Production-operation management. The chosen aspects

Dariusz Nowak
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PUEB PRESS
Poznań University of Economics and Business

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PREFACE

The principles of conducting production and operating activities are constantly changing. They are connected with both evolutionary and radical development. They are based on environmental changes, globalization, technological progress, innovation, the development of production methods, etc. There also appear new methods, instruments and tools supporting the management process. Their implementation into the main activity contributes to the achievement of better results. Among them, there are methods that focus on planning and control of production, on organizational and commercial activities, design, human factor, costs, etc. Therefore, it can be emphasized that the new solutions concern all aspects related to the production of products and services.

Production-operations management is one of the oldest and one of the most important functions of enterprise management. Many other functions realized in the enterprise depend on their proper course. Production and operations activity influences marketing, technical and economic planning, sales, logistics, employment, training, social matters, etc. They are also directly related to accounting activities, reporting, economic analysis, and settlements. In addition, they have an impact on other sectors of the economy. Production companies are the main recipients of raw materials produced by agriculture, they also affect services, both in material and non-material terms.

In the simplest terms, production and operations activities can be defined as a way of organizing production and operations related to the production of products or the provision of services. This problem relates to management of business practices aimed at ensuring maximum efficiency within a business, which in turn helps to improve profitability.

Its scope includes planning, organizing, scheduling, supervision and control related to the production of products in order to meet the customer's needs, both individual and institutional, as well as generating profits that are the basis for future development. This activity consists in transforming the resources at the company's disposal into products and services that are compatible line with the expectations and requirements of the market. Resources can be material or non-material. They include raw materials, materials, parts, details and semi-finished products from cooperation, as well as knowledge, method of production, machine

park or production potential described by production capacity. An additional specific resource is human capital, characterized by skills, competences, experience or qualifications. As a result of the transformation of resources, added value is created, which is the basis for the functioning of enterprises. Production and operational management therefore refers to the rational and reasonable use of resources and their transformation into products or services.

This e-book is the result of collaboration between several research centers in East-Central Europe. The authors' intention was to present the most important aspects related to production and operations management from the perspective of several countries. The considerations in each chapter should be useful both academically and practically.

The aim of the e-book is to present the theoretical, cognitive and practical aspects of the essence and complexity of operational management in a production company. The presented modern production methods together with the challenges and problems of contemporary enterprises, should better help to understand the issues of sustainable development, with particular emphasis on waste. The book is dedicated to people who deal with issues related to production and operational activities, both in theoretical and practical terms.

The first chapter, entitled "The nature of the industrial enterprise", focuses on the basic aspects of the company. Both popular and less known definitions of an enterprise, its features, functions and principles of operation are presented. An important part of the chapter is the presentation and formulation of strategic, tactical and operational goals. Moreover, the division of enterprises is presented with the use of various criteria and the features of the industrial market, which make it distinct. This chapter is the basis for further considerations in the following sections.

The second part on "The role of operational management in an industrial enterprise" discusses the evolution and concept of production and operations management. The management levels were also presented, indicating their most important functions. An integral part of the chapter is the essence of the production system, viewed through the prism of the five elements.

The third part deals with the functions and role of production and operational management. The reader can learn about the issues concerning the organization of production processes, production capacity and inventory management. This part also presents considerations on cooperation and collaboration between enterprises in the process of creating value.

The fourth part concerns the traditional methods used in production and operations activities. Methods such as benchmarking, outsourcing, core competences, JIT, MPR I and MRP II, as well as TQM and *kaizen* were introduced. Knowledge of these methods should contribute to understanding the activities of modern enterprises, the way of company functioning, the realization of production activities, as well as aspects related to building a competitive position.

The fifth part continues the chapter that discusses traditional methods. Here, the less common or less frequently used production methods, based on a modern and innovative approach, are indicated. In particular, it was focused on: shop floor control and cooperative manufacturing, environment-conscious manufacturing (ECM) and life-cycle assessment (LCA), waste management and recycling, Electronic Data Interchange (EDI), virtual enterprise, World Class Manufacturing (WCM), Quality Function Deployment (QFD) and House of Quality (HOQ), theory of constraints (TOC), Drum Buffer Rope (DBR), group technology (GT) and cellular manufacturing (CM), Demand Chain Management and competitive intelligence (CI). In the last section discusses: the role of sustainable statistical process control and computer-aided process planning in context formatting of information management.

The last part describes the problem and challenges related to production and operations activities. In particular, attention was paid to the threats related to changes in global warming, the growing scale of waste, or the processes of globalization. It was pointed out that the emerging problem may be both a threat and a chance for the development of enterprises. An integral part of the chapter are also considerations on technical progress, innovation and the importance of human capital in operational activities.

By presenting a short description of the chapters, I hope that the content of e-book will contribute to broadening the knowledge about contemporary conditions related to the production and operation activity of enterprises. It is an extremely important function, the knowledge of which is required both from a practical and theoretical point of view.

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The book was created thanks to the involvement of many people from several universities and various practitioners. The work on the preparation was carried out by staff and Ph.D. students from several universities: Taras Shevchenko National University of Kyiv, International Innovation Centre in Kiev, Kamianets-Podilskyi Ivan Ohiienko National University, The D.A. Tsenov Academy of Economics, Svisthov, Bulgaria, as well as the Poznań University of Economics and Business.

I would like to sincerely thank all the authors for their commitment and help in preparing both the theoretical and practical parts. In the first part Dariusz Nowak and Iskra Panteleeva presented their considerations on industrial companies, taking into account aspects such as: the features, functions, goals and tasks as well as typology of the industrial enterprises. Aneta Deneva and Iskra Panteleeva focused on the evolution and role of production and operational management in industrial enterprises. In particular, they showed the levels and functions of

operational management and discussed the production system and its elements. Bartosz Marcinkowski prepared texts on the organization of the production process, emphasizing its functions and role in the company. Aneta Deneva and Sebastian Narojczyk made a successful attempt to present selected traditional methods used in operational management. Along with other methods, they discussed benchmarking, outsourcing, core competencies, material requirements planning and a few others. The fifth part was prepared by Bartosz Marcinkowski, Sebastian Narojczyk, Dariusz Nowak and Vasyl Zalizko. The authors took up the challenge of presenting relatively little known methods used in operational management, including those related to sustainable development and reduction of waste. The last part, prepared by Natalia Mazur, Dariusz Nowak and Vasyl Zalizko concerns the problems and challenges that modern manufacturing companies have to face. The authors discussed the impact of environmental changes on the functioning of enterprises, explained the problem of globalization, pointed out the importance of technical progress and innovation, and also explained the role of the human factor in production and operational management. Thank you to all.

This publication would not have been written if it had not been for the international project, coordinated by Barbara Borusiak. It is thanks to her efforts and commitment that cooperation between universities from Croatia, the Czech Republic, Bulgaria, the Ukraine, Slovakia, Hungary and Poland has been established and strengthened. The project titled Central European Network for Sustainable and Innovative Economy (CENETSIE) is financed by NAWA funds intended for the development of international cooperation. The project was implemented in the years 2020–2022.

On behalf of the entire team of authors, I would like to thank assoc. prof. Anastasiya Marcheva for valuable comments, which allowed to clarify the content of individual chapters.

We would also like to thank the employees of the Publishing House of the Poznań University of Economics and Business for its help in publishing the e-book, in particular the editor Marta Dobrecka.

We hope that our publication will contribute to a better understanding of the problems related to production and operational management in the contemporary enterprise. We also would like our e-book to contribute to the development of discussions and polemics related to the problems of sustainable development in the company's main activities. The publication was created at a difficult time for everyone, when the world was hit by the COVID-19 pandemic. This factor strongly influenced our understanding of the issues raised, the form of cooperation and the problems faced by individual countries.

We hope, as a team of authors, that thanks to international cooperation on the book, a series of joint research, organisational and teaching works will be continued.

Dariusz Nowak

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1.

THE NATURE OF THE INDUSTRIAL ENTERPRISE

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Abstract: This chapter presents basic information about the nature and essence of the enterprise. The first subchapter shows both the well-known and less popular definitions of an enterprise and an industrial enterprise. They have been shown through the prism of various approaches, including definitions from various countries. The second part discusses the features of an industrial enterprise, with particular emphasis on: organizational separateness, economic separateness, legal separateness (legal personality), territorial separateness and technical and production separateness. The next part focuses on the goals and tasks of an industrial enterprise, with particular emphasis on the way they are formulated. Both strategic, tactical and operational goals were discussed. The subject of the considerations in the fourth part were the functions of an industrial enterprise, including a detailed description of the production, technical, organizational and personnel functions. The division of enterprises according to various criteria is presented in the next section. It focuses on such criteria as business profile, the size of the enterprise, form of ownership, production type, type of production process and market legal form. The last part discusses the market on which an industrial enterprise operates. Its features were presented, as well as the type of industrial products, types of customers and differences between industrial and consumer marketing. Particular attention was also paid to OEM (Original Equipment Manufacturer) and MRO (Maintenance Repair and Overhaul).

Keywords: division of enterprises, enterprises and industrial enterprises, features and functions of the enterprises, industrial and consumer market, industry.

1.1. Introduction

The development of the industry requires constant changes and continuous improvement of management methods. The basis are new conditions for business activity, which are related to the evolution of the business environment. It is indicated that this environment is shaped by new challenges related to climate changes, technological progress and innovations, state policy, and the industrial revolution 4.0. Moreover, new relations both inside and outside the industry change the nature of exchange, the way of competing and building a competitive advantage. The approach to cooperation is also changing, with existing strategies aimed at fighting with contractors being replaced by a proactive approach to joint achievement of goals. The dynamic change of the environment makes that the nature of the enterprise is also changing, including goals, strategy, management, etc. It should be understood as the way the enterprise operates, including the way of formulating strategic and operational goals, the approach to the implementation of tasks, as well as its policy in the field of finance, employment, quality, etc. The functions of enterprises and their features are also subject to evolutionary changes. Entrepreneurship which is seen as one of the main driving forces of the company has become extremely important. Flexibility becomes more and more important, both in production and management. The first concerns production programs, products and manufacturing technologies, the second is related to the decentralization of power, matrix organizational structure and approach to working time. It can therefore be emphasized that the management of a modern enterprise is becoming more and more complicated.

By analysing the complex and multifaceted nature of the enterprise, this section tries to familiarize the reader with its essence and nature. First, both the popular and the less known definitions of an enterprise and an industrial enterprise are presented. Then, its features, functions and the way of formulating goals in strategic, tactical and operational terms are discussed. An integral part of the chapter is also the presentation of the company according to various criteria, such as the domain of activity, the nature of work or the technology used. The first part ends with the characteristics of the markets in which the companies operate. Both the features of the industrial and consumption markets are discussed in detail, pointing to their essence and importance in economic development.

1.2. Concept of an industrial enterprise

Industry plays a very important role in any economy. It influences the development of regions, creates new place of works, contributes to the development of infrastructure, as well as improving the living conditions of people. It is associated

with the exploitation of natural resources and their processing in order to meet the needs generated by both consumer and industrial markets. Industry generally consists of manufacturing companies which domain of activity is related to production or service. It is characterized by durability, repeatability of production processes, large scale of activity with an appropriate division of labour, with the use of machinery and technical devices, and cooperation of means of work and people (Janasz, 2000, p. 65). The author points out that the main characteristics of the industry are (Janasz, 2000, p. 66):

- exploitation of natural resources,
- supply production tools and equipment as well as industrial services to other sectors of the economy,
- control of environmental processes and concentration of production,
- production continuity, taking into account the division of labour and cooperation of machines, devices and people,
- mass production and sales markets.

The industry can be defined as "a set of economic and other units that produce and prepare for the production of similar for economic purposes and used raw materials and products with the help of specialized equipment, typical technology and specially trained personnel" (Nikolov & Marinova, 1996, pp. 84–85; Deneva, 2013, pp. 29–30).

One of the most important entities that play a very important role in every economy are enterprises. On one hand, they provide the state with income and reduce unemployment, whilst on the other hand, they are a place for creating innovation, implementing new solutions and technical progress. Moreover, they enable investors to invest capital and at the same time obtain a return on the invested funds. The standard of living of a given society depends on their effectiveness and efficiency. Focusing on innovative and modern products or services, based on pioneering technologies, ensures development and a highly competitive position in the international arena.

Enterprises deal with various activities, including production and service. Some of them deal with both manufacture and provide manufacturing services. The subject of their activity can be very wide, from the provision of standard services and the production of simple products, to offering comprehensive, complex and complicated solutions that can be used in other enterprises. They can operate in a variety of markets, meeting local, regional, national, international and even global needs. They pursue their goals using a variety of strategies, ranging from price and quality, through the niche, mixed and follower strategy, to a diversified one conditioned by the market served. Enterprises direct their offer towards institutional or individual buyers, they can also satisfy the needs of all market participants by offering a dual product or service. Their basic activity should be related to the ability

to perceive changes in the market environment and adaptation to new realities, which may be evolutionary or radical.

Despite the great importance of enterprises and their growing role in the economy of each country, both the literature on the subject and the scientific discourse lacks an unambiguous definition that would simply explain their essence and nature. Definitional difficulties result primarily from the multithreading and universal concept of an enterprise as well as attempts to define it by scientists representing various scientific disciplines, such as: sociology, psychology, political and social sciences, legal, organizational behaviour, organization theory or strategic management. In the context of a wide range of concepts related to the enterprise, the attempts to define the essence of an industrial enterprise are of particular interest.

Semantically, the term "enterprise" derives from the personality of the entrepreneur who undertakes an initiative, invests capital, organizes the production unit (enterprise) and assumes entrepreneurial risk, regardless of the economic sector (production, services, etc.). Factories, plants, mills, conglomerates, hotels, restaurants, cinemas, cafes, etc. can be considered as enterprises.

Key features that characterize the essence of contemporary enterprise are the following: economic organization; financial and economic and managerial independence guaranteeing its economic freedom; relations with the market; use of own and foreign funds as capital of the enterprise; presence of entrepreneurial (economic) risk, pursuit of survival and profits, etc.

The **enterprise** is a formal organization. It has a structure, rules, goals, management, etc., but not every formal organization is an enterprise. A branch organization, e.g., is a formal organization with a chairman, a board of directors, a supervisory board, statutes, goals, and so on. However, it is not an enterprise. It was created to represent, protect and support its members. Its purpose is not to make a profit. The status of other formal organizations (church, foundations, etc.) is similar. Similar to enterprises, in households (as primary economic units) input resources are transformed into final products. Although it produces products, the household is not an enterprise. The created goods are used for own (personal) consumption. As with branch organizations, foundations, etc., the activities of households also lack a purposeful effort to make a profit. It is the goal of making a profit that distinguishes the formal organization "enterprise" from other formal organizations as well as the household from the enterprise (Varamezov, Naidenov, Panteleeva, Nikolov, & Ivanova, 2015, p. 3).

In the simplest terms, an enterprise is an entity that conducts business activity, the purpose of which is to identify and then satisfy specific consumer needs, i.e. to provide products or services desired on the market at a specified time and to the required standard (Bittnerowa, 1995).

An enterprise can be viewed through the prism of various approaches. In terms of the market, an enterprise is equated with an economic entity running a service

or production activity on its own account in order to achieve specific benefits. The enterprise defined in this way, operates with the use of production factors which include labour, capital and land. In a broader sense, an enterprise pursuing its goals, must have specific resources, including raw materials, materials, technical equipment, human resources, information, know-how, structure, etc. Moreover, conducting an economic activity it has to collaborate with other market participants from whom it acquires the resources needed for production, and provides produced goods or services rendered (Lichtarski, 2003). Thus, it is a link of a typical Porterian value chain, constituting a sequential system of interdependence. This chain in the company includes basic and support activities. The basic activities include (Porter, 2006, p. 77):

- internal logistics associated with the processes of receiving, depositing, warehousing, storing and distributing raw materials and materials that are necessary in production processes,
- operational activities related to the basic activity of the enterprise which involve the conversion of production factors into a finished product; these activities include many processes, such as: processing, assembly, shaping, cutting, grinding, packaging, renovation, maintenance, etc.,
- external logistics, primarily regarding the depositing and storage of finished products, resulting from the conversion process, i.e. the transformation of the input vector (power) into the output vector (effects), referred to in an industrial enterprise as a production process, and their delivery to buyers,
- marketing and sales, i.e. the activity of persuading a potential buyer to purchase a product or service; these activities can use a number of instruments, such as: advertising, promotional activities, direct sales, fairs and exhibitions, folders and catalogues, etc.,
- service, the task of which is to maintain the functioning of the company at a high level and ensure the appropriate quality of the offered product or service; includes both activities for the benefit of the machine park and the increase in employee competences.

Supporting activities, defined as supportive or assisting include four categories, including (Porter, 2006, p. 78):

- supplies, including all activities that must be performed to ensure the delivery of specific products, machinery and equipment, raw materials, materials or parts for which a demand has been submitted; these activities include processes such as identification of needs, identification and selection of co-operators, negotiating terms of cooperation, organization of deliveries, control, evaluation, etc.,
- technological development related to technical progress applies to both product development and the methods of its production; in the enterprise must be purposeful, rational, economically beneficial and lead to labour savings or improvement of its conditions, which is manifested in changes in production volume, improvement of quality, assortment variety, saving human labour, using new raw

materials, increasing efficiency and productivity, as well lower cost of products; is directly reflected in the improvement of the company's competitive position,
- human resources management, within which all activities related to the recruitment process, hiring and dismissing, remuneration and motivating, improving qualifications, acquiring new competences should be analysed; in practice, it is believed that the rank of human resources in an organization is higher than the rank of fixed assets because it is man who decides about their use, application, replacement or withdrawal, and
- the company infrastructure which covers all activities related to the organization of work, including management, planning, financing of activities, compliance with the law and applicable standards as well as quality management.

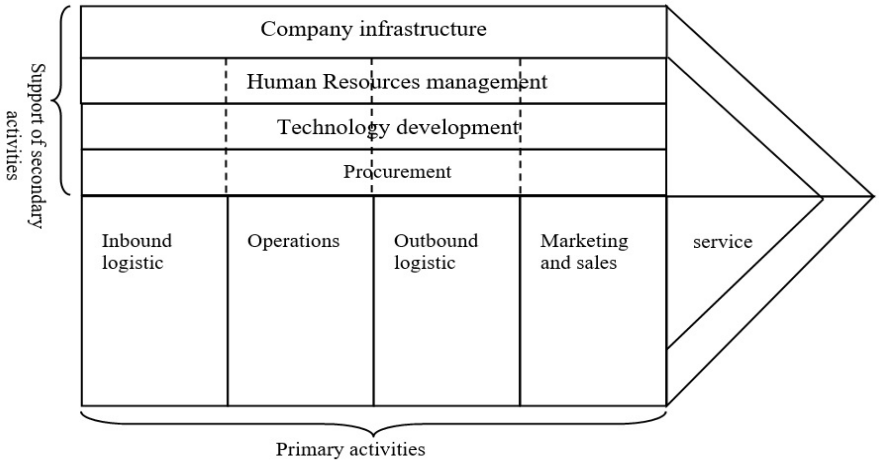

Figure 1.1. Porter's value chain analysis

Source: (Porter, 2006, p. 74).

Building a value chain is one of the basic conditions for cooperation and collaboration, under which two or more entities pursue their complex goals. The correct selection of contractors, both suppliers and recipients, will make the manufactured products and services available in the right place, for the right buyer and at the right price.

Value chain segment. This refers to the steps across the value chain that a product goes through from conception to creation and delivery to customers. These steps include research and development, design and development, inbound logistics, intermediate goods, supporting services, manufacturing, outbound logistics, marketing and after-sale services (Leurent & Shook, 2018, p. 4).

From the point of view of management sciences, an enterprise should be considered in the organizational category which means that it is an organized unit,

and its activity is based on a rational organization (Blinska-Reformat, 2009). This means that a given unit works towards the set and intended goals with maximum efficiency, when efficiency means completing the task in a correct manner, relating to the ratio between inputs and outputs (Zieleniewski, 1969; Krzakiewicz, 2006).

> Value-added activities. This includes all activities that add value to a product, in the form of physical value (assembly and other fabrication) or product design and development (Leurent & Shook, 2018, p. 4).

Supernat (2020) indicates that an enterprise has three basic meanings: subjective, objective and functional ones. In terms of the subject, an enterprise is equated with an entrepreneur, i.e. "a natural person, a legal person and an organizational unit that is not a legal person, the legal capacity of which is granted by a separate act, performing an economic activity" (Law of Entrepreneurs, 2018, art. 4.1). The above definition indicates that the economic activity performed by the indicated persons and organizational units must be legally independent, and the entrepreneur bears full responsibility for the established legal relations. In terms of the subject matter, the enterprise has been defined in Art. 55 of the Civil Code (Act of 23 April 1964, Journal of Laws No. 16, item 93, as amended). According to the code, it is "an organized group of intangible and tangible assets intended for business activities. It includes in particular:

1. Designation individualizing the enterprise or its separate parts (name of the enterprise).
2. Ownership of real estate or movable property, including equipment, materials, goods and products, and other rights in rem to real estate or movable property.
3. Rights arising from rental and lease agreements for real estate or movable property and the right to use real estate or movable property arising from other legal relationships.
4. Claims, rights in securities and cash.
5. Concessions, licenses and permits.
6. Patents and other industrial property rights.
7. Copyrights and property rights related to property.
8. Business secrets.
9. Books and documents related to running a business".

The functional approach is related to the permanent running of a specific economic activity for profit. It is indicated that in this sense it is only a definition of a specific economic activity conducted in accordance with the category specified in the Polish Classification of Activities (Firlit, 2018, p. 33).

An enterprise can also be defined in terms of sociology, in which it is treated as a social category. Basińska points out (2012, p. 23) that in "symbolic interaction the enterprise is considered as a field of interaction between employees and superiors". From this perspective, the focus is on social groups formed by various employees

as well as the relationships between them, their motivations and behaviour. It is emphasized that in such an organization a specific culture is created, at the base of which there is the process of joint determination of meanings. The enterprise is a network of relations between specific individuals in which the subject of the game is social position (Bourdieu, 2005). Psychology deals with a similar scope, including interpersonal relations in an enterprise.

The **enterprise** is the main structural unit of any economy in which the various types of production processes take place. In practice, the term is used with different meanings, the most common of which are the following:

- organizational form for carrying out entrepreneurial activity,
- a place for deployment of various machines, equipment and technology in order to perform certain production processes,
- a private business unit for the production of goods or services for profit,
- state-owned enterprise producing a strictly defined type of production to meet the needs of the population.

When analysing various types of attempts to define the essence of an enterprise, it is worth paying attention to **the industrial approach**. Industry is one of the most important areas of business activity. It should be understood as the non-agricultural field of material production related to the extraction of resources created by the natural environment and their processing on a large scale, using machines and devices as well as the application of the division of labour in order to satisfy various human needs.

Table 1.1. Enterprise and industrial enterprise in terms of individual countries

Bulgaria	**An enterprise** is an independent business unit that produces and sells various tangible and intangible goods (goods and services) in order to make or receive a profit. This is the smallest structural unit of the economy. **An industrial enterprise** is a legal, territorially organizational-technical and economically separate production-economic unit, which uses limited resources for production and sale of products and services, according to the market requirements and needs.
Czech Republic	**An enterprise** is an institution established to perform business activities. From a legal point of view, an enterprise is defined as a set of tangibles, personal and intangible components of a business. In general, **an industrial** enterprise is a complex social organism, composed of human and material elements, whose main function is to produce material goods.
Hungary	**An enterprise** is an economic unit which under their corporate names undertake business operations with their own liability in the interest of gaining profit and therefore also take risks. Although their activities (business operations) and properties separate from the other market participants, they are connected with them through the market. **The industrial local unit** is an enterprise, or a part of it, located on a site determined geographically. On this or from this site one or more persons carry out one or more, dominantly industrial activities (mining and quarrying; manufacturing; electricity, gas, steam and water supply) for the same enterprise. **The industrial enterprise** is an economic unit that carries out one or more, dominantly industrial activities (mining and quarrying; manufacturing; electricity, gas, steam and water supply)—according to the definition of "industrial local unit".

Poland	**An enterprise** is an entity that conducts business activity, the purpose of which is to identify and then satisfy specific consumer needs, i.e. to provide products or services desired on the market at a specified time and to the required standard. **An industrial enterprise** should be understood as an economic organization manufacturing products or providing industrial services, economically and organizationally separated in the economy of a country, region and having legal personality.
Slovakia	**An enterprise** is a set of tangibles as well as personal and intangible components of a business. The enterprise includes things, rights and other assets that belong to the entrepreneur and are used to operate the enterprise or, due to their nature, are intended to serve this purpose. **The indicator manufacturing of industrial products and industrial services** includes products produced in the industrial enterprise intended: – for sale outside the company and for own production consumption (internal consumption) and industrial services (modifications, repairs, maintenance, assembly—installation), including subcontracting, – finished products (wage work) and subcontracting of industrial services (work of a productive nature) which are intended for sale outside the enterprise.
Ukraine	**An enterprise** is an independent economic entity established by a competent public authority or local government or other entities in order to meet social and personal needs through the systematic implementation of production, research, commercial and other economic activities in the manner specified in this code and other regulations. **An industrial enterprise**, defined in the Ukrainian jurisdiction, is identified with an enterprise that produces industrial products in certain quantities in accordance with a given technology. The term "industrial enterprise" includes all enterprises belonging to the following economic activities: mining, processing, construction, electricity, gas, water supply and sanitation, transport, storage and communication services. An integral part of an industrial enterprise is the production process, involving the use of specific resources: raw materials, equipment, labour and technological processes, etc.

Source: Own study based on (Synek, 2010; Pytela, 1996; Act 513/1991, Výroba priemyselných výrobkov a priemyselné služby, 2013; Economic Code of Ukraine, 2003; Deneva, 2013; Lichtarski, 2003; Bittnerowa, 1995).

Therefore, it can be emphasized that an industrial enterprise should be understood as an economic organization manufacturing products or providing industrial services, economically and organizationally separated in the economy of a country, region and having legal personality. The essence of the separation is determined by the fact that the industrial enterprise is the owner, leaseholder or administrator of specific assets (land, buildings, machinery, equipment, energy infrastructure, materials, semi-finished products and products, bank capital). Thanks to possessing the legal personality, an enterprise may be an independent subject of rights and obligations in the field of economic transactions. Its core activity is manufacturing of goods or providing services. It renews its property resources on its own and by manufacturing products or providing services, it generates profit at its disposal in accordance with applicable legal regulations. In the activities of enterprises defined in this way, four phases can be distinguished (Janasz, 2000, p. 66):

- the first one is related to obtaining raw materials from the natural environment,
- the second one involves the processing of the obtained raw materials, their enrichment, removal of impurities, and similar processes,

- in the third one, the obtained ingredients are combined using various methods,
- the fourth one is related to the sale of manufactured goods.

An integral part of the industrial activity is the provision of production services which generate more than half of the revenues generated in the industrial goods markets (Strähle, Füllermann, & Bendig, 2012).

Contemporary industrial production combines and uses a set of diverse production factors (material resources, human resources, capital, technology, etc.) aimed at creating goods and services that meet specific groups of needs. Common to these resources is the following (Deneva, 2013, pp. 19–20):

- they create conditions for the production of other material resources, ensuring the normal functioning and reproduction of the labour force (furniture, clothes, food, drinks, appliances, etc.),
- they provide the necessary machinery and equipment for the production of these material resources,
- production of these material resources guarantees the prosperity and the national economy and security of each country.

Within the industry, there are many enterprises that invest certain resources, use certain technology and obtain homogeneous or heterogeneous end products. **Industrial enterprises** carry out similar or identical production activity, representing a combination in space and time of heterogeneous or functionally identical production operations and processes that lead to the creation of different types of industrial products. Their unification and inclusion in the industrial sector are based on the relative homogeneity of production and services (criteria for homogeneity: similarity in production technology; similarity in the raw materials used; similarity in the economic purpose of production; opportunities to combine production or vertical services, similarity in the quantity and quality of work performed).

All the characteristics of the enterprise in general are typical for the industrial enterprises. At the same time, they are characterized by some specific features arising from the specifics of the industry in which they operate and the industrial products and services which they create, i.e. the subject of their activity.

Industrial product is a product intended to be used in the production process as part of the fixed tangible assets of the enterprise, as a product for primary processing, finishing, assembly or installation, which the manufacturer offers for sale on the industrial market for money or counter-delivery (barter).

The subject of activity of the industrial enterprise is the organization and implementation of efficient production and sale of industrial products or services in order to meet the needs of the economy and the society and to make profit. Based on the definition of an industrial enterprise, from the positions of the subject of activity and the branch of operation, the following characteristics of the industrial enterprise can be indicated:

- Intensive use of fixed assets, with a dominant share in the economic valuation of the enterprise.
- High degree of mechanization and automation of production activities, including robotics, with a tendency to include artificial intelligence.
- Implementation and use of a significant number of heterogeneous machines, operating in spatial and temporal coordination.
- Production of products, which for the most part are intended for an unknown buyer or direct involvement of the buyer-guarantor in the process of defining and constructing the key parameters and functionalities.
- Dominated by the share of engaged persons who have long-term employment, i.e. there is a higher retention of staff in the company for a longer period of time.
- There is a clear organizational division between production and trade.
- Serial type of production prevails.
- A division of labour is applied, linked to a predefined, precisely fixed and predetermined course of production processes and activities (e.g. at the conveyor) etc.

The final products and services of industrial character created by the industrial enterprises are intended for realization on the industrial market.

1.3. The features of industrial enterprises

When analysing the definition of an industrial enterprise, one can point out its features which include:

- organizational separateness,
- economic separateness,
- legal separation (legal personality),
- territorial separateness,
- technical and production separateness.

Organizational separateness means that the enterprise is separated in technical and organizational terms which manifests itself in a specific organizational structure appropriate for a given entity (Marek & Białasiewicz, 2011, p. 46). Traditionally, this structure is a set of all organizational elements and connections between them (Krupski, 2004, p. 65), as well as relations of superiority and inferiority occurring in the enterprise. Its aim is to smoothly and competently manage each unit and to conduct business activities that will enable the achievement of the set goals while maintaining financial discipline. The essence of separateness is manifested in the hierarchy of power which is reflected in a separate board that makes independent decisions, sets goals and methods of their implementation, delegates powers to other members of the enterprise, and is responsible for the adopted direction of development. Organizational separateness, due to the detailed assignment of

tasks to individual identified units as well as precise responsibility, affects efficient and effective management. It can therefore be emphasized that a properly defined structure affects the effectiveness of the implementation of the company's goals and tasks and also proves its flexibility.

Economic separateness is related to the possession by an enterprise of certain resources that it can dispose of according to its own will, on its own, at its own risk and responsibility, according to the principles of economic settlement. This means that all expenses related to the current activity must be covered by the enterprise with the generated income, and the development, in the form of renewal of the possessed property, with the profit generated on the basic activity. It should be emphasized that if it is not possible to cover its liabilities from the generated income, the enterprise is subject to liquidation. This approach is related to the self-financing principle which is a natural verifier of business activity of enterprises. In practical terms, it is assumed that the use of resources at the company's disposal will be characterized by efficiency, manifesting in the difference between outlays and effects (Lichtarski, 2003, p. 58). The relationship between the effects and inputs in an enterprise's activity is defined as productivity which can be considered from the point of view of the whole (total productivity) and individual, specified elements (partial productivity). The productivity of technical equipment, labour, energy and capital is of particular importance in the company's operations. When analysing the economic distinctiveness, some authors identify another feature which is the risk of failure. It mainly concerns high competition from other entities, unsuccessful investments, inadequate production program, lack of sales, inappropriate asymmetric cooperation or poor management (Marcinkowski, 2017).

Legal separation means that the enterprise is an independent entity of rights and obligations in the field of economic transactions which means that it may incur various types of obligations, including loans, conclude purchase and sale contracts and transactions, and conduct settlements with other entities operating under its own responsibility on the market. The essence of separateness manifests itself in the enterprise's ability to enter into economic relations of a civil and legal nature. When running a business, an enterprise with legal personality must comply with specific, detailed legal regulations. It should also be emphasized that not all organizations conducting economic activity have legal separation.

Territorial separateness means that the enterprise conducts business activity in a specific, separated area or territory where buildings, structures, halls and other premises necessary for the conducting of business, are located. However, due to the progressive processes of globalization, unification and the emergence of large corporate companies, this feature is losing its importance, as enterprises conduct activities in diversified territories (e.g. by shifting production to countries with lower costs).

The technical and production separateness concerns the specific production equipment at the disposal of the enterprise as well as the technology and the ability

to use it, licenses, patents, know-how, production organization, etc. It is emphasized that there are no two identical units, even when they are equipped with exactly the same machine park. The distinctiveness is evidenced not only by the machines and equipment but also by production programs which can be identified with the company's offer aimed at the market, relationships, concluded contracts, production capacity, organization and work structure, etc.

The Commercial Companies Code (2000) considers the enterprise as the main object and subject of legal relations. According to it the enterprise is a set of rights, obligations and factual relations:

- the basic rights of the enterprise include: the right of ownership and other real rights, debenture rights, rights to intangible objects and various types of non-property rights,
- liabilities include liabilities arising from the conclusion of various contracts and liabilities on loans and other monetary liabilities,
- the actual relations are expressed in the established system for realization of the finished products, advertising activity, business contacts and the image of the individual enterprise.

According to the legal interpretation, the enterprise is an independent legal entity engaged in commercial activity. As such, it is a real existing structure that enters into relations with other economic entities and is subject to certain general rules and regulations for the implementation of economic activity.

From the point of view of the requirements of the Accounting Act, the term enterprise means a set of a number of economically separate natural persons and legal entities carrying out an activity permitted by law.

Therefore, the enterprise is a business unit in which a specific type of production activity is carried out. It is characterized by legislative, administrative and economic independence. Its legislative independence derives from its status as a legal entity. The administrative one is related to the construction of a certain organizational and managerial structure, and the economic one—is expressed in the final results of its activity.

Every enterprise, regardless of its size and industry affiliation, has an owner. As such, it can be an individual or a group of persons, a legal entity or the state as a whole.

In order to better understand the nature and characteristics of the enterprise, it is necessary to consider it from two different points of view—as an economic system and as an organization of people.

As an economic system, the enterprise is a complete set of interdependent elements for the realization of certain economic goals. The separate parts of this set form the main subsystems of the enterprise: the input, output and transform subsystem.

The main task of the input subsystem is to ensure the normal functioning of the system as a whole. It includes all machines, equipment, raw materials, materials,

labour and capital, which ensure the course of production processes. Their quantity depends entirely on the size and goals of the enterprise.

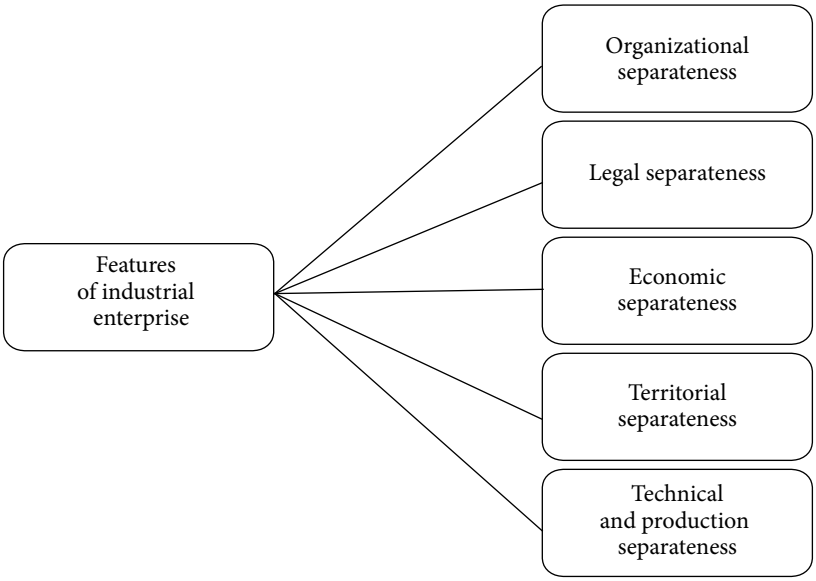

Figure 1.2. The basic features of industrial enterprises

Source: Own study.

In the transforming subsystem is the combination of the main factors of production. Here are the production processes for which the enterprise itself was created. The necessary condition for this is the presence of a certain technology.

The output subsystem includes the quantities of goods or services produced, in accordance with the objectives set in advance. Their realization provides the necessary funds for the existence of the business unit.

An obligatory condition for the normal functioning of the enterprise system is that its separate subsystems are interconnected and coordinated with each other, because each of them has strictly defined functions and tasks in the process of carrying out the production activity.

An enterprises can also be considered as an **organization of people**, which means that:

- it is an association of a certain number of individuals,
- it is created for the fulfilment of predetermined common goals.

In this case, as in any other organization, the main internal variables should be distinguished here, which to a large extent predetermines the results of the enterprise's activity.

1.4. Goals and tasks of an industrial enterprise

When analysing the definition of an industrial enterprise, it is often indicated that it must achieve a specific goal or objectives. In this approach, the goal should be understood as "the objectively and subjectively future, desired state or result of the organization's operation, possible and planned to be achieved, within the period covered by the short-term or long-term action plan" (Krzyżanowski, 1985, p. 57). The indicated definition is only one of the approaches disseminated in the scientific discourse. According to Krzakiewicz and Cyfert, the goal is an ambiguous concept (2009, pp. 24–25).

The goal should be understood as "the objectively and subjectively future, desired state or result of the organization's operation, possible and planned to be achieved, within the period covered by the short-term or long-term action plan" (Krzyżanowski, 1985, p. 57).

From the point of view of the company, the easiest way is to indicate what the goal is to specify what the company wants to achieve in the future and in how distant future, and what it must do to ensure the conditions of long-term existence and achieve these goals. There are two synonymous terms associated with the goal understood this way (Stabryła, 2012, p. 31):

- a task which should be understood as a spatially, objectively, subjectively and temporarily separated part of the goal to be performed within the set time limit, consistent with the time interval in which the goal should be achieved,
- mission which is equated with the concept of the company's business, the idea of its development and message as well as a general promise expressed in terms of the market.

Goals in an enterprise can be classified according to the various criteria. In the simplest terms, they are divided into general (official) and specific ones. In general ones, this is the state that a given entity wants to achieve in the adopted time perspective. Most often they are indefinite, fuzzy, indicating a certain desired position or situation in which a specific subject wants to find itself. They provide a framework for the development of specific objectives which means that they apply to the entire organization. Due to their general nature, they can be precisely broken down by assigning tasks for each unit or division in the organization. The split process continues until each group in the enterprise is held accountable for a subset of goals. This approach is known as the "cascade of goals" (Hatch, 2002, p. 129).

Precise definition of goals is also related to the management levels. The general nature concerns **strategic goals** defined by the top management of the organization which determine the directions of the company's development in the long term period. The length of this period depends to a large extent on the stability of the

external environment (e.g. political, legal and economic uncertainty shortens it). Due to the changes taking place in the environment, the goals at the strategic level should be formulated within a few or at most a dozen or so months, however, they look ahead for few or even several years. Strategic goals are set at higher levels of management as they relate to the effective use of the company's resources, including, among others, defining the company's mission and its prospects (e.g. entering new markets, including foreign markets, introducing a new product or service, improving the quality of the service provided whether the offered product or expansion of the company).

At the middle level of the organization, **tactical goals** are set that are related to the operationalization of activities necessary to achieve long-term goals. Their time horizon is much shorter and ranges from 6 to18 months. They are mainly related to the functioning of the company from the technical, organizational, resource, financial and employee side in the medium and short term period. These types of decisions are usually taken at the medium level of management and translate the general objectives set at the higher levels of management into the technique and method of their implementation at the lower level. The goals formulated at the tactical level may concern selection of new varieties of already manufactured products, introduction of a new product, elimination of an existing product from the production program, selection of production organization variants corresponding to the existing production equipment, selection of new technologies, new forms of organization and adjustment of the type and level of production capacity in responses to the changing conditions of the company's operation.

Operational goals, also called current, are set at the lowest management level in enterprises. They are set almost only in weekly intervals but there can be found also a daily shot. They usually relate to areas such as: determining the type and structure of work activities, organization of the working day, allocation of tools and tasks to be performed by individual units, analysis of performance indicators, information flow, etc. Their role is especially important in situations involving uncertainty and risk. The ability to react quickly and appropriately to threats in the core business proves the flexibility of the company and in many situations gives it a competitive advantage.

The goals in the enterprise can also be economic, material and social. The economic ones are often defined as the main goal, as they constitute the measure of the economic effectiveness of the processes taking place in the enterprise. In the context of the group of economic goals, the financial result is particularly important, as it is reflected in the generated profit which is the most synthetic criterion of rational management. It must go under operationalization which consists in decomposing the main goal into specific tasks and assigning them to the specific cells.

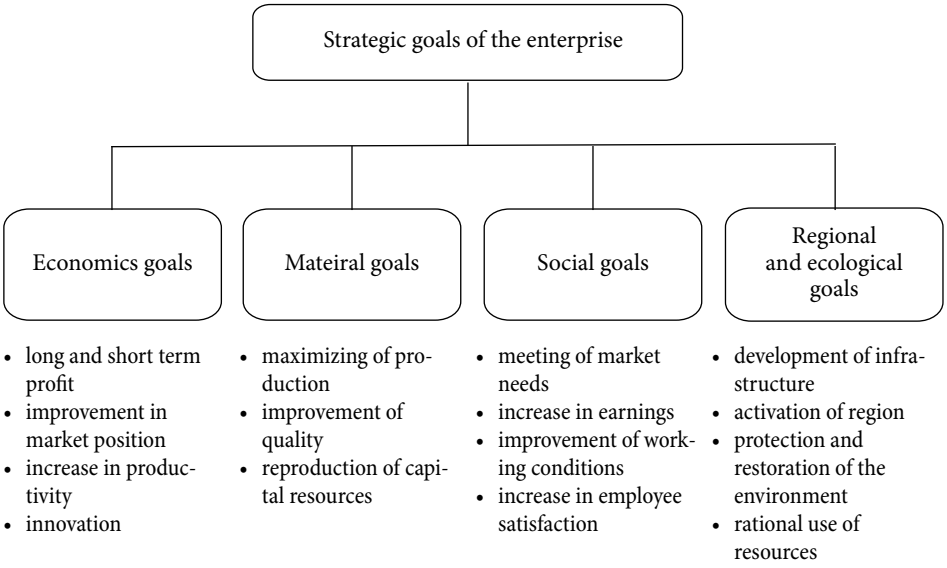

Figure 1.3. Company goals

Source: (Bieniok, 1997, p. 108).

It should be emphasized that the effectiveness of the company's operation is not determined only by the financial result but also the financial liquidity and should be treated as the economic and legal criterion for the company's survival. In practice, it is emphasized that the company's ability to settle its liabilities is periodic and result planning can be interpreted as an effective and anticipatory liquidity control tool (Nowak, 2013). Material objectives are shaped by the sales markets and mainly concern the quantitative and assortment structure of production and the dates of its implementation. This complicates production programming, time and space planning, and determines the achievement of other goals. The last group consists of social goals that concern:

- providing the employees with a workplace and personal income,
- fulfilment of aspirations regarding co-determination and co-responsibility for the fate of the enterprise,
- enabling employees to be promoted professionally, as well as ensuring job satisfaction and systematic improvement of working conditions.

These goals are limiting the implementation of economic and indirectly material goals due to the necessity to bear the costs of their implementation.

Objectives in the enterprise can also be classified according to the criterion of functional areas. Their essence is manifested in the necessity to meet a specific need within a specific time horizon. In particular, the functional goals relate to production, marketing, sales, human resources, finance, procurement, research

and development, etc. They must be compatible with each other, mutually agreed, coherent and consistent with the main goal. Summing up, it should be emphasized that there is no agreement to the number, nature and scope of goals in the enterprise. It is only indicated that they should be compatible with each other, consistent with the strategic goal and, above all, possible to implement.

When formulating goals for an enterprise, both in general and in detailed approach, it is important to respect certain conditions. In particular, attention should be paid to the necessity of:

- setting goals in a strategic perspective for the entire company and not for separate units or departments,
- specifying the goals separately, in operational terms,
- assigning a rank to individual goals and providing funds for their implementation,
- ensuring consistency between the goals set and the goals of employees and the principles of social coexistence,
- arranging goals according to the deadline for their implementation.

Following of the above guidelines will allow the company to set meaningful, consistent and logical goals that can be achieved within the set time horizon.

1.5. Company functions

Industrial enterprises, implementing their complicated and compound goals, simultaneously perform many specific functions that require, on the one hand general service related to the development of the enterprise and on the other hand the specialist service that relates to material and IT supplies. The following functions are particularly important (Krupski, 2004, p. 27):

- production function defined as supply, related to the core activity of the enterprise, technical and technological function related to product research and development as well as technical preparation of production, distribution function concerning the process of delivering manufactured products to the customer,
- supply function related to the acquisition of raw materials, materials and other means needed for production,
- organizational function based on the hierarchy of power,
- HR function viewed through the prism of people in the organization, social function identified with employee development and corporate social responsibility,
- financial function which manifests itself in taking care of the company's finances,
- the entrepreneurial function mainly related to innovative development.

The production (supply) function is considered to be basic and is related to the process of producing goods or rendering services. It is the basis of the company's

competitiveness, determines its current functioning, development and future. It is characterized by continuity and repeatability in strictly defined production cycles, whether dealing with unit, series or mass production. It is related to marketing activities, it is emphasized that it is justified when the enterprise generates sales revenues. It is very important to determine the production program in terms of quantity and assortment, production methods and defining the final recipient. Errors or mistakes in this regard will be reflected in serious perturbations which in extreme may lead to bankruptcy. Products and services are offered on various markets, alike local, national and international. It requires large investment expenditures, while carrying out the production process, the company must purchase the appropriate machinery, raw materials, materials, semi-finished products, parts, etc. The park must be monitored in terms of the degree of wear, use and suitability. In the event of any discrepancies with the adopted standards, the replacement or modernization investments should be carried out. The reconstruction defined as restitution, consists in the replacement of used parts or entire fixed assets with the new ones, without increasing the level of economic activity. The modernization is related to the development of the enterprise, which is manifested in the reduction of production costs, increase of production capacity, savings of materials and raw materials as well as energy, improvement of the environmental impact, better quality of manufactured products or services, etc. The production function is important both for the enterprise and its stakeholders as well as the immediate and further environment.

The technical and technological function is related to the preparation and implementation of the production processes. The technique concerns human activity that is related to the production of things or causes phenomena that do not occur naturally in nature, while the technology is related to activities in which the achievements of technology are used (Krawczyk-Dembicka, 2018). The technology covers the preparation and implementation of the production process which consists of research and development, construction, organization and preparation of production and the adoption of an appropriate production capacity strategy. It can be considered in terms of engineering, as a process of manufacturing a specific product or economically meaning a set of all production techniques or manufacturing methods that are available in a given enterprise (Krawczyk-Dembicka, 2018, p. 11). Thanks to this function, the company can correctly define its production profile as well as the means and actions needed to determine it. It is indicated that the technological function, due to technical progress, requires constant monitoring of the environment. A quick reaction to the changes taking place as well as taking them into account in the current activity, determines the current development and affects the future position. At the same time, it is emphasized that the correct choice of technology and its skilful production, influences the development

of core competences (Filipowicz, 2010) which can be a strong advantage in the competitive fight. From the point of view of a production company, this function is the basic instrument for shaping the possibilities, volume and effectiveness of sales of the manufactured products (Grzenkowicz, Kowalczyk, Kusak, Podgórski, & Ambroziak, 2008, p. 21).

The distribution function is related to the flow of products and services from the producer to the final buyer. It is related to other functions, including in particular sales planning, both in strategic and operational terms. In order to properly plan the distribution, the information on the quantitative forecasts of sales in individual time intervals and possible qualitative changes in customer service are required. The company can choose various distribution channels but must take into account their cost and planned benefits. The starting point is to identify customer preferences and requirements and then adopt one of the methods, i.e. indirect, direct and mixed distribution. In practice, the intermediary companies that specialize in serving a specific industry or market, are preferred. Direct sales are most often used in relations between large enterprises that cooperate in the production of a specific product. It is emphasized that thanks to distribution, there is a constant inflow of cash to the company. Therefore it is particularly important to take into account the cost accounting when planning it (Raport, 2014; *Business functions*, 2020).

The procurement function is closely related to the production function because the enterprise, in order to ensure an efficient and quick course of the production process, must ensure appropriate material and technical supplies. The analysis covers sources of supply, the method and conditions of transport, delivery time, availability, price, etc. When organizing the supply it should be taken into account to minimize costs while maintaining maximum inventory control. In practice, two opposing options are used. The first one is to maintain the maximum level of stocks in the company, the second one is related to shifting the costs onto the supplier who receives the appropriate remuneration for his work. In the first case, it is particularly important to define the size of the delivery batch, for which one of the following methods can be used: fixed order quantity solution, economic order quantity, lot for lot, period order quantity, least unit cost, least total cost and other. It is also important to determine the guarantee stock, which is calculated on the basis of the risk of running out of stock.

The organizational function concerns the enterprise considered as a system that is defined as a deliberately defined set of elements and interconnections between them which together define the features of the whole (Brzeziński, 2002, p. 17). Its essence is manifested in the organizational structure, i.e. the formal organization of the company, the sets of elements (organizational units, positions, departments, separated parts) and the links between them (information flows, formal division

of responsibilities, affiliations, etc.). Its task is to define formal relationships and dependencies between its participants (Jemielniak & Latusek-Jurczak, 2014, p. 89). In such a system, each employee has a role assigned to him which consists in performing assigned tasks, making decisions and taking responsibility. Thanks to the organizational function, it is also possible to properly shape resources, including material, financial and human resources as well as to develop their proper configuration which should contribute to the efficient implementation of the adopted challenges.

The personnel function, also referred to as personnel management, is related to the personnel policy of the company and concerns its staff, especially in the area of "human-work" (Piwowar-Sulej, 2013). It focuses on the characteristics and attributes of an employee, including the level of his education, experience, qualifications and competences as well as on issues related to the employment and dismissal, human resource management, assistance in professional development, etc. (Król & Ludwiczyński, 2010). The authors indicate that the personnel function is shaped by the company's structure, strategy, organizational culture as well as the external and internal environment. It is emphasized that it is carried out by all employees, including direct and indirect production, management and technical-engineering employees (Leśniewski & Morawska, 2012, p. 33). In the company, it is associated with two equal goals. The first one is of a business nature, considered to be basic, concerning the organization of work and increasing its efficiency which can be achieved thanks to the efficient management. The second one focuses on man, on satisfying his needs, both individually and in a group, expectations, aspirations (Marciniak, 2013, p. 15). As part of the personnel function, the following should be examined: reporting on human resources, liquidity and fluctuation of employee movement along with the analysis of causes and consequences, working time and the degree of its use as well as loss of working time, the level and changes in labour productivity, factors of labour productivity growth relations between labour costs and productivity in static and dynamic terms, size, dynamics and structure of labour costs, etc. (Muhlemann, Oakland, & Lockyer, 2001, pp. 455–467). It can therefore be emphasized that it is the entirety of activities related to the human resource of the enterprise, aimed at achieving the set goals while meeting the needs of employees (Walczak, 2013, p. 284).

The social function relates both to the company's employees and to its immediate and further environment. In the first approach, it concerns providing the employee with a workplace and personal income, satisfying his aspirations regarding co-determination and co-responsibility for the fate of the enterprise, enabling the employee for professional promotion, job satisfaction and adequate conditions. In the second one, it is associated with corporate social responsibility. It is emphasized that the modern market, apart from its positive aspects, is also a source of injustice, threats, inequality, social unrest, etc. When implementing the social function, the

goal becomes to correct or limit economic rationality in areas where the market does not work perfectly or at least sufficiently (Grzegorzewska-Ramocka, 2009, p. 60).

In other words, the financial function is the company's financial policy which should be understood as the entity's activity consisting in striving to achieve previously set goals using financial tools (Gołębiowski, 2009, p. 13). It includes (MonitorFx, 2020):

- accounting related to bookkeeping, reporting, forecasting and internal control measures,
- capital structure, i.e. the relationship between equity capital and liabilities under which the appropriate level of debt and equity is sought, acquired and maintained,
- capital planning, including investment selection, project valuation and forecasting,
- financial liquidity management, i.e. analysis of the ability to settle current liabilities for purchased goods or services,
- tax planning, i.e. looking for solutions to minimize tax burdens thanks to the use of legal provisions and regulations.

The main goal of the financial function is self-financing and generating an appropriate level of profit. Therefore it is directly related to the production function within which decisions are made regarding the assortment and the quantity structure.

The entrepreneurial function is seen as one of the main driving forces of the enterprise. It can be defined as the process of planning and organizing business activity along with the acceptance of the associated risk (Griffin, 2004). In particular, it concerns the identification of opportunities and possibilities of operating on the market, developing an action plan, gathering the necessary resources and managing the enterprise in subsequent stages of development (Polowczyk, 2009). This function consists of subfunctions, including the following: personality, managerial activities, individual entrepreneur and market (Wach, 2015). Its analysis should always take place in the context of employees who acquire experience, new qualifications or skills and use them in practice through creative solving of the emerging problems. This function is related to the innovative projects that can be practically implemented in all areas of the economic activity (Grzenkowicz et al., 2008).

1.6. Typology of the industrial enterprises

Due to the complexity, ambiguity and multiform nature of the industrial enterprises, they can be classified using various criteria. The use of a specific division facilitates various types of analyses and statistical reports, while avoiding methodological errors (e.g. an attempt to compare two or more enterprises with a different business profile or the same profile but they vary in size).

Table 1.2. Enterprise according to various criteria

Criterion	Type of enterprise
business profile	**production**: producing material goods, mainly the processing and mining industries **commercial**: retail and wholesale companies **service companies**: companies providing services, including shipping and transport, warehousing, maintenance, financial, legal, marketing, etc.
the size of the enterprise	**micro-enterprise**: the average annual employment of employees is less than 10 people, and the net income or balance sheet total is less than or equal to eur 2 million **small enterprise**: average annual employment of employees is less than 50 people and the net income or balance sheet total is less than or equal to eur 10 million **medium enterprise**: the average annual employment of employees is less than 250 people, and the net income is less than or equal to eur 50 million or the balance sheet total is less than or equal to eur 43 million **large enterprise**: all the others that do not meet the above-mentioned criteria
form of ownership	**private sector** **public sector**
production type	**unit production** **serial production** **mass production**
type of production process	**specialization** **diversification**
market	**industrial market** – OEM (original equipment manufacturer) – MRO (maintenance repair and overhaul) **consumer market** **dual market** (operation both on the industrial and consumer market)
legal form	enterprises of natural person limited liability company public limited company partnership

Source: Own study.

The basic division is based on the business profile. From this point of view, they can be distinguished as production, service and production or service companies. The first ones deal with the orderly and conscious processing of the resources at their disposal, using a specific technology, in order to manufacture products supplied to other enterprises, wholesalers, retailers or end consumers. Production is considered to be one of the most important activities of the enterprise as it results in the creation of new utility values (Brzezinski, 2002, p. 22). It is indicated that "manufacturing processes requires a knowledge of many disciplines, including design, process planning, costing, marketing, sales, customer relations, purchasing, bookkeeping, inventory control, material handling, shopping and so on" (Halevi, 2001, p. vi).

Service companies are concerned with the provision of industrial services by which we understand "service to customers engaged primarily in a process which creates or changes raw or unfinished materials into another form or product including the generation of electric power". One of the prevailing views is that industrial services are provided to industrial clients or clients with industrial production as opposed to consumer clients (Schmitz, Gitzel, Fromm, Setzer, & Isaksson, 2015).

Therefore, it can be emphasized that the basic criterion that distinguishes production services from non-production services is the type of recipient: an individual consumer or other enterprise running a production activity (Brax, 2005). An important criterion that distinguishes industrial services from non-industrial services is also the type and scope of cooperation. We deal with an industrial service when the recipient of manufactured products or other activities is another company with which a cooperation agreement has been concluded. In that contract all parameters, such as quality, type of raw material, technical data, quantity, price are strictly defined. Otherwise we are dealing with a manufacturer offering its products on the market. Moreover, it is pointed out that the element that distinguishes services from industrial services, is the scope of additional criteria. Apart from typical features such as: immateriality, impermanence, diversity and heterogeneity, the distinctiveness of industrial services is demonstrated by specialization, technology and consumption in irregular patterns (Schmitz et al., 2015). The typical production services include activities focused on: design, assembly, completion, processing, turning, milling, varnishing, painting, demolition, cutting and similar production-related services, which include transport, storage and warehousing, maintenance, current and scheduled repairs, etc. The production and service companies deal with both production and provision of specific services within their spare production capacity.

The enterprises can also be analyzed in terms of the nature of the work performed. The classification is based on the increasing technological complexity of modern products, the complicated manufacturing process and the need to shorten production cycles and deliver products to the market. The above changes led to the increased importance of specialization and concentration, disintegration of the value chain and globalization of enterprises operating in the industrial markets.

Specialization should be considered on two levels: social and technical ones. In social terms, it should be equated with the variety of collective actions taken, while in technical terms it is related to the development of a certain efficiency of action as a result of restricting certain works and repeating them (Smoliński, 1974).

As a result of specialization, the company focuses on those areas of activity to which it is best prepared in terms of resources, technology and skills (Janasz, 2000, p. 159). As part of the specialization, the enterprise dispose of areas of activity in which they achieve average or low results and focus on those in which the results are the best. The basis of specialization is the desire of enterprises to improve labour productivity while improving quality and increasing the volume of production. The

specialization allows to reduce the company own costs, improve the structure of using assets and resources, and build a competitive advantage and develop key competences.

The process opposite to the specialization of production is its universalization which takes place when there is an increase in the performance of various activities and operations carried out at individual workstations. As a result, the number of manufactured assortments and performed functions is most often extended.

Extremely different to specialization is diversification which should be equated with the extension of the scope of the company activity to multidirectional, often diametrically distant fields. This results in its functioning in various sectors (Urbanowska-Sojkin, 1998, p. 138). It is a conscious and deliberate policy of the company to expand the program of operations in order to achieve high effectiveness and efficiency using its resources and markets. It leads to the creation of a new quality in the product-market combination of the company, significantly exceeding the current processes included in the value chain (Rajzer, 2001, p. 63). A diversified portfolio of activities allows for more effective risk management and favours a wider exploration of new opportunities than specialization (Hagel & Brown, 2006, p. 84). It may consist in introducing new, not yet produced products or services that meet the new needs of buyers. Their production is based on the existing, new or modified technology. It means an increase in the level of production diversity with an increase in the degree of market diversity.

Another criterion is related to the type of market served. From this perspective, a company can offer products or services in the consumer or industrial goods market. In some cases, the offer is directed to both markets. In such situation we say that the product or service is dual. The typical examples of a dual product are the basic raw materials of the food industry, such as grains, flour, sugar, fruit, vegetables, etc. These products are used by both households and processing companies.

The consumer goods market is a place where the buyer "makes purchases for their own individual use and is characterized by their demographic, behaviouristic, psychographic and geographic aspects" (Ahmed, 2019). The sellers in these markets are usually producers operating through an indirect distribution system and the recipients are individual households.

The industrial goods market, also known as the business to business market, covers transactions involving the sale of goods and services between enterprises. The goods and services are offered by enterprises and the buyers are usually other enterprises, investors and the government (Janasz, 1997, p. 91). The specificity of the market is related to the type of goods or services which are divided according to the way they participate in the production process and their relative cost (Hutt & Speh, 1997, p. 45). Both the consumer and industrial goods market includes three types of transactions which in the first case concern: direct consumption, durable goods and services, and in the second case: trade in investment goods, raw materials and materials, and production services (Wojciechowski, 2016).

The goods offered on the industrial market can also be classified according to the criterion of their use in the production process. Then they take the form of entering goods, foundation goods and facilitating goods (Hutt & Speh, 1997, p. 45).

The entering goods are those that are processed in the production process and become a component of the finished product. They are divided into raw materials and industrial materials and parts. The raw materials are products of the extractive industries, agriculture, forestry or the processing of waste. The latter ones are particularly important and are described as the secondary raw materials, i.e. those production waste or used products suitable for reprocessing. They include (GUS, 2020):

- useful waste materials generated in production processes (post-production waste), in food processing companies, this product is defined as a by-product, because general waste cannot be further processed into human food,
- used products (post-consumer waste),
- pre-sorted (segregated) fractions of municipal waste (without their processing) not suitable for the direct use in the industrial processing.

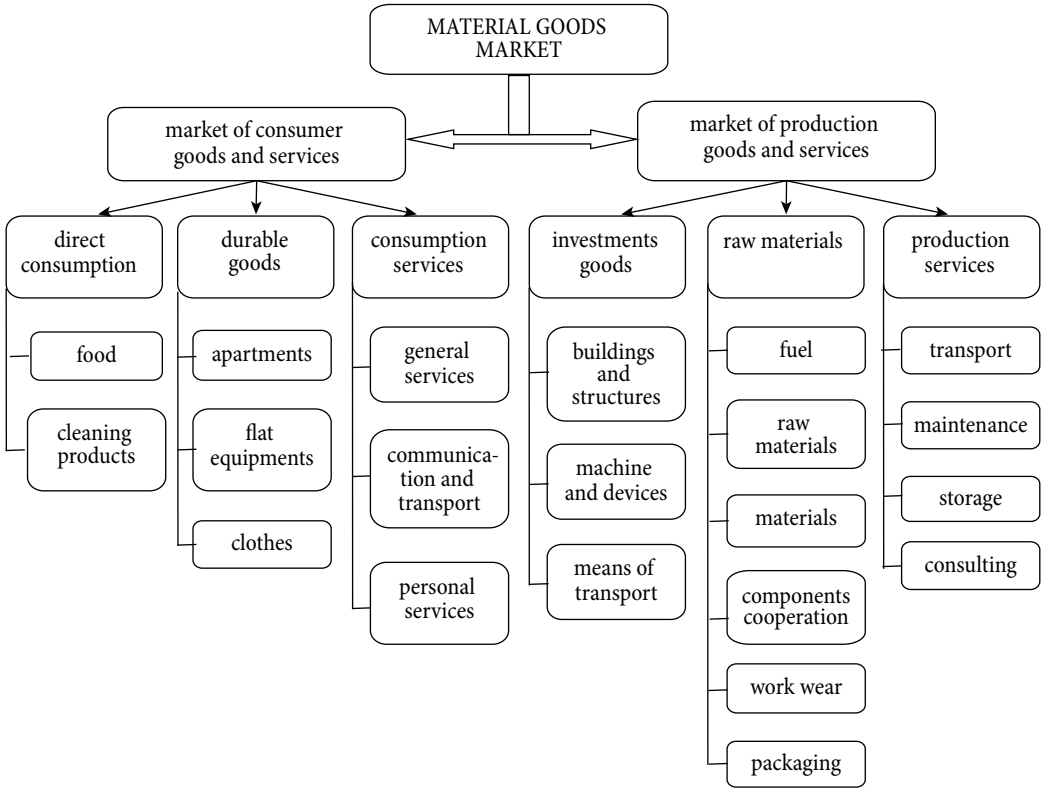

Figure 1.4. The material scope of the market

Source: (Wojciechowski, 2016, p. 15).

Industrial materials and parts, unlike raw materials, are subject to initial processing which is continued in the next enterprise. They also include semi-finished products, details, semi-finished products, fabrications and industrial standards, i.e. standardized, most often small elements that are widely used in industry. In particular, these are bolts, nuts, seals, bearings, belts, pulleys, etc. Their development took place thanks to the unification of production activities. The unification is a standardization method aimed at rationally reducing the variety of products or activities. It is obtained by standardizing the features of products—e.g. construction, shape, dimensions, quality parameters, functional features. The unification increases the versatility of machines, devices and products, enables the interchangeable use of various parts, facilitates the processes of production, transport and sales, enables concentration and specialization of production, allows for cost reduction (Smoliński, 1974, p. 235).

The foundation goods are capital goods which, when used in the production process, transfer their value to the manufactured goods or services in the form of depreciation. They include two types of goods, i.e. the devices and auxiliary equipment. The devices are quite broadly defined, apart from typical production equipment (machinery park), they include buildings and structures, means of transport, infrastructure, etc. The auxiliary equipment is small devices, machines or accessories, usually with low purchase costs which facilitate work or constitute a human work tool.

The facilitating goods mainly include supplies and services, the task of which is to support the operational activity of the enterprise. In a production company, the maintenance and repair articles that are used in the maintenance process are of particular importance. It applies to both the elimination of failures of machines and devices as well as their prevention through inspections and repair prophylaxis. In practice, it is believed that maintenance is one of the most important functions of a production company. A breakdown, inefficiency or a defect of the machine causes its downtime which is reflected in the increase in production costs, the inability to execute orders or delays, and even breaking cooperation ties (Hyla, 2018, p. 61). The services are related to the performance of work not directly related to the production of the product. They assume the nature of an order addressed to an entity that specializes in a given scope. The services may include repairs, renovations, cleaning, security as well as consulting, accounting, marketing, human resources, etc. Their development resulted from the search for savings in operating activities. Their use in operating activities influences flexibility, cost reduction, operational improvement, restructuring and even changing the domain of activity.

The industrial companies that manufacture goods or provide services can offer their products on the OEM (original equipment manufacturer), MRO (maintenance, repair and overhaul) market, or both ones.

The first one concerns the components of manufactured devices defined as: the first assembly equipment. The transactions concluded on this market are characterized by a very high value, a large number of elements in one assortment and direct cooperation, most often based on a formal agreement which specifies all the parameters of the agreement, including, e.g., the specific product features. In addition, the deliveries are successive and consists in the delivery of goods or the performance of services in smaller parts and at specified intervals (e.g. weekly, monthly, quarterly). The unit price of purchased products is usually much lower than in the spare parts market, the manufacturers usually use specific OEM price lists.

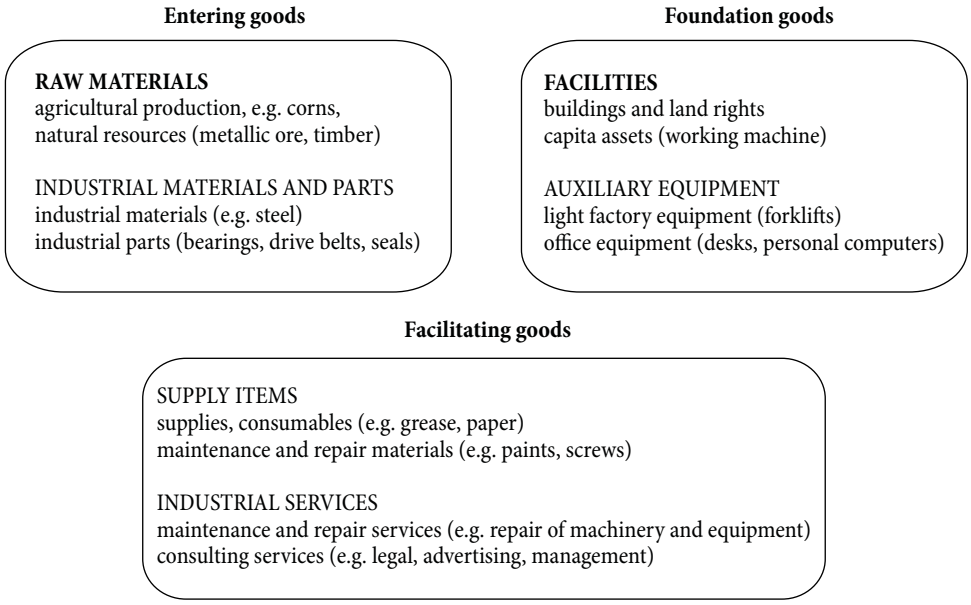

Figure 1.5. Classification of goods on the industrial market

Source: (Kotler, 1980, p. 172).

The second market is related to the repairs and renovations, also known as the after-market. It is emphasized that production activity causes wear and tear of the machine park which may be reflected in production downtime, deterioration of the quality of manufactured products, the increase in costs, or the inability to implement plans. The enterprises must therefore take measures to maintain their equipment in an appropriate condition which will allow (Muhlemann et al., 1992, p. 176):

- to enable product or service quality and customer satisfaction to be achieved through correctly adjusted, services and operated equipment,
- to maximize the useful life of the equipment,

- to keep equipment safe and prevent the development of safety hazards,
- to minimize the total production or operating costs directly attributable to equipment service and repair,
- to minimize the frequency and severity of interruptions to operating processes,
- to maximize production / operation capacity from the given equipment resources.

This market is characterized by much greater differentiation, higher price levels compared to OEMs and the activities of intermediaries who usually offer a full range of spare parts, including both original and replacement parts. This market is very sensitive to all kinds of turbulences and disturbances in the environment. In the first place, the investments related to planned repairs are abandoned or postponed. These renovations take the form of modernization (development) or replacement investments.

1.7. The features of industrial market

In general terms, industry is "the material production consisting in extracting natural resources from the earth and producing products in a mass manner using mechanical devices" (PWN, 2020). The industrial market, on the other hand, is a place where sales and communication go to other companies, not individual buyers. According to the Prospectus of the Institute for Industrial Markets Studies, the industrial market is "local or international market of products and services purchased by enterprises, government bodies as well as institutions (such as hospitals) used to manufacture new products (e.g. components or components), consumed (e.g. materials consumed in production, office supplies, consulting services), used (e.g. installations or equipment) or resold. The only markets that do not fall within the scope of this definition are those where traded products or services are these primarily aimed at personal use or consumption, such as packaged food products, household goods or consumer banking services. The factors that distinguish the market of industrial goods and services from the market of consumer goods and services are the nature of the customer and the way in which he uses the product. In the marketing of industrial goods and services, the clients are organizations, i.e. enterprises, government, institutions" (Hutt & Speh, 1997, p. 27).

Table 1.3. Type of industrial products

Raw materials	products that are sold in their natural state	coal, timber, metallic ores	cyclical market, regional supply sources, high transportation cost, bulky products,

Processed materials	products that have been partially processed before reaching an ultimate producer	plastics, glass, chemical, steel, lumber	commodity products, lose their identity, incorporated into other products
Supplies	products that are used up during the manufacturing process or during the daily operation of a business	lubricants, office supplies, welding rods	stock items, of the self, availability is important
Components	products that either are ready for direct assembly into the finished product or require only minor processing	pumps, electric motors, diesel engines, lamps, microchips	require no further processing, perform a vital function
Equipment	capital goods that support a user's manufacturing or other business needs	machine tools, aircraft, computers	high-cost capital goods, assets, reliability is important, so too are first cost and operating costs
Systems	capital goods that support a user's manufacturing or other business needs	process equipment, paper mills, steel mills	perform two or more function, high financial risk, to seller but also offer high financial rewords
Services	activities, benefits, or satisfaction that are offered for sale	advertising, legal service, marketing research, transportation services	intangible services

Source: (Günay, 1999, p. 227).

The above definition indicates two basic features differentiating the consumer goods market from the institutional market. They are namely:

- strictly defined nature of the buyer (enterprise, government body, institution),
- the nature of the intended use of products and services (for the production of new products, used up, used and resold).

Table 1.4. Industrial customer type

Industrial customers type	Market segments	Organizational missions	Buying behaviour
Commercial enterprises	– raw material producers, – construction manufactures, – services and professions, – wholesalers and retailers, – transportation, – communication and other public utilities	– serve a customer needs at a profit	– multiple influencers – multiple buying motives – complex purchasing process
Government	– federal – state – local	– provide for the welfare, defence, education, crime, prevention, transportation, infrastructure etc. need of its citizens	– negotiated buying – precise specification – bid buying

Industrial customers type	Market segments	Organizational missions	Buying behaviour
Institutions	– hospitals nursing homes – school college and universities, religious organization, non-profit foundations	– social concerns – charitable concerns	– professional influencers

Source: (Günay 1999, p. 229).

According to Wojciechowski (1992, p. 21), "…the basis for the relative separation of the materials market is the type and purpose of the goods traded on this market, the nature of the entities participating in this turnover and the specific features of its structure—different than on the consumer goods market." Also, the definition presented by the author indicates two basic features that distinguish the industrial goods market from consumer goods one. Additionally, apart from the intended use of the product and the type of buyer, its structure features are mentioned. The industrial goods market includes three types of transactions, including sales of processed goods, raw materials and services. It focuses only on those activities that result in the production of a separate end product. This process is conditioned by the acquisition of specific raw materials, materials, parts, energy and services that ensure, on the one hand, production safety, and on the other hand, the production of the product. This way defined market is characterized by specific features of which the most important are (Hass, 1986; Urbaniak, 1998; Wojciechowski 1999; Kuada, 2002; Mudambi, 2002; Vidovic, 2011; *Distinctive Features*, 2018):

- The intended use of the product: the industrial good is transformed into another product or is used in the production process to manufacture other products.
- The much higher value of turnover on the industrial goods markets and especially their concentration compared to the consumer goods markets where purchases are dispersed.
- The type, nature and scope of buyers, sellers offering goods on the industrial market cooperate with a much smaller number of buyers compared to the consumer goods market: usually these are production companies offering both final and less processed products, but these buyers are much larger, they concentrate significant transactions in their hands, especially in the case of industries such as mining, metallurgy, engineering, electromechanical, shipbuilding and automotive industries.
- The elimination of purchases in retail trade and focusing on direct trade or transit circulation (with the participation of agents—organizers): purchases directly from producers are based on long-term and formal contracts which are preceded by negotiations (they are comprehensive in nature, covering alike the type, technical features, quality, price, payment terms and delivery conditions, etc.).

- The dominance of purchases directly from producers: this applies in particular to those items that are technically complicated, or the cost of their purchase is very high.
- The existence of linked transactions which means that the buyer of production goods selects such suppliers who can also become his customers.
- The individual nature of the transaction, concerning in addition to specific contract terms, the supply of goods and services, created for a specific buyer, according to his preferences, requirements and often under his supervision.
- The formation of closed market segments that are usually inaccessible to other participants.
- Producers and buyers know each other because of the long-term nature of the cooperation.
- The derivative nature of demand for industrial goods in relation to consumer goods: it is usually larger and deeper, an increase or decrease in demand for consumer goods by one percent causes much larger changes in demand for industrial goods; they may lead to a sharp economic growth or a complete collapse of demand for investment goods; in bibliography this principle is referred to as the principle of acceleration (Blaug, 1994, pp. 184–185).
- Much lower price elasticity compared to the consumer goods market, especially over short periods: any upward and downward price movements have a minimal effect on the total demand for industrial goods and services; an increase in the prices of raw materials intended for production does not inhibit its purchases; in such cases the main task is to look for cheaper suppliers or substitutes; also a decrease in prices does not increase purchases due to the storage costs and concerns about lower quality of the products offered at a cheaper price; the reason for these things are also related to the production process which producers are not able to change in a given (short) period of time (Kotler & Dubois, 1989, p. 215).
- The purchasing professionalism, based on the skills and knowledge of the qualified employees of procurement departments: many employees of the company take part in the purchase process; their number depends on the nature of the purchase; in the case of important strategic decisions, the negotiations take place at the highest levels of the company; in the case of repetitive purchases, they are acquired automatically based on the procurement department.
- The dependence on imports of certain raw materials and materials that are not present in the territory.
- The existence of leasing, tenancy, rental and other agreements, enabling the improvement of efficiency and productivity of the use of production potential.
- The purchasing decision factors: more factors influence purchasing decisions on the industrial goods market than similar decisions on the consumer markets; the enterprises have special decision-making teams often consisting of a group

of experts, both technical and economic ones who make decisions about the purchase of a given good.
- The qualifications and skills of salespeople who must have the appropriate knowledge.
- The significant role of the personal sales (personal contacts) plays an incomparably greater role than advertising and promotion using standard media.
- Many participants take part in the purchase process: the initiator of the purchase, the person influencing the decision making process, the decision maker, the buyer, the user, the guard (Urbaniak, 1997, p. 27).
- The relatively high state intervention, especially in the case of raw materials and materials of strategic importance, e.g. military products, radioactive raw materials, etc.

The industrial goods market of course is not a hermetically closed, separate market segment. It is always an element of the global commodity market. It is governed by the same market laws which in certain situations may be different from the common rules of operation or may be based on completely different relations between market entities.

Table 1.5. Differences between industrial marketing and consumer marketing

	Characteristic	Industrial marketing	Consumer marketing
Market structure	competition demand demand levels reserve total marketing size size of buying market geography	oligopolistic derived levels more volatile frequent larger group concentrated	monopolistic direct les volatile infrequent smaller individual diffuses
Marketing philosophy	market segmentation investment requirement market perspective tactical marketing emphasis innovation transactional buyer / seller interaction reciprocity key accounts customer education	emporographics strategic global profit performance technology-push relationship frequent important strong	demographics tactical regional / national market share demand-pull rare non-existent weak
Buyer behaviour	customer / prospect mix order size and frequency purchasing motives and skills contractual penalties buying power vendor loyalty purchase involvement	small large, infrequent rational, professional common strong strong great	large small, frequent emotional, self-gratifying never weak weak smaller

	Characteristic	Industrial marketing	Consumer marketing
Purchasing decisions	decision making process accounting / tax consideration purchase risk	complex, lengthy important very high	simple, short unimportant low
Marketing research	orientation research approach questionnaire terminology precision of data cost of project	strategic empirical technical rough estimates low	tactical inferential nontechnical statistical precision high
Product / services mix	product life cycle product specification branding purchasing timing degree of fabrication type of packing services	shorter customized corporate family requirement planning value-adding stages required protective	longer standardized individual product immediate use mostly finished goods promotional less, point-of purchase
Promotion	promotional emphasis promotional objectives promotional themes role of salesperson sale promotion tools	personal selling preparing for sale call rational, factual problem solving specifications sheets, catalogues, direct mail, trade show	mass advertising positioning products and firm fanciful, imaginative persuasion coupons, samples, point-of purchase display
Distribution mix	channel length channel complexity product knowledge channel coverage delivery reliability	short direct complex strong direct, exclusive crucial	long, indirect simple weak intensive, selective not critical
Price	competitive bidding price negotiation leasing product life cycle cost and benefits discount structures promotional pricing	common common common important complex seldom used	rare rare rare usually ignored straightforward frequently used

Source: (Günay 1999, pp. 232–233).

Questions / tasks

1. How can you define an enterprise and an industrial enterprise?
2. What are the basic and support activities in Porter's value chains?
3. Explain the subjective, objective and functional meaning of the enterprise.
4. Give and discuss the features of an industrial enterprise.
5. What does the economic distinctiveness of an enterprise mean?
6. How can you define the purpose of an industrial enterprise?

7. List and discuss the operational goals of the industrial enterprise.
8. List and discuss the strategic goals of the industrial enterprise.
9. How important are social goals in the enterprise? Justify your answer.
10. How can the functions of an industrial company be defined?
11. What is a production function and what does it depend on?
12. The importance of the financial function in an industrial enterprise.
13. What is the difference between a manufacturing company and a service company operating on the industrial goods market?
14. What is the difference between specialization and diversification of production?
15. What are the dual products?
16. What is the industrial goods market?
17. What is the consumer goods market?
18. How can goods offered on the industrial market be classified?
19. What is the OEM market (original equipment manufacturer) and what is the MRO market (maintenance repair and overhaul). List the differences and features.
20. Characterize the features of the industrial market.

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2.

THE OPERATIONAL MANAGEMENT EVOLUTION AND ITS ROLE IN THE INDUSTRIAL ENTERPRISE

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Abstract: The topic introduces within the field of operational management from the standpoint of its historical-evolutionary definition context. The essential aspects are clarified, and the levels of operational management are presented. The principles of operational management are formulated in a short, systematized form. The nature and types of production systems are clarified, as well as their main elements. Definitions regarding the production process, organization of the enterprise and its main subsystems, forms of organization of the production process, forms of arrangement of the production units in space are clarified, too. The recommended fields for identifying good practices in the organization of the production process are also defined. It has been presented the main links that need to be made in terms of good practices, derived in theoretical terms and their main contributions to the enterprise to achieve the desired results by applying the good practices.

Keywords: definitions of operational management, good practices of organization of the production process, levels of operational management, organization of the production process, principles of operational management, production system.

2.1. Introduction

As an independent scientific discipline, operational management began in the '80s of the last century. The path that goes through the concept of management of operations is quite long and marked by both significant revolutionary changes and the gradual accumulation of knowledge and skills (see Table 2.1).

Table 2.1. Main stages of operational management

Years	General feature	Key approach
1700–1900	Stage 1. Manufacturing Management	Craft Production, Mass production, Scientific Management
1900–1980	Stage 2. Operations Management	Operations Research, Human Relations School
1980–1990	Stage 3. Operations and Supply Management	Post-mass production, Early imitation of ad hock Japanese approach
1990–2000	Stage 4. Integrated Operations Management	Lean Operations based on Japanese approaches

Source: (Piercy, 2012, p. 178).

As an **independent scientific discipline**, operational management could be classified as one of the "relatively new" economic disciplines. The main prerequisite for its development and validation is the awareness of the need for the implementation of effective and timely management decisions in the emergence of similar management problems in very different in nature organizations.

As a **type of management activity**, it has been practiced for a long time as the first time the term "operational management" was used in English literature, dates as far back as 1852.

Each of the periods in the development of operational management is distinguished by its strictly individual specificity and lasting reflection in both theory and business practice. In the first stages, the foundations of both modern management and economic theory are laid, as well as the scientific organization of the production activity. The beginning was related to the publication of the works of two of the most famous scientists in the field of economic knowledge—Adam Smith and Frederick Taylor. By developing the theory of the division of work, Smith enables a new approach to the construction of the production activity of the enterprise. Frederick Taylor, with his research, launched modern management and the foundations of the scientific organization of production. The role and place of another major researcher from this period—Elton Mayo, who based on an experiment in a specific production structure—the Hawthorne experiment, studied the impact of the environment on labour productivity should not be overlooked (Stevenson, 1993, p. 27). No less is the importance of the theory of standardized elements presented at the time by Eli Whitney, which helped to significantly increase labour productivity.

As a result of these developments and the practical activities carried out (such as the creation of the computer, the development of tables for the representation of dependencies, research and design of production operations), significant progress is made in terms of labor productivity. The main merit of these initial stages is in the search and development of methods to increase the efficiency of production processes.

After 1910, the development of operational management was associated with its mathematization and computerization as a matter of priority. A significant share of developments lead to the creation of specific models such as EOQ (Economic Order Quantity), MRP (Material Requirements Planning), PERT (Program Evaluation and Review Technique), CPM (Critical Path Method). Again during this period, operational management became an independent scientific discipline. The initial names of this discipline are "production management" and "operational management". It becomes clear that production operations are an essential element of the organization of the production activity.

Practical research is also a significant boost in this regard. The beginning is associated with the production line, used by Henry Ford and Charles Sorenson. A number of specific activities follow in the development of different standards and schemes for stock management, as well as for detecting and overcoming the tight spots in production. Their logical conclusion is the models already mentioned above: "Just-In-Time" (JIT). In the late 1970s one of the most famous models in operational management—5P was developed.

Historically, the development of operational management has been presented in Table 2.2.

Table 2.2. Historical retrospection of operational management

Year	Event / Theory	Author
1733	start of the British Industrial Revolution	James Kay
1764	introduction of steam power	James Watt
1774	machine tooling	John Wilkinson, Henry Maudsley
1776	*Wealth of Nations* book / Division of Labour	Adam Smith
1790	interchangeable parts	Eli Whitney
1832	*Economy of Machinery and Manufacturers* book	Charles Babbage
1911	scientific management *Principles of Scientific Management*	Frederick Taylor
1912 1920	time and motion study	Frank and Lillian Gilbreth
1912	applied Taylor's ideas to organization structure	Harrington Emerson
1912	scheduling and charting procedures	Henry Gant
1913	first moving assembly line / Ford's mass production	Henry Ford / Charles Sorensen
1915	the first mathematical model for inventory management	Ford Harris
1930	human resource based approaches / Hawthorne experiment	Elton Mayo

Year	Event / Theory	Author
1931	*The Control of Quality of Manufactured Products* book	Walter Shewhart
1938	first computer	Jon Atanasoff
1940	quality control techniques	Harold Dodge
1947	linear programming / simplex method	George Dantzig
1950s	Toyota production	Taiichi Ohno and W. Edwards Deming
1950s	first wave of Quality Gurus	Deming, Juran, Feigenbaum
1951	UNIVAC I mainframe computer / Universal Automatic Computer (UNIVAC)	EMCC
1957	critical path method (CPM)	M.R. Walker / J.E. Kelly
1958	Program (or project) Evaluation and Review Technique (PERT)	M.R. Walker / J.E. Kelly
1960s	second wave of Quality Gurus	Ishikawa, Taguchi, Shingo
1960	Material Requirements Planning (MRP)	Joseph Orlicky
1966	*GERT: Graphical Evaluation and Review Technique* book	A.A.B. Pritsker
1970	Just-In-Time (JIT)	Taiichi Ohno Toyota manufacturing plants
1971-	E-commerce	
1980s	third wave of Quality Gurus	Crosby, Peters, Moller
1981	6-Sigma	Motorola
1980s	Manufacturing Resource Planning / Management Resource Planning (MRP I and II)	George Plossl; Oliver Wight
1982	Supply Chain Management (SCM)	Keith Oliver
1990	*The Machine that Changed the World* book	Dan Roos, James Womack, Dan Jones
1990s	agility, mass customisation	
	Computer Aided Design (CAD); Computer-Aided Manufacturing (CAM); Computer-Aided Engineering (CAE)	
1990	Enterprise Resource Planning (ERP)	Gartner Group
1995	Siebel customer relationship management (CRM)	Thomas Siebel Siebel CRM Systems, Inc.

Source: (Sterligova & Fell, 2009, pp. 8–9; Tsvetkov, 1996, pp. 14–18; Kovacheva, 1972, p. 25; Mirchev, 1996, pp. 19–20; Piercy, 2012, pp. 154–178).

Operational management peaked in the 1980s and 1990s, when the integral approach in management began to apply and its new economic paradigm began to be implemented. The beginning is marked by the development of the TQM system, which delivers significant results in the field of quality management. With the appearance of the global network and the Internet, it becomes possible to develop a number of modern operational management systems such as PPS (Practical Project Steering), CAD (Computer Aided Design), EDI (Electronic Data Interchange), ERP (Enterprise Resource Planning), SCM, etc. The development of e-commerce and e-business is provoking new changes in the field of operational management related to supply chain management.

The events played a key role in the emergence and development of operational management are several:

1. The industrial revolution in England of 1770, led to the entry of machines into the production activity of humans and the creation of the first production structures.
2. The promotion of the capitalist, the dominance of the market principle and triggered the emergence of the first commercial companies.
3. Recognition of the role of the human factor in the production activity resulting from the validation of the behavioural theories in the period between the two world wars.
4. The need to economic recovery after The Second World War, including substantial improvement of existing infrastructure.
5. The service revolution related to the modern application of information systems in the economy.
6. Global competition, the completion of a single European market and the expansion of global trade.

2.2. Definition of operational management

Initially, operational management developed as rules and principles, the most famous of which were those of Frederick Taylor. Subsequently, the emergence of new schools in management, the separation of its different directions, the wider application of statistical methods, linear programming and informatics significantly changed its nature and scope. A significant part in shaping its modern vision falls on mathematical modelling, statistical analysis and quality management. The emergence and approving of numerous approaches and management systems requires two main perceptions of the role of modern management: as *science* and as a *practice*.

As a *science* production and operational management (POM) is a set of written rules, principles, and methods of organization management. It is characterized by its certain internal structure and organizational unity. As a *practice*, POM brings together many methods and approaches to manage productive activity of the people. This includes both well-known mathematical models, game theory, computer simulations, and more specific elements such as information technologies, institutions, etc. As a practice, it is defined first and foremost by the interests of individual companies and not by the political interests of the other stakeholders.

The goals and objectives of operational management are to provide basic knowledge about the implementation of the production process of an order in prespecified terms and quantities. In this way, it defines this process in the "time" and "place", in the direction of the general to the private (Tsvetkov, 1996, p. 21). In the case of time, the time limits for carrying out the production tasks, which may be

within the range of several hours to one year, shall be understood as "time". In turn, "area" is nothing but an element of the production structure such as enterprise, workshop, section, workplace.

Operational management can also be seen as one of the main *management functions* of the enterprise and as a *network of management decisions*. As a *function*, it is one of the three main functions of each business organization—finance, marketing and operational management of the production activity (Stevenson, 1993, p. 6). Each of these functions is directly related to the entrance and output of the production system and provides the necessary prerequisites for the implementation of the production activity. In parallel with these main functions, a number of other accompanying functions are performed such as accounting, planning, staff management, public relations, etc., which, in their unity and integrity, are a condition for the normal functioning of the enterprise.

Operational management as the main management function includes many different activities directly influencing the production of goods and services. We can refer to them the supply of raw materials and materials, the repair work, transport, production planning, control, etc. They are all directly or indirectly linked to the main subsystems of the enterprise—incoming, transformative and outgoing and ensure the continuity of the production process.

The presentation of operational management as a *network of management decisions* focuses on the place and role of the management decision-making process in the modern enterprise. In this context, the importance of one of the three main subsystems of operational management—the operational regulation of the production activity, is at the scheduling. Its main objective is to ensure continuity of production activity, to eliminate tight production places and to create conditions for compliance with the deadlines for production. For these reasons, significant attention is paid to problems related to both the nature and specificities of management decisions and the algorithms for their construction. The different types of models that greatly facilitate the management decision-making process are widely represented.

The introduction of the integral approach in management requires the separation of four different levels of integration of production activity directly related to operational management (Sterligova & Fel, 2009, pp. 23–27):

- **Operational level**: integration is carried out in separate operations and functions that are not directly related to each other. This requires the use of operational production cards and Gant tables.
- **Functional level of integration**: related to activities such as supply management, stocks, logistics, etc. In this case, attention is focused on controlling how resources are used, the design of the main material flows, etc.
- **Interfunctional level**: aimed at optimizing the final results of the company's activities. Its main tools are MRP, JIT, ERP, etc. At this level, the establishment of a single information system is of particular importance.

- **Inter-organizational integration**: related to ensuring the sustainable development of production systems, development of cooperation between different business structures and the implementation of common business processes. The applied toolkit includes MRP, JIT, ERP, etc. models.

In addition to science, operational management can also be seen as a *practice*. In this aspect, it is seen as a priority associated with the activities of the specialists in operational management. The basis for its implementation is the availability of knowledge and skills in the field of management and organization of production. Their main functions are related to:

- planning of the production activity,
- organization of production,
- control,
- management decision-making.

The main key areas of action of the operational managers are the production process, the efficient use of the resources of the enterprise, technological provision, logistics, quality of production, control of production activity, etc. A mandatory principle in carrying out their activity is complexity. They are responsible for both the material and cash flows of the enterprise. Moreover, it is these managers who break down the production tasks into parts, control their overall implementation and ensure compliance with the deadlines. It is not accidental that over 50% of the top managers of large corporations necessarily go through the position of the operating manager.

2.3. Levels of operational management

The key role of operational management in the enterprise requires the construction of its own system, including many different internal and external subsystems related to the functioning of the enterprise. In economic theory and practice, there is still a lack of common sense with regard to the subsystems that make up it. Some of the authors talk about two main subsystems—for the *management of the production operations* and *the finances* of the enterprise (Bandurin, Basalay, & Lee, 1999, pp. 22–26).

The first ones cover the production processes in the enterprise and aims at the operational management of operations, supplies and costs for the purchase and storage of raw materials. The management of operations includes—control and regulation of equipment, production facilities, deadlines for carrying out production operations, production stocks, etc.

Supply management includes the logistics of the enterprise, the supply of raw materials, warehouse processes, transport operations, the supply of spare parts and semi-finished products, the repair of machinery and equipment, the information services of the enterprise, etc.

Cost management is associated with the choice of supplier, delivery conditions, price of deliveries, distribution of delivery orders, delivery times, etc. The purpose of this management is to ensure a higher level of use of raw materials and to reduce the cost of raw materials.

The second ones include the management of debit indebtedness, short-term financial investments and the cash availability of the enterprise.

According to other authors, the operational management system includes three main subsystems—planning, organizing and control (Kumar & Suresh, 2008, p. 10). The *planning subsystem* covers the operational strategy of the enterprise, the forecasting, the selection of products and technologies, the development of different types of plan-schedules. The *organizing subsystem* aims at designing operations, project management, etc. The main task of the *control subsystem* is the implementation of in-house control, quality management and supply management.

Aggregate planning provides and realizes optimal proportions between the individual structural elements in the production process. It is an important part of the overall planning process. Its ultimate goal is to eliminate the negative effect of uncertainty and change, to focus on the main tasks and to facilitate the control of production. It finds expression primarily in the development of different types of plan schedules.

Operational control is a link between aggregate planning (AP) and operational regulation. Its main function is to collect information on the deviations between the actual and the forecast base state of the production system. Objects of this control are the movement of material flows, the completion of the finished product, the use of resources and the quality of the production.

The main function of the **operational regulation** is to eliminate the undesirable effects in the production and to bring the system into balance. Object of operational regulation are resources, the production process and the output.

Like any economic system, the system of operational management has its own internal structure. Due to the specifics of the place and the role of the operational management system, it is necessary to distinguish between two main types of structure within it—*organizational* and *functional*.

The *organizational structure* is essential for the efficiency and competitiveness of the company. Its proper formation is a testament to the skills of the managerial staff of the enterprise. In order to properly build the organizational structure, it is necessary to coordinate it in advance with the goals of the business organization and its capabilities. According to Peter Drucker (2010, p. 39), every organizational structure must meet two basic requirements:

– to create an organization of a business action,
– have as few levels of government as possible.

The organizational structure exposes the horizontal structure and the established hierarchical levels of the operational management system. It corresponds to the

existing levels of management in the business unit and depends entirely on the production structure built in it.

This structure includes three main subsystems:

1. Inter-plant operational management—carries out ongoing coordination of processes between individual plants, jointly preparing the finished product.
2. Inter-shop operational management—performs current coordination within the enterprise, between its workshops. The main unit is the workshop, and the object of coordination are the completion of the finished products, the beginning and completion of the individual operations, the technical preparation of the production.
3. In-house operational management—the object of current coordination are the processes taking place within the individual sections and workplaces within the workshop, and more precisely the beginning and completion of the operations carried out in them.

The *functional structure* of the operational management system is formed as a set of all tasks and activities performed in it. The main task is to carry out ongoing coordination of processes and activities within the system "resources-finished products". The purpose of this coordination is to ensure the maximum continuous movement of material flows and maximum use of resources in the individual micro periods of time.

In other words, the current coordination is a synchronization of production and consumption between the micro-units of the enterprise in the different micro-periods. Its characteristic features are:

1. Satisfaction of the needs for materials, technical documentation, equipment, labour force, units and details of the i-th micro-unit (workshop, section, brigade, workplace).
2. Synchronization of the needs in the j-th micro periods of time (hour, shift, day, week, month). This synchronization can be performed by quantitative parameter (by stocks), or by time parameter (by calendar terms).

Objects of the current coordination are main production process; servicing this process with the necessary equipment, repairs and transport services; the completion of the finished product.

This main function, in turn, decomposes into several main functions (see Figure 2.1).

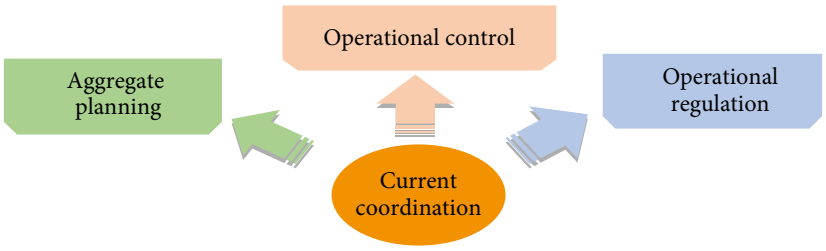

Figure 2.1. Main functions of the current coordination

Source: Own work.

These functions are also broken down into smaller partial functions, which cover individual sides of the main one.

In terms of aggregate planning, these are: *standardization* of the quantity and determination of the terms for movement of the material flows in the separate phases and operations; *forecasting* the state of production for the individual micro periods (calendar planning), etc.

The *partial functions of the operational control* are:

- operational control of the products,
- operational control of resources,
- operational control of reserves.

The *partial functions covered in dispatching* are respectively:

- preliminary coordination of plans with resources,
- making management decisions.

The last stage of the decomposition of the main function is the formulation of the tasks, namely:

- determining the size of the batches,
- determining the duration of the production cycle,
- rationing of stocks.

The 5P model: The construction and maintenance of optimal proportions both between the different types of resources and between the structural elements of production are the basis of production management. Its essence can best be expressed through the "5P" model. It was developed by Pryor, White and Toombs as a strategic management model focusing on 5 key areas for the organization's success (1999). Each of these areas is studied by separate disciplines. Enterprises or buildings are the object of industrial engineering, people—management of human resources, products and production operations—production engineering, planning—production planning, control—controlling, etc. The main elements of this model are:

- **Plants**: various organizations producing products or creating services; it is usually understood as a place for placing machinery and equipment for the purpose of production activity. Its synonymous terms are enterprise, factory, factory, service establishment, etc. Enterprises must provide opportunities for future development, provide offices for the implementation of the activity, to be distinguished by their internal design, security of installations and equipment, etc.
- **Processes**: design of business processes; represent a pre-designed sequence of production operations leading to a change in the properties and type of raw materials used. There are always different alternatives in its design, but the ultimate goal is to choose the most profitable among them. To this end, factors such as available capacity, staff skills, production costs, type and type of production, safety, maintenance, etc. must be taken into account.

- **Parts**: products and services; are generally defined as something that can be offered on the market and is designed to meet different groups of needs. The products are produced by the enterprises, going through the transformation from raw materials to finished products and services. They have a number of characteristics such as quality, quantity, price, appearance, production time and more.
- **People**: staff; human resources engaged in the operational management of the enterprise. From the point of view of the organization, they represent not only specific executors of the production activity, but also managers and controllers of the ongoing processes inside the enterprise.
- **Plan and control systems**: management functions related to the planning, control and regulation of production processes. Planning is mainly associated with the preparation of various types of schedules related to the supply of raw materials, transport, warehousing, production support.

2.4. The principles of operational management

The establishment of an optimal scheme of operational management requires the consideration and observance of a number of basic principles that determine the final results of the enterprise. The first principles of scientific management of organizations were formulated by Taylor in 1911 in his fundamental work *Principles of Scientific Management*. They are gaining popularity and are being widely implemented in American companies.

The development of management as a science has a significant impact on the principles of management. There are known attempts to group them by a number of authors: Emerson, Mooney, Peters and Waterman and others. According to Emerson (1973), the principles of management should be mutually conditioned and interconnected, emphasizing clear goals and objectives, common sense, strict discipline, normal working conditions and others. Mooney's rich practical experience is the basis for the formulation of his 4 basic principles of governance: coordination, power, delegation and specialization (Kravchenko, 2002, pp. 124–125).

In their book *Towards the Perfection of Corporate Governance*, Peters and Waterman (1988) present a newer classification of **governance principles**. They include the following principles:

- action orientation,
- facing the user,
- autonomy and entrepreneurship,
- increasing labour productivity thanks to people,
- attachment to one's own activity,
- simplified form, small management staff,
- simultaneous rigor and freedom of action.

A slightly different classification of the principles of operational management, consistent with real practice, presents Schaeffer (n.d.). According to it, the main principles are:

- **reality:** should focus on the problem, instead of the techniques;
- **organization:** processes in manufacturing are interconnected. All elements have to be predictable and consistent, in order to achieve a similar outcome in profits;
- **fundamentals:** the main part of the success is due to strict adherence to precisely maintaining records and disciplines;
- **accountability:** managers are expected to set the rules and the metrics, and define responsibilities of their subordinates, as well as regularly check if the goals are met;
- **variance:** variance of processes has to be encouraged, because if managed well, they can be sources of creativity;
- **causality:** problems are symptoms: effects of underlying causes;
- **managed passion:** the passion of employees can be a major driver of company growth, and it can be instilled by the managers if not coming naturally;
- **humility:** "get help and move on";
- **success:** what is considered success will change over time, but always consider the interest of the customer;
- **change:** there will always be new theories and solutions, so you should not stick to one or the other, but embrace the change, and manage for stability in the long term.

A number of other classifications of management principles can be mentioned. They are implemented on the basis of various features and criteria such as: needs of practice, level of competence of managers, specifics of the organization and others. According to the most common classification, modern management principles are divided into *fundamental* and *specific*. The *fundamental* ones are of fundamental importance for the organization and are related to its purposefulness, efficiency, flexibility and adaptability. The *specific* ones have a complementary role in relation to the fundamental ones. They are directly related to the new models of enterprise management and are aimed at decentralization, coordination and interaction between different sectors of the economy, etc.

The evolution of management principles also leaves its mark on the principles of operational management. In modern conditions, these principles ensure the normal functioning of the operational management system. The most important among them are:

1. The structure of the operational management system shall be determined by the type of production and not by its type.
2. The simpler a product, that is with fewer components and components, the simpler the operational management system.
3. The shorter duration of the production cycle reduces the complexity of the operational management system.

4. Simplification of reporting—the information submitted for each upper management level is consolidated and summarized according to pre-fixed sustainable indicators.
5. The maximum possible interval of operational management may not be less than the cycle of preparation of the finished products.
6. The production structure of the enterprise does not affect the structure of the operational management system.

2.5. Production systems and its elements

Operational management as a target orientation is aimed at the management of production systems, different in content, purpose, size and degree of complexity. From the abstract level, the production system is "a transformation process" of resources (labour; capital for machinery and equipment, materials, etc.; space as land, buildings, etc.) into useful goods and services. According to Chase and Aquilano (1992, p. 12) the **production system** can be considered as a network of components whose function is to transform the set of input resources into desired results, within the so-called transformation process. Babu (2012, pp. 1–13) defines a production system as a set of interconnected input-output elements and is made up of three components, namely inputs, processes and outputs (see Figures 2.2 and 2.3).

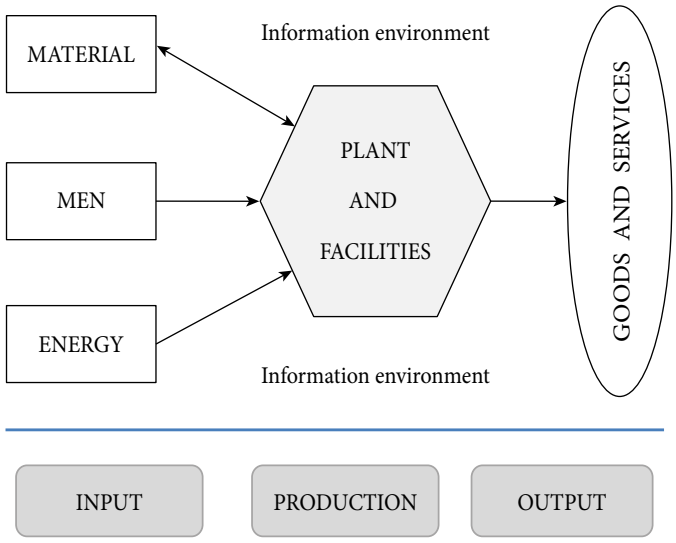

Figure 2.2. Production system

Source: (Babu, 2012, pp. 1–13).

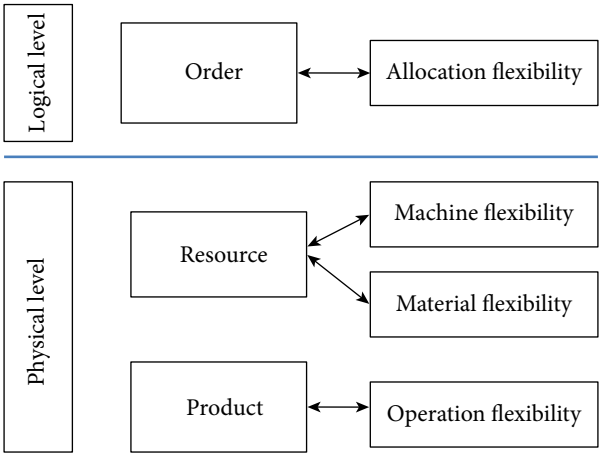

Figure 2.3. Basic elements of the production system (as a common logical and physical view)

Source: (Babu, 2012, pp. 1–13).

Based on the common definitions, Sindhuja (2020) constructs a simplified scheme for the production system, in which the emphasis is on the relationship between the inputs, outputs, series of operations or processes, storages and inspections (see Figure 2.4).

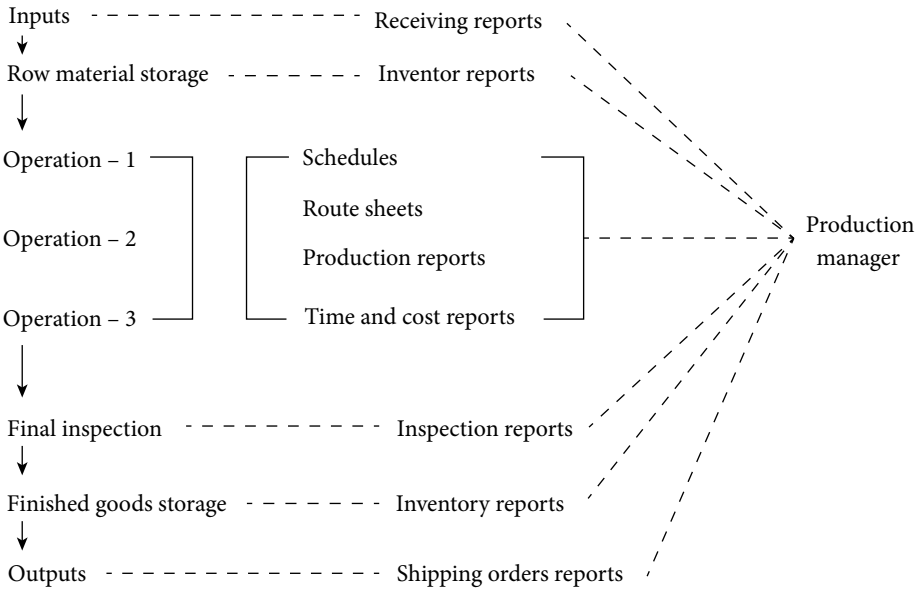

Figure 2.4. A simplified production system

Source: (Sindhuja, 2020).

The production system can also be defined from different points of view. In the Figure 2.5 has been shown simplified versions of these different understandings, with an emphasis on the specifics of each.

Production system	*Technical meaning*:	Transformation process of some goods in other.
	Economical meaning:	Transformation process of some goods in others of higher monetary value.
	Informatics meaning:	Transformation process of some data into more valuable data.

Figure 2.5. General understanding of the production system

Source. Own work.

From the **technical point of view** the production system is a set of any methods used in industry to create goods and services from various resources (Tanenbaum & Holstein, 2020). At the technological level "the current developments in manufacturing systems stem from the advances in machine tools, robots and controllers" (Tzafestas, 1997, p. 1).

From the **economic point of view**, as a value creation module, the production system may be described as a system transforming input (material, energy, information, and monetary means, etc.) into value-created output (a fabricated or assembled product), achieving through the synergy of value creation factors (process, organization, equipment, human resources and product) on the basis of organization procedures for managing enterprise activities. The processes include an amount of different technical operations (machining, assembly, testing, handling, conveying, sorting, collecting, packaging, storing, distributing, etc.). The operations are performed or supported by equipment and human resources. They are linked and involved within material flows (production, processing and distribution of goods within specified areas). It covers all forms of work objects (e.g. substances, parts, and carriers) movement in the production system either by manual or using automation (Rahman, 2020). From the **informatics point of view** it is carried out the transformation process of some data into more valuable data giving multiple benefits due to a synergy of data collection, proceeding and using as the based on the characteristic ubiquity. Computer-integrated manufacturing (CIM) "implies a systemic approach to the operation of a manufacturing enterprise, i.e. it involves: research engineering—plant functions—production—business functions—administrative functions" (Tzafestas, 1997, pp. 1–2).

Within the transformation process, very diverse impacts and changes can take place, leading to Chase and Aquilano (1992, p. 12):

- physical (mechanical / material / thermal) transformations (e.g. in production or industry),

- localization transformations (e.g. in transport),
- exchange transformations (e.g. in trade, especially in retail trade),
- transformations related to storage (e.g. in storage holdings),
- physiological transformations (e.g. in healthcare),
- information transformations (e.g. in the telecommunications sector).

The production system is a part of the system "industrial enterprise". Within the operational management and in a general organizational context, the transformation processes can be carried out in **four main types of production systems** (see Table 2.3).

Table 2.3. Analysis of production systems

Factors	Types of production systems			
	jobbing	batch	mass	process
Equipment	standard machinery size depending on whether the enterprise is engaged in light, medium or heavy engineering	similar to jobbing production but there may be some equipment	machinery designed for one range of product, largest product generally not greater then medium engineering	the entire "enterprise" is completely integrated at all stages. generally no isolated items of equipment
Type of buildings	in heavy and medium engineering will be single store and either single or multi-storey for light engineering; floor area per worker will be high	similar to jobbing production	similar to jobbing batch production the mass manufacture of light engineering products will be single or multi-stored buildings	quite often the equipment in progress manufacture will not be enclosed inside buildings
Layout of factory	similar machines will be arranged in groups—known as process or functional layout	similar to jobbing production but in some enterprises different machines may be grouped together to suit families of parts	all machines and processes will be arranged in operation sequence to suit the product—known as line layout	the entire enterprise will be designed like one huge machine and to produce a certain rate of a specific product
Type of flow	because of the difficulty of balancing demand with capacity work will wait between operations—known as intermittent flow	similar to jobbing production but a family grouping type of layout may reduce waiting but will also reduce machine utilisation	demand and capacity will be reconciled so flow will be continuous	as the complete layout has been designed for a specified flow production will be continuous
Cost and time required to make product	cost of one product in relation to turnover will be high; total time to make will be high and can be expressed as: total operation time / total time to make this will always be less than 1	similar to jobbing production but the ratio of total operation time to total time to make will be better	cost of one product in relation to turnover will be small; the total time to make will be low and the ratio of total operation time to total time to make will be near to 1	cost of one unit of output in relation to total output will be very small and the ratio of total operation time to total time to make will be theoretically near to 1
Work-in-progress	the amount of W.I.P. in relation to total output will be high	similar to jobbing production	the amount of W.I.P. in relation to total output will be small	there will be theoretically be no W.I.P. between operation stages

Factors	Types of production systems			
	jobbing	batch	mass	process
Materials handling	standard equipment and will depend on whether the enterprise is engaged in light, medium or heavy engineering	similar to jobbing production; but there a be some special purpose equipment	extensive specialised equipment	materials handling and processing will be completely integrated
Foremen	large technical content is supervisory function; ratio of supervision to operators about 1:30	specialists in the functions supervised, e.g. milling or capstans ratio of supervision to operators about 1:50	specialists in the particular aspect of flow production; ratio of supervision to operators about 1:50	concerned with co-ordinating and communicating; ratio of supervision to operators about 1:15
Sales and design	technical, large staff orders made to customers requirements	products and jig and tool design, orders made to customer's requirements	research and development product testing market research to test customer's requirements	research and development for products and process market research to test customer's requirements
Type of industry	ship building, civil engineering, process engineering, castings	machine tools, furniture, clothes, drop forgings	food, cigarettes, TV electric lamps vehicles	chemicals, oil petrol

Source: (Sindhuja, 2020).

In addition, the specificity of each production system depends also on the type of products and their purpose, the availability of resources, the market demand for industrial products and services, etc.

2.6. Organization of the production process (best practices)

Enterprises can achieve different results, which should be taken into account when organizing their activities, i.e. the final results of the outcome of the enterprise may have a tangible substance or no material equivalent or substrate (idea, decision, advice, service, etc.). For example, in enterprises with a material result, a rational combination in space and time of technological equipment, material resources and labour is carried out, which in practice finds expression in the *organization of production and labour processes*.

The **production process** in an industrial enterprise is a set of interconnected production-technological, labour and naturally occurring (e.g. time for ripening, drying, cooling, fermentation, baking) within which there is a direct or indirect impact on raw materials and semi-finished products and their transformation into finished products. This includes also the processes of storage, distribution and transportation, maintenance of workplaces, maintenance of machinery and

technological equipment, control of the production process, etc. (For more information see Varamezov, 2017, pp. 16–17; Kanev & Hristova, 2008 p. 22; Varamezov & Gutsev, 2017, pp. 31–32).

As a system, the **organization of the enterprise** includes **three subsystems**: organization of production (production processes); labour organization and management organization. Its content covers:

- design, implementation and subsequent improvement of the organizational structure of the enterprise and in particular the management structure, production structure and infrastructure,
- organization of the production process,
- application of effective forms of organization of production,
- organization of the production preparation,
- organization of the control of the processes in the enterprise,
- organization of the labour process,
- design and implementation of effective management systems.

The **organization of production processes** takes into account their specifics, i.e. whether they are main, auxiliary or service, manual, machine-manual, machine or hardware, intermittent (periodic) or continuous; as well as the type of production (unit, batch, mass and continuous).[1] (For more information see Varamezov, 2017, pp. 17–20; Varamezov & Gutsev, 2017, p. 31; Kanev & Hristova, 2008, pp. 23–25).

Several **forms of organization of production processes** are applied in industrial enterprises: individual, group, subject, flow, etc. In the **individual form**, all or almost all operations are performed by one employee. In contemporary conditions it is applied to a very limited extent, mainly in handicrafts, in the assimilation of new products or in the framework of some non-productive activities (Kanev & Hristova, 2008, p. 37). In the **group form** a universal type of machines is used, which are grouped by homogeneity in production sections or workshops; the operations are combined mainly in a sequential or parallel-sequential manner within an interruptible production process; the products are moved in batches; the contractors have a wide profile professional training; there is a wide range of products. In the **subject form**, the workplaces have a subject attribute; relatively universal equipment and personnel with general training are used; there is no uniform rhythm of production; the operations are combined by the parallel-sequential method. In the **flow form**, the production of the products is organized on the basis of a predetermined *pace* (the number of products made per flow per unit time) and *time* (the time interval during which a finished product comes out) of the process, and synchronization of operations, regardless of the degree of mechanization and automation of workplaces. The workplaces are specialized and are arranged mainly

[1] The type of production shows the degree of specialization of production and the stability of the workload with the same operations. It is determined by the volume of production, its serial (batch) number, repeatability of production, the type of technological equipment.

in a line of products. Staff training is also specialized; specialized transport is used (conveyors, conveyor belts, platforms, etc.).

The **form of the spatial arrangement of the units** in the industrial enterprise can be *pavilion or block (hull)*. In the ***pavilion form***, the workshops are located in separate buildings (usually in large enterprises). The main workshops are located depending on the course of the technological process, facilitating the transportation of the processed material resources and leading to cost reduction. The auxiliary workshops are located close to the main workshops and the users of their products, not to hinder the movement of material resources between the main workshops and to promote the rational formation of freight flows and the location of the warehouse. In the **block form**, the units are located in a single-storey or multi-storey building. In the one-storey layout, the processes are arranged in a line according to the course of the technology, avoiding the cross and return movements of the processed material resources and finished products of the enterprise. The multi-storey layout saves space and time but presupposes the presence of cross and return movements (Varamezov, 2017, pp. 10–11).

The application of various good practices should not be a specific private option for optimizing business processes, but should follow the general philosophy of a comprehensive economic approach, looking for opportunities to take advantage of the many business solutions within:

Facility management: It is aimed at maintaining property, buildings, equipment and other assets, as well as organizing their inclusion in the production processes carried out by staff to achieve a certain level of productivity. It aims to impact on the operational efficiency of the enterprise, facilitate and assist in maintaining and increasing the productivity of facilities and personnel, risk management of the use of facilities and personnel, counteraction and adaptation to external influences, application of good practices for long-term management of the costs, achieving the desired correspondences with indicators of other systems, providing a timely response to limit and overcome the consequences of natural disasters, implementation of adequate technological solutions, etc.

Manufacturing & assembly: A number of good practices are possible, covering the whole process of processing raw materials and semi-finished products, assembly of components, parts, assemblies, units, etc. in the form of finished products, ready for sale. Practices are applied for design, production and marketing of products for the shortest possible time for creation and assembly of products, lower costs for assembly, removal of technological waste and increase the reliability of products.

Production engineering: It covers the entire process of designing and moving product development activities to their exit from the production system of the enterprise, including activities of manufacturing engineers, design, selection of the best technologies and processes for the creation of products; planning and design of equipment and provision of machines for the production of products; control,

management, maintenance of the production system and search for opportunities for its continuous improvement.

Production planning: Practices for planning, distribution and use of raw materials, machines, equipment, personnel, etc. are applied. in order to optimize the time for execution of works and achieve completion of orders on time.

Quality assurance: It covers the cycle called PDCA cycle (Deming cycle), whose main phases are: Plan (planning and establishing the process related objectives and determine the processes that are required to deliver a high-quality end product), Do (Development and testing of Processes and doing processes changes), Check (Monitoring, modifying and checking the processes) and Act (implementing necessary actions for achieving process improvements).

Systematizing the purely scientific knowledge and business empiricism, the following **good practices** can be summarized (MANTEC, n.d.):

Implementing Lean Manufacturing: Enterprises use lean practices to achieve efficiency based on cost optimization by reducing waste without reducing productivity. Lower costs for stocks are realized, the term for development and expulsion of the products is shortened, higher efficiency is achieved, the quality of execution increases, an increased level of customer satisfaction is reported. In the end, a higher profit is realized.

Becoming More Environmentally Friendly: These practices are aimed at achieving compliance, maintenance and compliance with environmental regulations, thus avoiding financial sanctions and legal problems. Modern enterprises strive for waste recycling, application of non-waste technologies or a closed cycle of full utilization of all raw materials, introduction of environmentally friendly production and more.

Implementing Automation: In production systems and their organizational maintenance, automation and robotization of processes are widely used, achieving accelerated execution of works, improved quality of processes and finished products, almost without human intervention.

Implementing a Quality Management System: Timely changes and improvements are made in the preparation, organization, course and control of the production processes in order to maintain the high quality of the production systems and the results of their functioning. Effective quality management systems are being implemented.

Making Ongoing Training a High Priority: Continuous assessment of the achievements and progress of the staff and timely increase of knowledge, skills and competencies as a guarantee for maintaining the necessary correspondence between new trends and good practices, and the poor educational and qualification parameters of the staff. In this way, the aim is to ensure the maintenance of up-to-date knowledge and production experience related to the latest trends in the field of production processes and technologies.

A number of **specific good practices** can be applied in the industrial enterprises, the specific choice of which depends on the managerial decisions. Among the most commonly applied good practices are the following: lean, Just-In-Time, continuous improvement, *kaizen* and *kaikaku*, Total Quality Management and ISO 9000, ISO 14000, health and safety, Six Sigma, 5S, failure mode and effects analysis, Quality Function Deployment, new product development, Total Productive Maintenance, supply chain management, etc.

In Table 2.4 has been presented the main links that need to be made in terms of good practices, derived in theoretical terms and their main contributions to the enterprise to achieve the desired results by applying the good practices (in the other enterprises and the competitors).

Table 2.4. Linking between the best practice, its main contributions and enterprises performance

Researchers	Key concept to best practice	Results regarding practice-performance relationships
Swamidass and Newell (1987)	cross-functional co-operation, design for manufacturability	corporate performance is positively related to the role of manufacturing managers in strategic decisions
Voss (1995a)	world-class manufacturing, bench-marking, business process re-engineering, TQM, learning from the Japanese, continuous improvement (CI)	implementation of best (world class) practices leads to superior performance and capability
Ahmed and others (1996)	TQM, JIT, FMS, CE, bench-marking	when practices (operations strategies) are examined individually, companies using any of seven practices (FMS, CE, benchmarking, TQM, JIT, manufacturing cells and computer networking) have higher performance than those not using them
Bolden and others (1997)	WCM, employee development	the classification of manufacturing practices taxonomies developed provides insight into the role of individual practices, implementation and outcomes
Flynn and others (1997)	WCM, TQM, JIT	the best users of unique TQM practices, combined with common infrastructure practices, are capable of solving problems to improve production processes
Harrison (1998)	WCM, CI	WCM appears to facilitate operator commitment to continuous improvement, but leaders become more frustrated because they expected to achieve more. Cellular manufacturing in a UK-based company acted as a powerful change agent, which has led to more in terms of manufacturing improvement than previous initiatives, such as MRP II
Flynn and others (1999)	WCM, CI, JIT, TQM	the use of WCM, alone and together with other new practices, leads to improved competitive performance

Researchers	Key concept to best practice	Results regarding practice-performance relationships
Kathuria and Partovi (1999)	Cross-functional co-operation	better performing manufacturing managers strongly demonstrate relationship-oriented practices, such as team building and support, participative leadership and delegation, especially when the emphasis on flexibility is high
Rondeau and others (2000)	Work system practices, time-based competition	time-based manufacturing practices tend to lead to standardisation, formalisation as well as integration
Davies and Kochhar (2002)		best practices, performance, manufacturing planning and control; a structured approach used to identify direct qualitative relationship between practice and performance
Garver (2003)	Benchmarking, CI	integrating customer performance measures with internal performance measures (internal quality, productivity etc.) to identify improvement opportunities is found to be critical
Ketokivi and Schroeder (2004)	TQM, JIT, WCM, contingency	there are only few best practices contributing to competitive manufacturing performance in multiple dimensions

Source: (Boer, Frick, & Acur, 2005).

The choice of form of organization of the production process and the respective production system in which to implement this process is made on the basis of a multi-directional analysis of the appropriate prerequisites for the particular enterprise, the established restrictive conditions of production and specifics of products. Managers study the good practices in the industry, their advantages and disadvantages, the possibilities to achieve the set goals and realize benefits.

Questions / tasks

1. What are the main stages in the evolution of operational management?
2. What are the main theories in the field of operational management?
3. What are the key elements of the evolution of operational management?
4. What is the operational management system?
5. What are the features of operational management as a science?
6. What are the features of the organizational structure of operational management?
7. What is ongoing coordination? What does time and place coordination mean?
8. What elements does the functional structure of operational management include?
9. What are the partial functions included in the functional structure of operational management?

10. Identify the various tasks that complement the functional structure.
11. What are the principles of operational management?
12. What are the elements of the 5P model?
13. What is the production system? What are the different accents in the definitions clarifying the term from different points of view? And what is common between them?
14. What types of changes are taking place in the transformation process within the production systems in different sectors of the economy?
15. What types of production systems can you specify and what are their features?
16. If you are the manager of an industrial enterprise, what type of production system do you choose to apply and what arguments can you give to justify your choice?
17. What is the production process in an industrial enterprise?
18. What forms of organization of the production process are most often applied in industrial enterprises and what are their features?
19. What solutions can industrial enterprises apply in choosing the appropriate form of organization of the production process—in general, within individual areas and specific business practices in the field of operational management?

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3.

FUNCTIONS AND ROLES IN OPERATIONS MANAGEMENT

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Abstract: This chapter covers the main functions and roles of operational management. In particular, problems related to the organization of the production process, including its continuous improvement, were raised. In addition, the role of resource management in an enterprise was discussed along with tools for optimizing resource allocation. The issues related to purchasing management, its changing importance over the last years, tasks and methods of organization were also described. The concept of production capacity was explained, as well as the methods of analysing production processes aimed at maximizing efficiency. The importance of inter-organizational cooperation, both in static and dynamic terms, was also outlined, with particular emphasis on barriers and benefits.

Keywords: Enterprise Resource Planning, inter-organizational cooperation, operations management, production capacity, production processes, purchasing management.

3.1. Introduction

Modern enterprises operate in difficult, highly competitive conditions. They constantly have to adapt to the dynamic changes taking place in the environment, growing customer requirements, or the emergence of new, hitherto unknown barriers. It is therefore necessary to use every opportunity to gain a competitive advantage. In this light, the problems related to maximizing the efficiency of the production process and increasing production capacity becomes key. An appropriate approach to the acquisition and allocation of rare, hard-to-reach resources is becoming more and more important. It becomes necessary to change the optics of looking at the organization of the purchasing process. One can also observe a change in the approach to inter-organizational cooperation—more and more entities give up the antagonistic approach in favour of the exchange of knowledge, experience and resources in order to achieve common benefits. This chapter discusses the main functions and roles of operational management in the context of the needs and requirements of a modern economy.

3.2. Organization of production processes

All enterprises operating in the modern economy strive to improve operational efficiency in order to be able to effectively compete in an increasingly demanding market. One of the means to achieve this goal is the proper design and organization of production processes. It is well known that an efficient production flow can be achieved by skilful management of production processes, i.e. planning, organizing and controlling the processes. However, it should be noted that even companies of a similar size, operating in one sector, may significantly differ from each other in terms of production techniques, organizational structure, or the way of organizing work. Therefore, it is difficult to indicate a single, simple and effective method of creating an efficient production system (Szatkowski, 2014, p. 11).

Moreover, in recent years the structure and specificity of industrial enterprises has changed dynamically due to the intensive development of advanced technological solutions, increasing complexity of production processes and the growing importance of high technology products. The nature of these changes was so significant that it is interpreted as a new, fourth technological revolution (Mavlioutov, Belyaev, & Borisova, 2020, p. 2). The changes taking place during the successive industrial revolutions are presented in Figure 3.1.

It should be noted that in the literature there are many different definitions of the concept of a production process. Most generally, it can be said that it is a sequence of activities leading to the production of a product. Otherwise, it can also

be said that it is a set of events and consciously made decisions that result in the expected changes in the product, bringing it closer to the final product (Liwowski & Kozłowski, 2011, p. 15).

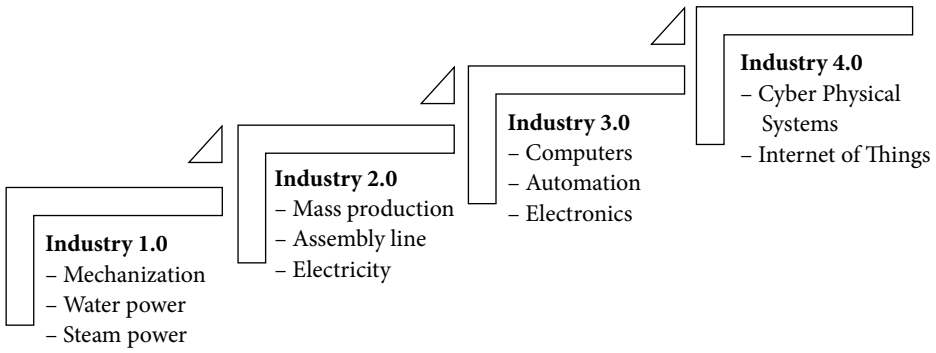

Figure 3.1. Industrial revolutions

Source: Own study.

It can be seen that the production process includes a series of successive activities (shown in Figure 3.2): production preparation, production execution, and production control. Preparation of production includes technical and organizational measures necessary to create favourable conditions for a smooth flow of production. Designing and constructing products involves determining the technical properties of the product, therefore at this stage it is necessary to decide on the following elements that will affect the future product:

- combined products,
- selection of technical characteristics of the product,
- material selection,
- creation of material nomenclature,
- determination of the technical norms of the material.

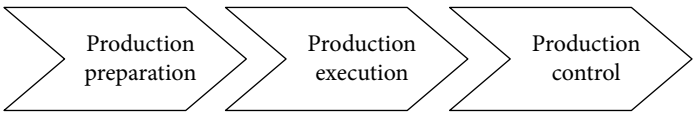

Figure 3.2. Production process

Source: Own study based on (Joksić, Nešić, & Nusev, 2017, pp. 10–11).

When choosing a product, it is important to consider the wishes and needs of consumers. Another important factor is the technical preparation time. The choice of the technical characteristics of the product is based primarily on the

characteristics that will ensure economic profitability. When choosing a metric, the type of material that is the most advantageous is determined, but in each case a replacement is also given if there is a shortage of the base material for any reason. In addition, it is necessary to define a material standard, which is the amount of material needed to create a product unit.

A technological process is a set of activities that change the composition, quality, shape or size of the materials produced in order to produce the desired product. It may undergo changes, e.g. when production procedures are changed in order to increase efficiency. It should be emphasized that organizational preparation measures are closely related to the implementation of the technological process. Correct estimation of the type of production depends on the selection of the optimal method of creating operational plans and its correct implementation. A well-defined business plan determines which operations, parts, and products need to be completed over which time frame so that the plan can be successfully executed when all workplaces are fully loaded.

The organization of the technological process depends largely on the production manager, whose responsibility is to organize workplaces and to ensure product quality. The optimal production rhythm is conditioned by effective production planning. The organization of internal transport represents the total movement of the means of production in the process of their creation. Production control is aimed at correct and timely observation of the flow of achieving planned results, therefore its task is to constantly monitor production results (Joksić et al., 2017, pp. 10–11).

However, it should be noted that before starting the production process, a make-or-buy decision must be made. After selecting the end product line, the manufacturer must decide which processes and intermediate products successively combined to final product will be implemented within the organization, and which will be delegated to external organizations. In the case of a decision to outsource, it is necessary to define the terms of the contract. In practice, this is a series of procurement decisions—sometimes referred to as a producer's make-or-buy program—involving many factors (shown in Figure 3.3) including design requirements; inventory needs; quality control; production, overhead, and transportation costs; and the capabilities, capacities, and negotiating strength of potential suppliers relative to those of the producer himself (Masten, 1984, pp. 404–405).

A very important issue is the continuous improvement of the production process. One method to achieve this goal is the 5S method. It is a set of 5 simple rules and a tool that allows to visually control the workplace. The name 5S refers to the five steps (shown in Figure 3.4) required to fully implement all assumptions of the method (Falkowski & Kitowski, 2013, pp. 127–128). The method is described in more detail in chapter 4.

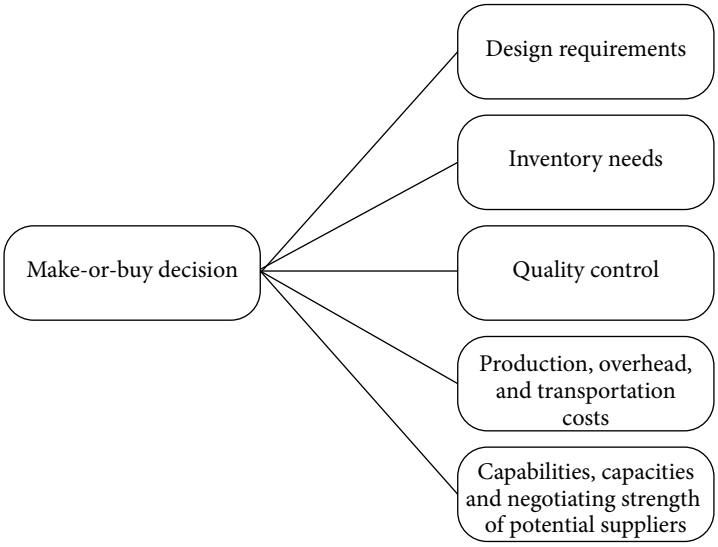

Figure 3.3. Make-or-buy decision determinants

Source: Own study based on (Masten, 1984, pp. 404–405).

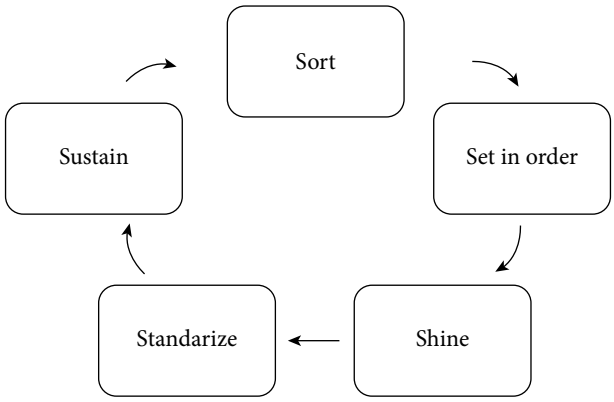

Figure 3.4. 5S methodology

Source: Own study based on (Falkowski & Kitowski, 2013, pp. 127–128).

3.3. Enterprise Resource Planning

In a changing world, organizations that want to gain a competitive advantage, ease of adaptation to customer requirements as well as an increase in the financial

result, often decide to introduce the Enterprise Resource Planning system (ERP). It is a tool that supports the effective planning of enterprise resource management. This support may cover all or some of the management levels and facilitates the optimization of the use of the company's resources and processes taking place in it.

ERP systems are scalable, multi-functional and complex systems that contain at least one module. The goal of ERP is to integrate information from the main functional areas of the organization (shown in Figure 3.5, e.g. finance, human resources, manufacturing, customer relations, supply chain management), in order to facilitate management and streamline the flow of information between functions, as well as between organization and stakeholders. It is now believed that ERP is the fundamental technology that organizations use to manage their information (Al-Mashari, 2003, pp. 22–27).

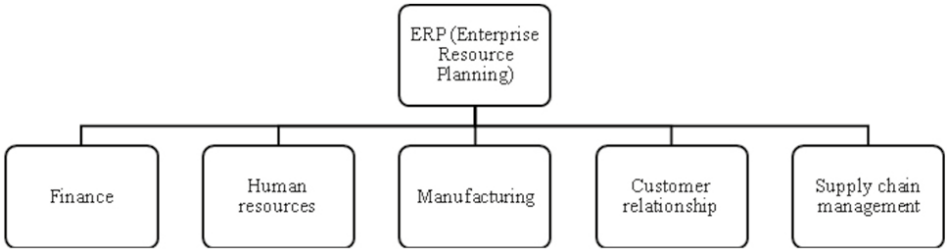

Figure 3.5. Main ERP modules

Source: Own study based on (Al-Mashari, 2003, pp. 22–27).

The implementation of an ERP system in an organization involves making many decisions, from defining business processes, selecting an ERP system supplier, to selecting the implementation methodology. Choosing an appropriate methodology will make it easier to go through each implementation stage. Currently, the most commonly used are *Agile* and *Waterfall* methods (Suder, 2018, pp. 277–285).

"*Agile methodology* was established in 2001 by creating a manifesto called Manifesto for agile software development" (Beck et al., 2001). Nowadays, it is used more and more because of its flexibility and simultaneous cooperation of all teams. When implementing tasks in ERP projects based on the methodology of agile programming, the following stages are distinguished (shown in Figure 3.6):

1) plan,
2) design,
3) develop,
4) test,
5) release,
6) feedback.

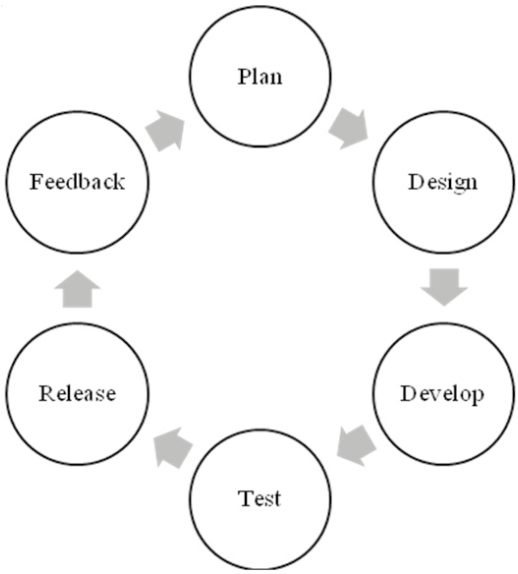

Figure 3.6. Agile methodology

Source: Own study based on (Beck et al., 2001).

The above stages form a cycle that is repeated until the system implementation is completed. It is very important to note that the subsequent cycles are to be used to possibly correct the prepared task on the basis of feedback. The subsequent cycles, however, are not intended to endlessly correct errors of a given task resulting from the omission or inaccuracy of the planning stage (Suder, 2018, pp. 277–285).

Waterfall (cascade) methodology was developed by Royce (1987, pp. 328–329), it consists of carrying out the basic activities as separate design phases, one after the other (see Figure 3.7). Each activity is the next step (cascade):

1. System planning (including requirements specification).
2. System analysis (including requirements analysis and feasibility studies).
3. System design (of individual structures, etc.).
4. Implementation (system creation).
5. Testing (of individual elements of the system and elements connected together).
6. Implementation and maintenance of the resulting system.

If any of the phases returns an unsatisfactory product, we go back by making subsequent iterations until we get a satisfactory product at the end of the steps. It should be emphasized that this model can only be used when the requirements are understandable and transparent, as each iteration is time-consuming and requires large improvement expenses.

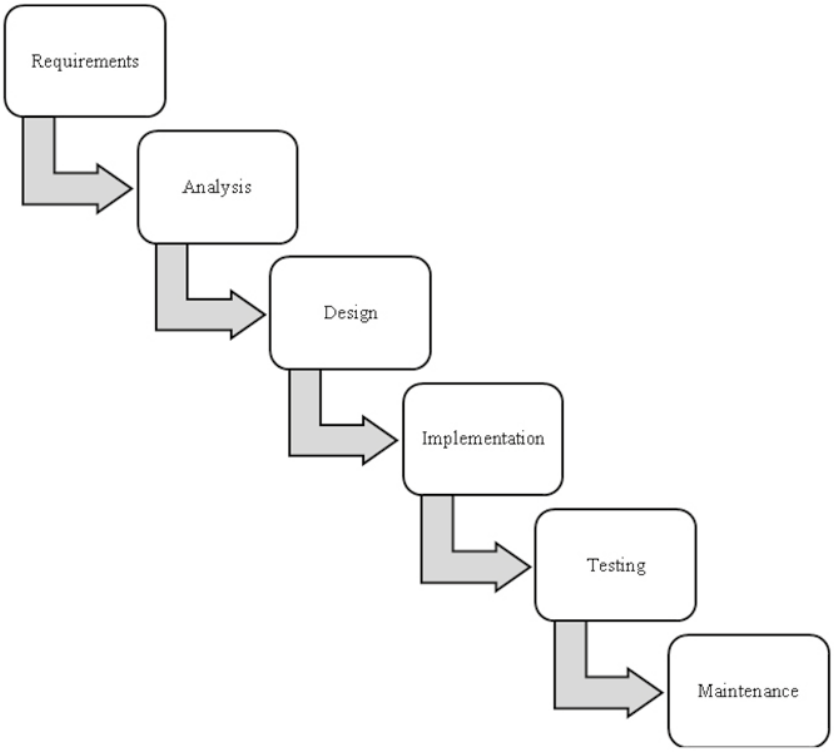

Figure 3.7. Waterfall methodology

Source: Own study based on (Royce, 1987, pp. 328–329).

It should be noted that ERP systems fulfil a number of functions in modern enterprises (shown in Figure 3.8). The main ones are as follows (Wodnicka, 2018, pp. 356–357):

1. They allow for planning, optimization and implementation of activities, as well as measurement of the efficiency of each link. They help in taking actions leading to the optimization or transformation of the implemented logistic processes and, consequently, to the reduction of associated risks, cost reduction, shortening the time of logistics processes, increasing the flexibility and effectiveness of the company.
2. They create the possibility of Internet communication, solutions increasing the level of functionality in the area of comprehensive management of processes inside the company (as well as outside it), from production and procurement planning, through production management, management of widely understood resources, to the sale and shipment of finished products to the customer, after-sales and service.

3. They allow the company to expand the chain of information resources, crossing the existing boundaries of the company and use data from external partners, suppliers or customers in real time.
4. They make it possible to monitor the state of inventories and finished products in warehouses and compare them with the anticipated demand, and thus quickly respond to changes in demand, and conduct ongoing analysis of critical areas in the company's operations, i.e. availability, efficiency, quality, customer satisfaction and profitability.
5. They are a helpful element in the management of an enterprise focused on building strong relationships with customers and business partners.
6. They enable enterprises to both integrate and optimize the logistics process, using additional tools applicable in the supply chain. The importance of integration with WMS (Warehouse Management System) applications is also growing, which not only support warehouse management, striving to optimize warehouse space, coordinating the movement of products, but as a result of creating more intelligent forms—support the management of a wider group of processes: carrier service, communication with sub-suppliers or inventory management.

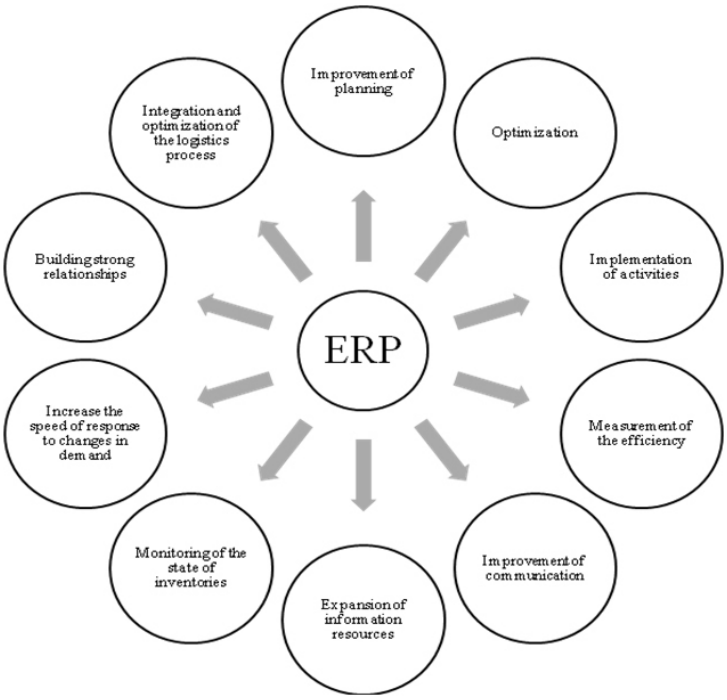

Figure 3.8. ERP systems main functions

Source: Own study based on (Wodnicka, 2018, pp. 356–357).

The importance of ERP information systems is increasing. In a turbulent environment, the possession of an integrated database by enterprises seems to be a necessity, which is an impulse to create new or improve the already existing functionalities in these systems. The possibility of adapting to the needs of each enterprise, regardless of the industry, results from their modular nature, i.e. the fact that they consist of independent, although cooperating with each other, applications and can therefore connect with other programs and applications necessary for management. Their basic foundation is the database, which is usually common to all other modules. These systems support the management of a large number of activities carried out in processes in the enterprise, also in a group of cooperating business partners, by collecting and sharing the collected data, which significantly improves the supply chain improvement. The improvement occurs as a result of a properly organized flow of goods (raw materials, finished products) between individual partners in terms of costs, timeliness of deliveries and quality of operation.

Therefore, the skilful use of ERP-class IT tools supporting the management of logistics processes can contribute, firstly, to their integration up and down the supply chain and, secondly, to support decision-making (Wodnicka, 2018, pp. 360–361).

3.4. Purchasing management

The organization of purchasing processes in the era of global competition and the growing share of procurement costs in the total operating costs in manufacturing companies is gaining new meaning. In the business practice of enterprises, an increased interest of managers can be observed this functional area. In the era of undeniable development of logistics and recognizing the benefits of logistics management, purchasing processes are gaining in importance because they are perceived as complementary to the logistics sphere, and also as another aspect of seeking to increase the efficiency of operations (Hadaś & Ragin-Skorecka, 2017, pp. 40–41).

When defining purchases, it is worth using the concept of Lysons and Klosa (2004, p. 13), who defines purchasing as "a function responsible for acquiring equipment, materials, components, parts and services by purchasing, leasing (...) for the purpose of consumption or resale". It can be seen that this definition focuses primarily on how resources are obtained. It should be noted, however, that in recent years the role of purchases has increased significantly (as shown in Figure 3.9). Nowadays, it can be said that purchasing plays a key role in managing a company (Bedey, Eklund, Najafi, Wahrén, & Westerlund, 2008, p. 6).

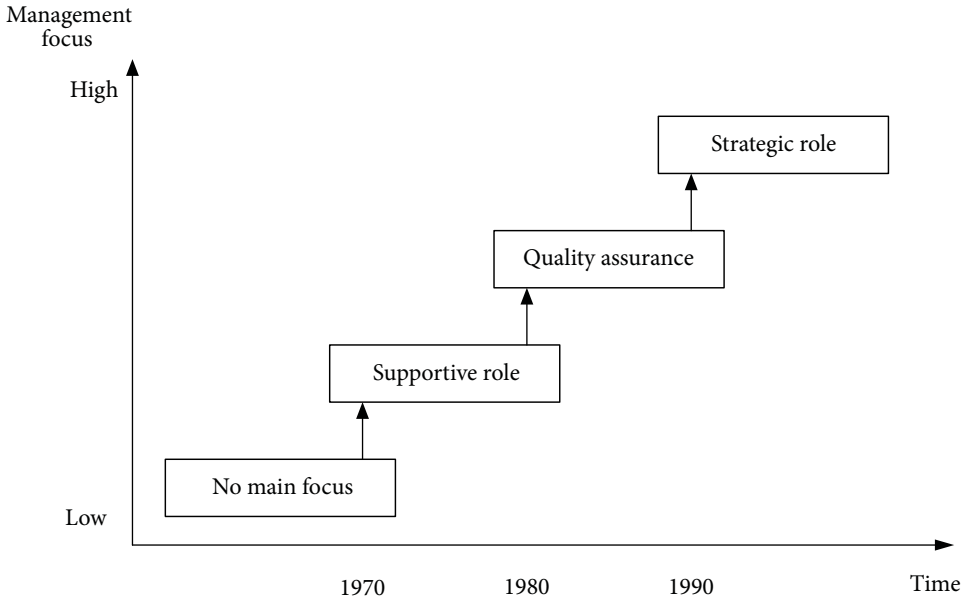

Figure. 3.9. Historical development of purchasing management

Source: (Bedey et al., 2008, p. 6).

In modern companies, as part of the purchasing process, a number of activities necessary for its implementation can be distinguished (presented in Figure 3.10). The most important tasks include (Hadaś & Ragin-Skorecka, 2017, pp. 40–41):

Figure 3.10. Purchasing tasks

Source: Own study based on (Hadaś & Ragin-Skorecka, 2017, pp. 40–41).

- segmentation of purchase items,
- establishing purchasing strategies,
- searching for sources of supply,
- supplier classification and evaluation,
- negotiations with suppliers,
- concluding contracts with suppliers of goods and services,
- determining the demand for goods, services or works based on reported needs,
- planning and inventory control,
- scheduling and control of deliveries,
- inspection of invoices for deliveries.

It should also be noted that in economic practice there are various forms of organizing purchases (illustrated in Figure 3.11). Enterprises adjust the organization of purchasing processes to the specifics of the industry, entity size, market characteristics, etc. The following basic forms of purchasing organization can be distinguished (Bendkowski & Radziejowska, 2005, as cited in Hadaś & Ragin-Skorecka, 2017, p. 41):

- centralized: one specialized organizational unit is responsible for purchases,
- decentralized: lack of one superior organizational unit responsible for purchases; purchasing tasks are scattered,
- mixed: purchases are centralized for selected assortment groups and dispersed for others.

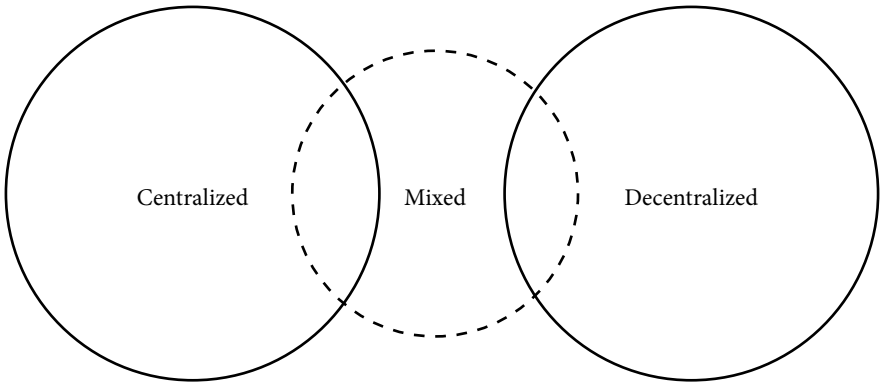

Figure 3.11. Forms of purchasing organization

Source: Own study based on (Bendkowski & Radziejowska, 2005, as cited in Hadaś & Ragin-Skorecka, 2017, p. 41).

Organizations that understand the role of purchasing create purchasing strategies. It is a unified, forward-looking and integrated plan, focused on purchasing activity. The purchasing strategy should follow the company's general strategy and should take into account conditions in the environment. The most frequently

created strategies relate to the number of suppliers (as shown in Figure 3.12). They are as follows (Hadaś & Ragin-Skorecka, 2017, p. 41):

- Single sourcing: there is one supplier, specially selected on the basis of established criteria, responsible for periodically repeated deliveries of a specific assortment item. Such a strategy often allows for large savings due to careful planning and implementation of purchases and deliveries according to the buyer's wishes.
- Multiple sourcing: it is characterized by cooperation with a relatively large number of suppliers, which allows to increase the security of purchases, reduce dependence on suppliers, forces competition among suppliers, and improves the continuity and reliability of supplies.
- Double sourcing: in this approach there are two suppliers. Vendors may provide a different version of the same product. There may be different proportions for dividing the contract. Security of supply increases, the buyer is sure that the object of purchase is always available from the supplier or in the warehouse. The advantages of a single- and multi- vendor strategy are used.

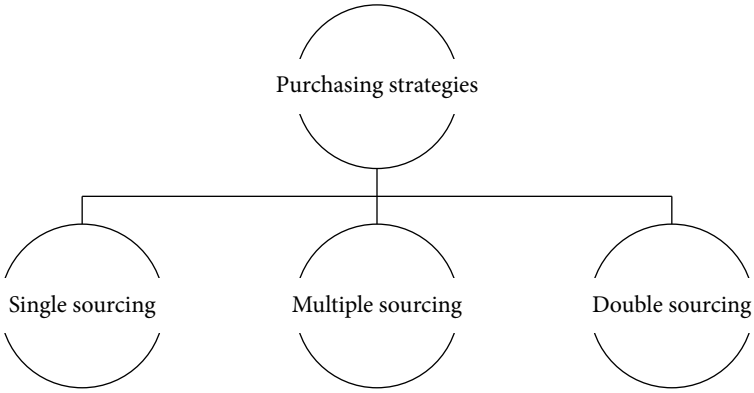

Figure 3.12. Purchasing strategies

Source: Own study based on (Hadaś & Ragin-Skorecka, 2017, p. 41).

Figure 3.13 presents a procurement management model including activities, resources and participants divided into two groups forming the internal and external networks. It should be emphasized that procurement management combines these two areas of activity. The internal tasks include cooperation within the internal network, operational purchasing decisions, defining purchasing strategies and interactions with the external network. As part of the external network of related activities, resources and participants, the main tasks are cooperation within the external network, management of relationships with suppliers, coordination of joint activities and monitoring, assessment and development of cooperation with suppliers (Bedey et al., 2008, p. 3).

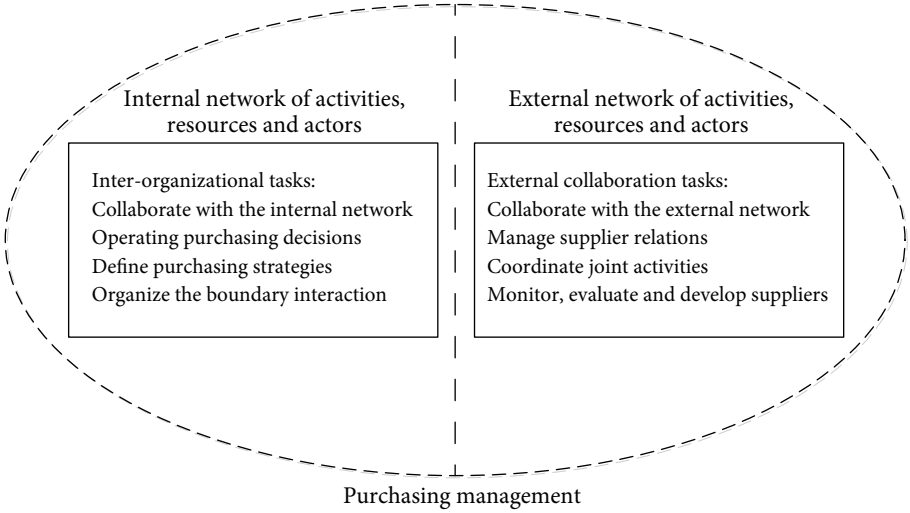

Figure 3.13. Conceptual model of purchasing management

Source: (Bedey et al., 2008, p. 3).

The procurement process can be divided into three basic stages: the stage before negotiations, negotiations and contract execution. At each of these stages, the steps taken in order to move on to the next one is distinguished. The following can be distinguished:

1. Identification of needs and development of specifications.
2. Determining the amount of expenses and analysing the market and potential suppliers.
3. Testing the purchasing strategy and identifying possible adjustments.
4. Preparation of offer documentation.
5. Preliminary selection of suppliers.
6. Supplier selection and contract terms negotiation.
7. Signing the contract and its implementation.
8. Internal operations related to the classification, record and storage of supplies.
9. Evaluation and conclusions regarding the concluded contract.
10. Control of the correctness of deliveries, quantity and quality, their timeliness and other conditions related to the implementation of strategic and operational goals of the company.

The last stage concerns the analysis of the cost of life of the product and the impact of the decisions made on their value. The aim of the analysis is the continuous improvement of, in this case, procurement management. The above considerations can be summarized using the Porter value chain model. The basic stages of the procurement process and auxiliary processes without which the implementation of the basic processes would not be possible are shown in Figure 3.14. This model

takes into account the operational and strategic perspectives and the relationship and impact of purchasing to the value of the enterprise. It is part of the value chain for the entire enterprise (Kukurba, 2016, pp. 9–10).

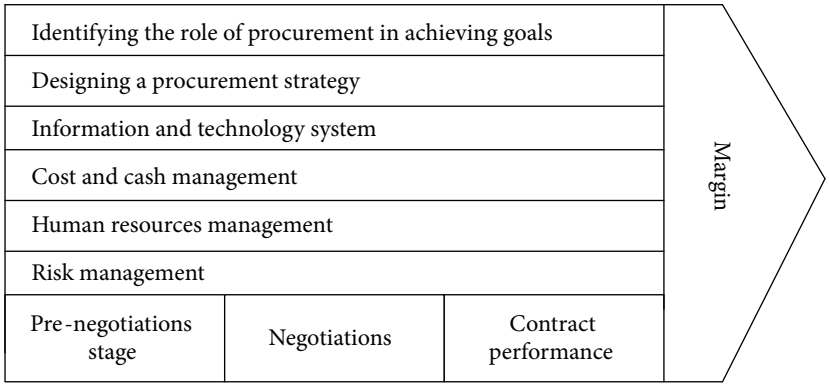

Figure 3.14. Value chain model in purchasing management

Source: (Kukurba, 2016, p. 10).

Attention should also be paid to frequent mistakes made by Polish purchasing managers. Rutkowski (2004, pp. 35–45) indicates the most important of them:

- establishing as the main goal of activities, narrowly understood reduction of purchasing costs,
- belief in the success of confrontational attitudes in negotiations with suppliers,
- narrow specialization in managing purchase categories,
- lack of in-depth financial knowledge and thinking in terms of profitability and goodwill,
- poor knowledge of other management disciplines (operations, logistics, marketing, accounting, etc.),
- misunderstanding of the idea of the supply chain and the role of partner relations,
- lack of strategic orientation.

3.5. Production capacity

The category of production capacity should be understood in many ways. The most common terms are theoretical and practical production capacity and normal and expected use of production capacity. They form pairs of concepts that are essentially convergent. Hence, the theoretical "capacity" of production means reaching the maximum production potential of the unit, with 100% use of resources, without

any disruptions to the process in the form of the so-called bottlenecks, interruptions and faults. Its approximation is the practical production capacity, expressing the production volume close to the upper limit (below 100%), possible to be realized in practice, taking into account downtime, diversified efficiency of machines and devices, and the degree of their use. An important category for the purpose of allocating fixed indirect production costs to inventory processing costs is the date of normal capacity utilization. It is considered to be the average production volume, as expected under typical conditions, for a given number of periods or seasons, taking into account scheduled repairs. There is a reference to the average production volume, characteristic for a specific type of activity, minus the planned repair and maintenance activities. The expression "number of seasons" used refers to the uneven course of production due to its cyclical nature. In this context, one should also read the concept of the expected use of production capacity, understood through the prism of the projected volume of activity in the conditions of constraints of external demand and planned events of the volume of activity for the next period or season, specific to this unit. Due to the restrictions in demand, manufacturing and/or trading companies are usually unable to sell all their products and/or goods in a given period, which results in the accumulation of inventories of tangible current assets in the warehouse. This is how the term of the sales volume is created (Chrobak, 2019, pp. 300–301).

In economic practice, agent systems are often used in the analysis of production processes and determining the production capacity. The manufacturing process can be treated as a certain group of agents negotiating with each other and providing services. Thus, multi-agent systems (MAS) are an ideal model for representing problems related to manufacturing processes that can be seen and solved from many different perspectives. The undoubted advantage of this is the possibility of distributed and concurrent implementation. The disadvantages include the complexity of interactions between individual entities operating in the environment. The characteristics of a multi-agent system are (Obrzud & Mazur, 2011, pp. 142–145):

- no centralized control,
- data decentralization,
- asynchronous operation,
- incomplete information or inability to resolve the problem.

A multi-agent system is formed by a network of computing agents that interact and typically communicate with each other. Agents may only know a partial model of the environment, may have a limited set of means for acquiring and integrating new knowledge within their models, and for directing the system towards their own goals. In multi-agent systems, the decisions and actions of different agents do not necessarily interact. However, only in the case of interactions, a multi-agent system can solve a problem that exceeds the competence of individual agents. In the community, agents must coordinate its activities with the other agents. Coordination

models provide channels and principles for managing agent interactions and dependencies. Coordination requires a certain regulated flow of information between them and the surrounding environment, i.e. communication. It should be taken into account that in MAS coordination, indirect communication through the environment or direct information exchange between selected agents is possible.

Collaboration means carrying out joint activities to achieve a common goal. For example, in an ordered field of machinery, agents may agree to perform certain tasks in order to fulfil an order at a given time. Common goals (order fulfilment) can only be achieved if all agents entrust themselves to the task for which they have previously agreed. General operations performed by the multiagent system affect the organization, which is imposed by individual agents. This is shown in Figure 3.15. It should also be emphasized that the benefits of using multi-agent systems in the analysis of manufacturing processes are as follows (Obrzud & Mazur, 2011, pp. 142–145):

- ensuring the resilience and efficiency of the system,
- cooperation with already existing systems,
- the ability to solve problems where data is distributed.

It should be emphasized that multi-agent systems are a technology that enables the modelling and implementation of individual and social behaviour in production systems. On the one hand, concepts such as autonomy, reactivity or action-oriented reasoning are used, which are related to the modelling and implementation of the individual behaviour of agents, and on the other hand, such terms as cooperation, coordination, negotiation, coalition formation, self-organization, which are related to the social behaviour of a group of agents (Obrzud & Mazur, 2011, pp. 142–145).

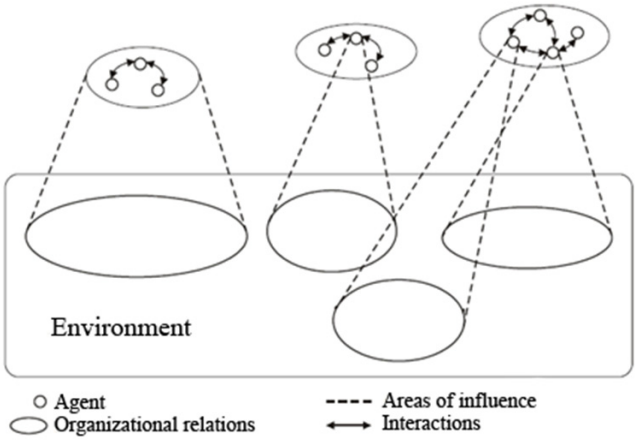

Figure 3.15. The general sphere of the multi-agent system

Source: (Obrzud & Mazur, 2011, p. 144).

3.6. Inter-organizational cooperation

Defining the concept of inter-organizational cooperation from the perspective of management sciences, it can be seen that it is most often treated as a collaboration focused on achieving benefits (Kaczyński, 2012, p. 166; Mazur, 2011, pp. 290–291; Nowak, 2012, pp. 15–35).

It should be noted that inter-organizational relationships are a source of the necessary materials and services, they contribute to overcoming the difficulties, conquering new markets and deploying new technologies. It helps to build a sustainable competitive advantage (Jacobs, Johnston, & Kotchetova, 2001, pp. 353–363; Ulaga, 2001, pp. 315–319). It is worth noting, that by creating inter-organizational relations based on various types of dynamic and multi-dimensional cooperation, each organization expects it will bring tangible benefits. Through cooperation, entrepreneurs seek to increase profitability, reduce costs, optimize the use of production potential, as well as access to scarce resources of knowledge, technology and new markets (Bengtsson & Kock, 2000, pp. 411–426; Dembińska-Cyran, Hołub-Iwan, & Perenc, 2004; Dudzik, 2005, pp. 2–8; Lenz-Cesar & Heshmati, 2009, pp. 1–25).

When deciding to cooperate, enterprises may choose one of several types of relationships, starting with simple forms of cooperation and ending with complex systems in which mutual integration of equipment, processes and management systems takes place. It is assumed that the types of connections between economic units form a certain chain (shown in Figure 3.16), the beginning of which is the so-called clean, non-contractual transactions and the end of a completely hierarchical integration of the company (Webster, 1992, p. 5).

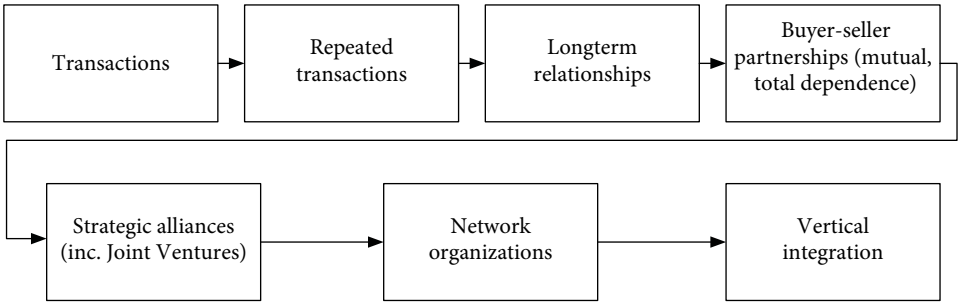

Figure 3.16. The scope of inter-organizational relations

Source: (Webster, 1992, p. 5).

At this point, it should be emphasized that companies operating on the market do not limit themselves to choosing one form of cooperation, but, obviously, decide

to establish many different relationships of a very different nature (Kale & Singh, 2009, pp. 46–47; Macias, 2012, pp. 6–11; Provan & Kenis, 2008, pp. 229–236). Moreover, it can be noticed that the forms of inter-organizational connections are not static, but dynamic and evolutionary—they transform over time, depending on the current requirements of entities, their stage of development, market situation or the adopted strategy of operation (Marcinkowski, 2015, pp. 297–310; Rangan & Yoshino, 1996, pp. 7–9).

It is also worth noting that in today's dynamically changing world an organization is more and more often perceived as a set of defined processes. Such an approach significantly facilitates the control of the achievement of goals, and thus the optimization of production time, reduction of production costs, or an increase in management efficiency. One of such processes is cooperation, which takes the form of an extremely complex, multi-faceted cycle consisting of a series of stages. In order to ensure efficiency and effectiveness of the operation, it is very important to recognize its course and the factors determining its shape.

In this context, the concept of inter-organizational cooperation developed by Ujwary-Gill and Choroszczak (2003, pp. 2–3) deserves special attention. Stressing the difficulties of creating a cooperative relationship, they simultaneously divided it into two basic stages—creation and implementation. In the first of step, a strategic analysis of the company is carried out, i.e. an assessment of its potential and the environment in which it operates. It is emphasized that before making a decision on cooperation, it is necessary to identify strategic options and select a strategy, which determines the selection of the area and form of cooperation most appropriate to achieve the company's goals. Then there is a search and selection of a partner. It is extremely important to use many different criteria when selecting a partner, such as: the ability to settle liabilities, the company's reputation, the breadth and depth of the offer, the quality of services provided, the level of service, timeliness, reliability and commitment, the potential necessary to perform tasks, having the necessary authorizations and permits, as well as the period of operation on the market (Matejun, 2009, p. 291). In the second step, the inter-organizational relationship is implemented by concluding a contract, starting cooperation and managing its course on an ongoing basis. A very important part of this stage is the control and assessment of cooperation, which allows you to see the need to modify the cooperation process. If the assumed goals are achieved, the enterprise may decide to terminate the relationship, and if further mutual benefits are expected, it is possible to continue the cooperation.

A more extensive description of the cooperation process is contained in the four-phase procedure created by Kaczmarek (2000, pp. 166–186), presented in Figure 3.17. It has a very practical dimension, as it can be easily implemented in an enterprise. The concept includes such phases of cooperation as: initiative and design, preparation, decision and implementation and implementation.

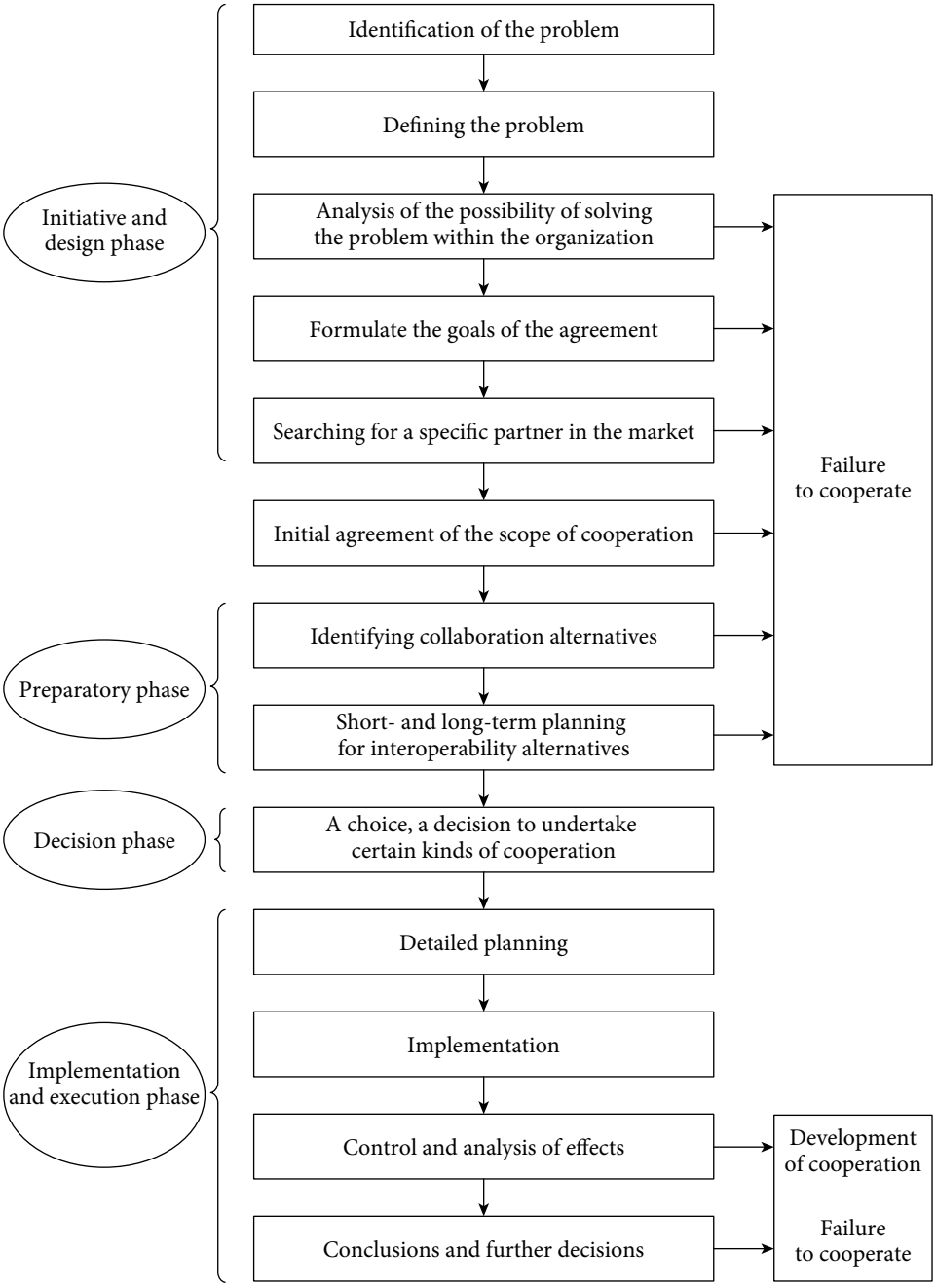

Figure 3.17. Diagram of the methodology for the preparation and implementation of decisions on cooperation between enterprises

Source: (Kaczmarek, 2000, p. 167).

The initial phase is the initiative and design phase, during which the first step leading to possible cooperation should be noticing and defining the problem, and then analysing the potential options for its solution. In this way, the goals that the company wants to achieve are formulated. As a result of the above, if the enterprise determines that the solution to the problem situation will be cooperation with another entity, it is necessary to examine whether there is an enterprise that meets certain requirements, and then whether this entity is interested in establishing a relationship at all. The next step is to determine what possible concessions to the potential partner the company must take in order to achieve its goals. In the event of a situation in which it is impossible to find a suitable partner, you should stop trying to cooperate or revise your goals, and then start the process anew. If it is possible to find an entity interested in cooperation, the decision-making process regarding the subject scope begins to extend beyond the scope of the initiator company.

It should be emphasized that at this stage it is extremely important to choose the right partner for potential cooperation. In the literature, you can find a number of guidelines for the correct selection of contractors, i.e. (Kumar, Vrat, & Shankar, 2006, p. 274):

- selection procedures based on a wide variety of criteria should be used,
- the assessment of potential partners must take into account the specificity of their activities,
- the adopted policy should be followed, which may impose certain restrictions, such as the maximum share of one contractor in the structure of suppliers or recipients, the minimum number of partners, etc.,
- it should be remembered that suppliers may impose certain minimum or maximum sizes of orders, which is most often related to their production capacity,
- when carrying out the assessment, pay attention to the delivery time.

The main goal of the next phase—the preparatory phase—is to transform the initial talks and exploratory contacts into binding agreements, e.g. based on contracts. In the previous phase, it was mainly the initiator-company that was active, while in this phase the burden is distributed more or less equally between both entities. Negotiations take place between the companies, through which the partners try to reach an agreement that takes into account the achievement of the goals of each party. This is the decisive stage for the success or failure of cooperation. In the literature, the following issues are mentioned as important in the negotiation process of enterprises: the learning process, tactics, cultural differences, local conditions, expected future cooperation, social relations, the order of submitting offers by entities, private information, bargaining power, personality of negotiators, contracts low risk, single goals, level of entity aspiration, utility maximization, private goals of partners, convergence of goals, legal agreements, transaction costs, time constraints, existing threats and requirements for contracts and their ratification (Eliashberg, Lilien, & Kim, 1995, p. 52).

The aim of the next phase—the decision—is to choose a specific type, scope, as well as legal and organizational form of cooperation. The decision in this area should be made taking into account the multi-criteria assessment and previously planned and agreed tasks. The basic factor conditioning this type of decisions is, of course, the desire to achieve the basic goal of the existence of each enterprise, i.e. achieving economic profit and increasing the value of the enterprise over time. For example, the right choice in terms of cooperation with the supplier, due to the large share of purchased goods and services in the cost structure, allows achieving a significant competitive advantage over rivals (Kasilingam & Lee, 1996, p. 347). However, economic practice shows that some agreements are concluded for other reasons, e.g. to avoid or limit market consequences, which allows the entity to be protected against competition. When deciding to cooperate with a specific partner, enterprises should follow criteria of an economic, technological, production, personnel, organizational and social nature, as well as spatial concentration and dispersion (Kaczmarek, 2000, p. 170, as cited in Haus, 1983).

The last phase of the procedure is the implementation and realization phase, which consists in developing a program for the implementation of a given solution, its implementation and constant analysis and evaluation. The implementation program should include main tasks related to cooperation, detailed guidelines for teams responsible for a specific area of joint activity, decision-making powers, deadlines and time for their implementation, as well as analysis and control of effects. It is this last stage—control—that is an extremely important part of the implementation and execution phase. Properly conducted internal control allows to be sure that the processes in the enterprise run in a way that minimizes the likelihood of fraud, error or uneconomic and ineffective practices. The control should be a system, the participants of which are the employees and management of the unit, supported by modern organizational and technical equipment, giving the opportunity not only to maintain, but also to constantly improve the efficiency of operation (Saunders, 1996, p. 32; as cited in Nadolna, 2009, pp. 272–273; Najwyższa Izba Kontroli, 2000, p. 74; Kuc, 2002, p. 83).

Questions / tasks

1. What is the fourth industrial revolution characterized by?
2. What stages does the production process consist of?
3. What is a make-or-buy decision?
4. What are the rules of the 5S method?
5. How can you implement an ERP system in an enterprise?
6. What are the main tasks of the purchasing department in the enterprise?
7. How has the role of purchasing changed in recent years?

8. How can purchases be organized in the enterprise?
9. How can the multi-agent model be used to increase production capacity?
10. What are the possible forms of inter-organizational cooperation?
11. What characterizes the process of establishing cooperation between economic units?

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4.

TRADITIONAL METHODS USED IN OPERATIONAL ACTIVITIES

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Abstract: The purpose of this chapter is to present the traditional methods used in operational management. The methods described include benchmarking, outsourcing, Just-In-Time, *kaizen*, Total Quality Management, MRP I, MRP II, and core competencies developed in various periods of the 20th century to improve the planning process and efficient management of the flow of resources, goods and information. Benchmarking consists of comparing the processes and practices used by one's own enterprise with those used in enterprises considered to be the best in the analysed field. Outsourcing means separating from the organizational structure of the enterprise some functions performed by them independently and transferring them to other entities for execution. Just-In-Time is used to reduce work in progress and inventory levels in production and warehouse processes. *Kaizen* and TQM are based on the continuous diagnosis and improvement of all elements of the company. MRP methods are based on computer systems and clearly defined, inter alia, the volume of demand, order fulfilment time and provide other data relevant to the company's logistics system and its operations. Core competencies are company-specific skills that are difficult to copy or win over to competitors. The authors focused primarily on the presentation of the main goals, principles of operation, as well as the advantages and disadvantages of the selected methods in operational management.

Keywords: benchmarking, core competencies, Just-In-Time, *kaizen*, MRP, outsourcing, Total Quality Management.

4.1. Introduction

This chapter presents the main traditional methods used in operational activities. These methods are well known in practice and often used. When analysing various criteria for the classification of production methods, it is worth paying attention to an interesting division proposed by Halevi (2001, p. 36). The described methods can be divided into five groups:

1) focus on product design methods (benchmarking),
2) focus on commercial aspects (outsourcing, core competencies),
3) focus on processing manufacturing methods (Just-In-Time, *kaizen*),
4) focus on production planning and control (Material Requirements Planning, Manufacturing Resources Planning),
5) focus on organization (Total Quality Management).

In each of the indicated groups, Halevi describes several detailed methods, indicating their type which is characterized by:

- software solution—requires computers,
- management—methodical directions for organization and managing,
- philosophical—modern management methods.

A brief description of the selected methods is presented below.

4.2. Benchmarking

The benchmark is the levelling point, which is the reference point when determining the location or height of buildings and topographic objects above sea level (Bogan & English, 1994). In the 1970s, the word began to be used in the context of business and management. It was then used to define the process of analysis for comparative purposes. In 1979, the American concern Xerox Corporation used benchmarking as a way of comparing the company with competitors. The company then adopted benchmarking as the most important element of its recovery strategy. It is worth noting that the corporation made this decision when competitors began to offer products at a price lower than the costs incurred by Xerox for producing such products. Xerox was a pioneer in the application of benchmarking and thanks to this strategy it regained its previously lost position in the market.

> Benchmarking is the search for the best industry practices which will lead to exceptional performance through the implementation of these best practices (Camp, 1989).

Currently, benchmarking is recognized as a method of comparing business processes and performance indicators with industry best and best practices from other companies. The elements that are measured are time, quality and cost. The use of

benchmarking is necessary in any serious process of organizational improvement, in which the current, ineffective state of functioning / operation of the enterprise will be partially or completely replaced by a more economic one, on the example of other enterprises. Thus, benchmarking contributes to the transformation and restructuring processes (Moriarty & Smallman, 2009, p. 484).

The main goal of implementing benchmarking is to obtain at least the average achieved by competitors from the same industry. In this case, learning from others is proposing one's own solutions based on the acquired knowledge, patterns, and not passive imitation. Benchmarking in production means the ability to meet customer requirements by adopting innovative practices regardless of their source. It is worth noting that access to statistical and production data of the enterprise plays a key role in this process. Over the years, manufacturing companies have developed various types of measures by which they can evaluate their performance. In most indicators, time is the basis of the measurement. In this way, enterprises can make calculations in various areas of operation. In a situation where enterprises are unable to obtain such data, they often obtain the necessary information from competing companies that have a common stage of the production process (Cupples, Macneil, Rimmer, & Testi, 1994).

The growing popularity of benchmarking in business practice results from the benefits it provides. These are among others (Kiziukiewicz, 2011, p. 393):

- better understanding of own individual and environment, identification of development opportunities,
- revealing the weaknesses of a given unit, defining the conditions for success,
- determining the necessary improvement actions (goals and tasks) and the necessary resources,
- improving operational efficiency,
- increasing competitiveness, strengthening the market position,
- better meeting customer expectations and improving relations with them,
- improvement of technologies and products,
- triggering the initiative and involvement of employees (promoting creative, innovative attitudes),
- attracting new investors.

The simplest division of outsourcing distinguishes between two types:

1) internal benchmarking: when the best (model) area is selected from among the areas of the enterprise with an extensive structure, where we have the adopted comparative variable (evaluation criterion). For example, this could be the area with the lowest costs and will be taken as a benchmark for comparisons and activities in other areas. By making such a statement, it is possible to identify the main factors determining the success of an individual in this respect and focus on their maximum use to obtain better results. The process of internal benchmarking is shown in Figure 4.1;

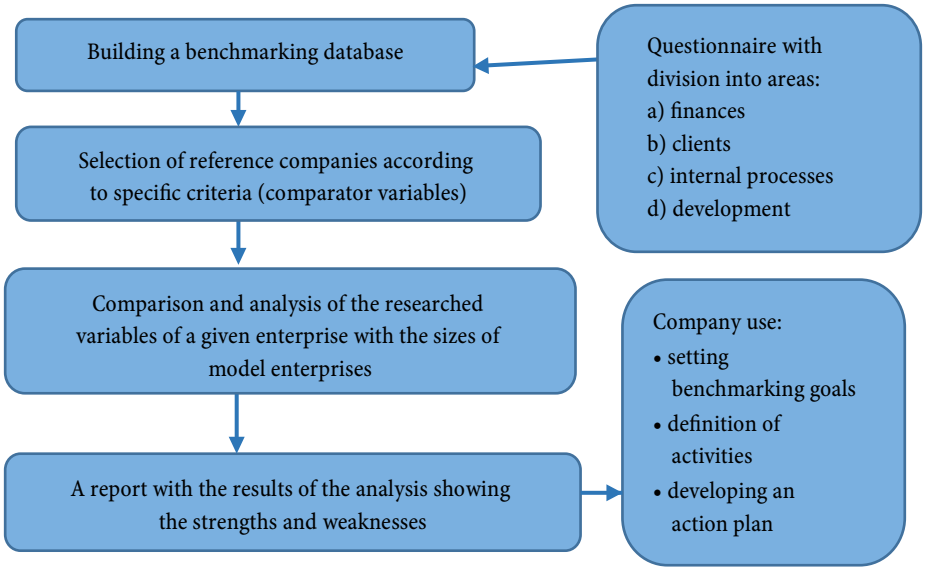

Figure 4.1. The process of internal benchmarking

Source: Own study based on (Kiziukiewicz, 2011, s. 396).

2) external benchmarking: when benchmarks are reference units from the environment. Taking into account the scope (scale) of its implementation, it is possible to distinguish international, cross-sector and inter-enterprise benchmarking (selection of the best enterprises, leading in terms of specific methods or processes—"best-in-class"). The functioning of external benchmarking is most often carried out according to the principle presented in Figure 4.2.

An important criterion for the division of benchmarking is also the subject of comparisons, and within such a classification one can distinguish benchmarking of processes, results and strategies (Balcerek-Wieszala, 2010, p. 245).

Process benchmarking concerns individual operational processes and work procedures, which are then compared with those already used by, for example, an industry leader. In this type of benchmarking dam, sales, R&D, products, marketing or production capacity can be compared.

Benchmarking of results focuses on benchmarking in terms of operational or economic efficiency. Analysing economic indicators or elements such as price or quality are also very helpful in determining a competitive position.

Strategic benchmarking is based on comparing the company with the leader, but not necessarily from the same industry. The basic goal is to recognize the leader's path of conduct not only in terms of the strategy he chose, but also the levels and type of investments. The effect of using this type of benchmarking is to create a long-term scheme of competitiveness.

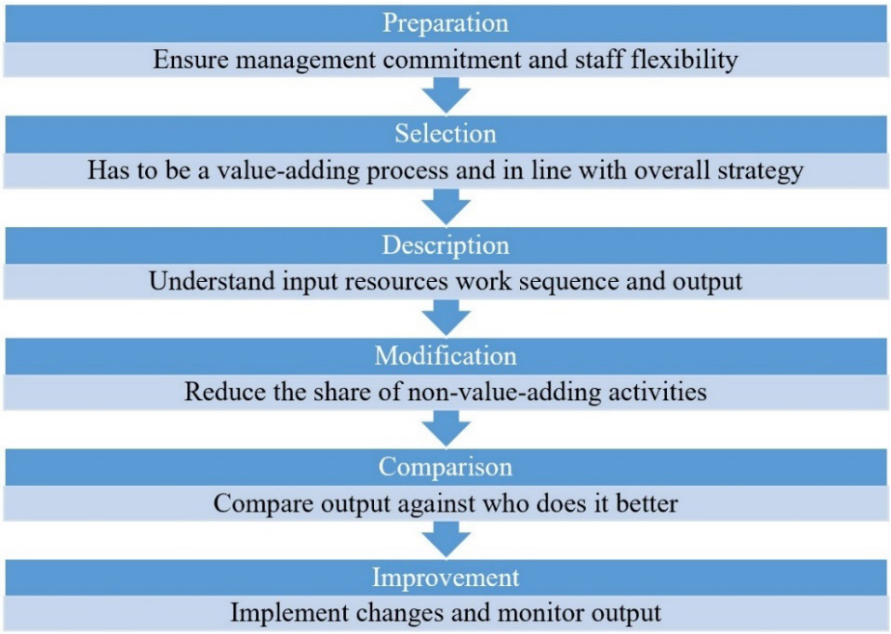

Figure 4.2. The process of external benchmarking

Source: Own study based on (Mohamed, 1996, p. 53).

In order to select an enterprise classified as a benchmark, first the selection criteria should be formulated. For this purpose, a given enterprise has to obtain information about leaders and possible partners who may support a given unit in carrying out benchmarking. This information may come from various sources—both own and external (Kowalak, 2009). Own sources include the database of competition created by the company itself, research and development works, personal contacts of employees, information collected on the basis of press announcements, advertising brochures, showrooms, telephone surveys, as well as an analysis of the biographies of model company managers, awards and distinctions that they have received. Foreign sources of information about leaders and potential benchmarking partners include companies creating databases on the best enterprises, sectoral data banks, professional magazines, conference materials, research institutes, universities.

A proven source of information is the benchmarking system, called the Benchmark Index, which was fully established in the UK in 1996.[1] This system is systematically expanded and provides many standard indicators within a given industry, which can be used for benchmarking comparisons on a regional, national and international scale.

[1] It currently has one of the largest databanks in the world, with companies from various industries and countries, with European countries dominating.

The well-known and widely used international quality standard ISO 9000 can also serve as a model. The ISO 9000–9004 standards have been established by the International Organization for Standardization and describe the requirements that must be met by: design, material sourcing, production, quality control systems and delivery systems in order to produce a high-quality product (product or service). Obtaining an ISO certificate is preceded by a costly and lengthy verification procedure. Having the ISO standard, however, is a great importance for the prestige of the unit and its competitiveness, because ISO accreditation is associated with the entry into the international list of guaranteed suppliers.

The information collected for the purpose of benchmarking is a point of comparison. The data on the unit looking for opportunities for improvement are compared with the figures considered as benchmarks. This allows to determine the deviations that may be (Sobańska, 2003):

1) negative (unfavourable), when the phenomenon (quantity) in a given unit does not match the standard, e.g. the production time of a specific product is longer than the time considered as the benchmark, the unit profit is lower than the benchmark or the unit cost is higher than the benchmark,
2) positive (favourable), when the phenomenon (quantity) in a given unit is favourable compared to the reference measure, so e.g.: the production time is shorter than the reference one, the product quality is better than the reference one, the unit cost is lower than the reference measure,
3) neutral (zero), if there is no discrepancy between the studied phenomenon (quantity) and the pattern.

After analysis, special attention should be paid to negative deviations. They prove the necessity to take actions to improve a specific parameter or phenomenon (process). Therefore, unfavourable deviations should be subject to an in-depth causal analysis. Within its framework, the following activities should be performed (Kiziukiewicz, 2011, p. 397):

1) the main factors influencing the achievement of exemplary results by the benchmarking leader (partner) are determined,
2) the differences between the results of a given unit and the reference results are determined,
3) the causes of discrepancies are investigated,
4) evaluation of the real possibilities of achieving the benchmark or better results in a given unit, taking into account its limitations,
5) the optimal (real) level of results for a given unit is determined,
6) a list of changes is prepared, the introduction of which determines the achievement of the desired level of what is the subject of benchmarking.

Then proceed to the last stage, i.e. implementation or post-benchmarking activities. Actions taken within its framework should lead to the implementation of an optimal solution in a given unit. It is of particular importance to establish rules and

methods for measuring improvement processes. Their selection should be determined by the benchmarking area and the variables (criteria, parameters) adopted for comparisons. The evaluation criteria used for the purposes of benchmarking may be non-economic and economic values. In the second case, the most often used are financial result and the factors that shape it (costs and revenues).

As previously emphasized, during the benchmarking process, an important issue is the selection of appropriate indicators and criteria. Suitable measures can be found, among others in a strategic scorecard, also known as the Balanced Scorecard (BSC). Data is grouped according to four key perspectives: finance, customers, internal processes and development. Examples of measures that can be used for benchmarking comparisons in individual perspectives of a balanced performance card are presented in Table 4.1.

Table 4.1. Perspectives of benchmarking

Perspective	Finance	Customers	Internal Processes	Development
Index	• return on investment • economic added value • profitability • revenue dynamics • dynamics of cost reduction	• market share • customer acquisition • customer loyalty • profitability of customers • customer satisfaction	• product quality • development of new products • length of time to introduce new products	• employee satisfaction • employees rotation • employee performance
Example of how to calculate the indicator	• probability of gaining a return from an investment • comparing net operating profit to total cost of capital	• number of customers, value, or quantity of sales • number of positive customer reactions, share of new customers in relation to the cost of acquiring them • sales growth rates for existing customers • net profit generated by market segment, taking into account specific costs related to servicing a given customer • customer satisfaction research using surveys	• the number of good products to the total number of production, the number of shortages, the number of returns or claims • percentage of sales of new products, the number of new products launched on the market compared to the competition and in relation to the plan • time to go out with a new offer	• surveys on factors such as commitment to the production process, recognition for a job well done, overall job satisfaction in the enterprise, etc. • percentage of employees who left key positions • revenue per employee, value added per employee, sales revenue ratio related to total salaries

Source: Own study based on (Gmińska, 2006, p. 75).

Benchmarking as a traditional method used in operational management is also particularly useful in strategic management accounting and in strategic management. The changes initiated on the basis of benchmarking and the assessment of the achieved effects require a longer time, because the introduction of changes must be preceded by research into the environment, analysis of the directions and scale of changes, defining the rules for their implementation and then examining the results. The main advantage of benchmarking is the possibility of flexible adaptation of the specificity of the areas and areas of improvement of a given company and the selection of various criteria (parameters) to express patterns (benchmarks) and the sizes, features or processes compared with them. It should be noted that benchmarking should be carried out cyclically and be systematically repeated (Kiziukiewicz, 2011, p. 402).

4.3. Outsourcing

Outsourcing is not a new concept in operational management, as evidenced by the words of Henry Ford, who already at the turn of the 20th century argued that if we cannot do something better, cheaper, faster than others, then there is no reason for us to do it themselves, and not commissioned it by a better person than us (Radło, 2011). Currently, the phenomenon of outsourcing should be considered not only from the point of view of organizations that take advantage of its possibilities, but also from the point of view of companies that specialize in the provision of outsourcing services.

Outsourcing consists in transferring responsibility for the implementation of specific areas of economic activity (e.g. tasks, functions or processes) to the side of a specialized an external partner, taking into account the economic (quantitative) and qualitative benefits and at the same time the possibility of developing the company's key competences and adding new value, which enables strengthening the market advantage and the company's development (Matejun, 2005, pp. 19–20).

Outsourcing means reducing the scope of the company's tasks and entrusting their performance to an external partner. Outsourcing may concern components, individual activities, functions, business processes, and even product modules (e.g. processors in telephones) (Laskowska, 1995, p. 186).

Enterprises often use outsourcing, considering it a kind of strategy that allows to restructure, change the profile of operations and increase flexibility, as well as reduce costs and improve operations. Its strategic dimension is determined mainly by attempts to adjust the size of the organization to the requirements of a changing environment and is related to the following factors (Fill & Visser, 2000, p. 44):

- reduction of operating costs,
- market forces,
- technical factors,
- capital and knowledge,
- production capacity and work efficiency,
- opportunities to focus on key competences.

There are three levels of outsourcing: tactical, strategic and transformational (Brown & Wilson, 2012). Tactical outsourcing is used to solve problems related to the activities of the enterprise. It mainly concerns: insufficient amount of investment funds, insufficient decision-making competences in the implementation of the tasks, functions or processes in question, lack of access to modern methods and equipment used in this area, or reduction of employment (Ghodeswar & Vaidyanathan, 2008, p. 25).

The basis for cooperation with a service provider in tactical outsourcing is a properly prepared agreement (contract). It describes in detail the provisions that are to provide the client with a higher level of quality of the outsourced services compared to self-performance at lower costs and with less involvement in supervising the implementation of tasks in this area by the client. In such a contract, there are usually also restrictions on the service provider's freedom in shaping the methods of performing the tasks assigned to them. Often, the assumptions regarding the methods of performing the commissioned tasks, as well as the anticipated effects, are reflected in the form of appropriate provisions in the contract. The main features of tactical outsourcing include:

- performance by the service provider of additional activities entrusted to him, which may help to solve the existing processes performed by the client,
- minimizing the costs of commissioned tasks,
- the investment risk is shared between the service provider and the principal,
- focusing attention on the profits achieved by ordering the service provider's performance,
- the possibility of changing the service provider when the intended goals are not achieved,
- the service provider's focus on achieving and maintaining the indicated quality level of entrusted orders.

The basic goal of strategic outsourcing is focused on the effective use of opportunities and possibilities offered by the market. The implementation of this level of outsourcing should be preceded by a thorough analysis of the benefits and possible risks associated with delegating to another entity the implementation of tasks performed so far on one's own. Strategic outsourcing is a type of strategic decision and is characterized by the formulation of a long-term business goal for the activity. It can relate to a specific product and market segment and aims to provide the customer with a specific added value. Collaboration is an integral part

of strategic outsourcing (Nowicka, 2016, p. 93). Companies decide to use strategic outsourcing in order to:

- restructuring or transformation of the enterprise,
- business risk minimization,
- increasing own competitiveness and innovation,
- flexible adaptation of policy to the requirements dictated by the market,
- increasing the value of the company,
- reduction of operating costs related to the implementation of individual processes.

Transformational outsourcing is the most developed form of cooperation with a service provider in the field of outsourcing. The service provider makes a radical redesign of the methods of performing the commissioned tasks, also participating in the implementation of essential improvements in the client's operations (Linder, 2004). The main purpose of this type of outsourcing is to achieve, in a short time, gradual, permanent and significant improvements in the performance of the entire activity of the client in which the service provider participates. The people who are involved in working together to achieve these improvements are also essential. The main features of transformational outsourcing are:

- main emphasis on the client's performance,
- the primary goal is to increase the market value of the company—the client,
- the role of the service provider is to cooperate with the client in redesigning his business in line with the client's strategic goals,
- focusing the service provider's efforts on the continuous improvement of the methods of implementing the ordered activities,
- optimization of operating costs and the use of reengineering,
- the change of the service provider made difficult due to the necessity to adapt the activity and equipment of the service provider to the client.

A typical outsourcing process is presented in Figure 4.3 and shows the outsourcing phases from the decision to use outsourcing to its implementation, management and evaluation of results.

The steps and elements in the figure are part of most outsourcing assignment. The outsourcing initiative usually starts in the strategy phase. The company determines the goals, scope and feasibility of the outsourcing concept. Then the total time of the project, planned budget and necessary resources are estimated. At this stage, requests for information are sent to outsourcing partners, so company can gain insight into the details of the outsourcing order. In the next phase, the scope of cooperation is determined and the level of service to suppliers is established. The areas to be outsourced and the areas that are under the company's control are agreed. This is where the request for quotation is usually sent to the recipients. Only suppliers that have qualified under the guidance outlined in the earlier stages may qualify for the next stage. The next phase is negotiation. Here, the client presents

the cost estimate of cooperation. The most common forms of collaboration are full-time equivalent cost, time and material, unit price, volume-based pricing, managed service fee, no solution—no payment, fixed price, etc. (Bartell, 1998). This is where the pre-contract phase ends.

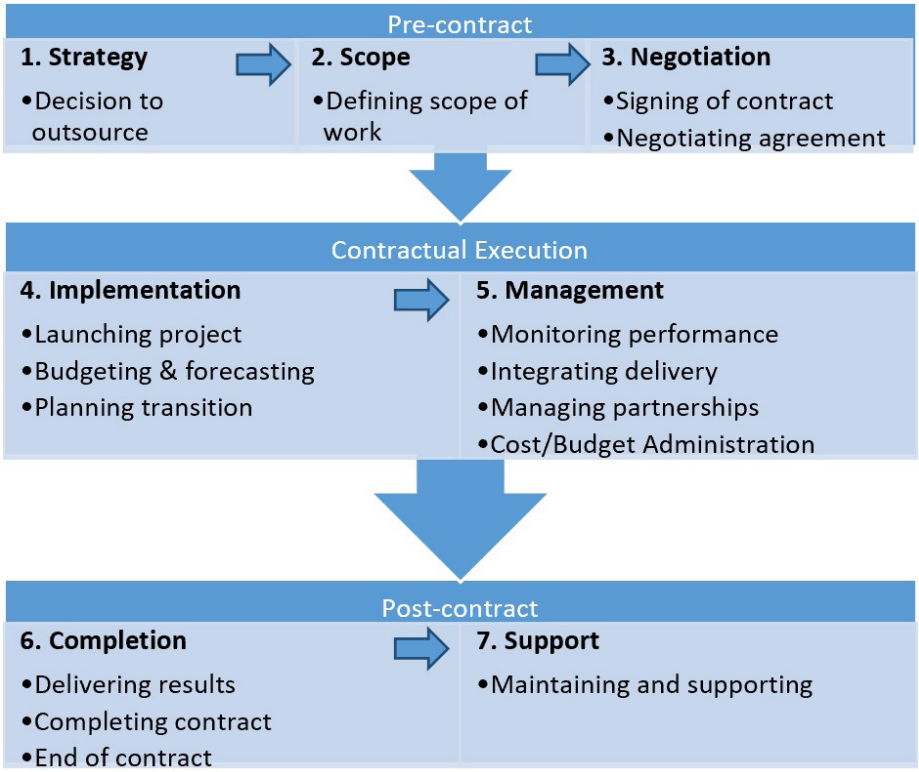

Figure 4.3. Process of outsourcing

Source: Own study based on (Ghodeswar & Vaidyanathan, 2008, p. 29).

Negotiations should end with the signing of a contract between the client and the contractor. In the next stage, the company analyses the quality of services provided and assesses the competences of the service recipient in the scope of activities performed for the company. The implementation phase means the transfer of the internal process to the external provider. This often includes a requirements assessment where the process is thoroughly examined by the host. The supplier can redesign the entire process to optimize it. Successful implementation is followed by a phase of continuous monitoring and management of outsourcing areas. The service provider now has an external company that carries out certain business areas for him and can focus on his own key processes. Initiating and implementing

changes is one of the key elements of this phase for a successful outcome. This marks the end of the contractual execution phase and the beginning of the post-contract phase. Contracts that can be extended are assessed at this stage. The service provider makes the final decision whether it extends the contract, amicably terminates the cooperation in order to consider cooperation with another provider or performs the function on its own.

The phenomenon of outsourcing results from the fact that it can be used in every area of the company's operation. The most frequently excluded from the organizational structure of the company are simple services that are associated with the involvement of significant resources, performing routine activities or little development opportunities. In practice, however, outsourcing is also used in more strategic areas. Examples and popular outsourced functions are presented in Table 4.2.

Table 4.2. Areas of use of outsourcing

Areas enterprises	Division of tasks / subfunctions
IT services	operation of computer networks; operation of data centres; infrastructure maintenance services; application operation; end-user support; group of security services (Disaster Recovery); Internet services
Financial services	accountancy; debt service; controlling; auditing; financial and analytical services
Human resources	recruitment and selection of candidates; employee training; creating incentive systems; personnel management; administration of personnel documentation; temporary employment
Manufacture	production of components; packaging; assembly of products; component design
Legal services	legal advice in various fields; legal services
Transportation services and logistic	product distribution; courier services, warehousing
Customer service	telemarketing; reception; secretary's office; helpline; call centre
Management and administration	maintenance of buildings and cleanliness; keeping archives; protection of people and property
Marketing	monitoring changes taking place on the market; research customer expectations; creating new concepts products; determining the promotional and advertising strategy; distribution; developing public relations

Source: Own study based on (Jagusztyn-Grochowska, 2002, p. 12; Rękas, 2002, p. 173; Trocki, 2001, pp. 46–49).

The business case for outsourcing varies by situation, but the benefits of outsourcing often include one or more of the following: lower costs (due to economies of scale or lower labor rates); increased efficiency; variable capacity; increased focus on strategy / core competencies; access to skills or resources; increased flexibility to meet changing business and commercial conditions; accelerated time to market; lower ongoing investment in internal infrastructure; access to innovation, intellectual property, and thought leadership; possible cash influx resulting from transfer of

assets to the new provider. As with any strategy or model, the outsourcing concept also has some drawbacks, as: slower turnaround time, lack of business or domain knowledge, cultural barriers, lack of control.

4.4. Core competencies

One of the most dynamically developing methods of operational management is the concept of core competencies, which is treated as an excellent tool for the reconstruction of an organization's performance and a driving force for changes at the operational level. It allows company to focus on those areas which (from the point of view of a given unit): are the most important, bring the highest revenues and profits, and the organization has the greatest competencies, characterized by parameters such as experience, practice, skills, equipment, technology, resources etc. (Nowak & Wojtkowiak, 2016, p. 53). The concept of core competencies was popularized by Prahalad and Hamel (1990), who consider it in the context of the source of competitive advantage. They believe that it is a company's predisposition to operate effectively and efficiently, and at the same time rationally, in market conditions, with the ability to respond to the challenges of the modern market at the same time. Core competencies are understood as the joint acquisition of knowledge in an organization, in terms of coordination of different production skills and integration of numerous technological streams. Therefore, it constitutes a certain predisposition to collective learning within strictly defined limits, determined by the potential and abilities of the organization. Within its framework, individual members communicate, exchange information and engage in work. At the same time, they emphasize that this process is a platform for building products and services in line with the expectations of potential and current buyers (Prahalad & Hamel, 1990).

At the beginning it should be noted that the concept of competence can be considered from the perspective of an individual or an organization and can be divided into individual and organizational (Wyrzykowska & Balanovska, 2018, p. 110). Individual competences include knowledge, skills, values and standards, motives, work ethic, enthusiasm and self-image. Organizational competencies, on the other hand, are specific abilities or skills related to the development, coordination and use of available resources. In addition, competencies are also determined by the management style and technological level. The main goals of building and developing organizational competences include:

- understanding what the competition will be in the future,
- developing the ability to find a future market niche,
- ability to mobilize all employees,
- ability to beat competitors without undue risk.

The process of creating competencies can be divided into five levels arranged according to the diagram below (Zakrzewska-Bielawska & Flaszewska, 2013, p. 224) (Figure 4.4):

1) resources-asset: concerning everything that the organization "owns"—buildings, machines, technology, reputation and other fixed and current assets,
2) skills: including what the company knows—know-how and abilities necessary for the organization to operate,
3) competencies: integrating the resources used with the acquired skills in order to achieve the strategies assumed by the company,
4) core competencies: higher form of competence,
5) meta-competencies: defining competencies of superior nature in the hierarchy of abilities, resources and competences. They are the basis on which enterprise can build, develop and verify their core competencies (Matwiejczuk, 2011, p. 34).

Figure 4.4. The process of the evolution of competences

Source: Own study based on (Javidan, 1998; Nowak & Sobolewski, 2016; Zakrzewska-Bielawska & Flaszewska, 2013).

Resources are the foundation that influences the development of an organization's capabilities. On their basis, the company creates competencies, some of which are transformed into core competencies. At the very top, there are meta competencies that enable the maintenance of the core competencies developed so far, but also additionally support the development of new resources, abilities or competences.

As already mentioned, the competencies of enterprises and their more developed form, core competencies, are obtained by creating various types of combinations. However, resources are in most cases the basis of these competencies (the so-called complex resources), enabling further implementation of the company's strategy (Urbanek, 2011, pp. 24–28). In order to show the full architecture of key competences, seven categories can be distinguished that can create them. A special graphic diagram is presented below (Figure 4.5).

The presented system is purposeful, because starting from material resources and then moving clockwise it can be seen that the listed elements are presented in descending order in terms of the possibility of control that the enterprise can exercise over the given elements. However, it is recommended that the process of creating company's own core competencies take place in areas where companies can create the greatest value for customers.

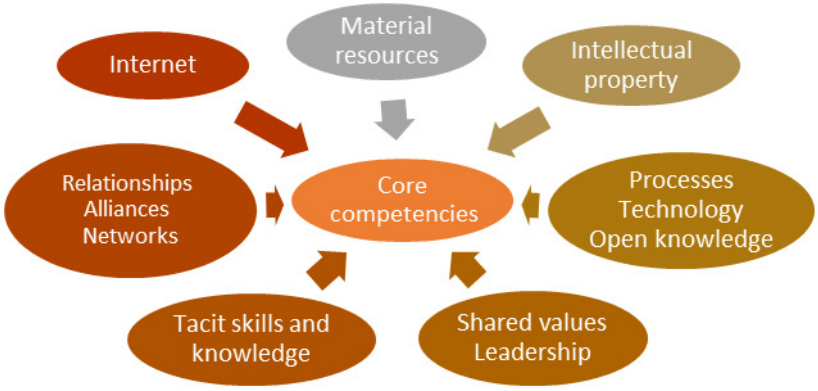

Figure 4.5. Architecture of core competencies

Source: Own study based on (Urbanek, 2011, p. 25).

Material resources are areas over which the company has total control, even when they are not owned by them (e.g. leasing). These assets contribute to the development of core competencies to a certain extent but are not their essential element. Due to the universal availability of this type of assets, they can rarely be a factor that distinguishes an enterprise. Intellectual property consists of patents, know-how, copyrights and trademarks. They are subject to legal protection, so that the company also exercises full control over them. Explicit knowledge, along with technology and processes, includes routines and procedures. It is codified and stored in databases collected in the company. Although this group of assets is largely controlled by the entity, due to the limited possibility of legal protection, it can be quickly copied by the competition. Leadership and organizational culture constitute a group of intangible assets that are of decisive importance in the appropriate shaping and management of the employee environment. The role of leadership is to develop effective procedures that will allow enterprise to select, integrate and retain leading employees. On the other hand, the organizational culture makes it possible to shape an environment in which employees will be able to use the maximum of their abilities. Tacit knowledge and individual or group skills determine the company's ability to properly respond to market opportunities and threats. They include flexibility of action, ideas, creativity and experience. Another category of resources are alliances, networks and other types of relationships that constitute strategic value for the enterprise. By interconnecting internal and external resources in the network, participants (companies) can increase their own strategic flexibility. This allows them to quickly configure their set of resources to adapt to dynamic market conditions. The last category is the Internet, which is one of the new external factors on which modern business models are built. The mobility and availability of this resource enable companies to quickly communicate with

recipients. However, control over numerous processes taking place on the Internet is negligible due to the possibility of creating informal networks for the exchange of opinions and views. In this way, company can quickly promote a product / service, but also destroy, e.g., the company's reputation.

Along with the development of this concept, the conditions that must be met in order to classify the competence as core have been defined:

- must make a significant contribution to the value of the manufactured product or the service provided,
- it must be unique, so it does not exist in the competition and is difficult to copy,
- it must form the basis of the company's operation, so it can be used in various areas of the company's operation.

Core competencies fulfill three criteria:
1. Provides potential access to a wide variety of markets.
2. Should make a significant contribution to the perceived customer benefits.
3. Difficult to imitate by competitors.

The combination of the indicated features into one coherent area allows enterprise to achieve the synergy effect, work coordination and optimal use of resources (Nowak, 2016, p. 14). This definition mainly focuses on certain production aspects of the enterprise. Production companies in the operational management phase, need to examine their core competencies, which are identified with the issues that contribute most to creating value for buyers. They should be adjusted and harmonized with other areas of the business unit's activity, in such a way that the company can react appropriately to the conditions dictated by the environment and at the same time implement the market policy. The lack of properly defined values / strengths of products, processes and production procedures prevents rational management of the company's assets. However, properly defined strengths allow, for example, to decide to outsource those areas and functions that play a smaller role in the value creation process (Halevi, 2001, p. 114). However, proper identification of core competencies is required, which should harmonize with each other. Only properly matched and correlated advantages can be the basis for development.

An essential element of the operational management of any company is the selection of specific strengths, enabling the company to distinguish itself in the market. This choice should take into account the best attributes of the organization that have a comprehensive impact on all areas of activity. The selection of the appropriate composition of distinguishing properties is the essence of the core competencies of the organization, which allow to use all possessed resources to a high degree: material, personal, financial, relational, organizational. However, identifying core competencies is not an easy task. Correct diagnosis requires compliance with

strictly defined procedures, the involvement of many employees (of various levels, representing various cells), knowledge of the market, contractors and competitors, and above all, own potentials and capabilities.

4.5. Just-In-Time (JIT)

The Just-In-Time method is known as the philosophy of enterprise management, and its essence is inventory, production and supply management. In simple terms, it consists in delivering and maintaining raw materials, materials, semi-finished products or finished products in exactly the right amount, at such a time and in such a place that it is possible to produce or deliver the right amount of products. A certain level of inventory should be available when the company actually needs them (Piasecka-Głuszak, 2011, p. 209).

Just-In-Time was first used in the 1920s by Henry Ford and perfected among suppliers by Toyota's vice president, Taiichi Ohno, from the 1950s to the early 1970s (Porter, 2009). His innovative approach to applying the JIT concept to Toyota factories has led to a reactive approach to Kanban inventory shaping. In addition, the time for retooling machines and devices was reduced to 1 minute and the distance between machines used in subsequent production stages was significantly reduced (Witkowski, 1998, p. 47). Nowadays, the JIT method is applied by many other companies such as General Motors, IBM, Apple and others.

Just-In-Time means doing only what is needed when needed and to the extent that is needed. In this way, they ensure the elimination of losses, incompatibilities and excessive needs and increase productivity.

Just-In-Time is a philosophy of action that seeks to maximize productivity by influencing all parts of the company such as purchasing control, engineering, marketing, personnel and quality control (Deneva, Hristova, Ivanova, & Petrova-Vakinova, 2017).

Most production systems use the so-called "Push" (Vonderembse & White, 1988, pp. 474–518) system for moving materials in the production process. Its main idea is that the materials are pushed through the individual operations according to a prepared schedule. The products are "pushed" from one work centre to another, but the centres are not aware of the real needs.

In contrast, JIT uses the so-called "Pull" system (Vonderembse & White, 1988, p. 485). Instead of pushing materials into the manufacturing process, the JIT system uses exactly as many materials as needed. The concept of the "pull" system is built on the basis of consumer demand. Just-In-Time concept aims to create a production system that meets market needs by eliminating all losses and striving

for continuous improvement. The phase Just-In-Time is applied because through it the system works with a low stock of goods and a small amount of inventory from the already finished products (Kumar & Suresh, 2009, p. 189). The products are assembled just before they are sold, the assembly elements are made just before they are assembled, and the components are made and assembled just before the assembly elements are made. This leads to lower costs and reduced deadlines.

Full JIT implementation is not limited to the company's production system, but also includes suppliers and customers. The process of achieving continuity and flexibility of flow between the production system, suppliers and customers is presented in Figure 4.6.

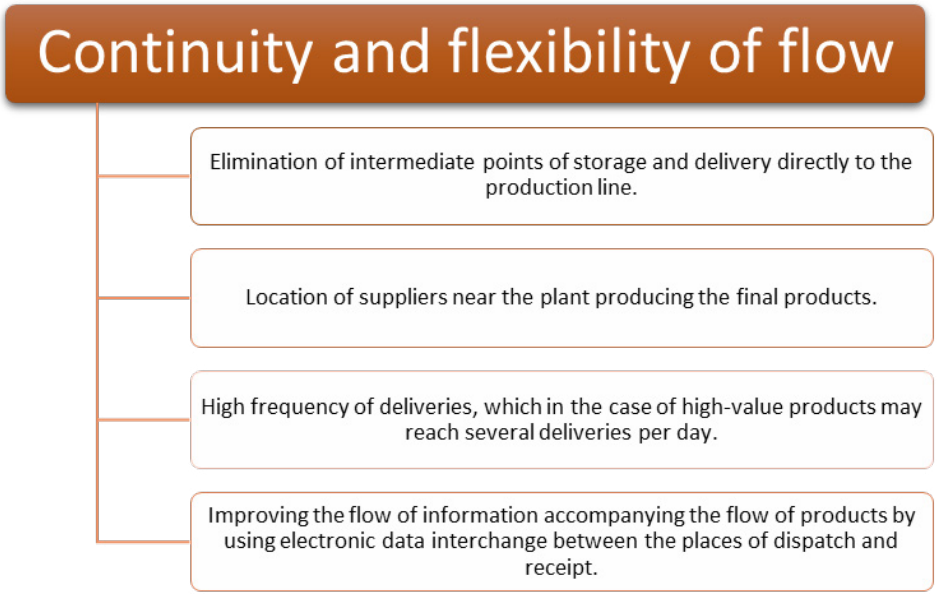

Figure 4.6. The process of obtaining continuity and flexibility of flow

Source: Own study based on (Witkowski, 2010, p. 195).

The Just-In-Time method is based on the waste elimination system (from the Japanese muda) and is based on the continuous improvement of the product flow processes and accompanying information. There are 6 basic principles that should be followed in the Just-In-Time method (Figure 4.7).

The Just-In-Time implementation process should be preceded by a detailed analysis of all factors determining its functioning, including transport costs and problems related to the natural environment. The effectiveness of the implementation work for the JIT method may depend on a number of factors, such as (Bendkowski & Radziejowska, 2011, pp. 161–162; Lysons, 2004, p. 250; Witkowski, 2010, p. 202):

1) gaining the approval of the crew, full commitment and training of employees,
2) achieving long-term and harmonious cooperation with suppliers,
3) the use of an appropriate material needs planning system based on production schedules, which will allow for precise formulation of requirements in the scope of delivery,
4) maintaining small stocks in the form of safety stocks only,
5) close IT connection based on a system of planning and control of supplies between enterprises and advanced Electronic Data Interchange (EDI),
6) proper organization of external transport, taking into account reliability time and transport costs.

Figure 4.7. Rules for applying the Just-In-Time method

Source: Own study based on (Bozarth & Handfield, 2007, p. 627).

JIT is a manufacturing methodology that aims to improve overall productivity by eliminating losses, which in turn leads to quality improvement. This technique ensures efficient production in the organization and delivery of only the necessary parts in the right quantity, at the right time and place, using minimal resources.

Loss means an activity that does not add value to the operation, so Toyota formulates several types of losses that can be eliminated through operations Just-In-Time (Kumar & Suresh, 2009, p. 189):

1) overproduction: it is defined as the biggest source of loss for the enterprise—it should not produce more than is necessary for the next process,

2) waiting time: this is the time spent preparing,
3) transport: unnecessary transportation of raw materials during the work process is another source of loss, planned changes can significantly reduce travel time,
4) manufacturing process: some operations do not add value to the product but exist due to poor design or maintenance of the machines, design improvements or preventative maintenance can eliminate these losses,
5) inventories of goods: inventories of various types of goods must be reduced because they are also considered a source of loss,
6) movement: simplifying labour movement will reduce losses caused by unnecessary relocation of labour and equipment,
7) defective goods: total costs for poor quality can be very high and include scrap materials, wasted working time and fast order time, leading to outstanding orders.

The greatest benefit of applying JIT technique is to improve the firm's adaptability to market changes, thus gaining a competitive advantage through (Kumar & Suresh, 2009, p. 189):

- Production costs: a reduction in costs is achieved by shortening the production cycle, reducing losses, inventories and eliminating value-added operations.
- Quality: is improved through continuous quality improvement programs.
- Design: changes are developed in a timely manner thanks to the quick response from engineers through alternative designs.
- Increase productivity.
- Flexibility of the production system.

In addition to the above-mentioned most important benefits related to the introduction of the Just-In-Time system, it is also worth presenting the advantages and disadvantages of this concept (Table 4.3).

Table 4.3. Advantages and disadvantages of Just-In-Time method

Advantages	Disadvantages
• improvement of cash flow and reduction of working capital • reduction of stocks of materials, work in progress or finished products • faster information flow, reduction of documentation • lower demand for warehouse space • less means of transport used in warehouses • establishing close cooperation with suppliers • increasing the level of logistic customer service • faster reaction to changes in projects	• difficulty in eliminating inventories with variable and difficult to predict demand • transport unreliability, delays affect the continuity of the production and sales process • suppliers should be located in close proximity to the company • fear of lowering the level and increasing costs associated with production downtime • difficulty in finding regular suppliers • during implementation, it is necessary to adapt the production and supply subsystem • requires a new approach to management • there must be solutions in the company that eliminate the effects of any disruptions

Source: Own study based on (Piasecka-Głuszak, 2011, p. 208).

4.6. Material Requirements Planning (MRP or MRP I)

The method of planning material needs MRP (Material Requirements Planning) is a computer system used to rationalize planning, by issuing purchase and production orders at exactly the right moment to the desired product appeared at the right moment and in the required quantity (Kowalska, 2005). The MRP system was created in 1964 by Orlicky, as a response to the Toyota's production program. In the beginning, its application was primarily in the automotive and aerospace industries (General Electric and Rolls Royce).

MRP is primarily used to properly coordinate the material requirements for production, determine what and how many materials (or components) should be ordered and when they should be ordered / delivered in order to reduce their storage time in the production process to a minimum. MRP operates in the so-called push system (as opposed to the Just-In-Time method) and consists in the fact that specific tasks are carried out according to the plan and then transferred to subsequent recipients, regardless of their current needs, which results in an increase in the level of maintained inventories (Piasecka-Głuszak, 2011, p. 197).

The MRP system is a supporting tool inventory management and planning the supply of materials and raw materials necessary for production, for which demand depends from the demand for final products (Zięba & Ziółkowski, 2012, p. 354).

The main goal of the system is to ensure the right amount of raw materials and materials necessary to implement the planned production and deliveries to the customer, to maintain the lowest possible level of inventories and to support the company's planning policy related to the creation of delivery schedules and assembly activities. Moreover, the group of intermediate objectives of the MRP includes:

- synchronizing the processes of ordering and delivering materials and components with production needs,
- better control of individual production stages,
- precise determination of the delivery times of raw materials and semi-finished products,
- reduction of material and operational stocks,
- faster response to changes in the environment,
- precise determination of production costs,
- better use of the infrastructure (warehouses, production capacities).

There are three key elements in an MRP system: input data, MRP program, and output data. Starting with the input data, there are three main sources of information as input (Moustakis, 2000, p. 2):

- production schedule: it defines the deadlines for the production of each product,

- specification of materials: is a description of all products and components necessary for the manufacture of the final product,
- time production cycle: the time and materials required for each stage of the production cycle; delivery times.

After collecting the input data, all information goes to the MRP program. Based on the reported demand for products, specified in the production schedule and on the basis of information from the material register, the MRP program converts and determines the needs for parts and materials needed for production. Then, based on the information obtained from the inventory register, it calculates the demand and prepares orders for the delivery of materials needed for production at a specified time.

The information processed by the MRP program is entered into a table called the MRP information presentation table (Vonderembse & White, 1988) (Table 4.4).

Table 4.4. Presentation of MRP information

	1 week	2 week	3 week	4 week	5 week
Gross material requirements					
Revenue schedule					
Initial inventory					
Net needs					
Planned proceeds					
Scheduled order placements					

Source: Own study.

MRP information contains 7 categories of data:

- gross material requirements: the total required quantity of a particular item in each period,
- revenue schedule: number of orders placed for an item that have not yet been received; this line records when an order should arrive and how many items should be in it,
- initial inventory: contains the planned amount of items that should be available at the beginning of each time period; if this quantity is not sufficient to cover gross requirements, then the line responsible for net needs indicates the need for a new supply of stocks,
- net needs: shows when the order should arrive in order to avoid shortage of necessary parts or materials,
- scheduled order placements: represents the time periods in which these orders must be placed in order to arrive at the right time.

The information received from MRP is called output data and includes instructions and reports on, for example (Piasecka-Głuszak, 2011, p. 200):

- quantity of ordered materials and order fulfilment dates for the purposes of future production or purchase,
- notifications about placing orders,
- cancellation of product shipment notifications,
- schedule changes,
- changes in order fulfilment dates,
- planned orders to be completed within a specified period.

In order to effectively use material requirements planning as an operating strategy in a manufacturing company, the following five key principles are required (Figure 4.8).

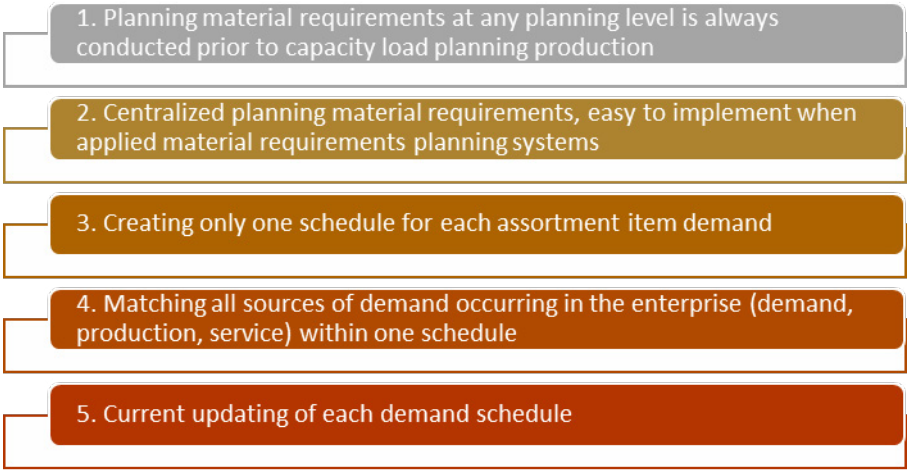

Figure 4.8. Five key principles for applying MRP

Source: Own study based on (Fertsch, 2003, pp. 33–34).

Applying material requirements planning allows managers to easily quantify each component for a particular order size, know when to place an order, and be notified when each product is needed. Others important benefits of using MRP planning are (Stevenson, 2012, p. 525):

- the ability to maintain low levels of stocks, thanks to the fact that the supply of goods meets the needs of demand,
- ability to monitor material needs,
- an opportunity to assess the capacity needs arising from a given schedule,
- MRP planning is a means of allocating production time.

In addition to the above-mentioned most important benefits related to the introduction of the MRP programme, it is also worth presenting the advantages and disadvantages of this method (Table 4.5).

Table 4.5. Advantages and disadvantages of Material Requirements Planning

Advantages	Disadvantages
• supporting the management of material flows • maximum use of production capacity and the possibility of long-term planning of their development • cooperation and coordination of the activities of individual logistics subsystems of the enterprise • quick detection of delays in deliveries and quick corrective actions • accelerating and delaying the execution of orders	• difficulties in introducing changes in the functioning of the system • ordering and shipping costs can increase as the company lowers its inventory levels and aims to create a system where smaller quantities of products are ordered and delivered when it needed • insensitivity to short-term demand fluctuations • high complexity and sometimes not in line with expectations

Source: Own study based on (Coyle, Bardi, Langley, Kempny, & Klosa, 2002, pp. 133–134).

4.7. Manufacturing Resources Planning (MRP II)

In 1989, for the needs of production, MRP was transformed into MRP II (Manufacturing Resources Planning) or production resource planning (Stevenson, 2012, p. 526). MRP II expands the scope of MRP by adding other functional areas to the organization's planning process. Compared to MRP I, the planning and control of other production elements, such as: materials, devices, machines, workforce, information, area, energy factors, capital, were taken into account. Such a combination enables the enterprise to use all the resources that are involved in production on a multi-level basis. As a result, greater control was gained over the current production process, sale of products or over the company's finances. Moreover, the application of MRP II allowed to precisely define the evaluation of the achieved results.

MRP II process is the planning of material needs, which begins with the summarization of information from all sources (standing orders, forecasts, safety requirements, etc.) (Deneva et al., 2017).

Just like the Just-In-Time concept, MRP is a pull system with a decentralized system of orders, tasks and execution control for individual cells, and the size of orders for subsequent phases of the production process results primarily from the actual demand reported by other executive or other departments.

The production, marketing and financial staff develop the basic production schedule. Information about the need for financial and marketing resources is important and therefore they must be planned not only in size but also in time. The company must have all the necessary resources for the successful implementation of the plan, so it is possible to revise the original plan based on an assessment of stocks.

After the approval of the production schedule, the needs for materials are planned, and the management moves to the capacity planning. At each of these stages, adjustments are possible in the production program. Most MRP II systems have the ability to perform simulations, which allows managers to answer a variety of questions in order to get a better assessment of the possible options and their consequences.

Therefore, a key element of the MRP II system is the database, which is usually common to all modules included in the program. The essence of MRP II is that the production cycle is described very accurately and in detail. Starting from the phase of orders for materials, through all phases of production, to the sale of the finished product. Only such a holistic approach can ensure an accurate determination of the material requirements for production.

In the case of MRP II, there is the so-called feedback of the production process. All information collected in a common database and computer-aided goes from individual units or departments to other cells, so that the plans and orders are up-to-date at all times, and the analysis takes place in real time. According to this method, the entire economic process in the enterprise is a closed-loop system in the field of production management and control.

Table 4.6 presents most important benefits and threats related to the introduction of the MRP II program.

Table 4.6. Advantages and disadvantages of Manufacturing Resources Planning

Advantages	Disadvantages
• high degree of internal integration of procedures • greater synchronization of activities • access to the database to all cells involved in the program • the possibility of shortening the order fulfilment cycle • reducing the frequency of production lines downtime • integration of financial planning with the company's activities • greater sensitivity to changes in demand as a result of receiving up-to-date data on an ongoing basis • more efficient delivery • greater planning flexibility adjusted to market conditions • the possibility of expanding the system with new modules	• need to have a large IT background • need to have centralized network configurations such as central computer-terminal, client-server, client-network • need to provide precise information from individual cells • failure to fully take into account production limitations • does not work well in managing the entire supply chain • very high license purchase price

Source: Own study based on (Piasecka-Głuszak, 2011, p. 202).

4.8. Total Quality Management (TQM)

Total Quality Management is a philosophical concept of management that assigns a decision to the continuous improvement of the quality of work and product. Moreover, it is a concept of achieving higher quality of work and achieving con-

tinuous improvement of the quality of products and services provided. TQM is committed to meeting the quality requirements and sustained satisfaction of both external and internal customers (Wawak, 2008).

The progenitor of the idea of total quality management is Armand Feigenbaum. As early as 1948, working for one of the large American companies General Electric, he created and implemented a quality system known as "quality costs". Its implementation provides an opportunity to simultaneously increase the efficiency of the quality management system and reorganize the activities of companies. It is the practical experience of building and implementing such systems that allows Feigenbaum to create the theory of total quality control known as TQC (Total Quality Control). In 1961, in his book *Quality Control of Production*, he first began to talk about the need for total quality management, based on the application of statistical methods for quality management and regulation of technological processes.

> Total Quality Management is sometimes defined not only as comprehensive quality management, but also as comprehensive quality management, consisting in continuous improvement of each activity at every level of the company's operation, with the involvement of every employee, so that quality improvement itself becomes the company's goal (Klimek, 2010, p. 121).

Another American researcher, William Edward Deming, has a very significant and important role in the creation and validation of the total quality management system. Its name is associated not only with the beginning of the so-called American period in quality management, but also with the formulation of one of the first comprehensive approaches to quality management known as the PDCA cycle (**P**lan, **D**o, **C**heck, **A**ct). The practical implementation of the Deming system took place in the '70s and '80s in Japan. In a short time, based on it, Japanese companies managed to make a breakthrough in the quality of manufactured products and Japanese quality became a global criterion for product quality.

Japan has played a leading role in quality management since the middle of the last century, and this is a reason to talk about Japan's contribution in this area. He is associated with the names of Kaoru Ishikawa, Akao Yozhi, Genichi Taguchi, Masaki Imai and others. Undoubtedly the most famous among them is Ishikawa, who is quite deservedly called "the father of the total quality management system". In 1962, he not only created the worldwide TQM system, but introduced a new method for analysing causation, known as the "Ishikawa Diagram" and started the activities of quality circles.

The Japanese approach to quality management is significantly different from all the others. It emphasizes the participation of all divisions and all employees of a company in quality management. It is no coincidence that Ishikawa considers total quality management as a set of different approaches—integrated management,

management with the participation of all departments, management with the participation of all employees and workers in the company, total management (Ishikawa, 1994, pp. 161–164). The Japanese approach to quality management, which became known in the world as TQM, is based on four basic rules, closely related to Japanese philosophy, traditions and morals and covers all levels in the company:

1. Participation of all staff in quality management activities.
2. Continuous staff training.
3. Regular internal audits of the quality management system.
4. Wide use of statistical methods for quality control.

The main goals of the total quality management system are related to the constant improvement of the quality of the products and the organization, the rational use of resources and optimization of the costs for quality management. However, before the company starts to implement TQM, first of all, it should adapt activities to the so-called the 14 rules of Deming. It is a set of management practices to help companies increase their quality and productivity (Deming, 2000, pp. 23–24; Hristov, 2020):

1. Create conditions for continuous improvement of work, products and services.
2. Adopt a new philosophy of conduct, reject the existing standards regarding problems, defects, complaints and delays.
3. Don't rely on mass quality control. Use statistical methods to prove that product quality is built into the production system.
4. Don't make purchases based solely on price.
5. Actively support all activities that improve quality and productivity, as this will reduce costs.
6. Introduce the principle of continuous training and learning of employees, the top management of the enterprise must also be involved.
7. Use appropriate forms of supervision. Its aim should be to help achieve better results at work.
8. Introduce freedom of questions and suggestions so that the employee does not feel any fear of presenting ideas or doubts.
9. Remove barriers between company departments. Develop cooperation as well as cooperation with suppliers, co-operators and customers.
10. Don't use empty slogans aimed at increasing productivity and quality.
11. Use numbers-based labour standards with caution as they can be detrimental to quality and production levels. Choose descriptive methods and supervision to help get the job done.
12. Remove obstacles and let employees evaluate their own work.
13. Apply training that introduces the latest methods and ideas. Teach employees new skills. They are necessary in order to introduce changes to new techniques, materials and processes.
14. Give each employee the opportunity to participate in teamwork to organize and make changes.

These principles correspond to the basic goals on which the philosophy of TQM is based (Figure 4.9).

Figure 4.9. The main principles of the TQM philosophy

Source: Own study based on (Evans, 2008).

The TQM philosophy can be divided into 8 main divisions:

- Customer orientation: in modern conditions, companies depend entirely on their customers and therefore it is necessary to know their needs and requirements, even more to strive to meet them ahead of schedule and exceed their expectations. Achieving such an approach requires the formation of consumer confidence in the manufacturer / supplier of the product or service, a balanced approach to the needs and requirements of consumers, consistent with the capabilities of the supplier and periodic survey and evaluation of consumer opinion.
- Leadership: leaders are obliged to create and maintain the necessary conditions for the implementation of total quality management in the organization. In addition, they must participate in the quality improvement process.
- Staff participation: people are the main driving force and essence of any organization. From the point of view of the organization they are not only specific executors of the production activity, but also managers and controllers of the ongoing processes inside the enterprise.
- Process approach: it is associated with the use of structured methods for identifying key quality management activities, clear and strictly fixed responsibilities

and accountability, specifying the internal and external relationships between management functions in the organization, risk assessment, consequences and impacts on consumers, etc.

- System approach: the system approach is the basis for building the strategy of each individual enterprise. It ensures its sustainable development. Applied to the quality management system, this approach requires the delimitation of the following main subsystems: quality planning; quality assurance; quality management and quality improvement (Tuzharov & Fileva, 2007). Quality planning includes all activities for the creation and validation of confidence that the product and the processes for its creation meet the established quality standards. Quality management includes methods and activities to meet product quality requirements. They are fully operational and include various standard procedures. Quality assurance, which is divided into external and internal, leads to building confidence in the staff of the company and its managers on the one hand, and in consumers—on the other, about quality. This is achieved through various procedures—internal audits, preventive actions under standard procedures and more. Quality improvement is a continuous process, a composition of various activities leading to improving the quality of processes and products.
- Continuous improvement: this idea is present in the earliest quality management systems. Many authors such as Deming, Crosby, Ishikawa and others. emphasize the need for continuous improvement. Indicative in this respect are the Deming-Schuhart cycle, the Noriaki Kano quality model, the ideas of reengineering, the Six Sigma model, and so on.
- Decision making based on facts: the analysis of data and objective information is the basis for making effective management decisions. The implementation of the principle leads to the exclusion of the possibility of imposing authoritarian/volitional decisions. In addition, the efficiency and accuracy of decision-making is significantly increased. The necessary facts are collected through the use of statistical methods for control, analysis and regulation.
- Mutually beneficial relations with suppliers: since manufacturers and suppliers are closely linked and their connections and relationships depend on the final results of each production system, it is very important that these relationships and relationships are beneficial to both parties.

TQM is a comprehensive approach to achieve long-term quality improvement and a higher degree of customer satisfaction. It includes several main stages (Deneva et al., 2017, p. 172) (Figure 4.10):

Approach for implementing the TQM system is based on the view that quality should be built into the manufactured product or service and possible defects should be prevented as soon as possible and at any cost. For these reasons, the total quality management system is seen not only as a set of methods, tools and tools for product quality control, but to a much greater extent as a new business

philosophy, a new way of thinking and a new perception of the category "quality". This explains the variety of approaches related to its development and implementation in the enterprise.

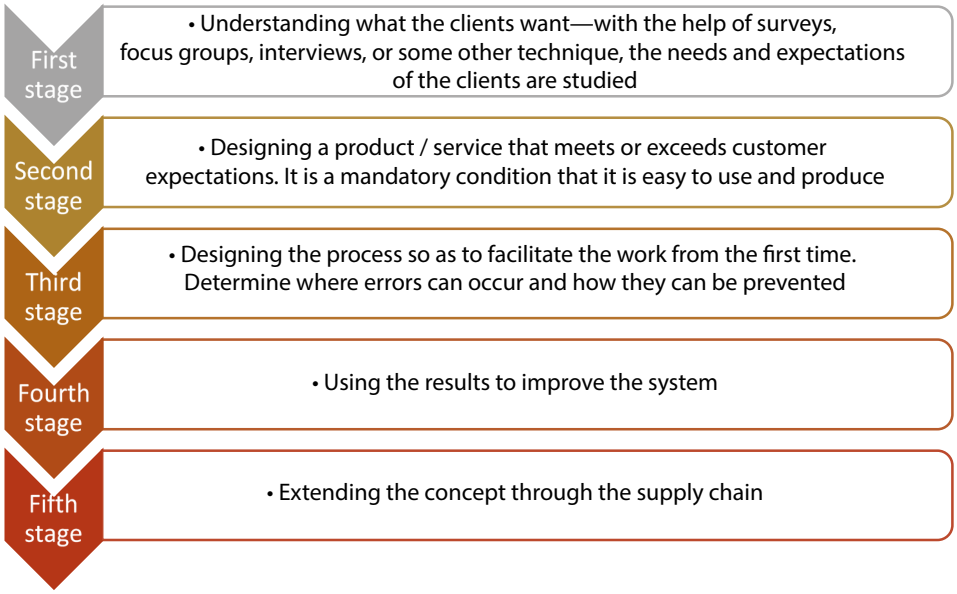

Figure 4.10. Stages of TQM

Source: Own study.

One of the most commonly used is undoubtedly the one proposed by the "father" of TQM—Ishikawa. He proposes to use seven basic tools, now perceived as classic, to build the TQM system. These are: graphs, diagrams and flow charts, frequency map, histogram, Pareto analysis, causal diagram, scatter diagram and control maps. Table 4.7 presents most important benefits and threats related to the introduction of the TQM philosophy.

Table 4.7. Advantages and disadvantages of Total Quality Management

Advantages	Disadvantages
• customer satisfaction • positive attitudes of the crew • effective communication • constant improvement • satisfaction of "internal" customers • elimination of losses	• too much innovation in activities • frequent lack of preparation and understanding of the program • lack of adequate training of all employees • lack of clearly formulated and structured rules regarding the organization of the enterprise and the division of responsibilities • lack of patience while waiting for the results • awareness that TQM is a never-ending process of improvement

Source: Own study.

4.9. *Kaizen*

The concept of *kaizen* derives from the tradition of the Japanese ethical code of warriors—samurai, known as Bushido. This tradition permeated all aspects of life and included, among others: philosophy, care for physical health, professional duties, improvement of culture, work performed, faithfulness and courage. Even after lifting samurai privileges in 1876 this code found application in industry and the military concept of Japan from the beginning of the 20th century. Later in the late 1940's it began to be used in corporations and public administration offices.

> *Kaizen* is a management concept based on the principle of constant search and application of even the smallest improvements in all areas of activity, at every workplace. Its goal is to achieve great success with small steps (Bernais, Ingram, & Kraśnicka, 2010, p. 164).

The *kaizen* concept was used for the first time on an industrial scale in Toyota's factories in the 1980s. Its creator is considered to be Masaki Imai, who in 1986 published his famous book *kaizen: The Key to Japan's Competitive Success*. At the heart of this concept is one of the main Japanese philosophical theories and practices—*kaizen*, which focuses on continuous improvement. Its essence is expressed through the sentence: "Every day I do my job better than yesterday."

The main requirement of the *kaizen* concept is the constant improvement of both the production activity and the management of the organization. Everyone from senior management to production workers is involved in its practical implementation. The main goal is to achieve lossless production. Its implementation is based on three key elements:

1. Organization of the workplace.
2. Elimination of unjustified losses.
3. Standardization of processes.

The organization of the workplace (*gemba*) is carried out through the application of five key elements known as the 5S (Goryunova, 2020):

- Seiri (*accuracy*): it is necessary to remove everything unnecessary from the workplace.
- Seiton (*order*): all the elements necessary for the work must be arranged in the field of view so that they can be found easily and quickly.
- Seiso (*cleanliness*): the workplace and the equipment used must be well cleaned and the tools and devices placed in the right places.
- Seiketsu (*standardization*): the first three steps are important should become common practice for everyone. To build a proper organization of the workplace, prescriptions and training are needed.

- Shitsuke (*discipline*): creating a system for observation and monitoring of procedures for organization and maintenance of the workplace.

The elimination of unjustified losses (*muda*) is associated with the elimination of all activities that do not create value for the organization. These include unproductive and unnecessary movements, delay of individual operations, errors in the technological preparation of production, long-term transport operations, defects, surplus production stocks and overproduction.

Standardization is related to the introduction and continuous improvement and maintenance of existing standards in the organization.

The *kaizen* concept combines many different methods and systems for quality management (Figure 4.11).

Figure 4.11. *Kaizen* concept

Source: (Goryunova, 2020).

There are different classifications of the principles of *kaizen.* According to some of them, they can be reduced to 16 elements (Goryunova, 2020):

1. *Focusing on the customer*: the most important task is the products to meet the needs of customers.
2. *Continuous changes*: continuous small changes in all areas of the organization.
3. *Open recognition of existing problems*: where there are no problems, improvement is not possible, which is a basic requirement of *kaizen.* Therefore, customer complaints are treated as a gift to the company. This is one of the main ways to solve the problem and a chance to solve it and improve the quality of production.
4. *Openness within the company*.
5. *Creation of working groups*: each worker is a member of such a group and its corresponding quality circle, and new workers are included in the "club of the first year".
6. *Project management*: in order for the individual groups to work effectively, a close connection between them and rotation is needed.
7. *Formation of "supportive relationships"*: for the organization are more important good relationships between its employees and their involvement in the activities performed than the financial results achieved. A good production climate always leads to high results.

8. *Horizontal development*: personal experience is available to the whole company.
9. *Self-discipline*: the ability to self-control, self-respect and respect for others and the organization as a whole.
10. *Self-improvement*: determine the questions for which you are personally responsible and start solving them first.
11. *Awareness of each employee*: all staff must be fully informed about the state of their company.
12. *Delegation of authority*: implies broad-based training, good and diverse work habits and skills.
13. *Managing means planning and comparing results with plans.*
14. *Analysis of the state of the enterprise on the basis of facts*: do not confuse the cause with its manifestation.
15. *Quality embedding*: quality management is a process and inspection does not create quality.
16. *Standardization*: application of methods and procedures for consolidation of the achieved results.

Kaizen is suitable for any company, regardless of its size and field of activity, and this is the greatest advantage of this concept. Other important advantages and disadvantages are also presented in Table 4.8.

Table 4.8. Advantages and disadvantages of *kaizen*

Advantages	Disadvantages
• cost reduction • improving the quality, efficiency and effectiveness of work • reduction of order fulfilment time • reduction the number of mistakes • increase in the efficiency of machines and devices • maintaining production continuity • increase in customer satisfaction • increase the level of customer service • introduction clear, legible standards, visualization of works • reduction, or even liquidation, of the number of deficiencies, errors and corrections • elimination, simplification, integration and automation of processes • optimal distribution of production resources allowing more efficient • better use of the production space	• long and slow process of changes • great meticulousness and detail • no radical changes to the existing state • the need to first create a friendly environment for introducing *kaizen* • the improvement process never ends

Source: Own study based on (Skrzypek, 2011, p. 144).

Questions / tasks

1. Why is the use of benchmarking so popular?
2. What types of benchmarking are there? Describe them briefly.
3. How many levels of outsourcing are there?
4. What does the outsourcing process look like?
5. List and briefly describe the areas in which outsourcing can be used?
6. What conditions must be met to name a key competence?
7. What types of resources can key competences be built from?
8. Briefly describe the Just-In-Time method.
9. On what factors does the proper implementation of the Just-In-Time system depend?
10. What rules should be followed when introducing Just-In-Time?
11. What are the advantages and disadvantages of the Just-In-Time method?
12. What is the MRP System (MRP I) for?
13. List five key principles for the introduction of the MRP system (MRP I).
14. What are the advantages and disadvantages of the MRP method?
15. Develop and characterize the MRP II system.
16. What are the advantages and disadvantages of the MRP II method?
17. What is Total Quality Management?
18. List Deming's 14 principles.
19. List the main assumptions of the TQM method.
20. How many steps are there in TQM (and describe them briefly)?
21. What are the advantages and disadvantages of the TQM method?
22. What is *kaizen*?
23. List a few of the most important assumptions of the *kaizen* method.

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5.

MODERN METHODS USED IN PRODUCTION-OPERATIONS MANAGEMENT

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Abstract: Climate change, resource depletion, technical progress, growing consumer awareness and changing requirements causes companies to look for new production methods. They may concern various areas of the company's activity, starting from product design, procurement organization, optimization of production processes, control of manufactured products and services, through improvement of work organization and reduction of production costs, and ending with the implementation of modern solutions based on digital technologies. The purpose of implementing new production methods is to improve labour mobility, optimization of the use of raw materials and resources, costs reduction, increase efficiency, productivity, etc. In the literature, there are many different types of methods that can be used by modern enterprises. It is practically impossible to present all methods in this study. The authors focused on the presentation of selected methods, which are characterized on the one hand by innovation and, on the other hand, by the possibility of implementation.

Particular attention should be paid to methods focused on environmental aspects. This group presents basic information on environment-conscious manufacturing (ECM), life-cycle assessment (LCA) and waste management and recycling. These methods allow to implement the concept of sustainable development and are directly related to the 17 goals set out in the 2030 Agenda for Sustainable Development and adopted by UN member states. In the group of methods related to next generation production management, the focus was on Matrix shop floor control and cooperative manufacturing. Of particular importance is cooperative management, because cooperation in practice is considered as a specific resource and one of the most important factors of a competitive position. The next group of methods concerned production planning and control. Drum Buffer Rope (DBR) and

theory of constraints (TOC) were discussed as part of it. From the company's point of view, methods related to manufacturing processes are very important, including group technology (GT) and cellular manufacturing (CM). Another group focused on commercial aspects, including demand chain management (DCM) and competitive intelligence (CI). The chapter also presents methods related to auxiliary software support, advanced organizational manufacturing and focused on product design. In the first case, Electronic Data Interchange (EDI) was discussed, in the second, virtual enterprises (VE) and World Class Manufacturing (WCM) were presented, and in the third, the assumptions concerning the Quality Function Deployment (QFD) and House of Quality (HOQ) method were shown. Additionally, Statistical Process Control (SPC) and Computer-Aided Process Planning (CAPP) are discussed within the framework of methods focused on cost and quality manufacturing.

Keywords: control, cooperation, production competence, production design and planning, production methods, quality and production costs, sustainable production.

5.1. Introduction

By implementing compiled and complex goals, enterprises can use various methods, techniques and tools in their core activities. Their choice depends on the industry branch, type of production and type of product, size of the enterprise, market in which the entity operates, etc. They can be divided according to various criteria. The basic criterion divides them into traditional and modern. The first of them are well known in practice and often used, while the second ones are less obvious, focus on specific conditions and problems related to a specific industrial activity. When analysing various criteria for the classification of production methods, it is worth paying attention to an interesting division proposed by Halevi (2001, pp. 20–23). The author divides methods used in production activities into 12 groups:

1. Focus on manufacturing hardware.
2. Focus on auxiliary software support (Electronic Data Interchange).
3. Focus on production planning and control (theory of constraints, Drum Buffer Rope).
4. Focus on next generation production management (Shop Floor Control, cooperative manufacturing).
5. Focus on processing manufacturing methods (group technology, cellular manufacturing).
6. Focus on commercial aspects (demand chain management, competitive intelligence).
7. Focus on organization,
8. Focus on advanced organizational manufacturing methods (virtual enterprise, World Class Manufacturing).
9. Focus on product design methods (Quality Function Deployment, House of Quality).

10. Focus on human factors in manufacturing.
11. Focus on environmental manufacturing methods (environment-conscious manufacturing, life-cycle assessment, waste management and recycling).
12. Focus on cost and quality manufacturing methods (Statistical Process Control, Computer-Aided Process Planning).

The methods discussed in this chapter are given in brackets.

In each of the indicated groups, Halevi (2001, p. 16), describes several detailed methods, indicating their type which is characterized by:

- technological solution, requires hardware resources,
- software solution, requires computer,
- management—methodical directions for organization and managing,
- philosophical—modern management methods,
- auxiliary programs to the methods that support the objective of company.

Some of the indicated methods are used in practice, some of them, however, have a typical theoretical nature and are difficult to implement. A brief description of the selected methods is presented below.

5.2. Shop Floor Control

In the simplest terms, a production hall can be defined as a building with a large area intended for production purposes. Various manufacturing processes take place there, including the processing of raw materials and materials as well as processing, bonding, cutting, forging, cutting, milling, assembly, packaging, etc., using automated systems or workers working on machines or devices. The production hall includes (Shop Floor Management, 2017):

- machines, equipment and tools determined by the sector in which the enterprise operates, the type of production and also the type of technology,
- materials, raw materials as well as other types of resources, such as parts, details, semi-finished products from cooperation, subject to the conversion process,
- information technology related to control systems, production execution, management of production operations, controlling, quality, etc.,
- quality control, i.e. activities aimed at checking whether the manufactured product corresponds to its characteristics,
- storeroom in which both production stocks and spare parts, auxiliary materials, utility goods, etc., used in the company's operational activities are stored,
- personnel consisting of direct production workers as well as technical and engineering workers who supervise the processes taking place in the production hall.

The production hall management concept is directly related to production management. It is based on the multi-agent paradigm and concerns the design and implementation of systems related to process control that take place in the

production hall. The basic opinion of the concept is to support discrete processes related to workshop manufacturing (Colak, 2004). It includes methods and a hierarchy system for priority tasks, supervising and reporting production orders, and preparing schedules. In addition, the state of production stocks, extensive and intensive use of production potential, labour and procedures for planning, organizing, scheduling and cost calculation related to the functioning of the production hall, are subject to special supervision.

Shop Floor Control (SFC) is a system of computers and/or controllers tools used to schedule, dispatch and track the progress of work orders through manufacturing based on defined routings. SFCs typically calculate work in process based on a percentage of completion for each order and operation that are useful in inventory valuations and materials planning (Gartner Glossary).

According to Halevi (2001), the basis of the philosophy of the production hall management concept is the flexibility of all parameters of the production process. Each of them can be properly adapted to the current needs and requirements which should contribute to the improvement of the productivity of the entire system. A machine, person, place, process, and even its course can be relocated. The only elements that are stable are the products manufactured and the resources used to produce them. The shop floor control integrates dispersed elements related to the organization of the production process into one coherent system that is subject to continuous monitoring and analysis. In practice, such an approach should contribute to an increase in efficiency, improved productivity and quality of production (Materna, Hinrichsen, Adrian, & Schulz, 2019). The implementation of the concept also enables the correct planning of resources, taking into account the inventories at the disposal of the company and their correct valuation.

Thanks to the use of shop floor control, the company is able to identify weak links, bottlenecks and other threats related to all aspects of a specific production environment. In addition, it is indicated that the purposes related to the management of the production hall include (Shop Floor Management, 2017):

- routing movement of material on shop floor appropriately,
- sequencing the procedures and processes taking place on shop floor,
- scheduling of workforce, resources and operations,
- finding deviation from standard procedures and processes,
- identifying loopholes in shop floor communication.

The implementation of shop floor control consisting in the permanent organization, piloting and control of production processes in the production halls should bring many benefits. They concern both the increase in the efficiency of using the production potential, material savings and the elimination of production errors or unproductive downtime. In particular, the following profits can be indicated (Shop Floor Management, 2017):

- increased operational efficiency through standardization of operations,
- reduction in occurrence of errors in work,
- revealing of loopholes in production or processes,
- increases productivity of the staff,
- positive impact on the revenue of a manufacturing business.

Figure 5.1. The shop floor control integration system

Source: Own study based on (Shop Floor Control, 1997, p. 21).

The indicated benefits are achievable only when correct data is provided to the system. Only the right information and its proper processing can contribute to the improvement of the productivity of all elements constituting the equipment of the production hall.

5.3. Cooperative manufacturing

Nowadays, no enterprise is able to function independently. Each of them, regardless of its structure, manufactured product, provided service or possessed resources, in order to achieve its complicated and complex goals, must actively seek, establish and maintain relationships with other enterprises. These relationships build a system of mutual dependencies and connections, within which cooperation develops in the production of materials, parts, elements, assemblies, subassemblies, or the provision of specific production services.

The cooperation can be interpreted through the prism of various approaches (Cittolin, 2018, p. 29):

- Sociology cooperation: a form of interaction in which individuals strive to achieve a collective and common goal, being essential in the constitution of most social groups.
- Economic cooperation: a cultural construction that is based on social interaction, where goals are common, actions are shared and benefits distributed with balance throughout the system.

According to Halevi (2001, p. 111), the basis of cooperative production is the belief "that it is difficult and expensive to anticipate disturbances and prepare meaningful programmed responses to a specific situation". Only joint action allows to overcome emerging difficulties, related to technological processes, resource availability, workforce, operational activity as well as innovative development.

Figure 5.2. Economic, sociological and ecological approach to cooperation

Source: Own study based on (Random House, 1993, p. 446).

In practice, the production process is divided into many sub-processes which are carried out by different companies (Hao, Shen, & Wang, 2005). Entrepreneurs also know their limited production capacities, they are also aware that some processes can be performed more effectively, efficiently and more efficaciously using external sources. It can therefore be emphasized that the increase in the scale of tasks entrusted to co-operators is related to the long-term strategy of enterprises. It consists in limiting own tasks in favour of those that are the most effective from the point of view of the competences held and that can bring the greatest profit. Limiting the number of own tasks in enterprises dealing with the production of final products contributes to the simplification of their structure, shortening of production cycles as well as faster offering of the product on the market with lower margins. Enterprises must therefore cooperate with other market participants. This cooperation may be simple, based on the so-called pure transactions or multi-dimensional, in which all aspects of the cooperation are specified. In the first case, the subject of the transaction are standard, generally available parts and elements, the so-called industrial standardized materials, in the second one, the

basis for the agreement is a product or service, manufactured according to the detailed specification of the recipient (passive co-operator), its schedule, quality, technological and cost requirements.

In practice, it is believed that each entity carrying out specific production operations related to the creation of a product, increases its value which affects the total value of the products. The entity brings its key competences to the joint venture which should complement each other, permeate and integrate. In this way, relationships of different nature, scope and strength of influence are created between the cooperating companies which guarantee long-term cooperation and contribute to taking up new challenges, setting new goals and tasks, and thus contribute to innovative activities. Thus, networks of cooperating enterprises are formed, legally and organisationally independent which create a new structure of business and operation.

The principle of reciprocity is defined as the desire and willingness to be polite and helpful to those whose behavior and action is based on courtesy, kindness and helpfulness, and to harm those who, through their actions, signal hostility and aversion (Keser & van Winden, 2000, p. 36).

In cooperative production, a very important problem is the selection of the right partners who will participate in the joint production process. The selected partners must have the appropriate skills, experience, competences, qualifications as well as be innovative and creative. An important problem is also the appropriate technology which must be compatible with the technology of a passive co-operator and other resources, including human resources.

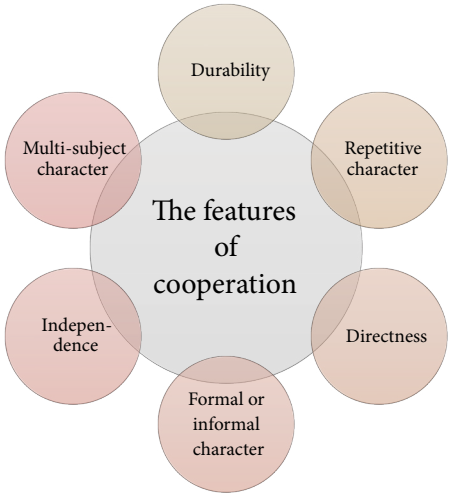

Figure 5.3. The features of cooperation

Source: Own study.

The basic condition of cooperative production is achieving benefits that outweigh the costs. These benefits essentially depend on the quality of the input made by other companies as well as their willingness to share that input with others. It can therefore be emphasized that the fundamental norm of cooperation is the principle of reciprocity (Koch, Kautonen, & Grunhagen 2006, p. 63). It says that in many social situations we pay back what we received from others. The principle of reciprocity emphasizes partnership and the willingness of entities to accept short-term difficulties, while expecting that other entities will show a similar attitude. In this context, there should be emphasized the proactive aspect of cooperation as opposed to the imperative aspect that occurs in interdependent activities. As a consequence, companies promote teamwork, jointly set goals and reach a consensus of action (Deepen, Goldsby, Knemeyer, & Wallenburg, 2008, p. 78). The principle of reciprocity has two important implications: the first one is related to trust which allows sharing experience and creating relationships, the second one involves specific investments that create a certain level of dependence between cooperating entities (Zook and Allen 2005, p. 96).

Cooperation may relate to various areas of business activity. Particularly important are (Nowak, 2012):

- research and development and technology transfer,
- preparation of production,
- designing, organizing, supervising, monitoring,
- production and assembly—manufacturing of specific elements, parts, subassemblies, assemblies,
- production service,
- services such as: transport and forwarding, loading, storage, unloading, maintenance, repairs,
- joint operation of fixed assets,
- joint investments,
- management and others.

Cooperation may be narrow, concerning one area or its fragment, or comprehensive, consisting in complete, large-scale cooperation.

5.4. Environment-conscious manufacturing (ECM) and life-cycle assessment (LCA)

The condition of the natural environment, both in Poland and in the world, is constantly deteriorating. The basis of degradation is primarily economic development related to humans striving to improve living conditions. Urbanization, expansion of infrastructure, devastating extraction of raw materials as well

as consumerism contribute to the pollution of air, water and land. The area of agricultural and forest areas is decreasing, the topography is distorted, water reservoirs are drying up, vegetation and individual species of animals are dying out, pollution increases which in turn leads to climate change. The processes related to the devastation of the environment have particularly intensified in recent years, especially in countries that are striving for rapid industrialization. The production activity contributes to the rapid degradation of the environment. Technical progress, implementation of new technologies, short product life cycles consume more and more resources, and at the same time impede sustainable growth.

The issues of the natural environment and sustainable development are widely discussed both on the national and international forum. On September 2015, the 2030 Agenda for Sustainable Development was adopted by all United Nations Member States. The agenda provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. The document defines 17 Sustainable Development Goals and 169 targets. They concern achievements in 5 areas—the so-called 5 × P: people, planet, prosperity, peace, partnership. Goals cover a wide range of challenges such as: no poverty, zero hunger, good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, industry, innovation and infrastructure, reduced inequalities, sustainable cities and communities, responsible consumption and production, climate action, life before water, life on land, peace, justice and strong institutions, partnerships for the goals (United Nations).

However, with the increase of pollutants emitted to the environment, the awareness of enterprises about the importance of sustainable development grows. More and more companies are making changes in production processes, focusing on ecological, socially responsible production, aimed at caring for the world around us. One of the methods that has become more and more popular in recent years is environment-conscious manufacturing (ECM). The main assumption of the concept is to minimize the harmful impact on the environment throughout the entire production cycle and the entire product life cycle which should ultimately contribute to a more efficient use of resources. Its scope covers all functions related to the production of a product or service, from planning and procurement, through the development and organization of production processes, to packaging, transport and disposal. It is assumed that each process will eliminate or significantly reduce waste emissions and production shortages. In addition, operational safety should be improved and the manufactured product after its useful life can be recycled or regenerated for reuse (Yusuff, Vahabzadeh, & Panjehfouladgaran, 2012).

The implementation of the ECM concept should therefore be reflected in three aspects:

- reduction or waste minimization which will prevent pollution,
- recycling strategy which involves the need to redesign the product and implement a new production technology,
- remanufacturing strategy, i.e. the ability to recover the value of a product or components.

Environment-conscious manufacturing (ECM) is the deliberate attempt to reduce the ecological impacts of industrial activity without sacrificing quality, cost, reliability, performance, or energy utilization efficiency. The principle of environment-conscious manufacturing is to adopt those processes that reduce the harmful environmental impacts of manufacturing, including minimization of hazardous waste and emissions, reduction of energy consumption, improvement of materials utilization efficiency, and enhancement of operational safety (Halevi, 2001, p. 150).

The above activities should be reflected in all production processes, production technology, resource management as well as activities related to materials and finished products. As a result, the consumption of energy and resources used in production should decrease which in turn will contribute to the reduction of pollution and protection of the natural environment.

The basic assumption of the ECM concept is a properly designed and manufactured product, with the assumption of minimal environmental impact. In the design process, there can be used the life-cycle assessment (LCA) technique. It is a method that focuses on all environmental aspects of production, including use, disposal and eventual reuse (Halevi, 2001).

LCA enables the reporting of potentially negative environmental impacts at each stage of the supply chain of products or services. Identification of threats allows to develop a set of remedial and corrective actions. The purpose of these activities is to repair, improve or replace specific environmental elements or their functions, if they have become damaged. Moreover, the strategy makes it possible to identify those raw materials and materials that have a harmful effect on nature, and to choose alternatives that are renewable or recyclable. The LCA analysis takes into account all phases of a product's life, from raw material acquisition, through production, distribution and use, to disposal (Figure 5.4).

The implementation of LCA in the core business of the enterprise can bring a number of benefits. These benefits can be considered both from the point of view of the enterprise, the consumer and as a whole. For entrepreneurs, they are associated with the possibility of making responsible decisions, increasing the credibility and trust of customers who are offered environmentally friendly products as well as the implementation of eco-innovations which is associated with cost reduction in the long term. The consumer receives better information about products and services, including their impact on the environment which contributes to raising

environmental awareness. Taken as a whole, it strengthens the sector's competitiveness in regional, national and international markets and provides better environmental conditions for society (Sala et al., 2016).

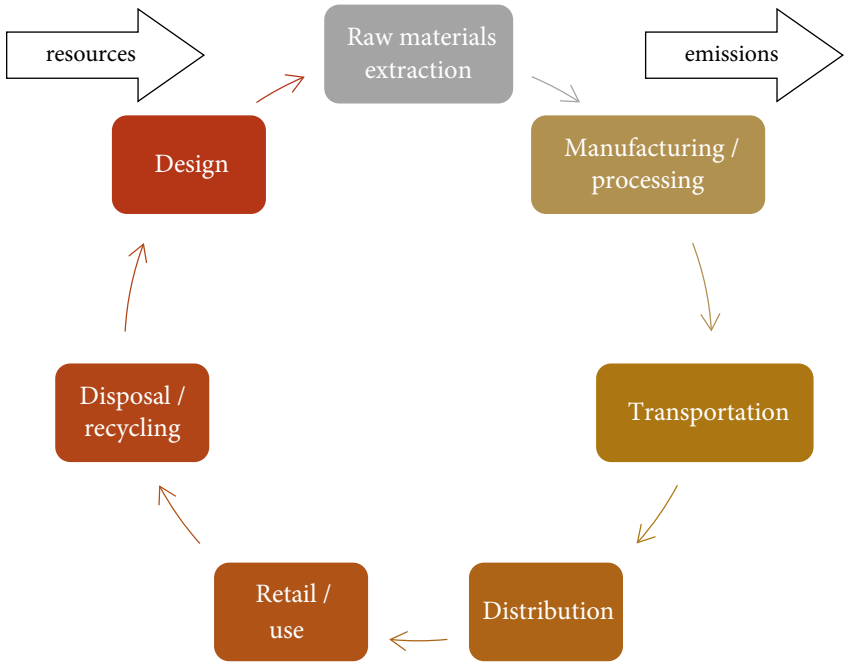

Figure 5.4. Life-cycle assessment

Source: Own study based on (Sala, Reale, Cristobal-Garcia, Marelli, & Pant, 2016).

5.5. Waste management and recycling

Enterprises, institutions and other types of environmentally conscious organizations may use the method referred to as waste management and recycling in their basic activities. The basis for the development of the concept are the problems related to the generation and collection of waste, and the prevention of its production. It is emphasized that with the change of lifestyle, technological progress and growing consumerism, the demand for new, more functional or prestigious products increases. At the same time, their life cycle is shortened. This process applies to most of the goods available on the market, ranging from clothing and food, through household appliances and electronics, and ending with luxury and exclusive goods. Therefore, there is a problem of what to do with products for which the demand has drastically decreased. These products could function successfully in many cases,

however, due to market trends and changing fashion, they are withdrawn. The process of losing value as a result of technological progress is known as obsolescence. It applies to all groups of goods, however, it is of particular importance on the RTV market (e.g. mobile phones, video, CD players or cameras) and sports equipment which new collections appearing every year. Waste generated both in households and in industry should be properly managed. The aim of such management is on the one hand to minimize them, on the other hand to reduce costs as well as to obtain additional practical benefits.

Waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is also carried out to recover resources from it (Bacinschi, Rizescu, Stoina, & Necula, 2010, p. 378).

An important element related to waste management is the implementation of an appropriate conducting concept which can be based on the assumption of "3Rs" reduce, reuse and recycle which classify waste management strategies according to their desirability in terms of waste minimization (Bacinschi et al., 2010, p. 379). According to the authors, waste minimization can take place on four levels:

- the first one is related to the reuse of waste in its original form,
- the second one concerns the segregation of waste, thanks to which it can be properly classified,
- the third one focuses on the analysis of the possibility of using waste by other enterprises,
- the last one is based on development of methods of treating waste in an environmentally friendly way while reducing costs.

Products that have reached the end of their life cycle are problematic waste for the environment. Therefore, it is required to develop an appropriate policy for the management of end-of-life items and other types of production process residues. The best method of reducing waste is prevention which increases the awareness of both businesses and individual consumers. In case of producers, there should be taken into account, first of all, the possibility of using such raw materials, materials, semi-finished products and other parts in the production processes that can be reused in the future. This approach significantly reduces the production of waste, as end-of-life products are recyclable.

Recycling, recovery and reprocessing of waste materials for use in new products. The basic phases in recycling are the collection of waste materials, their processing or manufacture into new products, and the purchase of those products, which may then themselves be recycled (*Britannica*).

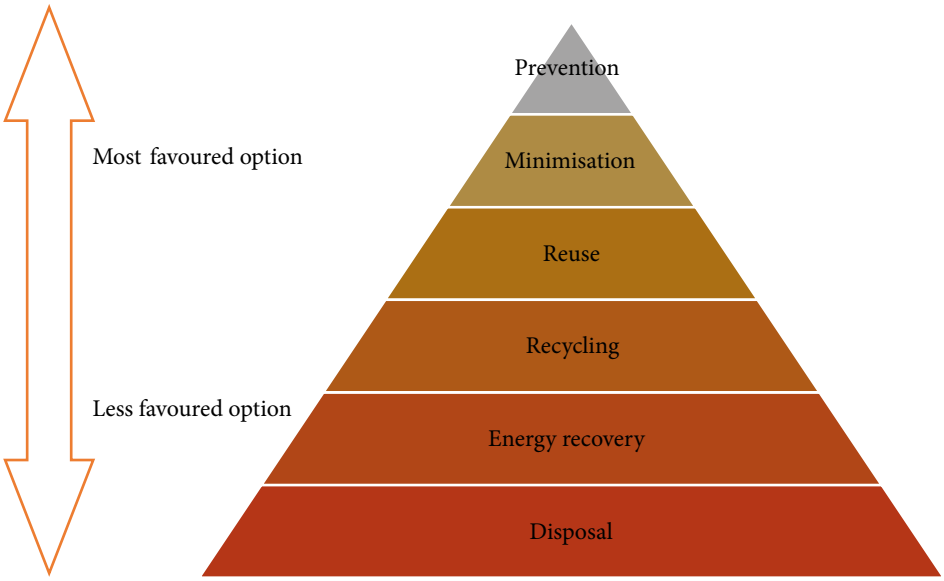

Figure 5.5. Diagram of the waste hierarchy

Source: (Bacinschi et al., 2010, p. 378).

Most of the raw materials and materials used in production processes can be recycled. It covers both steel and cast iron scrap, aluminium as well as paper, wood, plastics and others. The recovered and recycled materials are usually a substitute for raw materials obtained from the natural environment. They can be used by enterprises that used them initially or are used in completely different processes carried out by completely different enterprises. It is indicated that the main advantage of recycling is the reduction of waste in landfills which contributes to the reduction of air, water and land pollution. In addition, companies that emit less pollutants also reduce the costs of their core activities. Savings result from both the use of recovered raw materials and materials as well as the costs of their storage.

5.6. Electronic Data Interchange (EDI)

Electronic Data Interchange (EDI) is a form of information exchange between the computer systems of different organizations. It involves the direct exchange of standardized documents and messages transmitted electronically between the computers of two organizations (Andersen, 1998, p. 2). These business entities conducting business electronically are called trading partners. It should be emphasized that data transmission takes place using electronic equipment for data processing

(including digital compression) using cable, radio, optical technologies or any other electromagnetic means. Most importantly, the data is exchanged automatically without human intervention

> EDI is a method of communicating between organizations participating in an economic, administrative or other undertaking, consisting in automatic electronic transmission of formatted documents (Kot, Starosta-Patyk, & Krzywda, 2009, pp. 60–61).

The main assumption behind the introduction of EDI standards and their application is the increasing number of paper documents, high costs of their transmission and the fact that errors appearing in commercial documents translate into delays in business transactions and an increase in the operating costs of enterprises. At the same time, the progressive computerization and its dissemination mean that documents in paper version (e.g. for environmental reasons) go down and are replaced by electronic versions.

The popularization of EDI is also caused by the constantly growing requirements of today's market, e.g., by the necessity to introduce quick deliveries of products precisely tailored to customer requirements. As a result, only those entrepreneurs and their business partners who are able to communicate well and efficiently with each other are able to survive and meet the requirements of contractors. Therefore, the use of EDI, where this communication takes place automatically, allows to quickly respond to market demand and reduces inventory and shortens the time of order fulfilment (Kosmacz-Chodorowska, 2013, p. 18).

Initially, EDI techniques were developed in the transport, pharmaceutical, automotive and financial sectors. However, the development of many standards caused chaos and disorganization, therefore work was undertaken on a common document standard for the needs of tele transmission between computer systems. Currently, two standards are most popular in the world—the American ANSI ASC X12 and the international UN/EDIFACT, used in Europe.

Today, EDI is a well-developed system, deeply rooted in global business. It is estimated that in the United States alone, Electronic Data Interchange is used by over 100,000 companies, including giants such as Federal Express, Eastman Kodak, American Airlines, Nike, Staples, National Bank, JC Penney, and Prudential Insurance. In addition, many US government organizations also accept and transmit documents electronically (Edison SA, 2020).

In Europe, EDI is used by all large retail chains as well as many production plants and distributors. Some retail chains exchange up to tens of thousands of documents with their suppliers a month. The largest EDI users include Auchan, Carrefour, Lidl, and Castorama.

EDI standards are a set of strictly defined semantic rules as well as data catalogues and codes used to build, among others, EDI messages, which should be equated with paper documents. Each standard EDI document is therefore an equivalent of a paper document, e.g., order, delivery note, invoice. Figure 5.6 shows a schematic of standard EDI.

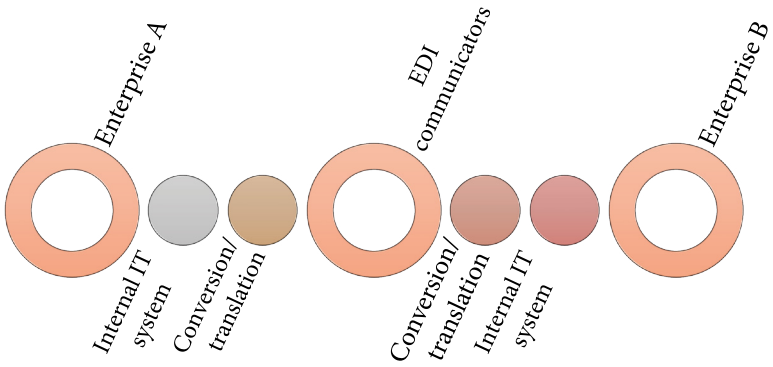

Figure 5.6. Schema of Electronic Data Interchange (EDI)

Source: Own study based on (Kosmacz-Chodorowska, 2013, p. 19).

EDI messages are created in a computer-readable format that enables their automatic and unambiguous processing on a specific set of words, generally known as data elements. Among standard messages, four basic groups can be distinguished:

1. Transaction messages: most often used due to the possibility of exchanging data necessary for the purchase and sale of products between the buyer and the seller. This group includes messages such as an order, invoice or price catalogues.
2. Information messages: used to provide constant data about goods and business partners.
3. Transport messages: include elements such as a transport order or a shipping/delivery note, thanks to which company can better organize the delivery process.
4. Financial messages: used to make payments and inform about cash movements. This group includes messages such as transfers or information about account traffic.

Such a wide range of standard documents that can be exchanged using EDI enables the exchange of documents with any business partner, if its technological advancement allows it. Figure 5.7 shows an example of a 9-steps EDI message flow between the buyer and seller.

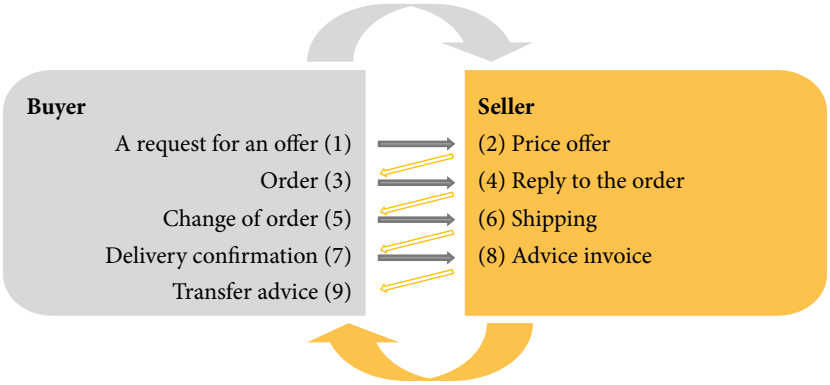

Figure 5.7. An example of the flow of EDI messages in commercial transactions

Source: Own study based on (Kosmacz-Chodorowska, 2013, p. 19).

The management of each company before deciding to apply EDI should be aware of both the pros and cons resulting from this implementation (Table 5.1). Assessing investments incurred on EDI, it should be compared to the changes and benefits it will have for the entire company, including the costs incurred for the reorganization of those departments that will be directly involved in EDI. For example, electronic invoicing and electronic money transfers can bring company the greatest benefits in the accounting department, and will also be noticeable in sales, production and more.

Table 5.1. Advantages and disadvantages of Electronic Data Interchange

Advantages	Disadvantages
• shortening the terms of order processing and delivery times • eliminating labour-intensive administrative and office activities • limiting additional communications due to any arrangements • standardization of the form, content and circulation of information provided • minimizing the costs of using documents • modernization of the organization and technology of enterprise management • reducing errors and increase accuracy by eliminating duplication of data from one paper document to another or manually entering data into the business application • inventory optimization by receiving appropriately early accurate information on customer needs and delivery times • improving the circulation of payments as a result of shortening order processing time and invoice verification time	• the need to create a detailed action plan for the implementation of EDI • the need to remodel business processes and procedures • the need to incur high costs of purchasing EDI software and its integration with the company's current IT system • conducting numerous training courses for employees and business partners • a cost-intensive and labour-intensive period of testing the system using EDI for sending commercial documents • high costs of leased lines and the use of the ICT network

Source: Own study based on (Fajczak-Kowalska, 2012, p. 32; Kosmacz-Chodorowska, 2013, pp. 20–21).

5.7. Virtual enterprise

In the last few years, virtual organizations have become a symbol of modern economic and social development. The concept of a virtual enterprise was introduced by Davidow and Malone (1992) and popularized by Byrne (1993).

A virtual organization is a temporary network of independent companies, suppliers, customers and even competitors connected with each other in an information and technological manner (Byrne, 1993). The purpose of these relationships is: exchange of know-how, cost diversification, mutual access to markets.

The most common view is that virtual organization is understood as something electronic, digital, cyber-spatial, elusive (Kisperska-Moroń, 2008, p. 9).

However, the term virtual organizations has been commonly divided into two main groups, namely virtual organizations in terms of processes and virtual organizations in terms of structure (Saabeel, Verduijn, Hagdorn, & Kumar, 2002, pp. 4–5). The process approach, i.e., coordination orientation, focuses on: behaviours and actions, identifies the organization on the functional side. The process approach also considers how the organization reacts to changes in the environment and assumes the continuous design and implementation of new business processes (Brzozowski, 2010, p. 39).

> A virtual organization is the right kind of collaborative organization to explore the competitive environment (Sieber, 1999, p. 213).

In the structural approach, a virtual organization is a specific organizational structure, based on various forms of cooperation in order to jointly use competences, knowledge and other resources to create a specific good or to use an emerging market opportunity (Burn, Marshall, & Barnett, 2001).

The virtual business model is characterized primarily by flexibility. A group of cooperating enterprises that are able to unite in order to take advantage of emerging market opportunities, who usually terminate the cooperation after the completion of these goals and the use of cooperative abilities. Each enterprise engaging in the creation of a virtual organization participates in creating added value only within its own key competences. Technology plays a key role in creating this hybrid. Human teams, composed of different members of a virtual organization, cooperate with each other simultaneously, not sequentially via the Internet in real time (Jacobsen, 2004, p. 15).

It is worth noting, however, that virtual enterprises have many common and diverse features with traditional organizations (Table 5.2).

Table 5.2. Similarities and differences between real and virtual enterprises

Similarities	Differences
• are created and operated by people • are focused on achieving the highest possible profits • are characterized by a division of work, roles and functions in the organization • consist of material and non-material factors • are capable of achieving the intended goals	• traditional organizations often exist for an extended period of time, a virtual enterprise is very short and covers the implementation period of a specific project • the traditional organization contains more material elements and relies more on material capital • a virtual enterprise cannot function without modern IT technology, unlike a traditional organization • virtual enterprise has an advantage in terms of speed and flexibility in adapting to changes • virtual enterprise is characterized by a faster appearance and disappearance on the market and the ability to seize market opportunities

Source: Own study based on (Brzozowski, 2010, p. 49; Kalisz & Szyran-Resiak, 2018, p. 481; Kisielnicki, 2001, p. 277).

The evolution of an enterprise into a virtual enterprise is determined by the following variables (Brzozowski, 2010, p. 110):

- direction: describes the vision and understanding for the future course of action in conjunction with its stakeholders,
- form: the method of transforming a goal into specific activities, indicates the degree of flexibility and responsibility in creating systems and structures for specific operations,
- communication: it covers organizational culture and processes related to collecting, grouping, processing and sending information,
- adaptation: it defines the learning processes that determine the ability to adapt to changes in internal and external conditions.

The process of creating a virtual organization best reflects the life cycle of a virtual organization. Its diagram is presented in Figure 5.8. Participation in a virtual enterprise is particularly attractive for smaller companies, as it helps them eliminate the differences between the advantages of large entities in terms of achieving economies of scale. A small company as a participant is able to access all kinds of resources that it would not be able to develop under normal conditions.

Virtual enterprise creates conditions for offering both simple solutions, such as a small product, to more comprehensive ones, such as technical consulting, service and support. The improvement of conditions also applies to the scale of operations from the local, regional and global market. The strengths and weaknesses of the virtual enterprise are presented in Table 5.3.

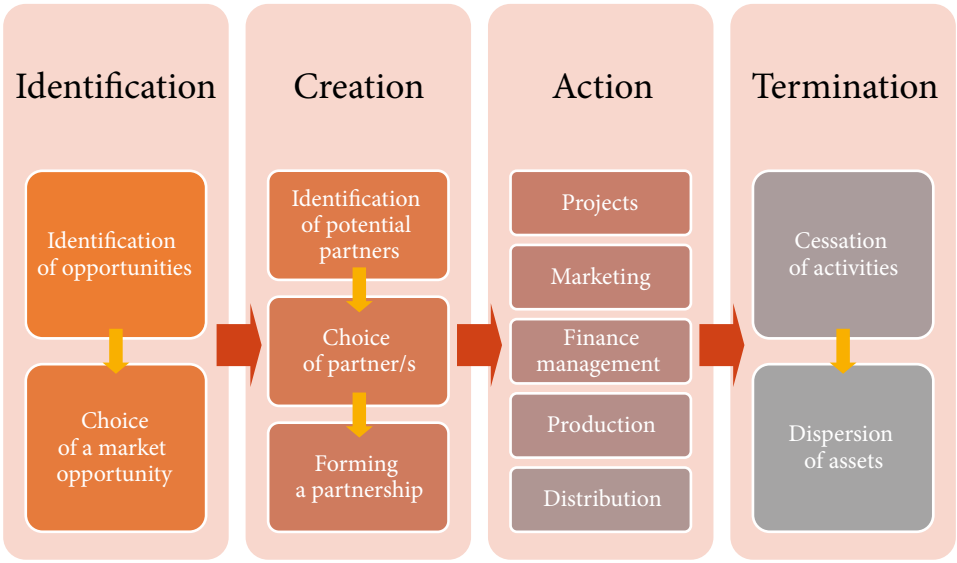

Figure 5.8. Virtual organization life cycle model

Source: Own study based on: (Strader, Lin, & Shaw, 1998).

Table 5.3. Advantages and disadvantages of virtual enterprise

Advantages	Disadvantages
• high flexibility and adaptability • faster transaction execution • increase in productivity • conducting a common policy regarding the operation of the organization • reduction of investment outlays necessary for the development of the organization • high quality of services resulting from focusing on the core business and cooperation with competent and effective suppliers • reduction of legal service of transactions to the necessary minimum	• the necessary trust in all organizations cooperating within virtual organizations • lack of patterns of behaviour • difficulties in developing the principles of distribution of the company's profit • virtual • difficulties in identifying the company and its partners in the network • the possibility of participation of incompetent and untested enterprises

Source: Own study based on (Kalisz & Szyran-Resiak, 2018, p. 493).

5.8. World Class Manufacturing (WCM)

As it was already noted in previous chapters, the automotive sector is the cradle of many traditional and modern concepts and management methods. Their formation is favoured primarily by the size of contemporary enterprises in this indus-

try—among which all major players are global organizations—with very strong competition and the specificity of the product. Hence, a great motivation to look for opportunities to stand out, attract attention, be among the best in the world and actually become such. One way to achieve this goal is to use World Class Manufacturing (WCM) (Walczak, 2015, p. 114).

The name World Class Manufacturing was introduced into literature by Hayes and Wheelwright in 1984. These authors made a comparison between the organization of processes in Japanese, German and American enterprises. They considered six factors particularly important for the existence of WCM: employee skills, technical competence management, quality competition, employee participation, renewal in the field of production engineering and continuous improvement

World-class production is a project based on the Toyota Production System (TPS) and the lean manufacturing concept, assuming in the final version a production characterized by zero accidents, zero losses, zero defects and zero failure. WCM is also a way of organizing an enterprise that allows to achieve the highest possible level of production organization by implementing modern concepts, methods and management tools (Dudek, 2013, p. 71).

> World Class Manufacturing is an integrated management system that allows achieving the highest level of international production excellence. It combines the best methods, concepts and management tools that aim to achieve the best global competitive position through the continuous improvement of the company's operations, production processes in the flow of raw materials, materials, components and finished products from the supplier to the final customer (Piasecka-Głuszak, 2017, p. 53).

The WCM name is most often applied by large enterprises with international capital, the intention of which is to increase the efficiency of their operation, among others as a result of cost rationalization (Gajdzik, 2013, p. 31).

WCM is based on two pillars: technical and management. The technical pillar consists of a set of tools used in modern production companies. The management pillar is a course of action carried out during the implementation of individual elements included in the technical pillar (Walczak, 2015, p. 115).

Each of the pillars is a set of guidelines that are divided into the so-called steps (each pillar has its precisely defined seven steps). Then, the progress of implementation of each pillar is assessed during control audits (internal and external). On this basis, each of the pillars receives points which, when summed, give a complete picture of the advancement of WCM implementation in the enterprise (Dudek, 2013, p. 72). Production plants wishing to become a world-class manufacturer must undergo a certification process. Depending on the result obtained, certificates are issued.

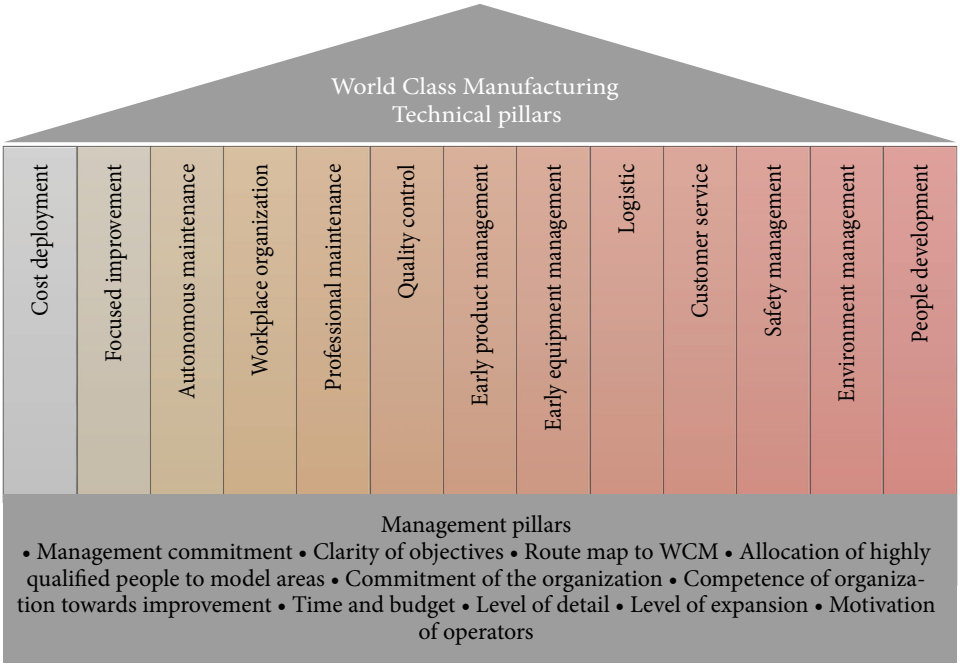

Figure 5.9. Main technical and management pillars of WCM (Temple of WCM)

Source: Own study based on (Dudek, 2013, pp. 71–72; Kruczek & Żebrucki, 2012, p. 788; Piasecka-Głuszak, 2017, p. 57).

The practiced way to assess the degree of WCM implementation is to determine the Index Implementation Methodology (IIM) index. In order to get a better visualization of the advancement of World Class Manufacturing implementation in the enterprise, medals are contractually applied, depending on the obtained indicator value, e.g. (Piasecka-Głuszak, 2017, p. 58):

- over 50 points—bronze medal,
- over 60 points—silver medal,
- over 70 points—gold medal,
- above 85 points—the enterprise reaches the level of WCM.

These scoring limits depend on business preferences and may be slightly higher. Each pillar is assessed on a scale of 0–10 and obtaining 0 points in a particular area means that the problem is not defined or understood.

Deploying WCM in an enterprise requires consideration of internal and external factors to a successful deployment. The behaviour and attitude of employees in the company, and employees at all levels, are considered the most important. The strengths and weaknesses of the World Class Manufacturing are presented in Table 5.4.

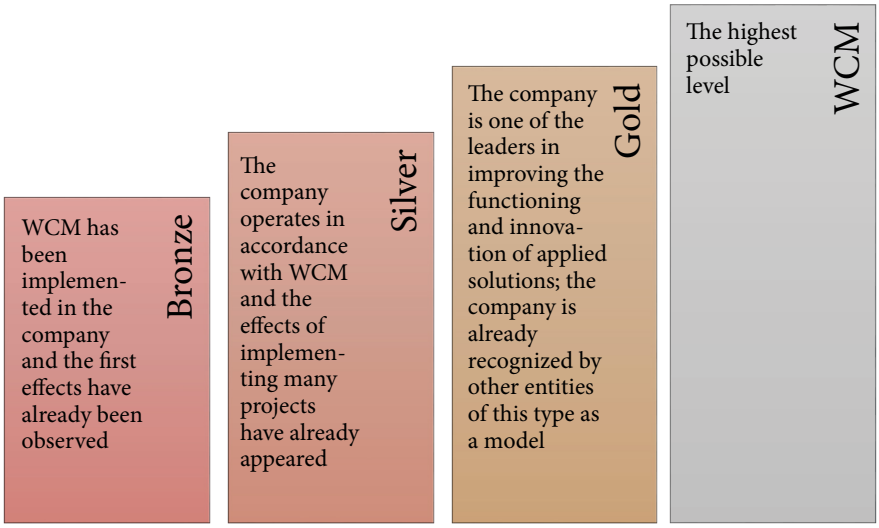

Figure 5.10. WCM certificate levels

Source: Own study based on (Gajdzik, 2013, p. 34).

Table 5.4. Advantages and disadvantages of World Class Manufacturing

Advantages	Disadvantages
• allows to reduce losses • optimize logistics flows • greater efficiency • greater flexibility • no space constraint • ensuring the timely execution of customer orders • improving working conditions for employees	• need for cost justification • resistance to change • lack of management support • lack of knowledge • lack of appropriate monitoring • lack of employee education and training • inadequate tools and equipment

Source: Own study based on (Felice, Petrillo, & Monfreda, 2013; Porter, 2001).

5.9. Quality Function Deployment (QFD) and House of Quality (HOQ)

The Quality Function Deployment (QFD) method is used to design new products and services and to modify the existing ones so that enterprises meet (as much as possible) the requirements specified by the customer. It belongs to the customer-oriented design methods. This means that when designing, the work does not start with planning the features of the product, but with the customer's requirements, and then designing the product or service to satisfy those requirements (Wolniak & Sędek, 2008, p. 179).

The discussed method was developed in the 1970s in Japan. The authors of the method are considered to be Akao and Mizuno. It was used for the first time at the Kobe shipyard and then the Japanese car industry.

Quality Function Deployment is a method of planning and developing a project or service, enabling research teams to make a precise specification of customer needs and requirements, and then translate them into the parameters of the product or service, its components and the parameters of the production process itself.

Currently, it belongs to the customer-oriented design methods. It is particularly important nowadays in the conditions of implementing Industry 4.0, where products must be designed and manufactured according to the customer's needs in conditions of strong saturation with automation and computerization. Moreover, the QFD method is often classified as a marketing research method.

In the QFD method, the original "customer voice" should be horizontally introduced into the following phases of product development:

- product planning,
- planning production processes, and
- planning production operations.

Then it should come back to the client as a new system. In addition, the "customer voice" must also be introduced vertically—by system levels. Often, this is where a mistake is made, and the customer's needs are lost sight of. For this reason, it is very important to conduct a systematic and planned procedure that does not allow any essential elements to be omitted in the design process (Wolniak, 2017, p. 2).

During the development and application of the QFD method, a diagram is used which, due to its specific shape, is commonly called the House of Quality (Figure 5.11). The standard House of Quality diagram consists of the following nine sectors, but their number can be modified depending on the needs of the organization and the complexity of the analysed problem (Zimon & Gawron-Zimon, 2014, pp. 1080–1083).

The first sector includes requirements that are important for the client and are treated as a starting point for further considerations. The respondents should be able to report information such as: cost-effectiveness of deliveries, speed of deliveries, regularity of deliveries, completeness of deliveries, the possibility of placing orders around the clock, the choice of hours and forms of product delivery, the length of the guarantee, the method of solving existing problems, etc.

Second sector contains information on the importance of individual customer requirements. Segregation is very important here as it allows company representatives to identify areas of improvement company need to focus on in particular.

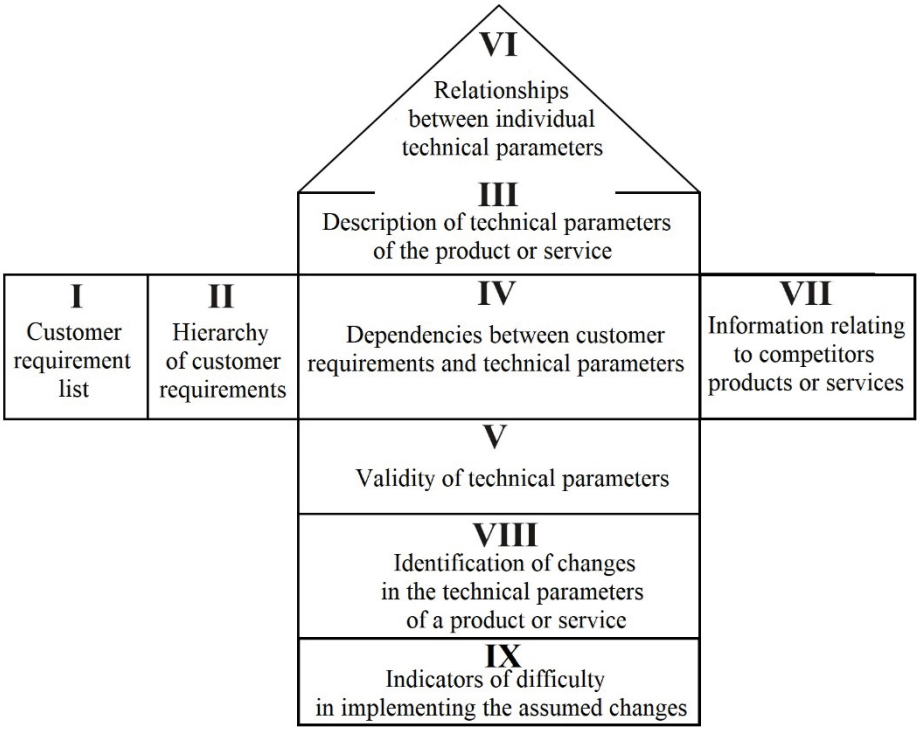

Figure 5.11. House of Quality diagram

Source: Own study based on (Zimon & Gawron-Zimon, 2014, pp. 1080–1081).

In third sector, the client's requirements in Sector I are "translated" into a specialist language. Technical parameters should be formulated in such a way that it is possible to express them in units that may be subject to possible corrections.

Fourth sector is dedicated to recognizing the dependencies between customer requirements (sector I) and technical parameters of the service (sector III). The occurring correlations can be strong, medium or weak. The values of each degree of correlation intensity are selected individually according to the needs of people using the QFD method. Based on the established dependencies, designers receive information specifying which technical parameters of the service should be corrected so that it more fully meets the needs of customers.

The importance of technical parameters is specified in fifth sector. When carrying out such an analysis, it is necessary to distinguish parameters whose modification will have the greatest impact on the increase of customer satisfaction.

In sixth sector, the correlation between the individual technical parameters of the service offered is established.

In seventh sector, the proposed service is compared with the services provided by competing companies. The management of an organization should strive to compare the services provided through its distribution channel with those of competing channels. The information obtained in this way should be an inspiration to implement improvement actions.

The analyses carried out so far are summarized in sector eighth. After carrying out the activities and operations that resulted in the filling of the previous sectors of the House of Quality, it can be concluded that the working group has an appropriate idea of the service and its individual parameters. Based on the analysis of the collected data, it is possible to define the target values that the service must have in order to meet the customer's requirements and be competitive with the services provided by other companies.

In the last sector, an assessment is made of the difficulties in implementing the changes proposed in the eighth sector. The assessment should be realistic and take into account the financial, technological and resources available to the enterprise. The management of the organization should be aware that not all changes proposed by the client can be implemented, and the organization needs to mature or prepare properly for some of them.

The application of the QFD method in enterprises will allow not only to precisely define customer requirements, but also to change and improve individual technical parameters of the physical product flow processes.

5.10. Theory of constraints (TOC)

The essence of the theory of constraints is a methodology for identifying the most important limiting factor (i.e. constraint) that stands in the way of achieving a goal and then systematically improving that constraint until it is no longer the limiting factor. In manufacturing, the constraint is often referred to as a bottleneck. Assuming that every system functioning in the economy has certain limitations, the following methodological stages (see Figure 5.12) can be distinguished (Goldratt, 1990, pp. 4–8):

1. Identification of system limitations. When this is achieved, remember to prioritize the individual constraints according to their impact on the achievement of goals in the enterprise. Otherwise, many resources may be devoted to tackling insignificant limitations, while the actual constraints, with a significant impact on the overall system, will remain.
2. Decide how to exploit the system's constraints. After deciding how to manage the limitations, you should focus on how to manage the rest of the system resources, which are not the limitations. Considering the fact that every wasted

minute due to the system not working is a waste that cannot be recovered, you must take the necessary measures to ensure the uninterrupted operation of the system to achieve maximum production capacity.

3. Note, however, that there is still room for many more improvements. Restrictions are not supernatural actions; you can do a lot with them. Regardless of the limitations, there must be a way to reduce their restrictive effect.
4. Through continuous improvement in the area of the identified limitation, it can be eliminated. However, this will not immediately maximize the efficiency of the production system as it will be affected by the next constraint.
5. If in the previous steps a constraint has been broken, go back to step 1. However, care should be taken that inertia does not cause the system to become constrained. It often happens that in the organization, due to the existence of limitations, there are many rules, both formal and informal. Once a constraint is removed, usually no revision of the rules is performed. As a result, today's systems are limited mainly by management policy constraints. We meet restrictions of the marketing policy more often than actual market restrictions. The bottleneck in the production hall is less often, and more often the restrictions result from the manufacturing policy. Restrictions rarely apply to suppliers, and often to purchasing policy. It should be emphasized that most policies were correct at the time of their creation, but after the removal of restrictions, they should be modified accordingly.

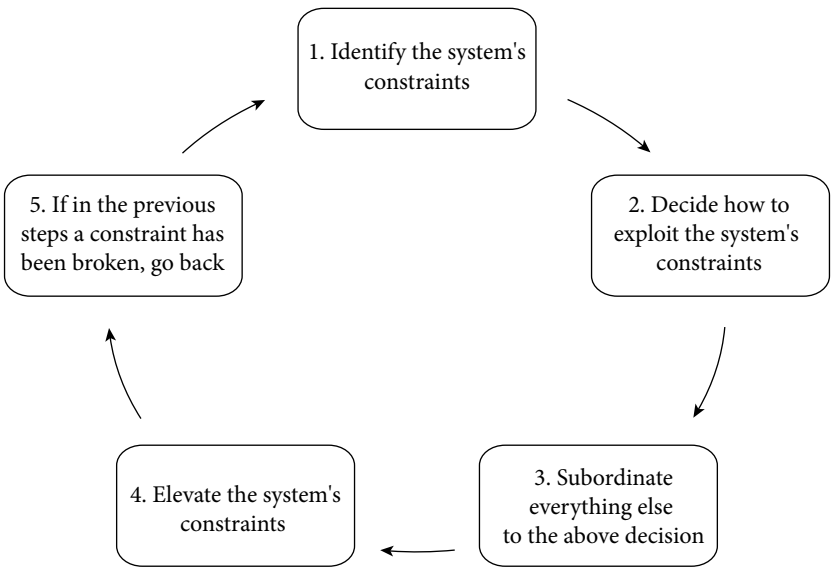

Figure 5.12. Theory of constraints methodology

Source: Own study based on (Goldratt, 1990, pp. 4-8).

It should be emphasized that the application of the theory of constraints principles in practice requires a comprehensive view of the entire production system. The main principle of theory of constraints is concentration, i.e. focusing on the most important issues. This means that all processes and positions should be supervised, although not all equally. The most attention should be paid to tasks that are crucial to the system as a whole. Appropriate identification of constraints offers many opportunities for business improvement and it positively affects the performance indicators (Trojanowska & Dostatni, 2017, p. 88).

5.11. Drum Buffer Rope (DBR)

Drum Buffer Rope (DBR) is the theory of constraints scheduling process focused on increasing flow by identifying and leveraging the system constraint. DBR was developed by Goldratt, the creator of theory of constraints (Goldratt & Cox, 2016). TOC requires the use in practice of a three-element production programming system, called Drum Buffer Rope, taking into account the production of products according to the transport batch and processing batch (an example of a DBR system with a single bottleneck is shown in Figure 5.13). The characteristics of these elements are as follows (Cox III & Schleier, 2010):

- Drum: gives the process an appropriate production rhythm, according to the adopted operational plan, taking into account "bottlenecks".
- Buffer: material stocks placed in the process before bottlenecks; There are three types of bottleneck inventories: performance-related, associated with the required number of items delivered, non-performance-related bottlenecks—located after operations at a position identified as a bottleneck.
- Rope: this is the principle of delivering materials or elements at the workplace according to the "bottleneck".

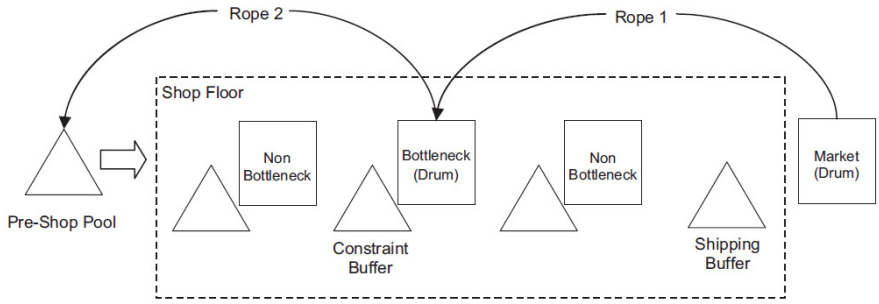

Figure 5.13. Drum Buffer Rope

Source: (Thürer, Stevenson, Silva, & Qu, 2017, p. 117).

The implementation of DBR allows to optimize the use of production resources, which results in better economic results of the company. However, it is important to measure the performance of operating results over time, including those based on indicators. It should be emphasized that the purpose of the indicators is to motivate the people involved to do what is good for the organization as a whole. Comparing the performance over time (before / after DBR) can provide company management with answers about the implications of implementing DBR in the organization. Understanding these effects can help you make decisions about how to best allocate resources and prioritize actions (Telles, Lacerda, Morandi, & Piran, 2020, p. 2).

It should be emphasized that although the DBR theory has its origins in the 1980s and 1990s, contemporary research confirms the effectiveness of the proposed solutions. The results obtained by Telles and others (2020, p. 7) show that after the implementation of DBR in the analysed company, the complex efficiency of the computer production line increased by an average of 19%, the display production line increased by 16%, and the electronics production line by 4%.

The usefulness of DBR methodology in the remanufacturing environment should also be noted. Remanufacturing is an industrial process that restores used products to a new condition, including repair, overhaul and regeneration processes. More and more products are being regenerated. The partial list of products includes airplanes (both military and commercial). aircraft parts, auto parts, diesel, gasoline and turbine engines, locomotives and railroad cars, and electronic goods.

Given that scheduling for remanufacturing is more complex and the planner has to deal with more uncertainty than in a traditional production environment. In order to properly create a production schedule in this environment, it must be able to cope with several complex factors that increase variability. The schedule must be adapted to conditional routes, routes that may or may not be selected due to the condition of the vessel. The schedule must also be adapted to dependent events, e.g. operation B cannot start until operation A is completed. Drum Buffer Rope (DBR) offers an extremely robust planning method. The schedule created with DBR can include both conditional routes and dependent events (Guide, 1996, p. 1081)a routeing that may or may not be taken due to the condition of the unit. The schedule must also be able to cope with dependent events, e.g. operation B cannot begin until operation A is completed. Drum Buffer Rope offers an extremely robust planning method. The schedule created with DBR can include both conditional routes and dependent events (Guide, 1996, p. 1081).

5.12. Group technology (GT) and cellular manufacturing (CM)

Group technology (GT) is a production philosophy that is based on the use of similar, repetitive activities. It is a widely applicable concept, potentially affecting all areas of a manufacturing organization. One particular application of GT is cellular manufacturing (CM). CM consists in processing sets of similar parts (families of parts) on dedicated clusters of different machines or production processes (cells).

CM is a concept commonly used to achieve Just-In-Time (JIT) production. It should be emphasized that new technologies often support or even dictate the use of the CM approach. Support is often in the form of emerging information technologies such as computer coding systems for parts in the cell production. On the other hand, the need to use CM results from the use of robotics and other forms of mechanized and automated material handling systems, as well as the desire to build closely related production systems with low throughput times. Effective use of these philosophies and technologies essentially requires a production approach based on a cellular structure (Wemmerlöv & Hyer, 1987, p. 413). This concept is now used in many production environments. The implementation of GT and CM brings many benefits, the most important of which include (Heragu, 1994, p. 203):

- setup time reduction,
- work-in-process inventory reduction,
- material handling cost reduction,
- equipment cost and indirect labour cost reduction,
- improvement in quality,
- improvement in material flow,
- improvement in machine utilization,
- improvement in space utilization,
- improvement in employee morale.

The main difference between the traditional manufacturing environment and the cellular manufacturing environment is the grouping and arrangement of machines. In traditional environments, machines are usually grouped based on their functional similarities. In contrast, in a cellular production environment, machines are grouped into cells, each of which is dedicated to the production of a specific family of parts. Typically, the machines in each cell differ in function. Such a system, in which sets of machines are dedicated to specific families of parts, allows for easier production control.

The main goal of a CM system design is to create machine cells, identify part families, and connect part families to machine cells to minimize intercell movement. When designing a CM system, a number of constraints must be taken into

account, such as available machine capacity in each cell, safety requirements, location, number and size of cells, etc. (Heragu, 1994, pp. 203–204).

The CM approach is most commonly used when the production system consists of mid-volume and mid-variety product mixes to reduce lead time, setup costs, material handling, and work in progress. Many methods have been developed to address the above issues, ranging from the similarity coefficient and clustering techniques to mathematical modelling (eg, constrained programming or dynamic programming).

In addition, to increase the efficiency of GT and CM-based production systems, they are often analysed from a broader point of view, covering areas such as scheduling, production and workforce planning, supply chain management, queueing theory, layout and facility localization issues (Alimian, Ghezavati, & Tavakkoli-Mogaddam, 2020, p. 1284).

5.13. Demand Chain Management (DCM)

Nowadays, companies connect their customers and suppliers into tightly integrated networks using the so-called Demand Chain Management (DCM). DCM is defined as a practice that manages the supply chain and coordinates the supply chain from end customers back to suppliers (Vollmann, Cordon, & Heikkilä, 2000, pp. 81–90). End customers trigger actions up the supply chain, and products and services are pulled (not pushed) from one link to another based on demand.

The importance of the DCM concept has dynamically evolved over the past years with the development of the Internet. Due to the fact that DCM requires deep integration between all business partners to be successful, such connections have only become possible thanks to information technology. It is worth noting that in the pre-internet era, there were no perfect solutions to trade-offs between low cost, rich content, real-time data, and wide deployment in supply chains using traditional methods such as EDI and Kanban.

The Internet has successfully solved these problems and allowed for tight integration between each partner in the supply chain. Once impossible, real-time demand information and inventory visibility is becoming essential for supply chain forecasting, planning, scheduling and execution. Real-time information is sent immediately backwards through these network-based, demand-driven supply chains while inventory flows rapidly forward (the comparison of supply chain integration strategies is presented in Figure 5.14).

Most importantly, goods and services are delivered quickly and reliably when and where they are needed. The more integrated the flow of data between customers and suppliers, the easier it is to balance supply and demand across the network. Greater online coordination with reduced lead time helps overcome the bull effect and contributes to higher productivity (Frohlich & Westbrook, 2002, pp. 730–732).

This approach to demand chain management creates a synergy effect between traditional supply chain management and marketing by starting from the specific needs of customers and designing the chain to meet those needs, rather than starting with the supplier / manufacturer and working for the forwards. Such integration seems mandatory in today's market where customers benefit from accessing their accounts in real time, making changes to customized product configurations, and communicating their individual service requirements (Jüttner, Christopher, & Baker, 2007, pp. 377–379).

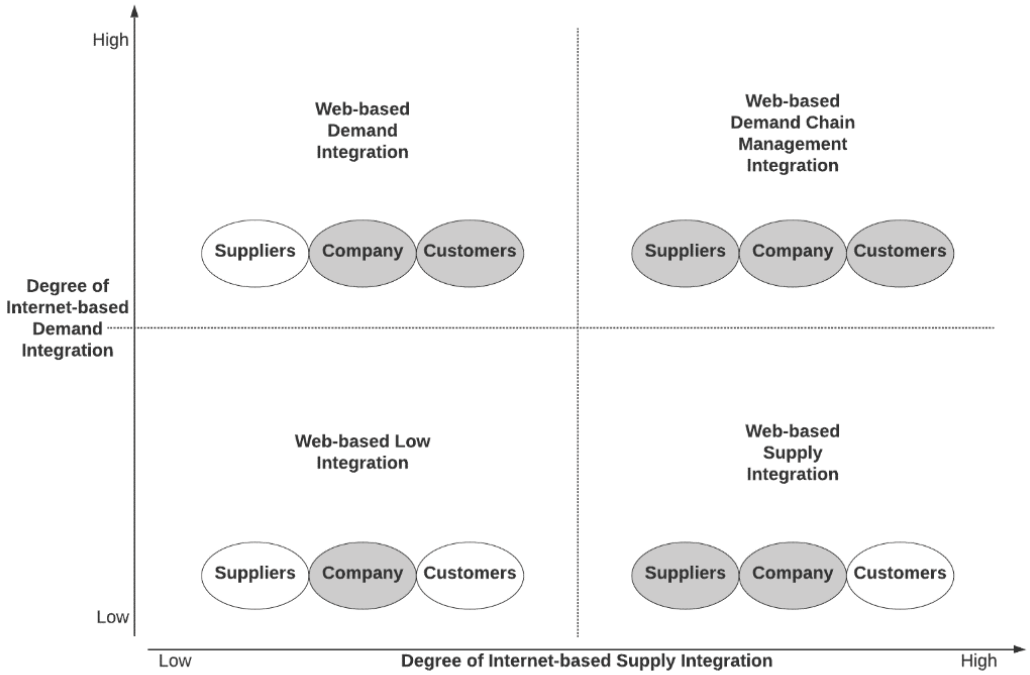

Figure 5.14. Four web-based supply chain integration strategies

Source: Own study based on (Frohlich and Westbrook, 2002, pp. 730–732).

It should be emphasized that Demand Chain Management is a much broader concept than the traditional Supply Chain Management. The broad scope of DCM concepts stems from the synthesis of demand fulfilment and demand creation aspects in the supply chain management and marketing. In other words, Demand Chain Management focuses on detecting customer response in real time and then reacting quickly to it.

Some researchers saw this as a mechanism for understanding customer requirements and turning this understanding into active strategies and plans for the entire group of companies involved in the network. In this context, Demand Chain Management is seen as an integrative function of the supply chain and marketing that can be explained by three sub-functional processes (shown in Figure 5.15): managing integration between supply and demand processes; managing the structure between integrated processes and customer segments; managing the relationship between marketing and supply chain management (Deshmukh & Mohan, 2017, p. 324).

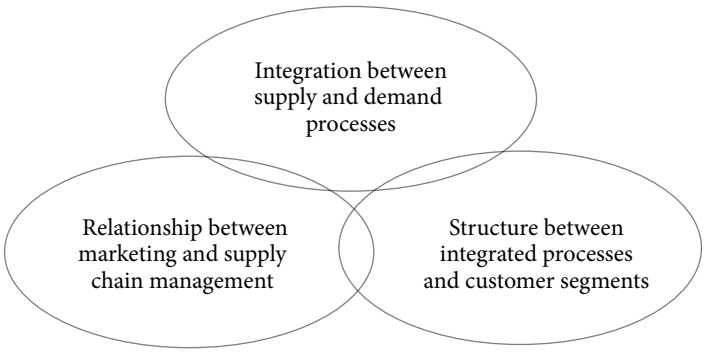

Figure 5.15. Demand Chain Management processes

Source: Own study based on (Deshmukh and Mohan, 2017, p. 32).

5.14. Competitive intelligence (CI)

The origins of the concept of competitive intelligence can be traced even over 5,000 years ago in Chinese religious and historical translations relating to the concept of intelligence. As early as 2,400 years ago, Sun Tzu wrote *The Art of War*, in which he detailed how to develop intelligence for military purposes. The idea of CI is also well reflected in the words of Frederick the Great (1740–1786) that "It is pardonable to be defeated, but never to be surprised" (Calof & Wright, 2008, p. 718).

However, it should be emphasized that over the years the concept of CI has changed and evolved. Currently, what we call as CI is defined as an ethical and systematic process, program and function of gathering, analysing, and managing information about the external environment. This information can be used to make decisions at any level, leading to a competitive advantage. Competitive intelligence manages information about the external environment and is proactive. Thanks to this, it can be used to assess the current and potential external environment, as well as threats and opportunities (Shujahat et al., 2017).

The importance of CI in the process of making managerial decisions is also indicated. SCIP (Strategic & Competitive Intelligence Professionals) defines CI as the process of legally and ethically gathering and analysing information about competitors and the industries that they operate in order to help your organization make better decisions and reach its goals. The Competitive Intelligence Ning (a discussion forum for competitive intelligence practitioners), defines CI as the interpretation of signals from the environment for an organization's decision makers to understand and anticipate industry change (Calof, Arcos, & Sewdass, 2018, p. 718).

It can be seen that the concept of CI is related to the concept of environmental scanning, which suggests a broader view of the organization's external environment. Thanks to these processes (shown in Figure 5.16), the organization senses, perceives, interprets and acquires knowledge, thus getting to know its competitive environment. The organization learns from the environment in three steps (de Almeida, Lesca, & Canton, 2016, p. 1284):

1. Scanning (monitoring and data collection).
2. Interpretation (giving sense to the data collected).
3. Learning in a cyclic process.

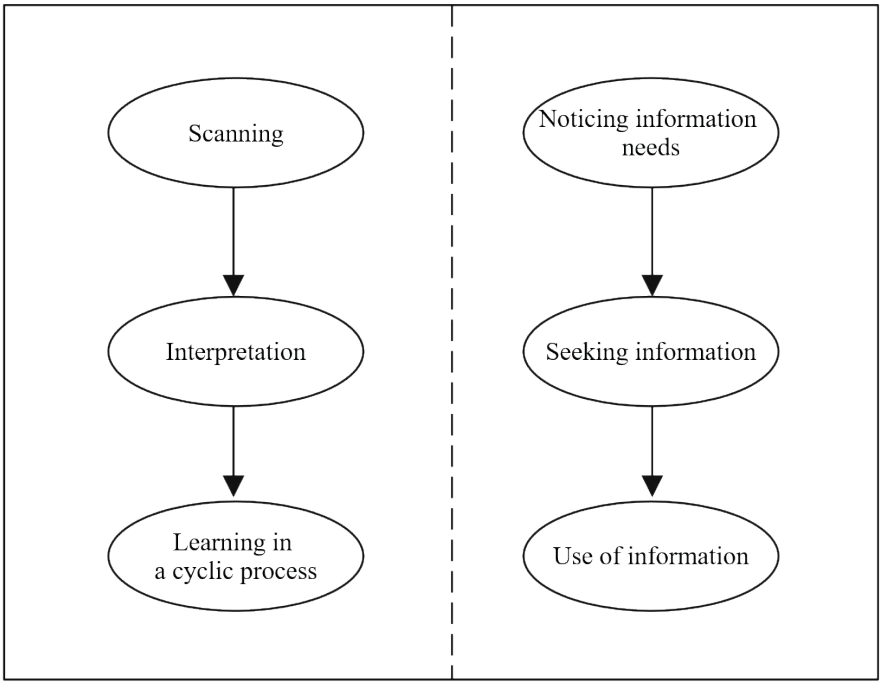

Figure 5.16. CI processes

Source: Own study based on (de Almeida et al., 2016, p. 1284).

In addition, it is worth noting that the collection and sharing of information and knowledge depends on the so-called information behaviour, which includes three groups of activities (de Almeida et al., 2016, p. 1284):

1. Noticing information needs.
2. Seeking information.
3. Use of information.

After noticing information needs, the search for information begins, and individuals look for information and change their state of knowledge. In an information exploitation activity, individuals select and process relevant information. Information-seeking can be conceptualized as the process of constructing knowledge and is influenced by three types of variables: cognitive, affective, and situational. Cognitive variables refer to the mental structures that people use to formulate information needs and interpret information found. The affective variable refers to the feelings and emotional states of people. Situational variables provide the proper context for the information-seeking task (de Almeida et al., 2016, p. 1284).

The literature emphasizes that a properly developed CI allows you to achieve a number of benefits and solve numerous problems, such as (Shaitura, Ordov, Lesnichaya, Romanova, & Khachaturova, 2018, pp. 2–3):

- anticipate changes in the market,
- predict the actions of competition,
- identify new or potential competitors,
- draw conclusions based on the successes and mistakes of other companies,
- track information related to patents and licenses,
- assess the possibility of acquiring a new business,
- learn about new technologies, products and processes that may have an impact on the business,
- study political, legal and regulatory changes that could affect business,
- justify the need to start a new company,
- assess the business from the outside,
- help you use the latest business tools,
- transform the weaknesses of the enterprise into competitive advantages,
- detect changes and react before it's too late,
- identify potential sources of information leakage,
- identify the weaknesses of competitors,
- collect information about partners and customers.

Moreover, research shows that companies operating in the market use CI primarily to achieve the following results (Calof & Wright, 2008, p. 723):

- new or increased revenue,
- new product or services,
- cost savings / avoidance,
- time savings,

- profit increases,
- financial goals met.

In particular, it can be observed that the information collected and processed with the use of CI is used in the decision-making process in such areas as (Calof & Wright, 2008, p. 724):

- corporate or business strategy,
- sales or business development,
- market entry decisions,
- product development,
- R&D / technology decisions,
- M&A decisions,
- due diligence,
- joint venture decisions,
- regulatory/legal responses.

This shows that CI affects a wide range of decision-making areas and is an important component in formulating a business strategy. It is difficult to identify any aspect of the organization's activities that would not benefit positively from the CI contribution (Calof & Wright, 2008, p. 724).

5.15. Statistical Process Control (SPC) and Computer-Aided Process Planning (CAPP)

The concept of "information management" defines a wide range of activities related to information resources, information flow management, technology and management in general. The behaviour of a person in the information society reflects the activity of the individual as a knowledgeable subject, his ability to navigate the information space. In information behaviour, the degree of accessibility and comfort of the use of aggregate information resources or, in other words, the opportunities that society provides to an individual who seeks to take place as a professional and personality is manifested. It's noted that information represents resources for human mental activity, which is the basis for the formation of new knowledge. This cannot be done without integration Statistical Process Control (SPC) and Computer-Aided Process Planning (CAPP).

Today there are five stages of information management (Figure 5.17). The first stage in the evolution of the necessary infrastructure for the integration of SPC and CAPP over the Internet was formed in the form of Web 0.0—Developing the Internet &Web 1.0 (1990–2000), when users only received information. SPC measures the outputs of processes, looking for small but statistically significant changes, so that corrections can be made before defects occur. SPC was first used within manufacturing, where it can greatly reduce waste due to rework and scrap.

It can be used for any process that has a measurable output and is now widely used in service industries and healthcare.

Web 1.0 was primarily used by companies and personal websites which only showed information (Loretz, 2017). This era empowered the common user with a few new concepts like blogs, social-media & video-streaming. Publishing your content is only a few clicks away! Few remarkable developments of Web 2.0 are Twitter, YouTube, Flickr and Facebook.

Figure 5.17. Stages of evolution of the World WEB in context information management SPC and CAPP

Source: Own study.

SPC became a key part of Toyota Production System and, by extension, lean manufacturing (Muelaner, 2019). However Basic Concepts of Process Routing Planning combined in Manufacturing of machining Processes. This stage contains generation of Principle of coincidence of references and factors causing machining errors of data, which improve of Methods for Technological References and Dimension Calculation and Recalculation of data (Wang & Li, 1991).

During the second stage Web 2.0 (2000–2006) users became participants in the generation and accumulation of statistics and were able to interact with each other (exchange information). Computer-Integrated Manufacturing has gained recognition as a most effective tool in increasing manufacturing competitiveness by activating of Computer-Aided Process Planning Systems knowledge (Wang & Li, 1991; Karpenko, Zhylinska, Zalizko, Kukhta, & Vikulova, 2019). Web 2.0 was the second stage or generation of the World Wide Web and it was known as "The Social Web" as users were able to not only read websites but also interact and connect with other users. All social media such as blogs, YouTube and many more emerged with Web 2.0 and companies realised the strength of community interaction with

business websites. People were able to collaborate on ideas, share information and generate information that was available to whole world (Loretz, 2017).

The third stage Web 3.0 (2007–2011): development of large databases. Almost simultaneously with the third stage, the development of social networks and messengers began, which allowed the exchange of instant information—Web 4.0 (2009–2019). CAPP-system fully automates the planning of technological processes using computer programs. The most popular computer programs in the world should be divided according to the following rating: 1) WeldOffice (CAPP—CSPEC, USA); 2) WeldPlan (CAPP—Force Technology, Denmark). Simultaneously SPC-system uses statistical methods to monitor and control process using computer programs outputs. SPC must be carried out in two phases. The first phase ensures that the process is fit for purpose and establishes what it should look like. The second phase monitors the process to ensure that it continues to perform as it should. Determining correct monitoring frequency is important during the second phase and will in part depend on changes in significant factors, or influences (Muelaner, 2019). This means that Web 3.0 is not only a read and write web but also a web that focusses on the individual user and machine (Loretz, 2017). In this context, a computer program that is quite useful is the Statistical Package for the Social Sciences (SPSS). SPSS system allows you to choose from many options for regression analysis (linear regression, least squares analysis, polynomial regression, ordinal regression, etc.).

The fourth stage begin in 2020 (Web 4.0): construction of the Neuronet—networks where communication between people, animals and things will be based on the principles of neurocommunication, and the use of artificial intelligence. Thus, digital technologies have been the driving force of society for several decades, causing radical changes in the economy due to its digitalization. In the general interpretation of the European Commission, the digital economy is an economy based on the widespread use of digital technologies (European Commission, 2014). In context Web 4.0 & Web 5.0 Artificial Intelligence is the capacity of a computer to communicate, reason and behave just like a human, and this is exactly what, some believe, will be seen with web 4.0 and beyond. Web 4.0 or "The Intelligent Web" will exist between the years 2020 and 2030 and some believe it will be as intelligent as the human brain. From computers being personal assistants to virtual realities, holograms, all house appliances being connected to the Internet (Internet of Things) and implants to restore vision; highly intelligent interactions between machines and humans will occur (Loretz, 2017).

The five stage begin in 2020 (Web 5.0). This stage will integrate the three most important systems: economic, social, environmental through application of SPC, CAPP and blockchain. The algorithm Web 5.0 involves joint application of the computer (SPC&CAPP) to assist process planners. This opens up

new planning functions define as Sustainable Statistical Process Control and Computer-Aided Process in context formatting of Information Management 5.0—the new competitive advantage of a new society of ideas and excellence. Let's highlight the main components SPC & CAPP contexting "The Telepathic Web" or "The Symbionet Web" will be present after the year 2030 and within this highly complex future web generation, some things such as brain implants will be very popular. Brain implants will give people, e.g., the ability to communicate with the Internet through thoughts, to think of a question and open up a web page (Figure 5.18).

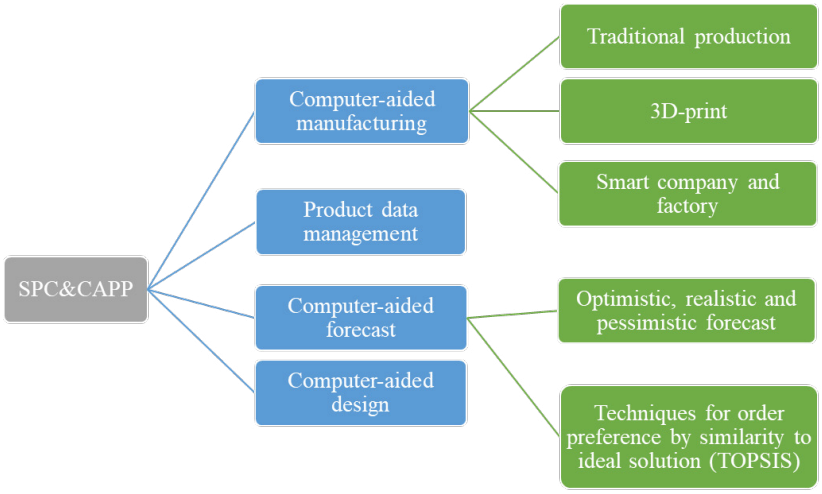

Figure 5.18. Systematization of structural elements SPC&CAPP

Source: Own study.

It allows scientifically grounded theoretical and methodological basis for the formation and implementation the strategy of Sustainable Statistical Process Control and Computer-Aided Process Planning in context formatting of Information Management. In this strategy considered as the key technology for integration of computer-aided design (CAD) and computer-aided manufacturing (CAM). This integration can be applied to machining e-tools, or to 3D printers for developing EU economical e-infrastructures.

A theoretical approach is substantiated to the formation of an innovative concept of Ukraine's economic security strengthening in the context of COVID-19, which provides for the formation of the gig-economic space as a new key driver of the national economy in the context of global epidemiological problems solving. An innovative system of weighted indicators of the economic security integral index is proposed. The proposals for the use of blockchain technologies make it possible

to attract domestic public investment for training, soft loans and retraining of the economically active population in the amount of 1 billion dollars.

A theoretical approach to the formation of an innovative concept of Sustainable Statistical Process Control and Computer-Aided Process Planning strengthening in the context of COVID-19, which provides for the formation of Supply Chain Management (SCM) as a new key driver of EU economy. An innovative system of identification of suppliers, raw materials, components and logistics services and the proposals for the use of blockchain technologies make it possible to attract domestic public investment for training, soft loans and retraining of the economically active population in terms formatting of Information Society.

Presented of systematization of structural elements SPC & CAPP combines well with the proposed concept of strengthening the economic system on the example of Ukraine (Figure 5.19).

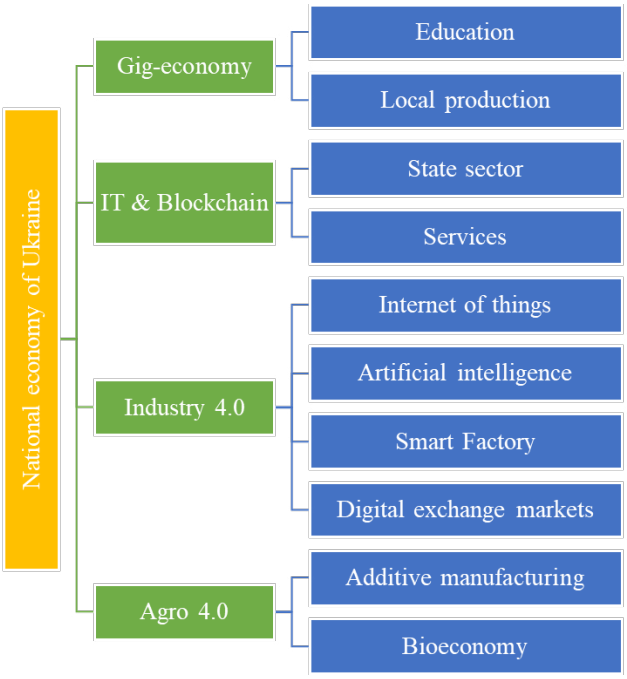

Figure 5.19. The concept of strengthening the economic system of Ukraine under the conditions of COVID-19

Source: (Zalizko, Nowak, & Kukhta, 2020).

From a practical point of view, it should be noted that SPC & CAPP systems are used mainly in the field of services (communications, consulting, etc.), but it is worth giving an example of the largest mining companies (Table 5.5).

Table 5.5. Ukrainian mining enterprises that use elements of SPC & CAPP system

Mining and Chemical Enterprise Polimineral in Stebnyk	Ukrainian Mining and Metallurgical Company PJSC
Marganets Mining and Processing Plant PJSC	United Mining and Chemical Company PJSC
SE Eastern Mining and Processing Plant	Mykolaiv alumina plant LLC
Boguslav Quarry, Open Joint-Stock Company	Druzhkivske Rudoupravlinnya PJSC
PJSC Kondrashivskyi Sand Quarry	Kremenchug Quarry Management Quartz PJSC
Northern Mining and Processing Plant PJSC	Central Mining and Processing Plant PJSC

Source: (Zalizko, Nowak, & Kukhta, 2020).

Presented of systematization of structural elements WEB 0.0–5.0 and SPC&CAPP combines well with the proposed concept of strengthening the strategy to stimulate the openness, strength and resilience of the EU's economic and financial system for the years to come. The outlined concept of strengthening the economic security in the context of the spread of acute respiratory disease COVID-19 caused by coronavirus SARS-CoV-2, provides for the institutionalization of gig-workers (freelancers), who must have not only tax benefits but also proper social, transport and information infrastructure (Zalizko, Nowak, & Kukhta, 2020).

Conclusions and suggestions. The outlined concept of strengthening the role of Sustainable Statistical Process Control and Computer-Aided Process Planning in context formatting of Information Management is important for minimization of the spread of acute respiratory disease COVID-19 caused by coronavirus SARS-CoV-2, as required provides for the institutionalization of remote CRM^{+-} system, which has the following functions:

1. Automatic enterprise resource planning and management.
2. Continuous acquisition and life cycle support.
3. Manufacturing requirement planning.
4. Planning the purchase of new goods, forecasting sales, analysis of marketing prospects, financial management, warehousing.
5. Automation of operational management tasks (manufacturing execution systems).
6. Remote execution of dispatching functions: collection and processing of data on the state of equipment, personnel safety, technological process (supervisory control and data acquisition).
7. Computer numerical control—mass installation of chips and controllers (specialized computers), which are built into the technological equipment with numerical software control (it is possible to use telephone sim-cards).
8. Automatic control of production life cycles in a single information space (product lifecycle management).

9. Distribution of income, payment of taxes, royalties and other payments on the principles of sustainable development of local areas.
10. Maintenance of a single information statistical database on gig-workers (freelancers).

These tasks must promote not only tax benefits but also proper social, transport and information infrastructure. First of all, we are talking about the potential innovative infrastructure of "Central European Network for Sustainable and Innovative Economy" that implements the synergistic effect of successful implementation of these proposals in local economic centers (united territorial community, rural areas, voivodships, megapolis, etc.) and must have proper social, ecological, transport and information infrastructure. This will help create an effective of Central European Network for Sustainable and Innovative Economy.

Questions / tasks

1. What is a production hall and what are its elements?
2. What is shop floor control?
3. What are the aims of shop floor control?
4. List and discuss the elements of Shop Floor Control.
5. What are the benefits of Shop Floor Control?
6. What is cooperative manufacturing?
7. What features of cooperation do you know?
8. What is reciprocity?
9. What is environment-conscious manufacturing (ECM) and life-cycle assessment (LCA)?
10. What is waste and what types of waste in an enterprise do you know?
11. How can company minimize waste in production-operation activities?
12. Discuss the diagram of the waste hierarchy.
13. Describe the Electronic Data Interchange process.
14. What advantages and disadvantages does the Electronic Data Interchange system have?
15. What are the differences and similarities between a real enterprise and a virtual enterprise?
16. Describe the virtual organization life-cycle model.
17. What advantages and disadvantages does the virtual enterprise method have?
18. What is World Class Manufacturing?
19. List the Pillars of Temple of WCM.
20. What advantages and disadvantages does the World Class Manufacturing method have?
21. What is the Quality Function Deployment method?

22. Describe the House of Quality diagram.
23. What are the stages of eliminating bottlenecks in theory of constraints?
24. What are the benefits of implementing the Drum Buffer Rope system?
25. What is cellular manufacturing?
26. What are the benefits of using group technology and cellular manufacturing?
27. What are the main differences between a traditional manufacturing system and a cell-based system?
28. What characterizes Demand Chain Management?
29. How does the organization acquire and process information?
30. How does the organization acquire and process information?
31. What are the benefits of having a properly developed competitive intelligence?
32. In which areas is competitive intelligence primarily used?
33. What is information management and what are its stages?
34. What are the CRM functions?

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6.

PROBLEMS OF SUSTAINABLE DEVELOPMENT AND CHALLENGES RELATED TO PRODUCTION AND OPERATIONS MANAGEMENT

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Abstract: Due to the changes taking place in the environment of enterprises, many problems arise in their strategic and operational activities. The basis of the emerging problems is primarily the overproduction associated with short product life cycles. It contributes to the excessive use of various types of natural resources, often in a predatory manner. On the one hand, such an approach increases waste, and on the other, contributes to the destructive degradation of the environment. The result is a lack of food and water in some countries, climate change and related extreme weather phenomena, as well as various types of disasters, such as pandemics, fires, floods, droughts, etc. Water, air and land pollution as well as global warming are reflected in deteriorating quality of life.

Despite many threats, more and more enterprises perceive the danger and undertake various types of adaptive projects. It should also be emphasized that the environmental awareness of both micro-enterprises and large corporations is growing.

The purpose of this chapter is to introduce the reader to the basic problems that companies may encounter in their operations activity. First, changes in the environment are discussed, with particular emphasis on the depletion of natural resources, pollution of a destructive nature, as well as waste and its causes. The next part deals with the topic of globalization, pointing to both positive and negative aspects. Technical progress and related aspects such as new technologies, new processes and materials are discussed in the next part. In this part, particular attention is paid to improving productivity, thanks to the implementation of new technical solutions. Technical progress is directly related to the innovations presented in the next section. This section describes the types of innovation according to various criteria as well as factors that are conducive to increments in the level of innovation in the enterprise. The last part is devoted to the most important factor in operational activity—human

resources. Competences, qualifications and the importance of human resources in the production process were discussed.

Keywords: environment, globalization, human resources in operational activities, innovation, problems and challenges, resources, technical progress, waste.

6.1. Introduction

A challenge is defined as "a new and difficult task or situation that determines the abilities and skills of a specific subject" (Hornby, 2000, p. 192). It requires adequate strength and fitness as well as "tremendous mental or physical effort and therefore is a test of personal abilities and skills" (Glen, 2018, p. 53). In economic terms, it allows to confront the potential, competences and resources of the enterprise with the conditions, assumptions or changes taking place in the environment. The source of "challenges" are usually new events, situations, legal regulations, rules of conduct as well as evolutionary or revolutionary changes that the entity has not dealt with so far and which must be taken into account in its activities.

Facing challenges, overcoming inconveniences or eliminating various types of threats related to dynamic changes taking place in the environment, enable the company to achieve its goals on the one hand and to take a competitive position on the other hand. The emerging problems may relate to various levels of management, ranging from strategic, through tactical, to operational management. They are particularly important related to the current activity which can be broadly defined as "a value and quality adding approach and philosophy to planning, organizing and controlling organizational resources or inputs for optimum results in terms of efficiency and customer expectations. Operations management is viewed as a systems-oriented and highly integrative study of methods, tools, processes, and techniques that coordinate 'the vital three' (people, systems and processes) with 'the central one' (physical and natural resources) in creating and adding value to meet organizational goals and customer requirements at an appropriate cost of acquisition, production, and distribution" (McFarlane, 2014, p. 16). The emerging complications may be simple what does not require the involvement of significant resources as well as complex, complicated and multi-faceted, requiring the use of experience, knowledge and competences of employees. The ability to solve standard problems is one of the basic duties of base level managers. They concern such aspects as the organization of production and operational activities, including supply, work of warehouses, departments, assembly lines, maintenance, preparation of workstations, quality control, organization of distribution, supervision, motivation, etc.

The challenges deriving from a hyper-competitive environment which is subject to constant changes, both evolutionary and radical ones, are much more important. Evolutionary changes, due to their long-term and predictable nature, do not pose a significant threat, especially for companies that follow and analyse current trends on an ongoing basis. Skilful identification of threats allows to generate a stream of activities, thanks to which it is possible to effectively manage operations in the field of planning, organizing, monitoring and controlling the organization's resources, and at the same time harmonizing the company's priorities with the demand from the market. Unfortunately, not all enterprises make the appropriate toil and effort. The lack of knowledge and skills as well as the lack of business tools contribute to the formulation of erroneous strategies, both in the perspective and in operational terms. As a result, these entities face great difficulties in effectively and efficiently coordinating resources for competitive advantage and success (McFarlane, 2014, p. 17). It should also be emphasized that a significant part of enterprises marginalizes or ignores current threats and changes, treating them as some kind of manipulation or fake news. Noticing a threat too late increases the risk and often contributes to serious perturbations, including the necessity to terminate economic activity.

The radical changes are related to a sudden, usually unpredictable event that fundamentally changes the conditions of running a business. The source of the revolutionary changes may be the sudden emergence of new needs, products, services, materials or raw materials as well as regulations, rules or principles that are most often not consulted with the interested parties. The examples include various types of limits, including production limits, pollutant emission limits, waste generation limits, location restrictions as well as decisions to prohibit specific activities. The dynamics of introducing changes is often a big surprise for entrepreneurs who most often do not have the appropriate means, resources and time to react effectively. The most common results are financial problems, a smaller scale of production, reduction of employment and in extreme situations, liquidation of the enterprise. It should be emphasized that attempts to change the sector, due to time constraints and relatively inelastic property, most often do not bring any effect.

By countering threats, entrepreneurs need to become more aware of changes taking place in the environment in which they operate and in which they plan and implement their operational tasks. Identification and recognition of changes should be reflected in a set of activities within which new, innovative methods and processes should be found, developed and used which on the one hand will reduce the risk, and on the other hand will allow to create new value based on better, more economical and more rational resource use. This collection should contain the most appropriate management tools and techniques, selected on the

basis of knowledge, competence and experience as well as reliable market intelligence. Only their implementation and skilful adaptation in current operations will enable appropriate change management and adaptation to the new reality (McFarlane, 2014, p. 18). Operational management in this context should be defined as the ability to consolidate the company's potential which includes material, human, intangible, financial, relational, etc. resources with methods enabling their effective use. According to Krajewski, Ritzman and Malhotra (2013, p. 2) operation management can be defined as "the systematic design, direction, and control of processes that transform inputs into services and products for internal, as well as external customers". The authors (Krajewski et al., 2013, p. 3) emphasize that operation management is effective and efficient management of operations or resources that perform all or part of one or more processes in value creation. These processes take place in every organization, both production, service, commercial, and even social or no-profit ones because each offers some type of product or service that must be accepted by market.

Analysing the extensive literature on the subject, it can be indicated that in the last decades, the most important challenges related to the operational activity of enterprises are related to:

- environmental changes related to depletion of natural resources, fossil fuels and global warming, waste, air, water and land pollution, intensive farming and deforestation, products harmful to the environment,
- globalization, i.e. problems related to the processes leading to increasing interdependence and integration of states, societies, economies and cultures,
- technical progress and technology diffusion in production and operational activities (technology has been one of the most important influences on the growth and development of production-operation management, continuous improvement, productivity),
- constant innovation (innovation and agility are imperative to compete in today's business environment),
- employees in operational management (education, key competences, experience, difficulty recruiting the right talent, the lack of right employees—finding the right staff).

The characteristics of the most important challenges from the point of view of modern enterprises are presented below.

6.2. Environmental changes

In the simplest terms the environment can be defined as a system consisting of living and inanimate elements, created by both nature and man. Its individual components

interact with each other, creating a uniform plane of mutual conditions, connections and systems. None of the factors that shape the environment can function in isolation from the others. Any change to one of them causes a whole sequence of events that are reflected in all the other elements. The *Oxford Advanced Learner's Dictionary* (Hornby, 2000, p. 421) translates the environment as:

- the conditions that affect the behaviour and development of sb/sth; the physical conditions that sb/sth exists in,
- the natural world in which people, animals and plants live,
- the complete structure within which a user, computer or program operates.

A similar definition can be found in the *Dictionary of Contemporary English* (2005, p. 523) which indicates that the environment is:

- the air, water, and land of Earth, which can be harmed d by man's activity,
- the people and things that are around you in your life (e.g. the buildings you use, the people you live or work, and the general situation you are in,
- the natural features of a place (e.g. its weather, the type of land it has, and type of plants that grown in it).

The common feature of the above approaches is the possibility of influencing and shaping the environment by various entities, such as: enterprises, factories, organizations, institutions, local and regional government units, and even individual households. This shaping can be negative or positive. In negative terms, it is associated with its devastation, usually through over-exploitation. It takes the form of excessive extraction and use of natural resources, both renewable and non-renewable, pollution of air, land and water as well as waste including food. The positive aspect concerns the implementation of various types of programs and procedures which are believed to counteract negative trends. It should be emphasized, however, that despite extensive campaigns, the process of revitalization and regeneration of the environment proceeds at an alarmingly slow pace. The policy of many countries which translates into the functioning of both individual units and enterprises, is not aimed at the sustainable use of natural resources. Their decisions are usually based on an economic calculation and striving for development at all costs, even at the expense of future generations. It is pointed out that particularly significant problems related to the environment include depletion of natural resources, fossil fuels and global warming, waste, pollution of air, water and land, intensive farming and deforestation, products harmful to the environment.

6.2.1. Depletion of natural resources

Natural resources are all resources that were created without human interference or influence. They include sunlight, atmosphere, water, earth with all its miner-

als, as well as vegetation and animals (*Oxford Dictionaries*, 2020). They can be renewable or non-renewable. Non-renewable resources are all those that cannot be renewed as a result of natural processes or take a very long time in geological terms. Here, coal and lignite, crude oil, iron, sulphur and other metals, etc. can be mentioned. Renewable ones include those that, if properly managed, are not exhausted and can be replaced by their equivalent due to natural processes in the environment. For example, renewable resources include water, air, solar energy, as well as animals and plants. It should be emphasized, however, that human activity, and in particular overexploitation, consumption and waste, contribute to the imbalance, and thus the depletion of renewable resources. In other words, the consumption of renewable resources is so intense that the natural substitution processes are disrupted.

Natural resources, both renewable and non-renewable, are largely used by enterprises in various technological processes. This use is related to the growing needs of people, regions and entire economies, which was reflected in the dynamic development of production. It contributes to the faster consumption of resources in relation to their renewal or replacement. At the same time, the depletion of resources causes an increase in their price, which enables the exploitation of new sources that have not been obtained so far due to the cost. It is indicated that the main causes of resource depletion include (*The needs of 7th billion people*, 2020):

- growing demand for resources related to overpopulation and the need to provide it with adequate living conditions (the population has exceeded 7 billion people, and it is estimated that by 2100 it will reach 11 billion); in addition, a growing population contributes to an increase in environmental pollution,
- wasteful and unbalanced use of resources which leads to over-consumption and waste, especially in industrialized regions,
- excessive extraction and exploitation of available sources which leads to environmental devastation (an example is Adamów S.A. Brown Coal Mine, located in Turek, Poland, whose activity led to a decrease in groundwater level and drying up of water reservoirs (Pepliński, 2016),
- deforestation and the destruction of ecosystems leading to a loss of biodiversity (e.g. the forest area on the island of Borneo was reduced by 68% between 1950 and 2020, see Figure 6.1),
- technological and industrial progress which leads to an increased demand for certain raw materials, materials and energy,
- pollution of the environment and resources, especially air, water and land.

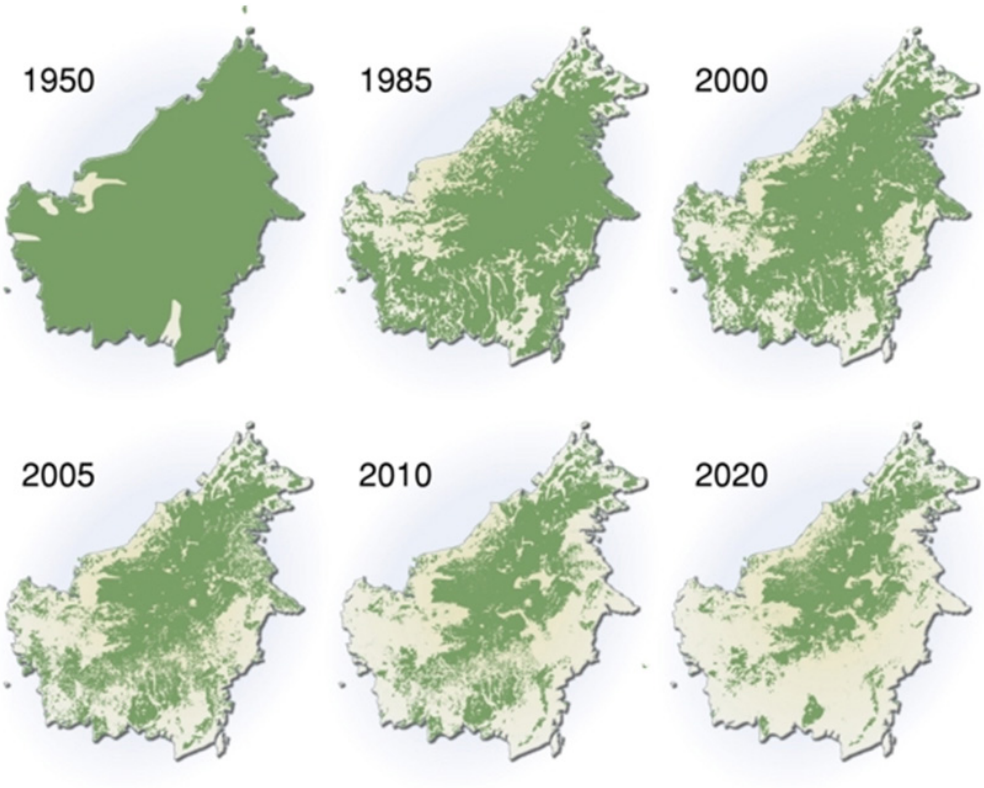


Figure 6.1. Deforestation of Borneo 1950–2020

Source: (*Extent of deforestation in Borneo*, 2006).

6.2.2. Fossil fuels and global warming

One of the biggest threats to the environment is climate change related to global warming. Here it is necessary to distinguish the concept of global warming from climate change.

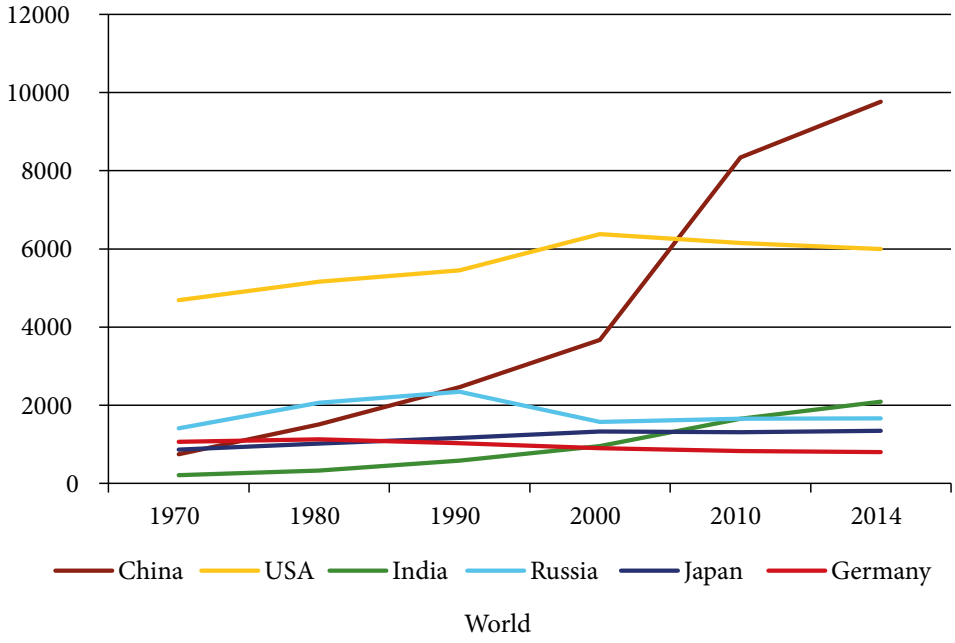
The first represents a systematic global increase in temperature of the atmosphere, oceans and the earth surface which has accelerated significantly in the last two decades (MacMillan, 2016). Climate change, on the other hand, is a set of complex factors that affect the weather and climatic systems of the planet (Nunez, 2019).

The increase in pollution contributes to the absorption of light and solar radiation which is reflected from the earth surface. As light and energy are absorbed,

the temperature rises, making the planet warmer. Under normal conditions, in the absence of pollution, this radiation would be emitted into space. Factors influencing climate change can be divided into external and internal ones. The external one is related to solar radiation, while the internal one is related to natural processes, such as volcanic and seismic activity of the earth and human activity which uses natural resources to excessively exploit the environment. It is indicated that the main sources of greenhouse gases include (Europejska Agencja Środowiska, 2019; Dobrowolski, 2020):

- the power plants based on hard coal and lignite, which have the greatest impact on global CO_2 emissions; it is shown that one third of the world CO_2 emissions are generated when this raw material is burned; the largest coal production is in: China (3,550 million tons), India (771 million tons), the United States (685 million tons), Indonesia (549 million tons), Australia (483 million tons), Russia (420 million tons), Germany (71.3 million tons), Poland (48.7 million tons) and Turkey (44.6 million tons) (BP, 2018; IEA, 2019),
- the road, air and water transport, especially the growing number of cars, planes and container ships, which emit, apart from CO_2, many other harmful substances, such as: nitrogen oxide, dusts and soot generated during the combustion of mazout (fuel oil) in maritime transport,
- the industry that produces a significant amount of poisonous and toxic industrial waste in the production of goods and services, which is usually emitted directly into the environment; it should be emphasized that the industry also uses oil, gas and coal; these raw materials are used to produce plastics, fertilizers, pesticides, rubber, drugs, solvents, dyes, asphalt and many other products, the production of which emits significant pollutants into the environment,
- the households, especially the energy generated by burning waste and low-calorie coal in the process of heating the house and producing energy,
- the cutting down forests, including tropical forests, which are largely responsible for the reduction of greenhouse gases.
- the agriculture, including animal production and changes in land use, deforestation, drying up of lakes, lowering of the groundwater level,
- the production of waste and their improper storage in landfills,
- the use of fluorinated gases in industry.

The ongoing climate change may lead to a global crisis. A 2-degree increase in temperature will render large parts of Africa and Asia unfit for life due to lack of water and arable land. This will cause a huge, estimated at 250 million people, wave of refugees by 2050 (Dobrowolski, 2020). Therefore, it is required to undertake various types of initiatives aimed at, on the one hand, making global communities aware of the need to reduce greenhouse gas emissions and to use alternative sources to fossil fuels.



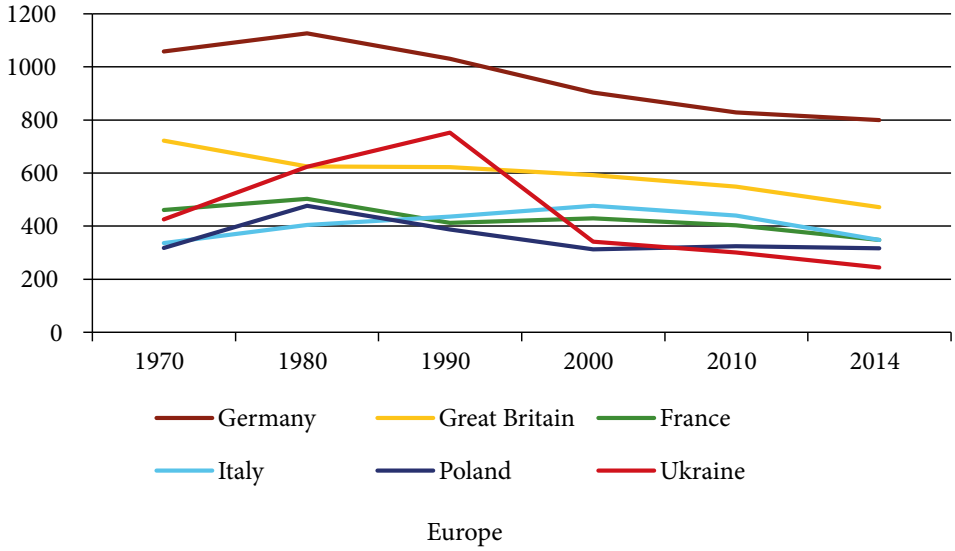


Figure 6.2. The largest producers of CO_2 in million tons in the world and in Europe during the years 1970–2014

Source: Own elaboration based on (BP, 2018).

6.2.3. Waste, air, water and land pollution

Waste, which is defined as consuming more than it is necessarily needful is another threat facing today's organizations. It mainly concerns resources, time, energy, etc. (Hornby, 2000, p. 1459). According to the Polish language dictionary, wastage is identified with "(…) reckless, useless, unprofitable dispensation, managing something, prodigality" (Drabik and Sobol, 2007). The authors also add that it is spending money excessively, dispensation, squandering of something, not using properly what we have, exposing to losses, unjustified spending of resources. It can also be described as a reckless, unprofitable and useless dispensation of some resource, often ignoring the possibility of doing something with less resource expenditure (Wyrwicka, 2009). The dictionary of synonyms shows that they are identified with such words as: mismanagement, extravagance, inefficiency or ineffectiveness (Cieńkowski, 2000, p. 100).

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Wastage also found its explanation on the basis of praxeological sciences. Kotarbiński, in the *Traktat o dobrej robocie* (Treaty of Good Work) (1974, pp. 156–157), thinks that the waste is: "(…) wasting of resources, or consuming resources of rare specific values for the goals achieved through the use of easily replaceable resources, the sluggish ending of the started work where the preparatory contribution is then lost, any unnecessary contribution, the excessive consumption of materials, apparatus, energy—over the real need, incorporating everything what is irrelevant."

Wastage applies to all entities operating on the market, starting from the state or from regions separated legally and organizational, through enterprises, institutions, self-government bodies and offices, and ending with the society and individual households. Each of them, conducting business or operating in a specific environment, needs a variety of resources with strictly defined parameters that provide him with the satisfying ever-growing needs. In practice, however, it happens sporadically that the demand reported by a specific entity closely corresponds to its consumption. The discrepancy between these two parameters contributes to the waste, i.e. the lack of use or incomplete use of certain resources at the disposal of the organization or a natural person. The essence of waste is the disproportion between the effective use of resources and other parameters influencing and deciding on the standard of living or the goals set by the organization. In the case of households, the waste primarily relates to food as well as other articles of everyday use, such as clothing, footwear, household appliances, electronics, etc., which serve

to meet the constantly growing consumer needs. In the case of enterprises and other business entities, this problem concerns raw materials, materials, production potential, space and even labour, its skills and experience. However, taking into account the self-government or state structures, there should be indicated the irregularities in the rational use of resources, including transfer of ownership, abuse, mismanagement, etc.

Wastage can be identified with the non-utilization or misuse (partially or not at all) of certain things. In other words, the unprofitable management of resources that remains with the organization or a specific entity. From the point of view of the company, it applies to all activities undertaken that do not increase the value of the product or service from the point of view of the buyer. This means that waste is all that brings no added value in the process of creating the product and delivering it to the buyer (Roother & Shook, 1999).

Analysing the considered concept from the point of view of the company, it should be pointed out that the sources of waste can be considered through the prism of eight types, seven of which are typically hard, and one is soft. The starting point is the division of activities into such ones that add value from the point of view of the buyer and those that do not make much sense which means that the client will not be ready to pay for them. Analysing the basic activity of the enterprise, particularly important types of waste are (Wiśniewska, 2005, p. 24):

- overproduction understood as the production of more and earlier than the customer needs,
- waiting: i.e. idle production, in other words it is hidden unproductivity caused by delayed delivery of materials or machine failure, planning errors, etc.,
- excessive processing: redoing activities or returning to activities that have already been done earlier in the previous positions,
- excessive transport: carrying out transport activities above the expected level,
- excessive stocks: purchase over demand, storage of additional parts or products that the customer does not currently need. In other words, this problem is related to the capital frozen in articles or work completed and waiting for its turn,
- excessive traffic: all additional or too long lasting activities needed to complete the task,
- errors and defects of products or otherwise the production deficiencies,
- unused human potential, including wasting employee creativity.

The presented approach is associated primarily with the production aspects, however, it should be noted that waste also affects the non-production sphere, associated with the organizational, administrative, legal work, etc. Summing up the considerations of the essence of wastage, it should be emphasized that in practice this phenomenon cannot be completely eliminated. Many activities must be performed although from the perspective of the buyer they do not create the value

(e.g. transport, management, quality control). According to Fabrizio and Tapping (2010), today's wastage has become a normal part of the activities undertaken in the environment.

A particular type of waste is food losses. According to FAO, it means "…any processed products, partly processed or unprocessed product intended for human consumption or for human consumption to be expected as well as those which, despite their manufacture, have not been eaten" (FAO, 2014). They refer to edible parts of food of animal and vegetable origin that arise at all stages of the agri-food chain (BCFN, 2012; Tielens & Candel, 2014).

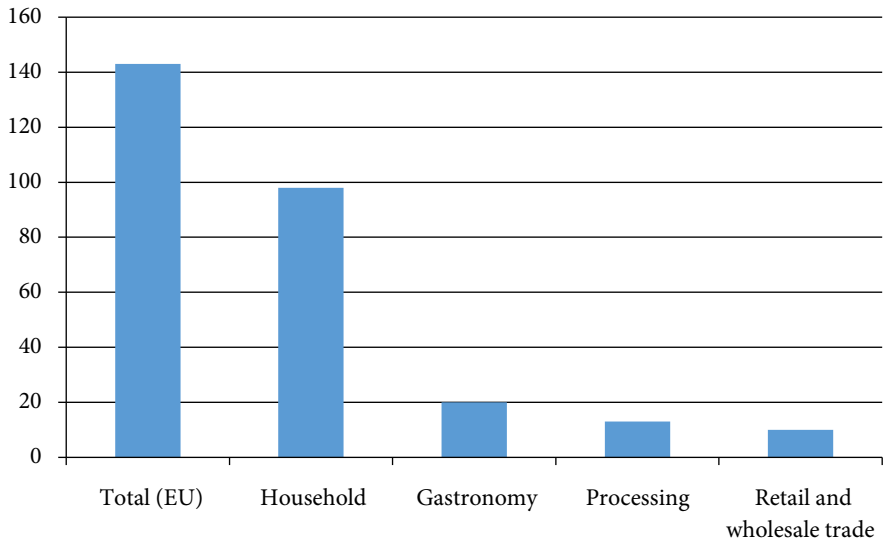

Figure 6.3. Cost caused by food waste in billion EUR

Source: (*Food waste*, 2012).

Analysing the process of food waste appearance, there can be pointed several interlocking stages:

- the first one, at the primary agricultural production stage, is associated with losses caused by the environmental factors; particularly significant losses are those ones caused by leaving raw materials in the field or in the orchard, or not harvested vegetables and undersized fruits,
- the second one, at the processing stage, concerns technical limitations that prevent effective processing,

- the third stage, referred to as the manufacturing process stage, is associated with the production-related activities, such as: packaging, transport, marketing, service,
- the fourth one is related to the storage processes, especially in the area of improper storage of the raw material and exposure to the weather conditions,
- another stage concerns transport, including spoiling, crushing, wrapping or tearing the packaging,
- the sixth stage concerns distribution and sales, in which losses arise as a result of the lack of correct estimation of demand and supply,
- the seventh one concerns the consumer and his approach to waste; it results from the excessive consumption and inappropriate methods of food protection.

It should also be emphasized that the literature distinguishes the concept of waste and loss (Gustavsson, Cederberg, Sonesson, Otterdijk, & Meyback, 2011, p. 2). Authors say: "Food losses refer to the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. Food losses take place at production, postharvest and processing stages in the food supply chain. 'Food' waste or loss is measured only for products that are directed to human consumption, excluding feed and parts of products which are not edible. Per definition, food losses or waste are the masses of food lost or wasted in the part of food chains leading to "edible products going to human consumption" (Gustavsson et al., 2011, s. 2).

In practice, the problem of waste is universal, massive, ubiquitous and practically applies to all aspects of social and economic life. These traits cause that the effects of waste and mismanagement find their negative reflection in the established and historically elaborated social order. At the same time, it is emphasized that if the negative consumption patterns are continued, soon the society will face a double environmental crisis, what is the shortage of resources on one hand and the excessive waste burden on the other one (Global Waste Management Outlook, 2015; Velenturf & Purnell, 2017).

The paradox is that the majority of individuals, enterprises and even self-governments, both at the local and regional level, are aware of the problem of waste. However, despite relatively high awareness, it is generally acceptable what results from the belief that waste is something irrational on which we do not have a direct impact. It can therefore be emphasized that the problem of waste will be difficult to solve using traditional methods of education, training or introducing specific legal regulations.

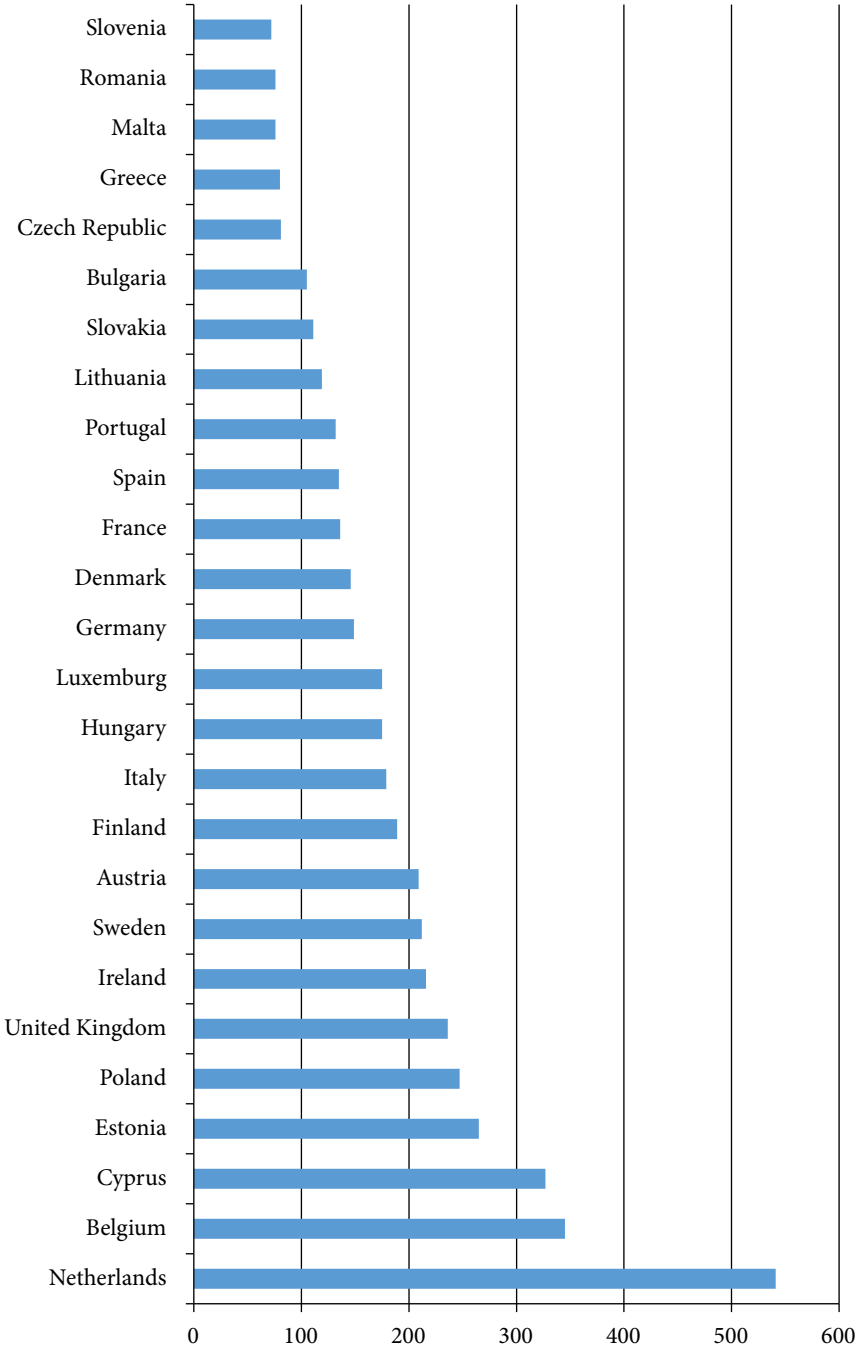

Figure 6.4. Losses in kg per person

Source: (Eurobarometer, 2016).

6.2.4. Problems related to environmental pollution

Another environmental problem that modern enterprises have to deal with, is pollution which should be understood as a process in which various harmful substances and toxins get into the atmosphere, water and earth, exceeding the permissible standards (Albiniak, 2017). As a result, there is contamination, poisoning or degradation of the environment, which becomes dangerous and unusable. Attempts to use such an ecosystem may have negative consequences what is reflected, on the one hand, in the health and condition of people, and on the other hand, in defective products that do not fulfil the functions and tasks for which they were intended. The pollutants emitted to the environment may be permanent or elusive. In the first case, it concerns the emission of specific fractions and components to the environment, which are components of exhaust gases, fumes, liquids, solutions, various types of substances, and even solid elements. In the second one, pollution is caused by artificial introduction of elements such as light, sound and temperature into the environment. The sources of pollution can be divided into natural and artificial ones. Natural ones are associated with volcanic activity, spontaneous outflow of liquid minerals, erosion and weathering of rocks, fires, floods, etc. Artificial ones are caused by human activity and take the form of contamination with household and industrial waste. The main component of household waste is organic materials, plastics, rubber, textiles, metals, wood and glass.

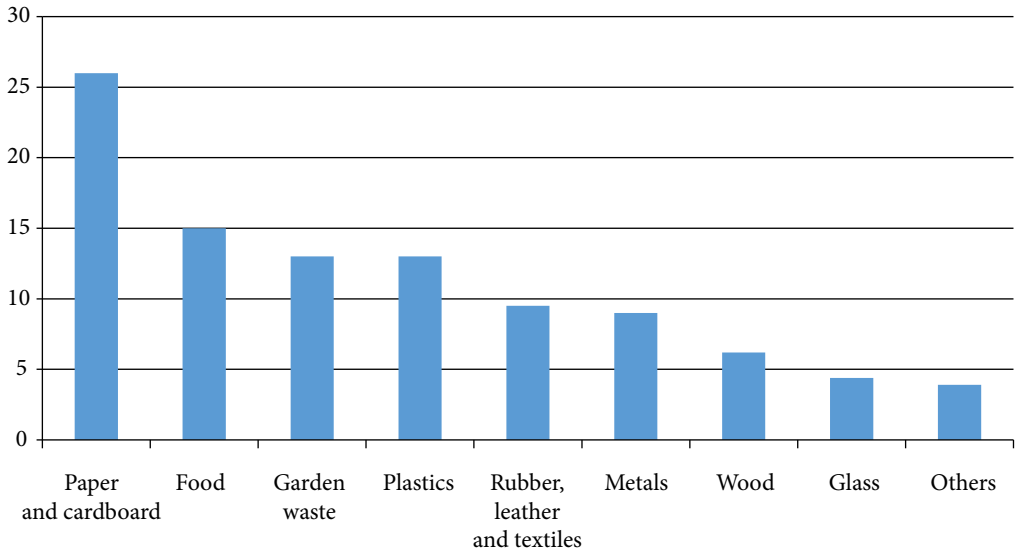

Figure 6.5. The percentage of household waste production

Source: (EPA, 2018).

The development of industry associated with the rapidly growing demand for various types of goods and services has a much greater impact on environmental degradation and disintegration. The most harmful compounds are generated by activities such as: hard coal and lignite mining, steel production, oil refining, pesticides and fertilizers production as well as sawn timber and stone from quarries (Vallero, 2014). Each of these processes produces products along with a few waste products that pollute water, air and land. These pollutants cause long-term damage to the world around us. They are the main cause of deteriorating living conditions as well as turning extreme weather events into natural disasters. They cover the emission of many pollutants, of which air pollution, light pollution, litter, noise pollution, plastic pollution, soil contamination, radioactive contamination, thermal pollution, visual pollution and water pollution are particularly dangerous. They can be liquid, sludge, gaseous or solid waste. It is indicated that the main causes of industrial pollution include:

- the lack of proper environmental policy in many countries,
- unplanned industrial growth, especially in less developed countries,
- the use of outdated technologies, generating large amounts of waste,
- the presence of a large number of small scale industries that emit many harmful substances and are practically out of control,
- the inefficient waste disposal related to the lack of clear and transparent rules regarding responsibility for the elimination of pollution, both in individual countries and in international spaces,
- the leaching of resources from our natural world, mainly related to the acquisition of raw materials and deep-sea minerals,
- the natural resource use which in many cases takes the character of robbery and plunder,
- the lack of regulations and solutions that would force enterprises to regenerate the damaged environment.

By counteracting the harmful impact of industry on the environment, the measures should be taken to reduce the negative impact of enterprises on individual ecosystems. In particular, the efforts should be made to replace old technologies and implement clean technological processes which should significantly reduce the production of pollutants at their source. These activities must be comprehensive and systemic, covering all countries, including, above all, those whose industry degrades the environment to the greatest extent.

6.3. Globalization in operation activities

The company operational activity is conditioned by the ongoing processes related to globalization and increasing global competition. The development of technology, facilitation of the flow of goods and services, new methods of communication as

well as political, social and economic changes make enterprises have to look for new methods of competitive struggle which will ensure their survival on the one hand and expansion on the other hand. The activity based on traditional goals and principles no longer brings the expected results, in the form of an increase in production, sales or the possibility of creating demand. According to Cullen and Parboteeah (2010), the domestic market no longer provides success and long-term profitability. The very concept of globalization is ambiguous as it is a multidimensional and multithreaded phenomenon that occurs simultaneously on many levels (Kucharczyk & Łajca, 2017). It is characterized by the intensity and speed of the changes taking place. Overall, it is the process by which products, technologies, information and jobs spread across national and cultural boundaries. It is related to the intensification of the flow of goods and services between even very distant places. This definition indicates the growing importance of trade and the interdependence between entities from different countries. It may concern various activities of humans and economic entities, including ecological, cultural, political, technological, financial and economic activities. It has many benefits that span multiple areas. In particular, it affects the development of the world economy and the intensification of the development of cooperative relations between enterprises from different countries.

Globalization can be defined as an extensive network of economic, cultural, social and political interconnections and processes which goes beyond national boundaries (Yeates, 2001, p. 629).

The intensification of globalization processes means that more and more companies are looking for opportunities for their development on foreign markets. These activities cover many aspects, from procurement and sales, through transport and financing, to the organization of production processes and acquisition of technologies. There are two reasons for the development of international activity (Ansoff, 1984):

- the first one is related to the operational activity of the enterprise in which materials, raw materials, equipment and technologies are obtained and surplus products are sold,
- the second one concerns the fulfilment of strategic needs, including, in particular, sustainable growth, improvement of profitability, avoiding stagnation, and ensuring the stability of the external environment.

However, according to Brooks (1999), the ongoing transformation is related to:

- the increased geographic dispersion of production,
- the greatly enhanced significance of interfirm alliances,
- the increased ease of engaging in foreign direct investment (FDI),
- the general shift toward "knowledge-based" economies in the most advanced countries.

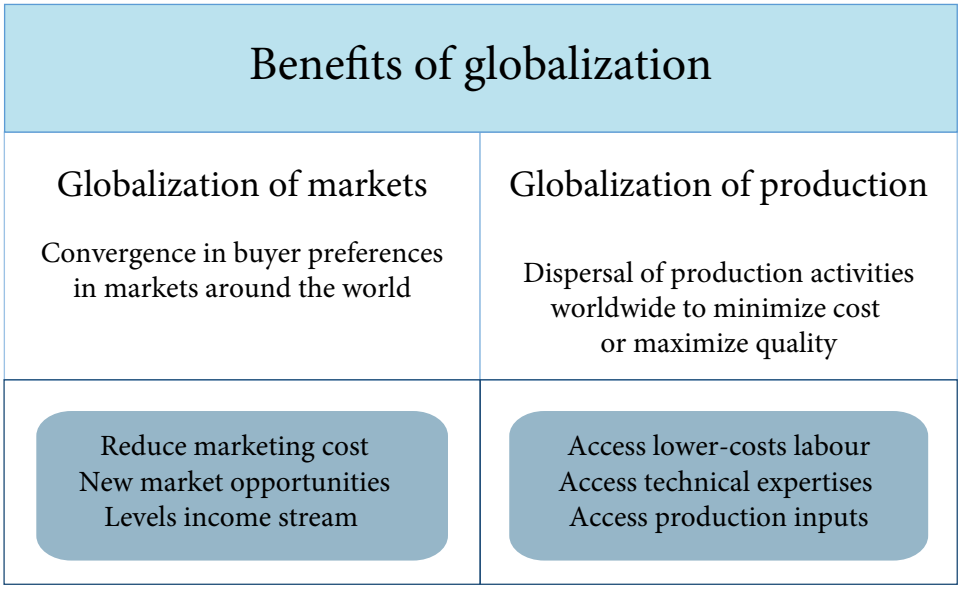

Figure 6.6. Benefits of globalization

Source: Own study based on (*Velocity Global*, n.d.).

It is emphasized that these processes are natural and are related to the development of science, technical progress, specialization and unification of production processes as well as the expansion of commodity markets. Globalization therefore enables companies to expand their business and optimize it, thanks to the free possibility of relocating production, quickly changing sources of supply, looking for more profitable sales markets and better financing rates. As a result, investors achieve a better return on investment. There are five factors at the heart of the development of globalization, including:

- The development of international trade which increases the interdependence between cooperating partners. It should be understood as "commercial activity, the subject of which is the paid delivery of goods or the provision of services between contractors based in different countries" (Jaszczyński, 2016, p. 374). According to the author, this development is conditioned by the state trade policy which sets goals to be achieved through international exchange. This policy should define the scope of exchange, its structure, size as well as dynamics and geographic directions (Jaszczyński, 2016). Nowadays, the value of turnover between countries increases with the economic development of individual countries, the deepening of the international division of labour, new production technologies and progress in the field of transport and communication (Białowąs, 2015). Moreover, the following factors are the basis of the development of international

trade: technical and economic, structural, cyclical, and political and systemic. International trade includes export, re-export, import and balance of payments. Both industrial goods, services and capital are interchangeable. In the first case, trading in raw materials, fuels and products of the processing and agri-food industries is particularly important. The scope of services includes transport and forwarding, tourism, IT and telecommunications services as well as commercial services. The last category is related primarily to foreign investments and the flow of patents, licenses, copyrights, rights to inventions, etc.

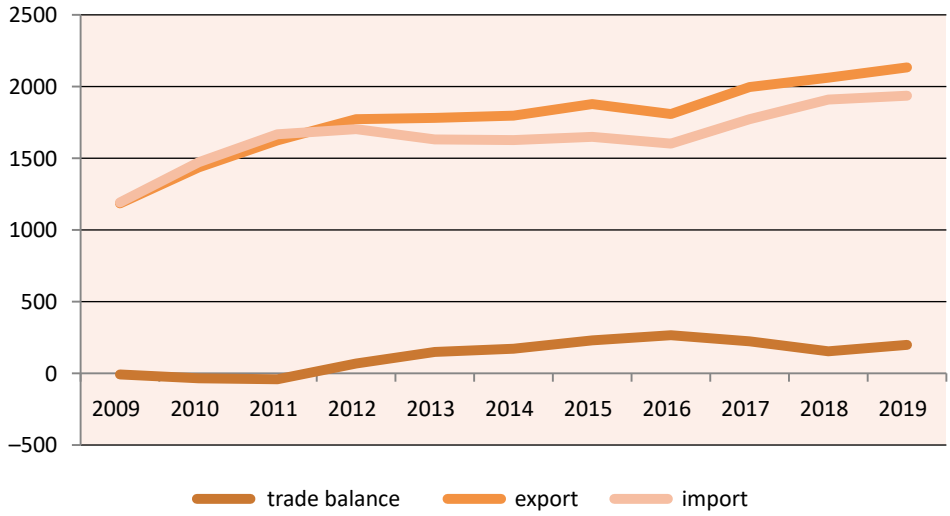

Figure 6.7. Changes in international trade in goods, EU 28, 2009–2019, in billion euro

Source: (Eurostat, 2020).

- The foreign direct investment which can be understood as "an investment undertaken in order to obtain a permanent share in an enterprise operating in an economy other than the investor economy where the investor goal is to obtain an effective influence on the management of the enterprise" (Górniewicz, 2013, p. 61). These investments depend on fundamental factors that shape the economic situation of a given country, including in particular macroeconomic conditions and the legal and regulatory environment (Humanicki, 2018). They can be divided into four basic categories. The first one concerns resources, including natural resources, labour and intangible resources that are not available in the home country. The second category concerns the market, in particular the striving to expand or maintain the current state of ownership, while blocking access to it by competition. The third aspect concerns efficiency which indicates a better use of the possessed capabilities, thanks to the appropriate economic

policy of the host country. The last category is related to capital and the possibility of increasing the ownership level thanks to the acquisition of a company or production capacity in which a foreign investor is interested (Wiśniewska, 2011). It is indicated that FDI has a positive impact on the economy of the host country as they enable the transfer of technology and knowledge as well as the inflow of financial resources which in turn increases the productivity of production resources and improves the quality of manufactured products (Humanicki, 2018).

- The flows in the capital market are related to the flow of money between markets for investment, trading and business purposes. In particular, they relate to foreign direct investment, real estate investment or purchase, investment in securities, granting loans and credits and other operations involving financial institutions (Dyrektywa, 1988). In enterprises they mainly relate to investment capital and outlays on research and development activities. These flows affect the efficiency of the global allocation of savings by financing those activities that are most productive and thus affect economic growth and global welfare (Alfaro, Kalemli-Ozcan, & Volosovych, 2006). At the core of capital flows is investor efforts to diversify their portfolios with a focus on international bonds, stocks and mutual investment funds.
- The migration which should be seen as the movement of people from one place to another, with the intention of temporary or permanent settlement. It can take the form of invasion, conquest, colonization and emigration / immigration. The main causes of migration are economic and non-economic factors. The economic ones are related to the improvement of living conditions, while the non-economic ones are conditioned by political, religious, social, family factors and crisis situations related to natural disasters. From the point of view of the operational activity of enterprises, the economic migration is particularly important. In practice, it is believed that migrants transfer their unique competences to the territory of the host country, stimulate the revival of industries and geographic areas that are not attractive to entrepreneurs of the host country, stimulate economic exchange and transfer of capital resources and bring an "entrepreneurial spirit" which stimulates rivalry and competition (Glinka, 2018, pp. 165–166). The migration affects the development of both host and developing countries. The second aspect is related primarily to the development of entrepreneurship as a result of the re-emigration of people who obtained education and knowledge abroad. Re-emigration may also have a negative effect, especially in the case of the loss of qualified employees who have decided to continue migration or return to their home country.
- The last factor influencing globalization is the diffusion of technology. This development is reflected primarily in communication facilities which affects the faster flow of knowledge, ideas, concepts or various types of initiatives. Moreo-

ver, the formation of transnational corporations contributes to the diffusion of production systems based on modern and innovative solutions (Ferri, 2003).

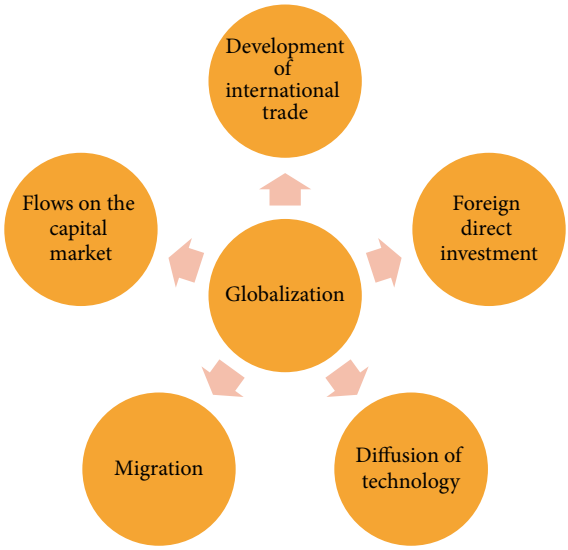

Figure 6.8. Factors shaping globalization

Source: Own study.

From the company point of view, the globalization affects two basic areas, i.e. the market and production. The market is primarily concerned with the processes of consolidation in which one integrated economy is created. This process also contributes to the alignment of preferences and tastes of customers who are influenced by a similar set of instruments. The offer is therefore included in standard, unified products and services which are increasingly taking a mass form. The aforementioned standardization, unification and normalization processes are also reflected directly in production. In operating activities, it may refer to various aspects, ranging from searching for suppliers of goods and services who offer them at an appropriate price and quality, through the relocation of production processes, taking advantage of the differences in labour costs in individual countries, and ending with the sale and distribution based on international multi-warehouses. The large scale of operations also contributes to the reduction of procurement costs. Companies that do business in different countries tend to purchase raw materials, materials and services at much lower prices than local businesses. Therefore, the cost of their operating activity is reduced which may be reflected in the cost of production and the market price of the offered product (Heimeshoff & Klein, 2013). The lower price of the offered products or services has a direct impact on the increase in the competitive position of global producers and thus their share in sales.

It can therefore be emphasized that production does not have to take place in one place. The individual components (elements that make up the product) are manufactured by various companies, located in different places, in different countries and even continents. The manufactured elements are sent to the company where the assembly takes place as a result of which the finished product is created. The division of the production processes of a specific product into many phases and their location in different countries is associated with the desire to improve competitiveness, as it enables the reduction of unit costs of production which, unfortunately, is negatively reflected in the so-called "wage repression" (Islam, 2015, p. 4). The globalization of production implies that firms are basing individual productive activities at the optimal world locations for the particular activities (Okoro, Ogochukwu, Nebo, & Okoro, 2017, p. 112).

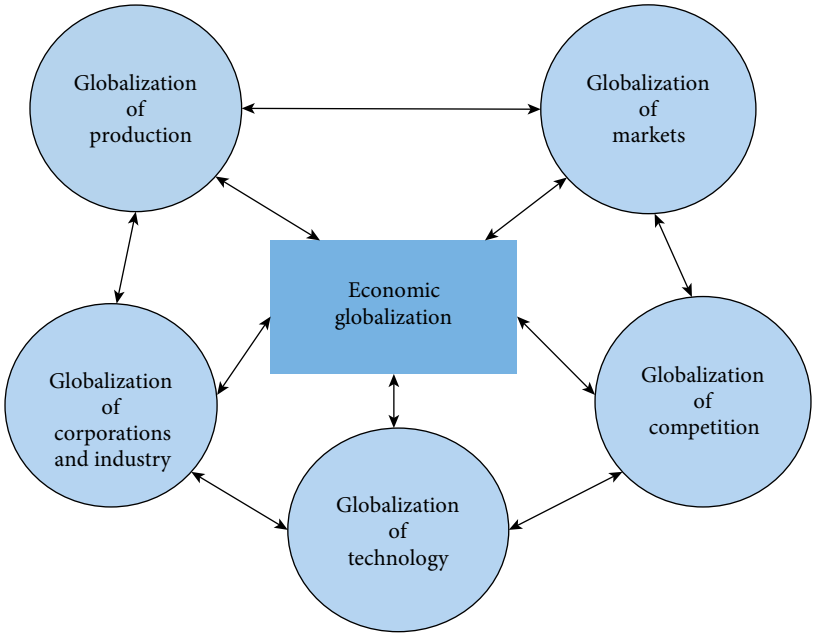

Figure 6.9. Dimension of economic globalization

Source: Own study.

Although such a product has a specific brand, associated with a specific country, it consists of components manufactured in different countries. The deliveries must therefore be properly synchronized, the lack of precise schedules may disrupt production processes which in turn may lead to disruptions in the implementation of plans or incomplete use of production capacity. From an operational point of view, globalization is also reflected in employee flows. The 1990s were characterized by

the intensity of restructuring and privatization processes in the countries of the Eastern Bloc. The negative effect was the drainage of individual economies from employees with high competences, experience and skills who were employed by large multinational corporations. As a result, the activity of global producers contributes to reduction in the pool human resource available to the domestic companies (Clougherty, Gugler, Sørgard, & Szücs, 2014). The effect of the activities of such companies was, inter alia, the liquidation of many research and development centres that specialized in solving the problems of specific industries or enterprises. Because "globalization of production involves splitting of the global value chain into different components, success depends critically on several conditions, including the technical capacity of the producers of components and assembly firms, the availability of workers with necessary skills, and the ability of managers to deliver according to strict time schedule" (Islam, 2015, p. 3). A very positive aspect related to the globalization of production is the possibility of relocating labour-intensive production, i.e. production that requires large amounts of human labour, to countries that have a surplus of labour. Such relocation indirectly contributes to the increase in wages in countries which have so far been characterized by relatively low wages. However, this process is long-term, requiring commitment from both the country in which the production is launched and the company that organizes the production. Moreover, the relocation of production contributes to the development of less developed regions, including the "learning by doing" process and thus contributes to the development of local entrepreneurship (Islam, 2015, p. 4). Strielkowski, Tcukanova and Zarubina (2017) indicate that globalization in operational management is also manifested in the technology transfer. This transfer applies to all areas related to the operational activities, from inventory management, through production, sales and marketing, to customer service, controlling and financial management.

6.4. Technical progress in production-operation management

One of the most important challenges related to the operational and production activity of the enterprise, due to its dynamic and permanent development, is the technical progress. It means a specific but not every change in the company operations. Basically, it is identified with the new technology, new production processes, the use of new raw materials, new production methods or changes in the organization of work. All the indicated elements are directly reflected in the current activity of the enterprise, related to the production of products and/or the provision of services, within the basic domain (Bińczycki, 2007, p. 7).

When discussing the issues of technical progress, it is necessary to point out the differences in terms of technique and technology. In practice, these two concepts are often equated with each other. The technique is most often associated with various types of human activity. Therefore, it concerns aspects such as the way of conducting research, presentation, thinking or demonstrations. It is defined as a set of knowledge of ideas and methods which are the result of many actions, both intentional and accidental. From the point of view of an enterprise, technique refers to the material resources used in the production of goods and services. The technology, on the other hand, refers to the method of preparing and conducting the production process. It can be defined as a combination of practical and theoretical knowledge with the ability to use them in various types of procedures and methods used in production processes (Palka & Stecuła, 2018; Banach, 2010). Technical progress is related to both the development of technique and technology.

> The term technical progress should be understood as all types of changes, both in the production technique as well as in the organization of work, leading to the improvement of economic efficiency (Mazur, 2006, p. 87).

In practice, the technical progress is defined as technological development, technological achievement or technological change which are based on innovations, inventions and new, more economical solutions. In the simplest terms it could be defined as new, and better ways of doing things, and new techniques for using scarce resources more productively (Muchdie, Prihawantoro, & Alkadris, 2016). In a slightly broader sense, it can be identified with the process of changes taking place in the enterprise which is based on the implementation of new, better or improved machines, devices and tools as well as new production methods which leads to a more economic use of resources (Janasz, 2006). It is emphasized that the implementation of the indicated solutions in the operational activities must be purposeful because when implementing progressive production methods, the focus should be to obtain more favourable results compared to the results obtained so far. The technical progress must therefore be subordinated to the principle of frugality (Bittnerowa, 1995).

The technical progress is directly reflected in an increase in labour productivity, an improvement in the productivity of production factors and a more favourable use of capital. Its scope includes the development of technology, its verification through research and development processes, and then making available and dissemination. The implemented solutions should be subject to continuous development, improvement and refinement. The technical progress can be characterized as a gradual, multiphase process, consisting of small increments along a clearly defined development path.

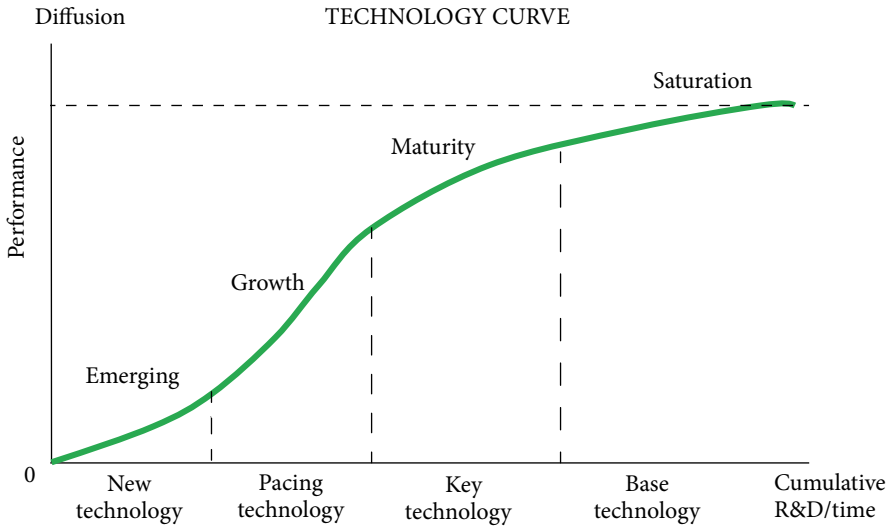

Figure 6.10. The curve concept of technology life cycle

Source: (Gao et al., 2013, p. 399).

In the classical approach, the four phases can be identified on the technological curve: emerging, growth, maturity, saturation. With the passage of time, the new technology becomes more and more popular, it spreads, it begins to be used more and more often, achieving universal acceptance. It should be emphasized, however, that the path of technical progress is not linear, there may be various disturbances, sudden turns and even stagnation which may lead to the interruption of the process related to technical progress (Gao et al., 2013).

The technical progress contributes significantly to better results for a company. It should be emphasized that this development is conditioned by a better, more efficient system that transforms resources and raw materials into products and services. It can therefore be emphasized that it directly influences the improvement of the company productivity, both in general and in part. In terms of partial productivity, there should be pointed out the improvement in the productivity of energy, production equipment and labour.

The technical progress also influences the optimization of the use of raw materials, materials and other substances used in the production processes. In practice, most of them are of a limited nature. In extreme cases, it is non-renewable which means that they are depleted and their renewal as a result of natural processes is impossible or takes a very long time. It can therefore be emphasized that the mere increase in the amount of raw materials or resources, e.g. as a result of greater extraction, is not a source of economic growth and development. It is required to implement an appropriate process, know-how or ideas that will generate more

products and services from a given resource, compared to the previous period when modern solutions were not used. It is also emphasized that the mere increase in production potential is not directly reflected in economic growth. The acquired machinery and equipment must be properly and skilfully used. Therefore, it is necessary to correctly synchronize the production potential with the skills, experience and competences of the employees. In addition, the degree of commissioning of the machine park should also be examined, including its readiness, efficiency and commitment. The technical progress is therefore associated with the company striving to improve productivity, i.e. a favourable ratio of effects to inputs. The economic growth is therefore a product of technical progress and not of an increase in the amount of resources.

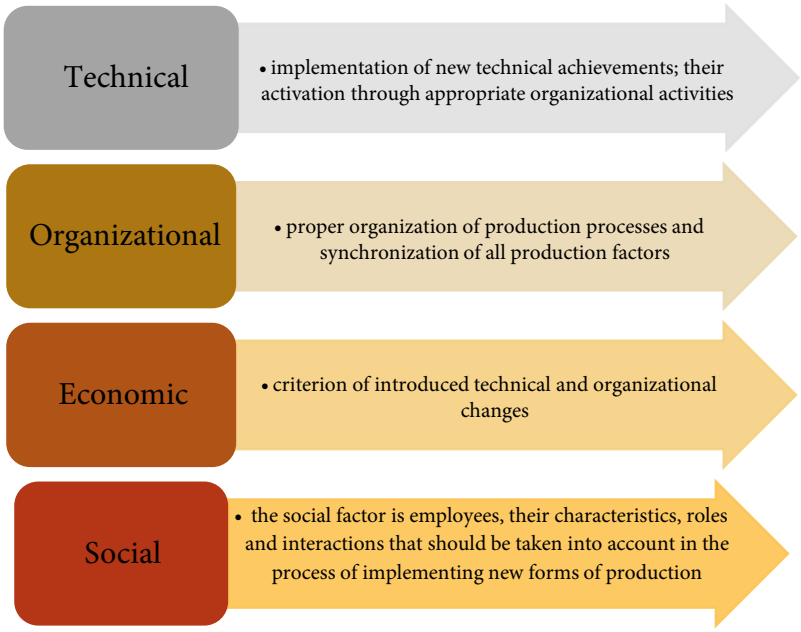

Figure 6.11. Factors of technical progress

Source: Own study based on (Bittnerowa, 1995, p. 102).

Therefore, in order to develop, an enterprise must introduce new, more efficient machines and devices, it must seek new production methods and skilfully coordinate human work with objectified work. Such an approach should lead to the improvement of working conditions, its savings as well as a change in the assortment and quantity structure in line with the market requirements, the use of new raw materials, improvement of the quality of manufactured products and services, increased efficiency and lower unit costs.

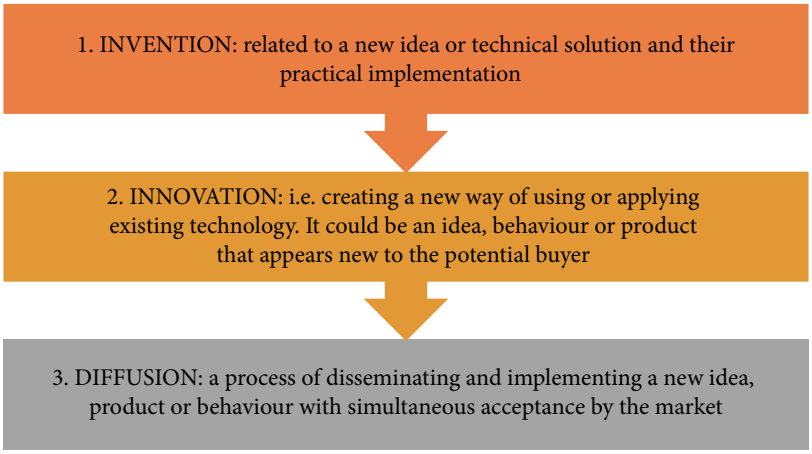

Figure 6.12. Phases of technical progress

Source: Own study based on (CFI, 2020).

From the operational point of view, the technical progress affects both the workforce, the development of production processes and savings in terms of means of production used. From the point of view of human resources, it improves working conditions and reduces the time needed to perform individual operations. In the production process, it contributes to the shortening of production cycles as well as improvements in the flow of materials, raw materials and semi-finished products through the production process. It can therefore be noted that technical progress is reflected in an increase in labour productivity, better, more modern products or services, improved quality and savings in the use of resources and energy.

The labour productivity is defined as the ratio of the effect to the expenditure, and it should express the effect of work per one employee, or per unit of working time. On the other hand, the effect of work is usually equated with the output which is expressed in natural or contractual units as well as in units of value (monetary) such as, e.g., value added, output, sold production and sales revenues.

$$\text{work efficiency} = \frac{\text{production value}}{\text{workload (in value)}}$$

Improving the quality of manufactured products and services is one of the main operational goals of the company. It should be considered through the prism of all functional areas of the enterprise, from design, procurement and production organization, through marketing and distribution, to after-sales service. It can be achieved by using modern machinery in production processes which is understood as machines and devices that constitute the company equipment. The main feature that characterizes the machine park is efficiency. It is emphasized that an

efficient machine park is necessary for the implementation of most production and logistics projects. Its skilful use should contribute to an increase in the value in use of products and this contributes to better meeting the needs of buyers. The quality of products and services can be determined by several criteria, such as: efficiency, functionality, durability, reliability as well as favourable conditions of use. In practice, it is emphasized that the quality of products or services is important not only for users but also for suppliers. For the manufacturer, the quality deficiencies mean additional costs related to control, testing, scrapping, correction, handling of complaints and grievances as well as fulfilling warranty contracts.

The striving to improve quality is related to the aspect of progress in terms of novelty. It means the production of products or the provision of services that have not hitherto been produced. They are often based on an original solution or the use of unconventional solutions, compared to similar products. In practice, however, special attention should be paid to imitations, replications and copies of company products.

The technical progress in operating activities is also reflected in the increasing use of new raw materials and materials, including secondary raw materials. Such an approach contributes to the reduction of the consumption of primary raw materials which are the products of the extractive industry, especially non-renewable ones. Moreover, the new technologies contribute, on the one hand, to minimizing the consumption of various types of resources in production processes, and on the other hand, to maximizing the amount of production with a given consumption of these resources. Therefore, it can be emphasized that technical progress in the company's operational activity contributes to the implementation of the principle of frugality.

The use of modern technologies leads to an increase in production and productivity which in turn is reflected in the generation of financial surplus by entrepreneurs. These surpluses can be successfully invested in the development of an enterprise, region or even a country, so technical progress contributes to the economic development of the country.

The technical progress related to the operational activity of the enterprise brings many benefits. The basic one is related to the use of the economies of scale, i.e. a decrease in average long-term costs along with an increase in the size of production. This growth contributes to expansion, both on domestic and foreign markets. On the other hand, the use of economies of scale in production processes may contribute to an increase in uncertainty and risk, related, for example, to the lack of raw materials, skilled workers or problems with sales. In this case, the effect is an increase in transaction costs, i.e. costs of coordination of the activities of enterprises resulting from the cooperation of many economic entities (Coase, 1937; Williamson, 1998; Gruszecki, 2002).

Summing up, it should be emphasized that with the development and economic growth, the importance of technical progress increases which is basically

conditioned by the innovations of the production process and product innovations. The innovations in the production process are related to the implementation of new production methods with lower production costs, the product innovations refer to a new, better-quality product, causing an increase in demand, increasing the production scale, expanding the market, increasing sales which in turn leads to a reduction in production costs. Thus, the innovations are significantly reflected in the production and operating activities of the enterprises.

6.5. The impact of innovation on production and operation activities

In order to build and develop a sustainable competitive advantage, companies must maintain a high level of efficiency, implement quality control processes and respond quickly to customer needs and requirements. The innovation is a factor that, on the one hand helps and on the other hand enables the implementation of the above-mentioned postulates. They should be treated as a driving force for the development of modern enterprises which at the same time strengthens and enhances the links between the organization and its environment. It is the basis of new ideas, concepts, products, services and processes. It allows to recognize, develop, specify and eventually implement a new solution. The innovative activities can be scientific, specialist, professional, technological, organizational, financial, commercial, etc.

The innovation and innovativeness are a concept defined on various levels, they relate to virtually all aspects related to the human activity. In its simplest terms, innovation means something different or something new. It is commonly associated with a change for the better, the improvement, refinement or modernization. From the point of view of the enterprise, innovation should improve the efficiency of activity.

> Innovation consists of the generation of a new idea and its implementation into a new product, process or service, leading to the dynamic growth of the national economy and the increase of employment as well as to a creation of pure profit for the innovative business enterprise. Innovation is never a one-time phenomenon, but a long and cumulative process of a great number of organizational decision-making processes, ranging from the phase of generation of a new idea to its implementation phase. New idea refers to the perception of a new customer need or a new way to produce. It is generated in the cumulative process of information-gathering, coupled with an ever-challenging entrepreneurial vision. Through the implementation process the new idea is developed and commercialized into a new marketable product or a new process with attendant cost reduction and increased productivity (Urabe, 1988, as cited in Kogabayev & Maziliauskas, 2017, p. 62).

The research base for innovative activity were developed by Schumpeter (Szabłowski, 2006, p. 18) who considered to be innovation the following:

- the introduction of a new product, new facility or creating a new need,
- the introduction of a new production method (production processes),
- finding new sales markets,
- finding new supplier markets,
- the introduction of a new organization.

The presented definition indicates a very wide spectrum of possible areas of innovation, covering many areas of the company's operation. The innovation permeates all phases of a business and all its functions, it may appear in the design, the product, the marketing technique as well as in the price, customer service, organization and management methods (Drucker, 2005, p. 75).

The innovation is therefore any idea, behaviour or thing that is new because it is qualitatively different from the existing solutions, it is a kind of progressive changes consisting in replacing existing states with new ones, better in the light of the criteria adopted by the organization. Innovation, therefore, is any activity that increases the level of effectiveness, increases the potential and strength of influencing the market, and contributes to the quality of service provision. The term defined in this way refers to (Janasz, 1999, p. 71):

- the concept (idea, concept, project) of some new state of affairs,
- the process of implementing this concept,
- the new state of affairs resulting from this process.

Product innovations	Process innovations	Organizational innovations	Marketing innovations
• implementation of a new or significantly improved product quality, unknown competition	• implementation of a new or significantly improved process leading to higher profitability, productivity, with lower unit costs	• changes within the organization and the organization's ability to change its relations with the environment	• implementation of a new marketing method involving significant changes in the design or construction of the product or in the packaging, distribution, promotion, or pricing strategy

Figure 6.13. The types of innovations

Source: Own study.

Innovations are treated in a similar way by the Oslo Manual which states that it is the "a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" (Oslo Manual, 2018, s. 20). Its significant element is the fact that the innovation must be new or a significant improvement to the existing solutions. It includes those products, processes, marketing and organizational methods that are developed in the enterprise as well as those that are adopted from other companies and organizations.

Innovations understood in this way are divided according to their object into „innovations that change the firm's products (product innovations), and innovations that change the firm's business processes (business process innovations)" (Oslo Manual, 2018, s. 70).

Product innovations are divided into two main types (Oslo Manual, 2018, p. 71):

- Goods include tangible objects and some knowledge-capturing products (see below) over which ownership rights can be established and whose ownership can be transferred through market transactions.
- Services are intangible activities that are produced and consumed simultaneously and that change the conditions (e.g. physical, psychological) of users.

Business process innovations concern the different functions of a firm (Oslo Manual, 2018, p. 73):

- production of goods or service,
- distribution and logistics,
- marketing and sales,
- information and communication system,
- administration and management,
- product and business process development.

The literature emphasizes that being innovative means success on the market and the goal of the implemented processes is efficiency and profitability which guarantee customer satisfaction and increased productivity (Cumming,1998, p. 21).

Innovation is a continuous process, it is a complex and multidimensional course of action which consists of many attributes. A broad view of innovation means it can apply to everything from a simple change to a complete rebuild (Chahal, 2017).

When analysing the operational activity of enterprises, the several phases related to their development can be identified. In the first place, the companies are focused on maximum efficiency, thanks to which there is a rapid increase in production and sales. Another one is related to the adoption of quality as a priority which contributes to strengthening and consolidating brand awareness among customers. The company focus on quality results in flexibility, that is, "the ability of the production system to produce various products without incurring significant capital expenditure on machines" (Budzisz, Urban, & Wasiluk, 2008, p. 37).

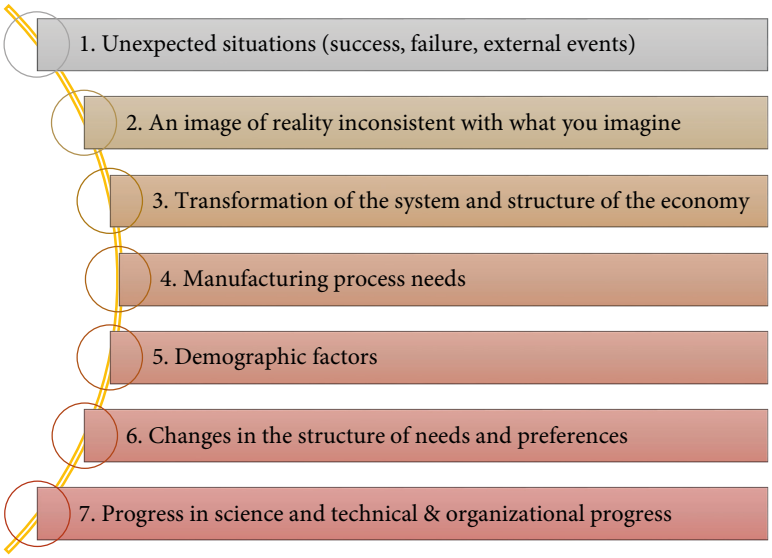

Figure 6.14. Seven factors of innovation

Source: Own study based on (Mazur, 2006).

The highest level is the so-called an innovative company that should be focused on a high level of efficiency, quality control and quick response to customer needs. Cheng, Choi and Yeung (2012) indicate that an innovative attitude, not only in product development but also in production development, is necessary to obtain and maintain competitiveness in the modern business climate. In operational activity, the innovative process is a creative activity in which the main emphasis is placed on the implementation of a new solution. It covers phases starting from noticing an opportunity, through its development processes and ending with the implementation of an idea and its realization (McGowan, 1994). The actions taken may take the form of conservative, complementary, radical and breakthrough changes. However, it is emphasized that an innovation, even if it occurs gradually, must in effect be something new or significantly improved. There is no innovation without novelty. Change is not automatically an innovation, but it can lead to innovation.

The implementation of modern solutions in production processes must be associated with appropriate innovation management which is defined as "(…) the systematic promotion of innovations in organizations and includes tasks of planning, organization, management and control" (LEAD, 2020). This management requires the activation of procedures related to the learning process at all levels of management, with particular emphasis on operational activities.

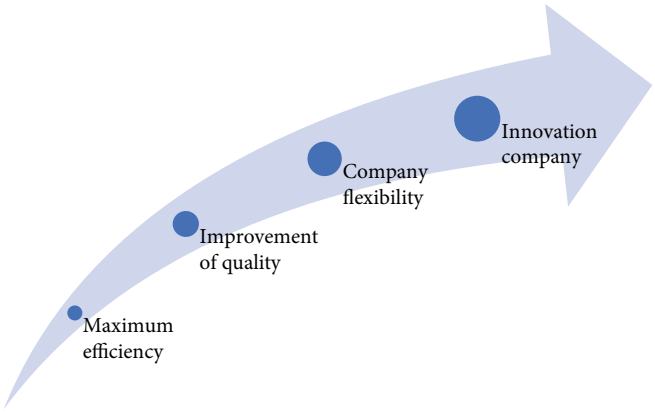

Figure 6.15. Transition of the archetypal manufacturing company

Source: Own study based on (Larsson, 2017).

Production workers should be supported by a system of training and workshops as well as the exchange of experiences related to both successes and failures and strengthening the cooperation network using appropriate tools and techniques (Skowronek-Mielczarek & Bojewska, 2017). All actions taken should be consistent, measurable, systemic, and focused on the development of innovation.

According to LEAD platform (2020) the innovation management deals with all measures to promote innovations in organizations and to generate benefits, e.g.:

- new products and services to conquer new markets,
- improved products and services to stand out from the competition,
- the improvement of internal processes in order to strengthen the company from within or to save costs,
- the development of new business models to exploit new sources of income.

When analysing the issues of innovation in the operational activities of enterprises, it should be noted that the development of production has a multifaceted nature because it is related both to the improvement of the production systems available to the company, and covers part of the process related to the product development. The production system should be defined much broader than the production process. Its scope covers several subsystems, each of which can be developed in order to obtain innovative solutions (Larsson, 2017). The indicated processes related to the development of the product and production technology should be subject to integration, since the development of the former is conditioned by the availability of technology and the related limitations.

The technology available in the enterprise, as a result of replacement and modernization investments, is subject to constant changes. In some cases, this change

becomes radical, as a result of which the company's activity profile is completely reconfigured. According to Larsson, "radical innovations may be difficult to achieve because they may entail too much discontinuity and change, as production systems are tied to current products and usually based on heavy investment" (Larsson, 2017, p. 2).

In many enterprises, the implementation of innovative solutions is the result of restructuring processes which is understood as "a complex conceptual aggregate describing all kinds of structural changes in the enterprise. It may refer to the property structure, capital structure, organizational structure, management, employment, production and assortment, supply and sales, technical and technological, etc. In this sense, restructuring appears to be an equivalent of the term 'reorganization', widely used in relation to strictly organizational changes" (Borowiecki, 2014, p. 17). Restructuring is therefore a consequence of innovative changes and practically applies to all areas related to operational and production activities.

The impetus for restructuring may come from both internal and external factors. Internal ones are related to the ineffective functioning of the enterprise, external ones are related to changes taking place in the environment, including increasing competition, technical progress, the emergence of new technologies, or new solutions in the field of finance, procurement, law, etc. The particularly important ones are connected with the changes taking place due to the fourth industrial revolution which is also a source of innovation. The concept of Industry 4.0 includes a set of assumptions that, on the one hand, constitute a kind of challenge, but on the other hand, will allow companies to achieve great results in the future. They include as follows: cybersystems, Internet of Things, Internet of Services, robotics, Big Data, cloud computing, and augmented reality (Ibarra, Ganzarain, & Igartua, 2017). Investments in these components will contribute to the development of smarter production processes based on machines and production modules that are able to communicate with each other, creating an intelligent production environment (Pereira & Romero, 2017; Sommer, 2015). They provide a framework for the total automation and digitization of production and services, with increased application of electronics and IT (Roblek, Meško, & Krapež, 2016; Vaidya, Ambad, & Bhosle, 2018). According to Stock and Seliger (2016), challenges related to Industry 4.0 concern also other areas, such as equipment, workforce, organization, processes, and products. The emerging changes result in building completely new relationships with clients, a possibility to produce new products and services, and create a new environment for collaborations, all of which contributes to the implementation of a new business model (Ibarra et al., 2017). This model requires adjustments in terms of standardization, work organization, availability of skilled employees and their competences, research investments, professional development, and legal framework (Thoben, Wuest, & Wuest, 2017; Maslarić, Mirčetić, & Mirčetić, 2016).

The purpose of undertaking innovative activities in operating activity is to achieve a competitive advantage, to develop their key competences and, consequently, to increase the effectiveness of the conducted activity. On the other hand, the effect may be the implementation of specific production methods, both focused on production planning and control, next generation production management, processing manufacturing methods, advanced organizational manufacturing methods and others. It should be remembered that the purpose of all changes that are of a different nature, size and scope, is always the increase in value for the customer, mainly by reducing costs and improving quality.

6.6. Qualifications, competences and human capital in the production-operation processes

One of the most important factors, influencing the production and operational activity of enterprises, is the workforce. In the simplest terms, it is defined as "all the people who work for a particular company, organization etc." (Wehmeire, 2000, p. 1493). In a broader sense, it is a resource of human units capable of working, of productive age, ready to undertake work, in typical conditions in a given economy (Milewski & Kwiatkowski, 2011) or, in other words, "the workforce is the total number of people in a country or region who are physically able to do a job and are available for work" (*Cobuild advanced learner's dictionary*, 2014). From the point of view of the company's operational activity, the workforce is often defined as: human capital, human resources, labour resources, employees, staff, human factor, personnel and intellectual capital. The last concept is particularly important as its scope, apart from the number of employees, also includes qualifications, skills, motivations and entrepreneurship. In practice, it is emphasized that the success of an organization depends on employees, their competences, education, experience, substantive knowledge, practical skills, conceptual and organizational skills, etc. In many cases, the rank of the employed people is higher than the rank of fixed assets, and it is the person who decides about their use, withdrawal and replacement. In case of operating activity, they should be treated as production assets, not a cost factor (Hendricks, 2002).

It can therefore be emphasized that human capital is part of the intellectual capital of a given organization. The two terms are often used interchangeably. This is due to the fact that human capital is treated as the most important element of intellectual capital. It can be viewed in a narrow or a wide perspective. In general, it is associated with a human being characterized by the prism of knowledge, skills and experience which he gains both during education and work (Popiel, 2015).

Human capital in wide aspect is defined as: all psychophysical features of the individual, such as possessed innate abilities, knowledge, level of education, skills and

work experience, health, cultural level, socio-economic activity, worldview, etc., which directly or indirectly affect the productivity of work and which are inextricably linked with man as the carrier of these values (Florczak, 2007, p. 113).

In broad terms, a number of additional features are additionally indicated, such as: health, lifestyle, way of spending time, culture, approach to tasks and duties, responsibility, worldview, physical and psychophysical fitness as well as the way of building relationships, both on a private basis and professional one. All the indicated elements should be considered through the prism of the value that may be the source of future income of the employee and the organization for which he or she works (Adamska, 2004).

It is pointed out that from the point of view of operational activity, particularly important are technical skills which are related to specialized tasks performed at a specific workplace. The usefulness of an employee is therefore evidenced by his specific knowledge which should be consistent with specific requirements. It may be associated with education and experience acquired, e.g., in the field of finance, law, management, accounting, budgeting, design. In practice, it is associated with excellent knowledge of the industry in which the employee is employed. From the production point of view, when analysing the employee's competences, the employee's ability to operate machinery and equipment is taken into account which can be accessed through the prism of the intensity of using the machine park. Proper organization of workstations and skilful connection of the employee's competences with the technical requirements of the machine allows to increase production per unit of time, and thus increase efficiency, which is reflected in the increase in production, timely execution of production tasks, quality improvement and, consequently, in achieving better financial results.

When analysing human use in production and operational processes, the concept of qualification should be distinguished from competence. In practice, these two terms are often used interchangeably. Qualifications are generally related to the education and work experience. They must be real, not illusory, measured with a specific resource of knowledge and skills at the disposal of an individual (Ludera-Ruszel, 2012). A skilled worker is an employee with a specific potential, shaped in accordance with the requirements and standards of a specific job. In practice, qualifications are called professional because they are conditioned by the acquisition of certain skills related to the performance of work (Orczyk, 2009).

Qualifications	Competences
• education and aptitude required to perform a function or profession	• the quality of being competent; adequacy; possession of required skill, knowledge, qualification, or capacity (Dictionary.com)

Competences are typically defined as "the scope of knowledge and skills, professionalism, expertise" (Kopaliński, 2006, p. 406). In practice, they are associated with synonymous terms, such as professionalism, expertness, craftsmanship, proficiency, experience, mastery, faculty, reliability, talent, etc. According to Siwak (2015), company competences comprise management competences of the company owners, employees, and associates, which altogether form the human resources of a given entity. It may therefore be said that the concept of competences covers the following aspects (Kossowska & Sołtysińska, 2002):

- mastering the knowledge of a given field,
- skills defined as procedural knowledge,
- an attitude of willingness and readiness to use this knowledge.

In more personalized terms, these qualities are often extended to include personal characteristics, mentality, disposition, individuality, character (Whiddett & Hollyforde, 2003), competences of the company owner and employees, and organizational memory and knowledge (Sigismund, Floyd, Sherman, & Terjesen, 2011).

According to Coulson-Thomas (2009), the identified competences should be grouped as: personality traits, awareness of business environment, sense of responsibility, vision and strategic perspectives, knowledge of corporate governance and its requirements, understanding of the structure and principles of top management, teamwork, decision-making skills, corporate experience, ethics, and respect for other values.

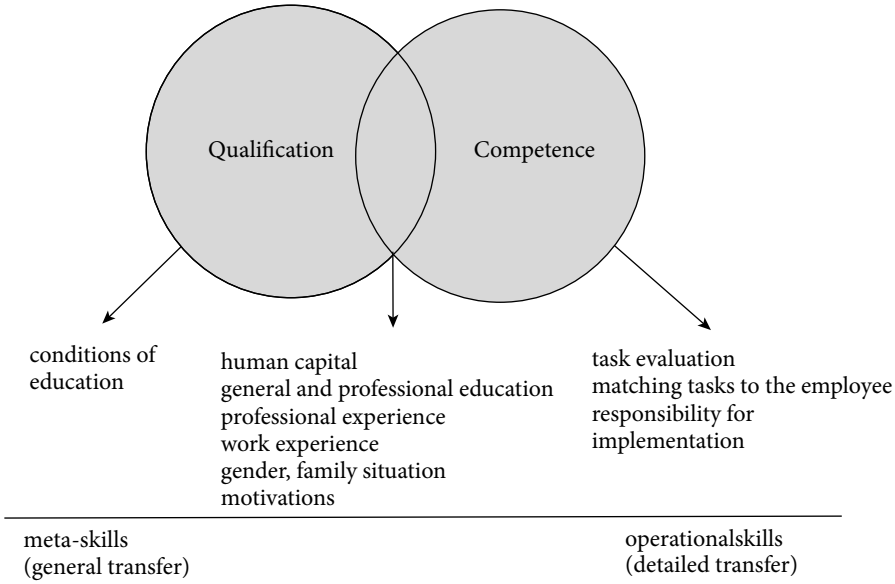

Figure 6.16. Relations between qualifications and competences

Source: (Orczyk, 2009, p. 27).

The effectiveness of human capital depends on its proper use which means that it must be managed. Human resource management means comprehensive activities related to the disposition and ordinance of employees employed in a given organization, undertaken to achieve its goals which are given a strategic dimension (Leleń, 2010). They should be consistent with the ambitions, plans and priorities of employees, both from the point of view of the individual and the community as a whole. Human capital management in operational activity includes five aspects (Muhlemann, Oakland, & Lockyer, 2001, p. 527):

- employment and manpower planning,
- education, training and development,
- shaping interpersonal relations, between employees as well as employees and managerial staff,
- health and safety and welfare,
- remuneration.

The first aspect is related to the recruitment and selection of new employees who must have appropriate qualifications and competences in accordance with the requirements of the position for which a given person is to be employed. Therefore, special attention should be paid to the accuracy of the job description, the needs of the company in terms of new workforce and its availability. In many countries we deal with the so-called structural unemployment which is related to the lack of employees with appropriate qualifications and skills in relation to the needs. This unemployment is most often the result of technical progress, the evolution of the production structure towards more labour-saving production and the liquidation of vocational profile schools. In the recruitment process, a company can use various methods, ranging from document analysis, simple interviews and interviews, to complex tests (*Selekcja i rekrutacja*, 2016). The employed employee should be introduced into the specificity of work, the requirements and obligations related to the position should also be presented to him. When analysing the education, knowledge and experience of a potential employee, it should be remembered that the quality and durability of a product or service depends on him and his approach to duties. In practice, it is emphasized that the key to the company's success is associated with a loyal team that will precisely and accurately implement production plans. This phase also examines the causes and motives of employees leaving which should be the basis for solving problems related to employees in the future.

A company acquiring human capital may use two approaches: on the one hand, to seek qualified employees with appropriate skills and experience, and on the other hand, looping for those who will improve their qualifications during their work. Regardless of the professional preparation and professionalism of the operation, it is necessary to periodically invest in it. Operational and production workers should be treated as one of the most important factors of production, because they determine the results of activity, manifested in the timely execution of tasks, quality

of products and services, cost reduction, optimal use of production potential, etc. In practice, it is emphasized that even the best team will not perform its work effectively, if it does not periodically improve its qualifications. It may concern the operation of the machine park, procedures and methods of performing production tasks as well as organizational aspects whose task is to increase the intensive use of the production potential. It is emphasized that people are a strategic resource of the company, have opportunities to learn, improve their potential, can think conceptually, are creative—these features make it possible to see opportunities and threats inside and outside the company and to use the former ones and limit the latter ones (Butkiewicz-Schodowska, 2015). Investing in human capital is a source of knowledge and innovation, improving productivity and efficiency, it allows individual knowledge to be transformed into the organizational knowledge, thus contributing to the development of the enterprise (Czyż, 2014). A characteristic feature of investments in human capital is their long-term effect, visible in the perspective of several or even several dozen years. The investments in question may take the following form:

- courses, trainings, workshops, etc., related to both apprenticeships to work and acquiring experience and practice in enterprises,
- teaching at all levels of education,
- searching for information about the economic situation of enterprises and career prospects,
- relocation of the population related to the search for a better job or employment opportunities,
- actions to improve living conditions, health protection and other social aspects,
- participation in research costs.

Enterprises that effectively invest in human capital increase their own effectiveness and efficiency which may contribute to rapid growth and development.

A significant problem related to human capital management in production and operational activities is building appropriate interpersonal relations, both among employees and between employees and management. It is emphasized that cooperation is a necessary condition for the functioning of any company. Actions and interactions are created between individual employees related to the performance of specific functions, from planning and procurement, through the organization of production processes, up to control, finance and sales. Proper relationships based on clear, precise and understandable conditions also have a direct impact on work efficiency. In general, interpersonal relationships involve the interaction and collaboration of people in groups that operate in different fields. In the industrial and business environment, the concept has a completely different connotation. In this context, it means the integration of people into a work situation which motivates them to work together effectively, providing them social, psychological and economic satisfaction (Velmurugan, 2016, p. 1).

An interpersonal relationship is an association between two or more people that may range from fleeting to enduring. The context can vary from family or kinship relations, friendship, and marriage, relations with associations, work, clubs, neighbourhoods, and places of work ship. They may be regulated by law, custom, or mutual agreement, and are the basis of social groups and society as a whole. Interpersonal relationship usually involve some level of interdependence (Velmurugan, 2016, p. 1).

In order to maintain a high level of relationship, based on mutual respect, trust and commitment, several rules (MSG) should be followed:

- individuals in an interpersonal relationship must share common goals and objectives; they should have more or less similar interests and think on the same lines; it is always better if individuals come from similar backgrounds,
- individuals in an interpersonal relationship must respect each other's views and opinions; a sense of trust is important,
- individuals must be attached to each other for a healthy interpersonal relationship,
- transparency plays a pivotal role in interpersonal relationship; it is important for an individual to be honest and transparent.

Moreover, when shaping interpersonal relations in an enterprise, it should strive to (Bojarczuk, 2002):

- ensure the actual adjustment of the employee to the organization by employing people with a similar value system,
- provide the employee with a sense of status and identification with the workplace,
- ensure the cooperation was based on mutual trust and commitment,
- make the employee to feel appreciated, pleased and satisfied with the work performed,
- create a sense of economic interdependence within the company.

Proper shaping of interpersonal relations has an impact on the effectiveness of the company and its long-term success. Therefore, it is necessary to ensure an appropriate ambience, acceptable to all employees, so that work becomes a pleasure, and not a necessity or a duty.

In order to ensure a high level of performance of production tasks, the company must also take care of occupational health and safety. Most of the provisions and rules of conduct are contained in the relevant legal regulations appropriate for each country. Some of them are obligatory what means that every company employing an employee must provide him / her with certain conditions, some are additional profits aimed at making the job offer more attractive. Complying with the legal requirements, the company must take into account such aspects as: proper and safe workplace, risk identification, protective clothing (especially for direct production workers), compliance with orders and prohibitions, health and

safety training and medical examinations, marking the workplace, keeping order, etc. (Rozporządzenie, 1997).

The last aspect related to human capital management is connected with remuneration. It is indicated that in this respect four problems should be solved (Muhlemann et al., 2001, p. 534):

- to setting up of a logical structure appropriate to the organization, the technology and the environment,
- the placing of employees within the structure,
- the use of incentive scheme,
- providing additional benefits.

The employee's remuneration includes a number of components, which include base wages, short-term incentives such as bonuses, commissions, etc., long-term incentives, fringe benefits and discretionary benefits (Borkowska, 2012).

Salary structure is the structure or details of the salary being offered in terms of the breakup of the various components that constitute the compensation. Salary Structure is the set of parameters that define the salary. Salary structure is a very important information which determines the in hand pay, gross salary, net salary, allowances etc. All these variables are paid to the employee as a part of his / her compensation and benefits (MBA Skool Team, 2020).

The structure of remuneration, especially in production and operational activities, should be flexible, determined by the actual work performed and not related to the position or status of the employee in the company. Such an approach directly influences the increase of efficiency and motivates the staff to better, more productive use of the production potential. Moreover, only an individualized approach to shaping the structure of remuneration, consisting in reducing the fixed part with a simultaneous increase in the variable part, contributes to the employee's new qualifications, skills and competences.

In operational activity, each task should be subject to evaluation which is understood as the differentiation of jobs and positions, due to the degree of difficulty, required competences, education, etc. In order to rank individual positions, an appropriate scale should be adopted which, for example, may be based on categories relating to ability, effort, responsibility and working conditions. The indicated categories can be broken down into more detailed criteria, but too precise division may make the analysis difficult (Muhlemann et al., 2001). It is important not to compare tasks related to completely different requirements and qualifications. A job valuation can also be used to evaluate it.

When shaping the remuneration, an additional system of incentives can be used, covering both standard aspects and additional benefits. The first group includes activities aimed at increasing labour productivity which should translate into an

increase in remuneration. The second one, in particular, may include additional medical care, insurance, various types of passes, social funding, preferential loans, training, participation in the costs related to raising education as well as a car, trips, holidays and business accommodation. The indicated benefits are individual, depending on the company's policy and its possibilities.

Questions / tasks

1. What are the challenges related to the operational activities of enterprises?
2. Discuss the changes taking place in the company's environment.
3. What are the causes of resource depletion?
4. What are renewable resources and what are non-renewable resources?
5. What is climate change and what are its causes?
6. List and discuss the main sources of greenhouse gases.
7. What is waste and what are its causes?
8. What types of waste do you know in an industrial enterprise?
9. Discuss the causes of environmental degradation.
10. What is industrial pollution?
11. What is globalization and what are its causes?
12. What are the benefits of globalization of operating activities?
13. Discuss the background of the globalization development.
14. What is technical progress and what are its causes?
15. What is the difference between technique and technology?
16. Discuss the phases of technological growth.
17. Discuss the factors and phases of technological progress.
18. What is work efficiency and what influences it?
19. How can you define innovation in an enterprise?
20. List and discuss types of innovation.
21. What is workforce and what is its importance in operational activity?
22. What is human capital?
23. What is the difference between qualifications and competences?
24. How can human capital be managed?
25. How can a company invest in human capital?
26. How to build positive relations between employees and between employees and managerial staff?

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