1 Marketing mix elements: (P)roduct: Delimitation and integrative approach with SCM

Introduction

This chapter presents how product-based decisions must be the result of creative synthesis and good cooperation between the marketing and supply chain executives of a business, as well as among work groups made up of staff from the main partners of a supply chain. In practice, the decisions made and their execution in relation to the product essentially have priority and decisively influence decisions in relation to the 3Ps of the marketing mix; without making a particularly detailed definition of the product, there is no need to make important decisions in terms of the pricing, distribution and promotion/communication of the product.

Learning goals

After reading this chapter, you will be able to answer the following questions:

- Why is cooperation important between the strategic partners of the supply chain in the efficient offer of product solutions to the final customers?
- What is the development process of the new product?
- What are the stages in the life cycle of a product, and the decisions that must be taken by the business in collaboration with the others involved in the supply chain?

Structure

1.1 Product design and operations planning within the supply chain context

The modern world is an extremely competitive environment. If there is a lack of feasible coordination in the optimal improvement of the entire supply chain to make it

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effective and efficient, the supply chain will not manage to create and maintain or increase its competitive edge in relation to the "product" packet that it will offer to its final customers.

As a result, even if one or some of the businesses that participate in a supply chain regulate their internal activities in an exemplary fashion, they still won't manage to satisfy the multiple and often conflicting demands of the stakeholders; these may include customers (end and intermediate), investors, workers, partners in the supply chain (suppliers and intermediates with the final customers), public and other institutions, as well as, of course, the wider public.

For example, a customer who visits a car sales outlet with the purpose of buying a new car is not at all interested in which businesses comprise the specific supply chain, or how they share and regulate their activities among themselves, or how they assign profits and expenses among each other. The customer will evaluate whether it is really worth paying the asking price for the whole product offer that she or he is presented with, against the corresponding offers of the competition.

If she or he proceeds to make the purchase of a new car from the car manufacturer, then the efforts of all the partner businesses in the supply chain will be rewarded, based on the supply chain's conditions within the cooperation agreement. Otherwise, even for the partner businesses that are characterized by an integrative approach in their effective and efficient internal operations, in this case at least, the expected outcomes will not be achieved.

It is argued that the scheduling of business operations starts with the design of the product and the supply chain, followed by the remaining planning levels. Thus, a rather myopic, one-sided view is being emphasized, and the contribution of the marketing executives (or whichever other part of the business) is being overpraised in the decisions made and their execution in relation to the product (Figure 1.1).

Businesses that wish to create and maintain or increase some strategic competitive advantage are duty-bound to take decisions in relation to product design; they must manage their product portfolios in the spirit of good cooperation, making a thorough

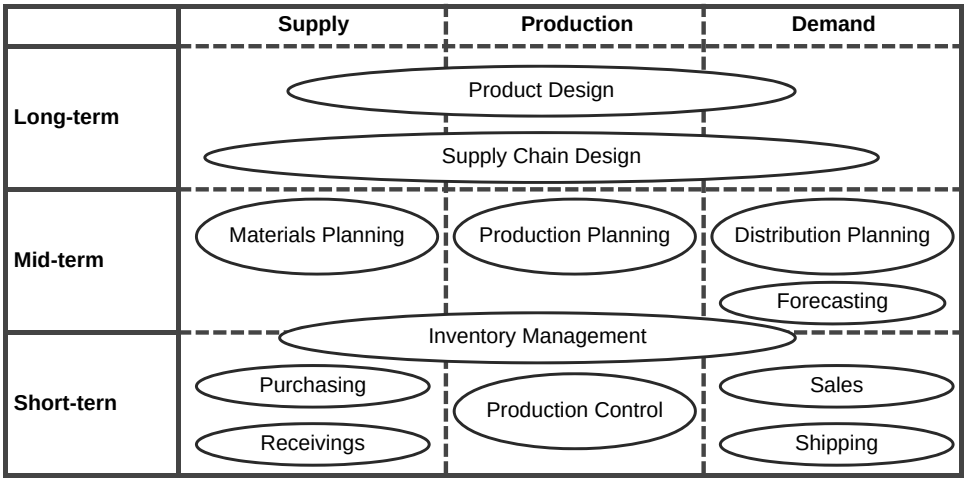


Figure 1.1 Product design and business operations planning (Adapted from Taylor, 2003).

investigation of the mutually beneficial tradeoffs with their other main partners in the supply chain.

This means that it is now virtually a one-way road for all businesses involved in a supply chain to aim toward the maximization of the provided added value of the activities of the whole supply chain instead of the autonomous self-serving pursuit of the business goals of each separate partner. The rapid development and groundbreaking technological revolutions of the last three decades – especially in the IT sectors, for example, electronic data organization, the internet, etc. – signal an historic turn from the Cartesian approach, where each business aimed to achieve its own goals, often at the expense of its other partners in the supply chain. Now, the survival of each business is highly connected with the success of the supply chain it participates in as a whole.

It is much easier now than in the past to collect, circulate and process vast amounts of data and information from all the business processes using unified technologically compatible methods in very little (often real) time and very little cost; simulation modeling is now possible, in the form of the simplest representation with mathematical and simulation models of particularly complicated systems.

Thus, possibly for the first time in human history, the opportunity has finally appeared to thoroughly investigate and assess the positive and negative consequences of complex tradeoffs in business operations, and, by extension, the supply chain. Initially, large industrial businesses managed to optimize and completely integrate their whole operation as opposed to each operational part (e.g. marketing, production, supply chain, etc.), maximizing the added value of the whole supply chain instead of each separate partner that comprises it.

For businesses to survive in an extremely competitive and rapidly developing business environment (at the micro- and macro-level), they have no other choice than to adopt and apply the strategic approach of a unified operation all the more efficiently within their supply chain, starting from the design of their product.

1.2 Definition and classification of products

A particularly thorough introduction of the product as part of the marketing mix of a business and, more generally, an organization (for or non-profit) takes place in the corresponding chapter of this book. A product can be whatever has the ability to eliminate, reduce and/or conceal the sad feeling that something is missing: more specifically, a need and/or desire. Within a wider approach, the product must be perceived as a set/packet of properties and advantages through which it is possible to offer usefulness either directly or even because of the perceived expectation of the satisfaction of needs and desires.

In the wider sense of the meaning of the word "product", we don't mean just tangible products, but also services and ideas, which are characterized by their intangible elements. But, in their majority, "material" goods are offered with a set of accompanying services. Take, for example, the purchase of a car: beyond the "material" good, the purchase of a car includes the various services that start before the potential transaction (its acquisition by the final user), for example, the provision of information, the possibility to choose its final configuration; this process continues through to the completion of the transaction with the provision of financial assistance, warranties, free road help, etc., and the provision of services for future maintenance and repairs.

Thus, the final decision of a potential buyer will depend not only on the set/packet of properties of the "material" good, but also – and possibly mainly – on the accompanying services, which are all estimated together. Therefore, for reasons of convenience, the term "product" is used in this chapter to describe a material good, a service, an idea, a place, an event, or whatever combination of the aforementioned, which tries to offer usefulness to its final user.

It should be noted that due also to the very acrid competition that exists worldwide in all markets/sectors, a customer-centric approach has absolutely definitely dominated in the determination of products' quality characteristics. In other words, the design of both the product and its production processes starts and ends with covering the needs and desires of the product's end users who it is believed could be satisfied more effectively and efficiently than with competitors' products.

Hence, businesses should search for the best possible matching (combination) among the needs and desires of their potential customers who are not adequately covered, and the particular abilities, skills and resources that the businesses themselves and their collaborating supply chains possess, in order to offer the best possible long-term added value to their potential clients.

Marketing as a business operation provides a range of tools for businesses and its supply chains so that they can correct mistakes and omissions in case of deviations in the definition of their products in relation to the way their potential customers will view/regard their products. Nevertheless, it should not be forgotten that a very aggressive environment makes its use virtually impossible due to the minimum profit limits – as they have now been shaped – in virtually all markets/sectors.

The classification of products is made using various criteria. The most commonly used are the nature of the product and the willingness to purchase it.

1.2.1 Classification based on the nature of the product

Products, based on their nature, are classified mainly as ***material*** and ***intangible*** goods (e.g. services, ideas, etc.). In this book, a rather thorough definition and analysis of services has been made. This analysis facilitates the understanding of four specific ***characteristics*** of ***services***, which distinguish them from material goods due to the fact that their main part cannot be perceived with one of the human senses. The four distinctive features of services are as follows:

1 *Intangibility*: This refers to the main characteristic of services, that is, the absence of physical properties that would allow us to perceive them on the basis of our sensory abilities.
2 *Indivisibility*: In contrast to material goods, services are produced and consumed at the same time. Indeed, for the production (provision) of services, cooperation is necessary between the providers and the customers (users) themselves.
3 *Inhomogeneity (Heterogeneity)*: The simultaneous production and consumption of services results in the essential weaknesses of the development and application of a control system that will guarantee the offer of services of a stable quality.
4 *Perishability/Wear and tear*: In contrast to material goods, services cannot be stored in order to be made available at a later time.

The greater integration of more and more accompanying services for material goods provides further proof for the need for good cooperation among the expert executives in the marketing and supply chain departments, both internally in the business and externally among the staff of the strategic partners. For example, the success of a newly introduced smartphone model depends, among other things, on the devoted support of the frontline staff in the collaborating retail stores. It also depends of course on the quick response of the distribution networks in terms of the waves of uncertain demand that will assure, on the one hand, the continuous availability of the product on the shelves of the retailers, and on the other hand, the lowest possible costs of maintaining supplies of the product.

1.2.2 Classification based on the willingness to purchase

The customers of a business acquire its goods with the intention that either they will satisfy their personal needs, and/or those of people close to them, or they will use them in the production process of other goods and services in their business or organization. Thus, based on the intention of purchase, products are classified as either:

- Consumer goods, which are bought to cover the buyer's needs, or other people's with whom the buyer is connected, that is, they are products and services that are bought by the end consumers for personal consumption; or
- Industrial goods, which are bought as inputs in the productive processes of other products.

Most products, however, can satisfy both consumer and industrial needs. For example, a packet of A4 paper or even a car can be regarded as consumer products, since they are acquired to cover the personal needs or desires of the buyer, or as industrial goods in the case where they are used in the production process of business entities. Furthermore, the tires of the wheels of a new car intended for private use are an industrial product, since they are acquired by a manufacturing company, while the tires thatwill be replaced later are consumer products.

Consumer goods

Consumer products are classified by the degree of involvement of the buyer, specifically the time spent and the effort made by the buyer to make their purchase decision, and the frequency of purchase of the specific goods, that is, the manner in which consumers buy them.

- **Convenience goods:** This covers products with a high frequency of purchase, even on a daily basis, of low cost, and often without a previously conducted price comparison among the choices available. Thus, the degree of involvement of the buyer is very low, that is, a minimum amount of time and effort are devoted to choosing them. Due to their nature, for these products, the strategy of wide distribution is appropriate, so that it can guarantee direct easy access to the consumer public. The most frequently used strategy of communication is that of attraction, where the producer of the product tries to create a branded demand for the product on the consumers' side.

  Convenience goods are further classified into:

- ***Basic*** products, which are bought very often without much thought, like bread and the weekly food shopping;
- ***Impulse buy*** goods, which the buyer did not plan on buying but decides to acquire due to the relevant stimulations he receives, like vitamin supplements to fight a cold, which she or he saw next to the cash register in a pharmacy; and
- ***Emergency*** products, which are bought because of an unexpected event that provoked the emergency, like an umbrella due to a sudden rainfall.

- **Choice goods:** These products are distinguished by the obvious higher involvement of the buyer in their acquisition. They include products that are bought less often, even once in a few years, whose purchase requires a significant degree of planning, and sometimes a significant financial outlay. Consumers co-estimate their opportunity costs, that is, the loss of the possibility to satisfy some of their other needs and desires. Thus, for the completion of their purchase process, a significant amount of time and effort is needed, so that a thorough comparison of the alternative choices is made in relation to the price, the relevant dimensions and the accompanying services. The distribution network strategy that is often chosen is that of selective distribution, while for planning and implementation of the communication strategy with consumers, cooperation between the producers and their strategic partners is vital at the retail level.

  Choice products are differentiated into:

  - ***Homogeneous***, for which customers believe that there aren't substantial differences among the alternative choices. Consequently, price is of utmost importance in the final choice, for example, in home appliances (washing machines, refrigerators, etc.) or even low to middle range cars; and
  - ***Heterogeneous***, which are characterized by the special features and properties of competitors' products. This has a result that price plays a much smaller role in the buying decision, as long as it falls within a logical range, like what happens with scientific services (e.g. doctors, lawyers, and the like), clothing items for special moments, etc.

- **Special products:** These products have a unique combination of characteristics. Because of this, a specific and relatively very small number of consumers understand that these products are not able to be compared, so they are predisposed to making a special effort to acquire them, even spending a lot of money on them. An example of such a product is a specific brand of women's handbag for which customers may need to wait for up to 2 years to acquire it, or hand-made luxury cars with a value of hundreds of thousands of euro.
- **No-demand goods:** These are products for which demand is not expressed either due to ignorance of their existence or because consumers do not perceive any interest in acquiring them. They are classified as:

  - ***New no-demand*** products, like new/innovative products until a satisfactory number of "neoterists" get to know them and are convinced of their value; and
  - ***Regular no-demand*** products, which are known among potential consumers, but require intensive promotional effort (personal sales, advertising, etc.) for

the demand to be expressed. An example is blood donation services and life insurance policies.

Industrial goods

The market for industrial goods displays significant variations compared to that of the consumer market, not just due to the purpose of acquiring products, but also because the purchasing behavior of businesses and organizations is characterized by the intense dominance of rationalism. It goes without saying that more standardized/formal and stricter procedures are followed for the achievement of specific predetermined goals. Also, the demand for industrial products is due to the demand for consumer products that will be manufactured by them; in other words, it is a *derivative or secondary demand*, in contrast to the *primary demand* of consumer markets. Therefore, to the degree that the marketing strategy of businesses is not influenced at least in the short term, the derivative demand is clearly more inelastic concerning the price in relation to the primary demand. Furthermore, the industrial markets are, in their majority, rather oligopsonistic in contrast to the vast majority of the customers in consumer markets. Consequently, industrial goods customers exercise direct and immediate reaction on the design and application of businesses' marketing strategy, starting from the design of new products and the improvement of existing ones, where decisions are often taken mutually among the strategic partners of the supply chain.

Industrial products are classified based on the following purchasing behavior procedure, as well as the reason for their use, as *capital goods, raw materials, processed materials*, and *supply/stock and services*.

- **Capital goods:** These include the *building installations* (production, administration offices, etc.), *fixed mechanical equipment* (e.g. production lines, information systems, etc.), as well as *auxiliary equipment* (such as portable micro-tools, computers, printers, and office furniture). Decisions related to building installations and fixed mechanical equipment are of vital strategic importance; they decisively influence the operation of the businesses in the long term, they are related directly to the production process, and the possibility to change them and adapt to new conditions is limited and comes with high costs. In contrast, auxiliary equipment depreciates in much less time and has an auxiliary role in the production process. In particular, the fixed installations (building and machinery) are very often designed and produced on the basis of the specialized needs of each customer.
- **Raw materials, processed materials and accessories:** *Raw materials* refer to either products of agricultural production/origin (animals, grains, fruit, and vegetables) or natural products (minerals, water, wood, crude oil, and fisheries). *Processed materials* are those goods that have already undergone some kind of processing but need further processing so as to be incorporated into the final product, for example, cement, fabrics, wire, etc. Accessories or component parts are products that are incorporated directly and immediately into the final product without extra processing, such as the mirrors, tires, and seats in a car. In the industrial products category, the preferences/requirements of each customer play a determining role in their critical elements, such as the technical characteristics, the

resupply process and maintenance of cycle and security stock, etc. Also, access to raw materials, processed materials and accessories, among others, decisively contributes to the design decisions of the supply chain network of a business.

- **Supplies/stocks and services**: *Supplies/stocks* are materials that contribute to the production process of products for business customers but are not incorporated into them. They refer to items that are used in the maintenance and repair of capital goods (e.g. paint, spare parts, grease products, etc.), as well as for operational purposes, for example, fuel, printing paper, etc. *Services* refer to the seconding to third parties (*outsourcing*) of the execution of operations that do not belong to the narrow core of the competitive advantage of businesses, such as cleaning services, security, transportation, etc. O*utsourcing* is of special interest, since its meaning constantly takes on greater significance in the operation of modern businesses that gain operational benefits, since specialized outsourcing businesses provide a high level of innovative services; they are also significant in financial terms, since businesses are relieved of the financial burden to cover fixed investments that do not contribute to the acquisition and maintenance of the competitive advantage.

The saving of resources and capital by cooperating with specialized companies that provide special services allows a business to invest in other basic goals and sectors, and to develop other activities. Additionally, it succeeds in the improvement of the quality and performance of its services, because these companies provide the appropriate resources as well as a wide accumulated experience and the appropriate technological infrastructure. Consequently, outsourcing provides immediate access to the latest technology without requiring the usual development period within the business. Upgrading the level of quality of the services provided consequently gains further satisfaction from the customers/final consumers. However, the long-term cooperation between businesses and service providers possibly may give rise to dependence of the former on the latter, due to the gradual loss of know-how on the part of their human resources. If a business chooses to outsource a large number of its vital processes, then its ability to innovate becomes limited. Also, there is the possibility that an external partner is unable to adapt to the particularities of the company, with the result that the level of services provided does not reflect the expectations of the business. A potential "bad" provision of services will surely negatively influence the entire image of the business in the market.

1.3 Decisions concerning the product mix, brand, packaging, and labeling of a product

1.3.1 Product mix

The product mix of a company refers to the set of *single products* that it offers to its customers and the way that these are classified based on their degree of involvement with each other, with reference to brand, price or special characteristics. A *line* or *series* consists of a group of products that are very closely associated with each other. For example, a food company has product lines such as fresh milk, dairy products, fruit juices, etc. The *width* of the mix refers to the number of different lines (series) that the business's portfolio contains. The *length* refers to the number of items in the product

mix. The *depth* refers to the entire number of alternatives that each product is offered in, for example, the number of versions of fresh natural juice based on their ingredients (orange, apple, orange-pomegranate-grape mix, etc.) and the size of the packaging (e.g. single serve packaging of 300 ml and family-size packaging of 1 and 1.5 litres). The *consistency* shows the degree with which the products lines/series of a business are associated with one another, taking into account different criteria such as their use, production process, distribution channels, etc. For example, a local dairy company will have a greater degree of consistency in its product mix in relation to an international business that is active in virtually the whole range of electronics products.

The strategic partners of businesses in the supply chain are estimated to influence more and more often the decisions related to the configuration of the product mix. For example, if a food company wishes to provide 2–3 extra flavors of ground filter coffee to its customers, but the retail sales chains which it cooperates with are not disposed to increasing the number of such related items on their shelves, then the chances of success in this venture are very limited.

1.3.2 Branding

Branding refers to the name, symbol, design or a combination of the aforementioned, which is used for ease of recognition and differentiation of products in relation to the competitors' products. Brands comprise very important property elements of the business, since they are associated with the perceptions and attitudes of its customers in relation to the expected benefits of the products, that is, the placement of the products on the perceptual map of the customers. The more customers trust a brand and are fixated on it, the greater its value. Thus, the development and management of brands is an issue of utmost importance for businesses.

In the relevant literature, various reasons that contribute to the difficult task of effective brand management are given: the constant availability of products whenever, wherever and however the customers want them; the possibility of production and supply of stable and high distinct product quality; the stable provision of high quality in relation to the price, appropriate or even advantageous placement of products in store spaces; the achievement of economies of scale, etc. A common determining element among all factors that contribute to the longevity of brands is the good cooperation of businesses with their strategic partners in the supply chain. For example, for a product to be constantly available, on the shelf in retail stores with a regulated low transportation cost and stock maintenance presupposes – ideally – a very good coordination and the continuous uninterrupted cooperation of the various actors involved in the supply chain.

1.3.3 Packaging and labeling of products

Packaging refers to any material that is used as a box or wrapping for a product with the purpose of the product's protection, transportation, availability and presentation, from its production to its final/end use. The role of packaging is multi-dimensional and is becoming more and more important, especially since 70% of purchasing decisions are estimated to be taken at the point of sale. The main functions that packaging entails are as follows:

- ***It protects the product***. Packaging plays a very important role in the protection of the product from different forms of deterioration (physical, chemical and microbial), including wear and tear. Hence, it contributes in a big way so that the product reaches the final user in the desired state that is determined by its producer and at the same time increases the period of its life.
- ***It contributes to the effective and efficient transportation, storage and distribution of the product***. The packaged product can be transported and distributed much more easily, quickly and efficiently in comparison to bulk products. It also facilitates to a great degree cycle stock and security management, thanks to modern technologies, in real time. A result of all the above is that it makes it more difficult to steal the product because of the possibility of tracing/tracking it.
- ***It communicates with the customer and promotes the product.*** The vast majority of consumer markets are of low involvement; therefore, especially in supermarkets and also some other retail outlets, the consumer has visual contact with more than 100 different products per minute of visiting time at such places. Packaging and labeling can play a determining role in visual differentiation in relation to competitors' products, and can facilitate the prospective buyer to recognize a particular product among the immense range of products that are found stacked on the shelf, one next to another. It can also potentially highlight and strengthen the basic messages that the producer wants to convey to customers in order to place the product in their personal perceptual map. At the same time, it provides a lot of important information about the product, often more than the minimum required by the relevant legislation, based on which the business wishes to highlight advantages about the product, in order to facilitate its choice over other products.
- ***It facilitates the use of the product by the finallend customer***. Depending on the frequency and the amount of use made of the product by the consumer, the same product can be contained in different volumes, for example, fresh milk packaged in different quantities: 250 ml, 500 ml, 1 litre, etc. The same product, for example, coca-cola, can also be packaged in metal or plastic cans of different volumes, or even with a different seal depending on its potential use by adults or children, facilitating among other factors the opening and resealing of the packages.
- ***It increases the value of the product***. The packaging of the product plays a very important role in its entire environmental footprint, in relation to the supply chain as well as after its consumption. Hence, the design of the packaging gains more and more importance due to the intense legal, social and consumer-imposed constraints and pressures, as a way to keep pollution under control, and to achieve more sustainable management of the limited natural resources. For example, packaging materials that are recyclable and/or biodegradable are used, which are labeled as such on the product packaging. To achieve this goal, the product packaging must potentially provide further product functions post-consumption of the original product.

1.4 The new product development process

1.4.1 Stages of the new product development process

Companies should, at regular intervals, renew and enhance their product portfolio in order to ensure their survival in the market, since virtually all products come to the

end of their life cycle eventually, most often by decline in demand and their potential withdrawal. Also, the (mainly) technological developments, among many others, constantly present new opportunities and challenges for the highest degree of satisfaction of the needs and desires of various market sectors/goals. The addition of a new product in an existing portfolio may be achieved externally with the acquisition of another business which already produces it, or by buying a patent for a new product, or a license or a franchise from another business. It may also take place internally, by the company itself and its partners, via the improvement/modification of its existing products, or the development of a radically new product.

There is no mutually accepted manner of defining a new product. However, from the perspective of a business, a new product is defined as that which – for whatever reason – is new to the company itself. In this frame, a new product can be perceived in the following forms/dimensions:

- *Innovative product*: This is a radical/revolutionary product in the market that has never been exposed before in the past, and which creates an entirely new market. It is estimated that approximately just 10% of new products belong to this category not only due to high costs, but also due to the very great business risk involved.
- *New line product*: This is the kind of product with which a business enters a new market for the first time and accounts for about 20% of new products that are circulated in the market.
- *Addition of a product to an existing line*: The new product is essentially a different version of an existing product, such as a new flavor of filter coffee, a smaller package size, etc. It is estimated that about 25% of new products increase the *depth* of businesses' *existing* product series.
- *Improvement of an existing product*: The new product incorporates some relatively small (not groundbreaking or continual) improvement in an existing one. This essentially suggests some kind of reaction in the changes of the technological and competitive environment. This category, as well as the next two categories, comprise 45% of new products in total.
- *Relocation of a product*: This refers to an existing product that is "relocated" in the perceptual map of the customers. It aims toward making the product become more accepted and used in the newer sections of a market.
- *Low cost product*: This refers to a product whose value:price ratio changes for an existing product, while the value offered remains unchanged (functional benefits), but the production cost is reduced, and by extension, the added value is increased.

The development costs of a new innovative product are generally very high. For example, large international businesses may spend hundreds of thousands of dollars (or euro), with the economic outcome remaining rather vague because a lot of time has been spent in its development. Moreover, there is a lack of relevant data that would make it easier to make trustworthy reliable predictions. As a result, a small part (perhaps less than 10%) of new products consists of groundbreaking innovative products.

It is estimated that 70%–90% of imported new products fail and are withdrawn from the market within their first year of circulation. Only a very small percentage of new ideas end up becoming a new product that are actually introduced into the market; thus, the development process involved in an innovative product is very time consuming, with high costs and a very high level of business risk. However, if new products are not

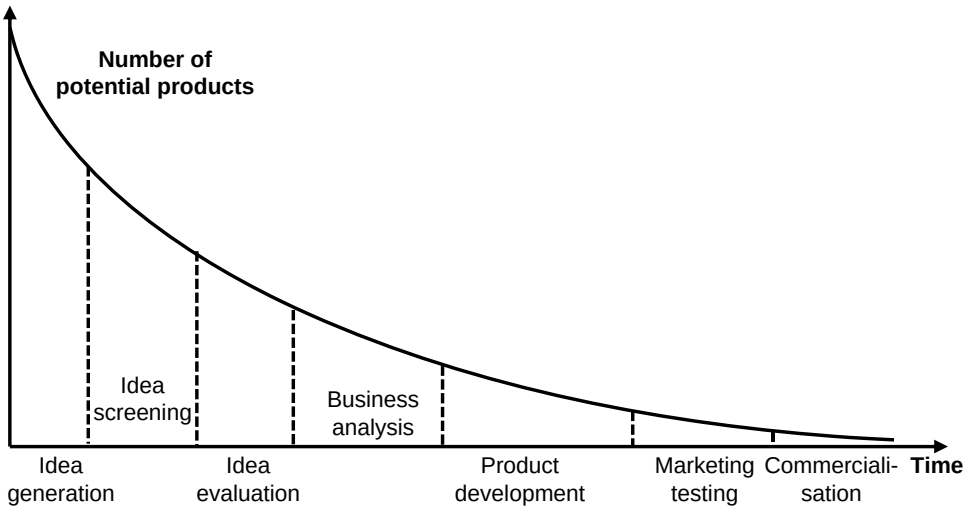


Figure 1.2 Development of a new product.

developed, businesses will soon stop keeping up with the competition and will themselves end up out of the market. As a result, there is no other choice apart from a methodical customer-centric approach in the development of new products, with the end result being the acquisition and maintenance of a competitive advantage through more efficient and effective satisfaction of the customers' needs as well as those of the other stakeholders of a business. The development process of a new product involves many stages. It begins with the collection of ideas, and is followed, in order, by the selection of the ideas, the evaluation of the ideas, the development of the product and its market testing. It is then concluded with the commercial development (Figure 1.2).

Idea generation

The development of new products starts with the systematic collection of ideas. Many thousands of ideas are usually needed in order for some of them to end up as a new successful product in the market. For example, it is estimated that among 5,000 pharmaceutical items evaluated at the initial stage, just 4–5 will manage to enter the market in the form of an original pharmaceutical product after 8–12 years of research, tests and development, and just one will manage to become commercially successful. Thus, it is estimated that the development cost of that one successful medicine will surpass 1.2 billion of USD. The truth is that the pharmaceuticals sector is characterized by particularities, but as a general rule, it is true that all businesses are obliged to develop and establish systematic methods of collecting a huge tank full of new ideas.

INTERNAL SOURCES OF IDEAS

Internal sources of ideas refer to ideas coming from staff members from all echelons and all operational units of a business, especially from the Research & Development

(R&D), marketing and production departments. In the customer-centric approach of the marketing philosophy, which all staff and executives of a successful business must embrace, each worker must be able to "see" all the internal customers (the other departments) of the business, the strategic partners of the distribution networks, right up to the end user of the product/service in whose production she or he participates. As a result, everyone's contribution is of value, irrespective of their position in the business.

Some large businesses have founded and established permanent mechanisms for the collection of ideas, where executives and other staff members from the R&D, marketing and production departments are encouraged to get together at regular intervals to come up with ideas for the production of new products and the establishment of new production processes.

EXTERNAL SOURCES OF IDEAS

Some businesses aim for a large percentage of new innovative ideas from external sources. The strategic partners of the business in the supply chain – both on the upside (suppliers) and the downside (distribution networks) – are invaluable sources of new ideas.

Businesses in many cases look to external partners (outsourcing) who are experts in providing services for the design of new products. They do this mainly through the systematic collection and processing of information related to the unsatisfied needs and desires of the existing and potential customers of the producers.

The most important sources of new ideas are often a business's customers themselves. Businesses often rely directly on the customers to evaluate their ideas for new products. Through this procedure, many new and interesting ideas emerge. Other companies take advantage of social media networks in order to extract new ideas from enthusiastic customers. These ideas often arise from various intense discussions by customers through online networks which the businesses themselves have established.

In some cases, customers offer companies their own ideas through the use of various products, and in different ways from those which the products were initially intended. For example, the main use of yoghurt is as a complete dessert meal, but, in many cases, it can also be used in various recipes.

Great attention must be paid to the weight attached to the evaluation of customer-derived ideas. A great deviation is often noticed in terms of the stated preferences of the consumers. Organic products and the deviation in their final form are an example of this in many markets within the prism of the market share that they eventually end up securing.

Idea screening

Initially a selection of ideas must be made, in order to weed out the largest volume of those ideas that have very few – if any at all – chances of commercial success. The sooner this has been done, the more useful it is for the effective and efficient use of the limited resources of a business. The need for the rapid removal of "dead-end" ideas, commercially speaking from the development process of new products, is particularly important in the modern business environment where the entry cost is constantly increasing at very high rates.

The choice of the most-likely-to-fail ideas, commercially speaking, is based on the evaluations related to expected sales, the potential price of the product, the development time needed until its introduction into the market, the production costs and the rate of performance of the investment. An especially important role is played by the availability of raw material supplies and accessories, as well as the potential intentions of collaborating distribution networks to support the product, especially during the stage of its introduction into the market. Businesses often adopt a standardized method of recording new ideas in order to make it easier to select the most promising ideas.

Idea evaluation

For products that pass the first selection stage, a more thorough evaluation then takes place. At this stage, a more detailed description of the goals and philosophies of the new product is made, so that more information can be collected for a more complete evaluation of the potential new product. The main feature of this stage is the testing of ideas by consumers in the target group, who are called on to evaluate various alternative clearly defined product ideas, and to state their preferences and intention to purchase the product.

Business analysis

In the next phase, a commercial analysis of the ideas that "survived" the filter stage is conducted. For the full evaluation of the potential commercial success of the new product, the development of an initial marketing strategy is necessary; the most important elements of an appropriate marketing strategy must be identified and formulated. Once the target groups and the value offer are clearly defined, the marketing strategy that emerges should provide valuable forecasts in relation to the calculations of the expected sales and revenues for the first few years after the product has been introduced into the market.

Taking into account the total annual costs, the profit and performance forecasts of the invested capital can be calculated. For the assessment of the total costs involved, it is crucial to record all its component categories, and the choice of an appropriate method or allocation of expenses that refer to the other products that the business produces. Not only a miscalculation upward or downward of the total but also the unit cost plays a catalytic role in taking the right decisions at this stage. Thus, it is very important that all the relevant assumptions are taken into account in the calculations, and a sensitivity analysis is conducted. A very important tool often used in business analysis is the break-even analysis: based on specific forecasts, the lowest sales quantity needed is calculated (in currency or product units) to cover all expenses. Due to the high level of uncertainty, it often remains impossible to make a reliable prediction of the values that crucial parameters will take, concerning the potential course of the new product in the market (e.g. expected price and acceptance rate by potential customers, reactions of the competition, changes in the external environment, etc.). It is, therefore, necessary to conduct a sensitivity analysis for the evaluation of different potential scenarios (optimistic, most likely to eventuate, and pessimistic).

New product development

Until this point, the new product exists as a concept, an idea that has of course been described analytically and is pending "acceptance" by the business analysis. In other words, it is generally accepted that it presents good expectations for survival in a tough competitive market. The next stage is the development of the product and its production process, that is, the creation of various prototypes, together with the design of the process that will ensure its production within the framework set by the strategic partners of the business in the supply chain, as well as the end users/buyers of the product. Apart from the operational benefits, the offer proposal of the new product often includes aesthetic elements, which also contribute to the determination of the prototypes.

This stage is especially critical in the future course of the potential new product, since it demands the systematic and methodical collaboration of interoperational work teams tasked with this job. These teams are chiefly made up of members of the R&D, production, supply and marketing departments of the business, as well as members from the strategic partners in the supply chain, whose contribution is of vital importance in the successful outcome of this effort. In certain cases, this is a very time-consuming stage (often lasting for some years); this usually refers to the iterative processes involved in the creation, evaluation and improvement of the prototypes until the design satisfies the many and often conflicting goals and preferences of the different stakeholders (the business, suppliers, distribution networks, final customers, regulating authorities, among others).

Marketing testing

Market testing refers to the limited pilot introduction of the product in real market situations, via the availability of a relatively small amount of product in specific geographical regions. Market testing is especially useful in cases where the introduction of a new product in the market presupposes a significantly large investment, since a lot of information is being extracted in relation to the new product and the chosen strategy of the marketing mix. In this way, an attempt is made to extract even more reliable conclusions for the predictions related to the acceptance of the product in the market, the support it will get from the main actors in the supply chain, and the potential revenues.

High costs are perhaps the greatest deterrent in the use of the market testing stage; this is why it is often avoided for products that comprise simple extensions of existing products of a business, or are similar to competitors' products already in circulation (i.e. when the development cost is relatively low, or when the business believes that the chances of failure are very limited). But the damage of a failed introduction of a new product can be very great, often reaching millions of dollars/euro; in such cases, market testing can play a very significant role.

It should be noted that there are many cases of new products introduced into the market after a successful market testing period, which were eventually withdrawn, even after a relatively short period of time of just a few months, because they ended up not being well accepted by the market. The opposite has also been verified in practice: a new product has a disappointing outcome in its first market tests, but it is highly successful later. Another disadvantage of market testing is the expected "leakage" of

useful information to competitors. Moreover, competitors are likely to react intensively during the market testing of the product, therefore making it difficult to extract safe and trustworthy conclusions about the new product. Furthermore, the timing of the market testing should be adequate so as to secure a relatively correct estimate of repeat purchases, which often comprises a critical factor of success for a new product. In the era of virtual reality, many alternatives are available that simulate the operations of market testing, often with similarly satisfying results, as well as clearly reduced execution costs.

Commercialization

A very small percentage of new ideas get to the stage of being introduced to the market. The cost is especially high; the revenues derived from the sales of these new products deviate widely from the expenses required for its support in term of its production, stock management, distribution among the marketing channels and, particularly, in terms of communication with the final consumers for its promotion. In practical terms, very few businesses have the ability to secure the immense financial capitals required, and the necessary maximal support and cooperation of the suppliers and distribution networks for the simultaneous introduction of the product in the desired and/or target markets. In their majority, manufacturers are initially satisfied by choosing just a few specific promising regions to jumpstart a successful introduction of the product into the market, having designed a programme of gradual spread in the remaining regions.

However, before choosing the regions for the introduction of the new product, decisions will have to be made concerning the appropriate timing of the presentation and distribution of the product in the market. In quite a few cases, businesses may delay its introduction if they think that potential improvements to it may make it more attractive to potential customers. The same can also be true, however, when the combination of circumstances of the macro-environmental forces make wild predictions about such a costly investment. In contrast, businesses sometimes need to quicken the pace for the introduction of a new product in the market due to an expected introduction of competitors' products. This situation is probably repeated very often due to the rapid technological developments at all operational levels of the supply chain, which the competition rushes to take advantage of. For example, the recall of entire batches of new products, for example, smartphones and car models, for some kind of partial repair or even complete withdrawal or replacement, may be due, among other factors, to the desire of businesses to be ahead of their competitors timewise in the introduction of their products.

1.4.2 Integrated management of the new products development process

The development of new products is an act involving a very complicated process that requires committing huge amounts of precious finite resources (human, capital, financial, etc.) on a long-term time scale. The result essentially determines the survival of the business, and consequently its potential to secure satisfactory rewards for all those involved in it, for example, investors, higher executive ranks, workers and collaborators in the supply chain. Consequently, an integrated and systematic approach for the management of the development process for new products is needed, in order

to successfully face the constant challenges by finding solutions, discovering unavoidable tradeoffs and striking a balance of conflicting forces.

Integrated management in the development of new products presupposes the following:

- Commitment of top management executives of the business: The development of new products is associated with high levels of uncertainty, as well as being time-consuming and expensive. It involves many executives from various operational departments of the business; thus, the constant, clear, precise and indisputable support and commitment of the higher management ranks is of vital significance in the management of expected failures, grievances, disagreements, etc. The stable and unwavering stance of higher management in the development of innovative products, making the necessary resources available and undertaking the appropriate responsibility, plays a determining role in the success of the development process of new products.
- Systematic development of a new product: For the evaluation of all potential opportunities for the maintenance and development of a competitive advantage in a business environment that is full of constant rapid catalytic variables, top management officials must establish and strongly support mechanisms that will guarantee the systematic development of a new product. In other words, the development and support of a corporate culture is required, with a view to innovation that will influence all the executives and other staff of the business, rewarding those who take an active role in finding and executing innovative solutions.
- Creation of multi-functional teams and appointing a manager: The development of a new product requires good unhindered constant collaboration from the R&D, production, supply, marketing and finance departments; it often includes the legal consultants of a business as well as the executive representatives of the main strategic partners of the supply chain (suppliers and distribution networks). Traditionally, the work was allocated among different departments and each department did its own work, following a rather linear process. This approach has virtually been completely abandoned now, thanks to the use of good communication of technological information that has broken down the traditional barriers that separated the different operational units. Communication between those directly involved, wherever they are, the collection and distribution of vast quantities of data and information among all stakeholders, and the evaluation of the tradeoffs among alternative plans through simulation of the whole supply chain are now taken for granted (or at least they should be).
- For the successful completion of the task of developing a new product, multi-functional teams are created whose members are responsible to a great degree exclusively with the execution of the specific task. The main aim here is the success in completing the task and not the promotion of the priorities and expectations of each operational unit. In this way, specialized staff from different operating units contribute to the completion of the added value process, since they offer valuable knowledge from their own particular field and the operational unit where they work; they also have a complete and systematic approach to the operation of the whole business and the entire supply chain. This spherical knowledge of the entire system (the business and the supply chain) constitutes a necessary condition for the successful execution of the next steps in the life cycle of the new product; here,

the challenges to be faced are much greater in intensity and consequence, and naturally much less controllable, since the introduction of a new product will cause an extreme reaction on the side of the competitors.

"*Success has many fathers, but failure is an orphan*", as the saying goes: the appointing of a manager is absolutely necessary for the operation of a successful team. The manager will always pass on his vision and keep it alive; s/he will coordinate all efforts through the potential allocation of the task; s/he will urge everyone to take on the initiative, and encouraging the team to continue in their efforts when faced with a difficult situation; most importantly, the manager will take on the greater volume of responsibility in the case of failure in the face of the management and the main shareholders of the company.

- Customer-centric approach: As previously stated, a business, and by extension the process of developing a new product, should satisfy the expectations of different stakeholders. A potential failure to complete the minimum expected level of requirements, even of one stakeholder, is simply unacceptable. The business's customers are its most demanding stakeholder: their preferences are like quicksand, constantly altered in storms caused by rapid and frequent changes in the external environment (mainly of a technological kind); without customers, there is clearly no meaning for a business and its supply chain to exist: no demand means no revenues. A business and its strategic partners in the supply chain (who are involved in the development of the new product) must identify their customers' needs and desires which they can satisfy more effectively and efficiently in relation to the competition based on their particular abilities, skills and resources. Thus, just as it is not feasible to develop a new product that attracts customers but cannot be supported adequately in terms of its production and supply chain, it is equally catastrophic to try to introduce a new product without thorough knowledge of the needs and desires of the customers. Thus, the process involved in developing new products must start with finding opportunities based on the unsatisfied or partially satisfied needs and desires of customers, and be completed with the discovery and offer of mutually beneficial solutions for the customers as well as the business and its supply chain.

1.4.3 The new product adoption process and strategies

The adoption process of a new product involves many steps, such as those outlined in the following diagram (Figure 1.3):

Initially, the new product is completely unknown to its users. Thus, the first step in its adoption is *informing* potential interested parties by promoting it and, for consumer goods, mainly through advertising, the goal being the creation of a demand for the brand. Advertising underlines the existence of the new product, emphasizing the brand and highlighting in an attractive way the particular characteristics of the product in order to lure the *interest* of the target buyers. The communication strategy followed should contribute in such a way that the potential customer will proceed to make an *evaluation* of the new product in relation to competitors' products; the advertisement must provide the appropriate information/indications that the new product offers the highest possible added value. At this stage, the contribution of the distribution networks is very important, mainly in the retail sector, so as to facilitate comparisons.

Figure 1.3 The new product adoption process.

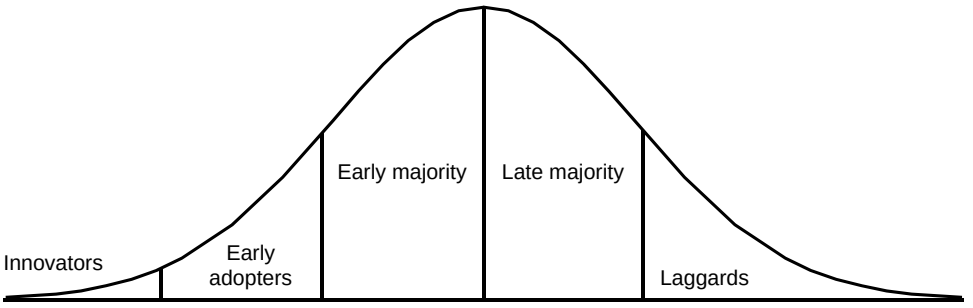


Figure 1.4 New products adopter groups.

Since the estimated value:cost ratio of the new product is of the highest importance in relation to competitors' products, prospective customers can proceed to *testing* it. Every new product is unavoidably accompanied by uncertainty concerning what it can really offer, so all efforts should be directed toward curbing the hesitations of the prospective customers, for example, simultaneous highlighting of its advantages, minimalization of perceived risk with the use of tools like free samples, small-size packaging, longer warranty period, possibility of getting one's money back, etc. Evaluation of the new product once it has been tested will play a decisive role in a buyer's intention to *adopt* it, but customer loyalty presupposes constant maintenance of quality standards and continual efforts to improve the quality:price ratio, as well as constant promotion of the product.

The time period needed for potential buyers of the new product to follow the adoption process shows a wide variation as can be seen in the following diagram (Figure 1.4).

Consequently, based on the adoption time of the new product, buyers are classified into the following groups:

- "Neoterists", 2.5% of the total buyers: They are the first to try the product. Their main characteristic is the high level of psychological willingness to be original that surpasses the unavoidably high perceived risk associated with the new product. They are usually young people with a high level of education and a relatively high level of income.
- Early adopters, 13.5%: They are similar to the neoterists to a great degree, and they often look for new solutions to satisfy their needs and desires, perhaps paying more attention to the perceived risks of the new products.

- Early majority, 34%: These people desire a better value offer than what they are enjoying at the moment, but prefer to wait till they are better informed by the experiences of the neoterists and the early adopters that are often published in various ways through social media.
- Late majority, 34%: These buyers are older in age and are slightly influenced by the promotional activities of the business selling the new product. They try it when it has become widely accepted in the market, mainly due to the good price it is offered at, or the respective adaptation to common social norms.
- Slow movers, 16%: This is the last group to try the new product. It is generally characterized by an aversion to change, and turns to the new when the old product they are using is withdrawn.

1.5 Product life cycle

1.5.1 Stages of product life cycle

When the development process of a new product is completed, the next step is its introduction into the market. The business has already invested precious resources for the development of the new product; thus, it will make all efforts to ensure that its trajectory in the market will reward its own expectations and those of its strategic partners in the supply chain. Ideally, the business would like the new product to comprise a source of revenue as soon as it hits the market; it is most likely the case, however, that some time will be needed before it becomes profitable in terms of sales. Moreover, the product will need to change over time in order to satisfy the needs and desires of the customers in relation to the competitors' products. Generally speaking, after their development, all products albeit each one in a different way will follow four distinct phases in their life cycle in the market: (a) introduction into the market, (b) development, (c) maturity and (d) decline (Figure 1.5).

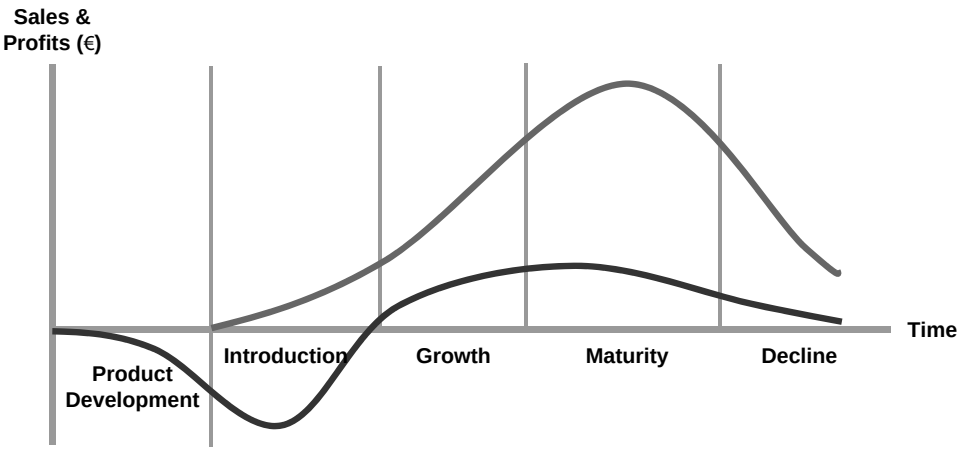


Figure 1.5 Product life cycle stages.

Introduction into the market

When the product is first introduced into the market, it is completely unknown to potential customers. No sale can be made until customers are informed adequately about it and the benefits that it could offer them compared to the competitors' product, so that they can be persuaded to try it. Moreover, it is not enough simply for the new product to reach the shelves of the retail stores; it is imperative for the product's successful introduction and trajectory into the market to secure its constant supply in the market (with as many stock levels as possible). It is, therefore, expected that at the introduction stage, the business continues to invest significant resources in the new product, even though revenues will lag behind significantly from expenses. Hence, the main characteristics of this stage are the thorough, constant and intensive promotion of the product. The main tools in this effort are advertising and promotional actions, while the ultimate goal is for the product to be tested by a very small share of the target market. Commitment to production factors and organization of the production process must ensure a constant flow of product in the distribution channels; production of a minimum stock level will guarantee availability and avoid shortages at retail stores, offering motivation and support to the target distribution channels. Due to the magnitude and uncertainty of the risk being undertaken, as well as the limited demand of the product by neoterists and some of the early adopters, the product is offered in just a few different versions, focusing on reliability and functionality, rather than the particular elements that will satisfy the specialised needs of discrete target markets. With regard to pricing, businesses may choose between two general strategies, *market pruning pricing* and *market penetration pricing.* In *market pruning pricing*, the business initially sets a high price to sell the product to the few customers that are aware of the very high value/usefulness of the product, and can't wait to acquire it. Later, it will gradually lower the price so that the people who regard it as less useful/beneficial will buy it. It is suggested to use *market penetration pricing* in determining a relatively low price that speeds up the growth rate of customers who will try the new product. The aim here is the fast acquisition of a relatively high market share and, subsequently, a reduction in the unit production cost and the distribution of the product.

This is the stage businesses would like to last for the shortest time possible; in practice, however, a long time passes until the right conditions are created (recognition and creation to some extent of a branded demand, support from the strategic partners of the supply chain, etc.), which will cause a rapid increase in product sales, giving rise to the transition to the next development stage. The factors that influence the rate of adoption of new products varies and it is difficult to make a precise estimate of their impact; it has been found, however, that some factors play a decisive role so that the product will pass relatively quickly onto the next stage of development. Specifically, the degree of superiority of an innovation in comparison with competitors' products, which reflects the offered value or the value/price ratio, has a positive correlation with the speed of acceptance of the new product. Similarly, a small degree of complexity, that is, how easy it is to use the new product, and the degree to which the innovation is compatible with the sociopolitical values and experiences of the adopters, also leads in the same direction. Moreover, there is a positive contribution in the potential of a partial testing or demonstration of the use of the new product: the degree to which communication of the advantages of the new product in relation to competitors' products is facilitated.

It is important to note, however, that some new products remain longer at the introduction stage than the time that the businesses estimated the investment and support to be worthwhile, and their journey in the market will end prematurely, and sadly, rather ignominiously.

Growth

The rapid increase in sales that signals the entry of the product to the development stage means that it is profitable for the business and it, therefore, no longer needs new capital for its support. At this stage, the product attracts interest and has been adopted by all the early adopters, as well as a large number of the early majority of potential customers. The main goal of the business is the acquisition of a larger market share since, due to the success of the new product, competing products are now making their presence known as similar or even improved versions. The business now has the possibility – and it vigorously pursues this – to increase the distribution channels it works with in the frame of pursuing a more intensive distribution of the product in the market. Moreover, the business increases the possible versions/alternatives of the product, some of which may have improved features, and it offers more support services for customers.

The unit cost is reduced even more, due to the achievement of economies of scale and the use of learning curves, as well as the more efficient and effective coordination of the business, both internally and externally, with its collaborating partners in the supply chain. The price is maintained at the same level as in the introduction stage, hence it may be reduced slightly. The expenses for its promotion remain at the same levels as in the introduction phase, or are slightly increased; due to the increase in the sales volume, however, the cost per product unit decreases significantly. The goal of marketing communication is not just the achievement of the product testing, but also to ensure repeat purchases through persuasion, and its increased use and frequency of purchase.

The most significant challenge of the business at this stage is to identify the optimal tradeoffs between the potential benefits and consequences of the available profit management alternatives. A more wide-ranging alternative is to invest a significant part of the profits into the product itself, to improve it and promote it more widely by extending and/or improving the distribution channel; the main aim here is to establish dominance in the market and to further increase its market share with a view to long-term benefits. On the other hand, it could aim for higher short- or long-term profits from the product and utilize them to increase shareholders' dividends, or improve the position of other products in its portfolio.

Maturity

The product enters the maturity stage when the sales growth rate slows down and saturation in the market is eventually achieved, which happens when the total customer set is using the product intensively. For most products, this stage lasts longer in relation to the others, and the goal of businesses is generally to elongate the time horizon of this particular stage. Hence, the product portfolio (mix of offers) of nearly all the businesses comprises mainly of products that are found at the maturity stage. Since constant changes are noticed in the sales levels (in both directions) and the

challenges of the competitive environment are complex with a very high intensity, businesses tend to focus their attention particularly on the effective management of their mature products.

This stage is characterized by intense competition among a plethora of similar goods. Customers usually can't distinguish significant differences between alternative products and are particularly sensitive to the price of the product, so there is a tendency to reduce it. Consequently, the profit margin shrinks. Despite this fact, the most-established businesses have the ability to sell products at the same prices as their competitors or even at slightly higher prices due to the services provided and the customers' habits, which lead to some degree of loyalty toward them. Also, businesses try to further develop the distribution network for the product to reach more customers and markets.

Marketing communication focuses more on persuasion since differences between competing products become all the more blurry. The ultimate aim is the creation and maintenance of safe distances of the product against those of the competition on the perceptual map of the customers. The product and its production process continue to improve, with the use of the rapid technological developments, particularly in terms of information technology and communications. Even in the case where technological changes don't lead to immediate improvements in the product, businesses can strengthen their support services and warranties. The result of an intensely competitive environment and market saturation by a rich variety of competitors' products is the withdrawal from the market of some competitors when they find they cannot offer a product with an attractive value/price ratio in market segments that are deemed sustainable.

From the aforementioned, it is obvious that businesses make a great effort to lengthen their products' maturity stage via a mix of relevant strategies. A strategy has to do with the consumption growth of the existing product, without it undergoing substantial improvements. This is achieved in different ways such as finding new users in existing or new markets, as well as discovering and promoting new/additional uses among existing customers. Moreover, groundbreaking technological innovations force businesses to seek continuous improvement of their product offers and the integration of highly developed support services. Furthermore, businesses resort to changes in other elements of the marketing mix, for example, by following different strategies for pricing in various discrete market segments, or attracting customers from competitors with lower prices, so that they can achieve new consumer segments. At the same time, it is feasible to invest significant amounts of capital and other resources in a broad intense promotional mix to establish the presence of the product in the market at an even higher level.

Decline

Some (admittedly very few) products manage to stay at the maturity stage for many decades or even more than a century (e.g. certain soft drinks). Most products, however, eventually reach a stage where their sales decrease to a great degree, which means that they have entered the decline stage. Due to the small size of the market and the significant reduction in the price of the products, a gradual removal of the less competitive products is observed, and the profit margins for the remaining companies are much smaller, to the point of meager. Businesses that prefer to stay in the market

will shrink the depth of the product to maintain the lines with the highest sales. The promotion expenses will be limited to the absolutely necessary (low) level, while the distribution network will focus on the relatively few still profitable channels.

The maintenance of products at the decline stage implies damage to the business, both in the short and long term, when revenues are lower than expenses, the performance of the committed resources is low in relation to its other products, and the renewal and maintenance of a balanced and sustainable portfolio is postponed. Thus, great care should be administered in the timely identification of products entering the decline stage; this makes it more difficult to calculate the costs involved, since a large part of the expenses are mutual among other products, and it is also difficult to predict trends in future sales due to uncertainty.

Businesses resort to different strategies depending on the particular circumstances. In certain cases, they choose to reposition the product in the maturity stage, through the aforementioned strategies. Sometimes they end up making a radical improvement/renewal of the product and its accompanying services so that it may even return to the development stage. The biggest and most established businesses often follow the waiting strategy for a significant period of time, until the competitive environment is ascertained; they may then remain in the market or in a particular segment, until the withdrawal of most competitors, utilizing their dominant position for a more profitable survival in a shrunken market. If forecasts are not so promising, businesses may make more profits in the short term by reducing their operational costs to the least possible level until they can secure satisfactory sales (product harvest/bleeding). In the worst scenario, they either withdraw the product from the market, or they try to sell it to another company.

1.5.2 Main issues concerning the product life cycle

The life cycle of the product offers a very useful semantic theoretical frame of approach for the stages a product passes through, from its introduction until its potential withdrawal from the market. Despite this, there are some critical elements that must be taken into account during its use in the relevant decision making.

Marketing and sales issues

The life cycle of the product refers to the total sales and profits of the entire sector that the competitive products belong to, while the sales and profits of each individual product usually show their own different development, for better or worse, in the relevant sector. Each individual product will often be at a different stage in its life cycle in relation to the sector. Moreover, sales and profits may show significant deviations from one market to another where the specific product is available.

The life cycle of the products generally tends to shorten due to the continuous emergence of groundbreaking technological developments – culminating in innovative high-tech products, such as smartphones and other electronic goods – which doesn't usually last longer than a year. Generally speaking, the life cycle of innovative products shows certain particularities in relation to other products, which are due to their very short lifespan, and the very high level of uncertainty, mainly concerning demand forecasts. For standard products, demand forecasts are very precise and reliable, due to the plethora of historical sales-related data, so it is feasible to use quantitative

methods; for innovative products, however, the absence of relevant data implies the use of quantitative data methods that support the estimates of business executives and the supply chain, as well as the collaborating experts.

The high level of uncertainty makes it difficult to predict critical future situations concerning the new product in the market, such as how quickly it will enter the development phase, what the sales growth rate will be, and what level sales will reach. Also, new high-tech products tend to show reversal signs that may provoke demand "epidemics". So, it is clear that significant dangers arise for the business and those involved in the supply chain as a result of making overestimations or underestimations of the actual/stated demand. Companies fail to take advantage of sales takeoffs due to a lack of time, excess costs and quality problems, while underestimation of demand causes incalculable damage due to excess stock, inactive units and mass returns (Figures 1.6 and 1.7).

The delayed entry of the individual product into the market in relation to competitors' products implies a longer stay in the introduction stage, with significant negative consequences for the business; the product will stay for less time in the profitable stages of development and maturity, with increased risks related to devalued stock.

Some products that belong to the "fashion" and "trend" category have a lifespan with very specific features. Fashion products are related to some kind of accepted or popular style, and are characterized by their short life cycle that is often completed quickly without showing any significant indications. Trend products are those fashions related to specific groups of enthusiastic customers and their life cycle is often even shorter and very volatile. Thus, the marketing strategy used for such products requires special attention due to the high level of uncertainty that characterizes their entire life cycle.

Although it may seem strange, competitors aren't always enemies. At the introduction and/or development stage, the existence of competitors may contribute to greater penetration of the product idea in the market and to the development of the

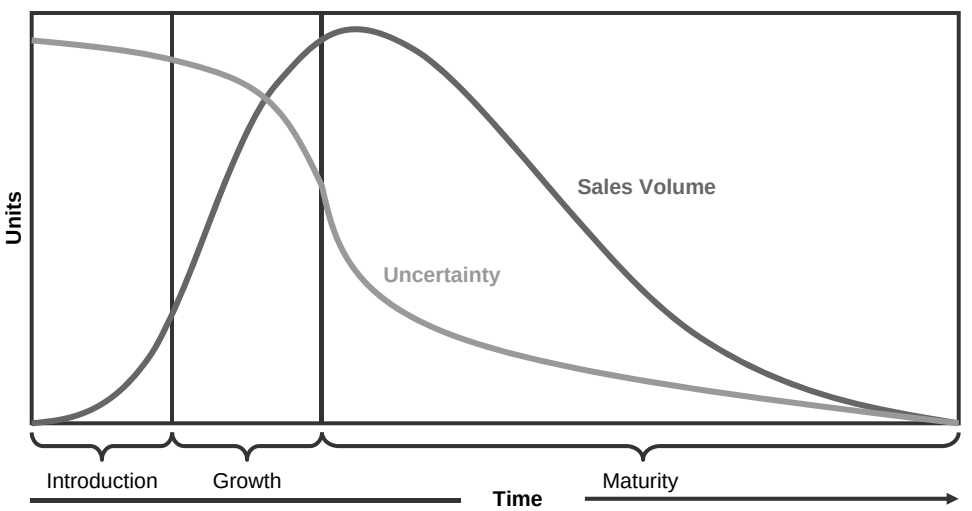


Figure 1.6 Uncertainty and sales volume during the innovative product life cycle (Adapted from Taylor, 2003).

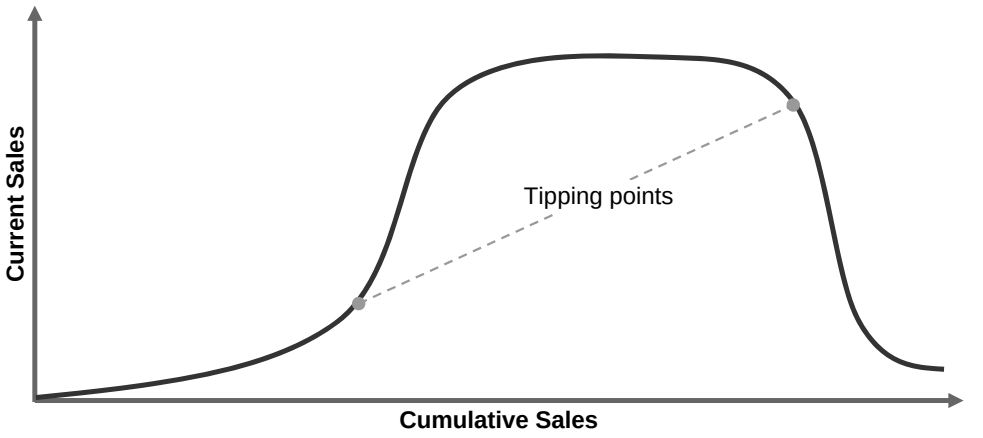


Figure 1.7 Tipping points in current sales of innovative products.

required distribution networks, due to coordinated efforts for its fast acceptance by consumers.

Determining the correct stage of the life cycle of an individual product, as well as estimating the duration that it will stay in that stage, constitutes a huge challenge. It is also very difficult to correctly predict when a product will pass from one stage to another, and to determine the contribution of different potential factors involved in such transitions.

The development of strategic marketing based on the life cycle of an individual product constitutes a huge challenge for the business: the chosen marketing strategy depends on the characteristics of the life cycle stage that the product is in. However, the strategy followed may contribute in a decisive way to staying in a particular stage, or to the speed and possibility to change to another one. For example, reduced sales of a product may be due to the fact that the product has irrevocably gone into the decline stage, with the result that a decision is made for it to be "harvested"/"bled", or even to be withdrawn. In reality, however, this may all be due to mishandling of the chosen marketing strategy, which didn't help a product to stay in the maturity stage as much as was feasibly possible, for example, by redesigning the product or ineffective promotional actions.

LOGISTICS ISSUES

Logistics management includes the design of five main business operations: determination of the desired level of customer service, demand planning, production planning, supply planning and, finally, transportation planning (Table 1.1).

The main reasons that give rise to the need for an integration process between the supply chain and marketing, as well as support for this process, could be the following (Papadimitriou, 2004):

- Increased market differentiation (differentiation of customer needs and preferences, personalization of market sectors, product differentiation, etc.).

Table 1.1 Logistics management activities

Operation/Function	*Examined actions*
Determination of the desired level of customer service	This concerns the philosophy/policy of the business that addresses the needs of the customer, always in relation to the possibilities of each business. These essentially concern actions taken by the business, viewing the customer (and the customer's needs) as the business's priority. In this way, when a business makes it its goal to achieve customer satisfaction in the best possible way, and manages to do this, this is regarded as a successful result.
Demand planning	The planning process of forecasting demand for a product/service. A precise forecast for customer demand improves customer service, simultaneously reducing costs arising from demand uncertainty.
Supply planning	The planning process to satisfy market demand based on available resources and stock levels. Covering supply demand guarantees that the security stocks are at the appropriate levels.
Production planning	The planning process that examines the available resources and draws up a schedule for optimal production based on restrictions imposed by practical limitations. It may automatically adapt production plans if certain suppliers don't have availability, or a key production element is out of order.
Transportation planning	The planning process for the best and most economical transportation and distribution methods, taking into account all restrictions, for example, delivery date/time, transportation method, etc.

- Increased competition at the level and quality of services and customer service (increase in demands for added value/additional benefits and usefulness connected with the market and the sale of goods).
- Shorter life cycle of the product.
- Trends associated with concentration on marketing, creation and development of new distribution channels.
- Integration of economic and decision-making processes (use of synergies on a micro-economic scale).
- Development of new technology in the goods sector, information flow, promotion, sales, etc.
- Development of entrepreneurship and innovation in market and economic activities.
- Completion and globalization of the market.

DEVELOPMENT OF ENVIRONMENTALLY FRIENDLY PRODUCTS

Environmental factors play a very important role in the production of new products. The most efficient design of new products and their packaging is regarded as that which is recyclable and economical in its use. Environmentally friendly products fulfill health and market expectations for people and society, being useful, safe and

cost-effective throughout the duration of their life cycle. They are made with the supply, production, transportation and recovery of renewable energy. Such products have been designed to have the maximum amount of renewable or recyclable materials and to be constructed with the best practices and the cleanest production technologies. Moreover, according to all the end-of-life scenarios, they are constructed using hygienic materials that are made in a natural way, so that the most appropriate materials can be used effectively and can be recycled.

Measuring, recording and monitoring all factors that negatively affect the environment throughout the entire life cycle of a product or service is a painful and difficult process due to the interaction of factors and the difficulty in accessing precise trustworthy information. This also emphasises the importance of ecolabels (green labels).

Ecolabels are means of communication with potential customers in relation to the producers' commitment to the internalization of external factors caused by the production and use of their products. These means are fully dependent on the market approach. However, given that ecolabels provide information related to environmental performance, this may help market participants in making choices with more economical and environmentally effective targets.

Ecolabels are a derivative form of corporate sustainability. They represent a concentration of basic reference information, so that much information refers to a single binary index. A product either fulfills the predetermined criteria and it is awarded the label, or not.

There are many non-profit organizations that impose sustainability standards for specific products, which independently control the production of those products, and then certify that they fulfill the criteria of being produced in a sustainable way.

The ISO 14020 (2000) standard classifies environmental labels into three groups:

1 Type I labels can be awarded to products that comply with environmental criteria issued by third parties. An example of this is the European ecolabel whose award criteria are issued based on the results of a life cycle assessment (LCA) under the auspices of the ecolabel committee. As a clearly recognized guarantee of environmental excellence, the EU ecolabel may constitute a basic marketing tool that addresses consumers who are interested in the environment.
2 Type II labels have a self-declared nature from the producers' side, based on the environmental performance of their products, for example, their ability to be recycled at the end of their life cycle.
3 Type III labels consist of a quantitative statement of the environmental performance of the products throughout their entire life cycle. The purpose of the environmental product declaration (EPD) is to provide transparent information regarding the environmental performance of the products and services for comparison purposes. The environmental performance information supplied by the EPD can be verified by third parties.

1.6 Inventory management

The term "inventory" (or "stock") refers to any product or material that a business acquires and stores for future use or (re)sale. Stocks are created when the quantities of raw materials, components and products that are imported – in a company warehouse, for example – exceed the quantities that are exported out of it.

Inventory management is an important function in a business, but it also raises issues in all companies in all sectors, as it involves balancing stock costs (supply, storage, maintenance, and insurance), and commitment of the business's space and working capital. Calculation of the optimal stock level of each product is, therefore, a very important logistics function; this implies minimization of total operating costs and maximization of overall profits (Chopra & Meindl, 2015).

The problem revolves around the uncertainty that lies between supply shortage costs and supply surplus costs. Efficient management offers resource savings, better product distribution and faster customer service. Within the company itself, different views may prevail on stock maintenance levels. From the sales point of view, maintaining inventory may imply being able to meet customer demand at any time, thus being able to generate a profit from it. The effects of stock depletion are obvious. Research has shown that sales losses caused by shortages are highly significant; when the product is out of stock (in both the physical and online stores), a sale cannot take place and customers will take their business elsewhere. On the other hand, with regard to financial management, inventory may imply capital commitments which, together with maintenance costs, implies a lower rate of investment and potential losses. Inventory management encompasses all the procedures that a company must follow in order to maintain the appropriate stock level for each product in the most optimal location for each kind of product.

Before a business decides to build up its product stock, it must finalize important decisions concerning the stock; decisions must be made about which kinds of products will be stored, in what quantities, how long the stock will remain (in the warehouse for example), the cost maintaining stock and the levels of security stock that the company will maintain for each of these items.

Inventory types

According to Singh and Verma (2018), a company's inventory comprises a large and very important share of its assets; it includes all raw materials, products undergoing processing and the finished products that are ready for sale. The following section lists different kinds of stock:

- Maximum stock level: The maximum number of products that a business can have at any one time, depending on the capacity of the warehouse that it maintains.
- Cycle stock: The average amount of stock needed to meet demand between receipts of shipments from suppliers – this is what the company orders at regular intervals. A company maintains its cycle stock to cover potential demand in between replenishment intervals. It is the most well-known inventory category and has been shown to be effective when order costs are not fixed, and maintenance/shortage costs are proportional to the stock volume. Cycle stock policy requires careful calculation of the stock level required for each product, to allow the company to balance maintenance and storage costs. Only the final products intended to meet customer demand are stored.
- Safety stock: The stock levels maintained to deal with uncertainty so that demand exceeds forecasts, and can meet forecasts in case of supply delays. Manufacturing companies also maintain safe stocks of raw materials so that production is not affected during a sudden or unexpected shortage. Thus, safety stock levels depend

on two important factors: the distance of the supplier to the company and how quickly/directly the supplier can respond to an order, and how important the product is for the company.
- Seasonal stock: Stock intended to meet seasonal demand (expected demand volatility), that is, demand created for products during one or more specific periods.
- Pipeline inventory: Stock that the company has ordered but has not yet received. In other words, this stock is on the move, from the supplier's to the company's warehouse. Pipeline inventory can also be stock on hold, which a business maintains to cope with an increase in demand during certain periods.
- Growth stock: The kind of stock maintained by the company in the belief that there will be a future increase in demand. So, this stock will be available to meet any potential demand, and it will likely be highly profitable.
- Obsolete stock: Stock remaining in the business due to lack of demand for a specific product. Because it implies a capital commitment, the company must liquidate this stock in whichever way possible.

Besides the aforementioned categories, stock can also be classified according to the nature of each product type, into the following categories: capital goods, durable consumer goods, consumables, raw materials for production, intermediate goods, finished products ready for sale and spare parts for its installations.

Continuous and periodic inventory control

The two main methods of stock replenishment are: perpetual inventory monitoring systems and periodic inventory monitoring systems.

In perpetual monitoring systems, or fixed-quantity ordering, when stock decreases and reaches a certain level (a predetermined supply or order level), an order is automatically placed for its replenishment. This has to do exclusively with the stock quantity at that point in time (and not the time when the new order is placed). This needs constant monitoring so that the need for replenishment will be felt immediately. In periodic monitoring systems, or fixed-period ordering, a company replenishes stock at a predetermined point in time. This is usually at the end of a specific period: the order-quantity level is related to the demand in the same previous period, and it may also be different from previous orders.

Stock acquisition policy regarding quantity to be transported and frequency of transportation

There are two options available: (1) the company is stocked (or resupplied) in large quantities but with a small number of itineraries, or (2) the company is supplied in small quantities each time, but it performs many itineraries on a frequent basis in order to meet demand. Let's take the example of a pharmacy owner, who has two drug supply options:

- Scenario 1: For high-demand over-the-counter medicines (e.g. painkillers), the pharmacy owner places a large order at, say, the beginning of each month. In this case, the supply volume is large, there is enough stock to meet demand, and the

company commits the required capital to acquire the stock. Regarding the four costs presented in the introductory section of this chapter, purchase and storage/maintenance costs are high, whereas transportation/sales and shortage costs (when the product is in short supply) are low.

- Scenario 2: For drugs whose demand is not constant or cannot be predicted (e.g. flu shots), the owner will order them when they are requested. This implies many itineraries per order pertaining to small quantities each time. In terms of costs, the exact opposite to the aforementioned scenario is true.

In short, demand must always be recorded, so that a business will be able to choose the best policy to acquire and maintain stocks.

ABC analysis

The problem with inventory management is making the right choices about which items to stock. This will be based on the significance of the product types for the business, and their sales figures. Pareto's law assumes that this will be proportional to their importance: the so-called 80:20 ratio implies that a relatively small number of items are responsible for the largest percentage of a company's sales (Figure 1.8).

The 80:20 rule implies that Class A products represent a low 20% share of the company's product range, but they form 80% of the company's sales turnover. Therefore, these items should be very carefully monitored due to their high importance. Class B materials possess a 30% share, but they have a very moderate value of just 15%. The remaining 50% of the goods stocked by the company represent just 5% of the stock value; hence, this category does not need to be monitored so rigorously (Rushton et al., 2010). Many researchers agree, however, that features such as criticality, delivery time, order cost, relevance, reparability and stock durability may affect a product's classification (Ramanathan, 2006). Table 1.2 illustrates an example of ABC analysis:

Pareto's law lays the groundwork for ABC analysis, which is a useful tool for improving the efficiency and effectiveness of any business's inventory management. A common mistake companies make in ABC analysis is that they consider Class B and Class C products to be far less important than Class A products, with the result that they accumulate a large amount of Class A stock and very little – or upon request – for

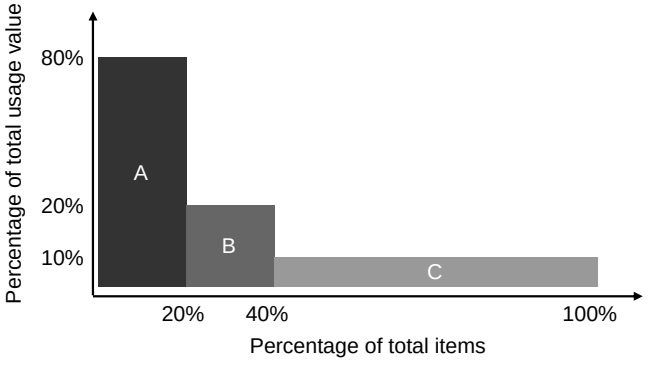


Figure 1.8 ABC analysis.

Table 1.2 Application of ABC analysis

Product	101	102	103	104	105	106	107	108	109	110
Unit cost	0.05	0.11	0.15	0.08	0.07	0.16	0.2	0.04	0.09	0.12
Demand	48.000	2.000	300	800	4.800	1.200	18.000	300	5.000	500
Revenue	2.400	220	45	64	336	192	3.600	12	450	60
Revenue %	32.52	2.98	0.61	0.87	4.55	2.60	48.79	0.16	6.10	0.81
	A	B	C	C	B	B	A	C	B	C

the other two categories, with the respective consequences ensuing (Coyle et al., 2003). A business should only stock up on items that are urgently needed for its operation, or what will be needed in the future, and always according to demand forecasts. Order quantity and frequency are two interacting variables: when the value of one variable remains constant, the other variable usually presents a fluctuation.

Economic-order quantity

Businesses – especially in times of low demand – are under pressure to keep their inventory levels low; at the same time, however, they have to maintain high stock levels to meet market demand. The economic order quantity (EOQ) answers the tricky question of "How much should I order?" It calculates the order quantity that corresponds to the lowest possible cost.

The main assumptions in its application are that demand is constant, order satisfaction/completion time is zero and there are no shortages, in a system where the time horizon tends towards infinity. It also holds true that the average annual total cost is equal to the sum of the average annual fixed order cost, the average annual maintenance cost and the average annual proportional order cost. Despite these assumptions being unrealistic, this particular method is still being applied today, as it has proved to be extremely functional and economically advantageous in production units where inventory management is directly related to its instant replenishment.

Figure 1.9 illustrates the average annual total cost in relation to the average annual ordering and maintenance costs in linear form.

The optimal order quantity lies at the intersection of the average annual maintenance cost with the average annual order cost, in the quantity where total average annual costs are minimized.

Stock-related costs

Inventory comprises a significant expense for a business, as it covers not only the product's cost, but also the costs associated with a company's inventory. These fall into three categories (Forcina et al., 2017):

- *Holding/storage cost*. This includes all costs associated with stock maintenance: maintenance/operation of the storage space, capital commitment, insurance costs, wear and tear and handling costs during storage and transport.
- *Stock supply cost*. This comprises the costs involved in placing orders and acquiring the products.

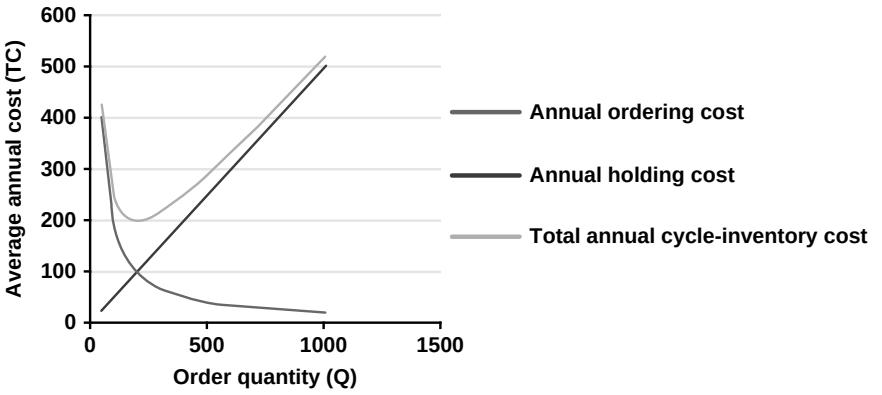


Figure 1.9 Economic order quantity model (EOQ).

- *Stock-shortage cost*. This involves the cost due to a product shortage, and profit losses due to not having stocks, and being unable to satisfy needs through sales (sales losses), including the loss of a company's reputation.

The goal of a business is to minimize its stock levels; in this way, it can manage stock maintenance costs with the lowest financial outlay, minimizing supply costs with a simultaneous absence of shortage costs. Various methodologies support this practice, as discussed in the following sections.

The just-in-time philosophy

The goal of a company's logistics system is to reduce operating costs and ultimately make a profit. The pressures exerted by continuous competition also push companies to find ways of meeting product demand directly. The just-in-time (JIT) philosophy is oriented in this direction (Inman et al., 2011). It is mainly expressed by the fact that stocks are acquired the moment demand is created. Calderone (2017) states that the logic behind the JIT philosophy is based on the company producing what it needs, when it needs it and only in the required quantities. There are three basic principles that govern the JIT philosophy: the goal of minimizing costs by minimizing stocks; the receipt of raw materials and semi-finished products only if there is a demand for them, with final processing being made on completion of the order; and the prerequisite of cooperation, with very few suppliers, in both the short and long term.

The JIT philosophy is defined as the ability to receive the right amount at the right time, but this is not just about the flow of materials. When JIT is applied to a production system, it concerns minimizing waste, not only in terms of the materials, but also in terms of machine hours and manpower, which should always be available the moment they are needed (Alcaraz et al., 2014). This philosophy was initially applied in the Japanese market by the market leader Toyota, which first applied it in its production system (Amasaka, 2014). In recent decades, BMW, Fiat, General Motors, Hewlett Packard, Harley Davidson and General Electric, among others, have also adopted the JIT practice. Its degree of success varies for each company. The

contribution of this method to management is significant in terms of achieving the business goal of high levels of customer service at the lowest cost (Khan et al., 2017).

The JIT philosophy can be analyzed in greater detail as follows:

- It proposes stock reduction. Stock maintenance costs are high; reducing then may contribute to a corresponding reduction in transport costs. Businesses that implement this particular inventory management system can reduce the number of warehouses they own or even eliminate them.
- It proposes the use of methods and tools in order to achieve perfection, with the aim of continuous improvement through the elimination of losses: the company carries out only those activities that add value.
- Products are designed according to customers' requirements.
- Cycle times are regular: JIT follows the logic of austere production, thereby reducing intermediate stocks; thus, it goes without saying that cycle regularity is required at both the line/series level and the level of individual workstations.
- Product families are formed based on the features of the production goals. This is similar to the adoption of grouping technology: component families are formed either on the basis of product features, or the characteristics of the production system, or a combination of the two.
- Special relationships are formed with suppliers, so that materials and components are delivered promptly. Companies that use this philosophy should be treating suppliers as partners and allies rather than competitors. By reducing the number of suppliers and drawing up long-term cooperation agreements, the company becomes a key customer of each supplier, which gives rise to cases where the customer and the supplier agree to let the supplier remain the owner of the stock intended for subsequent sale to a specific customer (the company). Sometimes they may come to the agreement that some products belong to the customer while others continue to be managed and replenished by the supplier (Johnson & Momyer, 1998).

The main advantages of JIT could be summarized as follows: an increase in productivity with simultaneous rcost reductions, stock reductions, decreased waste levels during production, increased innovation, improvement of staff motivation through the provision of incentives, increased cooperation, increased efficiency and a higher response level from both companies (Alcaraz et al., 2014).

The lean production philosophy

Lean production generally comprises a set of tools and methodologies that aim to continuously reduce all production losses. Losses may be due to production stocks, malfunctions, machine dead times, time-consuming changes in setting up machines, waiting times, unnecessary movement of materials and people, etc. It is essentially a management philosophy where stocks are kept at their lowest levels, or do not exist at all, and materials supply is based on the needs of each business.

From time to time, researchers emphasize the importance of lean philosophy in logistics management as a weapon for business consolidation, by referring to how a well-organized and well-designed supply chain should operate. Processes within the chain are smoothed out to reduce losses or actions that have no added value. Value-

added services are those that give rise to an effective placement of the final product in the customer's perceptual map. Lean production has the potential to reduce time by 10%–40%, stocks by 10%–30% and total costs by 10%–25% throughout the supply chain (Kovac, 2013).

The principles of lean production are as follows:

- *Recognition of losses*. Actions must be identified that add (or do not add) value to the product, from the customer's point of view
- *Stable processes*. Detailed production guidelines must be implemented, using a standardized regime.
- *Continuous production flow*. As far as possible, production must be continuous, without interruptions, wait times or other issues, with very fast product changes and in small batches.
- *A "pull" production system*. Pull production aims toward the production of only what is necessary at the time it is required.
- *Continuous improvement*. Constant efforts must be made to achieve perfection, consistently reducing losses as these are revealed.

Zero-level inventory

In essence, all companies regard stocks as a "bad" thing, and every company wants to avoid stocking inventory. In contrast, all companies must maintain a certain stock level to meet their customers' need. Research suggests that stock represents 40%–60% of a company's assets, which is almost the largest asset in its balance sheet. Thus, all companies want to minimize stock to the lowest possible level. In this way, a company will be able to reduce ownership and installation costs, thus gaining more liquidity for business expansion.

Zero stock could be achieved when the supply chain's response time is less than or equal to the demand time. Zero inventory is defined by Farlex (2012) as: "*A system in which a company keeps no or very little inventory in storage, simply ordering exactly what it needs to sell and receiving it in a timely manner. Zero inventory is the goal of just-in-time inventory management and the two terms are sometimes used to mean the same thing*".

But there are still some issues to consider:

- It seems that only large companies, for example, Dell, Toyota, which have a dominant position throughout the supply chain have the potential to fully achieve this goal. Some of these companies have invited their salespeople to set up new factories near their own factories so that delivery time and costs can be greatly reduced. Small businesses can hardly be expected to achieve this.
- The concept refers to only one zero-stock level at a certain point throughout the supply chain. Zero stock in the middle of the chain will put more pressure on partners before and after that point. In other words, the benefits are actually based on the supplier's highest risk level. In the short term, supplier costs will increase. In the long term, these costs will actually be absorbed by the customer (we know that all the costs arising from the supply chain will eventually be added to the final price paid by the customer).
- Instead of storing products in their own factories, some companies choose to authorize a dealer to look after the goods in order to achieve zero stock.

1.7 Demand forecasting

An important factor in better decision-making is demand forecasting. Demand forecasting includes the study and possibility to predict consumers' future purchasing behavior for a particular product. Forecasts are generated by analyzing a product's historical sales data. This may be unclear if sales data do not meet or fully capture actual consumer demand (Feiler et al., 2012). Historical sales data help to indicate future demand, but they do not take into account the external variables that affect them. Collecting and processing data using mathematical algorithms make it possible to draw useful conclusions together with the evaluation of exogenous factors (Kusiak, 2007).

When a business understands the exact quantities it needs to produce, it is already closer to its goals of reducing costs and maximizing profits. The solution to this complex problem lies in the timely determination of consumer demand before the product appears on the market. This is the first stage that all manufacturers must follow (Hamiche et al., 2018). Research has shown that by using a simple forecasting method, safety stock can be reduced by half, in comparison to safety stock estimations made without using any forecasting method.

A distinction must be made between the demand for finished products and the corresponding demand for the parts it is composed of. In Figure 1.10, demand for the final product A is labeled "independent", while demand for component parts B, C, D, E, F and G are labeled "dependent". It is plainly clear that if we know the former, we can calculate the latter (Figure 1.10).

1.7.1 Independent demand forecasting

Demand forecasting methods belong to two major categories: quantitative and qualitative. Quantitative methods are then divided into those based on time-series models and those based on causal prediction models. For a business to start applying a forecasting model, it must first define its problem. In other words, it should define that products it should ascribe a special weight, in order to apply the appropriate forecasting

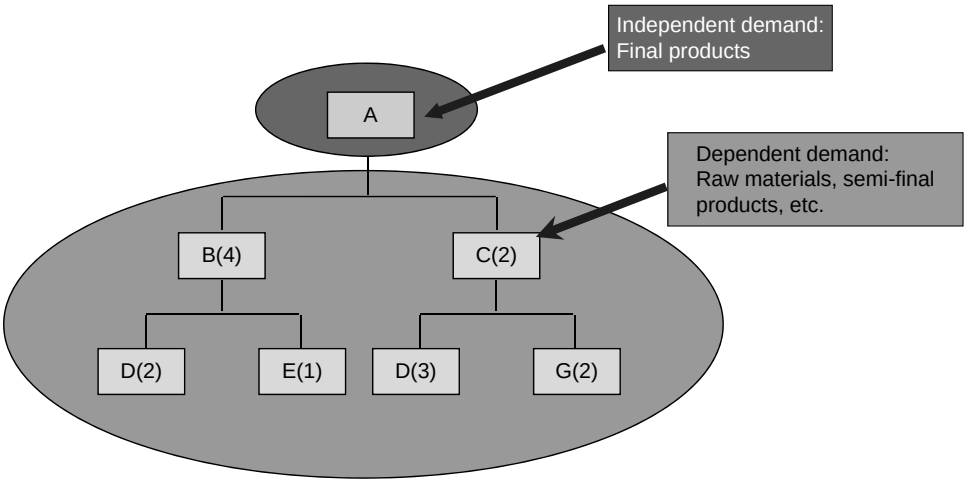


Figure 1.10 Independent and dependent demand.

model, so that it can decide on the chosen model for their management. One way for a business to manage large inventory units is to categorize them, setting boundaries and management methods according to the category that the products belong to.

Qualitative methods in demand forecasting

Qualitative methods in demand forecasting are based primarily on human judgment and experience. They differ from quantitative methods in methodology they use and the results they present. Unlike quantitative methods, they add a sense of "feeling" to the results, and not a numerically accurate result. This is because quantitative data are not used; instead, opinions and experiences are examined. Such results can also be used in combination with quantitative methods, together with other qualitative methods. They are suitable for use in the long-term horizon by companies that want to introduce a new product into a market, especially for medium- and long-term policy planning. The main qualitative methods are described as follows:

- *The Delphi Method:* This is also known as the method of consent. It was developed in the 1950s by the Rand Air Force Corporation, whose goal was to make better predictions with regard to estimating key nuclear targets in America. To achieve forecasts using this method, certain steps must be followed. The problem must first be identified and the participants selected. A questionnaire should then be created that participants should answer more than once individually. The biggest advantage of this method is that the participants do not interact with each other, to avoid the personality clashes: the personalities of some members could overshadow those of others. But this method has a big disadvantage: the whole process comprises answering structured questions in questionnaires, without any explanations. This gives rise to the potential to misinterpret a question, and give a misguided answer.
- *Market research*. Market research is made of two simultaneous approaches: academic and practical. Both aim at the collection, analysis, interpretation and use of data. In the academic approach, the aim is to understand and explain market practices, by interpreting participants' behavior, and measuring their preferences through the application of appropriate variables in a laboratory environment for the extraction of the results, so that the initial research questions can be answered. In the practical approach, the research aims to draw conclusions that will support a company's strategic decision-making (Steenburgh & Wittink, 2001). According to Zhixian Yi (2017), market research is concerned with collecting, analyzing and disseminating information to potential users in order to collect results on their wants, needs and perceptions, so that resources and services can better target them. Data can be collected by distributing questionnaires, through individual interviews or in groups. It is of utmost importance that the questionnaires are well structured; badly structured questionnaires with misguided questions will lead to drawing the wrong conclusions.
- *Expert panel consensus*. This method seeks experts' opinion on topics that require investigation. When it comes to matters for which there is no historical evidence, it is advisable to ask experts' opinions (Aidonis, 2016). In research related to medical issues, experts who have nothing to do with each other are quizzed in rounds/phases, in order for each viewpoint to be taken into account and evaluated

separately. This initially takes place using a questionnaire (Favalli et al, 2018). The board of experts in a company may consist of executives from different departments. In this way, an issue can be discussed in detail and different opinions from different perspectives can be heard, which can help in the decision-making process. A drawback of this method is that the personalities of some executives and the position they hold may influence the results by underestimating other personalities.

- *Basic research*. This kind of research is addressed to participants who are connected to the research object. Where it concerns the prediction of future product sales, the researcher should address the people who are selling the product, as they are the ones that come in direct contact with the consumer public. The sales manager is the person who will collect the results in order to proceed with the evaluation and extraction of the conclusions.

Quantitative methods in demand forecasting

Quantitative methods for forecasting demand use historical data in the form of a chronological series based on identifying, modeling and clarifying the existence of a trend. These methods are generally performed using the following steps (Montgomery et al., 2015):

- Determination of the problem.
- Data collection.
- Data analysis: sample tests to detect trends and seasonality; determination of their features in order to select the appropriate model.
- Selection of the model and its application.
- Model verification and error checking.
- Development of a model prototype.
- Monitoring the performance of the model to see if the procedure followed is efficient and its good operation can be guaranteed.

The main quantitative methods for forecasting demand are discussed in the next section.

TIME-SERIES MODELS

Time-series models are based on the assumption that a prediction is made through the analysis of visible trends in the available historical data. A basic tenet of this method is to clarify the existence of trends and seasonality. Trends are the gradual upward or downward movement of data over time, while seasonality is the repetitive movement of data over a relatively short period of time.

Simple moving average. Use of the most recent values of real data to create a forecast by calculating the average:

$$F_t = \frac{A_{t-1} + A_{t-2} + A_{t-3} + \ldots + A_{t-n}}{n}$$

where:

F_t: Prediction for the next period

n: Number of periods in the moving average

A_{t-1}: Actual price in period t-1

The simple moving average is suitable for samples in which no seasonality or trend is observed. It is one of the most basic forecasting methods, and it is used when the average demand value does not change. One of the advantages of this particular method is that it adapts well to stagnant time-series and equal weight is given to each of the historical demand values. Increasing the number of periods studied reduces variation between forecasts; in other words, the larger their number, the more accurate the forecast, as extreme values are not significantly affected. Moreover, the higher this value is, the lower the ability of the model to adapt to trend time series, since the change in the demand values is not perceived.

Table 1.3 presents an application of the simple moving average.

Weighted moving average. The weighted moving average is the evolution of the simple moving average. The differentiating factor is the use of weight coefficients in the values that we want to emphasise (are more significant for the forecasting). Weights are based on experience and intuition (but for a given set of past demand data, they can be optimized).

$$F_t = w_1 A_{t-1} + w_2 A_{t-2} + w_3 A_{t-3} + \ldots + w_n A_{t-n}$$

where:

$$\sum_{i=1}^{n} w_i = 1$$

Table 1.4 shows an example of a weighted moving average

Table 1.3 Application of the simple moving average

Week	*Demand*	*2-Week*	*3-Week*
1	12		
2	14		
3	15	13.00	
4	18	14.50	13.67
5	16	16.50	15.67
6	15	17.00	16.33
7	18	15.50	16.33
8	16	16.50	16.33
		17.00	16.00

Table 1.4 Example of a weighted moving average

Week	*Demand*	*Weights*	
1	12		
2	14		
3	15		
4	18		
5	16	0.1	1.6
6	15	0.2	3.0
7	18	0.3	5.4
8	16	0.4	6.4
		1.00	16.4

This evolving method is called the exponentially weighted moving average (EWMA), and is defined as the method where more importance is placed on the latest data, simultaneously taking into account the past values.

Simple exponential smoothing. In the simple moving average method, forecasts are based on past observations without placing any weight on any of them. Virtually all historical data have the same weight or weight coefficient equal to 1 (one). In simple exponential analysis, the following formula is used to calculate the next time period:

$$\text{New forecast} = \text{Last period's forecast} + a(\text{Last period's actual demand} - \text{Last period'sforecast})$$

or:

$$F_t = F_{t-1} + a(A_{t-1} - F_{t-1})$$

where Ft = New forecast

F_{t-1} = Previous period's forecast

a = Smoothing (or weighting) constant ($0 \le a \le 1$)

A_{t-1} = Previous period's actual demand

The method with which the weight coefficient of each value is calculated should have the following orientation: the coefficient should decrease as the values are older. This reinforces the view that the most recent observations lead to better forecasts for the future; exponential methods are thus the safest to use. In simple exponential smoothing, a specific period's forecast is equal to the older forecast with an error adjustment for the last forecast. The closer the value of the exponential smoothing coefficient is to 1, the more weight the new forecast carries in relation to the error adjustment. Moreover, as the value of the exponential smoothing coefficient increases, the ability of the model to adapt to trend time series increases, as the change in the sample becomes more easily and more quickly perceptible.

Table 1.5 illustrates simple exponential smoothing, where the coefficient takes two values: 0.2 and 0.4.

Table 1.5 Example of simple exponential smoothing

Week	*Demand*	*Forecasting 0.2*	*Forecasting 0.4*
1	12	12	12
2	14	12	12
3	15	12.40	12.80
4	18	12.92	13.68
5	16	13.94	15.41
6	15	14.35	15.64
7	18	14.48	15.39
8	16	15.18	16.43
		15.35	16.26

Double exponential smoothing. Double exponential smoothing is used in trend time series and comprises the evolution of simple exponential smoothing. There are several variants of this model: Holt's, Gardner's and Brown's (Lifeng et al., 2016); the most used is Holt's variant. The forecast comprises the sum of the forecast at the level and the trend forecast. The smoothing coefficient for the level is usually always greater than the smoothing coefficient for the trend. The higher the values of these coefficients, the more the latest values affect the result, and the more sensitive the model is to changes in slope and level. The model uses all available historical data, ascribing different weights to each one.

Triple exponential smoothing. Triple exponential smoothing, is applied when both trend and seasonality is observed in the sample. What differentiates double exponential smoothing is that the seasonal factor is calculated and it influences the forecast, precisely because seasonality has been observed. An important role of this method is played by the three smoothing values that are the ones that smoothen the time series, trend and seasonality values.

FORECAST ERROR AND EVALUATION INDICATORS

All the aforementioned forecasting methods are evaluated by comparing the real demand values with the forecast values. For this reason, various relationships are developed, by which the forecast is evaluated. This is explained in greater detail below:

- The forecast error (Forecast error = Actual demand – Forecast value = $A_t - F_{t)}$.).
- The cumulative sum of the forecast error (CFE) is calculated as follows:

Mean absolute deviation (MAD)	$MAD_T = \frac{\sum_{t=2}^{T} \lvert e_t \rvert}{T-1};$	$T > 1$
Mean absolute percentage error (MAPE)	$MAPD_T = \frac{\sum_{t=2}^{T} \frac{\lvert e_t \rvert}{y_t}}{T-1};$	$T > 1$
Mean squared error (MSE)	$MSE_T = \frac{\sum_{t=2}^{T} e_t^2}{T-2}.$	$T > 2$

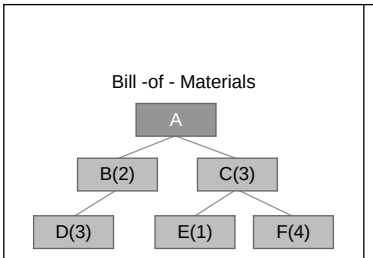
- Mean absolute deviation (MAD). This is one of the most widely used indicators and is calculated from the sum of the absolute value of the forecast errors over the number of periods. This indicator – as well as the following one (MSE) – is widely used, but due to the simplicity of their calculation, they cannot determine how big the error is in relation to the demand size. They are useful for studying the performance of forecasts in a data time series but cannot be applied to multiple time series.
- Mean squared error (MSE). This indicator is very often used to evaluate exponential smoothing methods, and other forecasting methods.
- Mean absolute percentage error (MAPE). This is another evaluation metric that estimates the accuracy of the forecasting method; it calculates the percentage error proportionally to the actual demand price. It gives the researcher an idea of how big the difference in the error prediction is in relation to the actual values in the time series spectrum. It is suitable for comparing the accuracy of the same or a different forecasting method for two completely different time series.

Table 1.6 Example of MAD, MSE, MAPE estimations

		Forecasting			*Error*			*| Error |*			*Error* ^{2}			*MAPE*		
Week	*Actual demand*	*A*	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*
1	12	12	13	12	0	−1	0	0	1	0	0	1	0	0.00	8.33	0.00
2	14	16	10	15	−2	4	−1	2	4	1	4	16	1	14.29	25.00	10.00
3	15	13	18	14	2	−3	1	2	3	1	4	9	1	13.33	23.08	5.56
4	11	12	16	10	−1	−5	1	1	5	1	1	25	1	9.09	41.67	6.25
5	10	14	14	11	−4	−4	−1	4	4	1	16	16	1	40.00	28.57	7.14
								MAD A 1.8	**MAD B 3.4**	**MAD C 0.8**	**MSE A 5**	**MSE B 13.4**	**MSE C 0.8**	**MAPE A 15.34**	**MAPE B 25.33**	**MAPE C 5.79**

- Mean percentage error (MPE). This is the average of the percentage errors in a sample. Since the absolute value of the error difference over the value of real demand is not taken into account, there are values with a negative sign, which are offset by the positive values. MPE is used to evaluate whether the sample is biased or not. If the MPE yields a high negative value, it can be concluded that the sample is constantly overestimating. If the MPE gives the researcher a high positive value, the conclusion is that the sample is constantly underestimating.

The following tables illustrate an application of the above evaluation indicators of three forecasting techniques (Table 1.6).



Lead Time	
Part	Day(s)
A	1
B	2
C	1
D	2
E	3
F	4

Day		1	2	3	4	5	6	7	8
A	Demand								50
	Order							50	
B	Demand							100	
	Order					100			
C	Demand							150	
	Order						150		
D	Demand					300			
	Order			300					
E	Demand						150		
	Order			150					
F	Demand						600		
	Order		600						

Figure 1.11 Application of the MRP algorithm for the calculation of dependent demand.

1.7.2 Dependent demand forecast

Dependent forecasting seeks to help companies calculate the materials needed to produce a product, and the appropriate time that these materials need to be supplied. It is implemented in the materials requirement planning (MRP) system. The system is based around dependent demand, that is, demand caused by the independent demand of the final product. The materials it is concerned with are necessary for the execution of the production program in intermediate stages, and they are either ordered from external suppliers or are a product of the production system itself; for this reason, the first step in designing an MPR department is to determine demand and its position over time. The inventory production and sales schedule is then determined.

MRP is a set of techniques used to design the production or acquisition of the sub-products, components and raw materials required to support the overall production plan. Historically, MRP was the first component to be implemented in a computer-based production control system, paving the way for today's integrated business information systems.

This system's goals are to ensure the availability of the materials, components and products that will be involved in either production or sales, simultaneously maintaining the lowest possible safety stock and scheduling the industrial/manufacturing activities, delivery schedules and ordering activities.

Figure 1.11 presents a sample application of the MRP algorithm. Suppose that an industrial production unit accepts a production order of 50 pieces of Product A in 8 days. The material quantities and the production schedule must be worked out. The required individual materials and quantities are initially provided in tree form (Bill-of-Materials, BOM), together with the required production time of each individual material and the final product (lead time) (Figure 1.11).

According to the schedule for the production of 50 pieces of Product A, the production unit must start work on this on Day 2, producing 600 pieces of Product F, continuing on to Day 3 with the production of 300 pieces of Product D, 150 of product F, etc.