

**Budapest Business University**  
**Faculty of Commerce, Hospitality and Tourism**

**The Challenges of Video Game Hardware  
Industry Supply Chain Between 2020-2023**

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### Declaration of thesis authenticity

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## 1.0 Abstract

The video game industry became the leading form of entertainment in the 2020s, surpassing both the music and the movie industries. As this interactive form of entertainment maintains its growth, the high demand, the concurrent geopolitical connections, and worldwide incidences are propelling the industry's supply chain into a fragile state.

Hence, the popularity and the profitability of the industry it is adequate to analyze its connections within commerce, marketing, logistics, and crisis management, notwithstanding the fact that the video game industry is still not as widespread in Hungary in 2023 as in other Western countries such as the United Kingdom or the United States.

With the ongoing factors between 2020 and 2023, such as the COVID-19 pandemic, a worldwide semiconductor shortage, and a cryptocurrency mining trend, the supply chain of video game consoles shattered, and a shortage emerged.

As a result of the topic being relatively niche, the number of relevant academic papers and scientific research is limited. In addition to a few academic papers, the collection of relevant secondary data in the region is also limited; hence, the video game industry is studied most commonly under the banner of psychology, not logistics or commerce.

This academic paper intends to analyze the conditions surrounding the video game console shortage, briefly, the main factors impacting it and possible solutions in the case of a similar shortage in the future. Furthermore, it contains relevant interviews with established members of the video game industry and relevant primary and secondary data based on focus groups, a branching survey, and relevant data found in reliable databases.

Triangulation is meant to discover correlations and contradictions amidst the collected data, therefore depicting a more precise knowledge of the industry and the shortage.

It contains possible solutions for a console shortage in the future based on the primary and secondary research results, and a description of a prototype warehouse management/price aggregator mobile application project developed using Adobe XD and Figma.

The goal of the scientific research is that by the end of the conclusion, the reader will have a comprehensive understanding of the video game industry and the console supply chain shortage phenomenon between 2020 and 2023.

## **2.0 Introduction**

### **2.1 The Entertainment Industry and the Emergence of the COVID-19 Pandemic**

The entertainment industry has always been a vital part of humanity; it has an immense cultural significance and an impact on sociology, but it also plays a tremendous role in creating commercial trends. It has an even more significant role in our ever-changing and fast-paced society. As most creations of the entertainment industry can be categorized as intellectual products, it can be troublesome to talk about the entertainment industry from the classical viewpoints of the supply chain.

Still, most of these intellectual properties need hardware to hear (in the case of music), to view (in the case of pictures or movies), or to play (in the case of video games). Therefore, the devices that are used to enjoy these intellectual properties (e.g., radio, television, video game consoles) can be researched within the main elements of supply chain management.

During 2020, humanity faced a series of unprecedented events with the spread of the COVID-19 virus and its consequences in the subsequent years. Multiple lives were changed because of the pandemic, and in correlation with these changes, consumer behaviors and the lifestyle of billions had a significant shift as well. With governmental restrictions on gatherings, outgoing, and work, life has changed: there were no concerts where a person could enjoy the music, the cinema was closed, and people could not go outside to the playground with their children. These changes altered consumer behavior and tilted it towards the online world of entertainment and work with streaming services (e.g., Netflix or Spotify), skyrocketing in terms of new users and revenue and the new form of work called "home office."

The supply chain of multiple products was in complete shambles. At the dawn of the pandemic, in March and April of 2020, several types of canned food, staple food (e.g., flour, rice, or sugar), or bathroom products (e.g., toilet paper) saw a shortage at retail stores worldwide. Only negligible deceleration was seen in the supply chain of these items. However, there were significant shortages.

This particular shortage happened, hence, as a phenomenon called "panic buying," where individuals hoard unnecessary amounts of a specific product due to the fact that they fear that they might not be able to acquire these items in the future. When this phenomenon happens, these individuals cause significant harm to an already unsteady (but not wholly unfunctional) supply chain, which results in substantial shortages, causing this phenomenon to be overly contra-productive.



## **2.2 The World of Video Games and the Purpose of the Thesis**

The world of the video game industry is fascinating, and the complexity is genuinely remarkable; hence, this complexity of both commerce, marketing, and logistics have a monumental role in this particular entertainment industry, which generated the most considerable revenue out of these industries, overtaking both the music and the movie industry. (Acosta, 2022)

The video game industry reached remarkable popularity amongst all generations, from the youth to the elderly, with its diverse portfolio of video games.

In connection with the research topic, it is worth mentioning that there are games that give control to the player to plan cities and manage the supply chain (SCM) of these (e.g., Cities Skylines or SimCity), there can also be popular video games which are entirely built around logistics and have in-depth simulations of supply chain systems: Transport Fever, Factorio. Furthermore, game-based learning (GBL) is on the horizon, with games designed specially to teach about logistics and encourage critical thinking and crisis-solving. (Ganske, 2021)

Based on a 2014 study on using video games as a tool to teach supply chain management (SCM) and logistics, video game-based learning was discovered to positively impact the instruction of undergraduate courses about supply chain management and logistics. (Chiung-Lin, 2016)

With the concurrent COVID-19 pandemic, its effects on this complex and flourishing industry, and the launch of the 9th generation of video game consoles, it was self-explanatory that there would be a great connection between these terms and worlds in the research.

The research is meant to analyze the events that caused the manufacturers of video game hardware to struggle with the demand that put weight on their shoulders at the commercial launch of Xbox Series consoles and the PlayStation 5 and the events, solutions, and overall public opinion about the console shortages that happened between 2020 and 2023.

The thesis is supposed to give the reader a comprehensive understanding of the video game industry and the supply chain of video game hardware through a fusion of resources between IT, Logistics, Commerce, and Marketing.

The topic has a lot of positive characteristics: it covers a recent and relevant issue. Hence, it happened during the COVID-19 pandemic, and multiple pertinent articles are found around the correspondent media outlets. On the other hand, the drawbacks can be traced back to the same statement: it is a relatively recent topic; therefore, it is burdensome to find valuable academic papers on it, and it has a smaller group of clients currently in Hungary compared to other countries as the United Kingdom, the United States or Japan.

Due to a combination of favorable and unfavorable factors, it can be affirmed that the research question pertains to a significant subject matter, but in itself, it is very niche and rudimental; therefore, one might find it hard to research.

The research aims to unravel the complicated dynamics and aspects affecting the supply chain's production, distribution, and efficient operation in this burgeoning video game hardware industry while introducing the reader to the world of the gaming industry.

In the following chapters, the thesis will delve deeper into the main characteristics of the supply chain of these specific products, their specific challenges, their implications, and potential strategies to enhance the resilience and effectiveness of the video game hardware industry supply chain during this critical timeframe.

The paper accumulates valuable primary and secondary data from professionals within the video game industry and its related press and fan base to triangulate these to achieve an accurate conclusion. It connects the world of SCM, logistics, and crisis management with the world of the video game industry.

### **3. Literature Review**

#### **3.1 Introduction and the History of the Video Game Industry**

Our world in the 21st century consists of a fast-paced, evolving society keen to use and consume different entertainment forms to pass the time, boost happiness, and have fun. Throughout the history of humankind, many forms of entertainment have been present; from the galant shows of prehistoric times to the booming film industry of Hollywood after the First World War, we humans have come far.

With computers making a debut in the 50s, a new form of entertainment was born: video games. (Rechsteiner, 2022)

Video games are the most complex form of entertainment ever created. They combine both the art of music and cinematography with interactive storytelling and form a great medley. The first commercial video game was released in 1971, but the actual popularity of the video game industry began in the 80s and 90s. (Wardrip-Fruin, 2021)

Although video games are spiritual products, they need a device to be played on: Video Game Consoles or a Personal Computer.

In September 1972, the first commercially available console, the Magnavox Odyssey, was released, and it was not a very popular product. Still, it established the pillars for later consoles like the Atari 2600, with more than 30 million sold units. (Lewin, 2020)

Many companies were keen to try themselves out in this new and fresh industry (Ex. Mattel and Nintendo). The first console made by the infamous Japanese company was the Nintendo Entertainment System (NES), which was released in 1985 and quickly became the most popular console back then. Nintendo helped the industry come out of a slump called the video game crash of 1983, which had been caused by oversaturation of the market with video games that had abysmal overall quality. (Cunningham, 2021)

Other notable companies with successful consoles during this period were Sega with the Sega Genesis and Sony with the ever-popular PlayStation. Later on, tech giant Microsoft also wanted a fair share of the growing market for video game consoles, so they released the Original Xbox in 2001. (Porter, 2021)

Video Game eras are divided into "Generations," defined by console generations. For example, the PlayStation 3 and the Nintendo Wii were part of the 7th generation of video game consoles. We are in the 9th generation with the Xbox Series consoles and the PlayStation 5. (Maldonado, 2021)

### 3.2 Taiwanese Exports and the Beginning of a new Generation of Consoles

The dawn of a new console generation always comes with new challenges for the companies manufacturing these devices. Still, none of the past nine generations had a rough start like the Xbox Series and PlayStation 5 commercial launch. (Byrd, 2022)

The ongoing COVID-19 pandemic and a troubled worldwide financial situation gave manufacturers a hard time. (Blows, 2020) It was genuinely unprecedented to see that companies such as Microsoft or Sony could not prepare their supply chain to keep up with the demand at the start of their new console generation.

The most essential component of video game hardware is the silicon chipset. Both the semiconductors and the graphics powering hardware in these consoles were designed by AMD, which is an American company; however, the production of these chipsets is conducted by Taiwan Semiconductor Manufacturing Company (TSMC). (Blows, 2020)

Compared to the rest of the World, Taiwan was relatively unharmed by the ongoing pandemic, with 4.5 cases per thousand people and no significant government restrictions. Despite this, Taiwan experienced a decline in GDP growth during the second quarter of 2020, coinciding with reduced export performance. The country's economy relies massively on exports, particularly to advanced economies such as the United States, Japan, and China. While there was an increase in exports during the third quarter of 2020, using this as an indicator of semiconductor manufacturing performance suggested that 2020 was anticipated to be a year of overall lower manufacturing and economic growth in Taiwan. (Blows, 2020)

In the following months after the commercial launch of the respective consoles, their situation worsened with more travel restrictions, a worldwide semiconductor shortage, and a supply chain that could not keep up with the demand, and it was anticipated that these woes would continue in the year 2021. (Patel, 2020)

In an interview made by The Verge in November 2020, the CEO of Xbox, Phil Spencer, said:

*“... we are going to be in this situation, probably into the spring, maybe not as tight as it is now, but demand is just really high, and we are building. We started the supply chain back in the summer. We are building, we are building. There is just physics in how many lines at the fab you can put in the assembly lines. You can build as many as you can build, and that is what we have been doing.”* – Phil Spencer, CEO of Xbox (Patel, 2020)

### **3.3 The Growing Market of Semiconductors**

The world and society are continuously evolving, and the central pillar of this progress is the technology surrounding our everyday lives. Since the invention of the first personal computer called Altair, which was developed in 1974, it is a fact that the most critical component of any computer is the processor, which in the first computer was an Intel 8080. (Mazor, 2007) Since 1974, the microprocessor market has been growing at a steady rate.

*CPU – The Central Processing Unit is the most critical hardware component and the core in the personal computer (PC) responsible for executing the user's instructions. It performs calculations to manage tasks and processes for the personal computer's operation.*

In 2022, the market size of microprocessors reached USD 108.63 billion and is projected to experience an annual growth rate of 7.1% over the next seven-year period.

Microprocessors are in everything that people use for work or school (ex., Personal Computers, Tablets), for entertainment (ex., Video Game Consoles, Smart Televisions), and also for health-related measurements (ex., Smart Watches and Sports Bands). The critical CPU (Central Processing Unit) production companies are Intel and AMD, based in Santa Clara, California, and Qualcomm, based in San Diego, California.

The largest microprocessor market is North America, but the Pacific Asian region is expected to emerge as it has been the fastest-growing region in the past five years. The growth is related to the rising penetration of smartphones worldwide, but mainly in the case of developing economies and other electronics such as laptops, mobiles, desktops, and tablets in the Asian region. (Grand View Research, 2022)

### **3.4 The Impact of the Crisis Caused by the COVID-19 Pandemic**

The year 2020 saw unprecedented events, including the rapid spread of the COVID-19 virus, leading to lockdowns, state emergencies, and changes in consumer behavior. An increase in flexible remote working, e-learning, streaming services, gaming, and online shopping drove these changes. During 2020, these changing habits and the increased demand for semiconductors reached the point where they far outpaced their current production. (Fioramonti, 2021)

Intel CEO Pat Gelsinger predicts it will take "a couple of years" to alleviate the ongoing chip shortage. (Fioramonti, 2021)

As a result, prices of memory and semiconductors will likely continue to increase, ultimately driving up the prices of all products that rely on them.

According to Goldman Sachs, the number of industries facing disruptions during this period was estimated to be at least 169, encompassing not only the technology and automotive sectors but others as well. (Howley, 2021)

### **3.5 Bullwhip Effect and the Creation of Customer Value in Logistics**

During the primary and secondary research analysis, the thesis will reveal the general consensus about this particular factor of the console crisis. The forces that caused a disturbance in the supply chain in the case of semiconductors are the same forces responsible for the scantiness of toilet paper, groceries, and bikes. This economic phenomenon is widely recognized as the "bullwhip effect" in the supply chain and logistics world. Understanding the bullwhip effect can show us why this shortage occurred and what could be done to get out of this economic slump. (Rivero, 2021b)

This phenomenon called the bullwhip effect, shows how even the most minuscule alterations in demand for certain goods, as small as toilet paper or as big as the CPUs, can bring about a conversion in the supply chain, causing bigger and bigger gaps in production.

Since humans cannot predict the future, retailers tend to introduce specific errors when they ratchet up their orders to reply to the anticipated demand. Nevertheless, no one calculated such a considerable margin of error as the COVID-19 juncture. The whole situation affected the semiconductor industry and was a nightmare for product managers, supply chain managers, and manufacturers.

This dynamic can be seen on a more prominent scale in industries such as the telecommunication industry or the computer components market; thus, these industries tend to do a "boom to bust" business cycle where the cycle starts when there is a considerable demand, and the distributors and manufacturers reply to this growth in demand by enlarging their inventories and production rates. At some point, the demand shifts, or the supply of the product exceeds the demand levels. (Hugos, 2011, p. 184)

In recent years, companies have rarely had a vertically integrated strategy when it comes to the logistics process because most modern companies have many partners they cooperate with (e.g., logistical/delivery partners, manufacturing partners, retail partners). (Gelei, 2013, p. 31)

In the case of Microsoft and Sony, the logistical partners are Maersk, Ocean Network Express (ONE), FedEx, UPS, and USPS in the United States and UPS in Europe, based on both companies' press releases and support pages.

Logistics of these products, such as the video game consoles, can create customer value during the transaction (the purchasing process of the console) if the perceived benefit of the given deal feels more significant than the expense paid in the eyes of the customer.

One of the most common customer satisfaction indicators is OTIF (on-time, in-full). This shows the proportion of the total customer order received delivered by the deadline set out in the order requirements within a given measurement period.

$$OTIF = \frac{R - HR}{R} \times 100\%$$

R is the number of orders received in the given period, and the HR represents the faulty, inaccurately served orders.

*e.g., If Sony was meant to deliver 1000 units of the PlayStation 5 console to the Hungarian gaming retail store Konzolvilág Kft. between 2020, the 1st of December, and 2020, the 7th of December, but only managed to deliver 500 units; the OTIF indicator would look like the following:*

$$OTIF = \frac{1000 - 500}{1000} \times 100\%$$

(Gelei, 2013, p. 41)

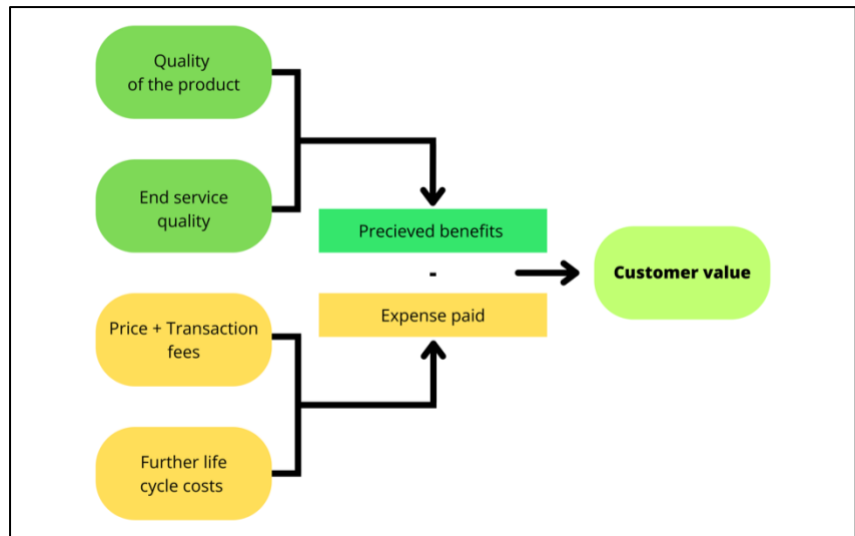
Not only did the CPU industry have unprecedented events that caused a malfunction in the supply chain, but the GPU (Graphics Processing Units) industry did as well.

*GPU – The Graphics processing unit is a specialized component primarily responsible for rendering graphics and accelerating various tasks linked to graphics and parallel processing.*

During the pandemic, there was a significant rise in cryptocurrencies and the mining process, which needs a hardware GPU, an ASIC (Application-Specific Integrated Circuit), and Mining Software.

Cryptocurrency mining uses specialized computer hardware (GPUs and ASICs) to validate transactions, secure a blockchain, and earn rewards in cryptocurrency.

If a particular individual possesses more graphic cards (GPUs) and better, stronger ones, they can obtain and mine more Bitcoin, for example. Therefore, the demand for quality GPUs for crypto mining has risen during the pandemic. This demand had adverse effects on other industries. The video game industry is one of the industries that suffered the most because of these disruptions in the supply chain and the suddenly rising demand.



*Figure 1: The components of the customer value (Anderson, 2006)*

Although the start of the Xbox Series consoles and the PlayStation 5 can be stated as a supply chain catastrophe, and based on OTIF values, it produced subpar performances, there was significant customer value created by a rare phenomenon that often individuals determine a mental equation:

$$\text{Rare} = \text{Valuable}$$

The harder it is to acquire an item, the higher its importance, esteem, or value. Given the situation in 2020 and 2021, it is reasonable to think that manufacturers of the consoles are saving significant budgets by gradually rolling out new stock to their retailers, elevating the preeminence, hype, and prestige of their new hardware. (D' Amore, 2021)

Despite this are the statements of Xbox and PlayStation, who constantly kept hope among their customers, saying that they are working on the solution, and they feel for the ones who could not acquire one of their new hardware. (Yeung, 2020)

During the primary and secondary research analysis, the thesis will reveal the general consensus about this particular factor of the console crisis.



### **3.6 The Dawn of the Ninth Generation of Video Game Hardware**

The two behemoths of the video game industry have announced (with Microsoft announcing the Xbox Series X|S in June 2019 and Sony in April 2019) their following generational video game console systems, which are considered part of the ninth generation of the console industry in 2020. (Williams, 2022)

Microsoft and Sony have stated they want to provide their 9th-generation consoles in time for the Holiday season at the end of 2020. (Molloy, 2020)

This is a usual release window for gaming products such as consoles or video games, as Christmas generates much higher sales than the rest of the year. However, because of certain factors, there will be a prolonged shortage of these products. (Szabados, 2021)

These complex gaming systems require cutting-edge technology to show almost photo-realistic images with no issues. Each console needs a powerful CPU and an even more powerful GPU to process these images and complex calculations. The fierce competition between the crypto miners and the gaming community to buy graphic cards has tripled the resale price and left thousands of hopeless customers needing a GPU to sign up for daily notifications to buy chips at a significantly higher price. (Rivero, 2021)

With the evolving situation, Microsoft and Sony had major supply chain lockups. However, they kept their word: the Xbox Series X|S and the PlayStation 5 were launched just before the 2020 holiday season. However, with the limited production of these consoles, customers could not find these systems anywhere. There were specific groups who hoarded both consoles (mentioned as scalpers during the rest of the research) when they saw them available. After buying them at the regular launch price - which was USD 499 for both the new Xbox and PlayStation – they tried to resell these systems at double or even higher than the regular price.

### **3.7 Development Cycle and Crisis Management in the Supply Chain**

Developing an up-to-date and profitable product or service is a genuinely tricky task for all companies, and it is even more daunting considering that consumer tastes shift more quickly as we progress in time. (Ogden, 2014, p. 107)

The development cycle in the research and development compartment of Xbox Series X/S started in 2016 (Gilbert, 2020) and for Sony's PlayStation 5 in 2013. (Strickland, 2021)

The most important factor of a new development process is the customer satisfaction cycle, which multiple departments of the company determine:

- Marketing department: Identify customer needs and trends.

- Research and development: Envision and develop the product.
- Finance: Verify that the particular product is viable and will be profitable.

(Ogden, 2014, p. 104)

The critical part of managing the supply chain risk is acknowledging the risks that may appear in a situation. The other giant of the CPU industry, Intel, developed a formalized risk management technique for the development cycle of a brand-new product.

Intel analyzes eight risk factors:

- Design
- Cost
- Legal issues
- Supply availability
- Manufacturability
- Quality
- Supply base
- Environmental, health, and safety impacts

By carefully studying these factors, a company can prevent a failure in the supply chain. (Ogden, 2014, p. 109)

Microsoft and Sony's consoles were set to launch by the Holiday Season of 2020 amid the pandemic, CPU shortages, and shifting consumer trends. There were too many unknown variables. (Blows, 2020)

When a specific manufacturer identifies the markets it serves, it can decide the performance mix needed by those markets. The video game industry is a growth market that requires elevated levels of customer service measured by order fill rates and on-time delivery. (Hugos, 2011, p. 152)

In the case of the new generational consoles, a build-to-stock (BTS) circumstance is occurring. Regarding BTS products, customers anticipate acquiring them immediately, whenever they need them. (H. Hugos, 2011, p. 155)

### 3.8 The Main Pillars of the Supply Chain in the Video Game Console Industry

The supply chain of a video game console consists of three main pillars:

- **Component Suppliers:** This stage involves the manufacturers of the various components required for making the console, such as processors, graphics cards, memory modules, and hard drives. (Ohio State University)

In the case of the ninth-generational video game consoles, specific cutting-edge technology was needed for these to be capable of rendering graphics in a 4K resolution (3840x2160 pixels) and 60FPS (frames per second). Microsoft decided to fortify its relationship with the American tech giant AMD to achieve this performance. (Will Tuttle, 2020)

|                           |   |
|---------------------------|---|
| <b>CPU</b>                | 8x Cores @ 3.8 GHz (3.6 GHz w/ SMT) Custom Zen 2 CPU                            |
| <b>GPU</b>                | 12 TFLOPS, 52 CUs @ 1.825 GHz Custom RDNA 2 GPU                                 |
| <b>Die Size</b>           | 360.45 mm <sup>2</sup>  |
| <b>Process</b>            | 7nm Enhanced  |
| <b>Memory</b>             | 16 GB GDDR6 w/ 320b bus   |
| <b>Memory Bandwidth</b>   | 10GB @ 560 GB/s, 6GB @ 336 GB/s   |
| <b>Internal Storage</b>   | 1 TB Custom NVME SSD  |
| <b>I/O Throughput</b>     | 2.4 GB/s (Raw), 4.8 GB/s (Compressed, with custom hardware decompression block) |
| <b>Expandable Storage</b> | 1 TB Expansion Card (matches internal storage exactly)                          |
| <b>External Storage</b>   | USB 3.2 External HDD Support  |
| <b>Optical Drive</b>      | 4K UHD Blu-Ray Drive  |
| <b>Performance Target</b> | 4K @ 60 FPS, Up to 120 FPS  |

*Figure 2: The specifications of the Xbox Series X with the main components highlighted with a green box (Tuttle, 2020)*

As mentioned previously, this pillar of the supply chain had significant setbacks because of the CPU and GPU shortages.

- **Assembly:** The components are assembled into the final product by the manufacturer. This stage involves various processes, including PCB (Printed Circuit Board) assembly, testing, and quality control. This stage also suffered due to lockdowns and the limited freedom of movement between countries.
- **Distribution and Retail:** The finished consoles are then transported to the distributors responsible for managing inventory and selling the products to retailers. The third stage

of the supply chain faced the hoarders who made it impossible for the average customer to buy the new consoles. (Ohio State University)

With errors occurring all around the supply chain, it was inevitable that significant customer dissatisfaction and continuous shortages would happen during the sales of these systems in the following months, and it was uncertain for how long this would last.



*Figure 3: Illustration of the logistics of a Video Game Console (Sperry, 2021)*

### **3.9 The Complexity and the Reasons for the SSC (Semiconductor Supply Chain) Shortage**

The reasons behind the SSC crisis are as complex as the supply chain. However, these can be categorized into three different groups.

- Disruptions due to the pandemic
- The complexity of the SSC
- Geopolitical issues

No industry was immune to the implications that the pandemic carried. During the peak of the COVID-19 pandemic, the microchip industry was projected to decrease by 55 billion USD in 2020. There was an increased and unprecedented demand, multiple disruptions in the branches of the supply chain, and workforce disruptions. (Accenture, 2022)

Logistic-related issues were also common. Semiconductor materials were delayed during the worldwide outbreak due to fewer flights and airport closures. The global transportation of COVID-19-related items utilized an extensive amount of capacity of the worldwide logistics. (Wassen et al, 2022)

Microchips are one of the most complicated items and the production process with the highest R&D intensity: up to 1,400 steps may be required to manufacture a semiconductor. This can vary if the chip is less or more complex. (SIA, 2021)

A semiconductor's conventional manufacturing cycle can take up to 20-26 weeks. The semiconductor wafer is made in around 12 weeks, and the following step, known as back-end assembly, testing, and packaging (ATP), could take up to six weeks. In conclusion, there may be a lead time of up to 26 weeks between a customer placing an order and obtaining the finished item. (SIA, 2021)

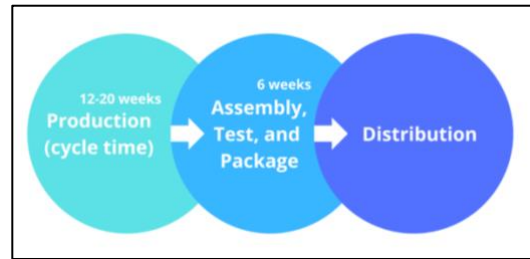


Figure 4: A semiconductor's conventional manufacturing cycle

Geopolitical tensions have risen globally in the past five years (2018-2023). The United States and China are locked in a modern "cold war," which on paper is a trade war between the two superpowers since the previous US administration was keen to make microchip manufacturing in China complicated. (Hoffower et al., 2021)

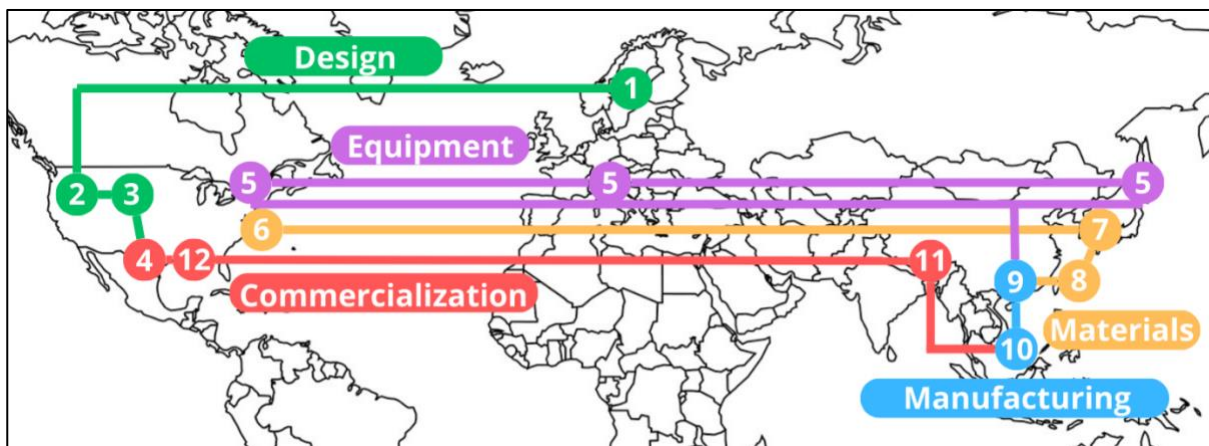


Figure 5: A Simplified visualization of the global SSC (Varas et al., 2021, Wassen 2022)

### 3.10 The Aftermath of the CPU, GPU (SSC) and Console Shortage

In 2023, the GPU crisis is showing signs of improvement. One of the primary GPU manufacturers, NVIDIA, has taken steps to address the shortage by dividing its state-of-the-art graphic chips into two simpler hardware: the GeForce is designed to gratify gamers, and the CMP (Cryptocurrency Mining Processor), crafted for crypto miners. (Wuebbling, 2021)

NVIDIA's most recent graphics card is the GeForce line, with specific components intentionally slowed down to reduce its attractiveness to miners.

The CMP, on the other hand, is based on an earlier version of NVIDIA's graphics card and lacks display outputs, making it unsuitable for gaming purposes. By dividing its products

in this way, NVIDIA aims to encourage miners to purchase CMP chips exclusively, leaving the GeForce chips for gamers. (Rivero, 2021)

*"What we hope is that the CMPs will satisfy the miners...[and] steer our GeForce supply to gamers," CEO Jensen Huang (Rivero, 2021)*

Ultimately, the premier goal of both NVIDIA, Microsoft, and Sony is to make specific changes related to their distribution and supply chain to keep their loyal gaming customers happy and, at the same time, to keep up with the demand of other groups who may use their products – but this is only in the case of NVIDIA. (Rivero, 2021)

## 4.0 Methodology

To direct the thesis to its primary purpose of analyzing the video game console shortage during the midst of the COVID-19 pandemic and in the aftermath of it, a mixed methodology research approach will be implemented to be able to get a far-reaching investigation on the events of the video game console supply chain.

Executing primary and secondary research on this topic is mandatory to triangulate the insights and, therefore, get more punctual data. Utilizing these diverse research methods will enhance understanding of the complex situation and problems of the video game console supply chain.

### 4.1 Primary Research

The primary research of the thesis has three main parts, which were all executed in four months between August 2023 and November 2023. Given that the console shortage is at the end of its three-year run, the research can already investigate the problems that caused the shortage and the possible solutions that solved this crisis.

**Survey:** The survey was created to obtain valuable qualitative and quantitative data from a broad variety of individuals, allowing to analyze specific trends, general consensus, and experiences about the video game industry and the console shortage crisis between 2020-2023. The survey for this thesis was created in August 2023, and it was sent out to various groups of individuals using the power of social media. It was posted twice on the following social media platforms: Facebook (post), Reddit (post), Instagram (story) and Twitter("X") (tweet). The survey was also completed by one of the interviewed individuals.

The survey was carried out within the limits of the application provided by Google called Google Forms, and it consists of two main branches and 14 questions. There are ten units of single-answer questions, two units of multiple-choice questions, and one long answer text.

The long answer text will also be necessary when doing text-mining to create a "Word Cloud" to visualize the qualitative data. It is an image that includes keywords found in a particular body of text, where the size of each word indicates its frequency within the text itself. (Sanil, 2022) The survey was filled out by 86 participants when it was finalized.

#### **Interviews with established members within the industry of video games:**

The thesis will conclude the description of two interviews: one with game designer and gamification specialist Adrian Hon with valuable insights about their perspective on the topic, details about how the shortage affected the market both worldwide and in Hungary, and

personal opinion on the topic and the future of the video game industry, and the editor-in-chief of Gamekapocs Magyarország (one of the most popular video game news outlets of Hungary) Dávid Szlavkovszki.

**Focus groups:** Diverse focus groups were organized and conducted with participants well-versed in the video game industry and daily users of video game hardware. These were held both online (via Discord) and offline. The focus group discussions will provide critical qualitative viewpoints and experiences during and about the console shortage.

#### **4.2 Secondary Research**

The secondary research will provide an extensive view of the history of the video game industry, its supply chain, and its significance.

**Existing research sources:** Comprehensive study and analysis will be performed on statistics already available on the databases of various platforms like Statista and KSH (if available). This secondary research will endorse and add to the original data collected, enhancing the study's validity and breadth.

#### **4.3 Triangulation**

Triangulation alludes to using multiple research methods or data sources in qualitative research to establish a broad understanding of the phenomena. The research methods used in this thesis are meant to provide comprehensive knowledge of the video gaming console scarcity, pulling from various views and sources by integrating both primary and secondary research approaches. The data triangulation will strengthen the conclusions' reliability and test validity and contribute to thoroughly examining the determined research issue through the convergence of the collected information. (Patton, 1999)



## 5.0 Primary Research Results

### 5.1 Interview with Adrian Hon (Video Game Developer)

In September of 2023, at an event organized for the future and the youth called Brain Bar, with multiple presentations, speeches, and brainstorming sessions, taking part in one of the brainstorming sessions, a short open interview on the opinion on the console shortages from Adrian Hon (the CEO of Six to Start), game designer, and gamification specialist was formed:



*Figure 6: Brain Bar open interview with game designer Adrian Hon (middle)*

- *My question is about the video game industry as a whole. Did you have any problems during the pandemic, or do you have any personal experiences with console or CPU/GPU shortages?*

- During COVID, obviously, many countries had lockdown; you could not go to the gym, you could not go to the cinema, you could not go to your friend's houses, so everyone shifted their entertainment consumption and the things they bought to online activities, that is why Zoom went up, that is why Peloton went up. Video game companies made so much money during the pandemic – they do not like talking about it because, obviously, it is embarrassing, and you do not want to be seen profiting off this – but most companies made so much money in 2020 in 2021 that when you looked at that profit in 2022, it goes down again, which is weird because typically profits go up.

- Yes, I found it hard to get a PlayStation 5, like that is what I wanted, and people were trying to get a PlayStation 5, people were trying to get an Xbox, you know there was a problem in the supply chains because they could not build enough.

- *Do you think that they could have resolved it if they had the resources, or was it intentional?*

- No, I do not think that it was intentional because, you know, manufacturing lines are only really designed to make a certain number of consoles per year; they could not predict that there would be so much demand, so they probably thought that "We can make 10 million PS5s

a year" or something like 15 million. They have made less than that because they had to shut down factories. It is really expensive to spin up more factories. It has not been great for them because they have sold less in the long run than they would hope to.

This interview shows the opinion of an established worker in the video game industry who has been a part of it for most of his life. Based on this interview, video game companies were not struggling financially during this period (2020-2023) because of the sheer amount of software sales.

Mr. Hon mentioned that the pandemic had a significant impact on the gaming industry. He also stated the importance of having contingency plans to mitigate the risk of shortages.

Although Adrian Hon could not fill out the survey analyzed in section 5.5 of the thesis, he mentioned that he found it hard to buy a PlayStation 5, which is an exceptional incident given that he is an established video game developer. This statement raises the question: What can be said about the regular customer base if a game developer found it hard to get this console?

## **5.2 Interview with Dávid Szlavkovszki (Editor-in-chief, Journalist)**

An extensive interview with the editor-in-chief of one of Hungary's leading and most experienced online gaming magazines: Gamekapocs.

With valuable information and personal opinions, Mr. Szlavkovszki was keen to answer all the prepared questions about the recent supply chain shortages. The interview was held on the 26th of September, 2023, in an online format using the instant messaging and VoIP social platform Discord.

*- What is your viewpoint on the projection of this troubled release of the new generational consoles? Because by the time of the release of these products, COVID-19 was already a thing; if they (Microsoft and Sony) knew that it would be a hard start, why did they still decide to release the new consoles?*

- These supply systems always have specific problems with or without COVID. A great example is the release of the Nintendo Switch in 2017 – COVID-19 was nonexistent and, therefore, had no impact on this release. It was still out of stock all around the world due to high demand – of course, the Nintendo Switch turned out to be a best-seller console by the end. However, it is self-explanatory that this shortage of the Xbox Series and PlayStation consoles would not be that bad without the pandemic. However, in some regions, deficiencies would be

still present. On some level, it can be said that, somehow, the correspondent companies should have managed this situation better.

*- To reflect on your last sentence: what kind of measurements should have been made after the problem was already a thing? How could they moderate the shortage better?*

- I cannot speak on behalf of the manufacturing lines, but the biggest problem was that both tech giants (Microsoft and Sony) have most of their manufacturing process in Asia. (This is where the chips come from, and this is where the new consoles are assembled)

Sony has their manufacturing process in China and Japan, and Microsoft is relying almost entirely on China. However, this industry is global. Not only were the factories closed, but the manufacturing companies needed time to make a safe environment after welcoming their workers back post-lockdown. This prolonged shortage lasted for almost three years, and we were constantly writing news on Gamekapocs on this topic, whether the shortage was being dealt with or becoming even worse.

*- Many stated during this sparse period that both companies were trying to push out further the end of the console shortages artificially to make their products look more valuable because if you are an end-user when something is rare, it means valuable for you. Is this a valid theory?*

- Probably from a marketing standpoint, they could have created a "better image" in the heads of their customers for these consoles as these were always out of stock, which meant that everybody wanted them, but this was only a blessing in disguise. The theory that they tried to play alongside this shortage and not trying to solve it is more of a conspiracy theory. As the PlayStation 5 had a better exclusive lineup in the first year of the console, out of the two companies, Sony was the one who had a more challenging time solving this shortage. The shortage of the new Sony console was worse than the Series X|S consoles and lasted longer; therefore, in this case, in the pop culture, there were many saying that this device was "gold," but despite this phenomenon, I do not think that either of the companies did not want to solve this problem.

*- Do you think the average user thinks more positively or negatively about these products after this time?*

- It has to be said that currently, in our region – in Hungary and Eastern Europe, the PlayStation has the higher ground, which can be traced back to the successful 8th-generation console, PlayStation 4. In the 7th generation, Microsoft was more successful in Hungary with the Xbox 360; these constantly change. Xbox and Nintendo are more prevalent in the United

States than Eastern Europe. Overall, I think that statement is appropriate because this period depicted a more positive image in the head of the average user.

- *What were the most significant factors impacting the supply chain of the video game industry?*

- It is a very complex process, but the global semiconductor crisis had the most significant impact on this supply chain. It is also worth mentioning that the crypto-fever probably had also an effect on this, but the shipping was troublesome as well.

- *Was the communication of Microsoft and Sony satisfactory during the shortage? By this, I mean the CEOs' press releases, posts, and statements.*

- We (the editorial staff at Gamekapocs) got the most data and projections about the shortage from third-party researchers. However, there were also public announcements from both Microsoft and Sony (not press releases) stating that they are working hard to solve the problem and will try to maximize their manufacturing capacity. Sony, however, had a very interesting choice when they announced in January of 2022 that during the shortage of their PlayStation 5 console, they extended the "lifetime" (the manufacturing) of the PlayStation 4, which is a weird decision to make when your manufacturing line is already packed. This was a band-aid but only partially successful solution. Turning back to the question: overall, not much more could have been done when looking at the communication between the companies and the consumers.

- *Has the shortage had a negative impact on the quality of the consoles?*

- I do not think so; the specifications were set in stone by the time of the pandemic. The overall quality of the consoles is excellent to this day.

- *Any personal remarks on this period?*

- Most of the time, the editorial staff members are invested to an extent in the world of video games, and they tend to order their own video game consoles on the first day they are available. There were some delays when they ordered these consoles. In the case of the Series X|S, there were no delays if you were at the front of the pack of those who ordered the console (If not, there were delays of 3-4 weeks). PlayStation had, on the other hand, some significant delays. Among the editorial staff, I was the first to pre-order the PlayStation 5 for personal use in the summer of 2020. The console was officially released in November 2020 and arrived in April of 2021, almost a whole year of waiting.

## 5.5 Google Forms Survey Results

As mentioned in the 4.1 segment of the thesis, one of the main features of the primary research was conducting a survey using multiple social media platforms (e.g., Facebook, Instagram, Reddit, Discord) to reach out to as many people as possible given the fact that in Hungary it is a very niche topic and has a minimal customer base compared to western countries. The survey was sent out and posted to mostly relevant groups who were able to submit the survey with valuable answers.

### 5.5.1 Progression of the Survey

The survey consists of 8 sections (The first section consists of the welcoming page of the survey and the description of it) and 13 questions with multiple branches of progression based on the individual answers given by the participants. By creating a branching progression tree, the survey can generate more valuable data, and by visualizing this branching progression tree, it can be easily followed.

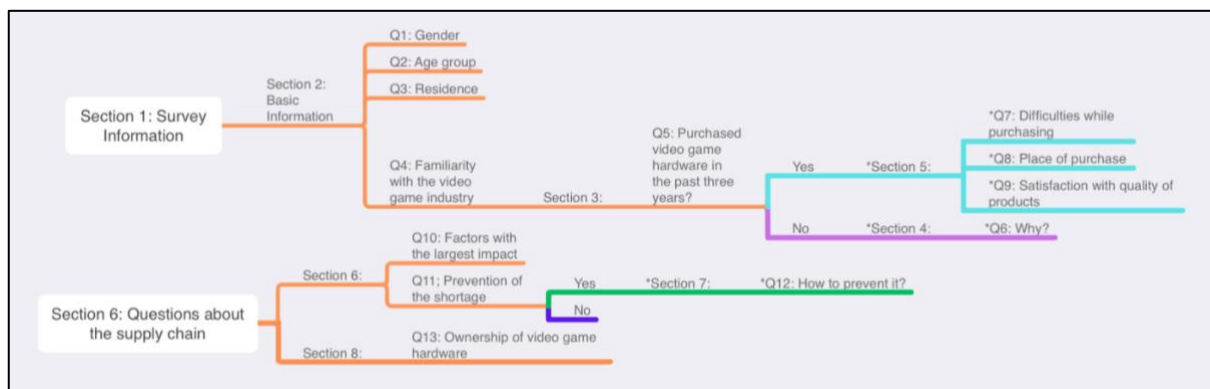


Figure 7: Visualization of the possible progression paths of the survey

### 5.5.2 Section 2:

This section consists of four questions regarding the basic information of the participants, which can be used to refine the collected data further.

#### Q1: What is Your gender?

The questionnaire was filled out by 86 individuals, of which 47 participants were male and 37 were female. Two participants identified themselves in the "Other" category.

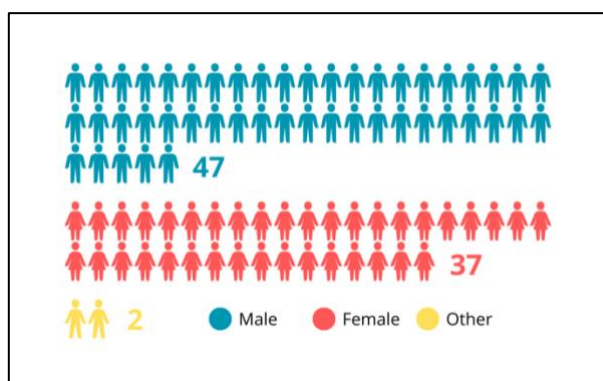


Figure 8: Visualization of the participants based on their gender

This information shows that the topic of Video Games is currently more popular among the male audience, with 54.7% of the participants being male.

This data overrides the projected 70% male participant percentage and shows that the Video Game industry is also on the rise among the female audience.

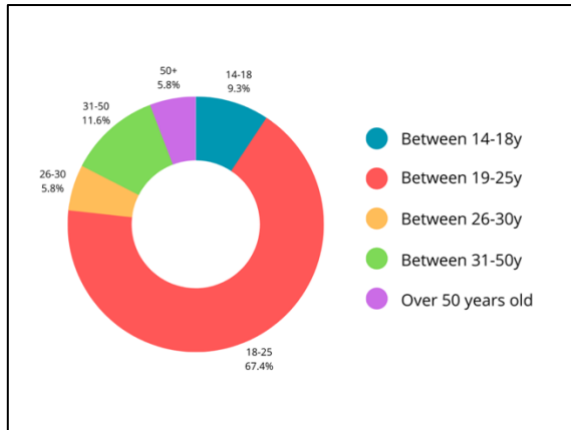


Figure 9: Pie chart of age groups

internet and the video game industry have been present since the birth of these members; therefore, it should not come as a surprise when these customers are involved the most in the industry based on the survey.

**Q3: Where do You live?**

The survey represents certain residence types almost equally, with 47 participants living in the capital or large cities (Municipalities) and 39 participants living in towns or even smaller settlements.

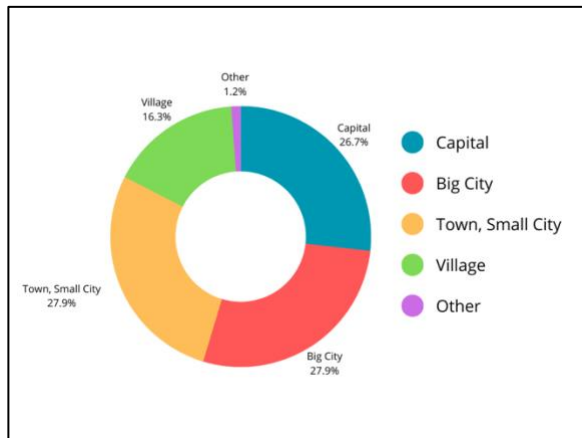


Figure 10: Pie chart of residence types

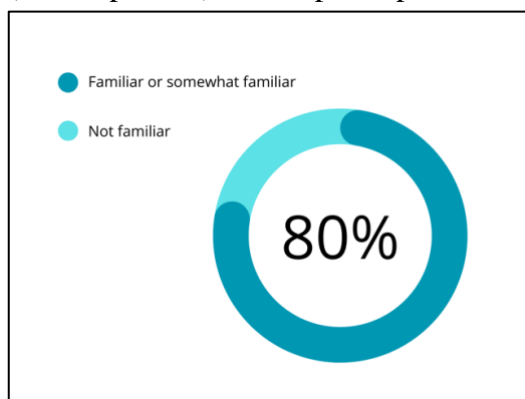


Figure 11: Visualization of the familiarity of the video game industry

**Q2: Choose your age group.**

Fifty-eight participants were between 19 and 25 years old, which shows that the most extensive customer base of the region's video game industry is Generation Z (members of individuals born between the mid-1990s and mid-2010s). The members of Generation Z are confident users of new technology, and the

**Q4: Are You familiar with the video game industry?**

Out of the 86 participants, 69 were familiar or somewhat familiar with the video game industry, meaning that 80.2% were familiar with the topic. However, out of the 47 male participants, only two said they were unfamiliar with the video game industry.

Therefore, it can be stated that video games are the most popular among the male members of Generation Z, and they are also the most familiar with the topic itself.

### 5.5.3 Section 3:

This section consists of one single yes or no question, leading to different progression branches based on the answer.

**Q5:** Have You purchased video game hardware products (e.g., Consoles) in the past three years for yourself or for your partner/children?

Fifty-two participants bought some video game hardware products in the past three years, which is analyzed in this research paper (2020-2023). Looking at the fact that in multiple countries, it was hard to find these systems between late 2020 and early 2023, it is surprising data that 60.5% of the survey participants could buy video game hardware in this period.

### 5.5.4 Section 4:

The section consists of one question exclusively asking the participants who had not bought any video game hardware in the past three years.

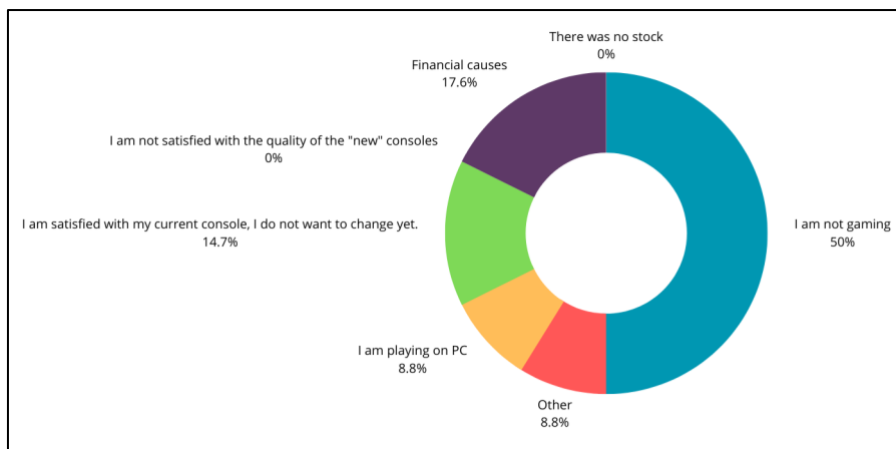


Figure 12: Pie chart of reasons why participants did not bought any video game hardware in during the time period of 2020-2023

**Q6:** Why did you not buy videogame hardware in the past three years?

Out of the 34 responses, 0 said that the stock shortage was why they did not buy any video game hardware, which shows that the shortage was solved

by the beginning of the year 2023. Seventeen individuals said they do not play video games, which correlates perfectly with the data shown in 5.5.2 Q4, where 17 people said they are unfamiliar with the industry.

None of the participants chose the option "I am not satisfied with the quality of the "new" consoles," which shows that the console shortages were not impacting the production quality of the new generational consoles of Microsoft and Sony.

### 5.5.5 Section 5:

The following section consists of questions about the current console generation (Xbox Series X|S and PlayStation 5) explicitly given to the participants who bought new video game hardware between 2020 and 2023.

**Q7:** Have You experienced difficulties in purchasing video game hardware products during the specified time period?

Out of the 52 individuals who bought some video game hardware (e.g., Consoles), 17 stated that they had experienced difficulties during the purchasing progression of a particular video game hardware, which is only 19.8% of all the participants. This can be considered marginal, but an optimal supply chain should work with a near-zero percentage error rate. If this very same error rate when a customer could not achieve their needed product is implemented theoretically in other industries (e.g., the food industry or the construction industry), the final outcome would be horrific, with massive food stock shortages and construction delays.

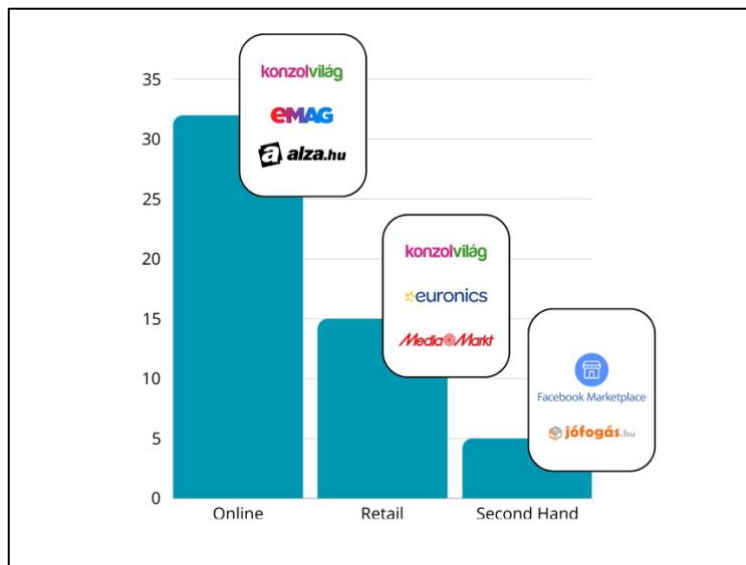


Figure 13: Where the participants usually purchase video game hardware (in number)

28.8% of the individuals stated that they still prefer to buy these devices in physical retail stores.

**Q9:** Are You satisfied with the quality of the current videogame hardware's?

Out of the 52 responses, 90.4% said that they are satisfied with the quality of the current hardware. This data further strengthens the fact that the shortage had no impact on product quality, as mentioned in 5.5.4 Q6.

**Q8:** Where do You usually purchase video game hardware products?

The trends of the past decade (2013-2023) in customer behavior are shown clearly in the results of this question. The second-hand marketplaces are marginal. However, 61.5% are buying these products exclusively online on various e-commerce websites. (e.g., Konzolvilág Kft., Emag.hu, alza.hu) The remaining



### 5.5.6 Section 6:

The section consists of questions about the problems of the supply chain. It includes one checkbox question and a yes or no type question with branching progression.

**Q10:** What were the factors with the largest impact on the "console crisis" (lack of stock) in Your opinion? (Checkbox type)

The console crisis caused a lot of frustration among gamers worldwide, and it's interesting to see the different factors that contributed to it.

In this question, the 86 participants could check in multiple answers.

Out of the possible seven factors, the most prevalent factors were the following: The Hoarders (who purchased multiple consoles at a time to resell them at a much higher price tag) with 43 votes, The COVID-19 pandemic with 39 votes, and the Problems in the supply chain system with 35 votes. This data represents the general public opinion of the recent shortages. With 30 votes, the global CPU/GPU shortage was also a popular choice among the participants. This global semiconductor shortage suffered from the most prevalent factors mentioned before.

On the other hand, the Bad Communication option only got 13 votes. Therefore, the majority of the survey respondents were satisfied with the communication of Xbox and PlayStation on social media or via press releases. This represents a positive aspect of the situation, indicating that the companies did a good job of keeping their customers informed.

**Q11:** Could the stock shortage have been prevented?

The most controversial question of the survey was with precisely 50% saying that the stock shortage could have been prevented, and 50% stated the opposite. This result can be traced back to the complexity of the SSC and console shortage. Despite the differing opinions, it is clear that the stock shortage had a significant impact on both consumers and retailers alike.

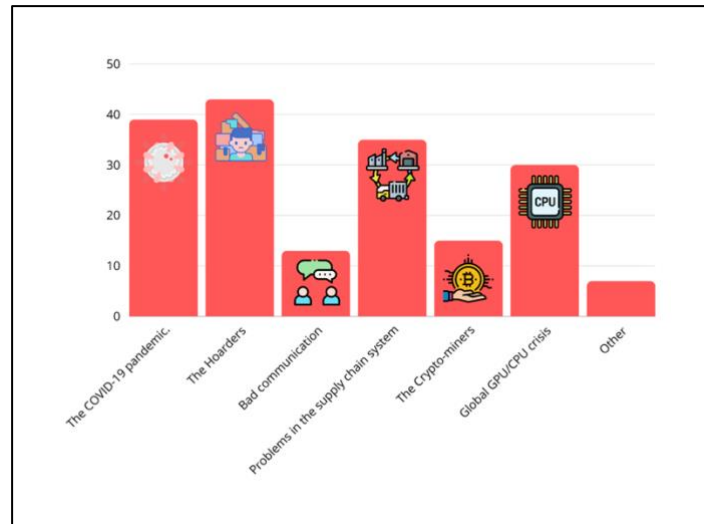


Figure 14: Visualization of the answers given to Q10 (in number)

### 5.5.7 Section 7:

It consists of a single long answer text asking the participants who said that the console shortage could have been prevented and their extended opinions on the solutions.

**Q12:** If yes, then how?

The participants gave valuable insights and possible solutions based on their experiences and general knowledge of the topic. The most popular solution method mentioned by the respondents was the introduction of some purchase limit per person or per credit card, therefore making the ways hoarders achieve these products almost impossible.

(Out of the 43 responses, 13 mentioned the "1 console/person rule")

Multiple answers stated that they could have projected the troubled release of the new generation consoles based on the shortages in other industries around the world during the dawn of the COVID-19 pandemic.

It was also mentioned that even after the pandemic rang off, multiple months passed until the shortage was solved, and this could have been prevented with exhaustive market research.

Multiple participants stated that they do not understand why Microsoft and Sony went on with the initial release date when they could have postponed the commercial release of both consoles to the end of 2021 while sending out prototypes to the media sources and content creators, therefore achieving valuable feedback from a competent group of customers, a stock surplus and a more robust commercial release whilst still maintaining the hype around the products.

Another reasonable solution was the introduction of "Xbox Authorized" and "PlayStation Authorized" stores (e.g., Apple Authorized Stores) or official shops, therefore achieving better moderation during the sales process.

### 5.5.8 Section 8:

The last section consists of one checkbox question and means to represent a quick market research to have more precise data on the popularity of different video game consoles in the region of Hungary.

**Q13:** What kind of videogame hardware's do You already own?

The most popular gaming device among the participants is the ever-popular Personal Computer, with 50% (43 votes) of the respondents stating that they own a PC. The reality could depict an even higher percentage.

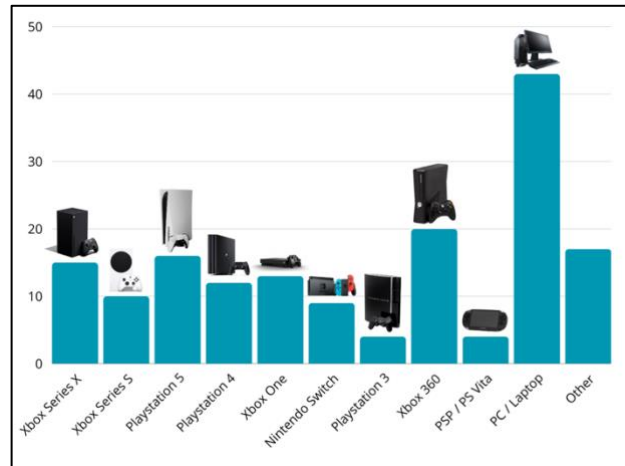


Figure 15: The most popular video game devices among the survey participants (in number)

The most popular console among the participants was the Xbox 360 (released in 2005), with 23.3% owning one. The most popular current generational console was the PlayStation 5, with 18.6%. The Series X got 17.4%, and the Series S got an 11.6% owning rate. The most popular handheld console was the Nintendo Switch, with 10.5% (9 votes).

In summary, the survey provided data that can describe the general voice of the video game community in the region, their consumer habits, their view on the console shortage, and the quality of these products.

### 5.6 Word Cloud Infographic

A word cloud can be used to monitor the most commonly used words in a massive text. In the word cloud, the most used word is written with the most prominent text size. The words with the most minor relevance do not appear in a regular world cloud to avoid clutter. The following word cloud was created based on a massive text that contains the answers of the participants of the Google Forms survey to Question nr. 12 (5.5.7). Appendixes, linking works, and non-relevant words were eliminated from the final version of the word cloud to get a clearer picture of the relevant words.



Figure 16: Word Cloud

## 5.7 Focus Group Results

Two different focus groups were held in September of 2023 with questions that resemble the questions asked from the interviewees and the survey participants. Both groups were constructive and keen to share their views and knowledge of the topic.

The first focus group session was held on the 18th of September 2023 with six participants in person at a café. All participants have a strong connection with the world of video games, and their answers can be analyzed in correlation with the survey data. All participants were between 21 and 27 years old; therefore, they were a part of Generation Z based on the general definition of Gen Z, and the residence of all participants is Budapest, the capital of Hungary. Out of the 6 participants, 5 were men and one woman.

There was a joint agreement among the participants during all of the questions asked of them. The participants stated that all of them had been able to buy a 9th-generation console. However, they could only get their devices by the end of 2021 and 2022. The most popular new console among the participants was the weaker but more affordable console of Microsoft: Xbox Series S. They chose this particular console for financial reasons. The economic situation of the region and the country (Hungary) can significantly boost the sales of the Xbox Series S in the long run.

The participants are satisfied with the quality of the new consoles. However, their positive opinion of Microsoft and Sony has fallen during the shortage, but they think that both companies did what they could, and it is the forward planning that bothers them. (2020-2023) One participant stated that the period between ordering her PlayStation 5 console was 11 months. Every participant mentioned the SSC shortage as the worst impact on the console industry, and they also mentioned the hoarders and the "1 console/person" rule.

The second focus group was held online using the instant messaging and VoIP social platform Discord. There were 10 participants, all part of a strong gaming community, with strong opinions and constructive critiques of the industry. All participants were between 21 and 27 years old. Seven participants were from Budapest, and three were from other Hungarian municipalities. Only three participants were able to purchase a ninth-generation console. However, five participants stated that they only play video games on their Personal computers and would never buy a video game console.

The consensus on the solution regarding the shortage was the postponement of the new generation and the "1 console/person" rule.

The participants also stated that this will not be the last time that a console shortage will occur.

## 6.0 Results of the Secondary Research

The secondary research results show that the future is bright for the video game industry in terms of revenue and global popularity.

### 6.1 Stock Performance

The stock performance of both Sony and Microsoft fell since the end of 2021 due to the current global public sentiment and geopolitical issues. The stock price of Sony significantly dropped after Microsoft announced the biggest acquisition of the video game industry ever seen: the deal to acquire the publishing behemoth, Activision Blizzard.

Microsoft stock tends to follow the Nasdaq Composite trends, and overall, the same pattern can be seen at both companies, with only Nintendo performing better lately. However, Nintendo entirely relies on the video game industry, Microsoft has multiple other divisions that can contribute more to stock performance, and Sony is very diverse.

### 6.2 How Significant are Microsoft and Sony's Video Game Division?

As the financial years pass, the gaming division becomes significantly more important for both companies. More people than ever tend to pass the time by obtaining a video game console and playing video games. Subscription services are flourishing in the 2020s, and the video game industry is no different: Microsoft's monthly gaming subscription service (Game Pass) had 25 million subscribers as of January 2022. The gaming division of Microsoft (Xbox) is the fourth most relevant division of the American tech giant based on revenue from external customers from 2016 to 2023, by significant product and service offering, and is projected to overtake the Windows division when the Activision Blizzard acquisition makes its impact. (Figure 27)

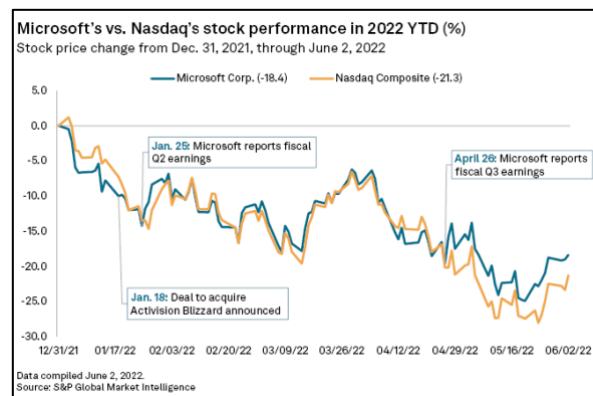


Figure 17: Microsoft's vs. Nasdaq's stock performance in 2022 YTD (in percentage) (S&P, 2022)

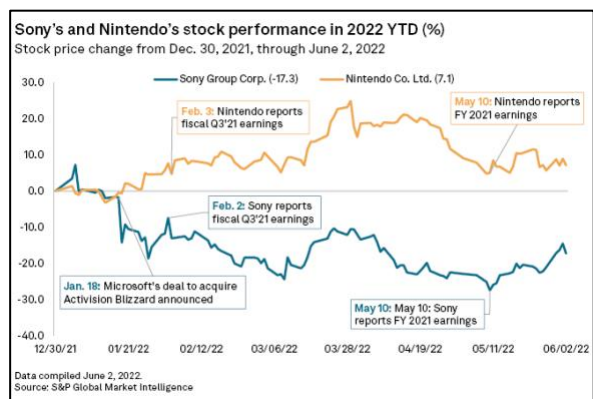


Figure 18: Sony's and Nintendo's stock performance in 2022 YTD (in percentage) (S&P, 2022)

As for the Japanese tech giant, its Gaming and Network Services are the company's leading division based on worldwide revenue from 2012 to 2022. The PlayStation plays a significant role as the main station of Sony's diverse portfolio. This division achieved a record-breaking 26.9 billion USD in revenues throughout the fiscal year of 2022. (Figure 28)

These figures represent the value that lies in the video game industry; therefore, the logistics and the supply chain of these divisions should work at an even higher capacity in the next decade than pre-pandemic.

### **6.3 Unit Sales of Xbox and PlayStation Consoles**

The ninth generational consoles had a troubled release due to multiple disruptions in their supply chain and due to increased demand; in the Holiday season of 2020, neither of the consoles debuted with huge unit sales, with 4.37 million PlayStation 5 units sold and 3.06 million Xbox Series X|S units sold. It is worth mentioning that the found data counts the two Xbox consoles as one.

Since their release, Sony has been able to sell more units, with a cumulative 41.17 million units sold. Xbox was able to sell 23.47 million units. It is also worth mentioning that the year 2023 is not complete, and both consoles will see a significantly higher demand during the holiday season. Nintendo was able to sell 80.47 million Nintendo Switch consoles. However, this data distorts the depicted picture because the Switch was already on the market at the beginning of 2020, while the Xbox Series X|S and PlayStation 5 consoles were released at the end of 2020. (Figure 29)

### **6.4 Revenue Growth of the Video Game Industry During the Pandemic.**

The video game industry's revenue had a humongous growth during 2020 due to increased free time cumulated by people during lockdown restrictions. The same evolution can be seen in the revenue of video game consoles; the most significant contributor to this growth was the Nintendo Switch. In 2021, 2022, and 2023, the market growth normalizes, and it is projected to grow at a steady rate between 1% and 2%. It can be stated that out of all the entertainment industries, only the video game industry could provide such a growth in revenue during the first year of the COVID-19 pandemic. (Figure 31)

## **6.5 Sales Revenue of ASML Worldwide and the Semiconductor Market Changes in Europe between 2020 and 2023**

ASML Holding NV is a holding company based in the Netherlands in the European Union. ASML Holding operates through one business segment, which engages in the development, production, marketing, sales, logistics, and servicing of advanced semiconductor systems; therefore, analyzing the sales revenue of this multinational semiconductor company can show a clear image of the state of the industry. The data (Figure 33) indicates that the most significant contributors to the sector are Taiwan, South Korea, and China, and the worldwide revenue kept growing even after the semiconductor shortage, which indicates that the demand stabilized and the supply chain interruptions were solved.

The data linked to the industry's performance on the European Continent shows that semiconductor sales decreased during the dawn of the pandemic (due to multiple restrictions, halted supply chain, and shortages). Still, since the end of 2020, the revenue kept rising significantly ever since the deficiencies were moderated and supplied. Since early 2022, semiconductor industry sales in Europe have shown that the market and the industry have found stability, and there are currently no supply chain errors impacting logistics. (Figure 34)

## **6.6 Online Shopping and Consumer Behavior in Hungary**

The data regarding online shopping habits of the population of Hungary indicates that the option to browse and order products online is becoming increasingly popular. During the period in which COVID-19 affected everyone's daily habits, the popularity of shopping online rose from 54.5% in 2019 to 65.7% in 2020. The leading e-commerce shops in Hungary in 2022 by net sales were emag.hu, kifli.hu, alza.hu, tesco.hu and mediamarkt.hu. (Figure 35,36)

## **6.7 Rising Popularity of the Video Game Market in Hungary**

Among the most common shopping queries entered into Google in Hungary in 2022, the data shows that the consumers were keen to search not only established garment trademarks but gaming products as well, with the term "Xbox" being the 8th most searched term among shopping-related terms on Google. Surprisingly, the words "Sony" or "PlayStation" are not in the top 10, based on the fact that the PlayStation 5 is currently the most popular console in the region. However, the presence of the term "Xbox" in the top 10 implies that the video game console industry is increasingly popular in Hungary. (Figure 38)

Additionally, based on the number of e-commerce transactions in Hungary in 2021, by product category, it can be stated that after the most popular category, which is "Apparel,

fashion, and sports," the second and third most popular category was the "Games and culture" and the "Consumer electronics" category. (Figure 37) This demonstrates that in spite of the fact that the gaming industry is still not as popular in Hungary as it is in Western countries, such as Germany, the United Kingdom, or the United States, it became increasingly popular in the period between 2020 and 2023.

### 6.8 Secondary Research Summary

Based on the data collected in segments 6.1-6.7, the video game industry managed to produce increased popularity and revenue despite its many flaws during the pandemic; the positives of the changing consumer behaviors conquered the negatives of supply chain errors. While both ninth-generation consoles are popular (excluding Nintendo Switch), the PlayStation 5 dominated the market from 2020 to 2023, and both Sony and Microsoft are continuously relying more on their gaming department. As for Hungary, the option to shop online is increasingly popular, and one of the most popular categories based on online transaction numbers is Games and Culture, which indicates the potential of this industry.

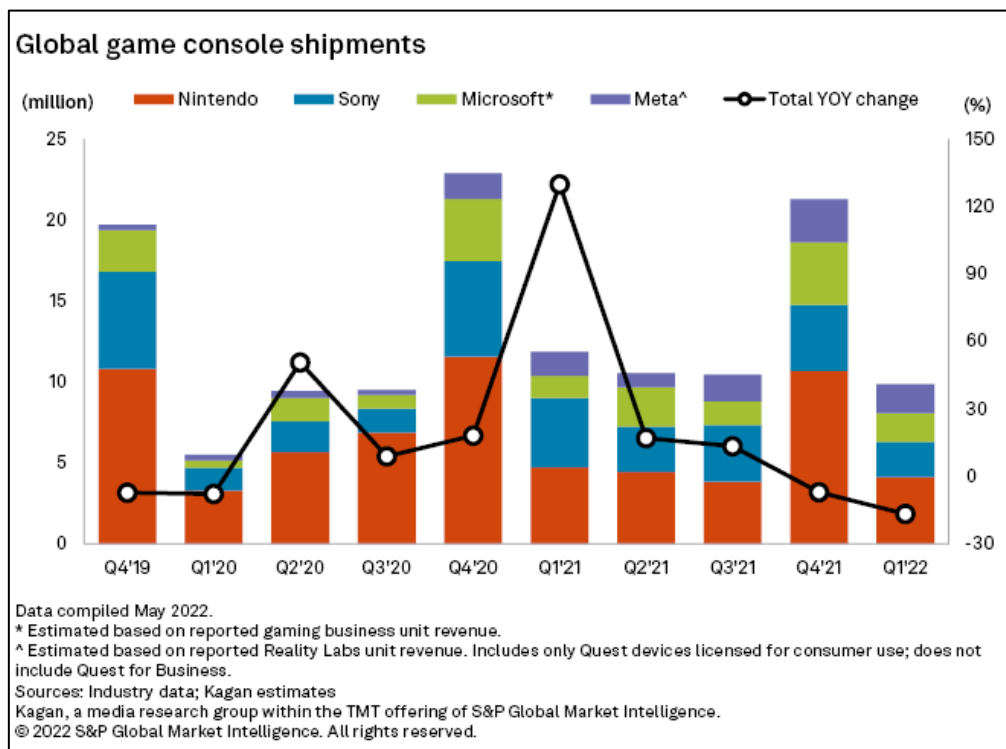


Figure 19: Visualization of the change in global game console shipments (in percentage) (S&P, 2022)



## **7.0 Triangulation**

The triangulation research method can be realizable with multiple relevant sources (the interviews, the survey, the focus groups, and the secondary data).

### **7.1 Correlations Between the Secondary Research and the Interviews, Focus Groups**

Despite all the negative factors, game Developer Adrian Hon stated that the video game industry had a great year in 2020. This firmly correlates with the secondary data discussed in section 6.4, illustrated on (Figure 31), which shows a staggering 20% revenue growth during 2020.

Editor-in-chief of Gamekapocs said that the shortage lasted for a more extended period in the case of the PlayStation 5 consoles, which indicates that the demand was higher for this product among consumers thanks to multiple new PlayStation exclusive video games. This statement can be strengthened by various sources confirming that Sony's console sold more units in both 2020 and 2021 (the years where the shortage was the worst). (Figure 29)

In the statement in which Dávid Szlavkovszki mentions that the most significant impact on the console supply chain was the semiconductor shortage because the region (Asia) where most semiconductors are manufactured and later the console is assembled were hit hard and had strict lockdowns can also be reinforced with data on the semiconductor sales and market revenue in Europe (Figure 34) which shows that not only worldwide, but in the region of Hungary this shortage could be felt, and the sales revenue of ASML (Advanced Semiconductor Materials Lithography) worldwide from 2018 to 2022, by region data, which indicates that indeed, the semiconductor industry leaders are Taiwan, South Korea and China. (Figure 33)

### **7.2 Correlations Between the Survey Results and the Interviews, Focus Groups**

In 5.5.5, the survey shows that 90.4% of the participants were satisfied with the current generation of video game consoles, which strongly correlates with the opinion of both interviewees and focus groups where they stated that the shortage was not impacting the build quality of PlayStation 5 and Xbox Series X|S consoles because the specification of these were already made in the year prior to the commercial release of these products, and after the release of these products, non-functional devices and hardware related problems were almost nonexistent. This is crucial, given the fact that, as an example, the 7th-generation consoles of Sony and Microsoft had much higher failure rates. (23.7% failure rate in the case of Xbox 360 and 10% failure rate in the case of PlayStation 3 consoles over the course of the first two years

of usage) Official data on the current generational failure rates is nonexistent. However, the official percentage could be around 3% for both products. (3%-5% is the average and acceptable failure rate of new electronics)

There was a joint agreement between the interviewees, the focus groups, and the survey participants on which factors had the most considerable impact on the console shortage. Most of them mentioned the CPU/GPU (semiconductor) shortage as the main factor and the scalpers/hoarders as the other main reason behind this supply chain crisis.

The one console per 1 person rule was mentioned among the participants of the survey and the participants of the focus groups as well, which indicates that the most popular solution to this shortage was to limit the number of purchasable products, as in the case of multiple other (mainly food) products during the pandemic.

### **7.3 Correlations Between the Survey Results and the Secondary Research**

Based on data that depicts the most popular shopping search terms on Google and the survey results, it can be seen that the most popular consoles were the Series consoles of Xbox in Hungary; however, based on news outlets, the demand was higher for the PlayStation 5.

The consumer shopping habits corresponding to the place of the purchase can be observed in both primary and secondary data. The most popular way to buy these products is through online retailers.

### **7.4 Contradictions in the Research**

Based on secondary data related to console units sold (Figure 29) and the interviews, the most popular console was the PlayStation 5; however, based on survey results, among the participants, the new consoles Microsoft were the most popular.

It could be that the sample size of survey participants was not representative of the larger population, or there may have been other factors that influenced the results.

## 8.0 Discussion

### 8.1 Possible Solutions

Based on the primary and secondary research results, several possible solutions have been identified to mitigate the impact of console shortages in the future.

With the known data and the suggested solutions, one of the simplest methods to solve a video game console shortage is to restrict the number of units a specific individual can buy. This can be realized with the introduction of the "1 console per 1 person" rule, which rule would rely on the ID of the consumer if the given product is purchased in-store or on the debit/credit card data or IP address of the consumer in the case of online shopping.

**STOP**

**Kedves Vásárlóink!**

Felhívjuk figyelmüket, hogy a volt hatósági áras termékek vásárlásakor mennyiség korlátozást vezetünk be.

**A volt hatósági áras termékek esetében a naponta maximálisan megvásárolható mennyiség:**

|   |  |   |
|---|--|---|
| <b>2 kg</b><br>* kristálycukor          | <b>5 kg</b><br>* házi sertéscomb<br>* csirke far-hát<br>* csirkehát<br>* csirkefar | <b>6 liter</b><br>* ultramagas hőmérsékleten hőkezelt<br>2,8%-os zsírtartalmú tehéntej              |
| <b>5 kg</b><br>* búzafinomliszt (BL 55) | <b>12 kg</b><br>* csirkeszármvág   | <b>3x1 liter vagy 2x2 liter vagy<br/>1x3 liter vagy 1x5 liter</b><br>* finomított napraforgó-étolaj |
| <b>3 kg</b><br>* csirkemell             |  |   |

*Figure 20: Announcement of Auchan Hungary about the purchase limit in the case of multiple products in 2023 (Index, 2023)*

With these limitations, which are common practice nowadays in countries such as Hungary (particularly in the case of FMCG products), a potential new shortage of the video game console industry can be slowed down.

In the future, the possible introduction of official retailers would also serve as a solution to overcome a shortage of consoles. Using Apple's retail characteristics as an example, all console manufacturers should open official retail stores and designate official partners. Therefore, the sale process can be more easily manageable, straightforward, and transparent.

These limitations and a new set of rules can not only help the fragile supply chain of these products but also provide a solution against scalpers/hoarders. Still, they can also help maintain a positive and more exclusive brand image worldwide.

The manufacturing currently takes place only in one region, which in the case of a global industry can come into sight as extremely fragile. This fragileness can be suppressed by relocating multiple manufacturing processes or realizing new factories.

Additionally, implementing a more robust crisis management plan can help reduce the impact of unexpected events, such as the COVID-19 pandemic or natural disasters. Finally, the development of alternative technologies, such as cloud gaming, can help reduce the demand for physical consoles and alleviate supply chain pressures.

While the solutions proposed in this seem promising in theory, it is important to evaluate their feasibility in practice. The "1 console per 1 person" rule, for example, may be difficult to enforce and could potentially cause frustration among consumers who want to purchase multiple consoles for legitimate reasons, such as for gifts.

Additionally, the introduction of official retailers may not be financially feasible for smaller console manufacturers who may not have the resources to open and maintain physical retail stores.

Relocating manufacturing processes or building new factories can also be a costly and time-consuming endeavor, and it may not be feasible for all console manufacturers. Similarly, developing alternative technologies such as cloud gaming may not be a viable solution for all consumers who may not have access to reliable internet connections.

Therefore, while the proposed solutions may offer some relief to the console shortage issue, it is important to carefully consider their feasibility and potential drawbacks before implementing them on a large scale.

## 8.2 E-commerce Application Project Named as “Project Consold”

### 8.2.1 The Description of the Project



*Figure 21: The  
purposed logo  
of the  
application*

With the use of the possible solutions mentioned in segment 8.1, the creation of a mobile application started in the Summer of 2023. The goal of the application is to grant a platform for the e-commerce and logistics process of video game hardware and software. This would help in the case of another supply chain disruption and is meant to solve a possible console shortage in the future. Both the project and the prototype bear the proposed "Consold" fantasy name.

The explanation behind the supposed name of the application:

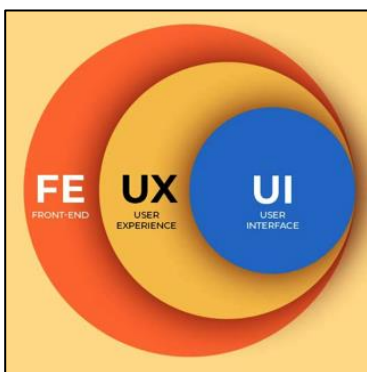
$$\text{Consol}[e] + [\text{Sol}]d = \text{Consold}$$

The project consists of two individual mobile applications:

One for consumer usage, which would work as a powerful search engine for video game products and video game product prices, similar to how the Hungarian product search engine (price aggregator) "arukereso.hu" works with a twist. The users will not only see the shops where their desired product is available and the price of the product, but they will also be able to achieve real-time data on the available units at each partner retailer.

One for business/logistics usage for video game retail companies, which would work on a subscription plan. It would serve as a "spokesman" between the manufacturing companies and the retailers. The retailers would have a wide variety of warehouse and shipment management functions.

### 8.2.2 The Realization of the Mobile Application Prototype



*Figure 22: Visualization of  
the parts of the frond end of  
an application*

The realization of the front-end prototype began in the September of 2023. The goal was to design a non-complex User Interface (UI) and visualize the general user experience (UX) using Adobe XD, a vector design program for web and mobile applications. This progress halted as the official support for the program was discontinued. Therefore, the project's development continued with the use of Figma, a tool similar to Adobe XD, which can be used to create complex and non-complex UIs.

- A Non-complex UI (User Interface) illustrates the essential functions of an application or website. Not every function is available; not every button is designed to work, only the basics. A non-complex UI is meant to represent an idea, a visualization of what can be later realized during the back-end (programming) development of the website/application.
- A Complex User Interface manages to visualize every possible outcome while using the application, therefore giving the back-end developers a more complex visualization of the software prototype. This method is less popular given that a design prototype of an application is meant to be partially functional.

### 8.2.3 Details on the Application Intended for Consumer Use

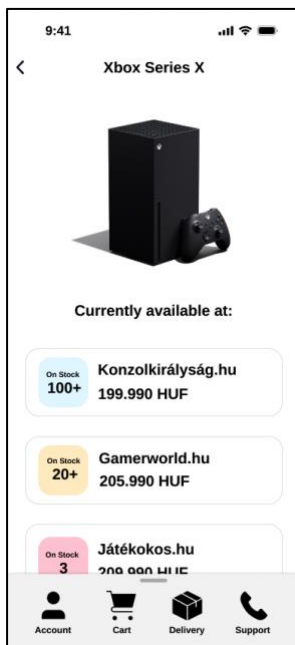


Figure 23: Screenshot of the prototype (a)

On the customer side of the application, when a new product launches, but the stock is less than expected, the customer will be able to buy only one unit of the product. This is verified with the customer's credit/debit card.

Furthermore, in the case of an item with limited availability, the application will show the exact number of units left in stock, updated automatically from data generated from the warehouse.

The notification system will be backed up by the automated warehouse management system, which uses RFID tags to have live stock availability data. If a saved product that was not in stock before finally arrives at a partnered retailer, the consumer will get a notification of the news and will be able to order it within a minute.

The order tracking and support systems will adapt to the industry standards with precise order location tracking and high-quality 0-24 support. The access to the public consumer application is designed to be completely free.

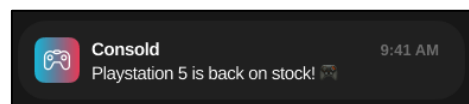


Figure 24: Visualization of the notification when a product is back in stock

## 8.2.4 Details on the Application Intended for Business Use

On the retailer side of the application, the retailer can quickly get in touch with the manufacturer and can order more stock easily within an integrated system. The company operating the application will provide high-quality and automated systems with the use of RFID tags.

*RFID tags: Radio Frequency Identification, in short RFID, uses radio waves to identify objects and products. There has to be a device that reads information contained in a wireless device without making any physical contact. – Definition by the Homeland Security of the United States government.*

The partnered retailer will be able to schedule orders from the application directly from the supplier via the "Place an Order" menu option.

During the delivery process, the retailer will be able to follow their order with live GPS tracking using the "Order Tracking" menu. These orders can be made recurrent orders in order to repeat them in the given period with the "Calendar View."

The retailer will be able to see live data on the stock that the store currently has in the "Warehouse Management" menu. If an item is low on stock, a notification will be sent to the retailer with an option to re-stock with the following order.

The application intended for professional business use is designed to have a subscription model, and each retailer that intends to use the application and the automated stock management system will have to sign an agreement with the application operator. With this method, the application designed for the consumers can remain completely free without advertisements.

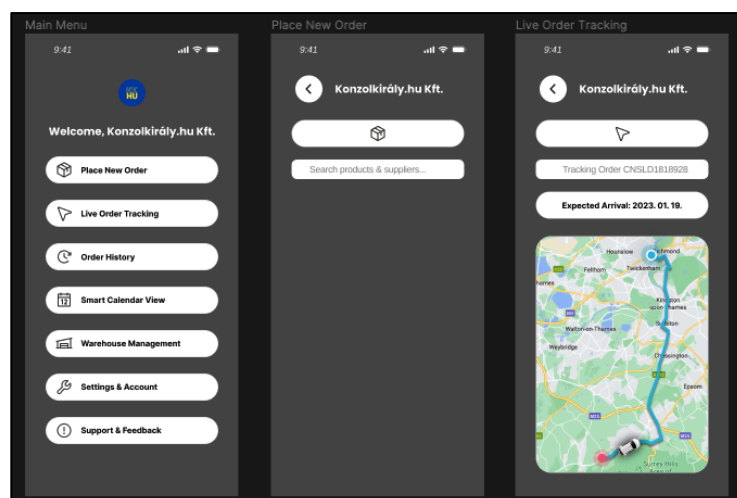


Figure 25: Screenshot of the prototype (b)

Planned subscription types and their proposed features:

- **Basic**

Ordering directly from official industry-leading gaming suppliers.

Live order tracking via GPS.

Future order planning is easily manageable with the "Calendar View."

The store will be visible on the "Consold" website and application.

- **Premium**

Ordering directly from official industry-leading gaming suppliers.

Live order tracking via GPS.

Future order planning is easily manageable with the "Calendar View."

The store will be visible on the "Consold" website and application.

Fully automated RFID Warehouse Management.

The "Consold" application will send notifications and precise live updates for the store's consumers on product availability and other news.

- **Deluxe**

Everything included in the Premium subscription package + Full priority support if needed.

### 8.2.5 Disclaimer about the Prototype of the Mobile Application

The name of the application, the detailed features, the design, and the pricing shown with the use of UI elements are subject to change and are meant to represent the fundamental idea and the essential functions supporting it. The prototype is not the final version of the application.

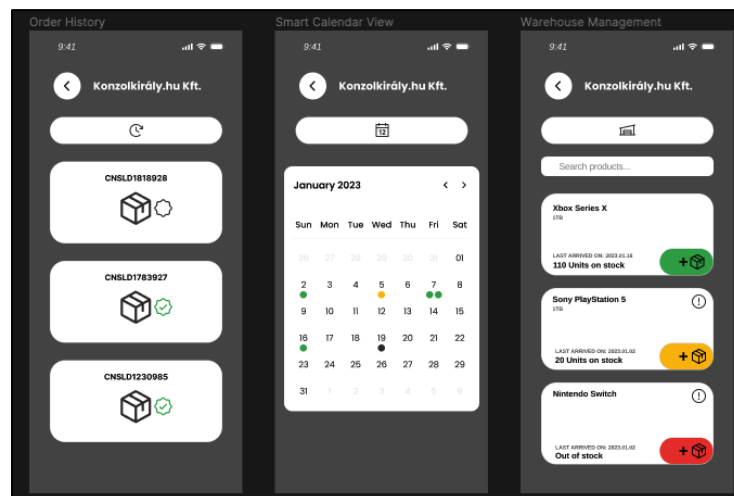


Figure 26: Screenshot of the application (c)



## 9.0 Conclusion

The video game console supply chain is one of the most complex supply chains, hence the complexity of the semiconductors and graphical processing units that are used in these products. This supply chain suffered major setbacks between 2020 and 2023 because of the semiconductor shortage and the scalpers.

The problem was too complex and excessively sudden to prepare the supply chain for the worst-case scenario: a vast shortage as a consequence of high demand and troubled procurement of the materials. Based on the Secondary research data, the problem was sorted out by the beginning of 2023. The solutions were carried out thanks to multiple measures managing the retail of the graphical processing units by creating GPUs exclusively for cryptocurrency mining, the stabilizing demand curve, and the end of the pandemic. However, the solving process could have been considerably faster with the suggested methods in this academic paper, such as the purchasing limit of consoles (1 console per 1 person rule), official retail partners, relocating manufacturing factories to multiple regions, and a proposed warehouse management/price aggregation app.

When a product shortage of this size occurs, definite crisis management and quality crisis communication are necessary. Both Microsoft and Sony were able to keep the news flowing on the current shortage situation. Still, no information was shared with the public about the measures taken to manage the situation.

The quality of the products was not affected by the slightest degree during the shortage.

The general public opinion of Microsoft and Sony was not affected; hence, the quality of the products and the consoles were treated as rare and valuable products to own by the public.

The video game industry continues to rise both worldwide and in Hungary.

Due to the complexity of the manufacturing process of video game consoles and an ever-emerging demand, a shortage in the future is still possible; however, the experiences that the industry earned during 2020-2023 can be used to ameliorate the deficit and have a quicker reaction.

*” Every age has its storytelling form, and video gaming is a huge part of our culture. You can ignore or embrace video games and imbue them with the best artistic quality. People are enthralled with video games in the same way as other people love the cinema or theatre.”*

*Andy Serkis, 2010 (Arnott, 2010)*

*“The supply chain stuff is really tricky.”*

*Elon Musk, Code Conference 2016*

## 10.0 Attachments

### 10.1 Reference List

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## 10.2 Statista figures

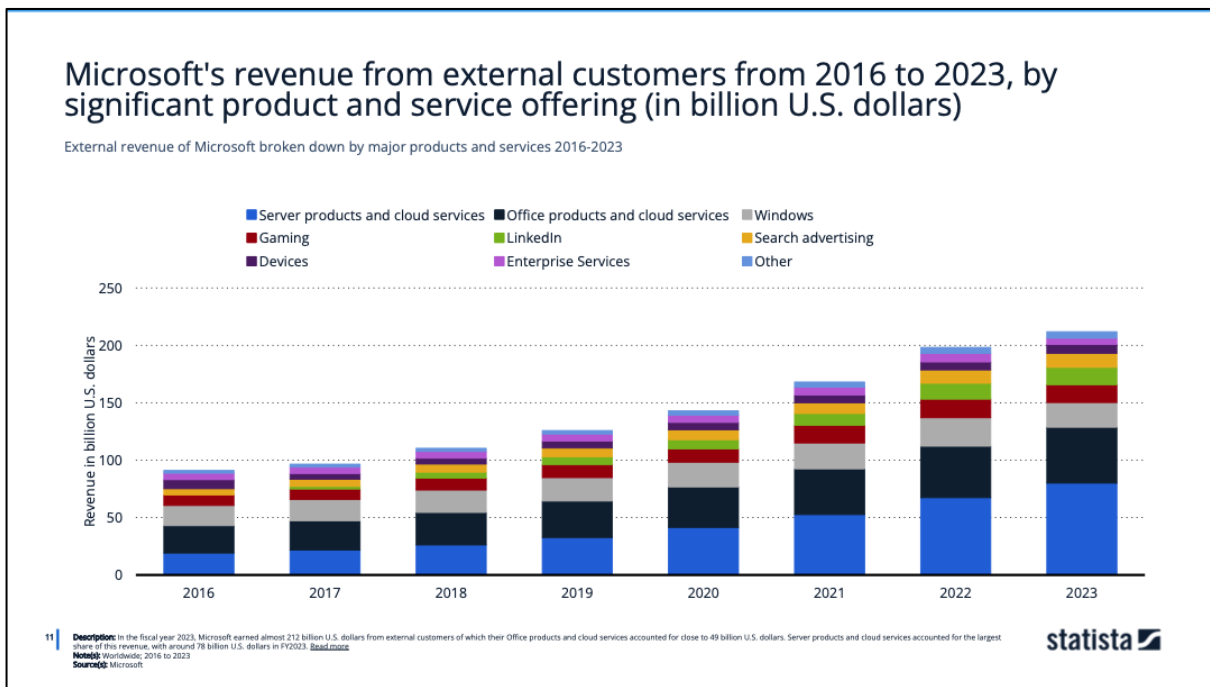


Figure 27: Microsoft's revenue from external customers from 2016 to 2023, by significant product and service offering (in billion US dollars) (Source: Microsoft, Available at Statista)

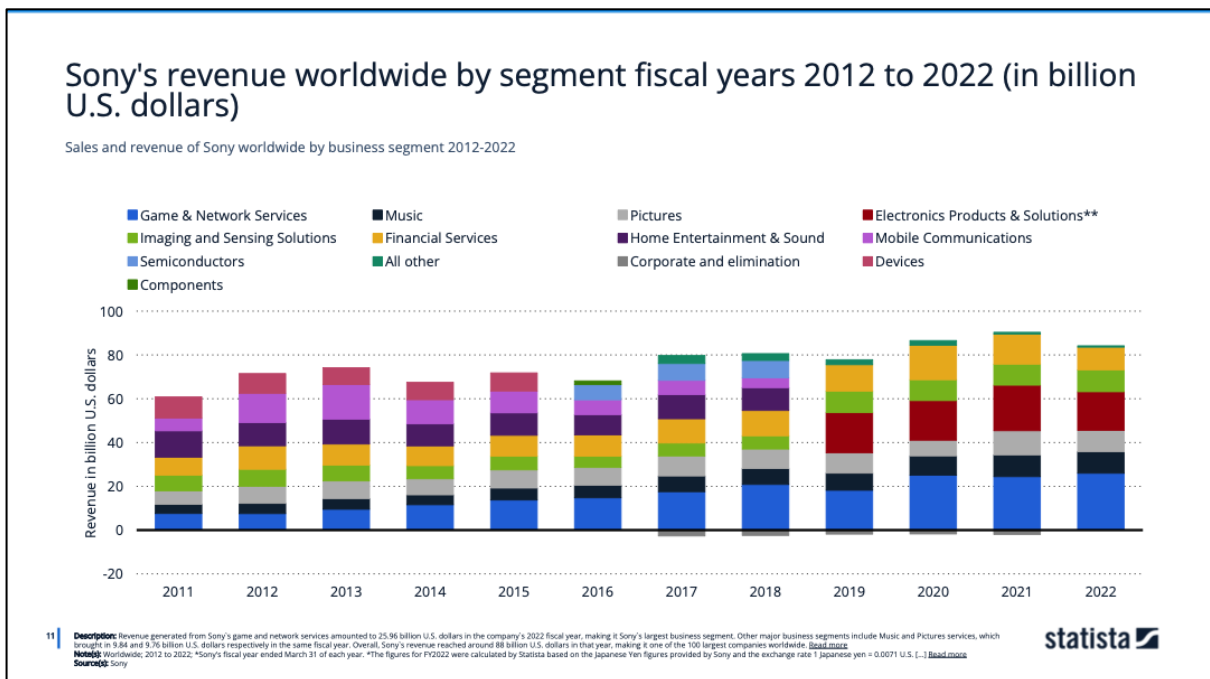


Figure 28: Sony's revenue worldwide by segment fiscal years 2012 to 2022 (in billion US dollars) (Source: Sony, Available at Statista)

## Current generation video game console unit sales worldwide from 2017 to 2023 (in million units)

Current-gen video game console unit sales worldwide 2017-2023

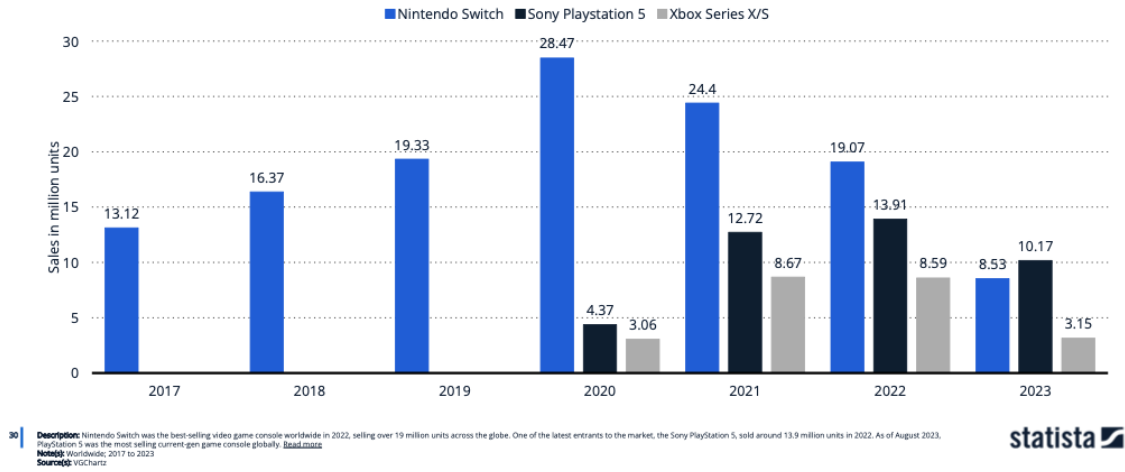


Figure 29: Current generation video game console unit sales worldwide from 2017 to 2023 (in million units) (Source: VGChartz, Available at Statista)

## Net sales and operating income of Sony's game and network services (G&NS) from fiscal 2012 to 2022 (in billion yen)

Sony game and network services: net sales & operating income FY 2012-2022

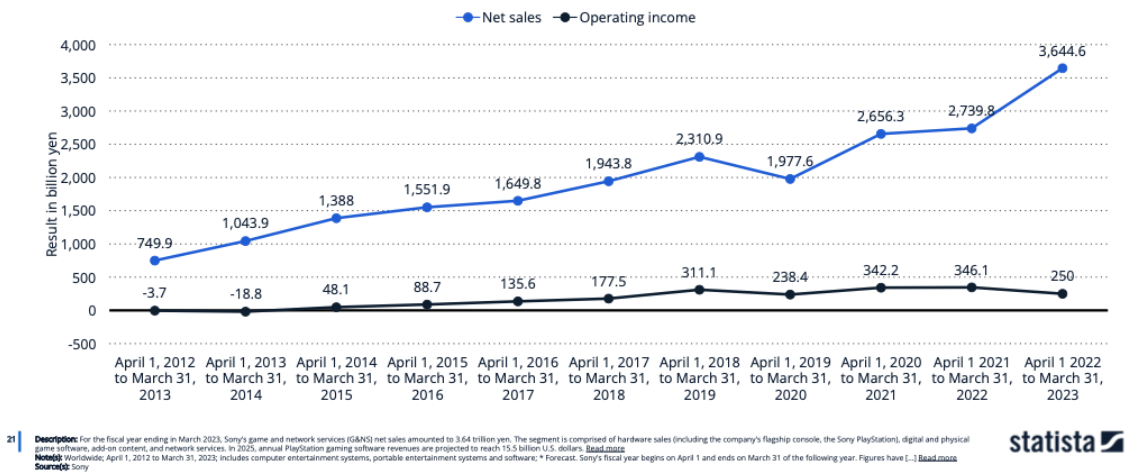
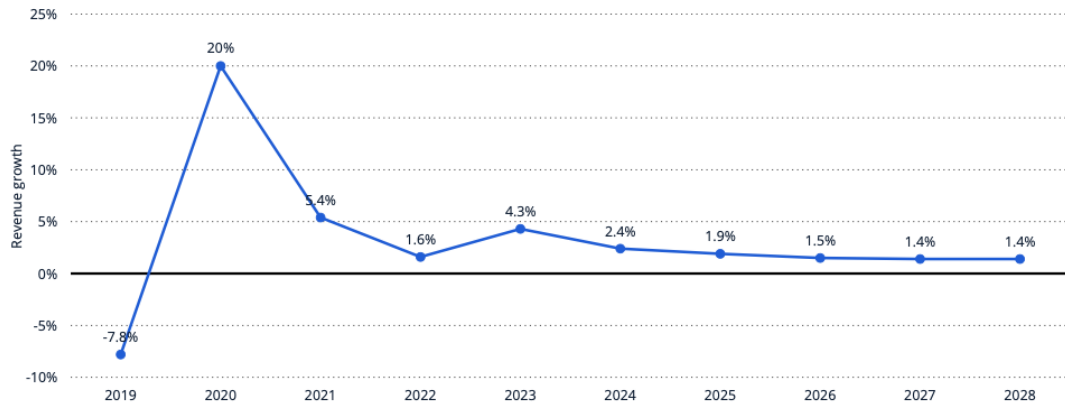


Figure 30: Net sales and operating income of Sony's game and network services (G&NS) from fiscal 2012 to 2022 (in billion yen) (Source: Sony, Available at Statista)

## Revenue growth of the video game consoles market worldwide from 2019 to 2028

Global video game consoles revenue growth 2019-2028



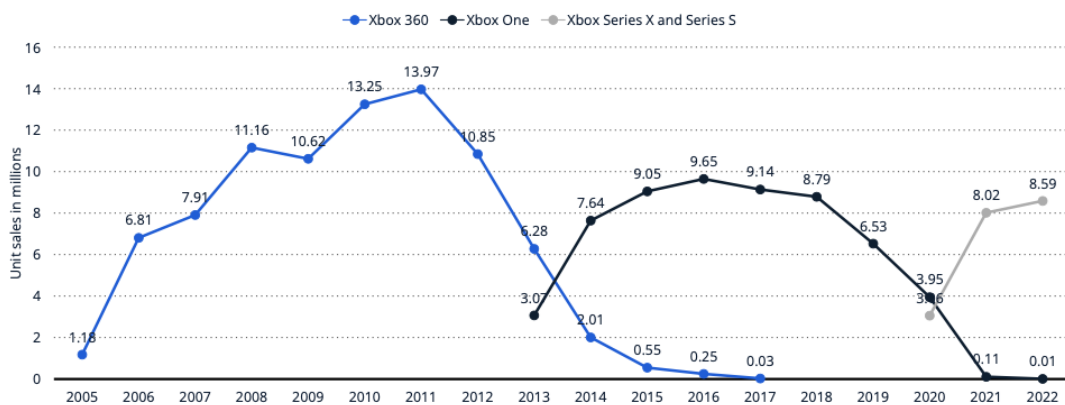
15 Description: In 2023, the global video gaming console market is projected to increase by 4.3 percent compared to the previous year. In 2027, the annual growth of the gaming console hardware market is projected to slow to an annual growth rate of 1.4 percent. [Read more](#)  
 Note: Worldwide, 2019 to 2028  
 Source: Statista; Statista Consumer Market Insights

statista

Figure 31: Revenue growth of the video game consoles market worldwide from 2019 to 2028  
 (Source: Statista Consumer Market Insights, Available at Statista)

## Xbox 360, Xbox One and Xbox XS gaming consoles unit sales worldwide from 2005 to 2022 (in millions)

Xbox 360, Xbox One and Xbox XS annual unit sales worldwide 2005-2022



16 Description: In 2022, the unit sales of Microsoft's Xbox Series X and Series S video game consoles amounted to nearly 8.6 million units, increasing considerably from just above eight million units sold in the previous year. Xbox XS's predecessors, the Xbox One, was put to market in 2013 and sold over 57 million units in total till the end of its lifespan in 2020. [Read more](#)  
 Note: Worldwide, 2005 to 2022  
 Source: VGChartz

statista

Figure 32: Xbox 360, Xbox One and Xbox XS gaming consoles unit sales worldwide from 2005 to 2022 (in millions) (Source: VGChartz, Available at Statista)

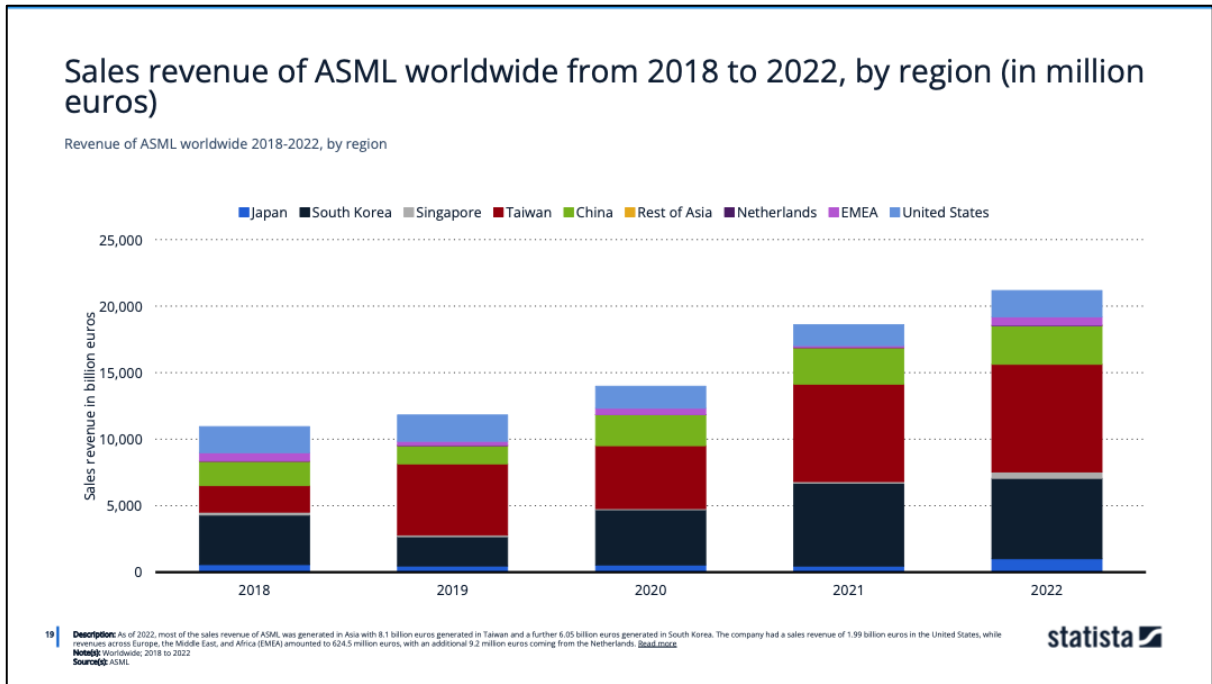


Figure 33: Sales revenue of ASML worldwide from 2018 to 2022, by region (in million euros) (Source: ASML, Available at Statista)

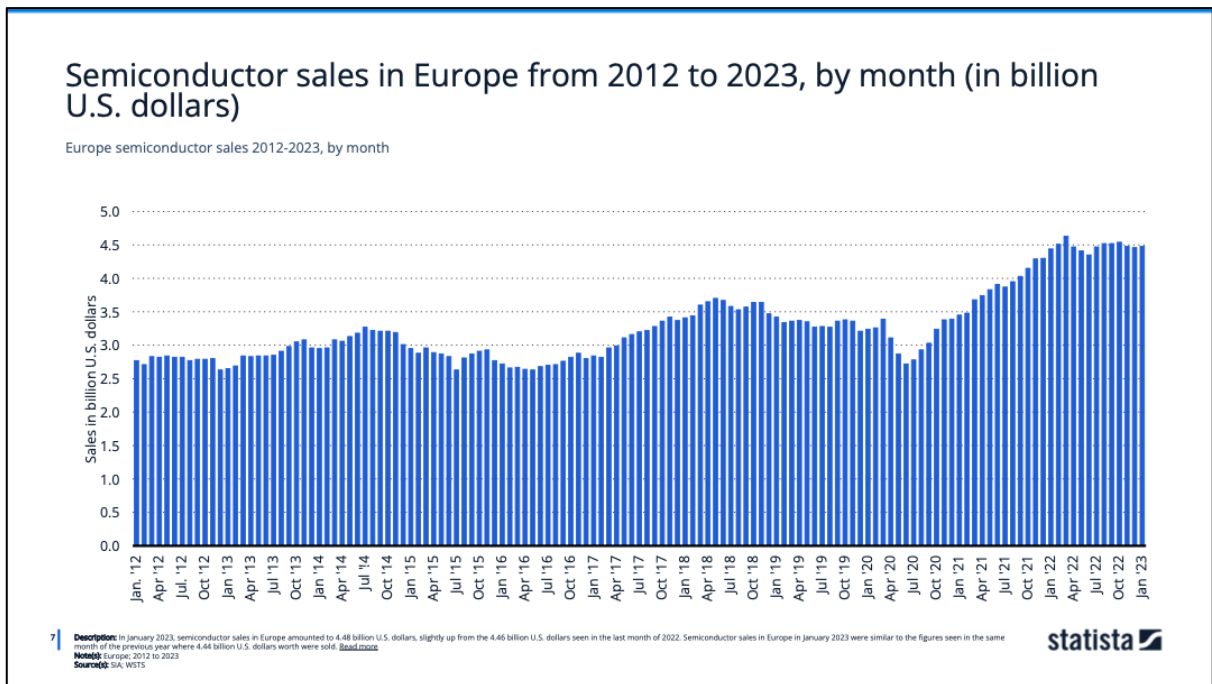


Figure 34: Semiconductor sales in Europe from 2012 to 2023, by month (in billion US dollars) (Source: SIA, WSTS, Available at Statista)



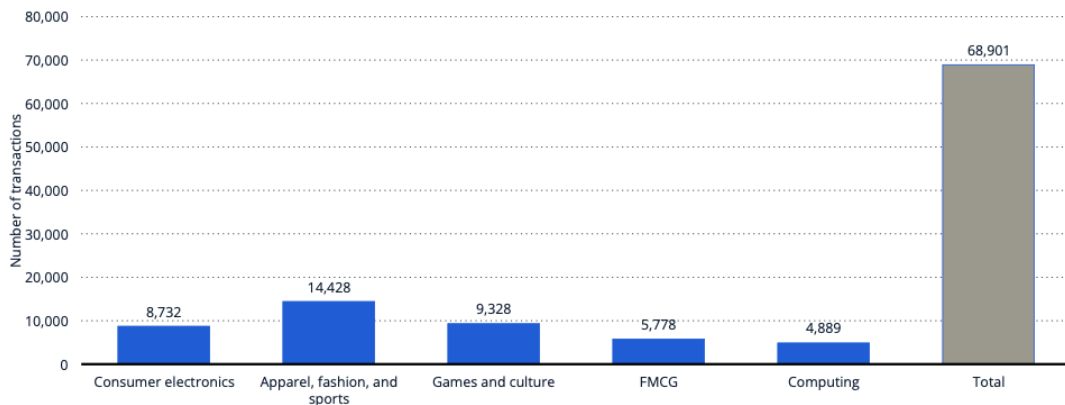
Figure 35: Share of population shopping online in Hungary from 2010 to 2022 (Source: Hungarian Central Statistical Office, Available at Statista)



Figure 36: Leading online shops in Hungary in 2022, by e-commerce net sales (in million US dollars) (Source: ecommerceDB.com, Available at Statista)

## Number of e-commerce transactions in Hungary in 2021, by product category (in 1,000s)

Number of e-commerce transactions in Hungary 2021, by product category



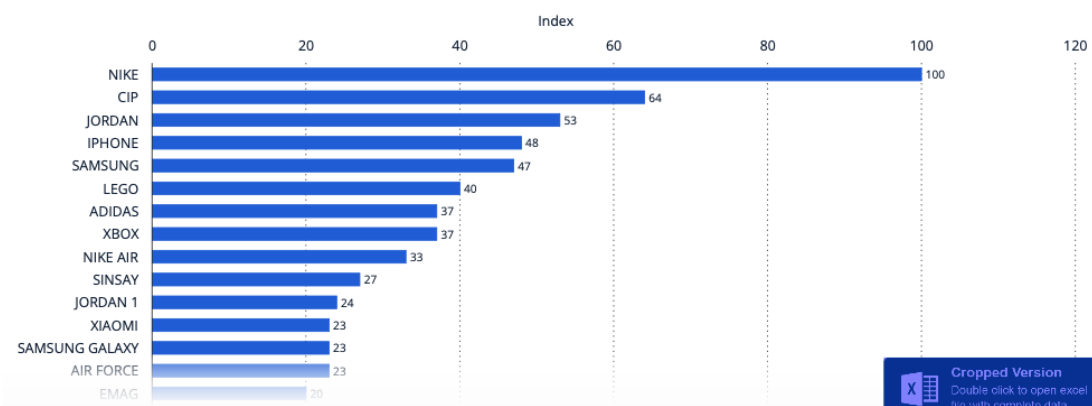
**Description:** In 2021, the number of e-commerce transactions reached nearly 69 million in Hungary. The highest number of online purchase transactions were made in the apparel, fashion, and sports product category totaling over 14 million. [Read more](#)  
**Notes:** Hungary, 2021  
**Source:** Árukereső.hu; GKI digital

statista

Figure 37: Number of e-commerce transactions in Hungary in 2021, by product category (in 1,000s) (Source: Árukereső.hu, GKI digital, Available at Statista)

## Most common shopping queries entered into Google in Hungary in 2022

Most common shopping queries entered into Google in Hungary 2022



**Description:** In 2022, the most popular shopping query entered into google was "Nike". "Cip", the Hungarian word for shoe ranked second with an index score of 64 points. [Read more](#)  
**Notes:** Hungary, 2022. \* Google does not publish search volumes, but the index column shows relative volumes for each query compared to search volumes of the top query. [Read more](#)  
**Source:** DataReportal; Google Trends; Meltwater; We Are Social

Cropped Version  
 Double click to open excel file with complete data

statista

Figure 38: Most common shopping queries entered into Google in Hungary in 2022 (Source: DataReportal, Google Trends, Meltwater, We Are Social, Available at Statista)

Table 1.

**Earliest Economic Indicator Releases Relevant to Figure 1: Journey of a Video Game Console**

| Release   | Acronym | Typical Month Release Order | Release Frequency  | Sample Size                                  | Some Examples of Video Game Console Data Available at Release   | Why Is This Release Important?  |
|---|---------|-----------------------------|--|--|---|---|
| Advanced Monthly Sales for Retail & Food Services | MARTS   | First                       | Monthly, approximately 9 business days after reference month.        | Approximately 5,500 companies.               | Retail and food services sales covered in: NAICS 443: Electronics & appliance stores, NAICS 4521: Department stores, and NAICS 454: Nonstore Retailers.   | Earliest available government measure of monthly retail sales estimates of broad-based retail trade activity.   |
| Advance Economic Indicators Report                | NA      | Second                      | Monthly, approximately 24-31 days after reference month.             | Methodology varies between three components. | International Trade in Consumer Goods, Wholesale Inventories in Durable Goods, and Total Retail Trade Inventories.  | Provides earliest measure of monthly international trade in goods, wholesale inventories, and retail inventories.   |
| U.S. International Goods and Services Report      | FT900   | Third                       | Monthly, approximately 34-36 days after reference month.             | Population.                                  | Exports, Imports of Harmonized Tariff Schedule 9504.50: Video Game consoles and machines.   | Provides monthly international trade balance in goods and services.   |
| Monthly Wholesale Trade Report                    | MWTS    | Fourth                      | Monthly, approximately 40 days after reference month.                | Approximately 4,200 companies.               | Wholesale Inventories, Sales, and Inventories to Sales Ratios in: NAICS 4239: Miscellaneous Durable Goods; which in part includes Toy and Hobby Goods and Supplies Merchant Wholesalers.  | Provides only available government measure of monthly estimates of wholesale trade activity.  |
| Monthly Sales for Retail & Food Services          | MRTS    | Fifth                       | Monthly, approximately 6 weeks after the end of the reference month. | Approximately 13,000 companies.              | Retail and food services sales covered in: NAICS 443142: Electronics stores, NAICS 452112: Discount Department stores, NAICS 45291: Warehouse clubs and superstores, and NAICS 4541: Electronic shopping and mail-order houses. | Contributes to two designated principal economic indicators and is an integral component of MARTS and MTIS. Provides current estimates of sales at retail and food services stores and inventories held by retail stores. |

Figure 39: Earliest Economic Indicator Releases Relevant to Figure 3 (S&amp;P, 2022)

### 10.3 Flow charts of the application prototype in Figma

