions are processed consistently, quickly, and with transparency. (Siepermann, 2018a).

To distinguish between BPMS and WfMS, we can once again note that BPMS are application systems that support a wide range from process modelling to process simulation and execution. WfMSs mainly focus on the automated execution of processes. Therefore, these two systems have related system landscapes, which may be quite similar in practice. Frequently, existing WfMS are supplemented by the modeling component and the result is a

BPMS as a complete system. In addition, there are WfMSs which also have components for process modeling and simulation. In the following, we will therefore only deal with the specific features of WfMS and not repeat the common components (with BPMS) again.

In general, WfMS can be used for almost any workflow, but their functional focus is mainly on the environment of commercial-administrative business processes. In the manufacturing industry, the processes are supported by production planning and control systems, which in turn also take over WfMS functionality or can be coupled with these systems (Gadatsch, 2017, pp. 137–138). The following figure contains a typical architecture of WfMSs.

Figure 11: Workflow Management System



Source: Paul Nikodemus (2021), based on Gadatsch (2017, p. 138).

Process handling is carried out manually by the typical administrative staff, but also partially automated and fully automated, for example, when computer systems carry out planning processes.

In contrast to business process management, workflow management's scope of action is slightly narrower. Individual business processes are analyzed, optimized and, if necessary, recombined. In any case, workflow management is an important part of business process management. The example in the figure makes it clear that workflow management in practice usually has the goal of coordinating the process participants in such a way that the process quality is optimized in terms of an optimal split of tasks and lead time. In this way, errors and redundancies should be avoided and quality assurance should be designed effectively. For data management, this means that the integration goal can only be achieved if the process properties and the processing status are transparent in each process step.

Workflow management systems (WfMS) support process handling primarily by handling process data in such a way that the functional actions and reactions ensure the aforementioned quality assurance. In practice, office communication systems in particular are integrated with other application systems using this approach. For example, e-mail applications such as Microsoft Outlook can be used in these systems for customer communication.

A completely different process control must be managed nowadays in the integration of industrial environments. In connection with horizontal linking within manufacturing, components are equipped with intelligent units that can communicate with the manufacturing equipment and machines. This transmits data which in turn parameterizes the individual manufacturing process. These intelligent processes are part of Industry 4.0 and, in this case, the Industrial Internet of Things (IIoT). They play a central role in the digital transformation of production processes. Workflow management is enhanced by the integration of the technical manufacturing infrastructure and thus also becomes more complex. The data generated in this way, in turn, can provide new benefits, for example in the form of predictions as part of digital maintenance management.

2.3 Document Management Systems

Document management involves the generation, editing, and intelligent distribution of documents. It also includes the entry and release of documents, as well as searching and archiving capabilities (Siepermann, 2018a). This is associated with minimizing throughput times and increasing the productivity of work processes. Systems that support this management task enable multiple users to access a document simultaneously. They also regulate the access rights of users and ensure data security. An automatic distribution function can be used to share documents with those authorized to access them. The documents are classified via catalog and folder systems and can be assigned thematically via knowledge domains. Keyword systems are then used to provide a semantic search (Siepermann, 2018a). Document management systems (DMS) are systems that optimize business process management in terms of application support.

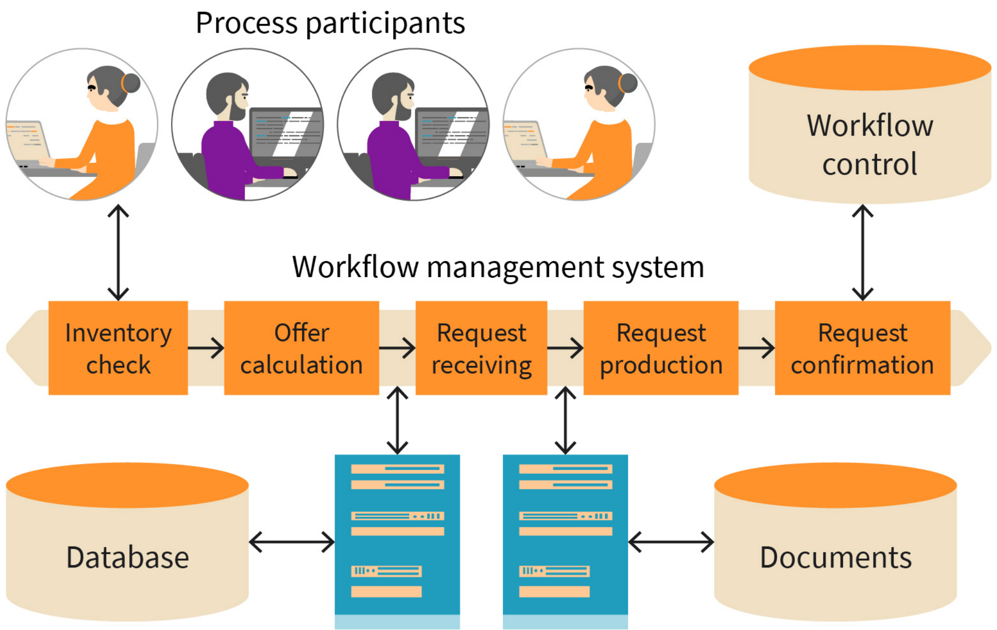
Every day, companies deal with information and documents in paper or digital form. To manage the volume of information, an intelligent system is essential. Documents should be managed in such a way that they can be accessed at any time and from anywhere in the organization. The applications required for this functionality should be available in information systems to manage documents. Among the important tasks that an administration should do are filing and the long-term availability and protection (archiving) of files, documents and records.

Especially for certain documents, storage periods must be considered, in particular, for electronically stored ones, both for the sake of lowering the costs and also for legal aspects. Technical developments in the field of data storage over the last years have greatly boosted this development. In addition, the lawmakers have defined the framework of regulations for the digital archiving of documents as well.

However, document management systems are more than just archiving systems, as they can provide important process support, especially in combination with other systems, for example for workflow management (see also the following figure showing an ERP system). Also, partially and fully automated document processing is possible because, with the integration of coding and text recognition systems, document receipt and corresponding bookings are no longer a challenge.

Functionality today already extends into knowledge management where semantic access routines support text search. In this way, applications operate based on context orientation, which goes far beyond the normal encoding of data. Therefore, document management becomes an intelligent unit in workflow management (Leimeister, 2015, pp. 167–168). For example, contract information, such as a liability insurance is stored digitally, and an intelligent software gives you a hint when you can cancel your contract to get a better one.

Figure 12: Workflow and Document Management System



Source: Paul Nikodemus (2021), based on Leimeister (2015, p. 168).

Document management systems are found in almost every industry and a large number of companies. Of course, their deployment only makes sense if a large number of documents have to be managed and archived. While the system supports are often limited to the archiving function, workflow-integrated systems are mainly employed in cases where, on sone hand, documents have to be accessed competitively by many users and, on the other hand, the access frequency is intensive due to the complexity and the volume structure. A glance at the relevant websites that offer information on this subject shows that this system world is also interesting for software providers.

SUMMARY

Business processes are the main driver of value creation in a company. As such, they are also a central activity area for information management when it comes to optimizing and supporting them with application systems and designing the technical infrastructures for their architectural implementation. Business Process Management is a key management discipline that links information management to corporate strategy in operational, tactical and strategic terms. Information management is structured and directed along the vertical hierarchy on the one hand and the horizontal value chain of the company on the other hand. Key application systems are designed around business processes and support the sub-functions that are directly related to their configuration and coordination.

While the information and communication technology are primarily responsible for the statics, and thus, also the technical stability of the infrastructures, the dynamics of the process-related execution must be supported by systems whose functional scope and data-side integration are defined for the structural elements of views on business processes.

Following the modelling of business processes, process engines can support process execution as a component of business process management systems and control the executing organizational units via interfaces. In modern architectures, such as SOA, this is done based on Web services with a software engineering standard that even makes it possible to orchestrate very different services that are connected internally and/or externally to “build” sophisticated overall solutions.

Workflow management systems have been known for a long time and are similar to BPMS. They are mainly used for processing operations in connection with operational applications and can be extended to reach the technical and functional scope of BPMS. In almost all companies today, large volumes of documents are generated in the course of business processes. It is obvious that application systems that support document management (DMS) are also used in this case. In combination with

BPMS/WfMS and the operational applications, they complete the range of subsystems supporting the process dynamics in process-oriented information management.

The system solutions presented above are not only useful in the administrative processes of companies but also in the technical field of manufacturing and production. The demand for their ability to communicate via interfaces is often higher in this case because, in addition to processing, partially and fully automated production sites and machines must be integrated.

UNIT 3

ENTERPRISE RESOURCE PLANNING

STUDY GOALS

On completion of this unit, you will be able to ...

- understand why companies use enterprise resource planning (ERP) systems.
- explain what objectives enterprises associate with the use of enterprise resource planning systems.
- outline how ERP systems facilitate planning and control in operational process management.

3. ENTERPRISE RESOURCE PLANNING

Introduction

Business processes require a system support that can ensure functional integration in the sense of a process-oriented organization. Vertical and horizontal integration represent two integration principles that should be aligned with the objectives of the deployed application systems.

While there used to be special application systems for specific departmental tasks, an integrated view of business processes also requires application architectures that facilitate comprehensive management of operational and strategic resources. The information systems for enterprise resource planning (ERP) offer an almost ideal solution for this purpose. In Germany, we know this type of system through its connection to the well-known German software company SAP. Nowadays, the importance of ERP systems is quite clear. Therefore, in this unit, we will address the following questions:

- What are the motivations for using ERP systems?
- What objectives do companies associate with the deployment of ERP systems when it comes to planning and controlling their operational and strategic process design within the value chain?

3.1 Motivation and Goals of Enterprise Resource Planning Systems

According to the ERP philosophy, ERP is more than about planning, because the processes for the management and control of resources are also part of the objective. Due to the popularity of certain suppliers of information and application systems for ERP, the term often and incorrectly also stands for the software packages associated with it. However, the ERP philosophy provides an organization-wide concept that represents an integrated view of business process support through information and application systems (Osterhage, 2014, p. 3).

ERP is a type of integrated software system used by organizations to manage and streamline various business processes across departments and functions. ERP systems typically provide a centralized database and a suite of interconnected applications to support core business activities such as finance, accounting, human resources, supply chain management, manufacturing, project management, and customer relationship management. (Minter, 2023).

ERP involves the organizational strategy of utilizing the company's available resources – such as finances, workforce, operational assets, materials, information and communication technologies, and IT systems – effectively in operational procedures to enhance the management of business processes. (Hofmann, 2018). This explanation asserts the comprehensive character of the ERP philosophy further because the listed business areas, represented by the resources mentioned here, show that it is all about an integrated overall process view.

In this context, enterprise ERP systems are modular, integrated applications deployed across the entire company to enhance operational value creation and ensure ongoing optimization of corporate and operational processes. Today's ERP systems are considered the second generation in terms of their information and communication technology design and feature flexible, web-based, platform-independent architectures. They extend beyond internal processes to encompass cross-company operations. (Hofmann, 2018). Initially, the focus of ERP was on system support that could manage the required materials close to production and manufacturing.

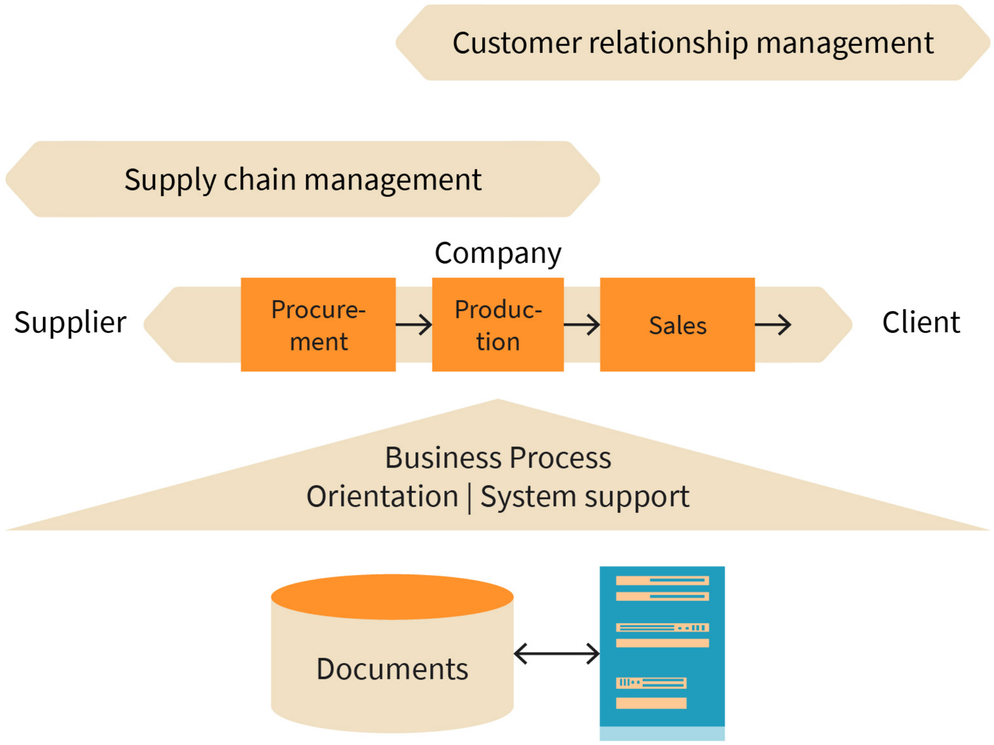
This approach of **material requirement planning** (MRP) was then extended by the facilities for the production (manufacturing resources) and finally inthea next step by the production planning and control (PPC). Further development with functions for plant data collection (PDC), machine data collection (MDC) and upstream and downstream areas such as purchasing, financ,e and sales lead to the ultimate ERP philosophy (Osterhage, 2014, pp. 3–4).

Material requirement planning
The MRP encompasses how the material supply is realized in a cost- and time-optimized manner.

ERP systems can also functionally serve the interfaces to the supplier and customer sides. The required relationship management includes the application domains of Customer Relationship Management (CRM) and supply chain management (SCM). The following figure shows the functional scope of the systems in a value-added-oriented approach. The integration aspect is also enhanced by the fact that ERP systems generally also support a high level of data integration.

This is illustrated in the figure by the use of a central database for all applications. ERP systems are designed primarily for the architecture of integrated information systems. There are cases where we may use several systems like Navision for procurement, Datev for accounting, SAGE for HR (unlike using only SAP products for all these cases) and in this case we have at least one database for every application. In such systems, we may have integration problems on the transactional layer.

Figure 13: ERP System and Cross-Applications Scenarios



Source: Paul Nikodemus (2021), based on Leimeister (2015, p. 173).

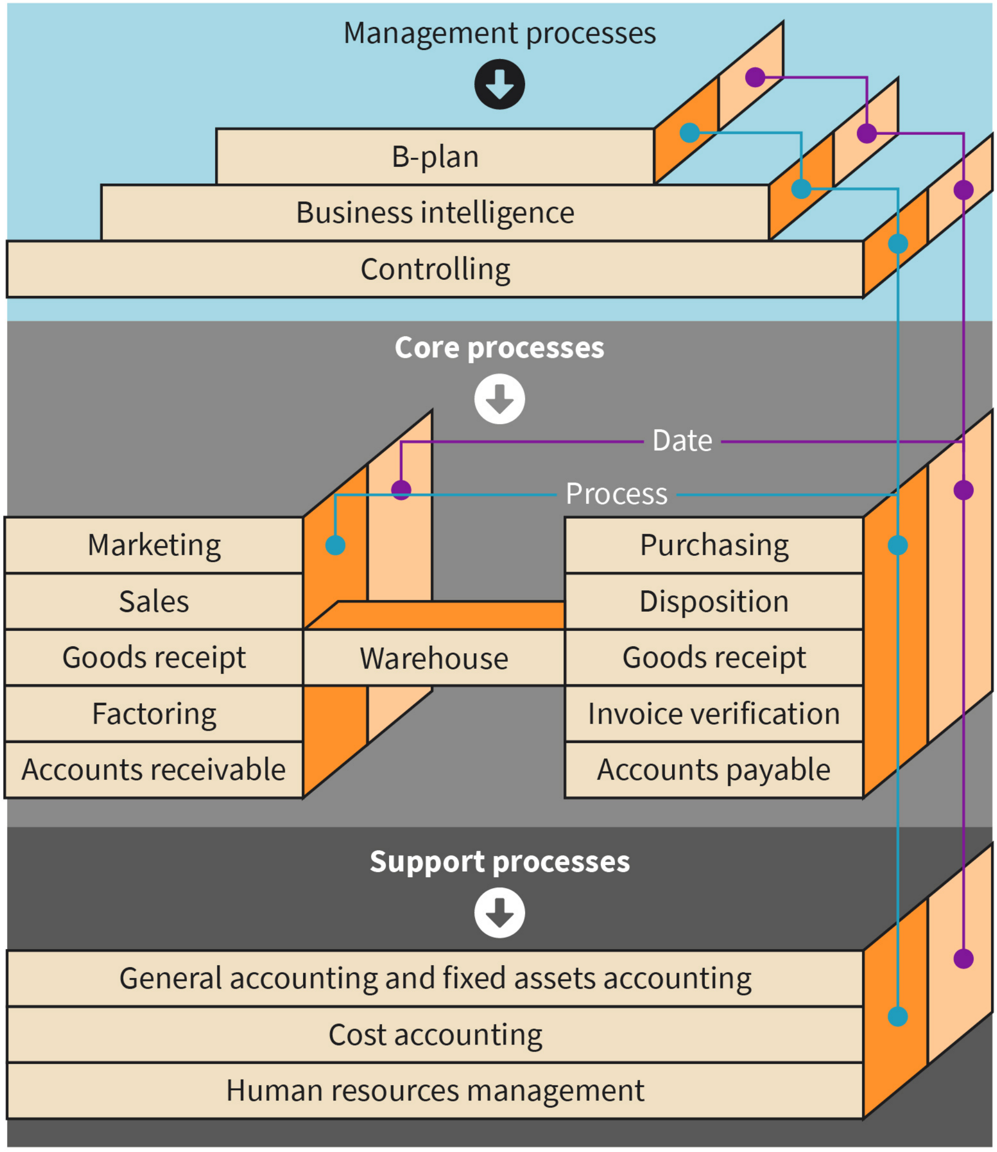
Strategic Objectives of EPR

Gronwald (2020, p. 8) mentions the following three important strategic objectives of ERP that he primarily associates with their implementation: specifically 1) the creation of a uniform business process architecture, 2) the standardization of internal and external master data, and 3) the standardization of the information system architecture.

Standardization of Business Processes

If business processes should follow a standardized architecture, the cross-company process components are a major problem. Although the homogenization of internal processes is controlled by the company, cross-company agreements normally need to be reached with several parties on the customer and supplier side (to achieve harmony). Regulations can help here by describing the business processes in such a way that they can be considered and implemented based on some predefined standard. One example is the “retail H-model” by Becker (2023), which illustrates a typical process landscape as it is common for a retail business including management, core and support processes. The retail H-reference model provides a specific architecture of an information system for the application in retail (see the following figure).

Figure 14: Retail H-Model According to Becker



Source: Paul Nikodemus (2021), based on Becker (2023).

In the H-model, the core processes reflect the core competence of the company for its value creation. Different business types can lead to different implementations of the reference process model. The umbrella of the model represents the management processes of controlling, business intelligence, and corporate planning. The data from the operational systems are processed to be suitable for use as a basis for decision-making and planning.

The core processes for merchandise management are extended to include the business administration support processes of general accounting, fixed asset accounting, cost accounting, and human resources management. These processes do not directly lead to customer benefits but are essential for the business model (Becker, 2023). Due to the specific business process architecture, the term retail information and merchandise management systems has also become established for application systems in the retail sector.

Data standardization

The standardization of data is also a task that has been the focus of business process design in the past and will be so in the future. The advancement in communication technologies and, therefore, increasing the volume of communication in the last two decades raise the demands and consequently, efforts to standardize the exchange of data. This means that the data exchange interfaces are designed in such a way that connections at the business process level can be realized efficiently. Master data, meaning the data that describes and defines the content of the relevant data objects within the value chain, is a major part of standardization.

Reference data models
These models, such as SAP's Financial Services Data Management (FSDM), support the standardization of master data.

The main emphasis is here on **reference data models**, which can be compared and aligned with the reference process models in terms of their requirements. Similar to the Retail H-Model, these data models are developed for a specific application domain. One example is SAP's financial services data platform (FSDP) in which the integrated financial services data management (FSDM) consists of a conceptual and a physical data model for companies in the finance and insurance industry.

However, standard data models used with ERP systems do not mean that customized data objects are no longer possible. The necessary extensions are modeled as separate objects and combined with the standard data models in such a way that the expected functionality can also be implemented in the application system. This extension expands the standard scope of data management to include specific requirements that are important for the business model. For example, in cases where specific products with a mixture of different investment forms (funds), and thus, different risks have to be provided with provider-specific markup or markdown factors.

Infrastructure standardization

The standardization of information system architectures is closely connected with the development of information and software technology. It is often the big providers of ERP systems that enable new technical implementation options in their environments. The interfaces that provide functionally seamless integration are relevant factors in this respect. ERP systems cover a wide range of application functionality and, therefore, need to be capable of communicating with other systems. The architecture of integrated information systems is also associated with a blueprint whose layers and development stages, from the business concept to implementation, reflect the comprehensive functionality of large ERP applications. If the modules of a single application system can cover the process view almost completely in functional terms, optimal integration has been achieved.

Another question is the dependency on only one system from a vendor. Two terms are closely associated with this perspective: “configuration and customization.” The definitions of Gronwald are suitable for explaining the two terms, according to which configuration is “the mapping of a company's value chain in an ERP system by configuring parameters in combination with the corresponding master data using only standardized business process modules of the system without external programming," while customization is "the addition or modification of business process modules by external programs not available in the standard ERP system," which includes "interface programs to third-party systems and reports" (Gronwald, 2020, p. 11). The respective scope of these activities follows from a process analysis with which the concrete requirements are incorporated.

Alternatively, preconfigured ERP systems can be implemented, where customization is carried out after business process gaps have been identified. In any case, when it comes to ERP systems, implementation projects are not without risk, as the customization effort is often underestimated.

Operational Objectives of ERP

In addition to the strategic objectives, the operational objectives of ERP and the application systems with ERP functionality are of course also of interest. The support services for resource management are particularly worth mentioning here. Osterhage (2014, p. 5) lists the following aspects:

- availability of resources,
- delivery reliability to customers,
- flexibility in serving the market, and
- reduction of lead times and lowering of costs.

The availability of material (raw or finished), whether in production or trade, is critical for the company. There are two approaches to address the requirement of material availability. Companies can operate based on a stockpiling system approach, or planning measures can ensure availability virtually in real-time. We associate the second concept with the just-in-time principle (JIT). Warehousing consumes resources, such as workforce and capital, and is an expensive option, which is why JIT ensures that the necessary materials are only available when they are needed. JIT is only feasible together with a reliable corresponding information technology system (Osterhage, 2014, pp. 5–6).

Customer orientation

Customer orientation has always been a primary objective of market-oriented companies, so it is not surprising that an important sub-objective of ERP is to meet contractually agreed delivery deadlines and the promised quality of the goods to be delivered. Companies are responsible for compliance with the contractual conditions negotiated with their customers. For competitive reasons at least, delivery reliability is crucial for such companies as the applications on the customer side today are capable of making the reliability of suppliers transparent through key figures (such as Google Reviews).

Flexibility

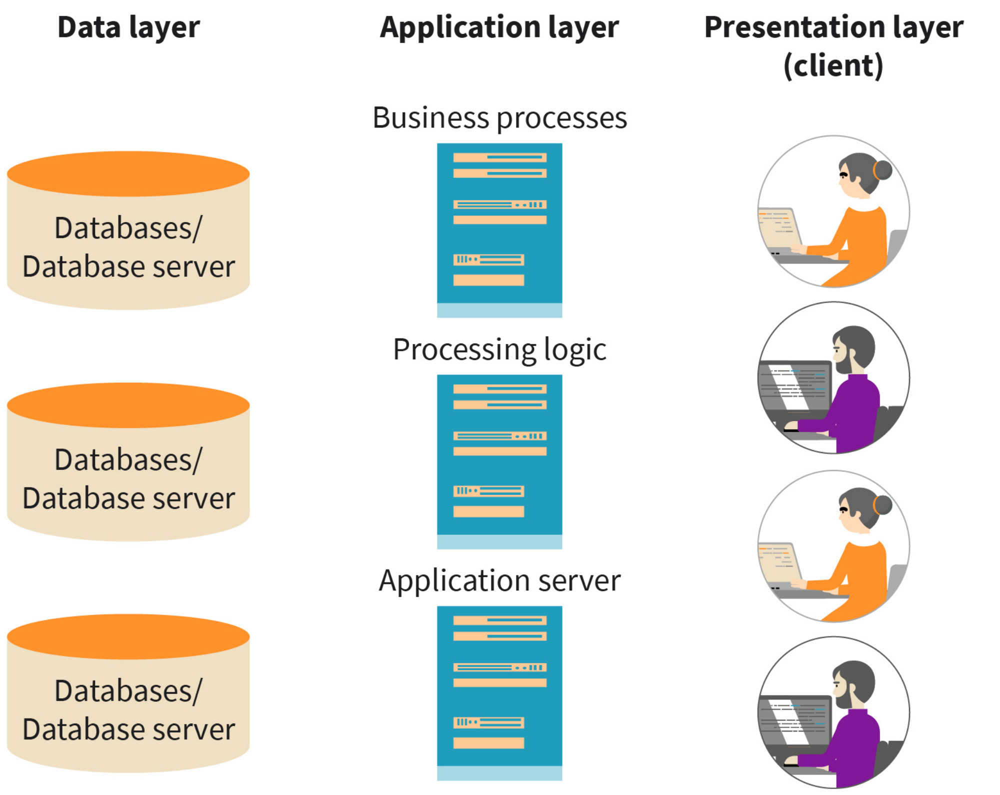
The flexibility of companies and the pressure they face, especially due to competition, can be clearly observed today through the effects of digital transformation. The term "Lot Size 1" is associated with manufacturing under the conditions of mass production while maintaining a high level of individualization and customer-oriented planning for product specifications and delivery conditions. Products should be customizable to meet specific customer requirements, for example in the automotive industry. However, we still expect production to be cost-effective, similar to what we consider to be standard for high production volumes. Achieving this level of efficiency and integration in industrial manufacturing, especially with the close coupling of planning data from the order side to the execution side, would be challenging without enterprise resource planning (ERP) support.

ERP systems are essential in this context, as they enable the ideal control of application systems through both vertical and horizontal integration. Furthermore, following the ERP philosophy, lead times are minimized, resulting in cost savings and increased customer satisfaction (Osterhage, 2014, p. 7). It is evident that with a business process-oriented design of the organization, excellent support is possible through the ERP philosophy. This equally applies to the competitive dimensions of effectiveness and efficiency, clearly illustrating the strategic and operational objectives of the ERP concept and the supporting systems.

Client-server
This is an architecture concept for applications and services in a network, where servers provide services and clients utilize these services.

When it comes to standardization, ERP systems have traditionally played a pioneering role in terms of software architectures, thanks to their extensive functionality and relevance in corporate information processing. The intense competitive pressure also means that these systems play a significant role in the realm of IT innovation management. The prevailing architectural pattern today is a **client-server** model with a hierarchical distribution of components across three layers (three-tier architecture). The first layer represents the presentation layer (display and input), the second layer for business processes and processing logic (application), and the third layer is the data layer (databases).

Figure 15: Three-Layer Architecture for Applications



Source: Paul Nikodemus (2021).

3.2 Planning and Control of Operational Resources

Companies shape their value creation daily, and in this “day-to-day business,” they must plan and manage, especially in a short-term time frame. A high degree of automation ensures that the business processes involved can run smoothly. Usually, the operational process area is characterized by the continuous availability of necessary resources, therefore, primarily satisfying market and customer requirements. The value creation model on the performance side and the revenue model are in equilibrium since the generated revenues ensure the reacquisition of resources and guarantee their availability.

For this purpose, companies engage in continuous business relationships that constitute procurement market and sales market activities. In these business relationships, primarily with customers and suppliers, continuous exchange processes occur, which we refer to as transactions in connection with value creation. Both tangible and intangible goods are transferred, along with their associated financial and information flows.

Business information systems that facilitate these transactions that support day-to-day operations must primarily offer decision-making and administrative functions for planning and managing daily activities while ensuring interaction and communication within and outside the organization. This process area primarily encompasses the value chain, as is also evident in horizontal integration concerning the placement of business information systems.

Operational Application Systems

Operational process design
The holistic and market-oriented design of value creation is part of a company's operational activities.

Operational process design in practice is supported by business application systems, which can also be referred to as operational application systems. They are structurally integrated into operational management and are used for the previously explained day-to-day operations. Their primary domain of operation is the business process landscape, which covers areas such as billing, scheduling, and administration. This systematization has led to the fact that, in the case of these operational application systems, we can also speak of administrative and directive application systems that accompany daily business practices.

Operational deployment primarily occurs within departments such as human resources, procurement, or administration. It is also influenced by industry-specific tasks, such as in the wholesale and retail sectors, manufacturing (automotive, pharmaceuticals, chemicals, energy, etc.), craftsmanship, and services (healthcare, insurance, banking, life sciences, etc.). When application systems are predominantly designed and used with a focus on a specific industry, they are referred to as industry-specific operational systems, as seen in the manufacturing industry. On the other hand, there are application areas that can be designed with both industry-specific and industry-neutral features, such as cost and performance accounting in accounting (Leimeister, 2015, p. 138).

If we now connect the ERP philosophy with it, we must especially include the idea of integration, as it becomes evident through the horizontal linkage in the value chain. Planning and control in operational process design, in the context of enterprise resource planning, thus, means that an application system provides the necessary support for it in an integrated manner, following the principles of information management. Simultaneously, when considering the advantages of high integration intensity for process optimization in terms of operational and structural design benefits, this also strengthens the competitiveness of business processes and models.

The providers of ERP systems will, therefore, strive to integrate the functionality required, especially in the operational administrative and directive planning and control areas, into their software packages. An example of this is SAP, which, with its ERP system, can offer industry-neutral functional areas for finance and accounting, human resources, materials management, and sales/distribution in a highly integrated application that can be used in a wide range of businesses. The following subsections provide brief explanations of these mentioned functional areas.

Finance and Accounting

Business application systems for finance and accounting are industry-neutral in their orientation. Typically, they must also adhere to regulatory requirements (regional, national, and/or international legislation). Compliance with these regulations necessitates a financial accounting system supported by an application system, as it is through such systems that compliance checks are performed to ensure that financial transactions are conducted in accordance with legal requirements, and reporting is done in compliance with regulations. Such accounting systems support a range of business processes that operate based on booking data and require automated generation of financial statements, reports, and accounting investigation and documentation reports with detailed information.

The sub-functions are interconnected accordingly, following the integration concept in the operational area. Core functional components are accounts receivable, accounts payable, and general ledger accounting, which consolidates the totals from the sub-ledgers. Master and transaction data represent the image of the transaction side and business transactions, serving as the basis for subsequent analyses, including strategic control (Leimeister, 2015, pp. 139–141). The described structure and booking format in finance and accounting enable the generation of financial statements, including balance sheets (general ledger accounting), and profit and loss statements (income accounts), effortlessly and at any time, thanks to the detailed database.

Human Resources

The two core operational components of human resources are payroll processing and time management. Payroll processing includes the calculation of wages and salaries, while time management involves documenting working hours. There are important interfaces between the HR department and payroll accounting. Similar to financial processes, payroll and salary processing also have legal and tax requirements that parameterize internal procedures and necessitate maintenance due to recurring changes.

In addition to the regular payment of wages and salaries, there are also specific functions for special cases such as travel expenses, commissions, bonuses, and company catering. The transaction-oriented nature of these systems becomes evident primarily through the management of master and inventory data, the processing of transactional data, and event-specific evaluations. For instance, attendance and absence times, particularly in the context of work organization in regular shifts or flexible time arrangements, play a significant role. Human resources management also includes functions for recruitment and development, which are relevant for training and further education (Leimeister, 2015, pp. 142–144).

Additionally, talent management, as a central discipline within HR development, encompasses activities related to personnel diagnostics and analysis, as well as competence and career management.

Procurement and Purchasing

While the functions in procurement and purchasing are similar in most companies, their significance naturally varies depending on the business's purpose and model. Trade and industry, in particular, exhibit differences in this regard. In the industrial sector, the interface between production and manufacturing is much more complex due to the focus on raw materials and components, as opposed to the retail sector, where only finished goods are procured. Therefore, the most critical master data for procurement are articles and materials, as they concretely represent the content's complexity. Conditioning supplier relationships also hold greater importance, as procurement strategic elements, such as tenders or managing dependence on suppliers, must be considered.

Key sub-components in procurement include the selection of suppliers with the ordering process, demand determination and purchase requisition, goods receipt, and invoice verification. In procurement, functions must also apply planning methods related to the disposition of future requirements, considering factors such as inventory costs, lead times for reordering, and safety stocks (Leimeister, 2015, pp. 144–145).

Distribution and Sales

The primary administrative functions in sales and distribution involve inquiry and quotation processing, order processing, and invoicing, which includes billing for the services provided. Discretionary activities encompass shipping coordination, logistics, and field sales. Inquiry and quotation processing typically involves cost calculations and pricing, customer quotation processing, and functions for monitoring demand. Order processing manages customer orders and interfaces with inventory management, production, invoicing, and shipping. Invoicing is responsible for issuing invoices and shipping documents and has a significant interface with accounts receivable.

The data generated through business transactions is also used as a source for generating management information and for control purposes. These data contain essential information about customers, products, and sales regions, representing the company's success. This information serves as the basis for customer relationship management (CRM) to shape business relationships and market development (Leimeister, 2015, pp. 145–147).

Industry-Specific Application of EPR Systems

When it comes to industry-specific functions within the operational applications of an ERP system, the specific characteristics of service delivery in the business processes of industry-specific companies are particularly significant. This will be illustrated based on common industries.

Manufacturing

As mentioned earlier, operational systems in manufacturing companies in the processing industry are unique. The term computer integrated manufacturing (CIM) refers to a concept that integrates manufacturing processes and the necessary organizational planning and control tasks. However, it is not a ready-made solution that can be universally used as a standard; rather, it is an architectural concept that is increasingly being implemented in practice as part of ERP systems today. We need to distinguish between two levels. CAx (computer-aided x) is associated with manufacturing aspects, while production planning and control (PPC) encompasses order-related and, thus, organizational aspects. The C-techniques (CAx) can be further divided into

- CAD (computer-aided design),
- CAP (computer-aided planning), and
- CAM (computer-aided manufacturing).

These subfields each represent specific computer-supported areas of manufacturing technology, from design to production planning of work orders and then application on typically computer-controlled manufacturing equipment and machinery (Leimeister, 2015, pp. 147–149).

Through integration into simulation environments, digital representations of real objects can now be used to assess the properties of objects, enabling utility assessments even before production. Such digital twins allow for an early concretization of behavioral patterns, thereby ensuring extensive quality assurance of components even before mass production.

Wholesale and Retail

A typical operational field for retail companies is inventory management, which is why computer-assisted inventory management systems in various dimensions have been part of the established system landscape in both wholesale and retail for many years. In addition to software-specific features, there are also specific hardware devices commonly used in **brick-and-mortar retail**. Cash register systems with label readers attached to the products, scales connected to the cash register system and reading devices (weighing scanners), card readers for cashless payment transactions, and mobile data capture devices for goods receipt and inventory are common system components in sales and inventory. Especially German discounters demonstrate how computer-assisted logistics chains can be combined with assortment and space optimization. With this concept, they have achieved success not only in Germany but also worldwide.

Brick-and-mortar retail
This term refers to the traditional form of retail stores with physical locations, as opposed to online or e-commerce retail.

Typical functions in merchandise management include procurement and distribution with purchasing, disposition, goods receipt, invoice verification/accounts payable, as well as marketing, sales, goods issue, invoicing, and accounts receivable. Due to capital commitment, inventory management plays a significant role in retail. The increasing intensity of online retail has led to traditional retail activities coming under greater pressure, particularly specialized retail under the current competitive conditions.

Procurement, inventory management, and sales are also the functional areas typically found in integrated merchandise management systems. ERP system providers have generally equipped their software packages with these functions today, and often, these applications are used as industry-specific packages in both wholesale and retail. When supplemented by systems for store management, decentralized merchandise management functions, and cash register operations, they constitute a substantial part of the information technology infrastructure of retail companies (Leimeister, 2015, pp. 149–153).

Financial Services

Comparable to the retail sector, credit institutions, and financial service companies typically have multiple application systems that support their operational business processes. Typically, there is a division into customer systems (front-office systems) and systems for internal task processing (back-office systems). In recent years, the service side has also grown significantly due to online banking and other internet services offered by banks, while branch operations have been reduced almost universally. Specific hardware components, such as ATMs and other self-service terminals, provide functional support, which is particularly important for business transactions and customer service.

In the front office, a multitude of transactions are generated, which can be recorded and settled through the back-office systems. This is further complemented by the institutions' business dealings with each other. Electronic banking is also present in this sector as part of the digital transformation, but it is also one of the core applications with the highest security requirements. Notably, there is an integration of financial services and business transactions, for example, when cash withdrawals can be made using a bank card at a supermarket checkout. Electronic banking is continually expanding, as evidenced by developments related to mobile payment via smartphones and new billing services in electronic commerce, such as Amazon Payments, PayPal, Klarna, and Adyen (Leimeister, 2015, pp. 155–158).

Planning Systems

In the context of operational process design, there are not only transaction-oriented disposition and administration systems but also planning systems. Planning processes that have a more operational character support daily operations and day-to-day business processes. Examples of this include personnel schedules in retail stores, day-specific route planning for delivery vehicles, or demand and capacity planning in manufacturing. It is important to distinguish these from plans that affect an entire business unit and have a more tactical or strategic character (Leimeister, 2015, p. 158).

Operational process design is an area that is particularly well-suited for support by application systems because daily operations, with their transaction orientation and associated data volumes, provide an ideal intervention level for generating efficiency advantages through automation. It is understandable that there is a correspondingly large supply of ERP systems in this area, which can offer mature functionality both on an industry-neutral and industry-specific basis.

3.3 Planning and Control of Strategic Resources

While operational process design primarily focuses on horizontal integration within the value chain, including functions from procurement to sales, including business-neutral functions, **strategic process design** is oriented more towards organizational leadership and management functions.

Strategic process design
The goal of strategic process design is to address long-term impactful tasks and provide decision-oriented support.

Since medium- to long-term decision-making processes related to resource allocation impact management, the supporting functions of the required application systems must align with the strategic nature of these issues. This vertical approach in system usage naturally connects with the operational domain within the framework of necessary information technology integration. Therefore, application systems for corporate management are often functional add-ons to operational applications or closely coupled sub-systems or components.

Strategic process design is associated with the decisions and strategic tasks that management has to make and handle in its leadership role. This is also reflected in the term “management information system (MIS)” as a strategic application system, which we use in this context as a synonym for the application systems that support these activities. Strategic tasks typically have a lesser impact on resource planning itself but rather focus on structuring the operational performance, corporate development, competitiveness, and the desired competitive advantage in a market environment that appears to be increasingly risky due to globalization and digitization. These tasks address opportunities, risks, strengths, and weaknesses and are holistically based (Gabriel, 2019). Examples include

- introducing new products and services,
- entering new markets or profile expansion horizontally or vertically,
- achieving a leading market position as a price or quality leader, and
- planning acquisitions for growth expansion.

The long-term assurance of resource availability complements the short-term operational tasks, which focus more on day-to-day performance. The transaction-oriented view of operational systems is now supplemented by the data-oriented view of strategically positioned applications for methodical decision-making support and decision-making basis. Decision support systems (DSS) was established for this type of system, and includes systems for scenario and portfolio analysis, as well as success factor and key performance indicator systems (Gabriel, 2019).

The competencies that companies build in this regard are referred to as business intelligence, marketing intelligence, or, in connection with Industry 4.0, Industrial Intelligence. As information processing can provide the necessary infrastructures, today, a large amount of data can also be made available in real-time for decision support. Big data and data science are the buzzwords that we encounter almost daily in professional discussions.

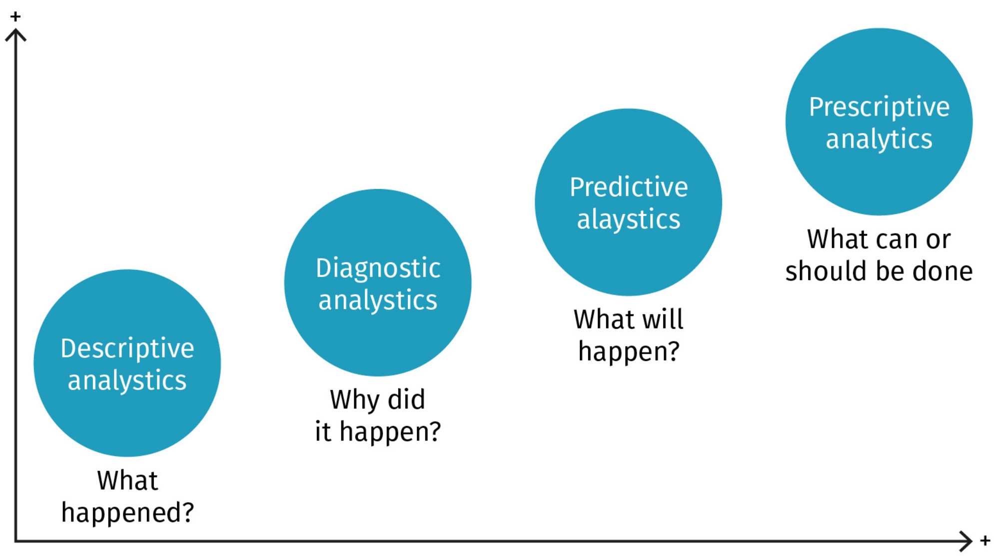
In this context, data science refers to "the science of extracting facts through the processing and analysis of very large, heterogeneous data sets to derive recommendations for management" (Hansen et al., 2019, p. 283).

The data analytics can then answer the following questions:

- What happened? Descriptive analytics refer to the past.
- Why did it happen? Diagnostic Analytics make relationships transparent.
- What will happen? Predictive analytics helps address future concerns.
- What can or should be done? Prescriptive analytics inform recommendations for actions.

The following figure illustrates how the mentioned four fields of data analytics are positioned in terms of their complexity and value contribution. The rule of thumb is the more complex, the greater the value contribution.

Figure 16: Data Analytics: Complexity and Value



Source: Paul Nikodemus (2021).

For its practical implementation, data science integrates the disciplines of statistics, operations research, and computer science, including methods of artificial intelligence and machine learning (Hansen et al., 2019, pp. 283–285).

In the following, we will provide a brief explanation of the key features and content focus of the application systems within the described design field. These systems are now an integral part of the ERP philosophy and are included in a company's system landscape, either as core components or as functional add-ons, to support strategic tasks of this nature.

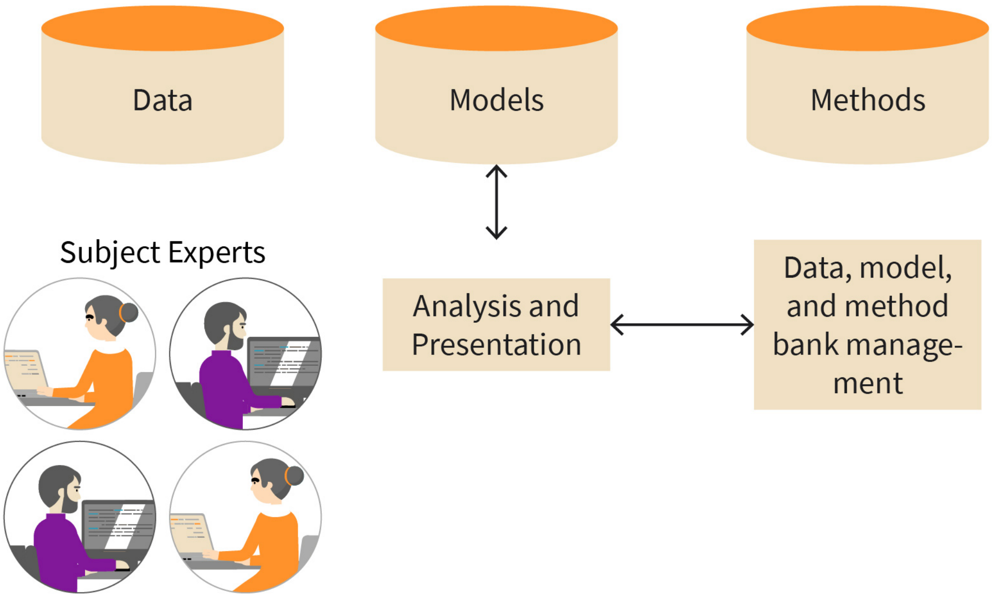
Classic Decision Support Systems

Decision support systems are used when hypotheses and assumptions need to be tested in a decision-making situation to arrive at the correct problem-solving approach. Based on a data foundation, factors relevant to the decision can be examined and assessed. A second meaning arises from the utilization of models and methods to derive ideal solutions or discern relationships among pieces of information.

Decision support systems (DSS) were introduced for this purpose. Users typically include subject matter experts, such as product managers who assess alternative sales plans based on varying market forecasts, analysts in retail who investigate customer purchasing patterns, or production planners who optimize order processing in the manufacturing chain through simulation. The core of DSS applications comprises decision models that "represent a simplified segment of reality in mathematical form through variables [...] and formulas" and "seek the optimal or a satisfactory solution" concerning a predefined target system within the model (Hansen et al., 2019, p. 296).

The target systems do not always pursue complementary sub-goals; rather, conflicts of interest typically arise. For example, in inventory management, the ideal timely readiness for delivery may result in higher stock levels, which, in turn, ties up capital and lead to increased costs. This conflicts with the ideal of keeping costs as low as possible. In such cases, optimized overall solutions must be found by adjusting the parameters while considering the operational constraints.

Figure 17: Components of a Decision Support System



Source: Paul Nikodemus (2021), based on Hansen et al. (2019, p. 297).

The above figure illustrates the components and operation of a decision support system (DSS). Subject matter experts use the DSS's client software to access the database and manage models and methods for targeted data analysis. The system also provides features for presenting the processed and determined results (Hansen et al., 2019, p. 297).

Business Intelligence

We refer to business intelligence (BI) as a management approach that focuses on the organization of data, information, and knowledge. Similar to the classic DSS, the BI approach primarily involves evaluations by combining different data sources. In practice, operational application systems are typically a significant source of raw data, which is then processed in BI applications. However, to obtain the most useful results, it is often necessary to integrate additional data sources, especially from external entities.

For example, to measure their own performance in a specific area, companies rely on having access to benchmark data for their market segment. These data must be explicitly acquired and incorporated into the BI approach for analysis. Continuous analysis requires the ongoing utilization of such external data sources. Moreover, existing infrastructures are often internally diverse, necessitating the inclusion of integration software and, if needed, hardware components and computing resources within the BI approach.

This transforms BI into a distinct system environment, frequently encompassing competitive and strategic application components. Modern and widely-adopted ERP systems often incorporate functional add-ons to provide users with the BI approach. In terms of inter-company networking, BI systems today are also capable of offering cross-functional aspects related to customers and suppliers in their analyses. The following figure displays a screenshot of a typical graphical presentation of results from Microsoft PowerBI.

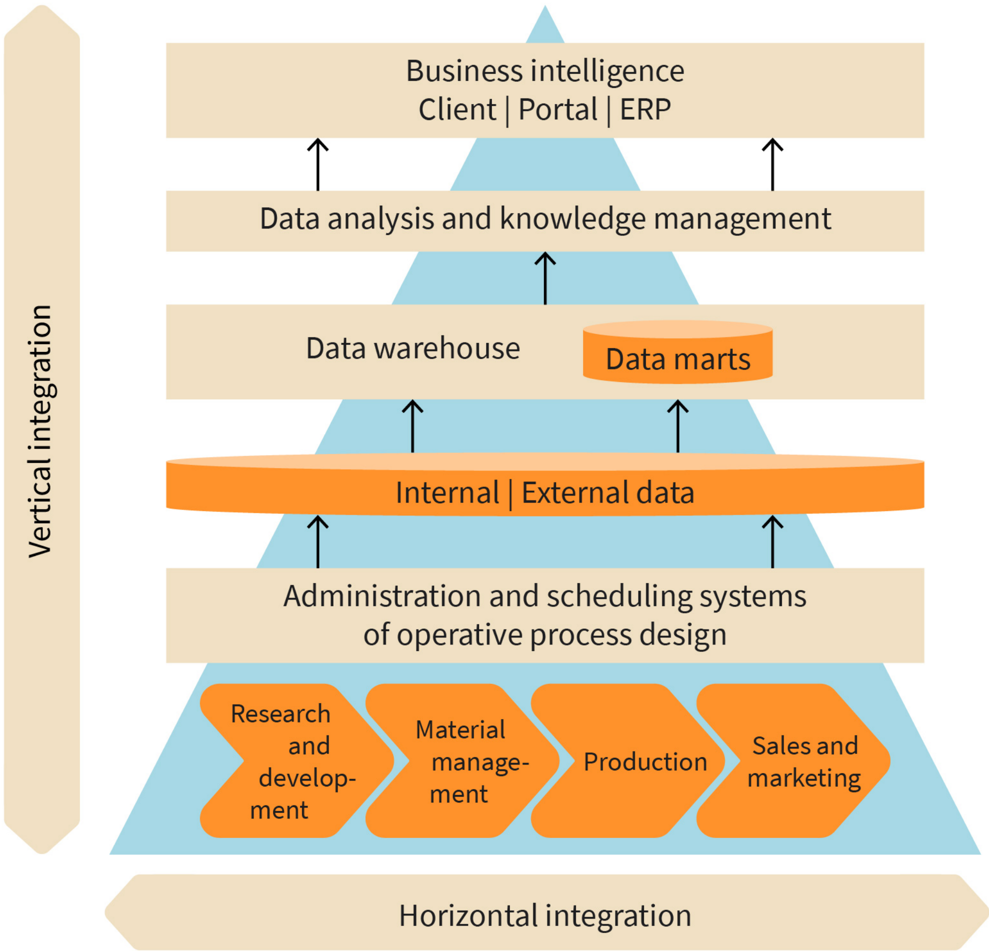
Figure 18: Example of the Presentation View of PowerBI

Source: On behalf of the IU (2024), created with Midjourney.

The following figure shows the integration levels and elements of BI and their placement within the vertical and horizontal integration of applications in companies The starting point and the lowest level comprise internal and external data sources, resulting both from the transactions of operational process design and the utilization of external data and information.

These data are organized in such a way that they can be made available for analytical purposes and organizational knowledge management. An organizational knowledge base is a data warehouse, while subdomains encompass context-specific data sets (data marts), such as sales data of a trading organization. The results obtained from the analysis can then be visualized using defined presentation media. These can be client applications of specialized BI tools, functions of a BI application within ERP systems.

Figure 19: Integration Elements of BI



Source: Paul Nikodemus (2021).

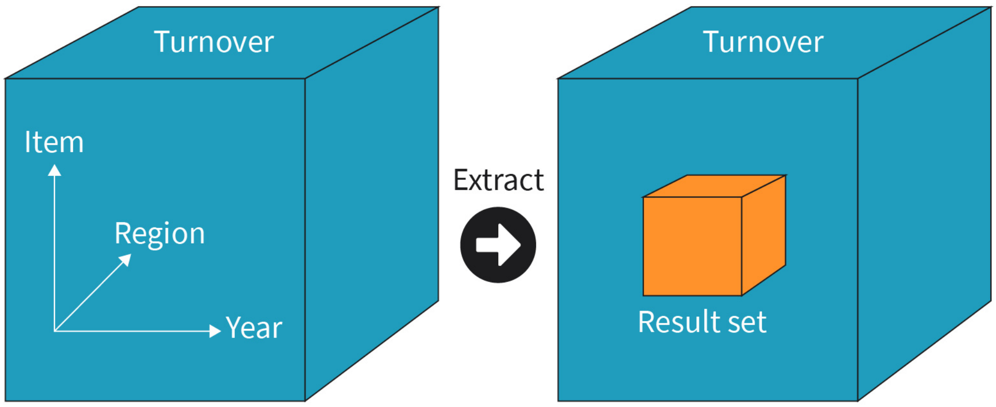
At the core of a data warehouse is an integrated database containing the information relevant to decision-making from business processes and external sources. The data is prepared as needed in three phases (ETL process):

1. Extraction involving access to the data sources,
2. Transformation with aggregation (e.g., grouping/sorting of data), error and consistency checks (e.g., deleting data duplicates, standardizing formats for dates or identifiers), and
3. Loading the data into the data warehouse (Hansen et al., 2019, p. 304).

When dealing with very large data volumes, organizations often create function-specific or domain-specific subsets of data from the main database for the sake of flexibility. These subsets are what we refer to as data marts in the diagram. In the context of terms like data science and big data, we also use the term data lake to describe data collections that are initially stored in their original form, sometimes in an unstructured form. This has the advantage that you can still organize any evaluations at a later time, the structure of which only emerges through an examination of presumed content-related correlations (Hansen et al., 2019, p. 306).

For the analysis of large data sets in real-time, powerful IT processes must also take place. This online analytical processing (OLAP) allows for the rapid "analysis of large data sets structured as multidimensional cubes. A cube represents a data structure that includes three or more dimensions. A typical example is queries that display sales data by regions, product categories, and items, then involving three dimensions. Using OLAP, existing data categories can be transformed into query dimensions" (Hansen et al., 2019, pp. 309–310).

Figure 20: Cube as a BI Instrument



Source: Paul Nikodemus (2021).

Top Management Information Systems

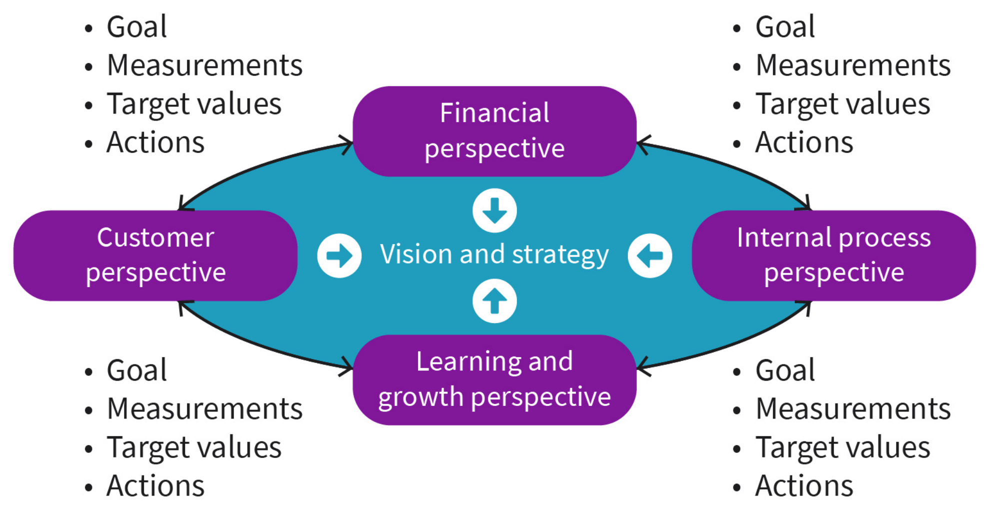
An executive information system (EIS), also known as a top management information system, is a powerful query and reporting system available to top management. Its primary purpose is to provide analytical situational awareness to top-level executives, primarily through key performance indicator (KPI) tracking. This system is a proven control tool, particularly in strategic control, as it can identify success factors and make comparisons.

The information structure typically takes into account organizational units (division, department, profit center, etc.), business functions (production, sales, etc.), business and macroeconomic metrics and indicators (revenue, profit, productivity, inflation, interest rate trends, etc.), as well as other market data. The main focus is on strategic control information as the basis for efficient company management, and annual plans are the most common time-related elements in such analyses. The most common fields of application are:

- portfolio, competition, strengths-weaknesses analyses in internal and external strategic planning,
- profit center, sales, investment calculations, cash flow, and balance sheet analyses, budget-to-actual comparisons, and trend analyses in strategic control,
- monitoring and control functions at the horizontal integration level of operational control, and
- decision-oriented planning calculations based on profit and loss statements and settlement-based financial accounting and reporting methods.

KPI systems are popular control systems at all management levels in practice. A well-known example is the Balanced Scorecard (see the following figure), which examines relevant perspectives on the company's activities.

Figure 21: Balanced Scorecard in Strategic Management



Source: Paul Nikodemus (2021), based on Reisinger et al. (2017, p. 228).

SUMMARY

Enterprise resource planning (ERP) represents the philosophy by which business processes and operational resources, including capital, personnel, goods, semi-finished and finished products, as well as general pro-

duction tools, are controlled and managed. ERP systems informationally map out the control of processes and production resources, making them a part of operational application systems.

The vertical and horizontal integration illustrates the orientation of information management within a company based on the value chain (horizontal) on one hand and the organizational hierarchy (vertical) on the other. This perspective is also adopted by the ERP philosophy when it starts from integrating application functions and, based on suitable architectures, achieves integrated support for the company's process landscape.

Operational application systems are used to provide and administer the operational functions within the value creation process and the associated business transactions. These transactions range from procurement to market engagement on the customer side. Planning systems are used to optimize short-term resource requirements in the production process. The application systems used for this purpose are industry-neutral for general functions in shaping exchange relationships, or they can be sector-specific, for example, when it comes to the service bundles in industry and commerce. Production planning and control, as well as discretionary merchandise management systems, represent this specific process support. Other industries, such as the financial services sector, have their particular functional and hardware equipment to be able to represent the necessary business process infrastructure.

On the other hand, the requirements for strategic process design in companies are more focused on the long term. Systems that support corporate management make up what's known as Corporate Intelligence, aiming to ensure the long-term security and development of a company's competitive position. In addition to general model- and method-based decision support, a concept has been established for almost two decades here, known as business intelligence. This concept involves organizing and enriching operational transaction data, including external data sources, to enable the analysis of business activities.

Data and information are archived and aggregated in a data warehouse or context-/function-specific data marts. These data can be analyzed multidimensionally through information technology processes, including real-time behavior (OLAP). Additionally, the top management has access to key performance indicator systems, which can provide transparency about the business situation at any time based on planning periods. This way, strategic control can be robustly supported with a high-quality quantitative data representation.

UNIT 4

SUPPLY CHAIN MANAGEMENT

STUDY GOALS

On completion of this unit, you will be able to ...

- understand what motivates companies to implement SCM systems.
- explain the main objectives associated with system deployments.
- analyze the functions that SCM systems offer for process design.
- outline what a practical deployment of SCM systems looks like.

4. SUPPLY CHAIN MANAGEMENT

Introduction

Supply chain management
SCM ensures the control and optimization of material, financial, and information flows from raw material suppliers to end consumers.

Supply chain management (SCM) is the division of tasks between companies along the supply chain from a company's suppliers to its customers. In addition to the flow of goods, the supply chain also carries information and financial flows. The process services relevant here must be integrated and managed, which is only possible today through the use of appropriate application systems.

The inter-organizational process design is remarkable in that it goes far beyond the optimization of technical interfaces through the use of systems. As is the case for overall performance, SCM's objectives are also oriented towards the competitive dimensions of effectiveness – synonymous with customer benefit – and efficiency, synonymous with cost–benefit ratio.

In this unit, we will address the relevance of SCM system implementation in practice by exploring the following questions:

- What motivates companies to use SCM systems, and what goals do they associate with them?
- What functions do SCM systems provide for process design, and what might an exemplary system implementation look like in practice?

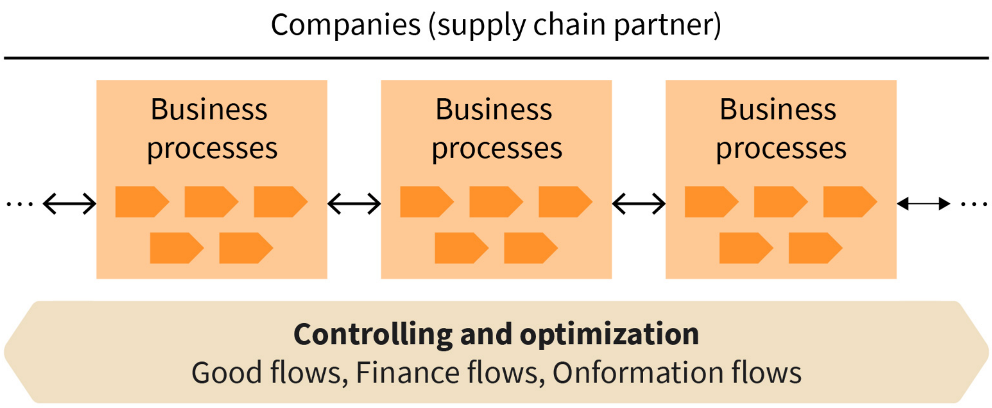
4.1 Motivation and Objectives of Supply Chain Management Systems

With the vertical and horizontal integration of corporate application systems, we have a comprehensive framework that explains the interconnections within the support of corporate processes through information systems. When we also take into account the interfaces that play a more prominent role in inter-organizational contexts, our primary focus shifts to logistical connections with suppliers. This becomes crucial when aiming to optimize and automate processes using information systems in this specific domain.

Supply chain management (SCM) is a strategic approach to efficiently coordinate and optimize the interconnected processes involving multiple collaborators in bringing a product to market. The primary objective of SCM is to facilitate seamless coordination and control across the entire value chain, encompassing various companies, while adapting to dynamic factors such as short product life cycles and heightened customer expectations. This includes maintaining business relationships with suppliers, to enable the flow of goods, finances, and information, as well as extending adapting the chain with the customers, to respond to the customers' evolving demands and preferences. (Okhrin, 2020).

The significance of this application area is also evident from the statistics. In 2021, major software providers for SCM achieved a revenue of 16.9 billion US dollars. SAP alone accounted for 3.2 billion US dollars of that (Statista, 2023).

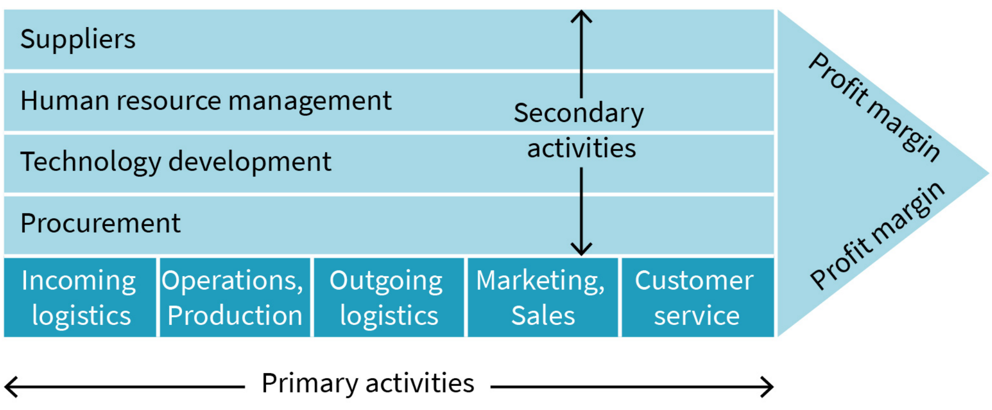
Figure 22: SCM for the Management of Goods, Financial, and Information Flows



Source: Paul Nikodemus (2021).

The term supply chain management itself suggests that this management approach is centered around orchestrating interconnected value creation. This terminology is purposefully linked to the concept of the value chain, as introduced by Porter (1985) to integrate business processes and activities (see figure below). Value creation stems from the services produced by the company, which are reduced by outsourced and external services. Supply chain management then focuses on process optimization, particularly at the internal and external interfaces of the value creation network (Werner, 2020, p. 5).

Figure 23: Value Chain According to Porter



Source: Paul Nikodemus (2021), based on Porter (1985, p. 11).

The SCM management approach encompasses entire corporate networks, consisting of a consortium of suppliers, manufacturers, and customers. SCM must intervene primarily concerning transaction costs that arise within business processes/transactions. Coordination plays a significant role here, as optimization among multiple partners can be promising only based on regulations and agreements. Many factors influence the cost level. These factors primarily include the organizational structure, process definition, and the level of uncertainty associated with business transactions.

Financial flows must also be considered because they involve invoicing of orders and potential opportunity costs through pre-financing and capital tie-ups. Of course, this is where enterprise application systems come into play, as their potential lies precisely in harnessing efficiency options – a significant prerequisite for cost minimization. In connection with digital transformation, the potential of these systems has even increased (Werner, 2020, pp. 5–6). Most companies are increasingly interconnected with other organizations through their business processes, made more digital through system deployment. Additionally, the total volume of data and information is increasing due to the digital transformation of customer and supplier business processes. Therefore, logistics and SCM processes are ideal candidates for support from enterprise application systems (Haas, 2018, p. 1).

Supply Chain Forms

From a business and functional perspective, we can affirm that the influence of SCM "extends from the source of supply to the point of consumption," encompassing "material, information, and monetary flows along the entire value chain (supply, disposal, recycling)," while also considering "the relationships among the actors (social aspect of the supply chain)" (Werner, 2020, p. 6). Within this definition, we can distinguish two practical implementation forms of SCM.

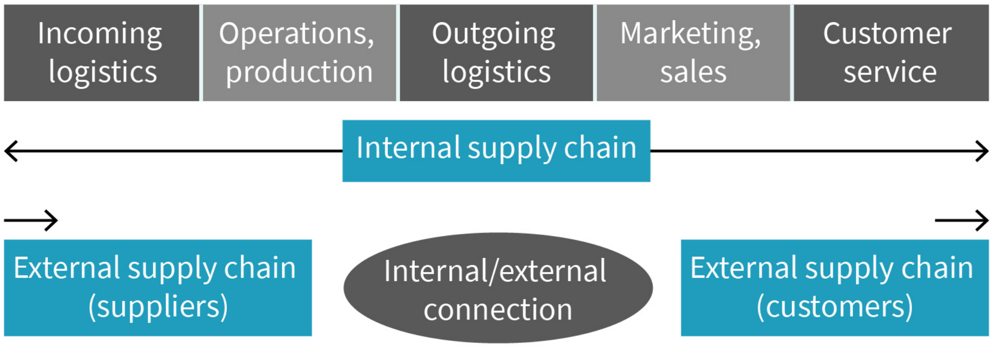
Internal supply chain
The internal supply chain includes the processes of value creation within a company.

Integrated supply chain
The integrated supply chain includes the interfaces of value creation towards the external environment.

Firstly, there is an **internal supply chain** within companies, constituting the value creation process from goods receipt to the shipment of their own service bundles. Secondly, in a network form, we can describe the **integrated supply chain** as a value creation line defined mainly by the company's external interfaces. These connections of the organization with suppliers and customers also include the suppliers of suppliers and the customers of customers in their external continuation.

Thus, it encompasses and connects all actors within the value chain stages, each contributing differently to value creation, from the raw material supplier to the end consumer. This also includes a combination of various manufacturing and trade forms. Both implementation forms usually occur simultaneously and interconnectedly (Werner, 2020, p. 7).

Figure 24: Internal and External Supply Chain



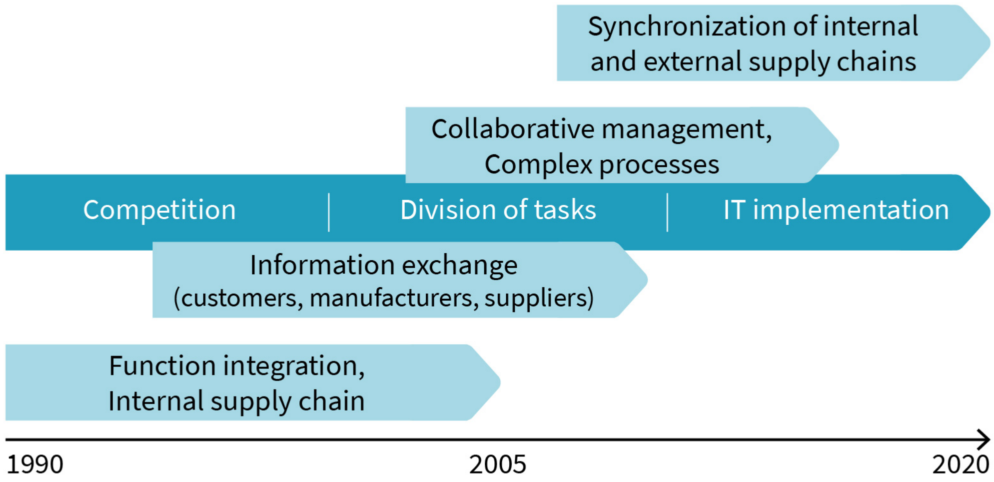
Source: Paul Nikodemus (2021).

Historical Development of SCM

The design of internal and external interfaces in the context of logistics and SCM also played a role in the development of related strategic orientations. With the increasing automation, the optimization of internal interfaces between the functional areas involved in value creation was initially the focus. As regional and then international divisions of tasks, along with globalization, became more prominent, there was an intensification of information flows between companies and their customers and suppliers. Electronic procedures with standardized content for business transactions were established, becoming an entry point into the process landscape, which is now an integral part of business models in connection with the topic of E-commerce. An example is the Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT), which is a set of rules for electronic data exchange between multiple business partners established by the United Nations (UN) and recognized worldwide.

The intensification of competition and the focus on core competencies made collaborative network design possible, and with the quality of information processing up to real-time behavior, this cooperation was further optimized. As a result, today, value creation partnerships with synchronous timing of supply chain activities intra- and inter-organization are possible. The network ensures a system behavior that, despite a heterogeneous partner structure, enables a homogeneous process landscape because integration through system-technical and content standards turns partner companies into functioning subsystems within the supply chain. The role of information processing is seen as the driver of these developments. The following figure illustrates the stages of development over time.

Figure 25: Development Stages of Supply Chain Management



Source: Paul Nikodemus (2021), based on Werner (2020, p. 15).

The Goal of SCM

The stages of development also provide insights into the goals associated with the use of SCM. The quality of the supply chain relies on its reliability, necessitating the avoidance of disruptions. Disruptions can imply various negative influences, primarily concerning the speed of flows of goods, information, and finances. Transaction and opportunity costs constitute another goal. They need to be minimized through the optimization of inventory, lead times, and the maintenance of delivery capability. The third goal pertains to planning security, which is achieved through the intensive use of information and communication technology and the conceptual elements of information management for shaping information systems and IT infrastructure.

Overall, this leads to an integrated use of tools that strategically influences the configuration of the value creation system, tactically shapes the planning level, and operationally focuses on the execution, control, and information technology design of the process.

These explanations highlight the potential of information systems for SCM objectives. They emphasize the importance of seamless integration and uninterrupted flow of both materials and information, supported by IT systems. This integration extends to various operations such as handling, picking, storage, and internal transport, facilitated by integrated material flow systems in the field of logistical planning through dispositive and administrative application systems. Inter-organizational information systems for logistics and SCM enable new forms of collaboration between logistics companies and their customers through electronic data interchange (EDI) and/or e-commerce in corporate networks. This can reduce transaction and opportunity costs, as well as error frequency, while increasing the quality of disposition and control tasks (Krieger, 2018).

4.2 General Principles and Challenges in SCM

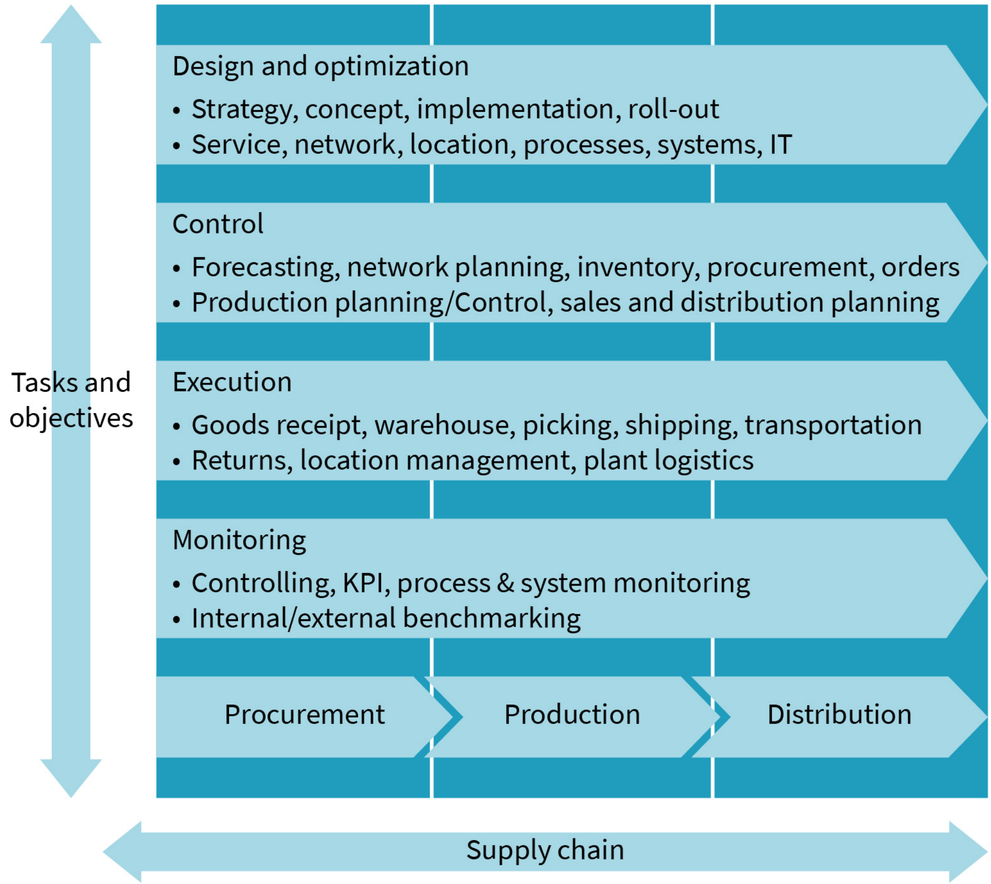
The inter-organizational networking along the value chain is a driver for potential optimization approaches. However, it also raises challenges in supply chain management (SCM) because inter-organizational coordination, compared to the homogeneous internal development of a single company, places higher demands on process design. These demands increase as the number of supply chain partner companies grows. Information processing plays a crucial role here.

While establishing cross-functional communication within an organization can be seen as an internal task, the exchange of data with direct market partners on the procurement and sales sides, which is required in the second stage of SCM development, presents a different set of challenges. Often, various systems need to be connected to automate the exchange of business transaction data. This becomes even more complex when business process design must be synchronized across inter-organizational and collaborative value chains. With several partner companies within the supply chain, accomplishing this through individual coordination between different system environments is hardly feasible.

Therefore, a completely different level of expectation is placed on information management and the use of enterprise application systems. Technical and functional intelligence becomes essential for the successful synchronization of systems. Due to the increasing digitization, data volumes are growing, and planning and control tasks are becoming more real-time oriented. Hence, modern data analysis techniques related to big data and data science must be utilized to enhance the quality of planning and control results, which, in turn, strengthens the market position of SCM partners in the competitive landscape. This challenge has significantly elevated the importance of tasks related to supply chain optimization within companies.

The figure illustrates the tasks and goals that are now strategically consolidated within modern organizations as part of their SCM. The underlying principle is to achieve holistic optimization of the supply chain. This serves a dual purpose: Firstly, it aims to reduce process-related losses that can have detrimental effects on optimization goals in terms of time, effort, and outcomes. Secondly, it seeks to harness the intelligence of logistics systems and resources to effectively shape the supply chain processes (Bundesvereinigung Logistik, 2017).

Figure 26: Tasks and Objectives of SCM



Source: Paul Nikodemus (2021), based on Bundesvereinigung Logistik (2017).

If we consider the two competitive dimensions, efficiency (cost side) and effectiveness (customer/market side), the willingness to establish collaborative relationships is likely to increase. Particularly, internationalization amplifies the complexity of coordination tasks because cultural interventions and the intensity of competition between global economic regions will play a more significant role alongside functional aspects.

Trade agreements, as well as discussions concerning the integration of specific countries of origin in the development of critical infrastructures, already illustrate that political questions often have a substantial impact on economic requirements. This is expected to become more prominent, and global disruptions, such as epidemics and pandemics, are already demonstrating their potential consequences for the interconnected supply chains. For example, a vulnerability would be evident if a grounded container ship blocked the Suez Canal, which is one of the most crucial waterways of global shipping. Events like these can last for days and cause significant disruptions in the flow of goods.

The increasing technological interconnectivity of information systems also brings about greater threats from malware and cyberattacks. These have already resulted in significant damages, and the security question remains inadequately answered. This situation necessitates cross-company and cross-border coordination. The potential dangers and risks in the realm of the network economy are sometimes incalculable because synchronous actions of affected interest groups can fail due to political influences. When we distill the significant challenges for SCM from these considerations, the following fields raise important questions for development.

Strategic and Organizational Framework

The SCM must be designed in a way that adequately considers the strategic interests of partner companies, which derive from their respective market situations. Companies positioned toward the end of the supply chain must align their strategic orientation with the competition dimensions of efficiency and effectiveness (cost and customer orientation) in their supply chain management. However, this might not necessarily apply to a company that serves as a raw material supplier within the same supply chain. Conversely, suppliers to premium manufacturers would pursue an appropriate quality strategy to significantly support the competitive position of their customers.

Design and configuration of processes along the supply chain

Interconnectivity across the supply chain leads to interwoven process chains at the interfaces of participating companies. To ensure smooth operation without process disruptions, agreements must be established to ensure lasting precision at these interfaces. Reference models can be used in practice to provide process design to the companies involved, which process stakeholders can adhere to. In practice, this plays a vital role when process configuration is crucial for the overall quality of performance. Just-in-time models, where the supplier delivers to the processing points of their customers in a way that optimally supports the production process, are concrete examples of optimizing interwoven process chains.

Collaborative coordination among supply chain partners

Partner companies within a supply chain make agreements aimed at optimizing joint value creation. However, these runtime behaviors do not occur automatically and must be established and monitored individually through coordination. A good example is the customer ticket system. One partner delivers service level agreement (SLA) for first and second support and another partner is responsible for third-level support. Therefore, the ticket systems must be highly integrated. Application systems can take on this role if they can support the aforementioned interfaces between companies. Nevertheless, there might be a need for an integrated entity responsible for monitoring the process states of the supply chain. Examples of this include platforms that enable connectivity for partner companies and carry their automated applications and data repositories to efficiently execute coordination.

Requirements from information technology coupling

The coupling resulting from process logic must naturally be implemented through information technology infrastructures. This can involve using integration concepts from information and software technology. These concepts range from individual application system couplings to intelligent systems for standardized coupling, such as **enterprise application integration** (EAI) or **service-oriented architecture** (SOA).

Enterprise application integration
EAI refers to the process-oriented integration of enterprise applications to optimize business processes.

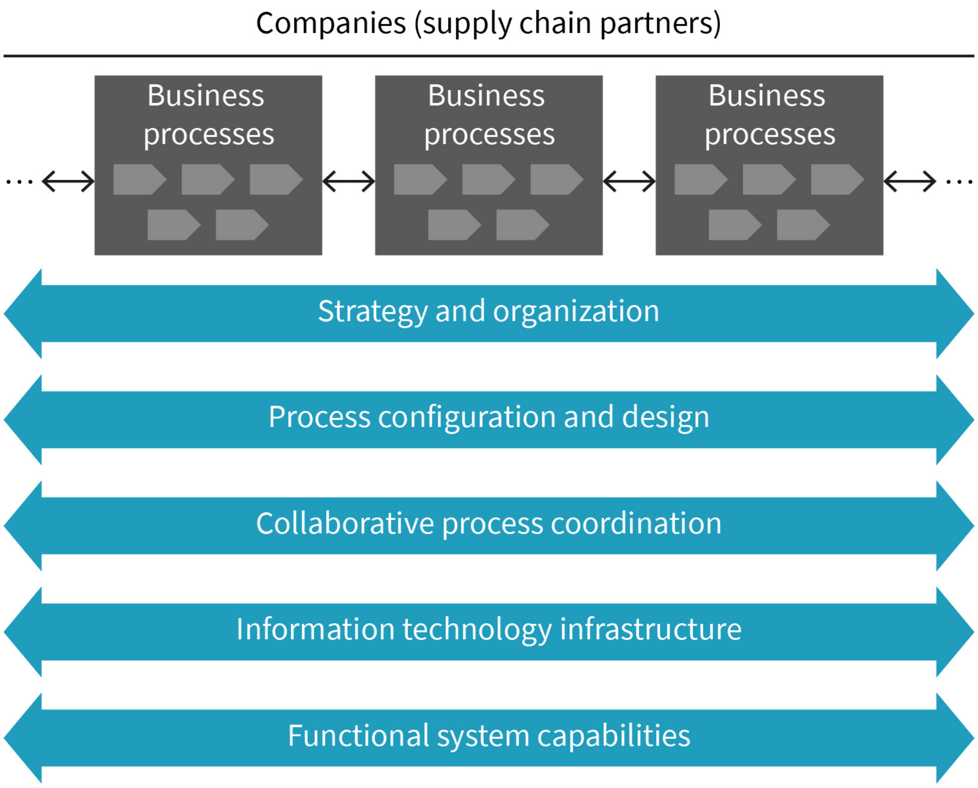
Service-oriented architecture
SOA is an architectural pattern for distributed systems that allows services to be used modularly in IT systems.

Functional features of coordination-supporting systems

Systems used for SCM support, both internally and inter-organizationally, must have sufficient functional capabilities. Modern enterprise resource planning (ERP) systems already offer modules and components for supply chain integration, which simplifies the implementation of supply chain management. However, many application systems currently in use often require significant expansion and customization to become SCM-capable. Digital transformation and automation have significantly increased the pressure on companies, and suppliers often need to demonstrate their ability to meet their customers' SCM requirements.

The following diagram integrates the discussed issues through interventions and design levels. The technical infrastructure and functional capabilities are crucial determinants for the enterprise application systems used in SCM. The double arrows indicate that the integration direction is bidirectional.

Figure 27: Interventions and Design Levels of SCM



Source: Paul Nikodemus (2021).

In this regard, the supply chain is a collaborative network of companies (supply chain partners) connected in pursuit of joint value creation. Through the value-adding steps and stages, they satisfy the target market's demand. The goal is to meet the requirements of supply chain partners and distribute the benefits (effectiveness) and costs (efficiency) in a way that the design of the common supply chain becomes a stable element in the market approach of the participating partners, strategically situated.

In this context, we can also talk about an N-Win situation, with N representing the number of network partners. Beyond the logistical goals of integrating goods, information, and financial flows, SCM also stands for inter-organizational management of business processes and the coordination of existing business relationships.

4.3 Functions of SCM Systems

SCM encompasses functions that can be described as the "coordination of all flows and activities between the partners of a value chain network to achieve common goal… The core processes of SCM include planning, procurement, production, distribution, and disposal" (Alpar et al., 2019, p. 332). SCM focuses on the logistical flow of goods, information, and finances. This approach considers not only the internal components of the value chain but also aims for a holistic perspective, spanning from raw material producers to end consumers in the retail sector. Consequently, SCM application systems are designed to align with dimensions that determine the success of value creation. Functionally, it involves enhancing both effectiveness, which leads to greater customer satisfaction, and efficiency , which achieves improvements by optimizing cost-related factors (Alpar et al., 2019, p. 332).

A suitable functional breakdown of SCM applications, aligned with the aforementioned logistical flow approach, is provided by the supply chain operations reference (SCOR) model. This model consists of the following five core processes:

1. Planning
2. Procurement
3. Production
4. Distribution
5. Disposal

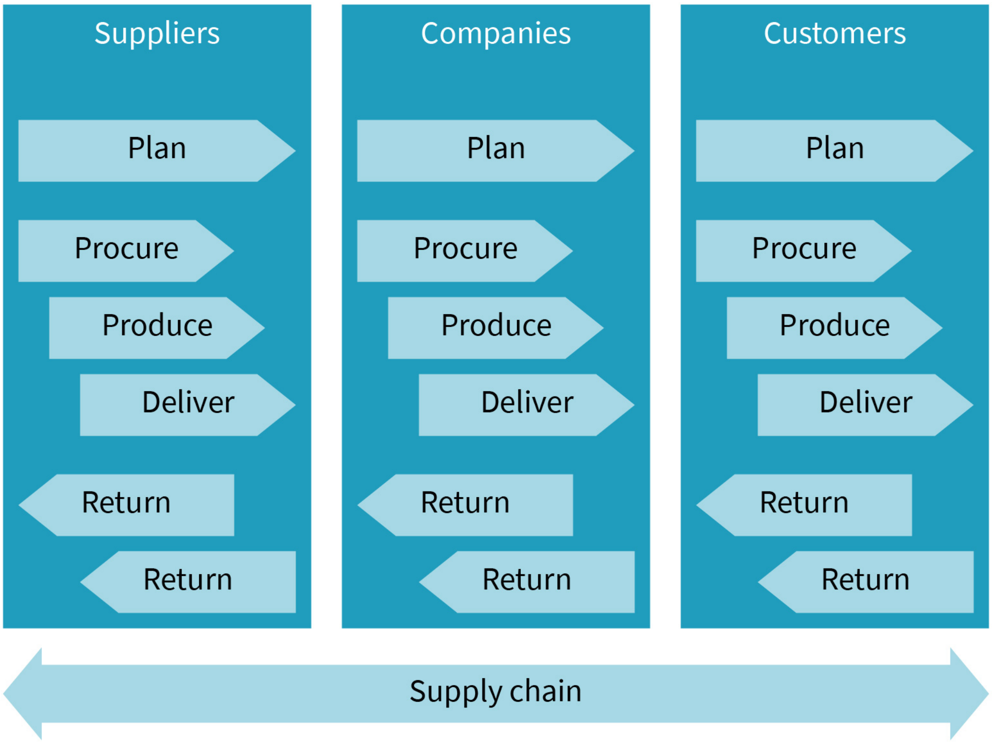
These processes are further categorized into three hierarchy levels: Top-Level, process categories, and process elements. The hierarchical structure allows for detailed definitions of individual process elements. This reference model was initially developed by the Supply Chain Council in 1996 for the field of supply chain management.

The basic concept of the plan, source, make, deliver, return, and enable (SCOR) model has six process types (top-level). These process types are (Fettke, 2020)

1. Planning (plan) involves organizing supply and demand for goods.
2. Sourcing (source) includes the procurement of goods, their receipt, inspection, storage, and payment instructions.
3. Making (make) encompasses all production steps.
4. Delivering (deliver) covers order processing and goods delivery to the customer.
5. Returning (return) involves the processing of returns, including repairs and maintenance.
6. Supporting (enable) comprises activities that facilitate supply chain process planning and organization within the other five process types.

The following figure illustrates the first five of the mentioned Top-Level process types (core processes). The “Supporting” process type is not separately presented due to its cross-sectional nature.

Figure 28: SCOR Model and Core Processes



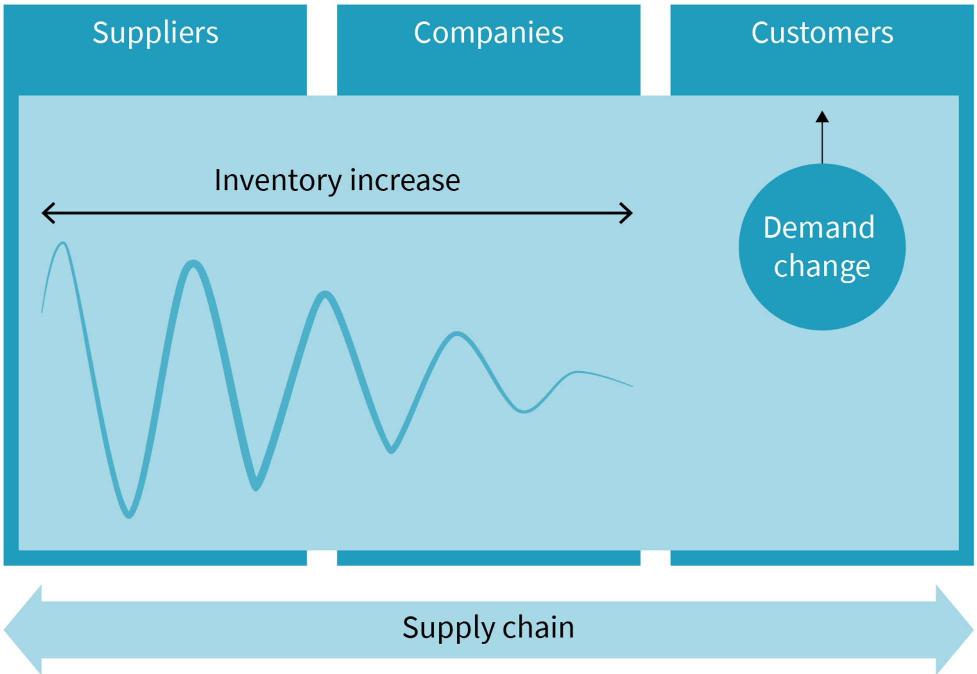
Source: Paul Nikodemus (2021), based on Fettke (2020).

The planning processes are a prerequisite for all other processes. They handle the planning of the strategic process configuration for the value chain as well as the planning for the operational production data exchange, which can occur daily. This time behavior is justified by the **bullwhip effect** where a slight increase in forecasted demand in retail leads to a stronger and exaggerated increase among producers and suppliers since downstream entities build planning security (inventory surpluses) to ensure their deliverability.

Bullwhip effect
The bullwhip effect describes the coordination issues in multi-tier supply chains due to demand fluctuations and safety stocks.

Unfortunately, this effect intensifies with the number of planning entities (network participants), resulting in higher inventories throughout the entire supply chain. The timely exchange of planning data through SCM systems can help prevent this effect. This type of integration of procurement, production, and delivery processes is also found in strategies such as industrial just-in-time (JIT), efficient consumer response (ECR) in retail, and vendor managed inventory (VMI), where producers take over inventory management for their customers (Alpar et al., 2019, p. 332).

Figure 29: Bullwhip Effect in SCM



Source: Paul Nikodemus (2021).

Integration of SCM and ERP Applications.

Due to the integration with materials and goods management, SCM applications must interact in coordination with ERP applications, a process referred to as SCM/ERP integration. The dynamic nature of SCM planning requires that operational ERP data be used within the SCM application so that real-time analyses and optimizations can be performed without significant delays. This places specific requirements on hardware and software capabilities to handle big data environments.

SCM applications act as a kind of engine for the supply chain, providing other ERP applications with the data they generate. Special applications include SCM control centers, acting as a monitoring and tracking cockpit, planning functionalities utilizing intelligent operations research methods, artificial intelligence algorithms, machine learning, and operational functions for supply chain execution, including order, transport, warehouse, and inventory control. For end users, web applications provide access to functions such as tracking and tracing, allowing them to determine the current shipment status of an order or track the shipment's transportation. (Alpar et al., 2019, p. 333).

SCM functionalities complement operational ERP systems and also offer interfaces to customer-oriented applications, such as tracking. An important interface exists with Electronic Commerce applications when integrating an online shop like Shopify, for instance. SCM application providers include well-known large companies like SAP and ORACLE, renowned for their ERP systems, but also Microsoft and specialists like JDA (Alpar et al., 2019, p. 334).

4.4 Example Scenario for the Use of SCM Systems

In connection with supply chain management (SCM), there have been several references to digital transformation, which now plays a significant role in system usage in logistic process design. Instead of speaking of a connected value chain, we can already talk about digitalization of value creation and system intelligence will be particularly required where its implementation can positively influence the success factors of SCM. The following explanations relate to this topic and describe the fundamentals and, through an example scenario, the application of artificial intelligence (AI) in procurement and SCM.

With the increasing digitization of production, the shift from a simple factory to a smart factory is taking place. The vertical and horizontal integration of information systems in an intelligent factory facilitates communication between humans and machines, as well as between machines and machines. This enables the autonomy and self-control of entire production facilities. SCM has pursued the approach of inter- and intra-organizational process integration for over twenty years, and digital technologies can lead to even more intense networking and optimization of logistical process performance within the supply chain. We have been referring to the digital supply chain for quite some time, which is an apt description of this situation.

Goods, as well as semi-finished and finished parts, can be equipped with small, intelligent systems (embedded technologies), and the functions of logistics and material/goods management can be increasingly automated, making them more efficient. Nearly seamless tracking from suppliers to consumers is already possible today, although not always at an economically justifiable cost. The data generated within the supply chain can be collected and analyzed to qualitatively improve individual process steps and optimize machine runtimes, which also minimizes capital tied up in the warehouse.

Logistics is traditionally an area that quickly incorporates innovations in information technology and processing into new solutions for process support. A prime example is the use of **radio frequency identification** (RFID) controls for tracking goods, which were introduced years ago. Therefore, digital logistics is at the forefront when it comes to monitoring inventory and goods traffic and further automating transportation.

Radio frequency identification
This is a technology using electromagnetic waves for data communication.

These aspects are particularly relevant in the food industry, where issues like maintaining cold chains and other factors affecting freshness and shelf life are crucial. The resulting improvement in the quality of logistics services naturally enhances efficiency and, thus, customer satisfaction. Information management ensures the synchronization of processes along the supply chain, connecting manufacturers, retailers, transportation, and logistics service providers (BITKOM, 2014, pp. 4–7).

In the context of SCM, we have already emphasized the impact of competition, which demands greater efforts since efficiency and/or effectiveness advantages over the competition can pay off very quickly and, in some situations, are a necessity due to the dynamics. However, these advantages cannot be achieved overnight; they are the result of continuous process improvements, which should ideally encompass many areas of the value chain. The digitalization of the supply chain leads to the acceleration of many processes, not only speeding up the transportation of goods but also eliminating many errors induced by human labor (BITKOM, 2014, p. 6).

The changes associated with digital transformation, for example, require logistics service providers to be capable of collaborating with competitors. The increase in complexity resulting from these competitive dynamics implies that processes need to be more decentralized. To achieve this, agent systems and cyber-physical components are required, ensuring autonomy and self-regulation. The Internet of Things (IoT) serves as the infrastructure in which real and virtual objects are interconnected, and software systems are used for decision support through **semantic knowledge management.**

Semantic knowledge management
This process uses concept elements of artificial intelligence, such as search algorithms.

As part of Industry 4.0, cyber-physical logistics systems act as control units to configure logistics objects and structure data generated along the supply chain into knowledge units that make up the intelligence of the overall system (such as motion mining to optimize the operation of a warehouse). The use of AI in this manner also necessitates the development of suitable concepts for secure interconnection of information sources.

Although a fully digital supply chain is still largely aspirational, many companies are already integrating their logistics processes with those of their market partners through modern platforms as part of their Industry 4.0 initiatives. It is anticipated that, due to the dynamic nature of technology development, application systems capable of meeting the requirements of a Supply Chain 4.0 will soon be in use (BITKOM, 2014, p. 14). Initiatives related to Industry 4.0 are also leading to the development of new logistics concepts that will result in a Supply Chain 4.0. In, 2022, approximately 1.6 billion euros were generated in the B2B e-commerce market in Germany (Statista , 2023b).

AI has already become a well-established technology, and hardly a day goes by without the media discussing this topic, particularly in the context of autonomous driving or the algorithms used by search engines. AI can be used in SCM, for instance, for intelligent algorithms to optimize processes. Big data is the term used to refer to the continuously growing volume of data, indicating that it is no longer confined to company-internal and structured data but also encompasses the Internet as a source of information with both structured and unstructured data.

When this data has business value, it becomes immensely important to market players because its utilization and processing can provide a competitive edge and contribute to economic success. This can play a role in business interactions between companies when crucial decisions need to be made in tight timeframes, for instance, during purchasing negotiations. In such cases, a learning AI can help process the data from business relationships and other sources to generate practical recommendations for buyers and supply chain managers (Heinrich & Stühler, 2018, pp. 77–78).

In the following sections, we will explain a use-case scenario that demonstrates such an application of learning AI.

Innovative Supply Chain Collaboration in Business Practice

At the core of traditional logistics process optimization, including SCM, lies the potential for improving efficiency. However, collaborative projects can also lead to product innovations that are developed in conjunction with suppliers and brought to market. The explicit connection to research and development necessitates that supply chain managers in the procurement department possess solid knowledge enabling them to identify suitable and innovative suppliers. Acquiring such knowledge requires a multidimensional review of adjacent industry offerings to yield useful search results. An example of this is the collaboration between automotive manufacturers and providers of electric propulsion and battery components. This type of cross-company cooperation has been supported by information systems for many years (Heinrich & Stühler, 2018, p. 78).

Innovative Information Systems in Business Practice

Information and application systems in value networks have evolved over the years, progressing from simple material management systems to production planning and control systems (PCC) in enterprise resource planning (ERP) systems used in supply chains. However, more extensive inter-organizational application systems and data integrations often fail due to the persisting economic individual interests in collaboration. Many companies need to first harmonize their internal system landscape through standardization, and they are frequently overwhelmed at this stage, especially when their size limits a stronger strategic anchoring of information management.

Consequently, the existing data and information landscape from ERP, planning, and other systems is hardly suitable for deriving proactive action options, even though these data can potentially have strategically valuable content. This necessitates an approach for information management in supply chain scenarios that incorporates the use of dynamic data from external sources in decision-making processes throughout the supply chain, especially in procurement. A structure-static internal database is augmented with an information pool that can dynamically validate and provide relevant external data in real-time for specific tasks. The software technological foundation for this is AI (Heinrich & Stühler, 2018, p. 79).

Artificial Intelligence and Machine Learning

Artificial intelligence refers to computer science applications that demonstrate smart behavior (Siepermann, 2018). When looking at it from a developmental perspective, there is moderate AI when machines – typically computer-controlled units – assist people in achieving their goals. This smart form of collaboration between humans and machines is called human-machine interaction.

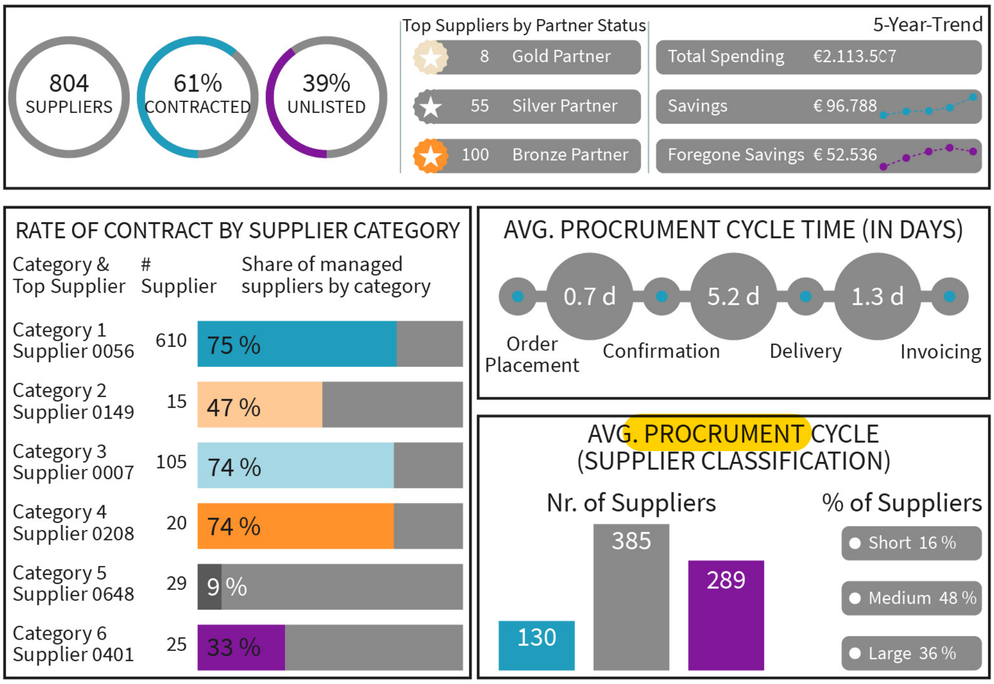
This is distinct from AI which stands for machine learning from massive data. Today, in the current development of AI systems, efforts are made to combine learning methods with expert knowledge in such a way that machine learning and the processing of large volumes of data are ideally linked (Siepermann, 2018). These explanations clarify the principles by which AI can be employed to achieve the goal of innovative data utilization.

Artificial intelligence and Machine Learning in the Supply Chain

To facilitate innovative collaboration in SCM, three key areas must be addressed. First, there's a need to identify innovative suppliers or innovative new offerings from already established suppliers. Then, the negotiation power for procurement needs to be assessed and ensured. Finally, risk must be minimized through supply chain transparency.

To accomplish these tasks, supply chain managers require a presentation view that serves as a graphical user interface, making the data generated by AI comprehensible and applicable. In information technology, such views are known as dashboards (Heinrich & Stühler, 2018, p. 83). In the figure below, you will find an example of a procurement dashboard.

Figure 30: Example of a Procurement Dashboard



Source: Paul Nikodemus (2021), based on Datapine (n.d).

Automated Identification of Innovative Suppliers

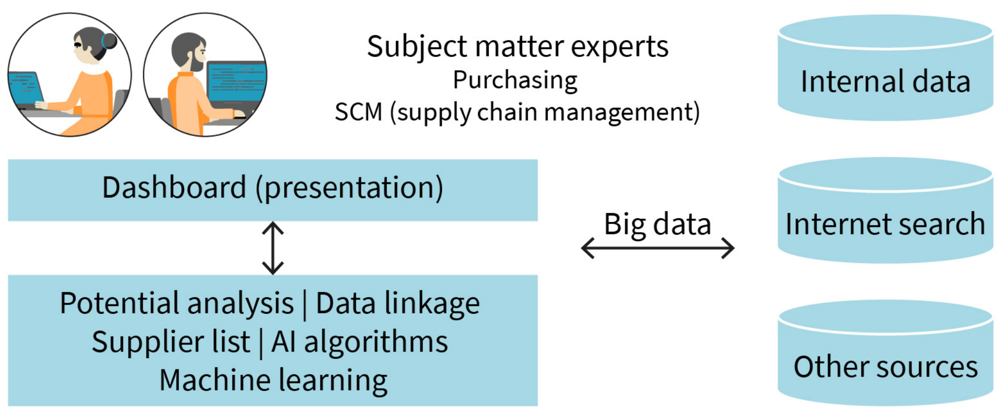
In the first step, the automated identification of innovative suppliers, four points need to be addressed (Heinrich & Stühler, 2018, pp. 83–85):

1. **Market analysis and supplier identification**: Market analysis requires a database that can be automatically found on the internet through selection criteria. AI software can enable language-independent searches, allowing for global exploration, and

resulting in a large pool of potential suppliers. Often, this can yield several thousand data records. With modern information technology, the search is typically completed within a few minutes. An example of this is SAP Ariba's electronic marketplace.

2. **Scalable acquisition of supplier information**: The actual useful data must then be generated by experts who further refine the already selected information and evaluate the corresponding data sources that have been identified. This complex activity is followed by linking the discovered information with existing knowledge components. The outcome should be a high-quality database of supplier options.
3. **Development of algorithms for candidate selection**: In this stage, machine intelligence comes into play, enabling a multi-dimensional search for the best candidates. Based on text features and keywords, connections, and relationships are established, mapping the search logic in a multi-dimensional space where results can be generated through similarity analyses. An intelligent search system of this kind also requires a correspondingly high level of technical and software equipment since the algorithms, in their application to large and complex data sets, often require significant computational capacity. The hardware components and processors used must be correspondingly high-performance. The quality and performance of this system, working according to big data and data science criteria, determine the quality of the results in the form of supplier lists containing a manageable number of possible candidates. The creation of this list is a fully automated step, providing the supply chain manager with the final results to directly approach the suppliers. The following figure shows the configuration from the perspective of information management.
4. **Machine training**: Finally, it is crucial to ensure that the evaluation of the results determined by the procurement management is also fed back to the system. This way, practical experience is used to further optimize the system's learning ability. Equipped with AI, the supplier search allows the buyer to conduct regional and global market analyses, leading to the identification of suitable market partners.

Figure 31: Components of an AI System for Supplier Selection



Source: Paul Nikodemus (2021).

The following figure summarizes the four points of the automated identification of potential suppliers.

Table 6: AI-Supported Supplier Identification

Workstage 1: Market analysis and identification	• Automatic search • Selection criteria • Worldwide
Workstage 2: Scalable procurement of supplier information	• Data sources • Data linkage • Experts
Workstage 3: Development of algorithms for candidate selection	• Search logic • Big data • Data science
Workstage 4: Machine training	• Result list • Validation • Learning process

Source: Paul Nikodemus (2021), based on Heinrich & Stühler (2018, p. 84).

Supplier failure

Another problem area in addition to the identification of innovative suppliers arises from how to react to a supplier's failure with whom the company already has business relationships. In such a case, the company can only avoid corresponding dependencies and associated opportunity costs with a given market power. With the solution implemented in the first step, it is possible to check at any time which other suppliers could be considered as replacements from the identified supplier list.

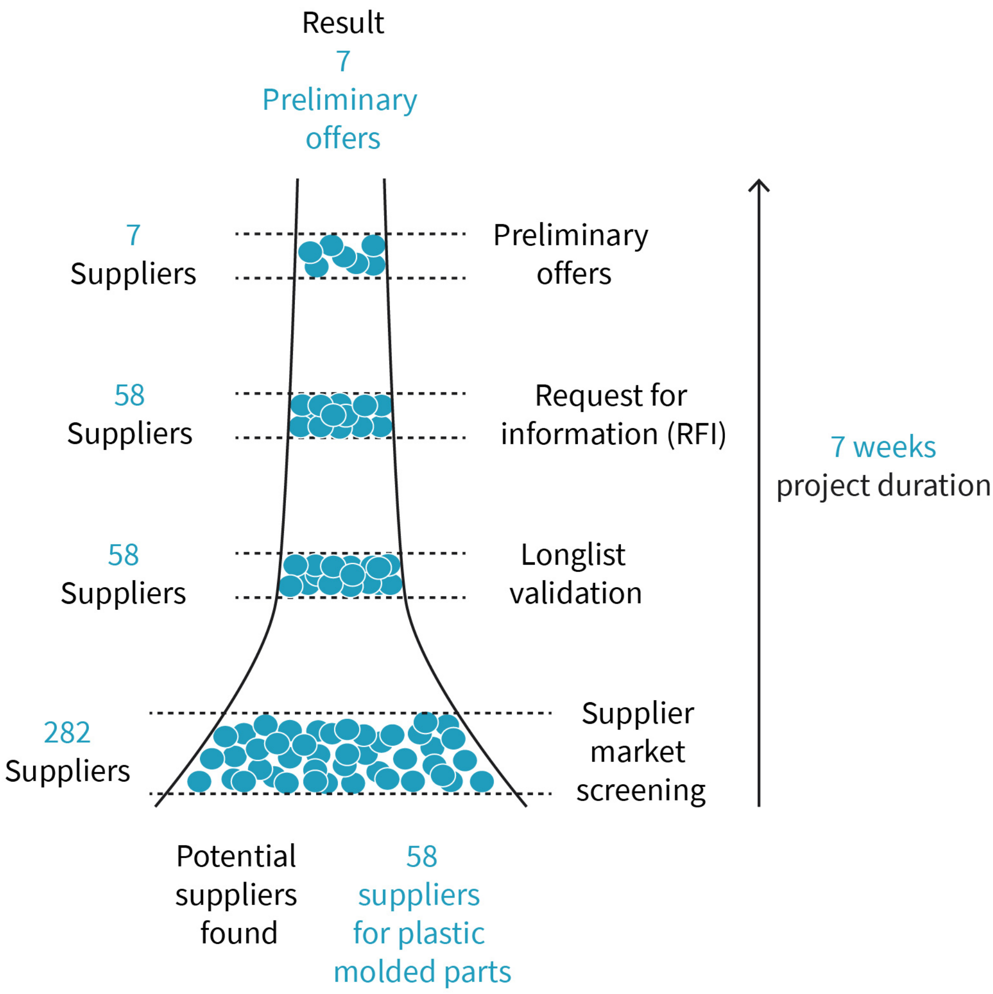
Naturally, this is not always easy to implement, as especially in innovation-based collaborations, a replacement is often not feasible in the short term. At least, the AI-supported application provides some leeway as it allows potential business relationships identified therein to be further examined.

Risk reduction through transparency

The third part of the practical example is about reducing risk by making the structure of value-added business relationships transparent. To do this, customer-supplier relationships on the internet need to be found and analyzed. Here, too, the technologies of AI and machine learning can be of concrete assistance. The company Scoutbee, founded in 2015, offers various platform solutions based on AI and big data, including one for risk management. According to company information, this solution “has a proven track record in facilitating procurement – from core categories to high-risk materials – controlling and mitigating the myriad procurement-related issues and conducting a comprehensive search for the best suppliers” (Scoutbee).

In an example, it is explained how a machinery company successfully managed the search for a replacement for a supplier threatened by bankruptcy. With the AI-supported supplier search from Scoutbee, 282 potential suppliers were identified. Of these, 58 were prioritized by the company. In seven cases, offers were obtained, and the company was then able to “quickly identify strong alternative suppliers while saving process costs and resources” (Scoutbee, n.d.).

Figure 32: Risk Minimization in SCM



Source: Paul Nikodemus (2021), based on Scoutbee (n.d.).

The practical examples in the scenario of application systems in supply chain management show that modern technologies, as we find them today in the context of AI, big data, and data science, can have a positive impact on strategic and operational process design. The application of these technologies in supply chain management for identifying innovative suppliers and procurement risk management can strengthen a company's competitive position. Users shape their processes in the sense of an agile and self-learning enterprise, and supply chain managers become decision-makers who can leverage the dynamics of data and information on the Internet to achieve their goals (Heinrich & Stühler, 2018, p. 88).

SUMMARY

With supply chain management (SCM), companies engage in a discipline that primarily focuses on optimizing value networks and supply chains. It involves cross-company process design in the areas of procurement/purchasing, production/manufacturing, and distribution/sales. These areas handle extensive transaction volumes, as the involved business processes lead to flows of goods, finances, and information, with their economic reach spanning multiple value-added stages, from raw material supply to end customer purchases. Particularly, the flow of information poses a significant challenge in this context, as its qualitative and quantitative implementation is seen as an enabler of competitive advantages.

Logistic applications have always been a field for IT use, and digital transformation, particularly in the context of big data and data science, has given this perspective greater significance, especially in connection with logistics and SCM application systems. Thus, it's not surprising that SCM systems significantly benefit from new digital technologies, and we can already describe concrete scenarios for the use of technologies like artificial intelligence (AI) in SCM.

However, the complexity of SCM and its supporting system integration results from the objectives and the demand for effective implementation. This is because it involves not only coordinating internal value contributions but also coordinating and collaborating between different organizations and value-added partners. SCM extends far beyond the isolated implementation of logistic processes due to the much higher degree of integration. Another crucial point is continuous process improvement, which can also be facilitated by system components that fall within the scope of machine learning. Therefore, SCM 4.0 is not a utopia; it is a development stage that aligns with the general progression toward Industry 4.0.

SCM is a critical success factor for many companies that define themselves as links in a value chain. For industries and trade that operate on an international scale, SCM concepts are not entirely new but are also found in established cooperation principles like just-in-time (JIT) or Efficient Consumer Response (ECR). With the Internet of Things and modern information systems, coordination and control tasks can frequently be carried out in real-time. However, this also brings significant challenges, especially considering crises and aspects such as operational stability and IT security. If one link in the supply chain fails to fulfill its tasks satisfactorily, it can result in more considerable disadvantages for all network participants. The bullwhip effect illustrates how inaccuracies in behavioral forecasts within the supply chain can negatively amplify.

When designing SCM application systems, functional components can be directly derived from process requirements. The SCOR model provides crucial insights into process types and offers suggestions for functional sub-process design and performance measurement. During the development and implementation of such application systems, it is also essential to consider interfaces. This is because SCM functions deeply penetrate the processes, which means that data paths to and from operational and administrative systems, as well as management information systems, must be designed. Due to the dynamic system behavior in SCM, these systems usually dictate the IT requirements. Alongside Customer Relationship Management (CRM), supply chain management (SCM) is another important discipline for cross-company process design to ensure companies' competitiveness.

UNIT 5

CUSTOMER RELATIONSHIP MANAGEMENT

STUDY GOALS

On completion of this unit, you will be able to ...

- explain what motivates companies to use CRM systems.
- understanding the goals associated with such a system implementation.
- analyze the main tasks CRM systems undertake in process design.
- outline what an exemplary use of CRM systems looks like in practice.

5. CUSTOMER RELATIONSHIP MANAGEMENT

Introduction

Customer relationship management (CRM) represents a strategic orientation of a company, focusing on the management of customer relationships with either consumers (business-to-consumer) or corporate clients (business-to-business). Thus, customer relationship management always involves managing the overall business relationship, as the long-term retention of customers requires the use of a comprehensive set of tools.

In the context of digital transformation, CRM takes a more central role in the change process, as the use of customer data has traditionally significantly influenced market activities. Customer data forms the basis for customization, and CRM systems must provide functions that, on the one hand, enable the use of large amounts of data and, on the other hand, optimize the business relationship through targeted customer engagement.

Turning a customer into a loyal customer naturally has economic advantages. Therefore, the goal of CRM also aligns with the competitive dimensions of effectiveness and efficiency. In this unit, we will focus on the relevance of CRM by addressing the following questions:

- What motivations can we identify in companies for using CRM systems, and what goals do they associate with them?
- What tasks do CRM systems take on for process design, and what could an exemplary system implementation look like in practice?

5.1 Motivation and Goals of Systems to CRM

CRM is a strategic approach used for the complete planning, control, and execution of all interactive processes with customers. The field of action for CRM, thus encompasses almost the entire company and, as the term "business relationship" implies, the customer life cycle plays a significant role. Conceptually associated with this are **database marketing**, and CRM systems as carriers of CRM functions (Holland, 2018).

Database marketing
This refers to market activities based on detailed customer information.

A purely product-oriented approach hardly leads to advantages over the competition in today's competition since products, even due to the intensification of competition, have become more homogeneous and, therefore, interchangeable. Only companies that have a technology and/or brand leadership in their market environment can still rely on a competition-determining attractiveness of their high-quality products. The market approach of most providers, on the other hand, is determined by their customer and service orientation as a differentiation in competition. Companies are at an advantage whose market environment has always been oriented in this way.

For the German market, the product alone was considered the key to success for a long time, and customer and service orientation took a back seat. However, in the context of new business models, we are now experiencing that customer-centricity is crucial for success in competition. Services “around the product” are often the more profitable part of the offering, especially in traditionally product-oriented business fields where the addition of service components restructures competition and revenue models. This does not mean that the product loses relevance; it means that a certain product quality is expected by customers (Helmke et al., 2017, p. 5).

In our daily practice as consumers, we often wonder to what extent providers actually demonstrate customer and service orientation. We frequently encounter only minimal service quality, seemingly aimed at just preventing a change of provider. We are all familiar with situations like complaints. Endless phone waiting loops, an inflation of email inquiry tickets, and a time-consuming process of forwarding and handover within the internal handling cycle seem more like avoidance and deterrence strategies. However, complaint handling is an opportunity to show the customer that their satisfaction is genuinely at the center of the service delivery (Helmke et al., 2017, p. 5).

CRM is concerned with customer relationships based on comprehensive knowledge of the customer and their processes, which is particularly important in business-to-business marketing. CRM primarily utilizes new technologies and customer-oriented application systems with the aim of achieving maximum customer orientation. CRM is not an isolated instrument but rather a philosophy of market management that needs to be supported by CRM systems on the information and communication technology side for optimal effectiveness. It focuses on

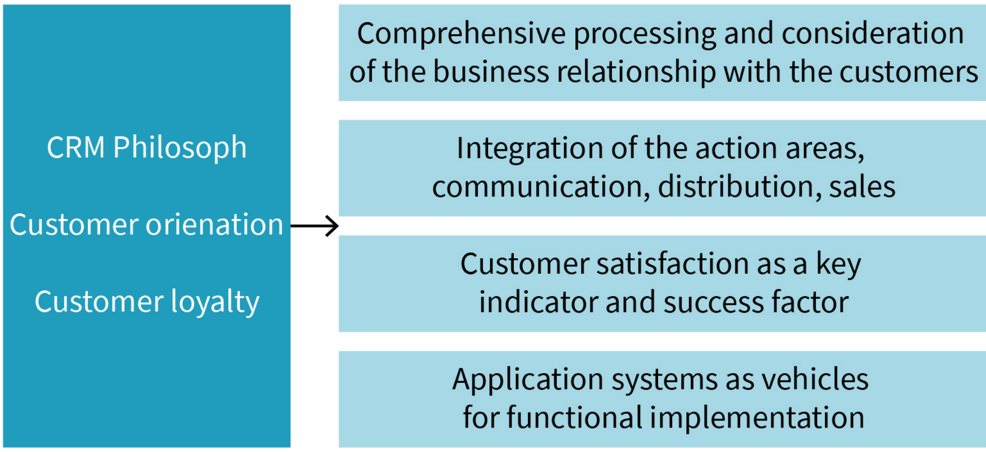
- ensuring the continuity, stability, and intensity of a business relationship.
- reducing acquisition costs.
- acquiring new business relationships through a reference effect of satisfied customers (Holland, 2018).

However, the intensity of customer orientation cannot be maximized arbitrarily, as the additional revenues generated by each measure must exceed the costs of the measure to achieve economic success. Therefore, success must be constantly measured to meet this goal. Inaccurately dosed customer orientation can quickly jeopardize a business model. For example, if machines are provided and supported free of charge for testing purposes during an acquisition phase, but this is not adequately included in the overall cost calculation, the business model may be compromised. Often, many creative ideas are generated without sufficient consideration of their meaningfulness from the customer's perspective. What the provider sees as customer-oriented services often represents unnecessary additional services for the customer. Companies frequently lose sight of their customers' real needs and are surprised when competitors can delight customers with rather simple but new services (Helmke et al., 2017, p. 6).

In summary, we can conclude that CRM aims to intensify the market and, in particular, customer management through the creation of innovative services. This leads to four sub-goals of the CRM approach (Helmke et al., 2017, p. 7):

1. CRM involves a comprehensive approach to a company's customer relationships.
2. CRM aligns the fields of action, communication, distribution, and sales in an integrated manner with customer needs.
3. Customer satisfaction is the central success factor, serving as an indicator of customer retention and, thus, the economic value of CRM.
4. CRM application systems are the carriers of the functional implementation of CRM.

Figure 33: CRM-Views and Parts



Source: Paul Nikodemus (2021).

What is most important is the long-term nature of business relationships with customers. Only lasting customer relationships can lead to increased profits and growth. A good and long-term business relationship prevents customers from immediately considering a provider switch due to price differences. They rely on their experiences and even share them with other potential customers. A business base consisting of many repeat customers can also optimize marketing and its costs. Repeat customers are more loyal and remain loyal to a company even in crisis situations.

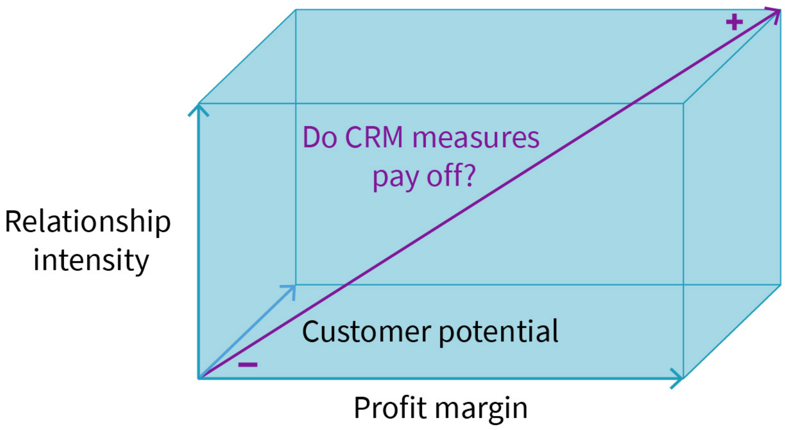
Of course, this only applies if customers also open up long-term revenue opportunities, making it worthwhile to invest in the business relationship, the value of a customer, often referred to in the literature as **Customer Lifetime Value** (CLV).

Customer Lifetime Value
The CLV is the customer value that represents the profitability of a business relationship over time and can be calculated using net present value methods, for example.

If a company wants to shape a business relationship in this sense, it generally requires an evaluation of customer relationships so that distinctions can be made between profitable, high-potential, unprofitable, and low-potential customer relationships. While an evaluation of the transaction potential of a customer relationship assumes the discounting of all expected future inflows and outflows to a reference point, non-monetary variables can also influence customer value. These include reference, information, cooperation, and synergy potentials, which represent relational potential and also result from the customer relationship.

The following figure shows how the question of the feasibility of CRM measures can be answered depending on customer potential, the intensity of the business relationship, and contribution margin. The red line in the three-dimensional representation indicates increasing or decreasing feasibility ("+" / "-"). Therefore, it is understandable that CRM measures tend to be worthwhile, especially when there is a prospect of a longer-term business relationship (intensity), an exploitable monetary and/or non-monetary potential exists, and the transaction revenues exceed the costs of CRM measures (contribution margin).

Figure 34: CRM and Customer Value



Source: Paul Nikodemus (2021).

Justifying the strategic implementation of the CRM philosophy, even if the costs are currently reasonable, is essential. The previous explanations have provided sufficient guidance in this regard. In summary, the motivation for implementing customer relationship management can be well-supported with the following statements:

- Consumers and business customers are becoming increasingly demanding.
- Customer needs are becoming more heterogeneous.
- The effectiveness of mass communication/advertising is decreasing.
- The product as a core service inadequately contributes to differentiation.
- Business relationships do not automatically remain stable.
- Acquiring new customers is becoming increasingly complex.

In the penultimate figure, the systems perspective is separately highlighted because a CRM system provides the necessary functional, information, and communication support in the context of customer relationship management. The purpose of system implementation is primarily to handle relationship management tasks more efficiently and with higher quality. Customer data is more effectively organized and utilized.

In this context, CRM systems support tasks in marketing, especially in sales and service. They form the foundation for the practical implementation of customized customer interaction (Helmke et al., 2017, p. 7). Managing customer data and analyzing it for targeted utilization within internal market processes, as well as for maintaining and enhancing competitiveness, are, from the perspective of information management, the defining tasks within the CRM domain. Key tasks in information management include the following (Helmke et al., 2017, p. 8):

- simplifying day-to-day operations (process optimization)
- rapid analysis of large volumes of customer data
- customer data integration and distribution
- automation of CRM processes

Information and communication processes can be effectively supported, particularly through workflow and groupware technologies, when intelligent database systems are used. These systems facilitate automated data flow among process participants. Unfortunately, this ideal scenario of customer-oriented information processing is not universally implemented in practice. Quantity often takes precedence over quality, with customer data dispersed among poorly integrated and differently organized sources. Poorly organized customer data leads to an information overload that the sales organization cannot efficiently manage.

Efficiency and effectiveness both decrease when system implementation lacks acceptance, rendering the information unused. Data's value must be systematically realized to build knowledge relevant to customer purchasing decisions and make it available in processes to enhance customer satisfaction. Information management must ensure that the collection and processing of information is goal-driven, derived from the CRM philosophy. Consequently, this strategic approach is operationally continued in the design of corporate application systems (Helmke et al., 2017, pp. 8–9).

5.2 General Tasks of CRM

The functionalities of CRM systems primarily aim to achieve four objectives, which can be pursued individually or in combination, irrespective of the application area. These objectives are as follows:

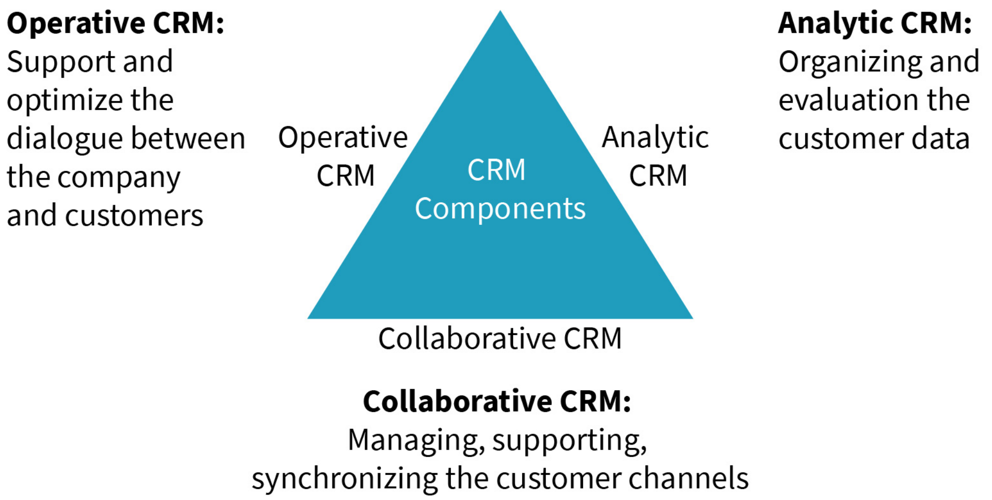
- generating innovative product bundles for customers
- optimizing business processes in customer relationship management
- enhancing the processing and analysis of customer data
- wupporting the marketing toolbox

To implement these objectives, CRM systems integrate multiple application components, which account for their wide range of capabilities. These components encompass customer databases, workflow functionalities, and data mining tools for analyzing relationships within customer data. The breadth of functionality is evident when considering the large number of CRM software providers. In their “CRM Software Comparison, 2021,” CRMmanager, a German web portal on CRM, lists 86 CRM software providers for various application areas, industries, and company sizes.

The following figure outlines the CRM components and their functional subareas, categorized into three forms:

1. Operational CRM
2. Collaborative CRM
3. Analytical CRM

Figure 35: CRM Components



Source: Paul Nikodemus (2021), based on Helmke et al. (2017, p. 11).

Operational CRM

Operational CRM functionalities include applications that support direct customer interaction. These functions are designed to enhance the dialogue between the customer or customer organization and the company, as well as the underlying business processes. CRM processes in the background, such as the workflow for complaint management, generate the information needed to effectively conduct these customer interactions. To achieve process and data integration, powerful interfaces to other systems, such as enterprise resource planning (ERP), must be implemented.

Analytical CRM

Functionalities of analytical CRM include applications for data organization, such as data collection and application-oriented analysis of customer data with the goal of shaping campaign management or optimally identifying target groups in the market. The knowledge gained in this way drives internal business process design. An important and systematic basis for analytical CRM is a data warehouse containing relevant customer data. The proximity to business intelligence (BI) systems is not surprising, and the concepts of data warehouse and data mining, which are common in BI, are also important design components of marketing intelligence, as the integration of CRM and BI is often referred to.

Collaborative CRM

The functionalities of collaborative CRM include applications for the overall control, support, and synchronization of the communication channels used to connect with customers. These channels encompass traditional methods like telephone and fax, as well as modern digital channels such as the internet with websites and social media, email, mailing campaigns, field service management, and more. These channels are operated to ensure that communication is as efficient and effective as possible. An essential component in this context is the customer interaction center (CIC), serving as a multimedia communication hub (Helmke et al., 2017, p. 11).

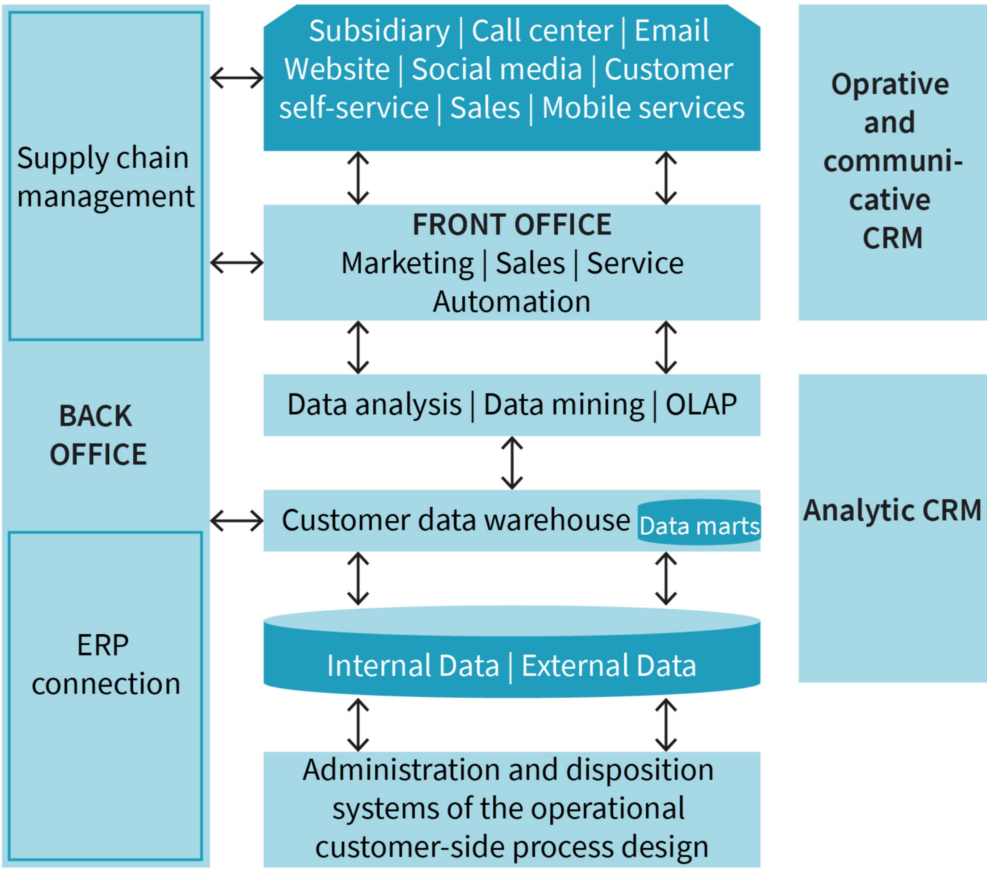
Given the increasing importance of social networks in a company's marketing efforts, the term “Social CRM” has been established for the enhanced utilization of this interactive and communication medium.

The explanations regarding the CRM components make it clear that the “goal of improving the quality of customer relationships through value-focused, differentiated customer management” (Holland, 2018, p. 0) requires CRM software and appropriate technologies to provide a comprehensive representation of customer profiles. Only in this way can information be consolidated and made available, and only through integrated information systems can the associated processes be equally effectively and efficiently designed. Thus, the use of CRM is economically justified because it leads to an optimization of the relationship between revenues and costs for process and system efforts (Holland, 2018, p. 0).

The measures resulting from the CRM approach for information management are quite demanding and often go beyond the usual scope for application systems. One example is Multi-Channel Management, which not only includes the operation, (i.e., the coordination of existing communication channels but also the configuration of these connections), which also presents a technical challenge and must be able to handle the integration of new channels. Due to the requirements for data storage and the number of external users, financial expenses for new hardware and software components are usually necessary, which can significantly increase the overall expenditures for information and communication technology.

The typical system architecture for CRM today is illustrated in the following figure. It shows the three functional categories of CRM with the system components and the relationships between the partial application systems, such as SCM and ERP integration. This figure demonstrates how CRM software and technologies are integrated to manage customer data and relationships effectively, helping businesses provide better value and customer experiences. The use of such systems can be financially justified by optimizing the balance between revenue and the costs associated with managing these processes and systems.

Figure 36: Architecture of CRM



Source: Paul Nikodemus (2021), based on Hilbert (2020).

Other important parameters that influence the functionality of CRM systems include (Helmke et al., 2017, p. 12):

- the type of customer relationship (e.g., business-to-business or business-to-consumer)
- the number of customers
- the volume of revenue
- the frequency of transactions with customers or businesses

These parameters help shape the tasks within the three CRM components, complemented by the planning and control phase. These tasks can be categorized into strategic, tactical, and operational questions, as summarized in the table below (Helmke et al., 2017, p. 13).

Table 7: CRM TASKS

	Time Frame		
Phase	Strategic	Tactical	Operative
Planning	Which measures should be taken to address customer needs?	How should budgets be allocated to the instruments? How to design the processes?	Who is suitable for which measures?
Analytics CRM	Which customer data are to be collected for what purpose?	To whom should customer data be forwarded? How should the data be structured?	Which methods should be used to analyze and prepare customer data?
Operative CRM	Which instruments are suitable for meeting which needs?	How should the instruments be coordinated? How should front and back-office processes be implemented?	Who carries out which measure? When, how, and with what is each measure carried out?
Collborative CRM	Which contact channels are suitable for measures and customer structure?	How should the contents be conveyed? What does harmonization look like?	Which staff is assigned to which channel?
Control	To what extent are the identified customer needs met?	How successful is CRM? Which methods and metrics should be used?	Who receives which reports? How often and with what tools are data analyzed?

Source: Paul Nikodemus (2021), based on Helmke et al. (2017, p. 13).

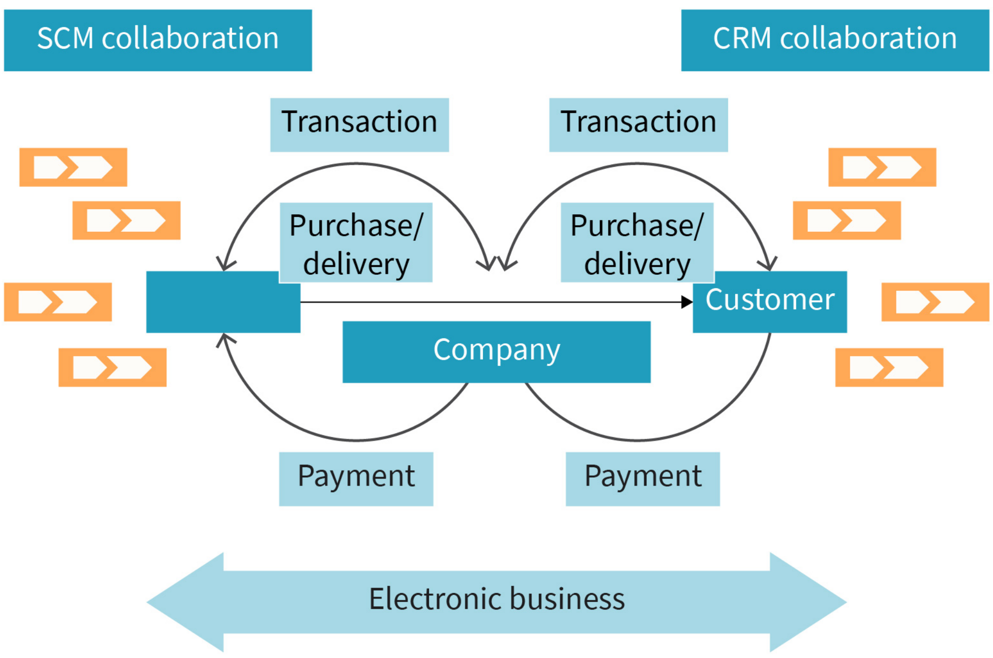
The interaction of CRM components can be illustrated using an example from the banking sector. A bank wants to expand its securities investment business for private customers. First, it needs to analyze the importance of these customers for its current business success. Additionally, the bank assesses the potential that can be attributed to this area in the future. To do this, the bank conducts an ABC analysis based on account transactions.

What matters are the customers who currently have a B or C status but have an A status in terms of potential. It can be assumed that committed investors (A status) today will also make investments in the future. For new business, the interesting categorizations are those where the actual and potential status differ, for example, a B/C status for the actual and an A status for the potential. In this case, a face-to-face advisory meeting is a suitable channel choice. For other combinations, such as C in the actual and B in the potential status, a “cheaper” instrument, like a call center, should be selected due to limited capacity (Helmke et al., 2017, p. 14).

This example demonstrates that instrument selection must initially be determined at the conceptual level (ABC analysis, channel selection). The acquisition of CRM software cannot replace this, as the right approach to problem-solving requires an analysis of processes and requirements for instrument usage. CRM software does not replace a CRM philosophy. In the context of data science and big data, a trend toward analytical CRM functionalities can certainly be identified.

The integration of SCM and CRM applications is also likely to occur more frequently in practice within the framework of integrated process organization, especially since major ERP system providers include SCM and CRM functions as part of their functional portfolio. The following diagram shows this process integration, where the company is a partner within the supply chain for its supplier but also an object in the supplier's customer relationship management. The company's CRM collaboration can be seen as the opposite process.

Figure 37: CRM–SCM Process Integration



Source: Paul Nikodemus (2021).

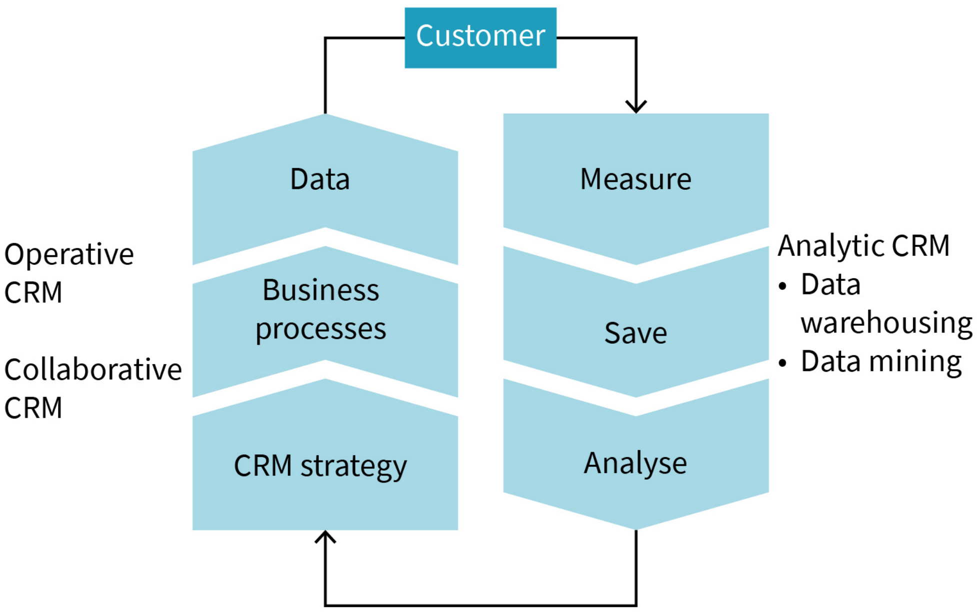
One of the most successful providers of CRM solutions is the company Salesforce. The CRM platform Customer 360 covers various industry applications, including sales, service, marketing, online and offline commerce, IT integration, and analytics. In addition to traditional CRM functions for market and customer management, it also offers integration solutions for app integration and extensive analysis capabilities through AI software. According to the company, they use this platform in various industries, including (Salesforce, 2021)

- automotive industry
- energy providers
- non-profit organizations
- consumer goods
- life sciences

- logistics
- media
- travel industry
- telecommunications
- retail
- mechanical engineering
- banking and insurance
- public sector

The functional areas included in the mentioned platform clearly indicate an overlap between CRM and business intelligence. This overlap is rooted in the CRM philosophy, where the core of the conceptual structure is the analysis of customer data. This naturally leads to the utilization of tools such as data mining techniques, which, with suitable user interfaces, allow for the recognition of detailed relationships within the data organized through data warehouse technology. This data analysis is then used for fine-tuning marketing activities from a process perspective (see the following figure).

Figure 38: CRM and "Closed Loop"



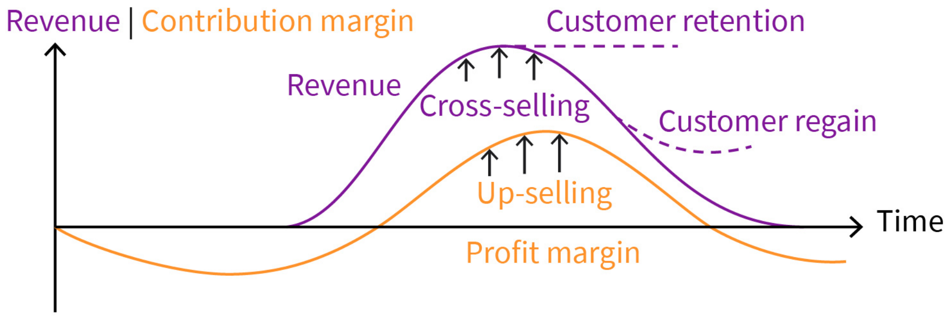
Source: Paul Nikodemus (2021).

This involves a kind of optimization within a closed-loop system, as the data resulting from CRM activities and business processes are stored in the data warehouse and can be evaluated through suitable analysis methods. The insights gained are then used to optimize the CRM strategy, which, in turn, leads to further fine-tuning of customer-side processes and activities. Due to its closed-loop nature, we refer to this as the Closed-Loop System of CRM.

In addition to the purely functional perspective, we must also consider the dynamics of the customer relationship and the functional focuses in CRM at different phases of relationship management. Customers typically have different needs, and there is no fixed recipe for managing a customer relationship. However, there is a customer relationship life cycle, which can be compared to the product life cycle. In this life cycle, revenue does not follow a linear path over time but has ups and downs. Consequently, customer management must also vary accordingly. The following figure illustrates an idealized life cycle with five characteristic phases, each with a different specific course but with the following characteristics (Preissner, 2016):

1. In the selection phase, the focus is initially on a company's offerings and the customers for whom these offerings represent solutions to their problems. Relevant here are the customers for whom there is revenue potential for the company and for whom relationship management is worthwhile and should be pursued.
2. In the acquisition phase, a provider needs to clarify the prerequisites for a business relationship and how it can be concreted based on customer expectations.
3. In the maintenance phase, the company must continuously maintain its attractiveness and stabilize and/or enhance customer satisfaction. The quality of the business relationship is the central focus here.
4. In the reactivation phase, the provider must attempt to win back lost customers or rekindle the customer relationship.
5. Only in the termination phase does the question arise to what extent the company may need to part ways with customers for whom managing the relationship no longer leads to business success. Due to the dynamics of business operations and the volatility of competitive situations, this issue must be handled very carefully.

Figure 39: CRM Measures and Customer Life Cycle



Selection phase:	Acquisition phase:	Maintenance phase:	Reactivation phase:	Termination phase:
• Analyze the market and obtain contact • Determine transaction • Relationship potential • Build awareness	• Perform requirement analysis, gather requirements • Acquire new customers • Generate test buyer • Build and establish trust	• Customer satisfaction management • Assessment of potential of customers • Complaint management • Customer retention management • Cross/ up-selling	• Recognize customer migration • Regain lost customers	• End unprofitable customer relationships

Source: Paul Nikodemus (2021), based on Preissner (2016).

The figure illustrates the phases over time and the typical actions that are suitable for each CRM phase, which should also be functionally supported by application systems.

In conclusion, we can state that CRM systems are likely to continue evolving in terms of functionality in the future. Digitalization, in particular, offers a fertile ground for development in this area, given the traditionally high level of information and communication technology integration. This makes it easier to establish new business model approaches at the customer interface. The potential for the application of CRM measures is expected to increase further. However, the provider landscape is already quite extensive, which could lead to consolidation in the future, as not all software manufacturers may have the financial resources to keep up with the pressure for innovation. Process integration, in particular, requires extensive knowledge of business value chains, knowledge that can mostly be provided by large providers and consulting firms.

In the future, customer orientation is expected to become even more critical as international competition intensifies this demand. Only by aligning their market activities even more closely with customer requirements will companies be able to achieve significant success.

5.3 Example Scenario for the Use of CRM Systems

The following application example illustrates how the integration of business processes can make assortment planning in retail more intelligent and faster

Company and Challenge

The eurotrade Flughafen München Handels-GmbH is a wholly owned subsidiary of Flughafen München GmbH and has been operating approximately 40 retail stores with around 14,000 square meters of sales space at Munich Airport since 1973. The sales area is divided into duty-free, fashion, press and travel necessities, and watches and jewelry.

In addition to products from well-known international manufacturers, the company also offers private labels and regional products and operates sales outlets in the **franchising** format (Munich-Airport, 2021).

Franchising
This is a distribution system based on the cooperation of a company with a licensee.

The background of the case description is the typical situation at airports, where waiting times for travelers and flight delays cannot be avoided. It is understandable that local retailers are keen for travelers to use these times for shopping. The company eurotrade wants to leverage the possibilities of digitization to enhance the shopping experience for its customers on the one hand and, on the other hand, to increase its sales (Avanade, 2021, p. 2).

The retail company had problems adequately incorporating technological progress into its own business model. With a wide range of products from local producers, including chocolate, books and magazines, to cosmetics and textiles, it was difficult to get an overview of the success of individual product categories and the specific demand for goods.

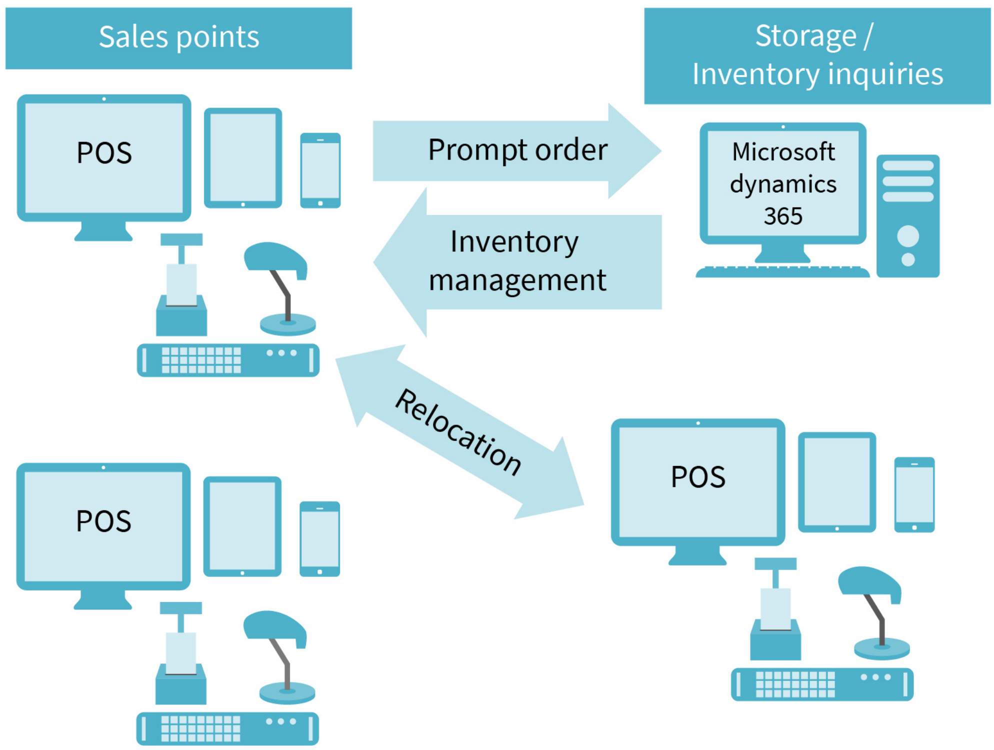
In addition, the existing information systems for sales and inventory management were insufficiently integrated, and as a result, a large part of the processes could not be automated, but only with the help of organizational and manual intermediate steps and preprocessing. As is common in retail and similar problem situations, the technical and organizational deficit was compensated for by an increase in personnel, which jeopardized profitability in the long run. It was evident that better integration of information processing could be achieved by implementing an ERP system, thereby simultaneously increasing revenue and customer experience (Avanade, 2021, p. 2).

Process Integration as a Solution

Together with a consulting company, a selection process was initiated to find a suitable ERP solution that fits the problem situation. Microsoft Dynamics 365 was identified as an application that could migrate to the three existing inventory management systems, thus creating an integrated and uniform platform for finance and warehouse logistics. Additionally, supplementary functions for supplier management and bank automation for optimized payment processes were added to establish a modern business process landscape. With the new digital features, sales staff can now react more quickly to current developments, reorder goods, or provide customers with relevant information, as they now have access to the system via tablet and smartphone. This ensures that inventory information is up-to-date and can be queried. Furthermore, goods arrive on time and in sufficient quantity at the sales outlets and, therefore, to the customers (Avanade, 2021, p. 2–3).

The integration of the point-of-sale (POS) and the ordering system is now optimized, allowing, for example, employees in the sales outlets to initiate a reorder of perfume testers via an app by sending a message to the warehouse with the item number, which is scanned using a barcode. Due to the regional distribution of sales outlets, it is common for an item to be missing in one location but available in another. Sellers can inquire online from any sales outlet whether a specific item requested by the customer, such as textiles in a certain color or size, is available in another sales outlet. The customer's request can often be met accordingly (Avanade, 2021, p. 3). The following figure provides an overview of the entire application.

Figure 40: Eurotrade Process Integration



Source: Paul Nikodemus (2021).

Results and Process Improvements

The achieved process integration serves as the foundation for 17,000 transactions at 148 sales points in the company's retail locations. The user identifies specific benefits as follows (Avanade, 2021, p. 3):

- The relief of staff in the retail locations provides more time to offer intensive customer advice and service, which is a prerequisite for increasing sales.
- The increased transparency of the assortment and product availability across sales points, for example, for re-orderings and relocations, enhances service delivery and customer orientation in sales.
- The automation of processes reduces operating costs.
- The creation of analyses and summaries in purchasing is accelerated.

The gained transparency, consistency, and accuracy in inventory management help continuously optimize inventory control. The integration of the new ERP system, Microsoft Dynamics 365, into the existing system landscape ensures active management of the assortment and stocks. The now possible evaluations show which sales point needs which product and when. The investment aids in improving process quality, lowering costs through automation, and thus increasing customer orientation. With the new tools, the company can supply customers with the requested products and provide higher service orientation with additional features (Avanade, 2021, p. 3).

The example illustrates how the introduction of new systems can enhance operational business. The potentials embedded in the ERP system also increases customer orientation because inventory management and service functions can be ideally linked. Process integration thus demonstrates how the improved customer relationship management, in line with a CRM philosophy, can have significant effects even in medium-sized companies.

The use of mobile components, enabling ad-hoc queries and service functions in sales and inventory management through apps, represents an entry into collaborative CRM based on broader process integration in the operational domain. Simultaneously, improved analyses can make the success of customer relationship management measurable through analytical functions. Here, flexibility is now available to establish additional functions to promote lucrative business relationships. In collaboration with other stakeholders in aviation, entirely new potentials can be unlocked.

SUMMARY

With customer relationship management (CRM), companies aim to optimize the interfaces to their business customers through relationship management. A prerequisite for this design area is a rational and comprehensible goal setting, along with a derived strategic anchoring of a CRM philosophy with the basic principle of a strong market and customer orientation. Business relationships are continuously processed and developed to increase the customer lifetime value (CLV) and thereby ensure the long-term economic success of the company. CRM systems provide support for this process design, allowing companies to intelligently manage and utilize customer data.

CRM systems offer a range of functions that focus on three areas, simultaneously serving as CRM components that constitute the conceptual side of system deployment. Operational CRM encompasses all functions that support work in business operations with customers. Collaborative CRM represents functions that mainly result from the tasks of steering and operating various connection channels (channels) to and from customers, while analytical CRM includes functions that enable the evaluation of customer data using specific analysis methods, with the results optimizing process design. Since this optimization occurs continuously in the form of a feedback loop, we refer to it as a closed-loop system of CRM. Thus, CRM systems can be categorized in information management, supporting processes for marketing and its instrument deployment.

In the context of digital transformation, CRM systems are crucial elements for the evolution of business models. They are already based on sophisticated IT infrastructures, and their network capability allows integration up to coupling with supply chain mnagement (SCM) systems. Regarding developments in data science and big data, they are also relevant players, as customer data is typically an object of data scientific investigation to improve sales and marketing.

Marketing intelligence and social CRM are terminologies that highlight the close connection of CRM systems to business intelligence (BI) and the utilization of social networks as an interaction and communication medium. Companies can enhance their service by leveraging insights from marketing derived from data obtained from customers in social networks. This underscores the relevance of CRM for the ongoing development of company activities at the interface with their customers.

The example scenario illustrates that even with the introduction of better process integration through suitable system deployment (ERP), a significant step towards improved customer orientation can be taken. The enhanced processes lead to an increase in the company's service orientation, and new features can enhance customer satisfaction and loyalty.

UNIT 6

MANAGEMENT INFORMATION SYSTEM

STUDY GOALS

On completion of this unit, you will be able to ...

- explain how analytical information systems operate and where they are employed.
- understanding what information structures look like from a management perspective.
- explore how exemplary use of management information systems is configured in practice.

6. MANAGEMENT INFORMATION SYSTEM

Introduction

The information and knowledge society primarily relies on an optimized organization of the daily information flow to make the right decisions in the management of process landscapes with the knowledge generated. This is especially true in the field of business, where, on the one hand, the volume of data constantly grows due to transaction volume, and on the other hand, decision situations demand increasingly short-term actions due to the intensity of competition.

To solve this dilemma, suitable information systems must be implemented to provide management with decision-making knowledge for timely and contextually appropriate actions and reactions in competition and market management. These management information systems are computer-assisted information systems for collecting and processing important company information, based on which analyses can be performed, problems solved, and strategic decisions made. In this lesson, we will focus on them by addressing the following questions:

- How do such analytical information systems operate, and what purposes do they serve?
- What do their information structures look like from a management perspective, and how can we describe an exemplary use case?

6.1 Analytical Information Systems and Their Applications

Today's competition confronts all actors in the market with the challenge that, as complexity increases and conditions change more rapidly, the demands on the production factor of information continue to rise.

Decision Support Through Data Analysis

The available data must be organized in such a way that information, and ideally knowledge, can be generated from it for decision-making. Only through comprehensive information management can it be ensured that the information and knowledge required for process design are available timely and in the necessary quality, both temporally and spatially. The development was initially characterized by adequately supporting operational business process components through information systems.

This is largely possible up to real-time behavior in transaction control and special forms of system integration, and now the focus of implementation is shifting more towards decision support, and thus, from the organizational perspective, towards the user group of specialists and executives in companies. Nowadays, there is an information demand among executives at almost all levels and areas of companies to use information and knowledge for the benefit of the company in the competition dimensions of efficiency and effectiveness. It is the task of information management to create the necessary organizational and technical access and thus strengthen the decision-making ability of the acting individuals (Gluchowski & Chamoni, 2016, p. 4).

Classical decision support systems are characterized above all by their flexibility regarding the usable analysis and evaluation methods and models for data organization and result presentation. However, this flexibility is usually achieved at the expense of user-friendliness since explicit expertise is often necessary for system use to maximize runtime behavior (Hansen et al., 2019, pp. 320–321).

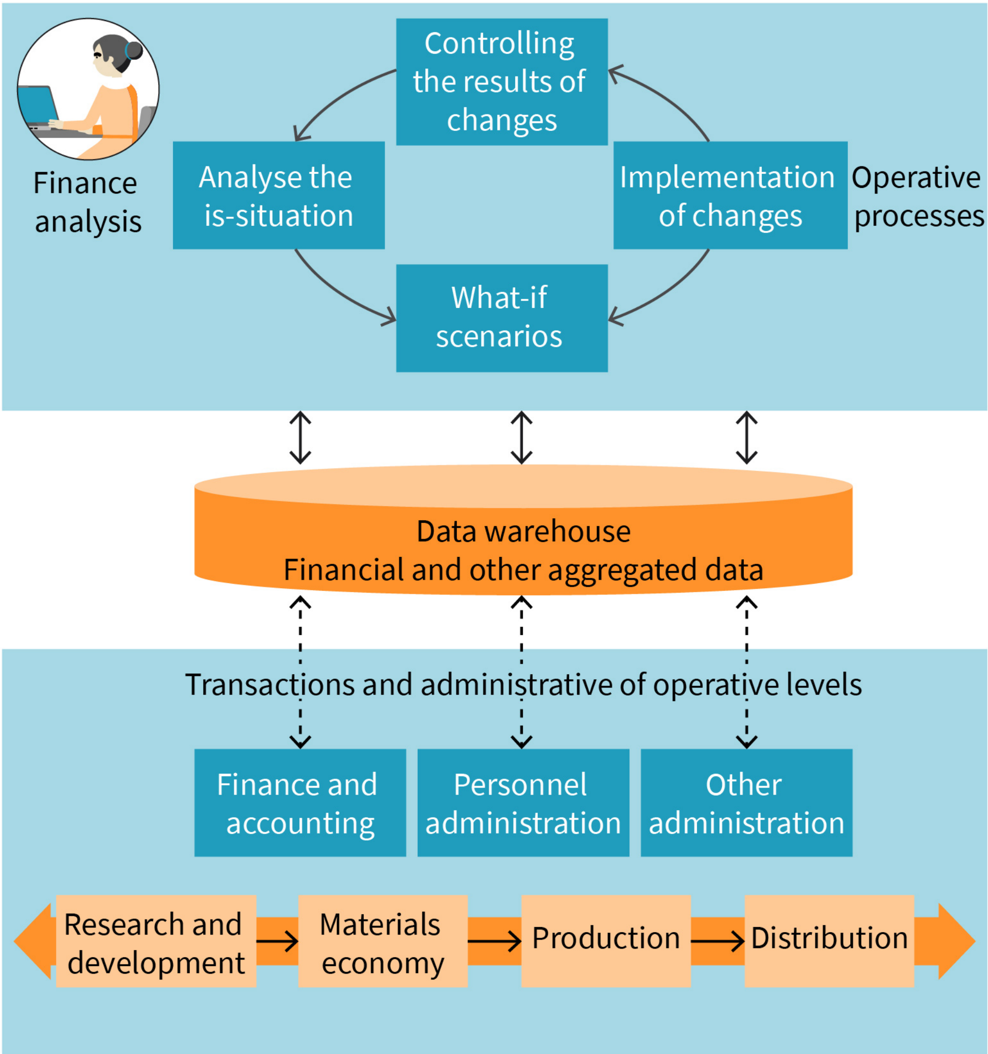
In contrast, analytical information or application systems can be classified at the operational level, where they are often a functional component of ERP, SCM, or CRM systems. Here, the analysis and evaluation methods and models, as well as the manner of result presentation, are more strongly determined by the existing operational data basis. The methods, models, and data determining the decision situation, for example, for measuring the efficiency and effectiveness of performance processes, are configured in module form. Analytical application systems are thus “pre-made solutions, usually integrated into ERP and externally visible information systems, to support specialists in specific operational and tactical decision-making processes” (Hansen et al., 2019, p. 321).

Business Analytics

The proximity to the operational applications of day-to-day business also led to the term “business analytics” for these analytical application systems, especially for the corresponding analysis functions in CRM or SCM (Hansen et al., 2019, p. 322). In connection with the constantly growing amount of data, the term “big data analytics” is often used today to address the fact of analyzing large amounts of data for decision support, also through terminological representation.

However, in addressing this topic, we cannot limit ourselves only to information and communication technological aspects but must also consider business, organizational, and strategic concerns (Gluchowski & Chamoni, 2016, p. 5). The following figure shows an exemplary example of the components of such an analysis system for corporate finance and accounting.

Figure 41: Components of a Finance Analysis System



Source: Paul Nikodemus (2021), based on Hansen et al. (2019, p. 323).

The basis of financial analysis is finance and accounting with its data, which are evaluated for the creation of an actual analysis and as a basis for operational planning. The analysis provides evaluations of the current financial and earnings situation of the company with a focus on effectiveness measurement as a prerequisite for decisions on possible improvements. Analytical planning then primarily refers to resource use through the use of forecast models and "what-if" scenarios, which are already available as ready-made functions. Questions about resources (quantities, costs) and the effects of changes on liquidity or the budget can thus be answered. This holistic view with simulations based on aggregated data leads to traceability of changes in the system in real-time (Hansen et al., 2019, p. 322). The main areas of financial analysis are as follows (Hansen et al., 2019, pp. 322–324):

- Financial success, expressed through key figures for productivity, profitability, and cash flow through target, actual, period, time, and operational comparisons.

- Cost structure, expressed through primary and secondary costs, the relationships between costs and other variables, and cost control through comparison.
- Expenditure cycle, expressed through the order process, conditions, contracts, payment methods, cash management, and control of critical expenditure categories.
- Revenue cycle, expressed through order processing, phases of sales processing, cancellations, returns, etc., and their effects on other variables.
- Payment transactions with customers, expressed through customer analyses, incoming payments, payment default and liquidity risks, as well as pricing and discount policies and the effectiveness of dunning.
- Payment transactions with suppliers, expressed through supplier analyses, outgoing payments, payment terms, and the use of discounts and cash discounts, as well as the identification of irregularities in booking.

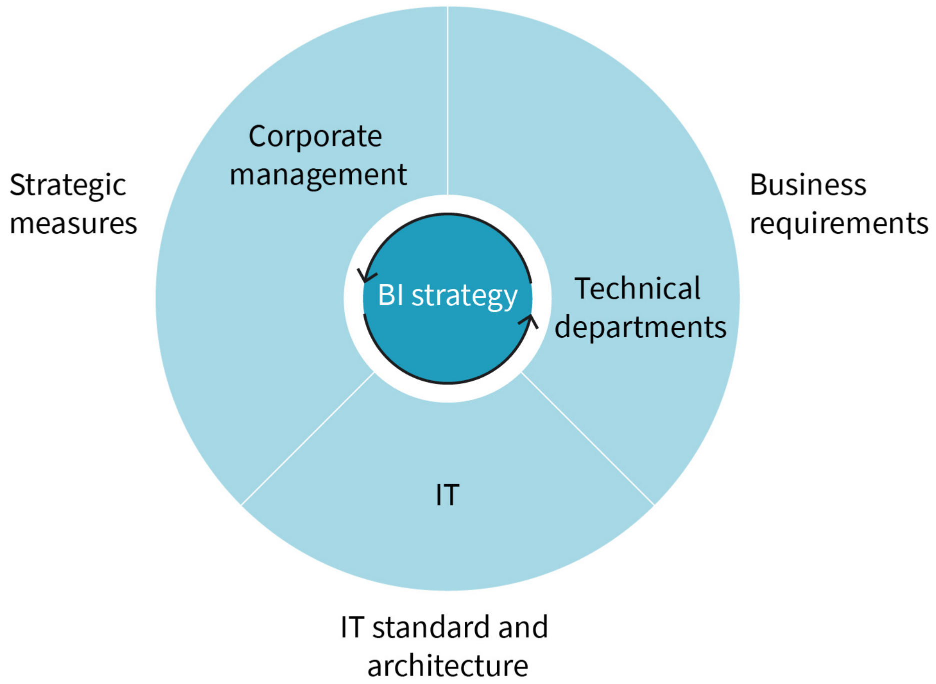
The listing also confirms that analytical information systems are “the logical complement to operational information systems,” as the data basis from operational business processes is an indispensable prerequisite for the analyses (Gluchowski & Chamoni, 2016, p. 7). This special connection of the analysis and evaluation side with the processes of operational business and their optimization also justifies the conceptual proximity of business analytics and business intelligence (BI), as it is precisely this type of intelligent process design that makes system usage seem very meaningful. Providers of analytical application systems often link the two concepts, as SAP does, for example, with SAP Analytics Cloud in conjunction with SAP business intelligence. Therefore, it is not surprising that important trends have been observed in the field of BI in the last ten years (Gluchowski & Chamoni, 2016, pp. 34–35):

- Big data: Analysis and evaluation of large amounts of data of different structures.
- New storage concepts: Main memory-based data storage (in-memory databases) and thus extremely short response times (real-time behavior).
- Cloud BI: Services or functionality for BI from the cloud.
- Mobile BI: Analysis and evaluation of data on mobile devices.
- Self-service BI: Simple functions, such as user adjustments to the data model.
- Agile BI: Iterative project approach in development cycles.

However, a prerequisite for successful BI implementation is a matching strategic positioning of business analytics and BI through the design of three fundamental core tasks, as also evident in the following figure (Gluchowski & Chamoni, 2016, pp. 39–41):

1. First, there are the professional requirements as the actual purpose of BI. The business design methods must be analyzed concerning their effects on BI application. For this purpose, information demand and supply are compared so that each user, within the strategic BI placement, can explain their needs in line with corporate goals. Information needs that cannot be justified have no or lower priority.
2. The second core task relates to the IT standards and architecture of the application landscape. Its processing must take into account the specific characteristics of BI.
3. In the third field of action, the strategic measures of corporate management and organization must be designed to avoid inconsistencies in structure and process. For this, cross-departmental collaboration and departmental cooperation, including IT areas, must function well.

Figure 42: BI Strategy and Operation Areas of Action



Source: Paul Nikodemus (2021), based on Gluchowski & Chamoni (2016, p. 51).

The definition of a BI strategy results in a concept for information supply, which defines the company-wide standards and thus also determines the projects that are to be carried out in the future to implement the strategy elements. However, this is not static but is constantly questioned and, if necessary, dynamically adapted to new requirements. Therefore, the strategy work in connection with business analytics and BI should be understood as a process (Gluchowski & Chamoni, 2016, p. 52).

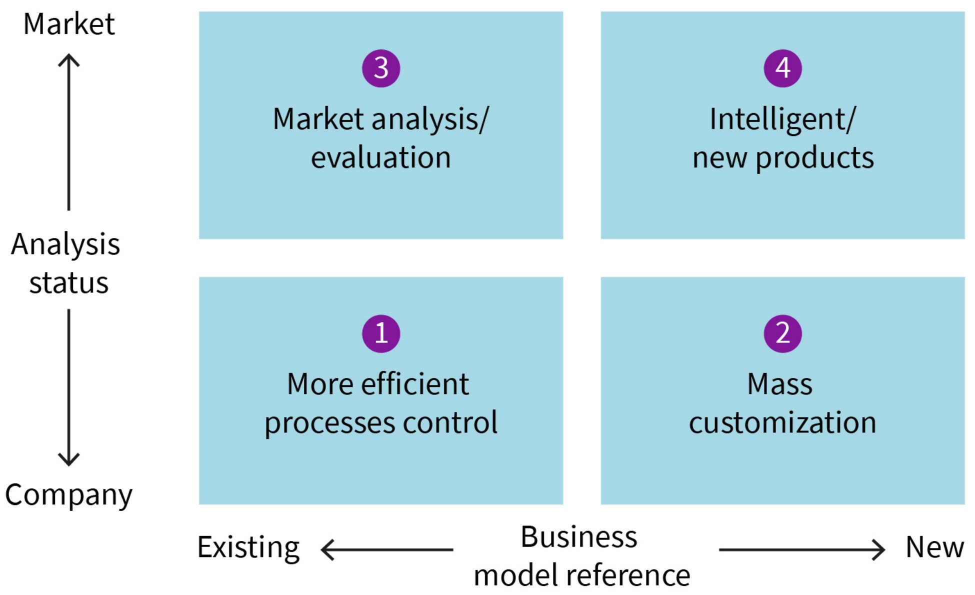
Data Analysis and Big Data

In the context of data analysis, the term big data is frequently mentioned. On the one hand, we associate the analysis and evaluation of large data volumes with the discovery of valuable insights, extending to new business model approaches. On the other hand, the transparency of consumer behavior associated with it is perceived as a risk by many. Besides data volume (Volume), the variety of data formats and structures (Variety), and processing speed (Velocity) also play a significant role (Gluchowski & Chamoni, 2016, pp. 55–56). “Considering the outlined characteristics, big data refers to methods and technologies for highly scalable integration, storage, and analysis of polystructured data” (Gluchowski & Chamoni, 2016, p. 56).

Despite the emphasis on the mentioned properties (the three “Vs”), big data is only a specific field of application of this analytical information processing, as most companies have been integrating administrative and dispositive data from various information systems for some time and creating analyses based on them, as we have already conceptually classified with business analytics and business intelligence (Gluchowski & Chamoni, 2016, p.

57). In discussions, however, this connection is not always seen so closely, as BI applications are more commonly associated with the analysis of data stored in a data warehouse from the past, while big data is thought of in the context of future-oriented digital business models and digital transformation. The following figure illustrates this view of the big data topic in terms of application areas, encompassing the dimensions of competition, efficiency, and effectiveness, but also expanding the perspective from the company and its process design to a comprehensive market analysis for finding new business opportunities and models.

Figure 43: Application Areas of Big Data



Source: Paul Nikodemus (2021), based on Gluchowski & Chamoni (2016, p. 59).

In the first area (1), the focus is on use cases that aim to improve the efficiency of the process landscape through big data. The existing business model is not changed but further developed through big data technologies. For example, sales forecasts are improved, subsequently optimizing resource usage. In the second area (2), the emphasis is on use cases that enable mass individualization through big data. The transition from the first area can occur, for instance, by improving customer-related performance processes to better accommodate individual needs.

In the third area (3), we find use cases that involve a more extensive consideration of different market participants. This is done through more intensive market analyses, but the connection to the existing business model remains. Examples include analyses of brand and/or product perception or recognizable market trends. The fourth area (4) concerns use cases related to new and innovative products, where big data stands primarily for the comprehensive consolidation of data sources, resulting in information about the potential of new bundles of products and services. New business models, such as through networking with other market partners and the associated tapping into new customer groups, can be generated (Gluchowski & Chamoni, 2016, pp. 59).

NoSQL
This is a method of data organization that is suitable for very large datasets, especially in big data scenarios.

In-memory technologies
Such technologies utilize the random access memory (RAM) of one or more computers as data storage

To implement these big data applications, classical technologies of business analytics and BI are mainly extended with hardware and software components that can handle the challenges and demands of big data. An example is **NoSQL** databases (Not-only-SQL databases), which, in contrast to widely used relational database systems, allow the processing of data of different structures. In conjunction with **In-Memory technologies** where a data set to be analyzed is held directly in the main memory of a computer, large data volumes can also be evaluated in real-time for decision support. Application examples can be found in price information systems on the Internet when trying to find the most cost-effective provider for a specific demand. Also, popular search engines rely on such procedures due to the requirements for search speed.

Thus, big data, on the one hand, offers significant opportunities as a driver for new application areas and the resulting options for new business models. On the other hand, big data also expands the classical toolkit of business analytics and BI through additive methods and technologies (Gluchowski & Chamoni, 2016, p. 64).

The important functional areas that can be mentioned for analytical information systems are (Gluchowski & Chamoni, 2016, p. 64)

- data presentation and analysis,
- data storage and provision, and
- data integration and preparation.

The task of data integration is to organize the data transfer between the operational and other source systems and the data storage systems of analytical information systems. Data is extracted cyclically from source systems, processed, and transferred to a data warehouse or another data store, for example, based on NoSQL databases. For real-time control, real-time integration is feasible, with data being transmitted immediately after its generation in the operational system.

If plan data is generated in the data warehouse, the data integration layer can also be used to transfer it to the source systems. Software components, usually data access components, are typically used for this, supporting the transfer and preparation of data. In addition to the functions integrated into the analysis systems, separate integration tools can also be used for this purpose, which are integrated via interfaces as add-ons (Gluchowski & Chamoni, 2016, pp. 105–107).

The storage of decision-relevant data occurs in databases specifically built for this purpose and is usually organized in a data warehouse. This concept is primarily suitable for the storage of structured data. To meet the demands of data analysis, database systems that can serve this purpose well can be used. They are characterized mainly by high query performance. To differentiate between function- or department-specific data areas, the data warehouse is structured into data marts. For example, financial data can be evaluated multidimensionally in a data mart.

The optimized data infrastructure aims to enable very fast analyses and evaluations. This behavior is achieved through Online Analytical Processing (OLAP), which can be implemented on the software side. To analyze multi-structured data from very different sources, newer database technologies, such as NoSQL, are suitable. An example is Hadoop, a free software system specifically for organizing large multi-structured data sets in connection with big data, based on Google's MapReduce algorithm (Gluchowski & Chamoni, 2016, pp. 108–109).

Various tools are used for data and result presentation, which can either be pre-configured in analytical information systems or integrated as separate applications. Dashboards, for example, serve the appropriate presentation of information and results in portals or in dedicated applications for professionals and executives. The most common presentation of key figures for management occurs in operational reporting as standard reporting.

Data is output in tables and graphs and in print or screen formats. In addition to such standard evaluations, short-term information needs must also be met by ad-hoc reporting. This can be equipped with interactive navigation in reports and by the individual compilation of evaluation content by the user with great convenience. Planning and simulation applications have become increasingly important by providing tools for data input, distribution, and the development of forecasts and scenarios. When, in addition to data analysis, methods of machine learning and artificial intelligence are used as part of data mining, the highest level of data analysis is achieved. In the industrial sector, for example, maintenance intervals can be determined machine-specifically from runtime data, optimizing maintenance (predictive maintenance) (Gluchowski & Chamoni, 2016, pp. 111–125).

6.2 Information Structure From a Management Perspective

Analytical information systems are also sociotechnical systems that connect individuals and technical organizational units. They equally constitute a bundle of components for decision support and the utilization of synergies through data exchange.

Sociotechnical Design Task

Based on a strategic positioning, the organization is structured in terms of structure and process, and the IT infrastructure, including applications, hardware, and software, is planned for this purpose (Gluchowski & Chamoni, 2016, pp. 68–69). The concept is thus not dissimilar to the architecture of integrated information systems (ARIS). The components can be classified based on their role in information processing and infrastructure. For example, a data warehouse is a component more related to architecture, while BI, from a technological perspective, also has architectural characteristics in its methodological approach. However, the use of BI in decision support is application-oriented and more business-focused (Gluchowski & Chamoni, 2016, p. 71).

Both the technical and business sides of the company are accompanied by a management approach with goals, planning, and organization/implementation. The aim is to ensure the organization has the right information of the right quality, and from an economic perspective that can satisfy the information needs for decision support (Gluchowski & Chamoni, 2016, p. 76).

In the company, concerning the organization of data and information, there are, of course, the classical areas of demand: regular operations and projects. While the project can be more precisely defined with its temporal limitation and a specific project assignment, regular operations are naturally subject to a continuous process of change that affects the entire value creation.

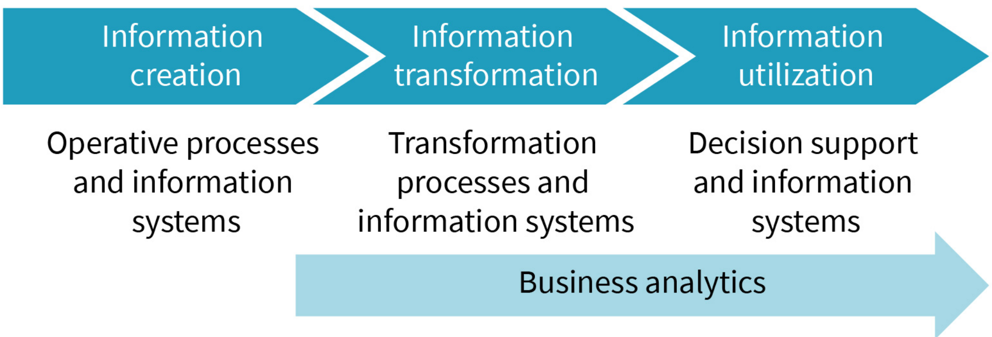
The system equipment for value-added processes and the system architecture in information management are formed according to strategic requirements arising from the company's competitive situation. Consequently, from a management perspective, an information infrastructure must also follow this guiding concept and, with a strategic positioning as a framework, meet the overarching strategic guidelines of the company.

Value Chain and Governance

Fundamentally, we can identify a kind of value chain for analytical information systems with the generation of data in operational application systems, data organization, and utilization in decision situations (see the following figure). Operational systems act as data suppliers; analytical applications transform the data and information, making them available to decision-makers. The transformation performance is oriented towards the business needs, while the actual implementation involves development work and maintenance of information system development, including the necessary subtasks such as modeling and project planning. Planning and control, and thus the coordination of this value chain, corresponds to the **governance** for analytical information systems (Gluchowski & Chamoni, 2016, pp. 79–80).

Governance
The organizational structures of a unit operating within the company, encompassing both its structure and processes.

Figure 44: Value Chain of the Analytical Information System



Source: Paul Nikodemus (2021).

For the consumer side of decision support services, the deployment of resources necessary for information systems is less relevant. The performance of analytical information systems should, therefore, be defined not in terms of resource consumption but in terms of the quality of support services. The focus for service users should lean more towards the effectiveness of analytical performance, while data transformation should, of course, adhere to efficiency criteria.

Thus, there is a difference in strategic emphasis between efficiency-oriented transformation and effectiveness-oriented service utilization. The central goal of analytical applications is to provide high-quality decision-making foundations. However, the required information infrastructure still needs to meet the requirements for efficient and synergistic operation (Gluchowski & Chamoni, 2016, p. 80).

Typical synergies are utilized in bundled sales when data analysis in one field leads to the offering of other or adjacent services. This is the case, for example, in cross-selling between banks and insurance or between airlines and hotel services. Synergies can occur intra-organizationally, between different divisions of a company, or inter-organizationally, between different companies in an offering network. This also highlights that effectiveness goals of the service strategy should primarily identify such synergies, as they particularly align with the overarching goal from a management perspective to make the right information available in the right quality and in an economically sensible manner for information needs satisfaction (Gluchowski & Chamoni, 2016, p. 81).

Organizational Implementation

The management perspective requires that, based on the identified strategic determinations for the performance of analytical information systems and the associated goal system, the structural and process organizational content elements are determined. Since infrastructures for operational systems already exist, a complete re-conception of organizational matters is not necessary. Usually, there are already overarching data and information flows, and from the established architecture of information and communication technology and its application side, system plans can usually be adapted to serve as a reference (Gluchowski & Chamoni, 2016, p. 82).

The required system and services can now be implemented differently in the organization. If the functions to be covered are distributed across platform operation, data and information provision, and information use in decision situations, basic patterns emerge, ranging from complete coverage (full service) to concentration in functionally assigned competence centers (competence center). Partial support of either platform operation or information use in decision situations is also conceivable.

The concrete design often depends on the general strategic orientation of information management. Standardized approaches are often chosen, such as the Information Technology Infrastructure Library (**ITIL®**), which describes best practice solutions for the effective and efficient design of IT services. Organizations can orient themselves to these recommendations and describe their processes, functions, and intended competencies in IT service management. The 2019 release of ITIL® also explains practical solutions for the field of business analytics.

ITIL®
This describes best practice solutions for the effective and efficient provision of IT services.

For process organization, it can be stated that not all business processes are suitable for support by analytical information systems. Processes that are especially structured and non-automated are particularly predisposed to deployment, while unstructured leadership processes are likely to be unsuitable. Structuring ensures that analytical evaluations can be defined and integrated more selectively, and the conditions required for decision-making can be implemented in parameters for the runtime or information system. In unstructured decision situations, this information basis is often lacking (Gluchowski & Chamoni, 2016, p. 89).

In a fully automated process environment, the conditions must also be completely converted into rules, which actually excludes the required analysis for individual decision cases. However, exceptions can be systems of artificial intelligence if a learning system can automate individual cases with specific conditions. An example is pattern recognition in the transformation of unstructured data from various operational information systems. The AI systems used here can automatically process large multi-structured data sets and select the information necessary for a decision situation through "learned patterns."

Analytical information systems are now an integral part of information management in many companies. From a management perspective, similar to other information and application systems, design and control issues take precedence, with a focus on cost-effectiveness and the integration of systems into existing infrastructures. However, it is important to note that, unlike many other system environments, the costs and value contribution of analytical information systems arise in different organizational units.

While the infrastructure elements can be attributed to the IT in terms of required resource expenditure, the benefits accrue to the business areas where executives rely on the support provided by these systems (Gluchowski & Chamoni, 2016, p. 92). Although robust reference models are still lacking, there are indications of developments that increasingly position business analytics as part of IT service management, as evidenced by the practical solutions in ITIL®.

6.3 Example Scenario for the Use of Management Information Systems

In the following company example, the focus is on the introduction of a business analytics platform in connection with integration into a cloud solution for a logistics company.

Company and Initial Situation

The Schnellecke Group (2021) is an internationally operating logistics service provider and supplier to the automotive industry with approximately, 20,000 employees at over 70 locations in Europe, Asia, America, and Africa, handling material flow management with planning, control, and execution tasks. The company offers comprehensive concepts that include

- transport and tour planning,
- warehouse management,
- pre-assemblies and add-on service
- sequential production of individual parts and modules, and
- container-appropriate packaging.

Additionally, under the brand KWD Automotive, the company produces body parts and assemblies for vehicle manufacturing. The family-owned business had already decided to use SAP Analytics Cloud as the core platform for business analytics and business intelligence. In this context, an enterprise data warehouse was to be introduced. Through a pilot project, financial control for the entire company was to be equipped with defined information structures, key figure models, and dashboards.

Key requirements included the performance, flexibility, and scalability of the new overall solution, as well as optimal support for the future **SAP S/4HANA environment** and the option to implement integrated planning processes in the future (Information Works, n.d. p. 2).

SAP S/4HANA
This is an ERP system with integrated technologies such as AI, machine learning, and in-memory database (HANA).

Piloting and System Components

The initial goal of the implementation project was the modernization of reporting for financial control. For this purpose, **SAP BW/4HANA** was technically provided, and processes for the environment were defined and tailored to the company's specific requirements. The new architecture of the data warehouse was planned, the application structure determined, and the procedures for operation and planned developments were documented.

SAP BW/4HANA
This is a data warehouse application.

This simultaneously laid the foundations for a new overall business analytics and business intelligence concept (see the following figure). The information structure of SAP BW/4HANA now provides dashboards, standard reports, self-service BI applications, and ad-hoc analyses for financial control and reporting. Furthermore, group-wide financial data from other information systems and system environments were integrated and prepared for analysis models. The SAP BW/4HANA platform can integrate standardized data structures from operational systems with little effort and make them immediately usable in productive operation. All individual requirements of the company for business analytics evaluations were also taken into account through adjustments and extensions of the models (Information Works, n.d., p. 2).

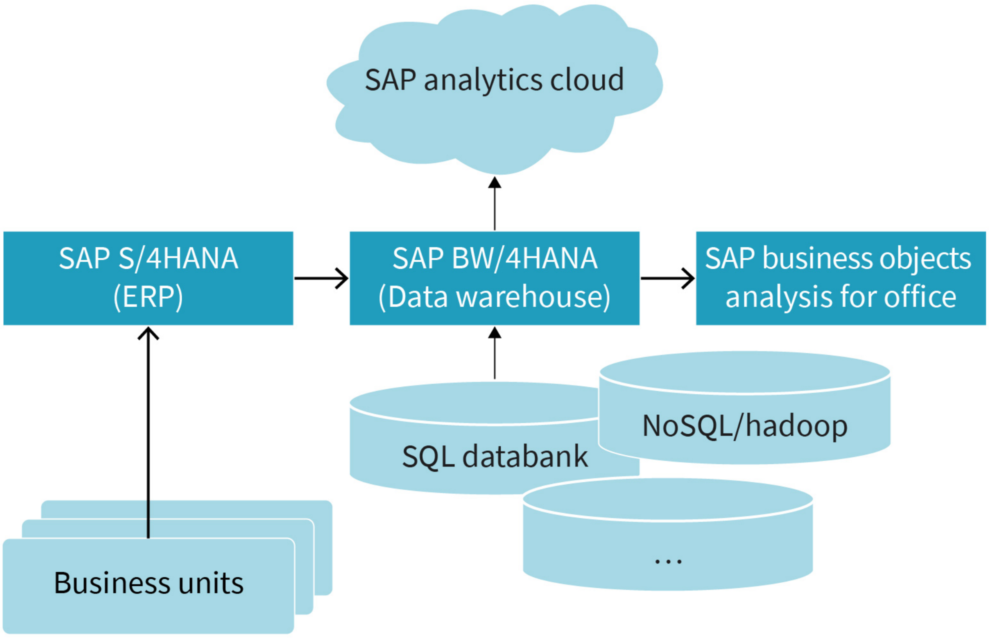
Business Analytics – Benefits and Advantages

With SAP Analytics Cloud, the company relies on a strategic application of SAP for self-service analytics and cloud-based BI applications. The consistent and reusable group-wide key figure models and information structures were decisive factors in choosing SAP BW/4HANA. The seamless functional integration from the operational processes of the business units to SAP Analytics Cloud is also a significant advantage, as central data structures can be reused in SAP Analytics Cloud with the help of SAP BW/4HANA. This enhances the quality of BI applications and accelerates implementation.

SAP BusinessObjects Analysis for Office
This is an analysis tool for OLAP with the ability to use Excel and PowerPoint for calculation and presentation.

SAP BusinessObjects Analysis for Office is used as a tool for Online Analytical Processing (OLAP) since it has been optimized for working with SAP BW/4HANA and uses the same analysis data models as in SAP Analytics Cloud. With real-time data access in SAP Analytics Cloud, all analysis data from SAP BW/4HANA is available for dashboards and self-service analyses, with no data contents stored in the cloud for security reasons. All information structures, key figure models, authorization concepts, and roles for access are managed and provided exclusively centrally and in a reusable manner in SAP BW/4HANA (Information Works, n.d., p. 3).

Figure 45: Business Analysis and BI Architecture



Source: Paul Nikodemus (2021), based on Information Works (n.d., p. 2).

SUMMARY

When we delve into analytical information systems, we naturally encounter terms such as data warehouse, online analytical processing (OLAP), and data mining. This is primarily because for many years, we have associated data analysis in companies with these technologies, and more recently, concepts of artificial intelligence and machine learning have also played a role in shaping the handling of data and information in companies. The overarching goal is always to use data from operational application systems in a way that contributes to the improvement of these business processes and, consequently, ensures and enhances competitiveness.

Processed data is transformed into information, and ideally, knowledge is generated from it, which is essential for decision-making. Decisions in companies are typically made within the circle of executives, (i.e., in management). Hence, the term management information systems (MIS) has been established for information systems that support this decision-making process, and terms like Business Analytics or business intelligence correspond to this view of the functional portfolio of these systems.

The central component is the data warehouse, serving as the foundation for analytical information systems. Here, the necessary company data is collected, potentially divided into business-specific segments known as data marts, processed, and stored. Retrieval occurs through online analytical processing (OLAP), now often in real time in connection with large datasets (big data), allowing for making short-term decisions based on extensive data utilization. Data mining examines data for specific correlations and patterns, using statistical methods to elevate data analysis to a higher quality level.

In contrast to operational information systems, the organizational allocation of business analytics applications is not straightforward. While data sources can be identified in the process landscape, the utilization of analysis results may occur elsewhere. From a management perspective, this necessitates specific requirements for the governance of the information infrastructure, ensuring both strategic alignment and a structurally and procedurally organizational implementation aligned with goals. The example scenario illustrates which system components must be considered and the integration efforts required, ranging from the use of applications for office communication to the analytical environment in the cloud.