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Seminar Paper

Critical Evaluation of Prices in the Information Technology Age: History, Features and Critical Comparison of Market/Value Based, Cost Based and Arbitrary Prices

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Abstract

Pricing strategies are prone to change. Prices continually adjust according to the ever-changing consumer behavior. In the information technology age, these price fluctuations are more significant than ever. Even though the praxis of yielding the highest profit margins from consumers remained the company's primary ideology, information technology-enabled companies to achieve it differently than before, on the more consumer-friendly manner. Today, information technology is one of the essential instruments the company possesses to stay competitive. This seminar paper should provide a detailed perspective and describe the enormous influence of information technology, namely its development over the years, features, and comparison between market/value based, cost based, and arbitrary prices.

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1. Introduction

Digitalization of the pricing technologies during the twentieth century enabled companies to manipulate with their outputs, customer demand, and, most importantly, to effortlessly persuade upper segments of the supply chain in their company's aims. What is more, the big corporations utilizing the personalized pricing strategies achieve higher profit margins than competitors acting as the market-followers (Guttmann 2019). Personally tailored marketing and pricing strategies indeed have more substantial initial costs. They are, however, much more effective and profitable in the long term. When selecting and opting for the specific strategy, the crucial factor is the differentiation sphere (Rajagopal 2020). The differentiation of a product or a service can substantially impact the company's overall success. When examining today's most influential market-leading companies, they all ordinarily have one thing in common: the uniqueness of their product or service (Rajagopal 2020).

Moreover, the uniqueness of their product is established by the successful fulfillment of several criteria. Firstly, the market-leading company ordinarily has to either place the revolutionary product on the market or significantly differentiate their product from market-competitors. To achieve the latter, the company has to invest heavily in market research and product development. Additionally, these companies have to limit themselves only to entering the less-saturated markets, because without the introduction of the revolutionary product to the market, they can rarely reach over to the competitor's customers. On the contrary, the companies that do not possess sufficient funds to differentiate themselves from the rest of the market, have to place a revolutionary product on the market. By utilizing this strategy, companies do not have to limit themselves on entering the less-saturated markets only, because the introduction of the revolutionary product imposes a considerable threat to the competition instantly. What is more, this market-entry strategy not only provides the company with a higher market share than the differentiation strategy, but it usually converts the company into the market leader itself (Guttmann 2019).

Even though the importance of gathering consumer-generated data dates back a couple of thousand years ago, its relevance became apparent at the start of the twentieth century. Specifically, only after the development of fundamental marketing strategies were the companies able to emphasize the importance that it had on their performance. In

addition, the personalization of marketing strategies became even more prominent, thus further increasing the profits achieved. On the contrary, marketing would not be accepted as a science until the late 1950s, despite importance marketing had on the end price (Rajagopal 2020). By the 1950s, the most relevant marketing factors were isolated: price, promotion, product, and placement. Although straightforward at first, these marketing spheres are challenging to fulfill, mainly because the improvement in one of the fields causes the worsening in others. As the world scholars researched the topic more thoroughly, new marketing fields emerged (Rajagopal 2020).

Furthermore, companies operating in competitive markets have several ways of achieving their desired market share. Factors that have proven to have the most significant impact on the company's revenue are product differentiation, competitive pricing, and strategic cooperation with their market competitors (Mata, Fuerst, and Barney 1995, 2-3). By utilizing information technology, all of the factors mentioned above could be more easily achieved. Also, Mata, Fuerst, and Barney argue in their 1995 paper that information technology could be used to achieve the desired revenue goals, but as a sole market differentiation tool.

Information technology enables flexible pricing, which often utilizes price discrimination but also increases the potential customer reach of the company. Simultaneously, implementing information technology permits the company to tailor its personalized business model without relying on market-leaders' generic business models (Clemons and Weber 1994, 488-489).

This seminar paper should provide a detailed manufacturers' perspective when setting the right price. The second chapter underlines the importance of selecting the proper marketing and pricing strategy for the product's total revenue to increase. Moreover, this chapter provides the historical development of marketing strategies during the twentieth century and its effectiveness over the years. From the beginning of the twentieth century when marketing was considered as an art, until today, when the selection of the marketing and pricing strategies imposes one of the biggest decisions. Furthermore, the different approaches in the price determination of the branded products will be directly compared with non-branded products. Namely, how significantly could the product's profit margins increase with the right branding strategy?

On the contrary, the company's losses are significant if the product is not branded correctly or at all. In addition to this, the adoption of the 4 P's marketing strategy during the twentieth century will be highlighted. By balancing the product, the price, the promotion, and the place, the profit margins can increase enormously. The most appropriate marketing strategy can be chosen by thoroughly observing the changes in revenue caused by the implementation of various approaches.

In the modern world, data-gathering, storage, and data processing methods are crucial. Consequently, the rapid development of information technologies over the years will be examined in the third chapter, their role in determining the right price policy for the product, and various implementation opportunities. Since the information technology allows manufacturers to adopt the new, demand-adjusted price instantly, its effectiveness will be the main focus of the third chapter. Equally important are the data-gathering methods practiced by the largest corporations and how personal data is collected and utilized to select the right price. Together with information technology development, data-gathering methods represent the core of the third chapter.

Finally, the direct comparison between market/value based, cost based, and arbitrary prices will be provided and further explained. The fourth chapter focuses on the pricing effects of the three types, the advantages and disadvantages of each price-setting approach, and their instantaneous switching or adjustment consequences. In addition to that, by the utilization of market/value based, cost based, and arbitrary pricing, price discrimination is frequent. Correspondingly, the fourth chapter compares the three different degrees of price discrimination and their influence on the consumers' demand and market reach.

2. The Evolution of Pricing Strategies during the Twentieth Century

In the early days of human society, approximately 10.000 years ago, humans first exchanged their goods and services to survive. Consequently, the first competitive market was created on a smaller scale than the markets are known today. Over the centuries, all of the markets created were based on the basic economic principles of supply and demand. However, until the early twentieth century, they were not known under the term of marketing. What is more, during the early years of the 1900s, extensive discussion was held to determine if the marketing should be considered as an art or science (Borden 1964).

The arguments for not considering marketing as a science were initially valid. Namely, until the first half of the twentieth-century marketing was mainly used in advertisement purposes (Rajagopal 2020). Moreover, to be acknowledged as a science, marketing strategies had to produce consistent results each time. On the contrary, marketing strategies cannot be implemented into different companies the same way, since they have to be aligned with the company's business model. Consequently, the marketing strategies implemented in various companies usually yielded mixed results (Borden 1964).

Furthermore, the marketing strategies were utilized only to increase the company's total revenue without considering its image, brand value, and product recognition as marketing's vital parts. Although not known at the time, these factors could have significantly increased the company's profits. With the adoption of the marketing mix into their business models, companies could finally separate the pricing policies from product, placement, and promotion. The separation resulted in the rapid surge of focus, efficiency, and profits within the company (Rajagopal 2020).

Additionally, the micro-economic aspects surrounding the company could be better examined due to the separation of price, product, placement, and promotion (Rajagopal 2020). Nonetheless, until the 1970s, the company's marketing efforts were mainly focused on increasing the advertisement quality and brand recognition. As a result, other aspects of the company's operations demanding the optimization remained unobserved.

According to Bartels (1976), to achieve a competitive edge on the highly competitive market, the company has to differentiate its products and services. In other words, the additional value for the specific product has to be recognized within the customers. To achieve that, the companies should utilize different marketing mix strategies, particularly tailored for their market position. More importantly, the company has to determine its exact position in the market and to respond respectively. Correspondingly, the companies operating as the industry's market leaders will possess more handling power, due to the increased customer reach. Market leader's profit margins could be set higher initially, but with the constant observation of the other market competitors (Rajagopal 2020).

Furthermore, the companies investing in their customer-orientated marketing strategies achieved higher brand loyalty. With the increased brand loyalty, the consumers are less likely to switch to the competitor's product, thus again making the company eligible for the higher profit margins without jeopardizing the consumer reach.

At the start of the twentieth century, scientific researches were conducted to optimize marketing strategies. By 1920, the marketing specialists had already distinguished between the "4P's" of marketing, namely between product, price, place, and promotion. The company's most profitable business model could be determined by isolating every marketing-sphere and thoroughly inspecting it for possible optimizations (Rajagopal 2020). However, the improvements in one of the spheres consequently cause worsening in others. Therefore, the optimal balance between the four spheres has to be found. Moreover, the successful marketing mix strategy can position the company above its competitors and, ultimately, position the company as the market-leader.

Given the importance of selecting the appropriate marketing mix for the company, the task of determining the most suitable marketing mix is given to the company's upper management, generally to its chief executive officer. According to Borden (1964), the leading market forces have to be highlighted to select the most suitable marketing and pricing strategy.

Firstly, the government's level of market control has to be determined. Due to the governments imposing huge red tape complications, market-entry barriers, product placement limitations, and advertisement limitations, the company has to consider the possible adverse effect of their actions taken. Moreover, there are numerous government limitations to the type of market in which the company can operate. Consequently, for breaching the government market-restrictions, the company could be financially penalized (Rajagopal 2020).

Secondly, market behavior presents the next market force, according to Borden (1964). Market behavior and the company's ability to adapt to instant changes in the competitive market could significantly influence its position. Furthermore, the consumer's buying patterns have to be thoroughly defined and their price sensitivity. By knowing the customers' exact price sensitivity, the company can achieve higher profit margins without jeopardizing the current customers. On the contrary, due to insufficient data, the company's consumer reach could be potentially lower. Hence, the fourth market force, namely the market competitors. By observing the competitors' pricing strategies, product innovations, and market position, the company can adjust product prices without losing the market share (Borden 1964).

Accordingly, marketing forces have to be taken into consideration when entering the competitive market. Moreover, marketing forces have to be combined with the company-adjusted marketing mix strategies to achieve a competitive edge on the market and demand a higher price. According to Rajagopal (2020), there are two types of marketing mix strategies, short-term and long-term. Whereas the long-term marketing mix strategy is adjusted and personally tailored for the foreseeable future of the company, the short-term marketing strategy is a consequence of the competitors' actions. The company usually has to react instantly to the changes in the fully competitive market; therefore, it is the middle-management generally responsible for setting the company's protective actions. What is more, due to the daily changes in customers' buying patterns, the product price must be adjusted daily. In addition to that, the right decision taken by the middle-management on the daily level paves the way for the successful, long-term marketing mix strategy (Rajagopal 2020).

With the marketing strategies evolving over the twentieth century, additional marketing factors were established and identified. Consequently, Rajagopal (2019) states other marketing factors, besides the price, promotion, product, and placement. Namely, people, performance, psychodynamics, pace, and packaging. The implementation of the additional five factors to the marketing strategy could result in the increased market percentage (Rajagopal 2019). People's marketing factor has changed tremendously over the last century, due to the companies adopting a consumer-centered approach. The change towards the consumer-centered approach came as a necessity for the smaller, market-following companies, as the more significant, market-leading corporations had already adopted this marketing approach.

Furthermore, Rajagopal (2019) underlines the performance factor as the "hybrid"-factor, combined from the newly developed marketing factors and marketing forces. Performance factor denotes the importance of the constant technological improvements, the optimizations within the supply chain, and the awareness of the market competitors. The psychodynamic factor is usually manifested as the grapevine effect. There are numerous ways to increase the grapevine effect by utilizing the promotional marketing tools, word of mouth, and sales promotion, all of which contribute to the increased brand loyalty (Rajagopal 2020).

Finally, for the manufacturers, the essential marketing factors are packaging and pace, which are capable of positioning the company as the market-leader. Namely, the optimized

and recognizable packaging significantly increases the product attractiveness, and consequently, the brand loyalty. The company's pace could be depicted as a combination of all of the factors mentioned above since it represents the company's ability to cope with the market competitors. Therefore, the company with the more versatile and adjustable marketing strategies could position itself as the market leader, and in some cases, as the first mover (Rajagopal 2020).

The companies with an adequate marketing mix usually acquire a higher market percentage. However, the long-term longevity of the company on the competitive market has to be further secured. Thus, product branding strategies have to be utilized to ensure the company's market position and customer loyalty.

2.1. Power of Branding

The power of branding was highly underappreciated in the twentieth century. Product differentiation is vital for the company to stay relevant in the competitive market (Onkvisit and Shaw 1989). Over the years, various differentiation methods have been utilized to achieve a competitive edge.

The differentiation methods could be accomplished by initially lowering the product price, thus capturing the higher market share. This strategy is also known as the market penetration strategy, and it is being utilized by various companies when launching a new product. However, the market penetration strategy does not guarantee that the acquired customer base will stay loyal to the product after an eventual price increase (Rajagopal 2019).

Furthermore, another type of differentiation is diversification of the company's product line. Although the diversification strategy could potentially yield the highest profits, it also portrays the most radical form of product differentiation. The newly developed product is launched on an entirely new market. What is more, for the company to engage in a diversification strategy, and to survive the potential failure, its financial situation has to be excellent (Onkvisit and Shaw 1989).

On the contrary, the companies engaged in branding their product or service do not require an outstanding financial situation or the necessity of lowering their product price. By branding, the company can differentiate its product and compile the desirable image of their

firm. Additionally, the companies offering the intangible services should focus even more on the branding and use it as their primary differentiation tool (Onkvisit and Shaw 1989).

In other words, branding presents a shift from the commodity product to the differentiated, branded product. The branded product provides the additional customer value that enables for the higher price. In the cases of a suitably branded image, the companies achieve an extraordinary level of pricing freedom. Furthermore, the consumer associates the branded products with the higher exclusivity, and with consistent performance.

According to Onkvisit and Shaw (1989), each profit-orientated company should attempt to become the "power brander". The "power brander" company is identified by having a distinguishable, relevant brand, and tangible product quality. Additionally, the company's services have to be branded and associated with the product.

The commodity producers are mostly operating in the saturated markets, hence making the price adjustments impossible. By increasing the price gradually above the competition, saturated market structure causes the company to lose the whole market share. Henceforth, companies should strive to create a valuable brand image to evade the commodity markets altogether, and to operate on the markets that are eligible for the higher profit margins (Onkvisit and Shaw 1989).

The company's business model can be segmented into two segments. According to Tiwana (2017, 12-15), the company should be perceived as a pizza. With the pizza crust representing the company's necessary infrastructure, a requirement for the company even to be able to compete in the competitive market. The business model's main advantages can be seen through the pizza toppings, namely, the effectiveness of the marketing strategies. Moreover, the power of branding and packaging could greatly determine the competitiveness of the company and its success on the market. The customer's feedback greatly influences both packaging and branding strategies, consequently making the data gathering and storing systems a necessity in the modern business (Tiwana 2017, 12-17).

2.2. Importance of Product Placement and Packaging on the End-Price

In today's society, product placement and packaging are especially important. According to Nancarrow, Wright, and Brace (1998, 110-111), over fifty percent of the retail store purchases are spontaneous. By adjusting the price momentarily according to the

consumers' willingness to pay in the given moment, the manufacturers could increase their revenues enormously. In addition to that, the sensor-equipped devices could instantly inform the manufacturer about the rise or fall in demand, thus influencing the price adjustments even further.

The adjustments in the product placement and its position also contribute to the overall success of the product. The right market placement can persuade the consumer to buy the product at the point of sale, hence lowering price sensitivity. Moreover, the manufacturers should focus on product packaging because it can change the customers' perception of the product. The product packaging could be associated with the whole company's brand and quality and is, therefore, vital for financial success (Nancarrow, Wright, and Brace 1998, 110).

The information technology advancements enabled for the enormous progress in product placement and packaging spheres. Namely, with the utilization of the radio frequency identification technology, the on-time resupply of the product is further improved, and the product shortages eliminated. The radio frequency identification sensors are also placed throughout the production and distribution process of the product, consequently reducing the production, shipment, and storage costs. Additionally, information technology allowed for the more optimal product's packaging design. The adequate design of the product is essential for various reasons. Firstly, the product design needs to comply with the legal framework of the domestic country. Secondly, the design has to raise awareness in the customer, to separate itself from the competitors, and most importantly, to reflect the company's values and brand image. Besides, the optimized product design allows for superior load-capacities, hence lowering transportation costs even further (Nancarrow, Wright, and Brace 1998, 112-117).

Correspondingly, the rapid advancements in information technology allow for higher profit margins. Companies are continually finding innovative ways of adopting new information technology due to the competitive edge that can be achieved with it. However, the development of information technology was incremental, with significant advancements occurring mostly in the twentieth century. The next chapter should depict the detailed growth of information technology over the centuries and its influence on the pricing policies.

3. Pricing in the Information Technology Age

Even before the first electrical devices replaced the humans in data processing and information acquisition, there was a necessity for the information exchange. To comprehend the information development, we need to observe the information means of exchange before the digitalization took place (Rojas and Hashagen 2002, 1-3). Namely, the word "computer" derives from the Latin language, and until the twentieth century, it described the process of a person that computes and was directly associated with human activity. In other words, computing represented all of the processes related to exchanging the pieces of information before the digitalization of society. Moreover, until the start of the twentieth century, computing was the process mostly referred to the human processing the necessary information (Rojas and Hashagen 2002, 2).

However, by the turn of the twentieth century, the core meaning of the word changed. With a rapid digitalization in many aspects of everyday life, the word computer started being associated with the programmable electronic devices that are capable of processing, retrieving, and storing data (Rojas and Hashagen 2002, 2). The twentieth century also marked the development of various marketing strategies, and consequently, the start of different pricing techniques (Singh 2012, 40-41). Before adopting digital information technology across multiple business models, marketing strategies were the main focus not only by global scholars but also by the big industries. The tremendous progress made in the marketing sphere during the early years of the twentieth century persuaded the influential sectors to rethink their pricing strategies (Rajagopal 2020).

What is more, the extensive debate over the status of marketing as a science or an art concluded positively for the marketing experts. The academic branch was able to intensify its research efforts by official adoption of marketing in the science sphere. Consequently, various macroeconomic and microeconomic beliefs were challenged and reconsidered for future implementations. Besides, the pricing techniques utilized up to that point demanded significant changes, which, before the twentieth century, could not be identified due to the insufficient studies conducted (Singh 2012, 42-43).

To distinguish between various eras that have ultimately led to the information systems known today, different information-exchange practices over the last millennia have to be carefully observed (Rojas and Hashagen 2002, 2). According to Rojas and Hashagen

(2002), the information systems were influenced by five different means of exchanging information, utilized throughout different eras. The first and most basic type used processing power of the brain. Naturally, this imposed considerable limitations on the amount of information that could be exchanged, processed, and stored. Consequently, the urge towards enabling the expenditure of the information flow surged. Therefore, by the seventeenth century, numerous devices were prototyped and widely adopted to speed up the information flow. For instance, the seventeenth century allowed for the first types of calculating machines. Namely, in 1621, Schickard's prototype of the calculating machine represented the most influential invention that paved the way for future developments (Rojas and Hashagen 2002, 3).

Schickard's invention enabled the third improvement to the information exchange. In 1645, Pascal's calculator was introduced. Serving as the first mechanical calculator capable of calculating more complex equations, it revolutionized the processing capabilities during the seventeenth century. Pascal's calculator achieved tremendous success, and its design represented the guidelines for future inventions. Based on Pascal's calculator design, the French inventor, Thomas de Colmar, designed the first mass-produced digital calculator Arithmometer. Arithmometer was incredibly practical because it possessed the necessary processing power demanded by the regular office environment, and was, moreover, easy to master and reliable (Rojas and Hashagen 2002, 4-5).

According to Rojas and Hashagen (2002), the transition from Arithmometer to electromechanical devices marked the fourth significant progress in information technology. The electromechanical devices were the first programmable machines, capable of automatically running the programs. A notable example is the electromechanical computer, Z3, which was invented in 1941 by Konrad Zuse (Weiss 1996, 3). Although Z3 was fully automatical, the initial constraints had to be entered manually, thus significantly lowering its capabilities.

Furthermore, the fifth evolution of the information technology included advancements in the field of electronic elements. Even though some of the features of the devices of this era were already implemented during the fourth era, their sheer progressions allowed for the broader adoption (Weiss 1996). Nevertheless, the products from this era were still immense and demanded a lot of training, funds, and space to operate correctly. The most

notable computer of this era was Electronic Numerical Integrator and Computer, or ENIAC for short, which was first put to use in 1945 (Weiss 1996).

Although various profit maximization strategies were developed during the twentieth century, one of the main advantages of digitalization was the automated process and instant adjustment of prices according to consumer demand. On the contrary, digitalization has left companies that were unwilling to switch to modern business means desperate to search for new ways to overcome their competition. In reality, however, companies that were technologically lagging found it impossible to detain their previous market share and, accordingly, their customers (Rajagopal 2020).

To determine the real impact of the information technology and pricing strategies on the company's profits and market share, various innovations in the past and their consequences have to be investigated and observed. Finally, the following sub-chapter should thoroughly depict the development of different information technologies over the past, their at-the-time significance and influence cased on the future inventions. Because ultimately, the present achievements in the optimal price-setting policies are mostly derivates from the past designs (Rojas and Hashagen 2002, 5-8).

3.1. Historical Overview of the Information Technology

According to Schmandt-Besserat (1981), the first primitive signs of information technology were clay tablets. After decoding the clay tablets, it was determined that they used to carry the various necessary information for the evolution of global trade in general. For instance, shipment trade was fulfilled and controlled by clay tablets. Moreover, land possessions, measurements, and prices were all readable from the clay tablets. Above mentioned states and underpins the importance of information and its exchange, in the period that dates back over a couple of millennia ago (Schmandt-Besserat 1981).

Furthermore, Jones (2016) placed ancient Greece as the frontrunner in informational technology and its development. Although Greece was the most advanced civilization at the time, the Roman empire and the Chinese empire were not lagging and have developed their own mechanical devices. However, to conduct astronomical calculations, Greeks had to create a unique computable device. Consequently, as soon as in the first century BC, Greeks invented the first mechanical analog computer. This complex invention, named the Antikythera

mechanism, enabled Greek astrologers to predict eclipses and astrological planet positions successfully. Due to Antikythera's possibilities, even the exact date of the Olympic Games, which were held every four years, used to be determined by Antikythera (Jones 2016).

However, informational advances stagnated until the 16th century (Chaudhuri 2004). During the 16th century in Europe, various informational advancements started emerging, mainly due to industrial progress. At the end of the 16th century, John Napier, the Scottish mathematician, discovered that complex divisions and multiplications of the numbers could be calculated by utilizing logarithms of the respective numbers (Montaner 1944). Consequently, an advanced type of calculating table was invented, named Napier Bone. It significantly decreased the necessary time needed to multiply and divide numbers (Montaner 1944). According to Kells, Kern, and Bland (1955, 92), further improvements were brought by Gunter Edmund. Gunter introduced the single logarithmic scale into the calculating device. As a result, Gunter's calculator significantly increased productivity, mainly in the academic sphere (Kells, Kern, and Bland 1955).

Furthermore, in 1645 the first mechanical calculator was invented. The invention was named after its inventor, Blaise Pascal. The calculator was capable of processing only four arithmetical equations, but has, nevertheless, paved the way for the future improvements (Chaudhuri 2004). Over the following decades, Pascal's design was incrementally improved. Finally, towards the end of the 17th century, the German mathematician and inventor Gottfried Wilhelm von Leibniz made further improvements to the mechanical calculator by adding a stepped drum mechanism (Smith 1959).

What is more, Gottfried Wilhelm von Leibniz also thoroughly explained the binary numeral system, the core foundation of all modern computers. Nevertheless, mechanical calculators remained a rarity until the nineteenth century. It will not be until 1820 that the first mass-produced mechanical calculator would be introduced to the market (Smith 1959).
Long before the idea of storing and processing personalized data in the electronic devices, calculating machines represented the most advanced type of computing devices (Lavington 1980). Even though the calculating machines enabled for more demanding scientific tasks, the primary problem was in storing the gathered data. Especially in the United States, where the demand for information storage systems was becoming a necessity, a new means of storing the information had to be found (Driscoll 2012, 15). With the governmental laws regarding the external revision in the United States fastening, additional financial information had to be

stored safely. What is more, the revision task demanded a significant increase in labor and processing power, making the traditional means of revision obsolete and unsustainable (Driscoll 2012).

As a result, at the end of the nineteenth century, a punched card system used for data storage was invented. These specially marked cards could later be revised and read by the machine. Machines utilized electromechanical counters and relays to achieve the exact recognition of the cards (Driscoll 2012). As the invention proved reliable over the decades, it was used in various astronomical calculations. What is more, the information storage system would be especially vital during World War II since all encrypted messages could be instantly stored for later retrieval and decoding. Once the messages were retrieved from the storage system, they were inputted for further decryption into Colossus, the world's first electronic digital computer (Cooke-Yarborough 1998, 104-105).

Even the most sophisticated computing devices from the early twentieth century were analog. In the early twentieth century, analog devices were perceived as a future direction of computer development. Analog devices represent the values corresponding to the object they represent, making them less flexible and complicated for the regular user. As the foundation for the analog computation served the mechanical wheel-and-disc integrator (Ceruzzi 2003). James Thomson invented a wheel-and-disc integrator. Over the years, analog computing devices were implemented and helped with numerous problems. For instance, the analog computation was capable of solving two linear differential equations simultaneously. What is more, they were successfully used during World War I for the gunnery calculations (Ceruzzi 2003).

Furthermore, one of the most successful analog devices, based on a wheel-and-disc integrator, was used in Liverpool's port and helped with the prediction of tides. This analog device remained in service in Liverpool port until the 1960s (Ceruzzi 2003). The outstanding success of the analog machine invented in 1872 by Sir William Thomson, resulted in the broader adoption of the analog devices worldwide, and substantially shifted the development focus towards analog devices (Ceruzzi 2003).

However, during the early twentieth century, and with the introduction of a differential analyzer, the analog devices reached their peak in usability (Coriolis 2008, 5). Henceforth, the analog-driven devices were mostly used from the end of the nineteenth century until the 1950s. During the 1950s, due to the rapid progress of digital electronic

devices, the analog devices would be incrementally replaced. However, due to the unique attributes of analog machines, their utilization remained a necessity in a few analog-computing branches (Coriolis 2008, 5-7).

Even the most sophisticated electronic devices during the 1930s served to calculate employees' wages, astronomical predictions and to manage the inventory lists. The basic processes, in today's sense, were considered impossible less than a century ago. Moreover, informational technology presents one of the most complex industry branches that, at the same, is recording extraordinary growth (Lavington 1980). Consequently, the analog-driven devices enabled further research and development of the electronic devices that were significantly less developed during the 1930s than analog devices (Lavington 1980).

Furthermore, scientists and scholars during the 1940s recognized the importance of further development of the calculating machines. Their usability, although limited and expensive, provided necessary solutions to the problems not solvable without their processing capabilities. Consequently, different thoughts and intentions were connected with calculating machines. Namely, calculating machines were previously only used in assisting the users to achieve their objectives. In contrast, the machines developed during the 1940s possessed the capability of solving complex problems without external assistance (Cooke-Yarborough 1998, 101-105).

The first complex machines developed during World War II were, however, electromechanical (Ceruzzi 2003). Electromechanical computation meant that when compared with modern computing machines, their internal parts were smaller, they possessed the mechanical switches that were called relays and had low processing power. Digital electromechanical computing machines were, on the other hand, the first computing devices to serve as a general-purpose digital computer. Although the transition from electromechanical to electronic computation would not happen during the 1940s, general progress in computation was inevitable (Lavington 1980).

The first step towards making the computer without an external assistance a reality marked newly introduced Zuse Z3. This electromechanical computing device served as the world's first programmable computer (Cooke-Yarborough 1998, 102). However, Z3 also possessed the main drawback as its predecessors had. It had to be manually fed with information to solve constraints.

Equally essential and from the same decade was the Colossus, the world's first electronic digital computer. Colossus's primary purpose was in decrypting messages since it was introduced during World War II. Like Zuse Z3, Colossus was programmable. However, both were designed to perform a single and specific task (Cooke-Yarborough 1998, 104-105). In other words, they were not versatile. In addition, both Z3 and Colossus were unable to store their programs internally but had to rely on switches and plugs to alter the wiring (Lavington 1980). Also, the operator had to modify the physical wiring of the whole system to implement any changes in the task given to Colossus. Both Zuse Z3 and Colossus demanded an immense amount of learning in order to be utilized in their entirety. Nevertheless, Colossus demonstrated the capabilities of a well-developed digital machine, although its operations were limited to the specific cryptanalytical tasks that decrypted messages with counting-related equations (Cooke-Yarborough 1998, 106).

Researches had intensified intending to overcome the single-task problem and lack of internal storage issues. By this time, however, researchers had two functioning machines capable of solving tasks, both of which needed to overcome the same problems as mentioned earlier. As a result, in 1948, the first electronic digital computer named small-scale experimental machine (SSEM) was developed. Consequently, the first computer with internal storage capacity was introduced to the market (Enticknap 1988). According to Enticknap (1988), before SSEM, the main problems that the developers had encountered was to recognize and store the computational results. Namely, the predecessors of SSEM were able to save the input coming from the external peripheries, the keyboard, for instance, but lacked internal storing. SSEM was the first computer to overcome storage problems (Enticknap 1988).

After the gradual progress of the 1940s, the information technology industry's growth trend continued in the next decade. By combining the positive aspects of Z3, Colossus, and SSEM, the computing industry intensified its development intending to produce the first computer to be commercially available. The newly developed revolutionary device was mainly intended for military purposes, research establishments, and aircraft developers (Cooke-Yarborough 1998, 101).

Finally, in 1951, the first general-purpose computing device was made available for the public. Named Ferranti Mark 1, it marked the first commercial success that possessed the primary and secondary storage capabilities (Cooke-Yarborough 1998, 103). Although Ferranti

Mark 1 possessed over 4.000 vacuum tubes and a weight of almost 5 tons, it represented a significant improvement over the previous models. For the first time, Ferranti Mark 1 marked the general-purpose digital computer that was commercially available. Nevertheless, regardless of public availability, only nine models of Ferranti Mark 1 were sold, with only three computers leaving the United Kingdom (Napper 2010). What is more, as Ferranti Mark 1's predecessors, Ferranti Mark 1 also consumed tremendous amounts of electricity, more than 25 kilowatts. Nevertheless, the solutions for the power consumption problem were already in development (Cooke-Yarborough 1998, 102-105).

During this era, the immersion of electronics into programmable computers meant that their functionality and speed could be drastically increased. Additionally, with their processing power increases, more demanding tasks could be solved. On the other hand, rapid innovation demanded solutions in the power consumption sphere. With Ferranti Mark 1 consuming over 25 kilowatts, the newer machines would consume even more power (Napper 2010). As a result, the continuous development of transistors during the 1940s resulted in the first transistorized computer, just two years after the introduction of Ferranti Mark 1. By comparison, the new, transistorized computer consumed only 150 watts instead of 25 kilowatts, the amount of power that Ferranti Mark 1 demanded.

In 1951, the same year Ferranti Mark 1 started selling commercially, the idea of microprogramming started to emerge. Microprogramming related to the implementation of the read-only memory, which would possess all of the necessary information to control the central processing unit (Horowitz and Winfred 2019). Due to this change, the development of the central processing unit was accelerated dramatically, mainly because of the high speed of read-only memory. Although developed in 1951, microprogramming would not be used until 1955 (Horowitz and Winfred 2019). The first computer to possess the microprogramming capabilities was EDSAC 2 (Wilkes 2004).

With the development of microprogramming, researches on the central processing unit were substantially accelerated. Consequently, it marked the end of the first generation of computers. The second generation of computers was based mostly on the transistors replacing traditional vacuum tubes (Wilkes 2004). The implementation of transistors into computers brought huge advantages over the conventional vacuum tubes. Firstly, transistors were significantly faster, tinier, produced less heat, and required less power. Secondly, transistors lowered the cost, the size, and operational costs of running the computer. In

addition to this, the second-generation computers possessed a longer service life and substantially higher reliability (Wilkes 2004).

What is more, the peripherals of the computer benefited from the implementation of transistors electronics also. The most significant progress was made in the data storage units' sphere, which represents the basics of today's data storage systems. These systems are a necessity to determine the appropriate price for the product. Moreover, during the 1960s, removable data storage units were revolutionary, increasing productivity levels and reducing storage price.

With the commercialization of the computers due to the lower total cost and increased capabilities, the first supercomputer started developing during the 1960s (Lavington 1998). The Atlas, the world's first supercomputer, was finished and operational by 1962. Additionally, virtual memory was firstly implemented on Atlas. The supercomputer was located in the United Kingdom and was operational until the early 1970s (Lavington 1998).

Furthermore, during the mid-1960s, the third generation of computers was developed. The major innovation responsible for this technological progress was the integrated circuit. Initially produced for military purposes, the integrated circuit was later considered a crucial part of commercial computers. The integrated circuit allowed for further reduction in the size of the computers, consequently bringing the more powerful machines to the broader audience. What is more, the third generation of computers saw a large number of new manufacturers entering the market, thus making the computer-market more competitive and lowering the price for the end-consumer (Wilkes 2004).

Finally, the fourth generation of computers is marked by microprocessors (Betker et al. 2002, 1-2). Microprocessors derived from the previous technological advancements, namely from transistors and integrated circuits. The fourth generation started with the invention of the microprocessor in 1971 and represented the most crucial part of the information technology advancements. In 1971, Intel, one of the largest microprocessor manufacturers, developed two chips: Intel 4004 and Intel 8008. Intel 4004 was designed specifically for the calculators, whereas Intel 8008 was meant for the general-purpose computer.

Furthermore, Intel 4004 was the first 4-bit microprocessor intended for commercial use. Soon after Intel 4004 introduction, the central powering unit was integrated into general-purpose computers instead of calculators. The Intel 8008 microprocessor presented the more

powerful, 8-bit version of the chip. In addition to that, Intel's microprocessors were revolutionary because they allowed for the first time for the whole central processing unit to be placed on one chip, and they were, moreover, programmable. However, the microprocessors would not become instantly widely adopted. At first, the general public was unsure of the implementation possibilities of the newly developed microprocessors and their everyday usability. On the contrary, Intel's 8080 microprocessor, introduced in 1974, due to the higher marketing efforts and processing power increase, became highly successful (Betker et al. 2002, 2-6).

The microprocessors represent the core for today's successful price optimization and its instant adjustments. Depicting the evolution of the information technology, Intel 4004 had just over 2000 transistors, while today's modern microprocessors possess 10 to 50 billion transistors on the single-chip (Intel 2020). The rapid increase in the number of transistors on the integrated circuit is a direct result of the research conducted to supply the ever-increasing market. The co-founder of Intel, Gordon Moore, stated in 1965 that the number of transistors on the integrated circuit would increase by two-fold every 24 months for the next decade (Moore 1965, 1-2). His statement later became known as Moore's law. Moore's prediction was not only accurate for the following decade, but the transistors continued doubling every 24 months until 2010. Between 2010 and 2017, the number of transistors on the integrated circuit increased drastically, but not at the pace claimed by Moore's law. However, since 2018, the number of transistors started doubling every 24 months again (Intel 2020). What is more, Moore's law serves as the guideline and measurement of the success for the microprocessor developers.

Ever since the first information exchange means, the whole society highly relied on the speed and accuracy of the received information. Consequently, present trends of adjusting the right marketing strategy and the right price, highly rely on the correct utilization of the information technology means. In the next sub-chapter, the historical overview of the data storage systems will be provided, and various data gathering methods and influence on the end-price will be underlined.

3.2. Information Technology as the Enabler of Determining the Most Appropriate Price

With the exponential growth of information technology over the last century, many industries had to change and adapt drastically to remain competitive in the ever-more technologized market. The adoption of various marketing strategies undoubtedly helped the leading companies to acquire larger market shares (Rajagopal 2020). What is more, the developments in the data processing industry and the implementation of computers into everyday decisions made pricing strategies more prone to change. Additionally, the improved strategies, when implemented correctly, yield higher profit margins.

Furthermore, advancements in data processing and data storing spheres enabled the leading companies to gather more personal consumer data. By processing the collected data, companies can instantly adjust the product price and observe the changes in demand for their product more optimally. In addition, information technology progress enabled better communication among various parties, thus further increasing the informational flow. The multiple benefits could be seen in many industries, where the optimization of the supply chain leads to immense cost cuttings. For instance, the aviation industry and logistics service providers benefit from the improved information industry tremendously. Namely, by implementing tracking chips on to their vehicles, companies can easily adjust the optimal route, traveling speed, and stoppage times.

Chapter 3.1. described developments in the computing industry that allowed the companies to process the newly acquired data. However, the storage of the received data and its classification had to be proportionally developed also. Consequently, the following sub-chapter provides a historical overview of the main milestones achieved in the data-storage sphere.

3.2.1. Historical Development of Data Storage

Long before the invention of the computer storage systems, gathered data had to be manually processed and stored. The earliest documented storage means were clay tablets and engraved wood (Goda and Kitsuregawa 2012, 1). The oldest information storage device still used today is the paper, which was invented more than two thousand years ago in China. With

the mass production of paper, and due to its capabilities, more information could be stored than before.

Consequently, with the paper, the significant increase in the information flow was enabled. Moreover, by broader adoption, the literacy rates surged globally, thus further broadening the information reach. What is more, the paper remained one of the most crucial storage mediums in today's society (Goda and Kitsuregawa 2012).

During the nineteenth century and with the invention of the mechanical calculator, the intention of using the paper as the computer's information storage media was born. Consequently, the punched card system was developed to serve as a data storage and calculation medium. Over the following decades, the punched card system continued its incremental development. By the end of the 1900s, a machine capable of electrically reading the punched cards was prototyped. The device greatly influenced the punched cards system. Therefore, previously manually read punched cards were now significantly faster processed. The machine detecting the holes in the punched cards was named the Tabulating Machine, and it came at the right time for the United States Statistic's Department, which was facing huge issues in 1890 due to the massive immigration. Namely, a decade prior, in 1880, the Statistic's Department required more than seven years to process the punched card data manually. Therefore, with increased immigration, the government of the United States estimated that Statistic's Department would not be able to process the data before 1900. However, with the help of the Tabulating Machine, the entire data was processed and verified in less than two years (Goda and Kitsuregawa 2012, 1-2).

The punched card system was incredibly successful, and it stayed the most utilized data transportation and data storage medium until the 1950s. With the invention of the electronic computers during the 1950s, the punched cards system was incrementally substituted for a newer data storage medium, magnetic tape. The magnetic tape dates back to the end of the nineteenth century. It was not, however, until 1928 that a commonly referred to magnetic tape was developed. Moreover, the first magnetic tapes were intended for the audio recordings. Over the following decades, their usability in the computing sphere has been recognized.

Consequently, in 1951, the UNIVAC I was introduced. UNIVAC I served as the first electronic, general-purpose digital computer that utilized the magnetic tape to store the

information. From that point onwards, the magnetic tape served as the default storage option on many devices (Goda and Kitsuregawa 2012, 2-3).

The early versions of the magnetic tape were relying on the reel-to-reel type of storage. However, by the 1970s, the reel-to-reel versions were replaced with magnetic tape in cartridges. Since magnetic tape's initial purpose was for the audio recordings, it allowed only for sequential data access. On the contrary, when used for data storage purposes, the computer usually demands the random access of the data. Therefore, the magnetic tapes started being replaced by magnetic disks, because the latter possess the capabilities of the random data access.

What is more, magnetic tapes were becoming obsolete, and more data centers relied solely on the magnetic disks to store their data. Nonetheless, magnetic tapes consume significantly less power when compared to magnetic disks. With the rise in power consumption awareness globally, some of the data storage facilities are opting for the magnetic tapes as their data storage medium (Goda and Kitsuregawa 2012, 2-5).

On the other hand, magnetic disks are a dominant secondary storage option in data centers and on laptops and computers as well. Initially, magnetic disks required massive power supplies and large cabinets to operate, limiting their usability only on large computers. By the end of the 1980s, their functionality increased, and they could be implemented into various computing devices, ranging from data centers to laptops. Additionally, during the 1990s, disk arrays were introduced. They were composed of numerous magnetic disks to increase the storage capacity. This external data storage alternative started gaining popularity due to its cheapness and instant data accessibility capabilities (Goda and Kitsuregawa 2012).

For most of the twentieth century, the storage mediums mentioned above provided the necessary capabilities for storing and manipulating data. However, at the start of the 1980s, the magneto-optical and optical disks were the dominant data storage means. These disks stored the information by modifying the disk-recording surface. After that, the information could be easily read by projecting the light beams onto the changed surface, and by examining the received reflection. According to their exact recording methods, these storage mediums can be categorized into four types. The first type is the read-only optical disk, which is mainly distributed in the form of CDs or DVDs. The second type is the write-once-read-many optical disk, where the data, once recorded, cannot be written again. The most noticeable products are CD-R and DVD-R. The third type is the optical disk with the

rewritable characteristics, from which CD-RW and DVD-RW are the most recognized products. Finally, the fourth group consists of rewritable magneto-optical disks, on which the disk drive changes the disk's recording surface. As most of the information goods, the main characteristics of the optical and magneto-optical disks are their initial cost to produce, but on the contrary, their cheapness to reproduce.

Consequently, optical and magneto-optical disks are used for various information goods. Namely, the CD is mostly utilized as the medium for audio storage, whereas DVD is mostly used for visual products. What is more, both mediums were heavily used as the distribution medium for computer software. However, in recent years, major software companies switched to online distribution (Goda and Kitsuregawa 2012, 3-4).

The data storage medium marking the highest commercial usage in recent years is the storage class memory. Even though the latest advancements in data storage enabled today's high usability of the storage class memory, it dates back to the 1950s. However, it was not until the 1990s and the invention of the flash memory, that storage class memory became broadly available. The main advantage of the flash memory over magnetic disks is in the significantly lower latency. The most notable products using the storage class memory are the SD cards and solid-state drives. Solid-state drives are used in modern computers, ordinarily storing the computer's operating system and applications for faster access and lower latency (Goda and Kitsuregawa 2012, 5).

One of the significant milestones achieved by the data storage technology was storage networking. New methods of storing the data had to be invented to keep pace with the exponential growth of the information shared. The storage networking not only overcame the problems of the local storage by connecting the various types of storage devices but had a dramatic positive influence on productivity. The storage networking provides a solution to the traditional bus technology serving only one specific computer. Namely, it interconnects all of the storage devices and grants higher accessibility to the data stored. The total data storage capacity could be partitioned and allocated, thus further optimizing the company's storage resource management. By acquiring the consumer data, storing, and accessing it more optimally, a better overview of the consumer demand can be depicted (Goda and Kitsuregawa 2012, 6-8).

With further improvements to the broadband networks, the cloud storage services started being offered. Commonly known as storage outsourcing or cloud computing, the

customer would use the outside data center's capacities to store, access, and store their business data (Goda and Kitsuregawa 2012, 7). The major cloud computing companies are Microsoft Azure, Amazon Web Services, Google Cloud, Alibaba Cloud, and IBM Cloud.

Today, the market-leading companies use different means of storing the data to access it timely and reduce costs. However, each company gathers its consumer data differently. Consequently, the next sub-chapter explains different ways of acquiring consumer data.

3.2.2. Consumer Data Gathering Methods

Today's society relies predominantly on the Internet as their information source. On the one hand, the Internet and its availability are responsible for the fast spread of the information. On the other hand, the Internet acts as the biggest playground for large companies to gather personal data. The value of personal data is priceless. With it, companies can not only adequately adjust their prices but also improve their product and, in some cases, sell sensitive data to third-party companies.

What is more, with the ever-increasing ubiquity of the devices connected on the Internet, the manufacturing companies possess a vast amount of personal data (Weber 2015). The Internet of Things represents the connected devices equipped with sensors that are capable of interacting with the environment. However, these devices were first introduced to enable the sufficient supply chain and save the additional costs by the on-time delivery. The Internet of Things devices were first equipped with radio frequency identification technology to allow for goods to be tracked, timely ordered, and delivered. Over the years, however, with the improvements in technology, their applications widened, becoming part of everyday life (Weber 2015).

Therefore, the Internet of Things provided a significant flow of personal information for the companies. On the contrary, daily activities on the Internet can be tracked and processed by big corporations. For example, Google, one of the biggest corporations in the world, accumulates an immense amount of personal data by offering their services for free. On the other hand, by providing most of its services for free, Google manages to acquire significant market share, and consequently, a large amount of consumer data (Vise 2007). Google has an overall presence in the internet world, from the most popular search engine to YouTube, the most popular online video sharing platform. What is more, Google offers various

other services in its portfolio, all of which are the most used in their respective operating branches (Vise 2007).

Most of the big corporations share a similar business model. They are offering their digital products free of charge and then incrementally start to run personalized ads to achieve revenue. However, the companies have to be cautious not to lose their customers by running the ads. It could be caused by either showing the excessive amount of the ads or by their irrelevancy to the customer.

The problem of showing the irrelevant advertisement to their users Google solves by optimizing their search algorithm. For instance, Google applies its Page Rank algorithm to consider various variables when presenting the advertisements to users. The detailed explanation of the Page Rank algorithm, its applications, and its effects on the advertisements' price and Google's revenue will be explained in the upcoming chapters.

3.2.3. Influence of Consumer-*Behavior* Data on Setting the Right Price

The most crucial decision within every company is in determining the right price. According to Baker, Kiewell, and Winkler (2014), even a one percent increase in the product price leads to an over eight percent increase in total revenue. However, over thirty percent of the middle and upper management's pricing decisions do not correspond to the initially set revenue targets. Furthermore, today's technology enables instantaneous price adjustment, thus capturing the largest market share.

On the contrary, to implement the information technology into everyday business decisions, the companies have to make significant upfront investments, reorganize the managemental decision-making process, and, to determine a way of obtaining the consumer data. Although companies already have the necessary tools to collect big data, their processing demands further improvements. Additionally, many of the data is processed manually, and the companies' decisions are slowly met.

Consequently, the regular price increases are rarely based on scientifically processed customer data. On the contrary, most price increase decisions are the result of the competitors' market actions. As a result, the marketer cannot adequately justify the price increase to the customers, ultimately leading to lower product revenues (Baker, Kiewell, and Winkler 2014).

Furthermore, the data gathered has to be processed on the micro-scale instead of the macro-scale. Processing the data on the micro-scale is especially problematic in the large corporations that are ordinarily operating in the business to business environments. Due to the lack of granularity of their business operations and gathered data, large business-to-business corporations are potentially losing up to eight percent in yearly revenues (Baker, Kiewell, and Winkler 2014).

Baker, Kiewell, and Winkler (2014) state that to optimally gather and process the customer data, the company needs to embrace four ways of managing the big data. Firstly, the method of setting the right price is ordinarily, not a data gathering, but the data-processing problem. Moreover, business-to-customer companies tend to have better data-processing solutions that are simultaneously analyzing macro-economic changes and micro-economic changes. On the contrary, the business-to-business companies, also perform the data-processing methods but not to detect the most appropriate price, but to manage and sort their big data. Secondly, automatization with the company is highly essential. By automatizing the data gathering processes, more data can be collected and sorted.

What is more, similar data clusters could be built, thus enabling the repetitive price adjustments automatically. The company also benefits from the previous historical data and its price solutions. Thirdly, the right price must be determined by the active cooperation between the lower-management, middle-management, and upper management. Consequently, through different opinions, the more appropriate price can be determined. The resulting product price is better accepted by the customers (Baker, Kiewell, and Winkler 2014).

Ultimately, the companies have to synchronize their profits targets regularly. Only by observing the product profit changes could the big data be timely utilized to achieve the price yielding the highest profits. The businesses that failed to transition from the traditional price-setting policies to the optimal price-setting using big data leave substantial profit opportunities unutilized (Baker, Kiewell, and Winkler 2014).

4. Comparison between Market/Value Based, Cost Based and Arbitrary Prices

The markets of today are highly competitive. Due to the widespread of information technology, most companies have switched their operations from brick and mortar stores to the online means of operation (Smith et al. 1999). Especially for today's high-tech companies, the pricing strategies present the most critical decisions. What is more, instant adjustments of the prices according to the competition present a necessity to survive on the market. The longevity of the companies' pricing policies has disappeared due to the rapid development of information technology. Consequently, marketers could be categorized in one of the three categories, according to the utilized pricing strategy: market/value based pricing policy, cost based pricing policy, and arbitrary pricing.

The market-based pricing presents a lucrative way of entering or remaining competitive in the highly saturated market. The price could be initially set higher when introducing the product to the market. However, over time, due to a lack of product-promotion, the price has to be adjusted. When utilizing the market-based pricing strategy, the price should be set according to the competitors. On the contrary, by gathering the market data, the company can achieve a competitive edge, and adjust its price at an initially more adequate level.

Nevertheless, when the market is not fully saturated or has excessive demand, the product price should be increased (Smith et al. 1999). The product's life-cycle is another factor that profoundly influences the price of the product in the market-based market. Hence, the newly introduced product yields higher profits, mainly due to the lack of competition. Furthermore, when the product reaches its saturation point, and the competition strengthens, the product's price has to be lowered.

To determine the market-based price, the product's production costs, market factor price, and additionally, product premium should be added. However, pricing policies usually depend on competitors' actions, and therefore, neglect the consumer demand (Smith et al. 1999).

Furthermore, cost-based pricing is aimed towards covering the total product cost and towards achieving a substantial profit margin (Plinke 1983). Moreover, the companies in the cost-based markets usually have lower profits per unit. However, smaller profit margins do not necessarily implicate for the lower total profits, because the total revenue significantly

increases. On the contrary, the companies utilizing the cost-based pricing strategy have to keep their production costs low. Consequently, a minor increase in the production costs could lead to a significant total cost increase, resulting in the company's loss of market share. This pricing strategy combines the costs of producing, distributing, and selling the product. The product's fixed and variable costs represent the total cost of the product (Plinke 1983). By adding the desired markup to the product's total cost, the final product price is created. Nonetheless, this pricing strategy does not observe the competitors' pricing behavior nor the ever-changing consumers' demand. Although the cost-based pricing has various disadvantages, it can prove beneficial for the market-leader companies that can achieve a higher price markup and retain their market percentage (Plinke 1983).

Finally, the arbitrary pricing methods are mostly utilized by the companies operating in the monopoly or oligopoly. In other words, arbitrary pricing demands a large customer base and small competition. Moreover, the arbitrary pricing strategies record significant plunge due to the rapid surge of information technologies. Nevertheless, some companies competing in saturated markets manage to implement arbitrary pricing successfully by differentiating their product. Namely, these companies utilize mostly first-degree price discrimination and third-degree price discrimination strategies, which will be described in the next chapter.

4.1. Utilizing the Discriminatory Price Strategies

Some customers are willing to pay a higher price for the same product. The sellers should try to utilize this fact to maximize their profits (Shapiro and Varian 2010). Moreover, the sellers achieve price differentiation by the adoption of first-degree, second-degree, or third-degree price discrimination strategies.

Furthermore, whereas the first-degree price discrimination and third-degree price discrimination do not provide the customer with self-selection, second-price discrimination does. First-price discrimination utilizes the individual pricing strategy, consequently providing each customer with a different price. In other words, each customer is offered the amount equal to customers' maximal willingness to pay for the product. The first-degree price discrimination is also known as the perfect price, since its utilization capture the whole consumer surplus, maximizing the profits (Shapiro and Varian 2010).

Third-degree price discrimination represents the most utilized way of a price differentiation strategy. It consists of charging a different price for the different consumer groups. What is more, the customers are separated based on their individual or regional characteristics.

The only category possessing the customer's self-selection character is second-degree price discrimination. Namely, the seller is offering a different version of their product, where the customer can select the most suitable one. There are various product dimensions that versioning influences, namely: delay, convenience, speed of operation, capability, features, and support.

Price discrimination strategies indeed provide large profits. However, to be implemented without losing a significant market share, the company must first determine the exact market structure. In addition, the consumer-base has to possess different price sensitivities. Especially essential for the price differentiation is the dynamic pricing, which enables the more effective and timely individual pricing strategy. Dynamic pricing allows instantaneous pricing strategies to be applied (Shapiro and Varian 2010).

On the one hand, technological developments accelerated the expansion of price differentiation pricing. On the other hand, however, due to the improvements in information technology, consumers can easily detect huge price fluctuations. The following sub-chapter demonstrates the effects of machine learning algorithms on everyday pricing strategies and total revenue.

4.2. Adjusting the Prices to the Ever-Changing Consumer Behavior via the Market Data and Machine Learning Algorithms

At the start of the twenty-first century, the large corporations, mostly from the technology sector, started implementing new strategies to price their goods more effectively. With the wider adoption of the information goods, there was a necessity for better pricing techniques. The information goods possess different characteristics when compared to conventional products. On the one hand, the information goods are cheap to reproduce, have no production limits, and do not have incremental production costs. On the other hand, their initial production cost is high. Therefore, if not successful, they are usually presenting sunk costs for the company. Consequently, due to the risks connected when funding the new product, the large corporations had to implement different pricing strategies.

Therefore, the new means of finding the right price were implemented. Most of the large companies adopted machine learning algorithms to assist them in scaling their price optimally, without jeopardizing their customer base. The machine learning utilizes artificial intelligence to enable systems to recognize various patterns automatically, and to improve their outputs over time, usually without external assistance. What is more, they are focused on enhancing data-gathering and processing software (Alpaydin 2020).

The machine learning could be categorized into three groups: supervised learning, unsupervised learning, and reinforcement learning (Sathya and Abraham 2013). Firstly, under supervised learning, the machine has to be externally supplied with the labeled data. The machine-produced output has to be labeled also. The classification problem and regression problem represent the basic types of problems solvable utilizing supervised learning. The machine learning used in classification-related problems profoundly influences the processing time of the company's data storage. Not only that, but the better classification of the customer's buying patterns enables the quicker data-retrieval and its consequent implementation.

Additionally, the regression algorithm is used for the tasks of predicting the continuous quantity (Alpaydin 2020). Therefore, it is highly utilized by the companies in predicting the possible price movements, or the stock market price of the selected company. Moreover, supervised learning can be useful to evaluate the risk of the investment or to make a revenue forecast for the newly released product. However, to be reliable and successful, the supervised learning algorithms have to be fed with a sufficient amount of labeled input and output data (Alpaydin 2020).

The second category of the machine learning algorithm is unsupervised learning. The input consists of the unlabeled data, and the machine learning algorithm has to attain the undetected patterns, without external supervision. In addition, the unsupervised learning algorithm only uses the unlabeled input as the training data and produces the unlabeled output. Moreover, unsupervised learning is used to solve clustering and association problems.

The clustering algorithm is valuable for companies that are gathering a vast amount of customer and market data, and especially for companies with their business model orientated towards targeted marketing. Namely, the company with a large amount of customer data could use the clustering algorithm to cluster and separate the different types of customers

and to combine it with their purchase-behavior (Kassambara 2017). Moreover, the customers could be grouped based on their similarity, interest, willingness to pay, and the intention of buying the product.

Furthermore, the association algorithm involves discovering hidden patterns in data, the correlations, and similarities. For instance, Amazon utilizes the association algorithm to obtain a similar product based on customer preferences and to offer it to the customer, thus selling an additional product and increasing the total revenue. Due to its characteristics, the unsupervised learning algorithm is mostly used by the business to detect the sale anomalies and to create recommendation systems. However, the difficulty with unsupervised machine learning is in the algorithm training period since the algorithm has to establish the output without external supervision (Kassambara 2017).

The third category of machine learning is the reinforcement algorithm. The main difference in reinforcement machine learning is that there is no predefined input data. Still, the algorithm operates by placing an agent that interacts with its environment, consequently getting a reward or an error for the processes engaged. The reinforcement learning algorithm has various application possibilities, and it can significantly influence the company's optimization of the supply chain and make it more efficient (Sutton and Barton 1998).

Moreover, machine learning presents an essential part of Google's business model. One of their main revenue streams is advertising, which is ahead of its competition due to the utilization of machine learning algorithms. Namely, the advertisement pricing strategy is dynamically optimized, thus achieving the most suitable price for the advertisers, the best experience for the consumers, and the best quality-price ratio of the advertisements for Google.

In contrast to the conventional auction system, Google utilizes the second price auction system for advertisements and their position within the topic searched. In the traditional auction system, the highest bidder would receive the first advertising position. However, the highest bidder's advertisement does not guarantee its quality. Although Google prioritizes the revenue, they have to maintain the customer's satisfaction, but also the advertisers' satisfaction by presenting their advertisement to the relevant audience (Hansen 2009). To fulfill these strict criteria, Google does not only apply the second price auction principle but, additionally, their page rank algorithm. The page rank algorithm consists of several constraints.

The first constraint is the advertisement's expected clickthrough rate. It shows the percentage of users that click on the advertisement shown, thus depicting the advertisement's relevancy to the customer. The second constraint is the landing page experience. This constraint takes into consideration the relevancy and originality of the landing page, its navigability, and transparency. The final two constraints are securing the advertisement's relevancy and advertisement's formatting style. By utilizing the Page Rank algorithm, namely by combing all of the factors as mentioned above, Google guarantees not only the best experience for the users by showing them relevant and highly optimized advertisements but for the advertisers also. Moreover, Google's machine learning algorithms used to set the most appropriate price are depicting the importance of information technology in today's society, the necessity of gathering the consumer data, data-processing tools, and real-world application (Hansen 2009).

5. Conclusion

Over the last centuries, significant advancements in information technology have been made. The parallel development of marketing was applied and combined with information technology to achieve a competitive edge. With a better understanding of the market, the companies are more successful in setting the most optimal price. However, the consumers possess a greater knowledge of the market, consequently forcing the marketers to utilize the new means of calculating the most appropriate price.

Furthermore, with the number of consumer data gathered by the companies on the rise, the new pricing models have to be developed. Thus, the new pricing models started to emerge, utilizing data-driven pricing strategies. By optimally managing the gathered data, the company can combine more variable factors into price decision-making, consequently winning the larger market share. Additionally, with more data about the actual market situation, company, and the macroeconomic situation, a more competitive price can be determined.

Implementing machine learning into setting the price has enabled a dynamical, constantly adjusted pricing strategy that yields the highest profits. Nonetheless, machine learning implementation demands high upfront costs and the constant algorithm optimizations. Moreover, machine learning pricing effectively introduces price discrimination policy within the company, which could lead to lower customer satisfaction levels.

Nevertheless, the companies lagging in making the necessary transitions could be overtaken by their competitors. Therefore, the combinations of the proper marketing-mix strategy, traditional pricing strategy, and data-driven pricing strategy are advised.

Bibliography

Alpaydin, Ethem. *Introduction to Machine Learning*. Cambridge, MA: MIT Press, 2020.

Baker, Walter, Dieter Kiewell, and Gerog Winkler. “Using Big Data to Make Better Pricing Decisions.” McKinsey & Company, June 1, 2014. https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/using-big-data-to-make-better-pricing-decisions.

Bartels, Robert. *The History of Marketing Thought*. 2nd ed. Homewood, IL: Irwin, 1976.

Betker, Michael R., John S. Fernando, and Shaun P. Whalen. “The History of the Microprocessor.” *Bell Labs Technical Journal* 2, no. 4 (August 14, 2002): 1–28. https://doi.org/https://doi.org/10.1002/bltj.2082.

Borden, Neil H. *The Concept of the Marketing Mix*, 1964.

Ceruzzi, Paul E. *The History of Modern Computing*. Cambridge, MA: MIT Press, 2003.

Chaudhuri, Pal P. “Input/Output Organization.” *Fundamentals of Computer Organization and Design Texts in Computer Science*, 2004, 767–824. https://doi.org/10.1007/0-387-21566-2_19.

Clemons, Eric K., and Bruce W. Weber. “Segmentation, Differentiation, and Flexible Pricing: Experiences with Information Technology and Segment-Tailored Strategies.” *Journal of Management Information Systems* 11, no. 2 (1994): 9–36. https://doi.org/10.1080/07421222.1994.11518038.

Cooke-Yarborough, E.h. “Some Early Transistor Applications in the UK.” *Engineering Science & Education Journal* 7, no. 3 (January 1998): 100–106. https://doi.org/10.1049/esej:19980301.

Coriolis, Gaspard-Gustave. “Coriolis, Gaspard-Note Sur Un Moyen De Tracer Des Courbes Données Par Des Équations Différentielles.” *Journal De Mathématiques Pures Et Appliquées*, 2008, 5–9.

Driscoll, Kevin. “From Punched Cards to ‘Big Data’: A Social History of Database Populism.” *Communication 1*-1, no. 1 (August 2012): 1–35.

Enticknap, Nicholas. “Computing's Golden Jubilee.” Computer Resurrection Issue 20, 1988. https://web.archive.org/web/20120109142655/http://www.cs.man.ac.uk/CCS/res/res20.htm#d.

Goda, Kazuo, and Masaru Kitsuregawa. “The History of Storage Systems.” *Invited Paper* 100 (May 13, 2012): 1–8.

Guttmann, A. “Effectiveness of Marketing Strategies Worldwide 2018.” Statista, October 17, 2019. https://www.statista.com/statistics/693269/marketing-strategy-effective/.

Hansen, Jacob. „The Economics of Search Engines – Search, Ad Auctions & Game Theory. Copenhagen Business School, Applied Economics and Finance, 2009.

Horowitz, Paul, and Winfred F. Hill. *The Art of Electronics*. New York, NY: Cambridge University Press, 2019.

Intel, 2020. "10th Gen Intel® Core™ Processors." https://www.intel.com/content/www/us/en/products/docs/processors/core/10th-gen-processors.html.

Jones, Alexander. *The Inscriptions of the Antikythera Mechanism*. , Greece: Hellenistic Society of History, Philosophy and Didactics of Sciences, 2016.

Kassambara, Alboukadel. *Practical Guide to Cluster Analysis in R: Unsupervised Machine Learning*. S.l.: CreateSpace Independent Publishing Platform, 2017.

Kells, Lyman M., Willis F. Kern, and James R. Bland. *The Log Log Duplex Decitrig Slide Rule, No. 4081: a Manual*. New York: Keuffel & Esser, 1955.

Lavington, S. H. *A History of Manchester Computers*. Vol. 2. Swindon: British Computer Society, 1998.

Lavington, Simon. *Early British Computers: the Story of Vintage Computers and the People Who Built Them*. Manchester: Manchester U.P., 1980.

Mata, Francisco J., William L. Fuerst, and Jay B. Barney. "Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis." *MIS Quarterly* 19, no. 4 (1995): 487. https://doi.org/10.2307/249630.

Montaner, Simon. *Diccionario Enciclopedico Hispano-Americano De Literatura, Ciencias y Artes*. Barcelona: Montaner y Simón, 1944.

Moore, Gordon E. "Cramming More Components Onto Integrated Circuits." *Electronics* 38, no. 8 (April 19, 1965): 1–4. https://doi.org/10.1109/jproc.1998.658762.

Nancarrow, Clive, Len Tiu Wright, and Ian Brace. "Gaining Competitive Advantage from Packaging and Labelling in Marketing Communications." *British Food Journal* 100, no. 2 (1998): 110–18. https://doi.org/10.1108/00070709810204101.

Napper, Brian. "The Ferranti Mark 1." Ferranti Mark 1. The University of Manchester, 2010. http://curation.cs.manchester.ac.uk/computer50/www.computer50.org/mark1/FM1.html.

Onkvisit, Sak, and John J. Shaw. "Service Marketing: Image, Branding, and Competition." *Business Horizons* 32, no. 1 (1989).

Plinke, Wulff. *Cost Based Pricing: Behavioral Aspects of Price Decisions for Capital Goods*. Hannover: Univ., 1983.

Rajagopal. *Qualitative Marketing Research: Understanding How Behavioral Complexities Drive Marketing Strategies*. New York, New York (222 East 46th Street, New York, NY 10017): Business Expert Press, 2019.

Rajagopal. *TRANSGENERATIONAL MARKETING: Evolution, Expansion,and Experience*. S.l.: SPRINGER NATURE, 2020.

Rojas Raúl, and Ulf Hashagen. *The First Computers: History and Architectures*. Cambridge, MA: MIT Press, 2002.

Sathya, R., and Annamma Abraham. "Comparison of Supervised and Unsupervised Learning Algorithms for Pattern Classification." *International Journal of Advanced Research in Artificial Intelligence* 2, no. 2 (2013). https://doi.org/10.14569/ijarai.2013.020206.

Schmandt-Besserat, Denise. "Decipherment of the Earliest Tablets." *Science* 211, no. 4479 (January 16, 1981).

Shapiro, Carl, and Hal R. Varian. *Information Rules: a Strategic Guide to the Network Economy*. Boston, MA: Harvard Business School Press, 2010.

Singh, Meera. "Marketing Mix of 4P'S for Competitive Advantage." IOSR Journal of Business and Management 3, no. 6 (2012): 40–45. https://doi.org/10.9790/487x-0364045.

Smith, David Eugene. *A Source Book in Mathematics*. New York, 1959.

Smith, Michael F., Indrajit Sinha, Richard Lancioni, and Howard Forman. "Role of Market Turbulence in Shaping Pricing Strategy." *Industrial Marketing Management* 28, no. 6 (November 1999): 637–49.

Sutton, Richard S., and A. G. Barto. *Introduction to Reinforcement Learning*. Cambridge, Mass: MIT Press, 1998.

Tiwana, Amrit. *IT Strategy for Non-It Managers: Becoming an Engaged Contributor to Corporate IT Decisions*. Cambridge, MA: MIT Press, 2017.

Vise, David. "The Google Story." *Strategic Direction* 23, no. 10 (2007). https://doi.org/10.1108/sd.2007.05623jae.001.

Weber, Rolf H. "Internet of Things: Privacy Issues Revisited." *Computer Law & Security Review* 31, no. 5 (2015): 618–27. https://doi.org/10.1016/j.clsr.2015.07.002.

Weiss, E. "Konrad Zuse Obituary." IEEE Annals of the History of Computing 18, no. 2 (1996): 3. https://doi.org/10.1109/mahc.1996.489747.

Wilkes, M. V. "IEEE Annals of the History of Computing." *IEEE Annals of the History of Computing* 26, no. 1 (2004). https://doi.org/10.1109/mahc.2004.1278843.