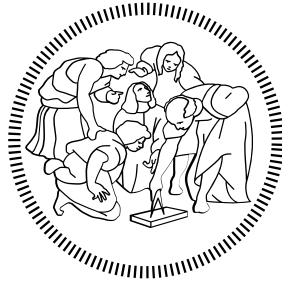# POLITECNICO
MILANO 1863

Livello Grab n Go Store SmartBox24

Thesis Advisor
Prof. Silvia Deborah Ferraris

Company Advisor
Ali Yurtseven

Candidate
Saifali Satkhed

Academic Year
2021/2022

POLITECNICO

MILANO 1863

Scuola del Design
Corso di Laurea Magistrale
Design & Engineering
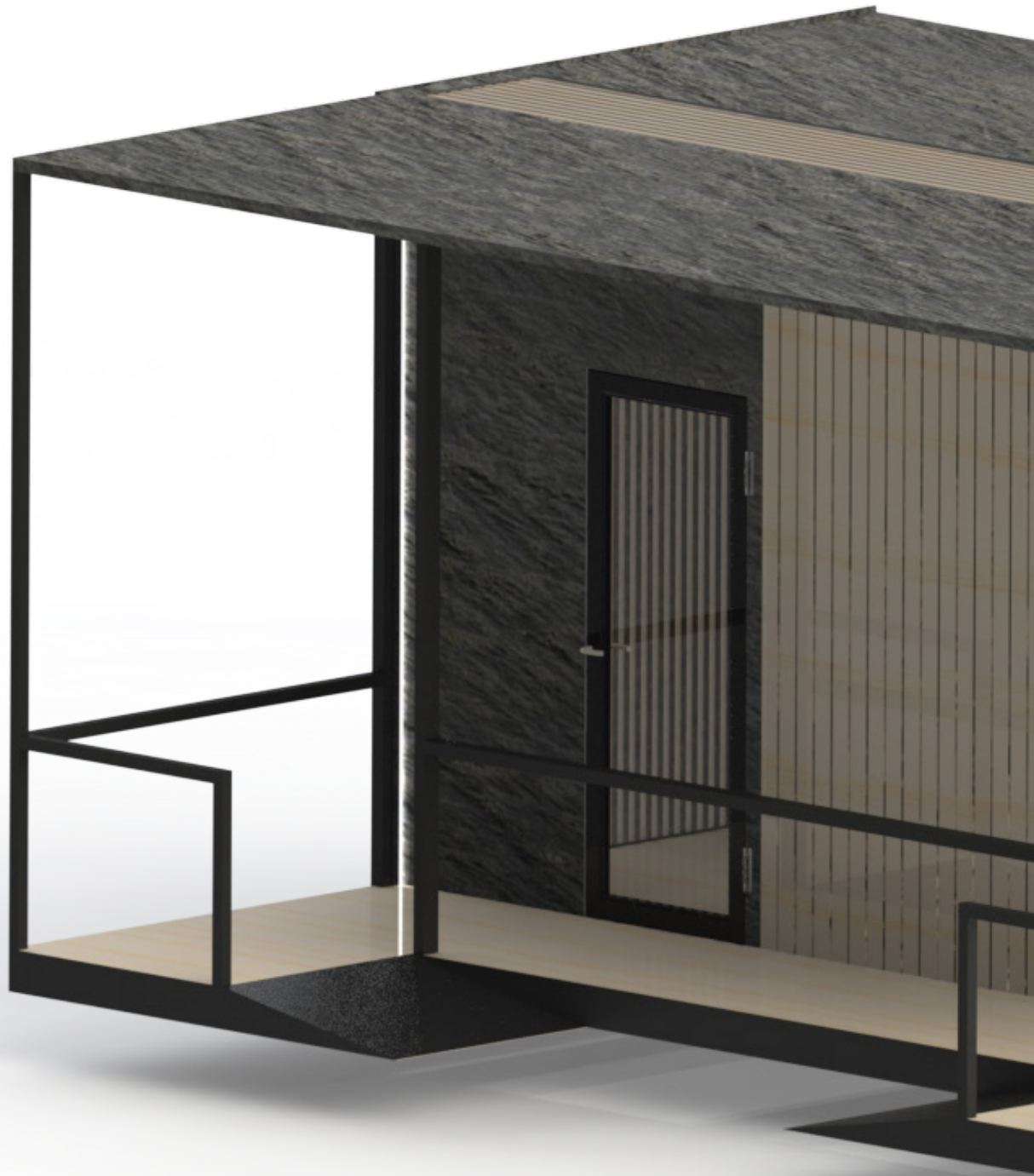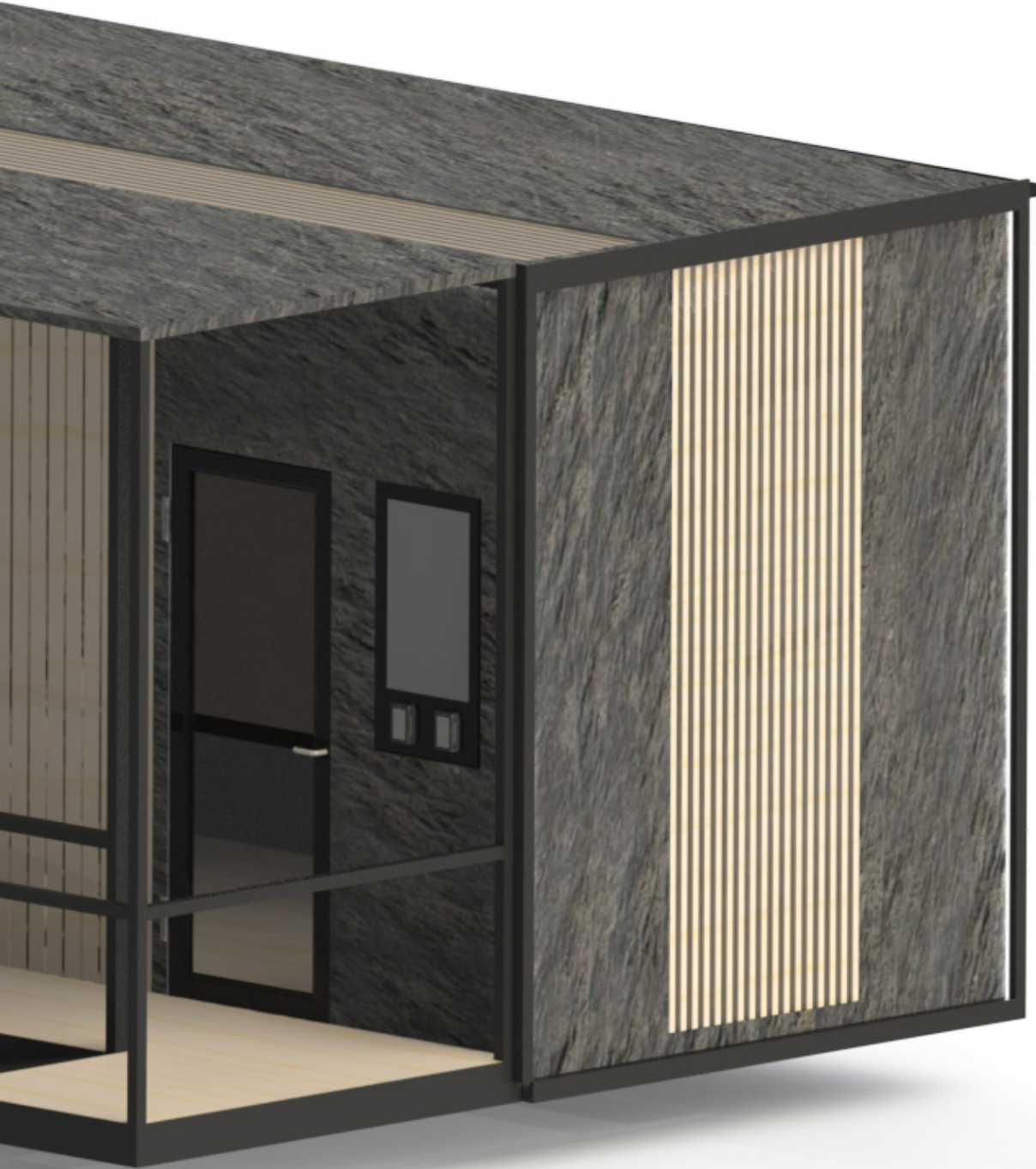
Livello Grab n Go Store SmartBox24

Thesis Advisor
Prof. Silvia Deborah Ferraris

Company Advisor
Ali Yurtseven

Candidate
Saifali Satkhed

Academic Year
2021/2022

ACKNOWLEDGEMENT

I would like to express my deepest gratitude and appreciation to all those who have supported and contributed to the completion of this thesis.

First and foremost, I am immensely grateful to my supervisor, Prof. Silvia Deborah Ferraris, and my Co-supervisor Mr. Ali Yurtseven for their guidance, expertise, and continuous support throughout this research journey. Their invaluable insights, constructive feedback, and unwavering encouragement have been instrumental in shaping the direction and quality of this thesis.

I would like to extend my heartfelt thanks to the Livello GmbH, Alexander Eissing, for their valuable time, expertise, and valuable inputs. Their constructive criticism, suggestions, and scholarly guidance have greatly enriched the content and depth of this work.

I am indebted to the faculty members and staff of Politecnico di Milano, whose knowledge, resources, and dedication have played a crucial role in shaping my academic and research capabilities. Their commitment to fostering a stimulating learning environment has been invaluable in my academic growth.

I would like to express my gratitude to my colleagues and friends who have provided support, encouragement, and fruitful discussions throughout this research endeavor. Their insights and willingness to engage in intellectual debates have broadened my perspectives and enriched the quality of this thesis.

I am deeply grateful to the participants of this study, whose cooperation and willingness to share their experiences and insights have contributed significantly to the research findings. Their involvement has been pivotal in the successful completion of this work.

Lastly, I would like to express my heartfelt appreciation to my family for their unwavering love, understanding, and encouragement throughout this academic journey. Their constant support, patience, and belief in my abilities have been a source of inspiration and motivation.

While it is impossible to name everyone who has contributed to this thesis, I am sincerely grateful to all those who have played a part, no matter how big or small. Your support and encouragement have been invaluable, and I am truly thankful for the opportunity to undertake this research and share its findings.

ABSTRACT - (Italian)

Il progetto di design del negozio di container automatizzati 24 ore su 24, 7 giorni su 7 con chiosco intelligente mira a rivoluzionare il settore della vendita al dettaglio creando un'esperienza di acquisto completamente automatizzata e accessibile. Questo progetto prevede la progettazione di un negozio compatto ospitato all'interno di un container, dotato di tecnologia avanzata e di un sistema di chioschi intelligenti.

Il negozio di container automatizzato utilizza robotica e intelligenza artificiale all'avanguardia per offrire ai clienti un'esperienza di acquisto comoda e senza interruzioni. Il chiosco intelligente funge da hub centrale, consentendo ai clienti di navigare e selezionare i prodotti, effettuare pagamenti e ricevere i propri acquisti, il tutto senza la necessità di assistenza umana.

Il layout interno del negozio di container è ottimizzato per un'organizzazione e un recupero efficienti dei prodotti, utilizzando sistemi robotici per gestire l'inventario e il rifornimento. I clienti possono accedere al negozio in qualsiasi momento, 24 ore al giorno, sette giorni alla settimana, consentendo flessibilità e convenienza per stili di vita frenetici.

Il chiosco intelligente funge da interfaccia interattiva, fornendo ai clienti una piattaforma di facile utilizzo per navigare tra le categorie di prodotti, leggere informazioni dettagliate e confrontare i prezzi. Utilizza algoritmi di apprendimento automatico per personalizzare i consigli in base alle preferenze dei clienti e agli acquisti passati, migliorando l'esperienza di acquisto.

Le misure di sicurezza, come telecamere di sorveglianza e sistemi di controllo degli accessi, garantiscono la sicurezza sia dei clienti che della merce. Il negozio di container è progettato per essere rispettoso dell'ambiente, incorporando tecnologie ad alta efficienza energetica e materiali sostenibili.

Attraverso questo innovativo progetto di progettazione di negozi 24 ore su 24, 7 giorni su 7 con un chiosco intelligente, il settore della vendita al dettaglio può soddisfare le esigenze in continua evoluzione dei consumatori, offrendo un'esperienza di acquisto comoda, efficiente e personalizzata. Questo progetto ha il potenziale per rimodellare il futuro della vendita al dettaglio, combinando automazione, intelligenza artificiale e tecnologie intelligenti per ridefinire i confini dei tradizionali negozi fisici.

ABSTRACT - (English)

The automated container 24-7 store design project with smart kiosk aims to revolutionize the retail industry by creating a fully automated and accessible shopping experience. This project involves designing a compact store housed within a shipping container, equipped with advanced technology and a smart kiosk system.

The automated container store utilizes state-of-the-art robotics and artificial intelligence to provide customers with a convenient and seamless shopping experience. The smart kiosk acts as the central hub, allowing customers to browse and select products, make payments, and receive their purchases, all without the need for human assistance.

The container store's interior layout is optimized for efficient product organization and re-trieval, utilizing robotic systems to manage inventory and restocking. Customers can access the store at any time, 24 hours a day, seven days a week, enabling flexibility and convenience for busy lifestyles.

The smart kiosk serves as an interactive interface, providing a user-friendly platform for customers to navigate through product categories, read detailed information, and compare prices. It utilizes machine learning algorithms to personalize recommendations based on customers' preferences and past purchases, enhancing the shopping experience.

Security measures, such as surveillance cameras and access control systems, ensure the safety of both customers and merchandise. The container store is designed to be environ-mentally friendly, incorporating energy-efficient technologies and sustainable materials.

Through this innovative automated container 24-7 store design project with a smart kiosk, the retail industry can meet the evolving needs of consumers, offering a convenient, efficient, and personalized shopping experience. This project has the potential to reshape the future of retail, combining automation, artificial intelligence, and smart technologies to redefine the boundaries of traditional brick-and-mortar stores.

TABLE OF CONTENT

DESIGN RESEARCH

What is Smart Store?

In recent years, the retail landscape has witnessed a profound transformation driven by technological advancements. Among the innovations that are reshaping the industry, smart stores stand out as a game-changer. A smart store, also known as an intelligent store or connected store, refers to a retail establishment that incorporates advanced technologies and digital systems to enhance the shopping experience, streamline operations, and improve overall efficiency. It leverages the Internet of Things (IoT), artificial intelligence (AI), data analytics, and other cutting-edge technologies to create a more intelligent and interactive retail environment.

Key features and components commonly found in smart stores include:

Internet of Things (IoT) Devices:

Smart stores are equipped with IoT devices such as sensors, beacons, and RFID tags. These devices enable real-time tracking of inventory, monitor customer behavior, and gather data on various aspects of store operations.

Digital Signage and Displays:

Smart stores utilize digital signage and displays to deliver targeted and dynamic content to customers. These displays can showcase personalized advertisements, promotions, and product information, enhancing the visual appeal and engagement within the store.

Mobile Apps and Beacons:

Smart stores often have mobile apps that customers can download to access additional features and services. Beacons placed throughout the store interact with the mobile app, providing location-based notifications, personalized offers, and navigation assistance.

Artificial Intelligence and Machine Learning:

Smart stores leverage AI and machine learning algorithms to analyze customer data, predict purchasing patterns, and offer personalized recommendations. AI-powered chatbots and virtual assistants may also be employed to provide customer support and answer inquiries.

Contactless Payments:

To facilitate quick and seamless transactions, smart stores often adopt contactless payment methods such as mobile wallets, NFC (Near Field Communication) technology, or QR codes. This reduces checkout times and enhances convenience for customers.

Inventory Management Systems:

Smart stores employ advanced inventory management systems that integrate with real-time data from IoT devices and sales transactions. This enables automated inventory tracking, stock replenishment notifications, and efficient management of product availability.

Customer Analytics and Insights:

By analyzing customer data and behavior, smart stores gain valuable insights into customer preferences, buying habits, and shopping patterns. These insights can inform targeted marketing strategies and help retailers optimize product placement and assortment.

Enhanced Security Systems:

Smart stores prioritize security measures, utilizing technologies like video surveillance, facial recognition, and RFID tags to prevent theft, monitor foot traffic, and ensure a safe shopping environment.

Seamless Omni-channel Integration:

Smart stores aim to provide a seamless experience across multiple channels, including

online and offline. They integrate inventory, customer profiles, and purchasing history to enable customers to switch between channels effortlessly and enjoy consistent service.

The ultimate goal of a smart store is to create a personalized, engaging, and efficient shopping experience for customers while enabling retailers to gain actionable insights and optimize their operations. By leveraging innovative technologies, smart stores are at the forefront of the retail industry's digital transformation, adapting to evolving consumer expectations and driving business success. Smart stores combine cutting-edge technologies to create an immersive and personalized shopping experience for consumers.

Smart Store

Determine store
- GPS
- Beacons
- Manual selection

Scan in store with phone
- Camera
- NFC
- QR
- Products
  - Windows
  - Apple iOS 11
  - Android
  - Camera
  - Barcode
  - Check stock in current store
  - Available variants (color, size)
  - Impression images and videos

Floorplan
- Where users interact with products
- Notification when visitor enters store
- Heat map of product interactions

Proximity Marketing
- Beacons
- Personalized welcome message
- Personalized offers
- Cross selling (you might be interested in ")

Business Intelligence
- Conversions
- Time: store visit
- Interaction with products
- Compare physical stores

Smartphone payment methods
- LevelUp
- Square
- PayPal Here
- Apple Pay
- iPayment MobilePay
- Android pay

Enhancement of User Experience from a Smart Store:

Smart stores combine cutting-edge technologies to create an immersive and personalized shopping experience for consumers. The Advantages presented by the Smart store for a User Experience stance are as follows:

Enhanced Customer Experience:

Smart stores prioritize customer satisfaction by offering an array of features that revolutionize the shopping experience.

a) Personalization:

By leveraging data analytics and artificial intelligence, smart stores can deliver personalized recommendations, tailored promotions, and customized experiences. This enables retailers to forge deeper connections with their customers and create a sense of exclusivity.

b) Interactive Product Discovery:

Augmented reality (AR) and virtual reality (VR) technologies in smart stores empower consumers to virtually try products, visualize them in various settings, and gain a comprehensive understanding of their features. This immersive experience assists customers in making confident purchasing decisions.
c) Convenience and Efficiency:

Smart stores streamline the shopping process through features such as mobile apps, digital maps, and seamless checkouts. Customers can locate products, receive real-time offers, and make payments effortlessly, enhancing convenience and efficiency.

Operational Advantages:

Smart stores offer numerous operational benefits to retailers, transforming the way they manage and operate their businesses.

a) Data-driven Insights:

Through the Internet of Things (IoT), smart stores gather real-time data on customer behavior, preferences, and buying patterns. Retailers can leverage this information to optimize inventory management, pricing strategies, and targeted marketing campaigns. Data-driven insights help retailers understand customer needs better and refine their business strategies accordingly.

b) Efficient Inventory Management:

By constantly monitoring stock levels, smart stores enable retailers to optimize inventory, prevent stockouts, and streamline the replenishment process. This results in cost savings, reduced wastage, and improved customer satisfaction.

c) Streamlined Operations:

Automation and AI-powered systems within smart stores facilitate various operational processes. These include inventory management, supply chain logistics, and customer service. By reducing manual efforts and optimizing efficiency, smart stores enable retailers to allocate resources more effectively and enhance overall productivity.

Transforming the Retail Industry:

Smart stores are playing a pivotal role in shaping the future of retail and revolutionizing the industry.

a) Seamless Integration of Online and Offline:

Smart stores bridge the gap between physical and online retail by creating a seamless integration. They leverage technology to provide a consistent and personalized experience across multiple channels, enabling customers to switch effortlessly between online and in-store shopping.

b) Data-driven Decision Making:

Smart stores empower retailers with actionable insights derived from real-time data. This data-driven decision-making approach allows retailers to anticipate market trends, optimize operations, and stay ahead of competitors.

c) Innovation and Differentiation:

By embracing smart store concepts, retailers can differentiate themselves in a crowded marketplace. The integration of advanced technologies helps them create unique and memorable experiences for customers, fostering brand loyalty and attracting new audiences.

Smart stores represent the future of retail, redefining the way customers interact with brands and transforming how retailers operate their businesses. With enhanced customer experiences, personalized services, and streamlined operations, smart stores are revolutionizing the industry. The continued integration of emerging technologies, such as IoT, AI, AR, and VR, will drive further innovation in the retail sector, offering new possibilities and opportunities. As consumers demand convenience, personalization, and immersive experiences, smart stores will play a vital role in meeting these expectations and shaping the future of retail.

History of Automated Stores:

Automated stores, also known as self-service or unmanned stores, have a history that dates back several decades. The concept of automated stores emerged as a response to the growing demand for convenience and efficiency in retail. Let's explore the detailed history of automated stores:

Vending Machines:

The earliest form of automated stores can be traced back to the invention of vending machines in the late 19th century. These machines allowed customers to purchase simple products, such as snacks and beverages, by inserting coins and selecting the desired item. Vending machines provided a self-service model that eliminated the need for human interaction during the purchase process.

Self-Service Grocery Stores:

In the early 20th century, the concept of self-service grocery stores started to gain popularity. Clarence Saunders, an American grocer, is often credited with pioneering the idea with his creation of the first self-service Piggly Wiggly store in 1916. Instead of relying on store clerks to retrieve items for customers, shoppers could now browse the store themselves, select products, and proceed to checkout.

Supermarkets and Self-Checkout:

The development of supermarkets in the 1930s and 1940s marked a significant milestone in the history of automated stores. These large-scale retail establishments offered a wide variety of products and implemented self-service models to allow customers to choose and collect items themselves. As technology advanced, self-checkout systems were introduced, enabling shoppers to scan and pay for their items without cashier assistance.

Automated Vending and Kiosks:

With the advent of electronic and computerized technologies in the late 20th century, automated vending machines and kiosks saw significant advancements. Vending machines expanded beyond snacks and beverages to include a broader range of products, such as electronics, DVDs, and even prescription medications. Self-service kiosks emerged in various industries, enabling customers to perform tasks like ticketing, information retrieval, and self-checkout in locations like airports, train stations, and retail stores.

Online Retail and E-commerce:

The rise of the internet and e-commerce in the 1990s and early 2000s revolutionized the retail landscape. Online retailers like Amazon pioneered the concept of virtual automated stores, where customers could browse and purchase products online, eliminating the need

for physical stores altogether. This shift towards e-commerce paved the way for concepts like click-and-collect, where customers could order products online and pick them up from designated locations or automated lockers.

Cashier-Less Stores:
In recent years, advancements in technology, particularly artificial intelligence (AI), computer vision, and sensor technologies, have given rise to cashier-less stores. Companies like Amazon Go have introduced a new generation of automated stores that utilize a combination of sensors, cameras, and AI algorithms to track customer movements, detect selected items, and automatically charge customers as they exit the store. These stores offer a seamless shopping experience without the need for traditional checkout processes.

The history of automated stores demonstrates a continuous evolution driven by technological advancements and changing consumer preferences. From the early vending machines and self-service grocery stores to the emergence of cashier-less stores, the retail industry has consistently sought ways to enhance convenience, efficiency, and customer autonomy. As technology continues to advance, it is expected that automated stores will continue to evolve, offering even more innovative and immersive shopping experiences.

First Automated Store:

Keedoozle:

Keedoozle, the first fully automated grocery store in the United States, was an innovative concept that was ahead of its time. It was developed by Clarence Saunders, the founder of Piggly Wiggly, who revolutionized grocery shopping by introducing the self-serving store model in 1916.

With Keedoozle, Saunders aimed to take the browsing element of shopping to the next level by replacing clerks with technology. Customers were given a key to use while shopping, and they would punch the corresponding key for each item into their card. The punched tape was then processed by a cashier, initiating the movement of goods on conveyor belts and tallying the total cost.

However, the Keedoozle system proved to be too complicated for the available technology at the time. Circuits often got mixed up, leading to customers receiving the wrong merchandise. The conveyor belt system also struggled to handle the high traffic load during peak times.

Only three Keedoozle stores were built, all in Memphis, Tennessee. The first store opened in 1937 but closed after a few months due to technological limitations. It reopened in 1939 but failed again. The third store, built in 1948, lasted a little over a year before meeting the same fate.

Despite its failures, Keedoozle can be seen as a precursor to the self-checkout shopping environment that exists today. Historians consider Saunders' concept to have been fifty years ahead of its time, and some believe that with modern technology and changing consumer attitudes, a similar concept could potentially succeed in the future.

Different Types of Smart Store

Smart stores come in various forms, each incorporating different technologies and catering to specific retail needs. Here are some different types of smart stores:

Automated Stores:

Automated stores, also known as cashier-less stores or grab-and-go stores, leverage advanced technologies like computer vision, sensors, and machine learning algorithms. Customers can enter the store, pick up desired items, and leave without going through a traditional checkout process. The system automatically detects the products taken by the customers and charges their accounts accordingly. Examples of automated stores include Amazon Go and Grabango.

Augmented Reality (AR) Stores:

AR stores utilize augmented reality technology to enhance the shopping experience. Customers can try on virtual clothing, visualize furniture in their homes, or see how makeup products will look on their faces, all through the use of AR applications. This immersive technology allows customers to make more informed purchasing decisions and provides a unique and interactive shopping experience. Brands like IKEA and Sephora have implemented AR stores.

Virtual Reality (VR) Stores:

VR stores take the shopping experience to a whole new level by immersing customers in a virtual environment. Customers can navigate virtual store layouts, interact with products, and make purchases through VR headsets or immersive platforms. VR stores are particularly beneficial for retailers selling large and complex products, such as automobiles or real estate. Audi and Alibaba have experimented with VR stores.

Pop-up Stores:

Pop-up stores are temporary retail spaces that appear for a short period, typically in high-traffic areas or during special events. Smart pop-up stores integrate technology to offer unique and engaging experiences. They may feature interactive displays, digital signage, mobile apps for personalized promotions, and data collection to gather customer insights. Pop-up stores are used by brands to generate buzz, test new markets, and create a sense of urgency for customers.

Connected Stores:

Connected stores leverage the Internet of Things (IoT) to create a connected and intelligent shopping environment. IoT devices, such as smart shelves, beacons, and RFID tags, enable real-time inventory tracking, personalized offers based on customer preferences, and optimized store layouts. Connected stores improve operational efficiency, enhance the customer experience, and provide retailers with valuable data for decision-making.

Mobile Commerce Stores:

Mobile commerce stores focus on providing seamless shopping experiences through mobile applications. These apps offer personalized recommendations, easy product search and browsing, secure mobile payments, and order tracking. Mobile commerce stores integrate with loyalty programs and provide location-based services to enhance customer engagement and convenience.

Robotic Stores:

Robotic stores utilize robotics and automation technologies to handle various aspects of the shopping process. Robots can assist customers with product information, restock shelves, provide recommendations, and even serve as automated cashiers. Robotic stores improve operational efficiency, reduce labor costs, and create a futuristic shopping atmosphere.

These are just a few examples of different types of smart stores. The retail industry continues to evolve, and new innovative store concepts are constantly emerging as technology advances and consumer expectations evolve.

Automated Store

An automated store, also known as a cashier-less or self-checkout store, is a retail concept that utilizes advanced technologies to streamline the shopping process and eliminate the need for traditional checkouts and cashiers. These stores leverage a combination of technologies, including computer vision, sensor fusion, artificial intelligence, and data analytics, to create a seamless and efficient shopping experience for customers. Let's delve into the various aspects of an automated store in more detail:

Entry and Authentication:

Customers typically enter an automated store by scanning a QR code or using a mobile app to authenticate their identity and gain access to the store. This authentication process links their digital profile to their physical presence in the store.

Product Scanning and Tracking:

Automated stores employ various technologies to track and monitor the products within the store. These technologies include computer vision, RFID (Radio Frequency Identification), weight sensors, and shelf sensors. Computer vision systems, equipped with cameras and image recognition algorithms, can identify and track products as customers pick them up or put them back on the shelves. RFID tags or other unique identifiers on the products help in their accurate tracking, and weight sensors on shelves can detect changes in product quantities.

Virtual Carts and Automatic Payments:

As customers pick up products, the automated store system adds them to their virtual shopping carts. The system uses data from the sensors and computer vision technology to accurately identify and tally the products. Once customers have finished selecting their items, they can proceed to the exit without going through a traditional checkout process. The automated store system calculates the total cost of the items in their virtual carts and automatically charges their linked payment method, such as a credit card or mobile payment app.

Real-time Inventory Management:

Automated stores provide real-time inventory tracking and management capabilities. The sensors and tracking technologies in the store enable retailers to monitor stock levels, track product movement, and receive automated alerts when items need to be restocked. This data can help retailers optimize their inventory management processes, reduce stockouts, and enhance overall operational efficiency.

Enhanced Customer Experience:

Automated stores aim to provide a seamless and convenient shopping experience for customers. By eliminating the need for traditional checkouts and cashiers, these stores save customers time and reduce friction in the shopping process. Customers can browse and select products at their own pace, and the automatic payment process eliminates the need for manual payment transactions. This convenience contributes to an improved customer

experience and increased customer satisfaction.

Analytics and Insights:

Automated stores generate a wealth of data on customer behavior, product preferences, and shopping patterns. This data can be analyzed using artificial intelligence and data analytics tools to gain valuable insights. Retailers can leverage these insights to understand customer preferences, optimize product placement, personalize marketing efforts, and improve overall store operations.

Security Measures:

Automated stores employ security measures to prevent theft and ensure a secure shopping environment. These measures may include surveillance cameras, theft detection systems, and customer authentication processes during entry and exit.

Examples of Automated Stores:

Amazon Go is one of the most prominent examples of an automated store. Since its launch, Amazon has opened several Amazon Go stores in various locations. Other retailers and tech companies have also been exploring and implementing their own versions of automated stores, each with its own unique features and technologies.

Amazon Go Store:

Transforming the Future of Retail

Introduction:

In recent years, the retail industry has experienced a revolutionary shift with the emergence of Amazon Go, an innovative and groundbreaking concept that reimagines the traditional brick-and-mortar store. Amazon Go stores have gained significant attention for their cashier-less shopping experience, powered by advanced technologies such as computer vision, sensor fusion, and artificial intelligence. This essay explores the intricacies of the Amazon Go store, delving into its technology, benefits, challenges, and implications for the future of retail.

Technology Behind Amazon Go:

a) Computer Vision:

Amazon Go stores utilize a sophisticated network of cameras and computer vision algorithms to monitor customer movements and track the products they select. These computer vision systems analyze video footage in real-time to identify products and customer interactions accurately.

b) Sensor Fusion:

Alongside computer vision, Amazon Go employs a combination of sensors, including weight sensors, shelf sensors, and RFID tags, to enhance product tracking and inventory management. Weight sensors can detect changes in product quantities on shelves, while shelf sensors and RFID tags provide additional data for precise product identification.

c) Deep Learning and AI:

Deep learning algorithms process the vast amount of data collected by the cameras and sensors, enabling the system to identify and differentiate between products accurately. Artificial intelligence algorithms continuously learn from customer behavior and improve accuracy over time, resulting in an increasingly seamless shopping experience.

The Amazon Go Shopping Experience:

a) Seamless Entry:

To start shopping at an Amazon Go store, customers download the Amazon Go app and link it to their Amazon account. Upon entering the store, they scan a QR code generated by the app at the entrance gate, which authenticates their identity and grants access.

b) Just Walk Out Shopping:

Once inside, customers are free to browse and select products without the need for traditional checkouts. As customers pick up items, the computer vision and sensor systems track their selections and add them to their virtual carts in the app.
c) Automatic Payment:

When customers are finished shopping, they simply leave the store. The Amazon Go system accurately calculates the total cost of the items in their virtual carts and charges their linked Amazon account. Customers receive a digital receipt in the app, eliminating the need for physical receipts.

Benefits and Implications:

a) Convenience and Time Savings:

The cashier-less experience at Amazon Go stores eliminates the need to wait in lines or deal with manual checkouts, providing customers with a convenient and time-efficient shopping experience.

b) Enhanced Customer Experience:

Amazon Go stores focus on delivering a seamless and frictionless experience, enabling customers to enjoy a more relaxed and personalized shopping environment. By removing traditional checkout processes, customers can browse at their own pace, promoting a sense of freedom and convenience.

c) Real-time Inventory Management:

The combination of computer vision, sensors, and AI-powered algorithms allows Amazon Go stores to perform real-time inventory tracking. Retailers can closely monitor stock levels, analyze product popularity, and optimize inventory management, reducing stockouts and enhancing operational efficiency.

d) Data-Driven Insights:

The wealth of data collected by Amazon Go stores provides valuable insights into customer behavior, preferences, and shopping patterns. Retailers can leverage this data to personalize marketing strategies, improve product placement, and optimize store layouts, ultimately enhancing customer satisfaction and driving business growth.

Challenges and Future Developments:

a) Technological Complexity:

The advanced technology required to operate Amazon Go stores presents challenges in terms of implementation, maintenance, and scalability. Ensuring accurate product tracking, minimizing errors, and managing the vast amount of data generated pose ongoing challenges for retailers.

b) Scale and Adaptation:

While Amazon has successfully launched several Amazon Go stores, scaling the concept to larger store formats or multiple locations remains a challenge. Adapting the technology to handle high customer volumes and diverse product categories will be crucial for future expansion.

c) Potential Job Displacement:

The rise of automated stores like Amazon Go raises concerns about potential job displacement, particularly for cashier positions. However, it also opens up new opportunities for employment in managing and maintaining the advanced technologies behind these stores.

Conclusion:

The Amazon Go store represents a transformative step in the retail industry, leveraging cutting-edge technologies to redefine the shopping experience. Through computer vision, sensor fusion, and AI-powered systems, Amazon Go has successfully created a seamless, cashier-less store concept. With its convenience, enhanced customer experience, real-time inventory management, and data-driven insights, the Amazon Go store paves the way for a future where retail combines technology and personalized experiences to meet evolving customer expectations.

Smart Stores in Europe:

Smart stores have gained significant popularity in Europe, where innovative technologies and digital advancements have been embraced by retailers. These smart stores leverage various technologies to enhance the shopping experience, improve operational efficiency, and cater to the changing needs and expectations of European consumers. Let's explore some examples of smart stores in Europe:

MediaMarkt Saturn, Munich, Germany:

MediaMarkt Saturn, a leading consumer electronics retailer, has introduced a smart store concept in Munich, Germany. The store incorporates interactive digital displays, augmented reality (AR) applications, and smart mirrors to provide an immersive and personalized shopping experience. Customers can virtually try out products, access detailed product information, and receive personalized recommendations through interactive screens and AR technology.

Miele Experience Center, Milan, Italy:

Miele, a renowned manufacturer of home appliances, has established an interactive Experience Center in Milan. The smart store showcases their latest products and innovations in a unique and engaging way. Visitors can experience virtual reality (VR) demonstrations, interactive product displays, and even participate in cooking classes using Miele appliances. The store provides a hands-on experience and educates customers about the features and benefits of their products.

Alibaba's Hema Supermarkets, Multiple Locations, Europe:

Hema Supermarkets, operated by Alibaba Group, have expanded beyond their native China and have made their way to Europe. These futuristic supermarkets combine physical shopping with online features and digital integration. Hema stores utilize technologies such as mobile apps, QR codes, and digital payment systems to offer a seamless and convenient shopping experience. Customers can scan products using their smartphones for detailed information, make cashless payments, and have their groceries delivered to their doorstep.

Albert Heijn "Tap to Go" Stores, Multiple Locations, Netherlands:

Albert Heijn, a leading supermarket chain in the Netherlands, has introduced "Tap to Go" stores. These compact, unmanned stores provide a grab-and-go shopping experience using smart technology. Customers can enter the store by scanning their loyalty card or using a mobile app. Inside the store, they can simply tap their card or app on the shelf to add products to their virtual cart. The system automatically charges their account, and customers can leave without the need for traditional checkouts.

Zara's Smart Fitting Rooms, Multiple Locations, Europe:

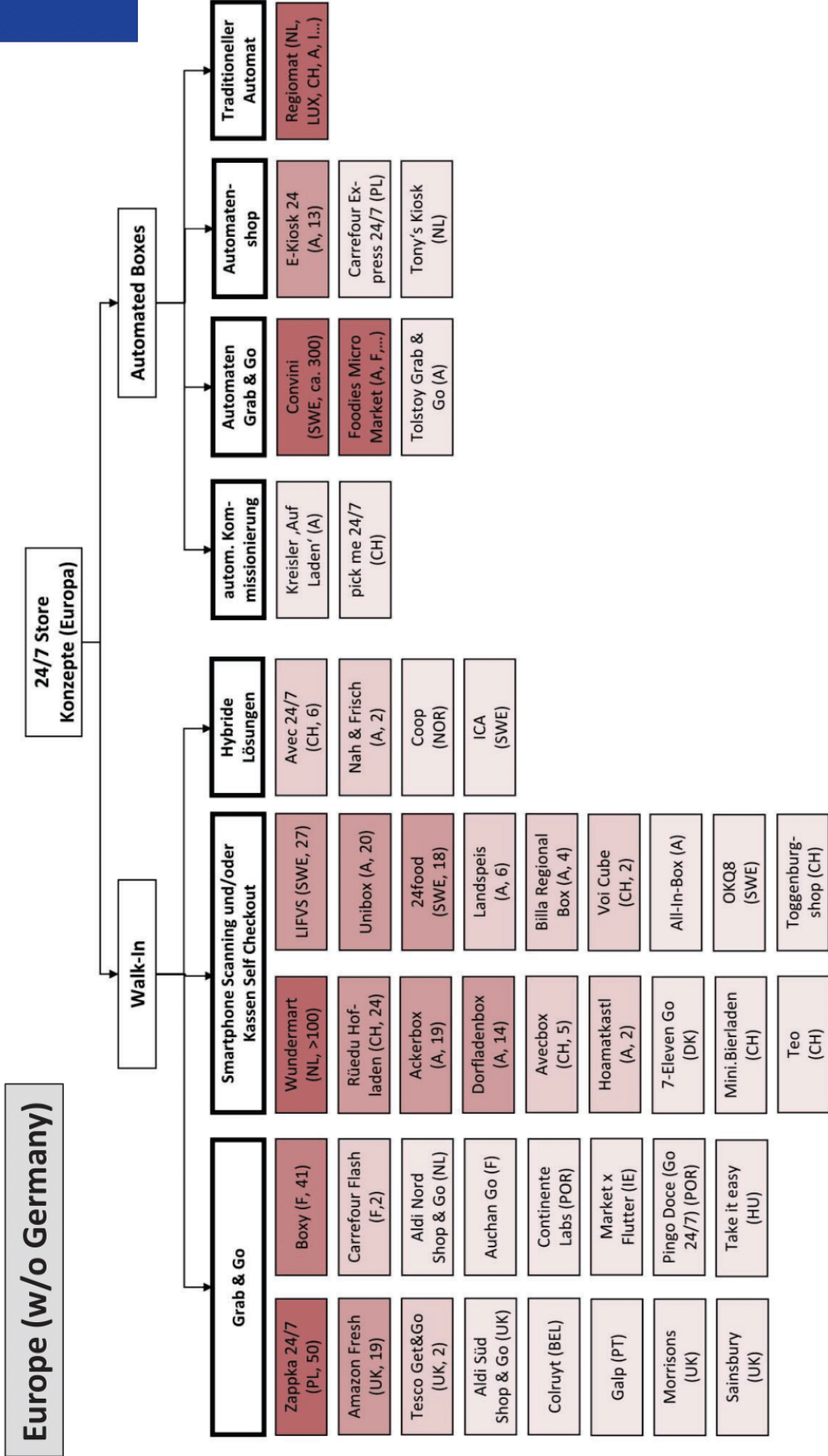Zara, a popular fashion retailer, has implemented smart fitting rooms in select stores across Europe. These fitting rooms are equipped with RFID technology, allowing customers to request different sizes or colors of items they are trying on by scanning them using a touchscreen mirror. The system notifies store employees to bring the requested items to the fitting room, providing a seamless and efficient experience for customers.
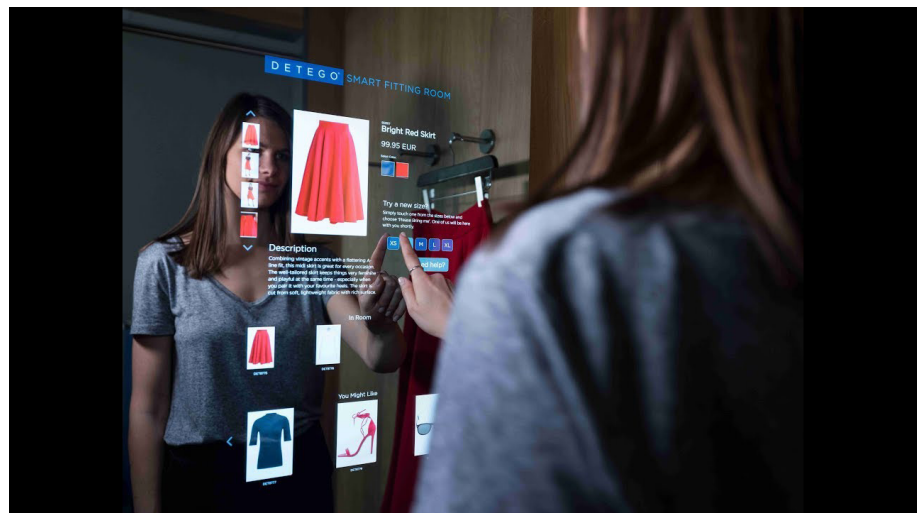
These examples illustrate the diversity and innovation within smart stores across Europe. From interactive displays and augmented reality applications to unmanned stores and RFID technology, European retailers are embracing smart store concepts to deliver enhanced customer experiences, streamline operations, and stay at the forefront of technological advancements in the retail industry.

Europe (w/o Germany)

24/7 Store Konzepte (Europa)

Walk-In

Grab & Go
- Zappka 24/7 (PL, 50)
- Boxy (F, 41)
- Amazon Fresh (UK, 19)
- Carrefour Flash (F, 2)
- Tesco Get&Go (UK, 2)
- Aldi Nord Shop & Go (NL)
- Aldi Süd Shop & Go (UK)
- Auchan Go (F)
- Colruyt (BEL)
- Continente Labs (POR)
- Galp (PT)
- Market x Flutter (IE)
- Morrisons (UK)
- Pingo Doce (Go 24/7) (POR)
- Sainsbury (UK)
- Take it easy (HU)

Smartphone Scanning und/oder Kassen Self Checkout
- Wundermart (NL, >100)
- LIFVS (SWE, 27)
- Rüedu Hof-laden (CH, 24)
- Unibox (A, 20)
- Ackerbox (A, 19)
- 24food (SWE, 18)
- Dorfladenbox (A, 14)
- Landspeis (A, 6)
- Avecbox (CH, 5)
- Billa Regional Box (A, 4)
- Hoamatkastl (A, 2)
- Voi Cube (CH, 2)
- 7-Eleven Go (DK)
- All-In-Box (A)
- Mini.Bierladen (CH)
- OKQ8 (SWE)
- Teo (CH)
- Toggenburg-shop (CH)

Hybride Lösungen
- Avec 24/7 (CH, 6)
- Nah & Frisch (A, 2)
- Coop (NOR)
- ICA (SWE)

Automated Boxes

autom. Kommissionierung
- Kreisler ‚Auf Laden' (A)
- pick me 24/7 (CH)

Automaten Grab & Go
- Convini (SWE, ca. 300)
- Foodies Micro Market (A, F,…)
- Tolstoy Grab & Go (A)

Automaten-shop
- E-Kiosk 24 (A, 13)
- Carrefour Ex-press 24/7 (PL)
- Tony's Kiosk (NL)

Traditioneller Automat
- Regiomat (NL, LUX, CH, A, I…)

Source: DHBW Heilbronn

Germany

24/7 Store Concepts (Ger)

Walk-In

Grab & Go
- Rewe Pick & Go (2)
- Hoody
- Netto MD Pick & Go
- shop.box
- Zappka
- Kübler Go — *coming soon*
- Penny — *coming soon*
- Rewe To Go — *coming soon*
- Bini — *in Planung*

Smartphone Scanning and/or Self Checkout
- Tante-M (30)
- TEO (20)
- Emma´s Tag und Nacht Markt (7)
- Dorfladenbox (3)
- Frischwerk (2)
- Kisten Krämer (2)
- DB 24/7 Service Store
- Eintracht Frankfurt Fanshop
- EnBW Hypershop
- Josefs nahkauf Box
- Kübler Go
- Micro-Market
- Smart-Box
- Smart Store 24
- Tante Martin
- Wanzl (GO24/7)

Hybrid Solutions
- Würth24 (30)
- Tante Enso (15)
- Netto MD „Späti' (7)
- Förch 24/7 (3)
- Combi

Automated Boxes

Automatic Order Picking
- Roberta Goods (2)
- BakerSoft Pickup Store
- collect.box
- E 24/7 Karow & Sommer
- Edeka Südwest 24/7
- Friedas24
- Metzgerei Klein
- Rewe ready (Smart Automat)
- TYPY
- Latebird — *coming soon*
- Metzgerei Oberhammer — *coming soon*

Machine Grab & Go
- Foodies Micro Market (100)
- Convini (30)
- OHA

Vending Machine Shop
- Regiomaten-Ministores (ca. 100)
- Herr Anton (14)
- E-Kiosk 24 (8)
- 24Sieben Shop (3)
- Flavura 24/7
- Ki24/7
- Regiomarkt 24
- Twenty47
- Lekkerland (Smart Stop) — *coming soon*

Vending Machine
- Regiomat (>5.000)
- Regio-Box (>50)
- Fürth Automaten (12)
- My Pizzabutler (3)
- Migimat
- „Eierautomat"
- …

Smart Stores in Germany:

Germany, known for its technological advancements and strong retail industry, has witnessed the emergence of various smart stores that integrate innovative technologies to enhance the shopping experience. Let's explore some notable examples of smart stores in Germany:

MediaMarkt Saturn, Munich:

MediaMarkt Saturn, a leading consumer electronics retailer, has established a smart store in Munich. This store incorporates cutting-edge technologies such as interactive digital displays, augmented reality (AR), and smart mirrors. Customers can interact with screens to access detailed product information, virtually try out products, and receive personalized recommendations. The integration of AR technology allows for an immersive and engaging shopping experience.

Amazon Fresh, Berlin:

Amazon Fresh, the grocery delivery service by Amazon, has introduced smart stores in Berlin. These stores combine traditional shopping with digital convenience. Customers can use the Amazon Fresh app to scan and add products to their virtual cart as they shop. The store utilizes advanced sensors and computer vision technology to track the items selected by customers. Once they leave the store, the app automatically charges their Amazon account, eliminating the need for traditional checkouts.

Edeka "smartLAB", Hamburg:

Edeka, a major supermarket chain, has introduced its "smartLAB" store in Hamburg. This store focuses on sustainability and technology-driven solutions. It features smart shelves that adjust the temperature and humidity to maintain the freshness of perishable items. Customers can also find digital price tags and information screens throughout the store. The smartLAB store showcases innovations in energy efficiency, waste reduction, and smart packaging solutions.

Adidas "Store of the Future", Berlin:

Adidas, the renowned sports apparel brand, has launched its "Store of the Future" concept in Berlin. This smart store aims to create a personalized and interactive shopping experience for customers. The store incorporates features like digital touchpoints, virtual reality (VR) experiences, and interactive product displays. Customers can customize and personalize products, virtually try on shoes using AR technology, and access exclusive digital content related to Adidas products.

Rewe "Markt der Zukunft", Cologne:

Rewe, one of Germany's largest supermarket chains, has introduced its "Markt der Zukunft" (Store of the Future) concept in Cologne. This smart store focuses on convenience and efficiency. It includes features such as self-checkout options, digital price tags, and smart shopping carts that scan products as customers add them. The store also incorporates digital displays and screens for promotional offers and product information.

These smart stores in Germany exemplify the integration of advanced technologies to create enhanced shopping experiences. They showcase interactive displays, augmented reality, automated checkout processes, and personalized recommendations. With a strong focus on innovation and customer-centric approaches, these smart stores are redefining the retail landscape in Germany.

Container 24/7 Stores:

A container 24/7 store, also known as a container store or a vending container, is a compact retail unit constructed from a shipping container that operates around the clock, providing customers with access to products and services at any time of the day. These stores offer a convenient and self-service shopping experience, typically stocked with a selection of commonly purchased items. Let's delve into the details of a container 24/7 store:

Structure and Design:
Container 24/7 stores are built by modifying standard shipping containers, typically 20 or 40 feet in size. The containers are equipped with various features to create a functional retail space, including insulation, lighting, ventilation, and security systems. The store design may include large windows, digital displays, and attractive branding to attract customers.

Product Selection:
Container stores usually stock a range of everyday products to meet customer needs. These may include snacks, beverages, personal care items, over-the-counter medicines, mobile accessories, and other essential items. The product selection is carefully curated to cater to the immediate needs of customers and maximize the use of limited space.

Self-Service and Automated Operations:
One of the key features of a container 24/7 store is the self-service aspect. Customers can browse the products displayed, make their selections, and proceed to the checkout without any assistance from store staff. The stores are equipped with automated systems, such as vending machines or electronic payment kiosks, that allow customers to make their purchases independently.

Security Measures:
Given the nature of operating without staff present at all times, security measures are essential for container 24/7 stores. These may include surveillance cameras, alarms, secure locks, and remote monitoring systems to ensure the safety of the store and its products.

Accessibility and Convenience:
Container stores are designed to be accessible and convenient for customers. They are strategically located in high-traffic areas, such as urban centers, transportation hubs, residential neighborhoods, or university campuses, to maximize customer reach. The 24/7 operating hours ensure that customers can access essential items at their convenience, even outside regular store hours.

Technological Integration:
To enhance the customer experience, container stores may incorporate various technological features. This can include touch screen interfaces for product selection, contactless payment options, and even digital advertising screens to showcase promotions and offers.

Flexibility and Mobility:
One of the advantages of container 24/7 stores is their flexibility and mobility. These stores can be easily relocated to different locations based on demand or specific events. They can serve as temporary retail solutions or be deployed in areas where traditional brick-and-mortar stores are not feasible.

Container 24/7 stores offer a unique retail concept that combines convenience, accessibility, and self-service. They cater to the evolving needs and lifestyles of consumers who seek on-the-go solutions for their everyday shopping requirements. With their compact size, extended operating hours, and ability to adapt to various locations, container 24/7 stores present an innovative approach to retailing in urban environments or areas with high customer footfall.

Container 24/7 Stores In Germany:

Mymarket

Container 24/7 stores have gained popularity in Germany as a convenient and accessible retail solution. These compact, self-service stores offer customers the flexibility to make purchases at any time, even outside regular store hours. While there are various container store operators in Germany, one prominent example is the "Mymarket" container store.

"Mymarket" is a German company that specializes in container 24/7 stores. They have implemented their stores in various locations across the country, including cities like Berlin, Munich, Hamburg, and Cologne. These stores are strategically placed in high-traffic areas such as residential neighborhoods, transportation hubs, and business districts to maximize customer reach and convenience.

The structure and design of "Mymarket" container stores are based on modified shipping containers. The containers are fitted with insulation, lighting, ventilation, and security systems to create a comfortable and secure shopping environment. The exterior of the containers is often branded with attractive signage and logos to catch the attention of passersby.

Inside the container stores, customers will find a selection of everyday products and essentials. This typically includes snacks, beverages, toiletries, personal care items, and basic household supplies. The product range is curated to cater to immediate needs and provide convenience for customers who require quick purchases.

The stores operate on a self-service model, allowing customers to browse the products, make their selections, and proceed to the checkout independently. Automated systems, such as vending machines or electronic payment kiosks, are utilized for easy and efficient transactions. Customers can use cash, card payments, or contactless options to complete their purchases.

To ensure security, "Mymarket" container stores incorporate surveillance cameras, alarms, and secure locks. These measures help maintain the safety of the store and protect the products inside. Additionally, remote monitoring systems may be in place to provide real-time surveillance and address any security concerns promptly.

The flexibility of container 24/7 stores allows them to be placed in different locations as per demand. They can serve as temporary retail solutions for specific events or be stationed in areas where traditional stores are not feasible. This mobility aspect makes them an adaptable and innovative retail concept in Germany.

Container 24/7 stores in Germany, such as those operated by "Mymarket," offer a convenient shopping experience, especially for customers who require essential items outside regular store hours. With their strategic locations, self-service operations, and secure design, these stores cater to the needs of busy urban dwellers and provide a modern retail solution in the country.

Another Container 24/7 Stores:

Mobymart

Cloudpick is a technology company that offers innovative solutions for automated retail and cashier-less stores. One of their flagship products is MobyMart, a revolutionary mobile retail store that brings the convenience of a grocery store directly to consumers' doorsteps.

MobyMart is essentially a self-driving vehicle that serves as a fully functional mini supermarket on wheels. It combines advanced robotics, artificial intelligence (AI), computer vision, and sensor technologies to provide a seamless shopping experience. The concept behind MobyMart is to eliminate the need for physical stores and traditional checkout processes, enabling customers to shop for groceries without ever leaving their homes.

The MobyMart vehicle is designed to be compact yet spacious enough to accommodate a wide range of products, including fresh produce, packaged goods, beverages, and more. The exterior of the vehicle is equipped with large transparent windows, allowing customers to view the available merchandise from the outside. This transparency helps create a sense of trust and convenience, as customers can see what products are available before entering the vehicle.

To use MobyMart, customers simply need to download the accompanying mobile app, which allows them to locate the nearest MobyMart in their area and access its inventory in real time. They can browse through the product catalog, add items to their virtual cart, and even customize their preferences for specific products. The app also provides information on product details, pricing, and promotions, ensuring customers have all the necessary information to make informed decisions.

Once a customer has finalized their shopping list, they can request a MobyMart to come to their location. The self-driving vehicle then navigates autonomously to the designated address, using advanced mapping and GPS technologies to ensure accurate and efficient transportation. The customer receives notifications throughout the process, including estimated arrival time and any updates regarding the availability of selected items.

When the MobyMart arrives, customers can enter the vehicle using a secure access code provided by the mobile app. Inside, they will find a well-organized and neatly displayed selection of products. The shelves are equipped with sensors and cameras that detect when a customer picks up or puts back an item, automatically adding or removing it from their virtual cart.

The AI and computer vision systems in MobyMart enable it to track customers' movements and behaviors, analyze their preferences, and make personalized recommendations based on their shopping history. This level of customization enhances the shopping experience and helps customers discover new products that align with their tastes and preferences.

Payment for the selected items is automatically processed through the mobile app, eliminating the need for traditional checkout counters or cashiers. Customers can choose from various payment methods, such as credit cards, digital wallets, or even mobile payment apps. Once

the transaction is completed, the customer simply exits the vehicle, and the MobyMart continues on its route to serve other customers.

Cloudpick's MobyMart is not only convenient for consumers but also offers benefits to retailers. By eliminating the need for brick-and-mortar stores, retailers can significantly reduce overhead costs associated with rent, utilities, and staff. The automated nature of MobyMart also minimizes the risk of theft or shoplifting, as all items are tracked and accounted for electronically.

Overall, MobyMart represents a paradigm shift in the retail industry by leveraging cutting-edge technologies to redefine the shopping experience. It combines convenience, efficiency, and personalization, allowing customers to access groceries and everyday essentials in a hassle-free and time-saving manner. With Cloudpick's continued innovation, MobyMart has the potential to transform the way people shop for goods and open up new possibilities for the future of retail.

Livello GmbH

Introduction:

Livello GmbH is a prominent technology company based in Düsseldorf, Germany, that specializes in providing innovative solutions for the hospitality industry. With a strong focus on optimizing operational efficiency and enhancing guest experiences, Livello has established itself as a leader in the field.

Founded in [year], Livello has rapidly gained recognition for its cutting-edge products and services that cater to the evolving needs of hotels, restaurants, and other hospitality establishments. The company's mission is to revolutionize the industry by leveraging technology to streamline operations, improve customer satisfaction, and drive business growth.

At the core of Livello's offerings is their advanced software platform, which seamlessly integrates various aspects of hotel management and guest services. This comprehensive platform incorporates modules for property management, reservations, housekeeping, customer relationship management (CRM), point of sale (POS), and more. By centralizing these critical functions, Livello enables businesses to optimize their workflows, reduce manual errors, and enhance overall efficiency.

Livello's property management system (PMS) is a flagship product that provides hotels with a powerful tool for managing their operations effectively. It allows hoteliers to automate tasks such as check-in/check-out, room assignments, inventory management, and billing, streamlining the administrative processes and freeing up staff to focus on delivering exceptional guest experiences. The PMS also offers insightful reporting and analytics capabilities, enabling businesses to make data-driven decisions and drive profitability.

In addition to the PMS, Livello offers a range of specialized modules to cater to specific needs within the hospitality industry. Their reservations module facilitates seamless booking management across various channels, including online travel agencies (OTAs), direct bookings, and corporate accounts. The housekeeping module optimizes room cleaning schedules, tracks maintenance requests, and ensures efficient housekeeping operations.

Livello's CRM module enables hotels to build and maintain strong relationships with their guests. It stores comprehensive guest profiles, allowing businesses to personalize their services, track guest preferences, and provide tailored experiences. This module also integrates with the loyalty programs, enabling hotels to reward their loyal customers and drive repeat business.

To enhance revenue streams, Livello's POS system offers a user-friendly interface for managing food and beverage operations, including ordering, billing, and inventory management. It supports various payment methods and can seamlessly integrate with the PMS, ensuring smooth communication between different departments and eliminating the need for manual data entry.

Livello's commitment to innovation is evident in their continuous development of new features and functionalities. They stay ahead of industry trends and emerging technologies, incorporating them into their solutions to meet the evolving needs of the hospitality sector. The company also places a strong emphasis on customer support, providing timely assistance, training, and ongoing maintenance to ensure a seamless experience for their clients.

With a strong presence in the Düsseldorf region and beyond, Livello GmbH has established itself as a trusted technology partner for hotels and restaurants seeking to optimize their operations and deliver outstanding guest experiences. Through their innovative software solutions, they empower businesses to stay competitive in a rapidly evolving industry, driving growth and success in the digital age.

Livello Product:

The Smart Kiosk:

The Livello Smart Kiosk is an advanced self-service kiosk solution developed by Livello GmbH. It is designed to enhance customer experiences and streamline operations in various industries, including retail, hospitality, healthcare, and more. This report aims to provide a detailed analysis of the features and benefits offered by the Livello Smart Kiosk.

Interactive Touchscreen Display:

The Livello Smart Kiosk features a high-resolution interactive touchscreen display that provides a user-friendly interface for customers. The large display allows for easy navigation, product browsing, and information retrieval. Users can interact with the kiosk by tapping, swiping, or using gestures, creating an intuitive and engaging experience.

Self-Service Capabilities:

The primary function of the Livello Smart Kiosk is to provide self-service options to customers. It enables users to perform a range of tasks independently, such as product selection, payment processing, self-checkout, and even service inquiries. This self-service functionality reduces wait times, empowers customers, and improves overall efficiency.

Product Catalog and Search:

The Smart Kiosk is equipped with a comprehensive product catalog that can be easily accessed by users. It allows customers to browse through various products, view detailed descriptions, check availability, and even compare options. Additionally, the kiosk offers a search feature that enables users to quickly find specific items or categories, enhancing the convenience of the shopping experience.

Personalized Recommendations:

By leveraging advanced algorithms and customer data, the Livello Smart Kiosk can provide personalized product recommendations. It analyzes user preferences, purchase history, and browsing patterns to offer tailored suggestions, promoting upselling and cross-selling opportunities. This feature enhances customer satisfaction and drives revenue for businesses.

Integrated Payment Solutions:

The Smart Kiosk incorporates secure and convenient payment processing capabilities. It supports multiple payment options, including credit cards, mobile wallets, and contactless payments. Users can complete transactions seamlessly, ensuring a smooth and hassle-free checkout process. Integration with existing payment gateways or systems enables businesses to manage transactions efficiently.

Multi-Language Support:

To cater to a diverse customer base, the Livello Smart Kiosk offers multi-language support. It allows users to choose their preferred language, ensuring clear communication and accessibility for customers of different nationalities and backgrounds. This feature enhances inclusivity and improves the overall user experience.

Real-time Analytics and Reporting:

The Smart Kiosk provides real-time analytics and reporting functionalities, enabling businesses to gain valuable insights into customer behavior, sales trends, and operational efficiency. The kiosk collects data on customer interactions, popular products, peak hours, and more. This information can be utilized to make data-driven decisions, optimize inventory management, and enhance marketing strategies.

Remote Monitoring and Management:

Livello Smart Kiosk includes a robust remote monitoring and management system. Business owners and administrators can remotely monitor the kiosk's performance, track transaction logs, update content, and perform maintenance tasks. This feature allows for centralized control and ensures the kiosk operates smoothly and efficiently.

The Livello Smart Kiosk offers an innovative and feature-rich self-service solution for businesses in various industries. Its interactive touchscreen display, self-service capabilities, product catalog, personalized recommendations, integrated payment solutions, multi-language support, real-time analytics, and remote monitoring features make it a versatile and valuable asset. By leveraging the Livello Smart Kiosk, businesses can improve customer experiences, increase operational efficiency, and drive growth in today's competitive market.

EMV card reader for credit, debit, NFC and mobile payment

Cameras and computer vision analyse customers and product movement

Smart shelves with unique 3D weight sensor system for inventory tracking

Smart LED light system adjusts to products and interacts with customers

GPS and location tracking

Embedded System and single-board computers

Temperature / humidity sensors and digital thermostat to ensure HACCP

RFID tags, labels and reader for contactless product identification

Touch screen user interface for replenishers and customers

HD displays play video content based on promotions, user behavior

Loudspeakers provide audio guidance and product information

Motion sensors detect customer movement and counts visitors

Electronic shelf labels display dynamic product info / pricing

Proximity beacons provide tailored offers to nearby consumers

5G / LTE gateway router, Lan, WiFi or LTE internet connection

Access control system with magnetic electric door locks

Project-SmartBox24

FROZEN
ENTER

Design Brief:

Autonomous Grab and Go Store Using a Container

Background:

The retail industry is evolving with new technologies that are enabling businesses to provide better services to customers while minimizing operational costs. Autonomous stores, which use advanced technologies such as computer vision and artificial intelligence, are an emerging trend in the retail industry. These stores offer a new shopping experience where customers can pick up items without the need for a cashier or waiting in lines. Additionally, using a container as the store can offer flexibility and mobility to the business.

Objective:

Design an autonomous grab and go store that utilizes a container as its structure. The store should be designed to be self-sufficient and able to operate without human intervention. The main goal is to provide a seamless shopping experience for customers while minimizing operational costs.

Target Audience:

The target audience for the autonomous grab and go store is anyone looking for a quick and easy shopping experience. The store should be able to cater to a wide range of customers, including those who are tech-savvy and those who are not.

Key Features:

Autonomous Operation:

The store should be designed to operate without human intervention. Computer vision and artificial intelligence should be utilized to enable the store to recognize items and track inventory levels. The store should be able to restock items and perform basic maintenance tasks autonomously.

Container Structure:

The store should be built using a container to offer flexibility and mobility. The container should be modified to provide a comfortable shopping experience for customers, including adequate lighting and temperature control.

Easy Access:

Customers should be able to enter the store easily and quickly. The store should be designed to minimize waiting times and congestion.

Secure Payment System:

The store should have a secure payment system that accepts various payment methods, including cashless options such as credit cards and mobile payments.

Customizable Inventory:

The store should be able to offer a wide range of products that can be easily customized based on customer demand. The inventory should be regularly updated to ensure that customers can find the items they are looking for.

Energy-Efficient:

The store should be designed to be energy-efficient, using renewable energy sources where possible. The store should also be equipped with energy-efficient lighting and temperature control systems.

Constraints:

Space Limitations:

The store should be designed to fit within a standard-sized container. The store should also be able to fit within a designated space for mobile retail.

Cost:

The design should be cost-effective, taking into account the cost of materials and technology required.

Regulatory Compliance:

The design should comply with local regulations and safety standards.

Durability:

The store should be designed to withstand harsh weather conditions and potential wear and tear during transportation.

Scalability:

The design should be easily replicable and scalable, allowing for expansion to new locations.

Deliverables:

1. Conceptual design of the autonomous grab and go store using a container, including layout, materials, and technologies used.
2. Detailed specifications of the technologies used in the store, including computer vision, artificial intelligence, and payment systems.
3. Budget proposal that outlines the costs associated with building and operating the store.
4. Environmental impact analysis, including the store's energy consumption and carbon footprint.
5. Implementation plan, including timelines and resources required to build and launch the store.
6. User manual for customers and maintenance staff, including safety guidelines and troubleshooting tips.

Project Key Feature Requirements:

Automated Check-in and Check-out:

Smart Store leverages computer vision to identify items as customers take them off the shelves and add them to their virtual cart. This allows for automated checkout, removing the need for customers to wait in line and interact with a cashier. The shopping experience for the customers should be simple, faster and reliable.
Requirements for Container Store.

Container Requirements:

The container should be made of durable and weather-resistant material, such as steel or aluminum, to protect the store's contents from the elements. The container should be able to withstand harsh weather conditions, including wind, rain, and extreme temperatures.

Interior Requirements:

The store's interior should be designed to optimize space and enhance the customer's shopping experience. The interior should also be designed to accommodate the installation of the 8 smart kiosks and provide sufficient space for customer traffic.

Smart Kiosks:

The store will need to install 8 smart kiosks, which will require space for customers to use them comfortably. The kiosks will need to be installed in a neat and aesthetic way but it should be easy to service.

Storage Requirements:

The store will need to have sufficient storage space for hardware equipment, such as servers, switches, and routers, to support the smart store's computer vision and data analytics systems. The storage space should be secure and climate-controlled to protect the hardware equipment from damage.

Camera Fitting:

The store will need to install computer vision cameras in strategic locations to monitor customer traffic and behavior, and to enable product identification and customer identification. The cameras should be strategically positioned to ensure maximum coverage and accuracy.

Lighting:

The store's interior should be well-lit to provide a welcoming and safe environment for customers. The lighting should be designed to enhance the visibility of the store's products

and signage, and to ensure that the computer vision cameras can capture clear images.

Power Supply:

The store will need a reliable power supply to support the smart store's computer vision and data analytics systems. The power supply should be designed to meet European standards for safety and efficiency, and should be able to handle the store's power needs without interruption.

Overall, the container store's interior, storage, camera fitting, lighting, and power supply are critical components of the smart store's design. These elements should be carefully planned and executed to ensure that the store provides a safe, welcoming, and efficient shopping experience for customers.

Hardware and Software Implementation Requirements for an Smart Grab and Go Container Store with Computer Vision and Smart Kiosks:

Customer Authentication and access control:

The store requires an authentication and access control method to enable the store to ensure that only authorized customers can access the store and use the smart kiosks, and provide a personalized shopping experience for each customer.

Computer Vision Cameras:

The store requires high-quality computer vision cameras that can accurately recognize the products placed in the containers and the customers in the store. The cameras should be strategically placed to capture clear images of the products and ensure that they are correctly identified when picked by the customers.

Computer Vision Software:

The store requires computer vision software that can accurately recognize the products in real-time and automatically add them to the customer's purchase. The software should be able to handle multiple products and customers, and accurately identify them, even if they are partially obscured or eclipsed.

Smart Kiosks:

The store requires Smart kiosks that help customers to purchase their desired items. The kiosks should be equipped with high-resolution touch screens and intuitive user interfaces that are easy to navigate. The kiosks should also be connected to the inventory management system and the computer vision software to provide real-time updates on product availability and purchase.

Payment System:

The store requires a payment system that can handle a variety of payment options, including credit cards, debit cards, and mobile payments. The payment system should be secure, reliable, and able to process transactions quickly and accurately.

Inventory Management System:

The store requires a robust inventory management system that can track the stock levels of each container type in real-time. The system should be able to provide real-time updates to the Smart kiosks and the computer vision software to ensure that customers only see items that are available in stock.

Data Analytics Software:

The store requires data analytics software that can collect and analyze user data to better understand customer preferences and optimize inventory management. The software should be able to generate reports on sales trends, popular products, and customer behavior, and provide insights into ways to improve the customer experience.

Customer Authentication and access control:

Customer authentication and access control are critical components of a smart store with computer vision and smart kiosks. These mechanisms enable the store to ensure that only authorized customers can access the store and use the smart kiosks, and provide a personalized shopping experience for each customer.

Here are some ways to implement customer authentication and access control in the store:

Customer Registration:

Customers will need to register with the store in the App before using the store. During the registration process, customers will need to provide their name, email address, phone number, and any other relevant information. The store App will then generate a unique QR code for each customer, which will be stored in the database.

QR Code Scanning:

When customers arrive at the store, they will need to scan their QR code at a entrance of the store. This will authenticate the customer and grant them access to the store and they access the smart kiosks.

Verification:

The store will need to verify that the QR code belongs to an authorized customer. The store can do this by comparing the scanned QR code to the stored database of authorized customers. If the QR code matches a customer in the database, the customer will be granted access to the store.

Access Control:

The store can also use the QR code to control access to certain number of customers in the store at a point of time. It can also help the system to recognise multiple customers accessing the same store and linking them to be identified by the CV software.

Personalization:

The store can use the customer's QR code to personalize their shopping experience. For example, the kiosk can display a personalized greeting, recommend products based on the customer's purchase history, and offer discounts or promotions tailored to the customer's preferences.

Overall, QR code-based authentication can provide a secure and efficient way to authenticate customers and grant them access to the container store and the smart kiosks. It can also enable the store to provide a personalized shopping experience for each customer.

PC Requirements

The hardware requirements for computer vision and machine learning software can vary depending on the specific software and the complexity of the tasks it is performing. However, here are some general hardware requirements to consider:

Processor:

A powerful processor is essential for running computer vision and machine learning software. The processor should have a high clock speed and multiple cores. Intel Core i7 or i9 processors or AMD Ryzen processors are good options.

RAM:

The software will require a large amount of RAM to store and process data. 16GB or more is recommended for computer vision and machine learning tasks.

Graphics Processing Unit (GPU):

A GPU can significantly accelerate the performance of computer vision and machine learning software. Nvidia GPUs are often preferred for machine learning tasks due to their high performance and compatibility with popular machine learning libraries. At least an Nvidia GeForce RTX 3010 or higher is recommended.

Storage:

The software will require significant storage space to store data and model parameters. A solid-state drive (SSD) with at least 256GB of storage is recommended for optimal performance.

Operating System:

The software will require a 64-bit operating system such as Windows 10 or Ubuntu Linux.

Other Hardware:

Depending on the specific software and tasks, additional hardware may be required, such as a networking devices, external hard drives for storage.

High speed Internet connectivity:

The container require high speed internet connectivity to communicate with the Backend. Power Backup for PC and camera in case of a power failure.

Networking

Router:

The router is the central networking device that connects all devices in the store to the internet. The router should have sufficient processing power to handle the store's network traffic and support advanced features such as Quality of Service (QoS) and Virtual Private Network (VPN) connectivity.

Switch:

A switch is used to connect all the devices within the store to the router. The switch should have sufficient capacity to handle the data traffic generated by the intelligent kiosks and computer vision cameras. A managed switch is recommended as it offers better control and configuration options.

Ethernet Cables:

You will need Ethernet cables to connect the devices to the switch. The cables should be of high quality to ensure reliable and fast data transmission. Cat6 or higher quality cables are recommended for Gigabit Ethernet connections.

Network Interface Cards:

The devices that need to be connected to the LAN network, such as the computer vision cameras and kiosks, must have network interface cards (NICs) installed. The NICs should support the same Ethernet standard as the switch, and should be configured with static IP addresses.

User Persona:

Persona 1: Max Schmidt

Background:

Max is a young, 28 year old, male professional who works for a software company in Berlin. He is tech-savvy and interested in new technologies that can make his life easier. He lives in a shared apartment with roommates and often cooks his meals at home. He is concerned about his environmental impact and is interested in eco-friendly and sustainable solutions.

Goals and Motivation:

Max's primary goal is to find a convenient and efficient shopping solution that fits into his busy schedule. He is motivated by saving time and avoiding crowded supermarkets. He also values eco-friendly and sustainable solutions and would appreciate a store that aligns with these values.

Scenario:

Max finishes work late in the evening and realizes he needs to pick up some ingredients for dinner. He remembers hearing about an autonomous grab and go store in his neighborhood and decides to give it a try. He enters the store and is impressed by the variety of eco-friendly and sustainable food options. He scans the items with his phone and pays using a mobile payment app. He exits the store in less than five minutes and feels satisfied with the quick and easy shopping experience.

Challenges:

Max's busy work schedule often leaves him with little time for grocery shopping. He is concerned about the environmental impact of traditional supermarkets and would prefer to shop in a store that prioritizes sustainability. He is also concerned about the cost of groceries and would appreciate affordable options.

Behaviour:

Max is tech-savvy and comfortable with using mobile apps for various tasks. He is interested in new technologies that can make his life easier and more efficient. He prefers to use contactless payment options and is open to trying new technologies. He enjoys cooking his meals at home and is interested in healthy and sustainable food options.

Key Takeaways:

The autonomous grab and go store should provide a convenient and eco-friendly shopping experience for tech-savvy customers like Max. The store should prioritize sustainability and offer affordable and healthy food options. Contactless payment options and mobile apps are preferred by Max, so the store should offer these payment options. Overall, the

store should prioritize convenience, sustainability, and affordability to attract customers like Max.

Persona 2: Anna Müller

Background:

Anna is a busy 34 years old professional who works long hours in a fast-paced environment. She lives in a small apartment in Munich and often finds it challenging to manage her time effectively. She prefers quick and easy shopping experiences that allow her to pick up essential items on-the-go without wasting time.

Goals and Motivation:

Anna's primary goal is to find a convenient shopping solution that fits into her busy schedule. She is motivated by saving time and avoiding long queues in supermarkets. She also values eco-friendly and sustainable solutions and would appreciate a store that aligns with these values.

Scenario:

Anna finishes work late in the evening and realizes she has run out of bread and milk. She remembers seeing an autonomous grab and go store on her way to work and decides to try it out. She arrives at the store and enters through the automated door. She is impressed by the clean and modern interior of the store and the ease with which she can locate the items she needs. She scans the items with her phone and pays using a mobile payment app. She exits the store in less than five minutes and feels satisfied with the quick and easy shopping experience.

Challenges:

Anna often finds it difficult to fit grocery shopping into her busy schedule. She also prefers

to avoid crowds and long waiting times in stores. She is concerned about the impact of her shopping on the environment and would appreciate a store that is eco-friendly.

Behaviour:

Anna is tech-savvy and comfortable with using mobile apps for various tasks. She prefers to use contactless payment options and is open to trying new technologies. She enjoys the convenience of online shopping but is concerned about the environmental impact of packaging and shipping.

Key Takeaways:

The autonomous grab and go store should provide a quick and convenient shopping experience for busy professionals like Anna. The store should utilize technology that is easy to use and reliable. Eco-friendliness and sustainability are important to Anna, so the store should prioritize these values in its operations. Contactless payment options and mobile apps are preferred by Anna, so the store should offer these payment options. Overall, the store should prioritize convenience, speed, and eco-friendliness to attract customers like Anna.

Overall Key Takeaways:

Quick and convenient shopping experience.

Environment-friendly shopping experience.

Sustainability and offer affordable and healthy food options.

Affordability.

Contactless payment options and mobile apps.

Easy to use and reliable technology.

Market Research:

The rise of automation and technological advancements have revolutionized the retail industry, leading to the emergence of automated stores. These stores, equipped with advanced technologies like artificial intelligence and robotics, aim to provide seamless and efficient shopping experiences to customers. To understand the competitive landscape and identify key players in this rapidly evolving market, conducting comprehensive market research is essential. We explores the market competitiors and evaluate their products to understand the Interior Layout and User journey.

Research Objectives:

The main objectives of the research are to understand and analyse the following features and hardware used by the competitors:

1. Interior Architecture of the Container

2. User Journey

3. Mechanical Hardware

4. Computer Vision Hardware

5. Exterior and other key features.

Lets go in more detail about the market research and propose the best User flow and Interiror Architecture.

The four competitors choosen for Analysis for;

Interior Architecture Design:

We do a top view analysis of the floorplan first to understand the interior architecture and User flow.

1. Zappka

Żabka is a chain of small and convenient stores that responds to the needs of millions of customers every day. For 24 years of presence on the Polish market, the company has established itself as the leader in the modern convenience segment.

Website - https://www.zabka.pl/o-zabce

⬜	Accessible area	🟦	Screen & Payment terminal	🟨	Instructions
🟥	Not Accessibile area	🟧	Display / Logo	🟫	Coffee counter
🟪	Interior/Exterior	⬛	Not Accessible in layout / Door	🟩	Open & Closed Shelf

2. Boxy

Boxy is building a micro retailer by designing a new store format that is fully autonomous and deployed where people work and live.

Website - https://www.getboxy.co/

Exit   Entrance

⬜	Accessible area	🟦	Screen & Payment terminal	🟨	Instructions
🟥	Not Accessibile area	🟧	Display / Logo	🟫	Coffee counter
🟪	Interior/Exterior	⬛	Not Accessible in layout / Door	🟩	Open & Closed Shelf
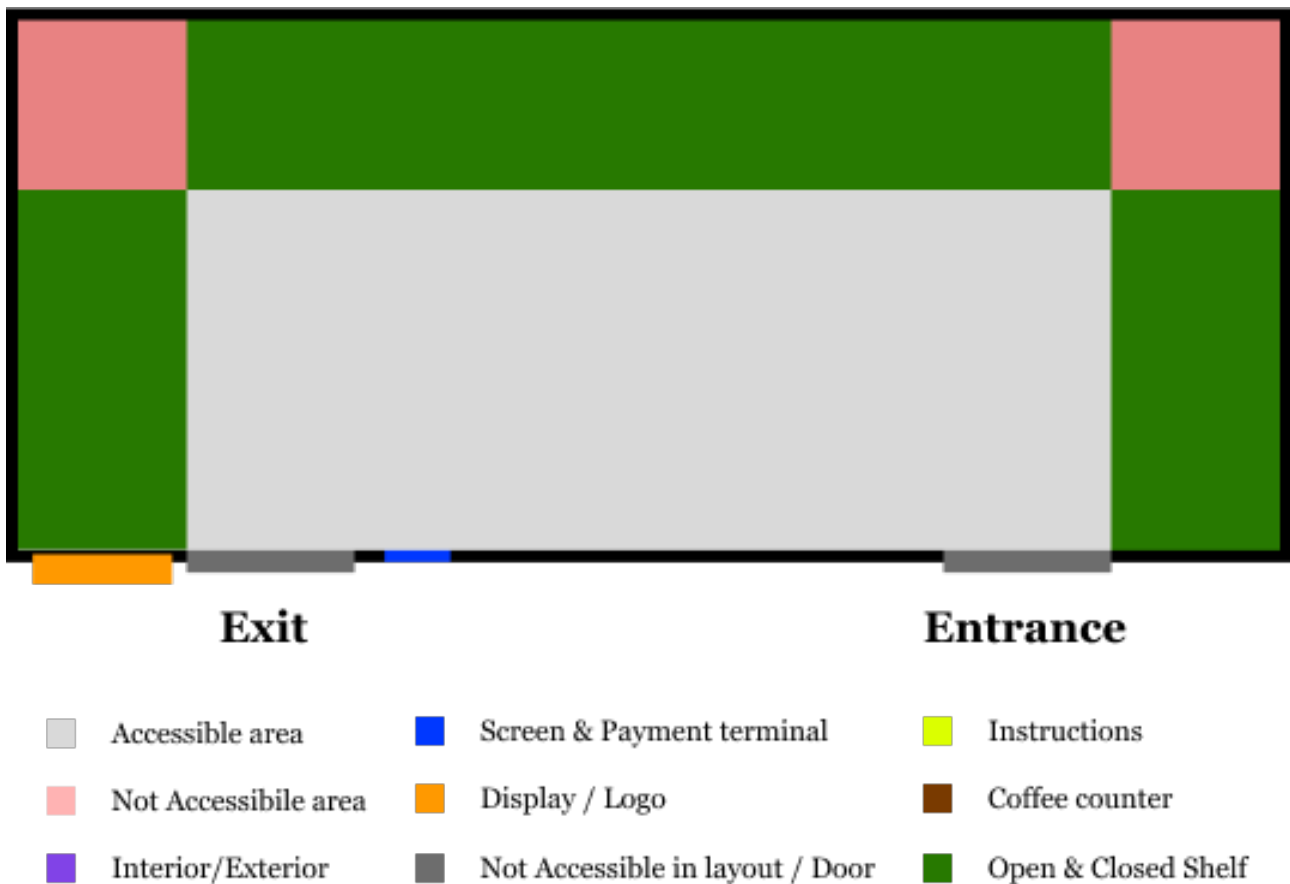
3. Albert Heijn

Albert Heijn is the largest supermarket chain in the Netherlands, It was founded in 1887. Since 2019, the company is testing a new version of the formula without staff and cash registers. The customer scans their debit card and cameras register the customer and the items that are picked, after the customer leaves the right amount is deducted from their account.

Website - https://nieuws.ah.nl/ah-to-go-heeft-europese-primeur-met-pin--en-kassaloos-shoppen/

Exit   Entrance

▢ Accessible area	■ Screen & Payment terminal	■ Instructions
▢ Not Accessibile area	■ Display / Logo	■ Coffee counter
■ Interior/Exterior	■ Not Accessible in layout / Door	■ Open & Closed Shelf
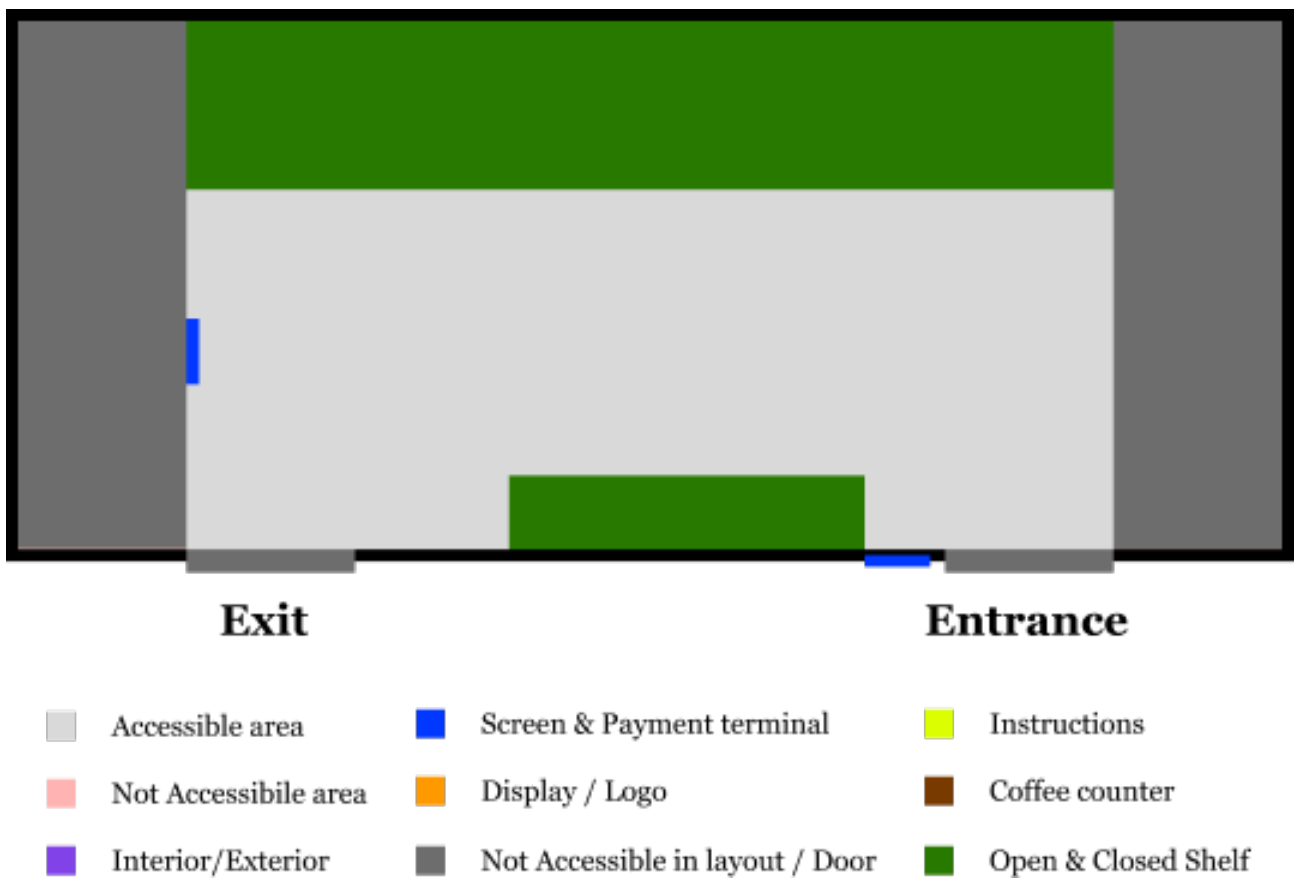
4. Aifi-Verizon

Aifi is a computer vision technology development company that provides an unrivaled shopper experience for retailers and consumers around the world. They have partnered with Verizon 5G to deliver this experience to a variety of audience.

Website - https://www.verizon.com/business/5g-edge-portal/partners/aifi.html

Exit   Entrance

⬜ Accessible area		🟦 Screen & Payment terminal		🟨 Instructions	
🟪 Not Accessibile area		🟧 Display / Logo		🟫 Coffee counter	
🟪 Interior/Exterior		⬛ Not Accessible in layout / Door		🟩 Open & Closed Shelf	
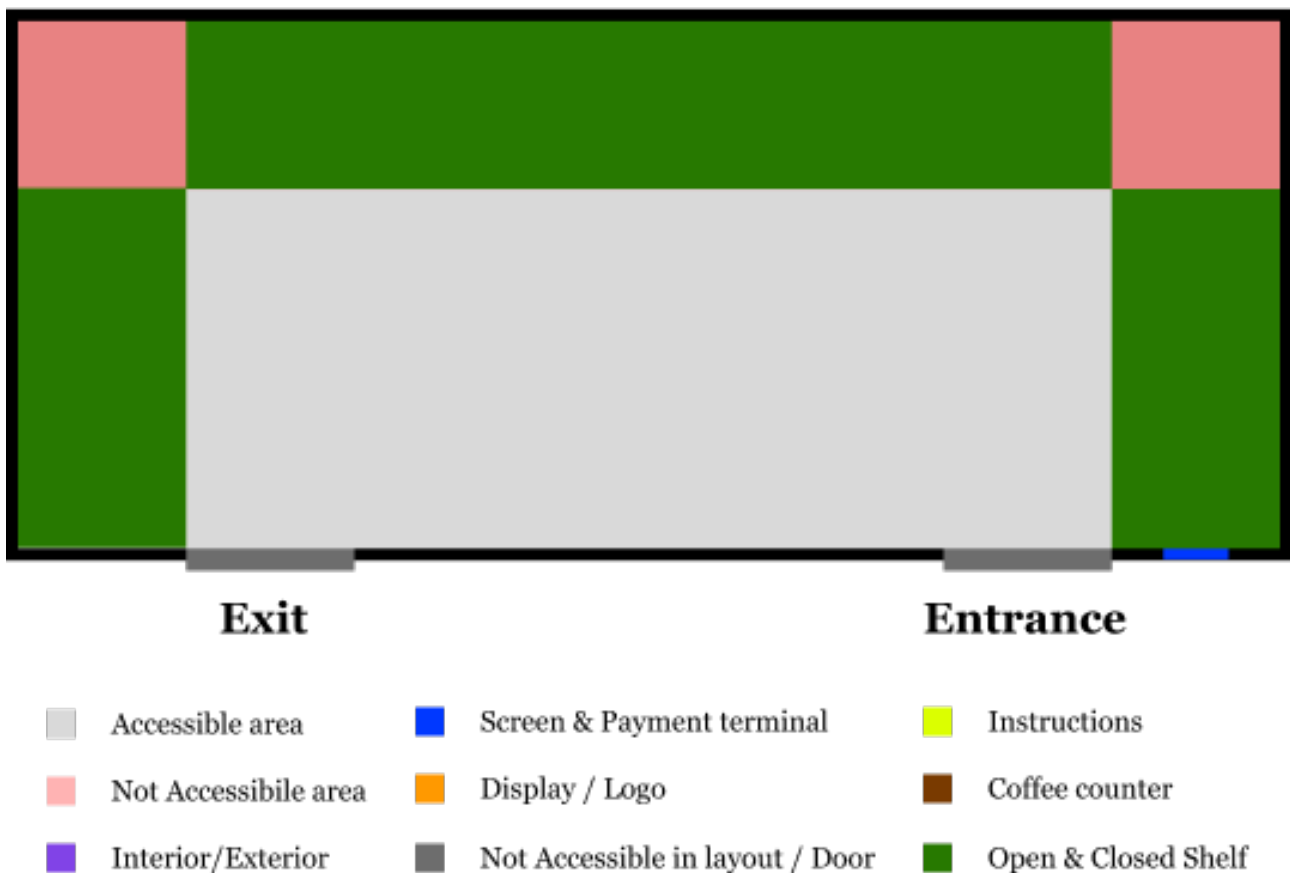
Proposed Interior FloorPlan:

Constraints:

Utilize the maximum space to keep the smart kiosk - Business Requirement.

Spacious for 4 number of customers at a time - Requirement from the Company

Accessibility - For People in wheelchair and People with strollers

Utilizing the space for storage above the Smart Fridges Kiosk for Computer Vision hardware.

Screen and payment terminal at entrance and a Screen at exit for displaying the Customer Shopping list before exiting the store.

Business Constraint - Use of in house smart Kiosk (maximum possible ~ 8) along with an open shelf as shown below.

The Proposed concept takes into consideration the Business requirements and also the accessibility of User experience to give a good Customer Buying experience.

Entrance

Exit

Single Fridge

Open Shelf
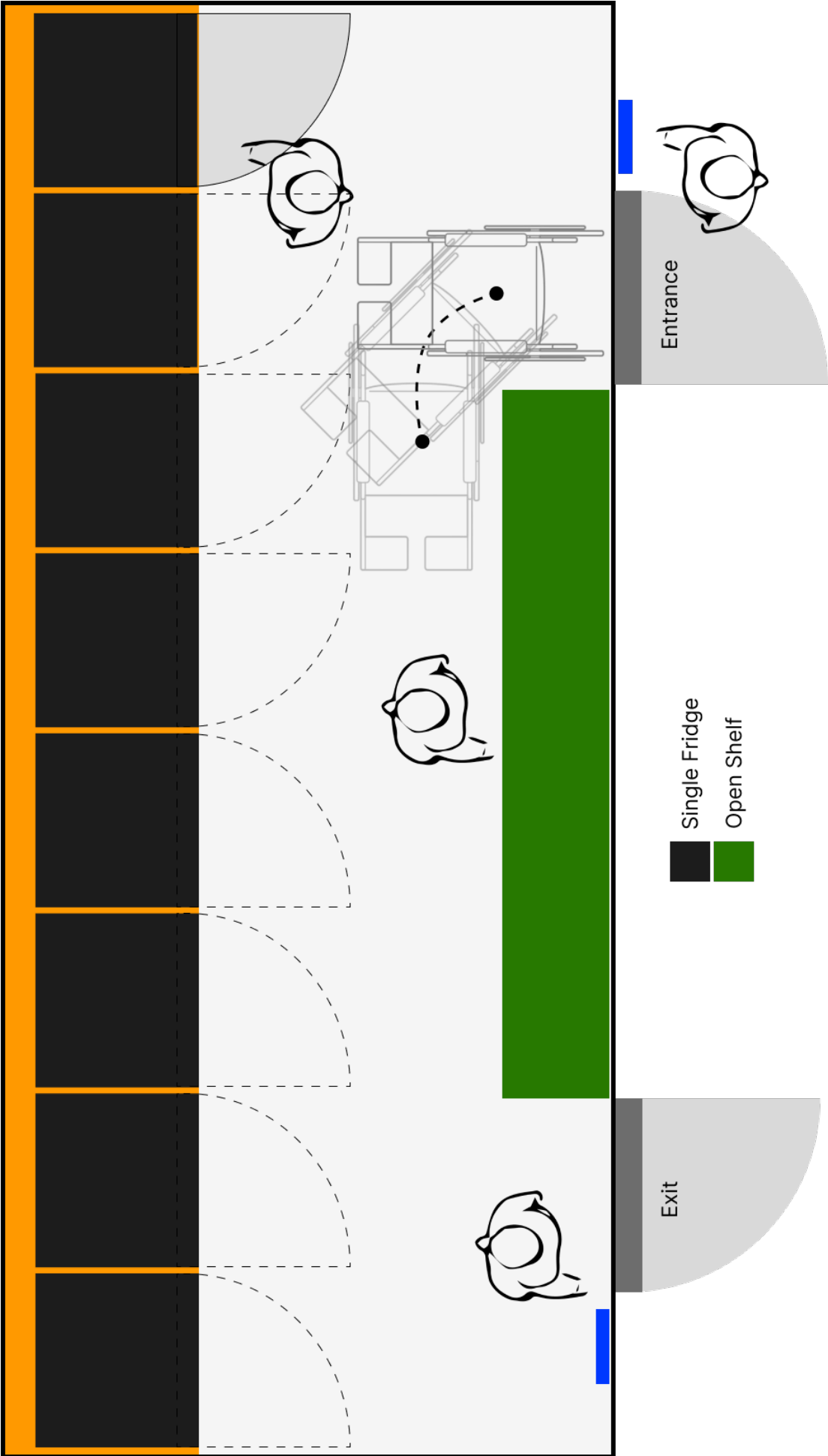
Camera Positioning orientation for Computer Vision based on the Proposed Layout:

Using 4 cameras to cover the entire area of the container for people tracking

2 cameras at the corners allow us to cover the entire container area and other 2 cameras are placed for shelf marking, they also work for tracking too.
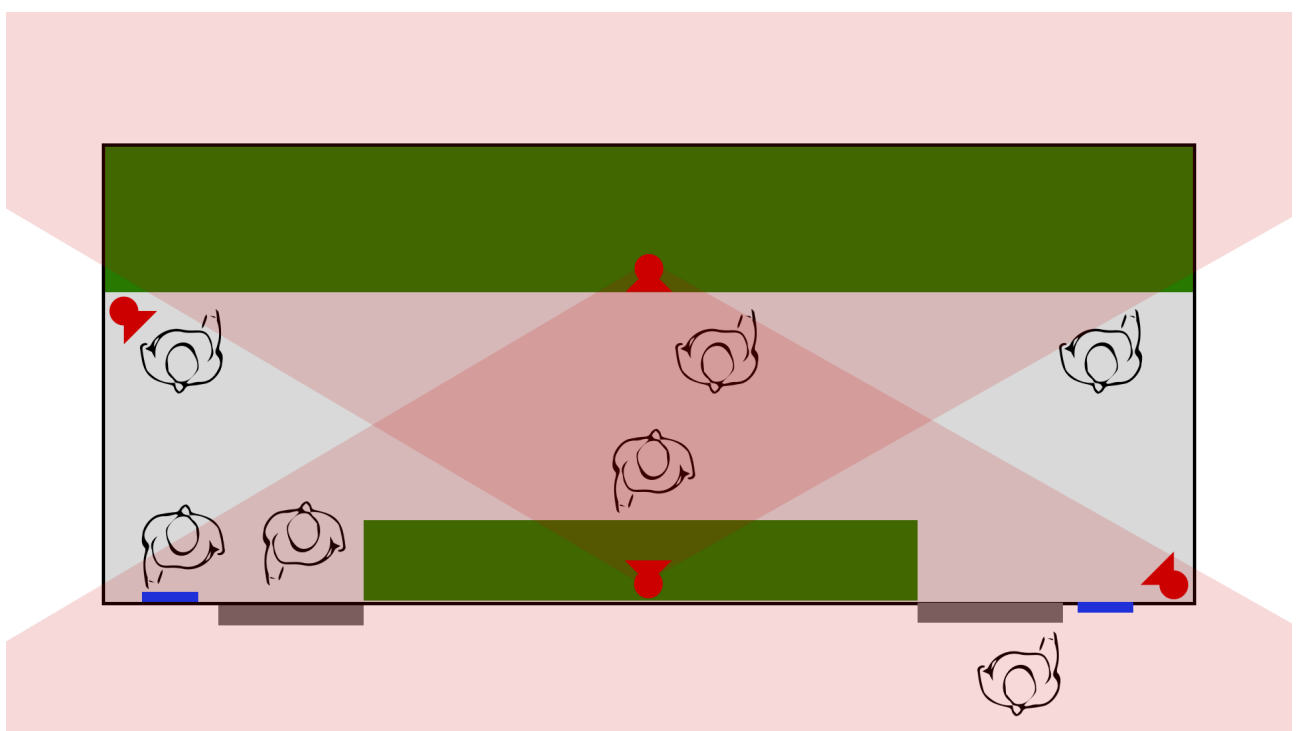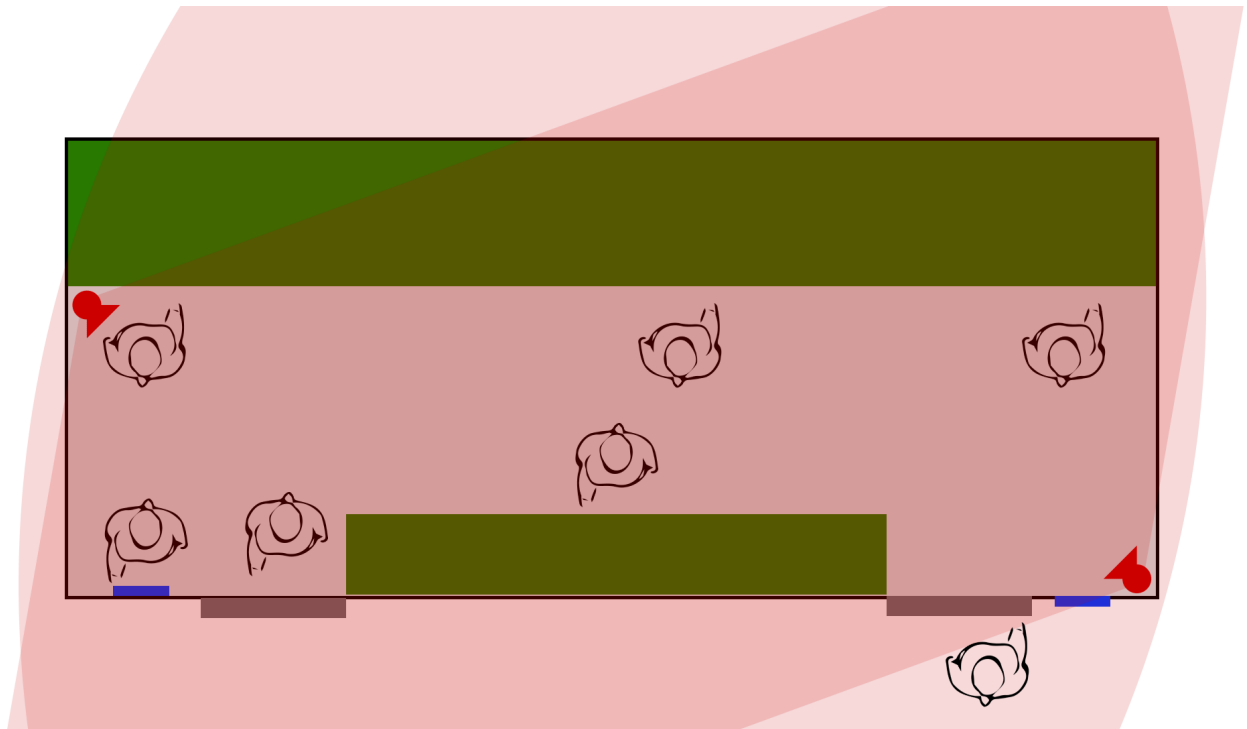
User Journey Flow:

Competitor Analysis:

Moby Mart:

Moby Mart and all the other competitors have a simple User flow and they are all similar to the example of mobymart shown below.

Proposed User flow:

Start the app on your phone

Use the app to enter the store

Put away your phone

Anything you take will be added to your virtual shopping cart automatically

If you change your mind, just put the product back, our system will remove the product from your virtual cart for you

Your family members and friends can be shopping with you using the same account. What they take will also be added to your cart

After shopping, just walk out of the store. There are no lines for checkout

You will receive a receipt in a few seconds on your phone with the list of items you purchased

Design direction for Container Design:

Two main directions which we finalized according to the requirements are
Minimalist Design and Industrial Design

Why these two approaches?

Because they align with our existing smart Kiosk design and they are easy for customization if required as a white label product.

As per the design requirement, going with a metal and wooden design is a good fit for a white label product, also Livello is a fresh food tech company, so the use of natural material will give it a more green and sustainable design approach. Something similar to the design on the right.

Moodboard for Interior:

Black Powder Coated Steel

LED Lighting with illumination control

Breathable Lenin material for wallpaper

Transparent Glass

Concrete tiles for the Flooring

Wooden Pallet
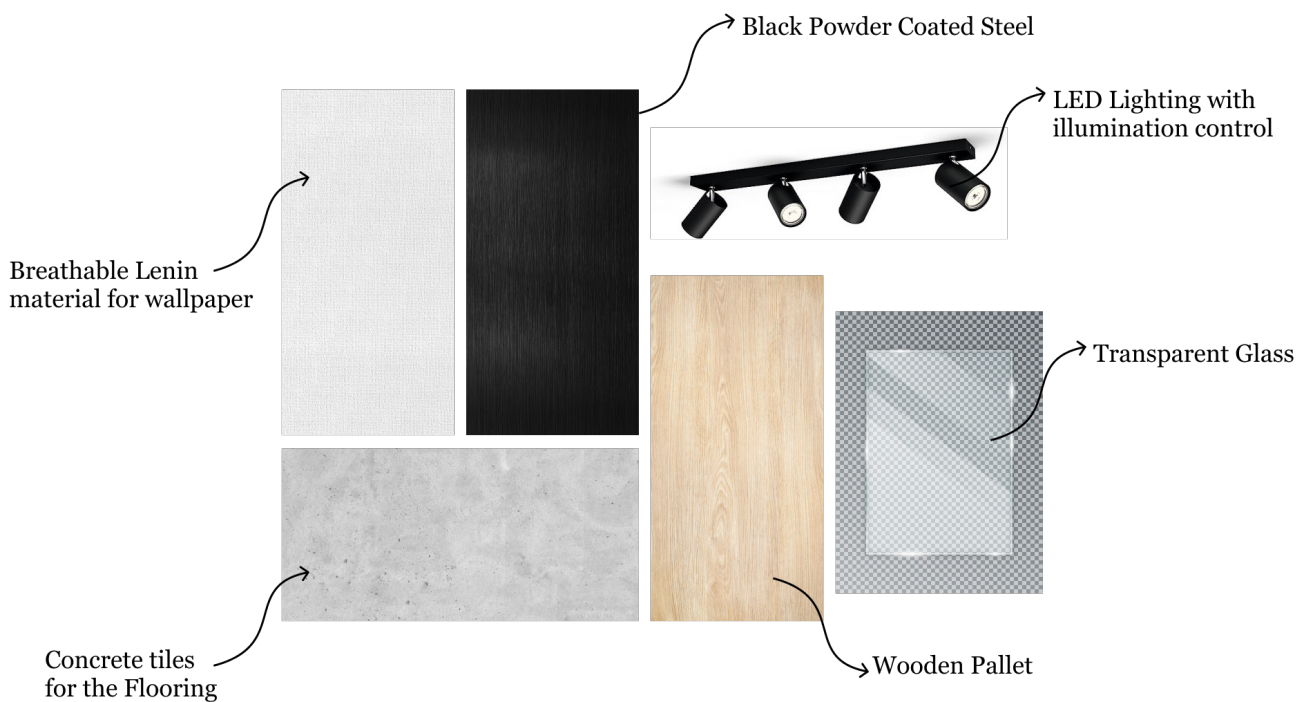
Interior Concept Renders:
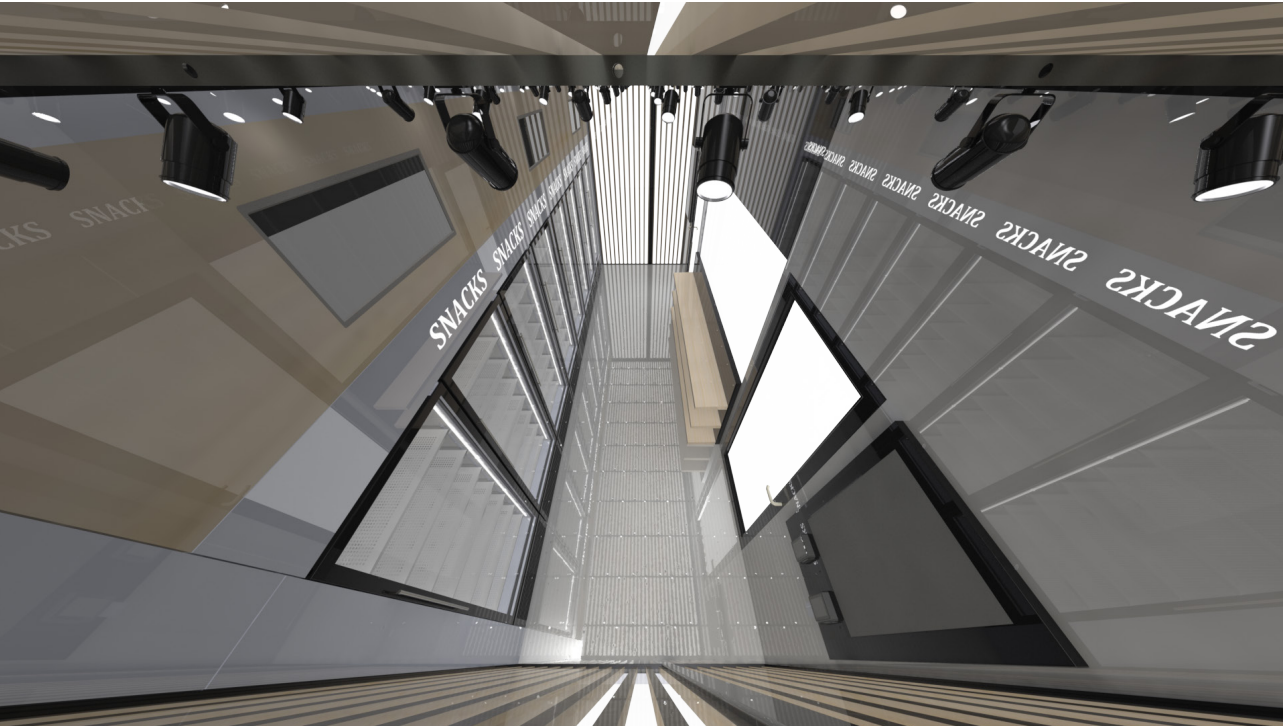
Assembly:

The main components to assemble are as follows

1. Smart Kiosk

2. Payment System

31.5 Inch
4k screen

QR Code
Reader

IM 30
Payment
Terminal
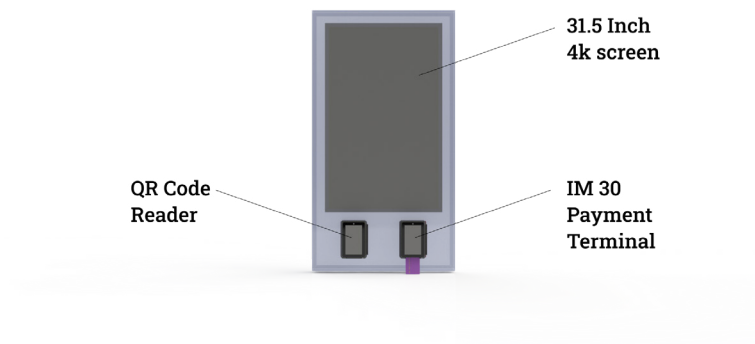
3. Open Shelf

4. Cameras

5. Computer Vision Hardware

6. Ventilation system

7. SOS System
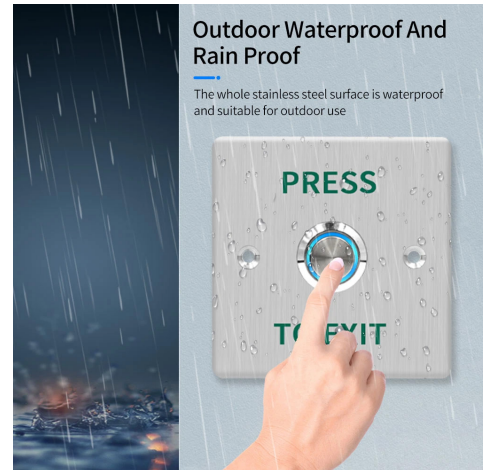
8. Container

The container will be already assembled with the following components:

1. *Power inlet*
2. *Fuse box*
3. *Screens*
4. *Doors and Bolt locks*
5. *Ventilation Vents*
6. *lighting system*
7. *Drain System*

System Diagram

Power Supply

Power Fuse Box

Computer Vision Hardware

Camera Array

Fridge Master

DB9 Connection

Screens Inside

Screens Inside

Screens Inside

Fridge Slave

DB9 Connection

Fridge Slave

DB9 Connection

Light System

Fridge Slave

DB9 Connection

Fridge Slave

DB9 Connection

POS Entrance

SOS

POS Exit

Fridge Slave

DB9 Connection

Fridge Slave

DB9 Connection

Ventilation System

Fridge Slave

DB9 Connection

Open shelf

Fridge Slave

DB9 Connection

Assembly (Continue):

Major Parts will be assembled by the container manufacturer only things like the kiosk needs to be assembled after the container is produced.

For this its important that the door of the kiosk are capable of fitting a single door kiosk.

Thats why we choose the maximum size possible of a door among the available standard door sizes in the market that is **2134 x 915mm**. This will help put kiosk and other insturments easily.

As for maintenance all the electronics of the kiosk are located at the top so to do a maintenance all they have to do is open the top cabinet with screens for easy access just as shown int the render below:

The same is used to accesse the Computer vision hardware and all the wires that run through the container for easy and straight forward maintenance in case of any issues.

TOP SHELF FOR MAINTANEANCE

Exterior Design:

Inspiration board for Exterior:
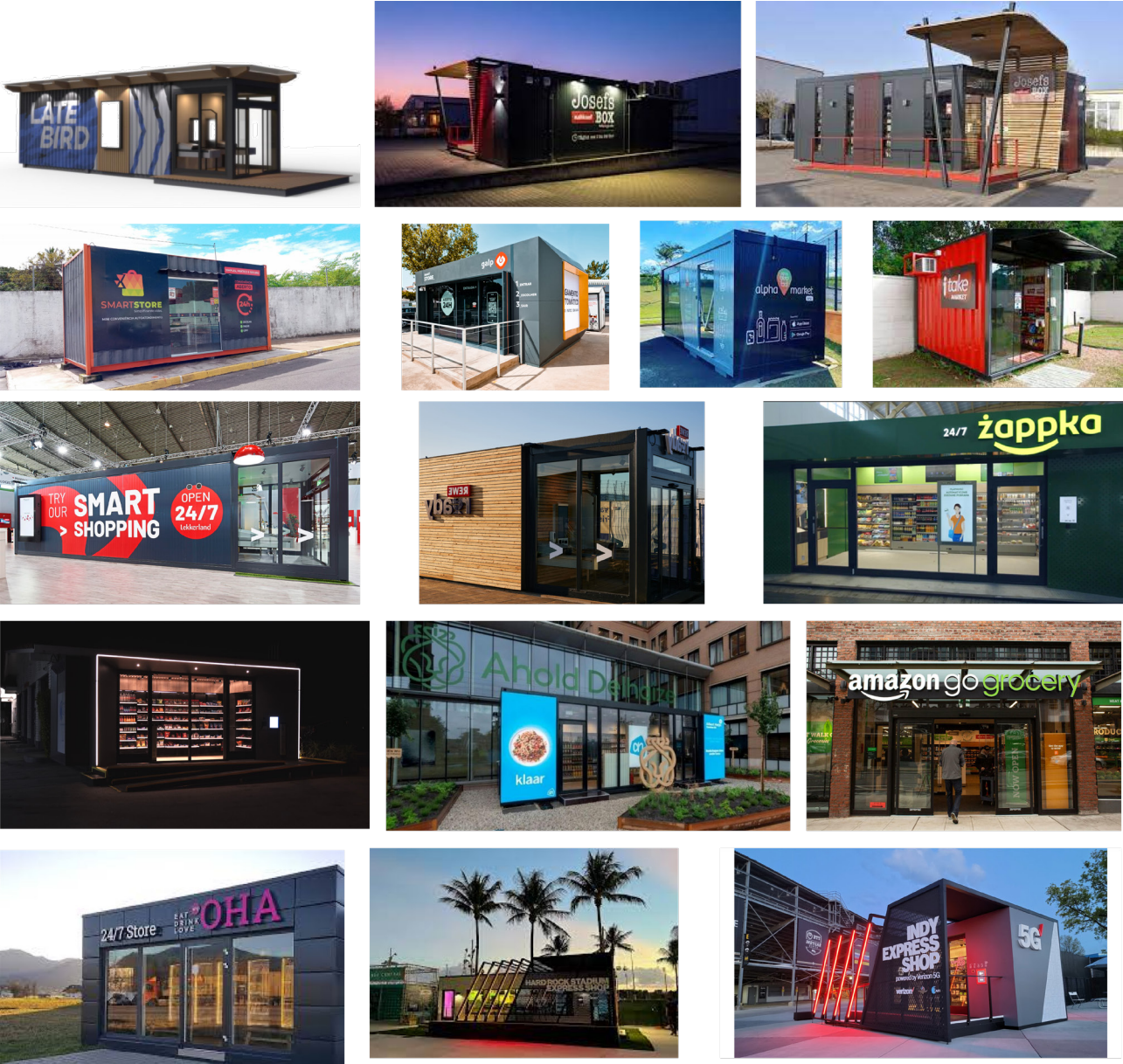
Concept Designs for Exterior:
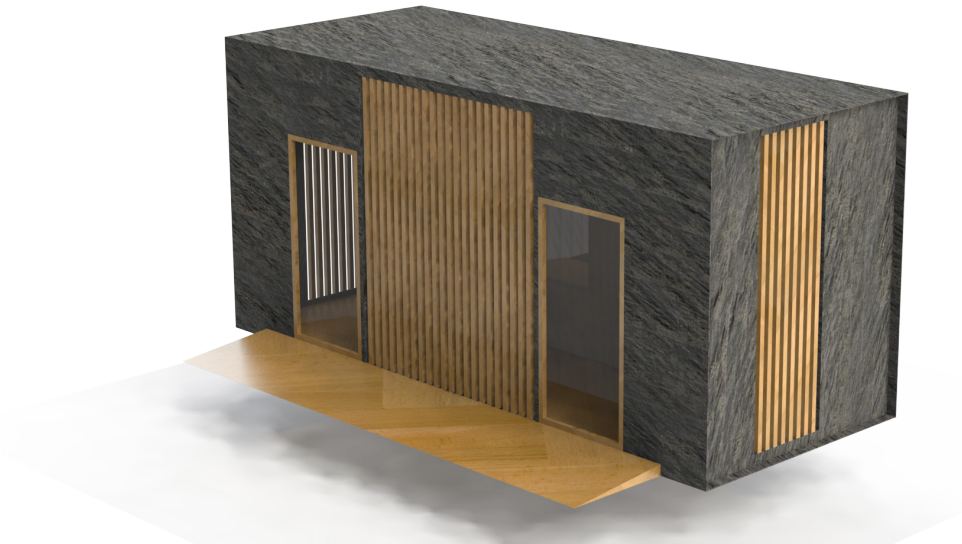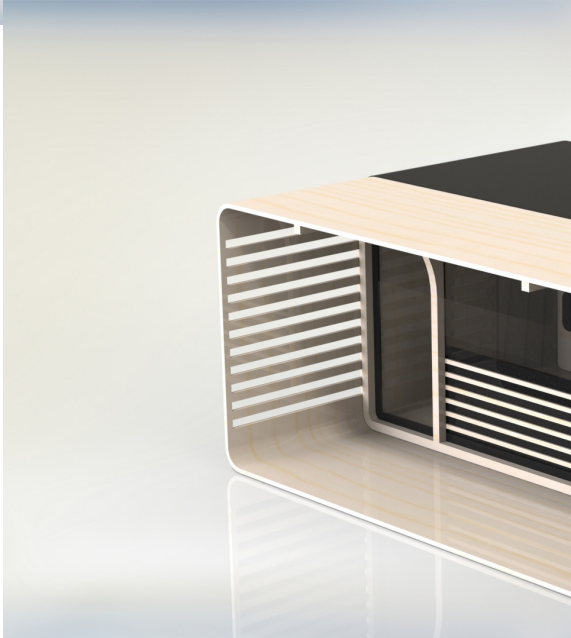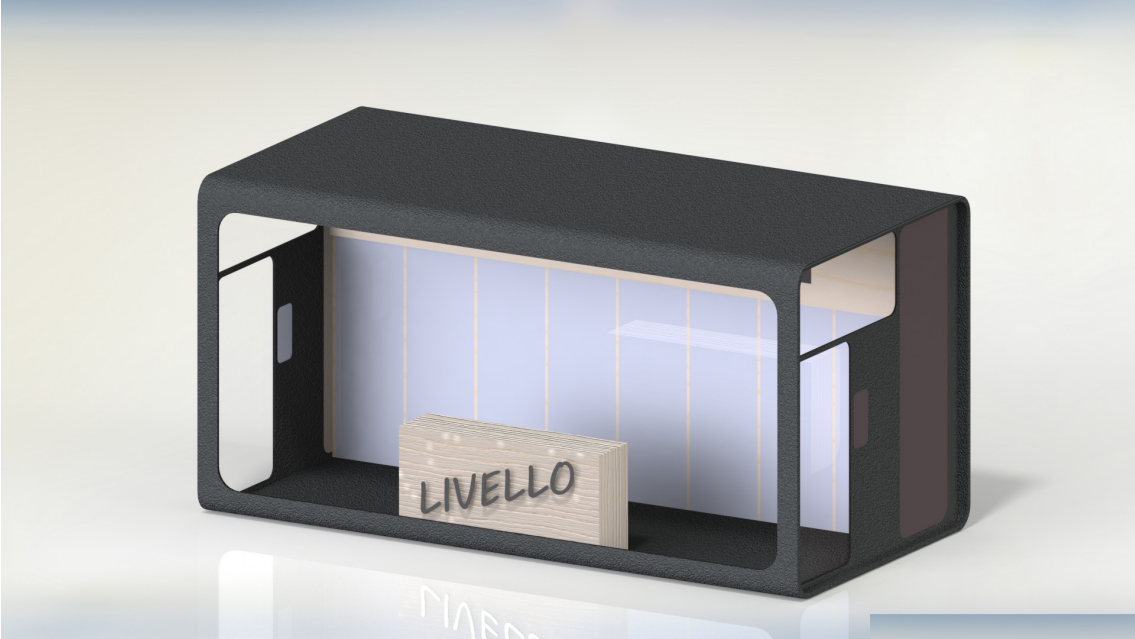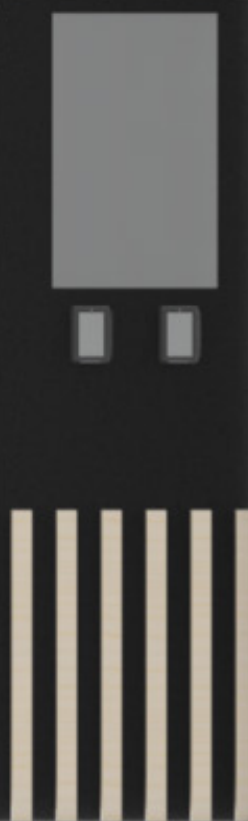
Other Systems of the Project:

The Smart Kiosk:

Smart kiosk is the main product of livellos portflio and they would like to use it in their container store. We have already discussed it before just to summarize and compare its benefits with a normal vending machine here are some important features;

LIVELLO VS TRADITIONAL VENDING MACHINES

Replacing vending machines with micro-markets increases sales on average by 80%

	Livello	vending machines
Consumer app / user loyalty features	✓ Standard feature	✗ Not available
Easy replenishment / cleaning	✓ Fast: under 5 min	✗ Difficult: many components
Flexible merchandising format	✓ Sell any product	✗ Only pre-sized slots
Hardware costs	✓ Cheap in mass production	✗ High material costs
Kiosk, user and inventory analyses	✓ Livello Analytics	✗ Low data capacity
Maintenance-free	✓ "Plug & Play" components	✗ Intense technical maintenance, prone to errors
Positive brand awareness	✓ People love fridges	✗ Unhealthy, outdated
Predictive maintenance/ remote access	✓ Realtime alert system	✗ Not available
Product capacity (i.e. cans)	✓ max. 720 cans per fridge	✗ max. 180 – 500 cans
Product change / adjustment	✓ Easy via "Drag&Drop"	✗ Difficult configuration, requires special tools
Product/ shelflife tracking	✓ Realtime	✗ Not available
Retail experience	✓ Open shelves like supermarket	✗ Not available
Smart supply chain management	✓ Livello Mission Control	✗ Not available
User and inventory analytics	✓ Livello Analytics	✗ Few data points
Weight / mobility	✓ Lightweight (110 kg) + rolls	✗ Heavy/ large (350+ kg)

The Smart Kiosk Electronics:

The Kiosk Has it own smart system which is powered by a raspberry pi and controls and communicates with the cloud server through LTE, wifi or Lan connection depending on the clients preference.The following is the image of the Electronics Schema for the entire smart kiosk electronics:
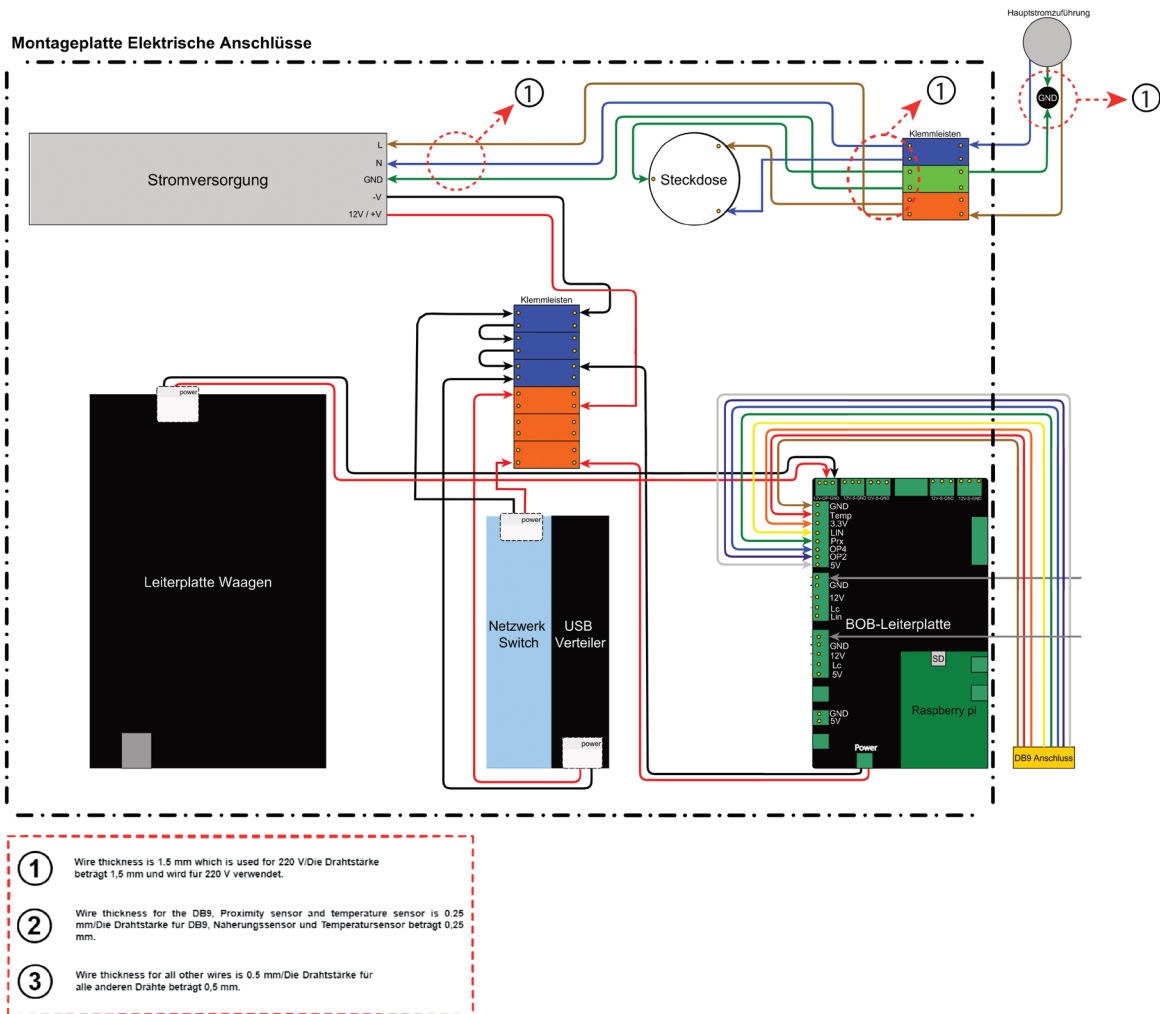
Smart Kiosk Blueprints:

64

19

30

159

27

87
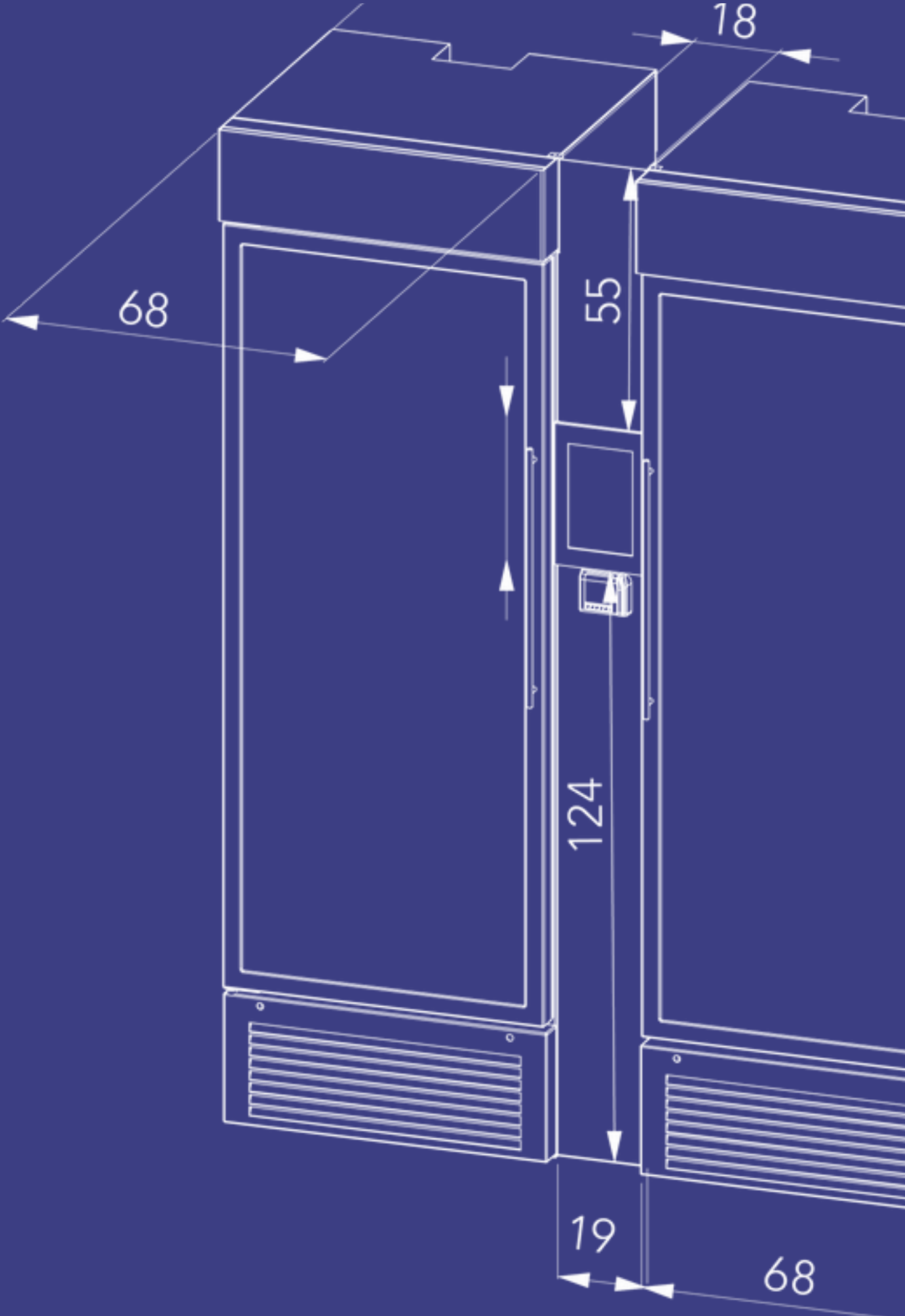
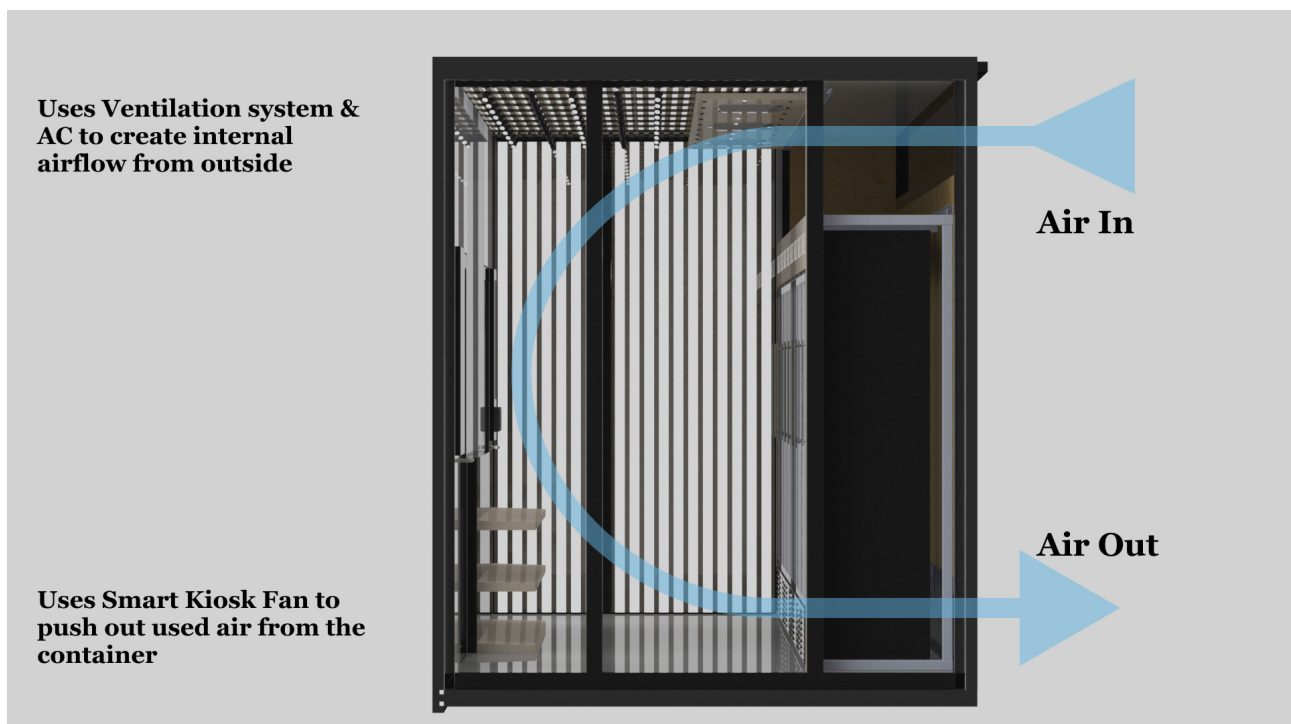# *The Design for Ventilation System:*

Components involved:

1. Fans for air inlet
2. Air Conditioner
3. Automatic Vents with electronic shutters
4. Digital Thermostat

The Container uses a smart system to maintain an ambient room temperature using a smart automated system using smart kiosk fans on the bottom and at the top we use Air conditioner & Air Inlet Fans that create the Air flow, and the Automatic vents with electronic shutters is optimally used to control the ambient indoor temperature.

The following images show two stages of Air flow;

Stage 1: Inlet of Air from Outside

Uses Ventilation system & AC to create internal airflow from outside

Air In

Air Out

Uses Smart Kiosk Fan to push out used air from the container

Stage 2: Smart Airflow inside the container

Uses Ventilation system & AC to create internal airflow from outside

Air Circulation in Winter season to control warm environment inside the container and to be more sustainable using smart kiosk fans to circulate air inside the container

Uses Smart Kiosk Fan to push out used air from the container

Air In

Air Out
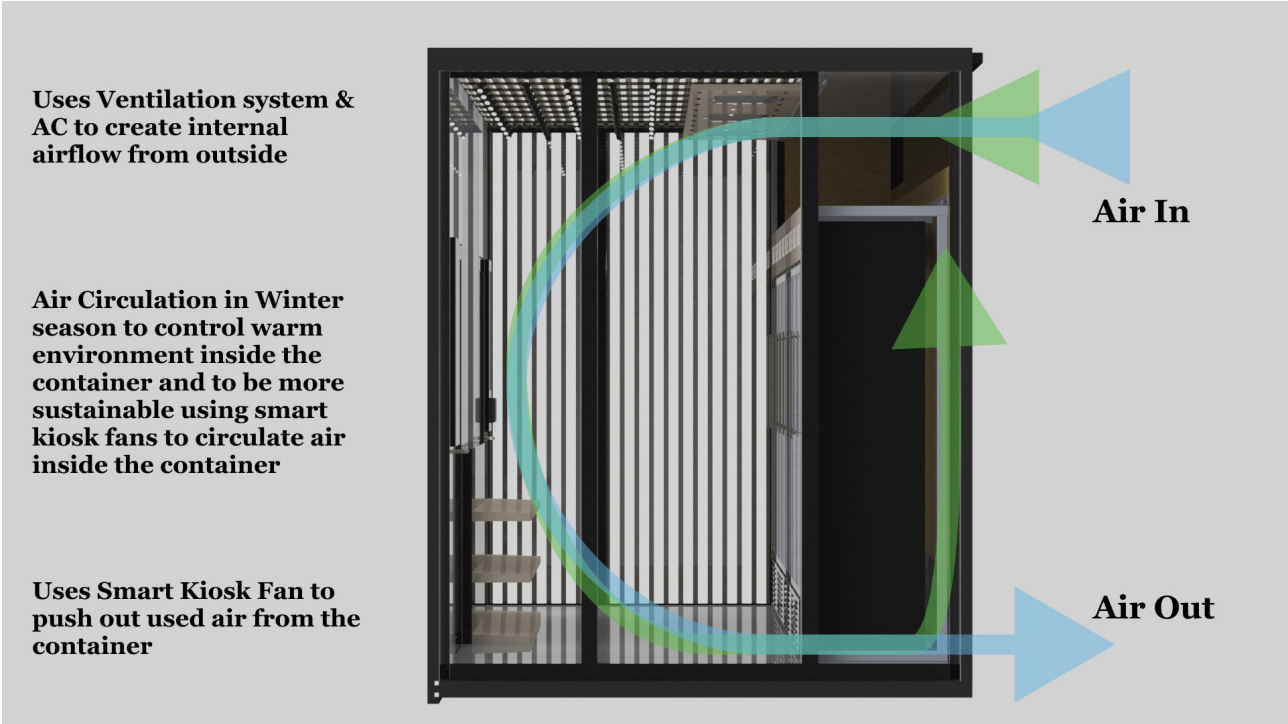
Safety Compliance:

Here are some detailed explanation of the compliances required for a Smart Autonomous Grab and Go store with cameras and fridges in Germany:

Data Protection Regulations:

The General Data Protection Regulation (GDPR) and the German Federal Data Protection Act (BDSG) are designed to protect the privacy and personal data of individuals. If the Smart Autonomous Grab and Go store uses cameras to monitor customer behavior, it must comply with these regulations. This would include obtaining consent from customers before collecting and processing their personal data, providing them with access to their data, and ensuring that their data is secure and not shared with third parties without their consent.

Food Safety Regulations:

The EU Food Safety Regulations are designed to ensure the safety and quality of food products. The Smart Autonomous Grab and Go store with fridges would need to comply with these regulations, which include guidelines for temperature control, hygiene, and labeling of food products. For example, the store would need to ensure that the temperature of the fridge is maintained at a safe level to prevent the growth of bacteria and other microorganisms that can cause foodborne illnesses. It would also need to ensure that the food products are properly labeled with information about ingredients, allergens, and nutritional values.

Building Regulations:

The Smart Autonomous Grab and Go store would need to comply with building regulations, such as fire safety regulations, electrical safety regulations, and construction regulations. For example, the store would need to ensure that its electrical wiring is properly installed and meets safety standards to prevent electrical hazards. It would also need to ensure that it has proper fire exits, fire extinguishers, and smoke detectors to prevent fire hazards. Additionally, it would need to ensure that the building construction meets structural and safety standards to prevent accidents and ensure the safety of customers and employees.

Energy Efficiency Regulations:

The Smart Autonomous Grab and Go store would need to comply with energy efficiency regulations, which are designed to reduce energy consumption and greenhouse gas emissions. This would include guidelines for the energy efficiency of buildings, appliances, and equipment. For example, the store would need to ensure that its fridges and other appliances are energy-efficient and meet energy efficiency standards. It would also need to ensure that the building insulation meets energy efficiency standards to reduce energy consumption and greenhouse gas emissions.

Health and Safety Regulations:

The Smart Autonomous Grab and Go store would need to comply with health and safety regulations, which are designed to protect the health and safety of customers and employees. This would include guidelines for the use of equipment, handling of food products, and emergency procedures. For example, the store would need to ensure that its employees are trained in the proper handling of food products to prevent contamination and foodborne illnesses. It would also need to ensure that its equipment, such as the automated door, is properly maintained to prevent accidents and injuries. Additionally, it would need to ensure that it has proper emergency procedures in place, such as a fire evacuation plan and a first aid kit, to ensure the safety of customers and employees in case of emergencies.

Camera

The computer vision camera is a critical component of an smart grab and go container store with computer vision technology. It is responsible for capturing high-quality images of the products placed in the containers, and then using computer vision algorithms to identify the products accurately.

Here are some key requirements for the computer vision camera:

Image Resolution:

The camera should have a high resolution to capture clear and detailed images of the products. A high resolution is critical for accurate product and customer identification by the computer vision software. A minimum resolution of 1280 x 720 pixels is recommended for the camera.

Image Quality:

The camera should produce high-quality images with accurate colors, brightness, and contrast. The images should be clear and well-defined to enable the computer vision algorithms to recognize the products and customers accurately.

Field of View:

The camera's field of view (FOV) should cover the entire area where the customers will be. The FOV should be wide enough to capture all the areas in the container, and identify customers regardless of their location.

Lighting:

The camera should have appropriate lighting to ensure that the images captured are well-lit and free of shadows. The lighting should be uniform across the entire FOV and should not create glare or reflections that could interfere with the product and customer recognition.

Frame Rate:

The camera's frame rate should be high enough to capture real-time images of the products. A minimum frame rate of 30 frames per second (fps) is recommended for the camera.

Durability:

The camera should be durable enough to withstand the wear and tear of daily use. It should be made of high-quality materials and designed to withstand the rigors of a commercial environment.

Maintenance:

The camera should be easy to maintain, and any maintenance or repairs should be easy to

carry out. The camera should have a warranty and technical support available in case of any issues.

Overall, the computer vision camera is a crucial component of an smart grab and go container store with computer vision technology. It plays a significant role in ensuring the accuracy and efficiency of the product and customer recognition process, which is critical to the store's success.

Computer Vision Software

The Computer Vision Software is the backbone of a smart store with computer vision and smart kiosks. It is responsible for processing the images captured by the computer vision cameras, accurately identifying the products and customers, and updating the inventory and purchases in real-time.

Here are some key requirements for the Computer Vision Software:

Product Identification:

The software should be able to accurately identify the products placed in the containers based on the images captured by the computer vision cameras. The product identification should be able to handle different shapes, sizes, and colors of products and should work even if the products are partially obstructed.
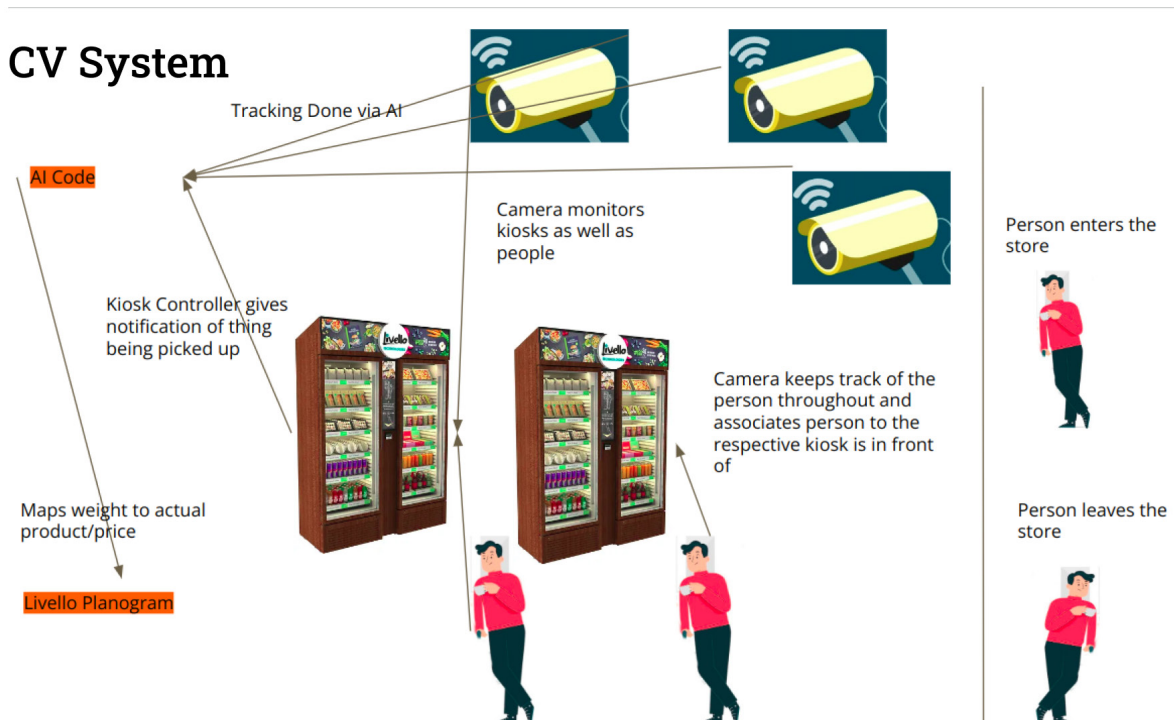
Customer Identification:

In addition to product identification, the software should also be able to identify the customers in real-time. This can be done using some identification methods. Customer identification is essential to ensure that each customer get billed exactly the products they purchased.

Inventory Management:

The software should be connected to the store's inventory management system to update the inventory in real-time. When a customer selects a product from the smart kiosk, the software should check if the product is in stock and update the inventory accordingly. This ensures that store managers are updated with the status of inventory and the products are replenished on time.

Machine Learning:

The software should be designed to learn and adapt over time. It should be able to recognize new products and adjust to changes in the store's layout. The machine learning algorithms should be able to improve the accuracy of product and customer identification over time, based on feedback from the computer vision cameras and the smart kiosks.

Data Privacy and Security:

The software should be designed with data privacy and security in mind. It should comply with relevant data privacy regulations and ensure that customer data is kept confidential and secure and follows the GDPR laws.

Scalability:

The software should be scalable and able to handle a certain number of cameras, products and customers. As the store traffic improves, the software should be able to handle the increased demand without sacrificing performance or accuracy.

Integration with Other Systems:

The software should be able to integrate with other systems, such as the payment system and the customer service software. This ensures a seamless shopping experience for the customer and improves the efficiency of store operations.

Overall, the Computer Vision Software is a critical component of a smart store with computer vision and smart kiosks. It enables accurate and efficient product and customer identification, real-time inventory management, and personalized shopping experiences for customers.

Data Analytics Software

Data analytics software is a critical component of a smart store with computer vision and smart kiosks. It is responsible for analyzing the data collected from the computer vision cameras and the smart kiosks to provide insights into customer behavior, product trends, and other key metrics.

Here are some key requirements for the Data Analytics Software:

Data Collection and Integration:

The software should be able to collect and integrate data from various sources, including the computer vision cameras, the smart kiosks, and other systems such as the store's inventory management system and the payment system. The data should be collected in real-time to ensure timely and accurate analysis.

Data Processing and Analysis:

The software should be able to process and analyze the data collected to provide insights into customer behavior, product trends, and other key metrics. It should be able to handle large volumes of data and apply advanced analytics techniques such as machine learning, predictive analytics, and natural language processing to provide valuable insights.

Visualization and Reporting:

The software should be able to present the analyzed data in an easy-to-understand format through visualizations and reports. This enables store managers and other stakeholders to quickly understand the insights and take action to improve store operations and customer experiences.

Personalization:

The software should be able to provide personalized recommendations to stakeholders based on the purchase history, preferences, and other relevant data. This enables the store to offer a more personalized shopping experience and increase customer loyalty.

Real-time Alerts:

The software should be able to provide real-time alerts to store managers and other stakeholders when specific events occur, such as low inventory levels or long wait times at the smart kiosks. This enables store managers to take action quickly to improve store operations and customer experiences.

Security and Compliance:

The software should be designed with data privacy and security in mind. It should comply with relevant data privacy regulations and ensure that customer data is kept confidential and secure.

Scalability:

The software should be scalable and able to handle large volumes of data as the store grows. It should be able to handle the increased demand without sacrificing performance or accuracy.

Overall, the Data Analytics Software is a critical component of a smart store with computer vision and smart kiosks. It enables store managers and other stakeholders to gain valuable insights into customer behavior and product trends, and take action to improve store operations and customer experiences.

Smart Kiosk Software

The Contianer is equipped with its own Wifi and LTE module to connect to the internet to communicate with the backend server of the kiosk software and the Webapp for the interaction of the Container and Banking transcations.

The following is the Architecture of the Kiosk Bnakend software;
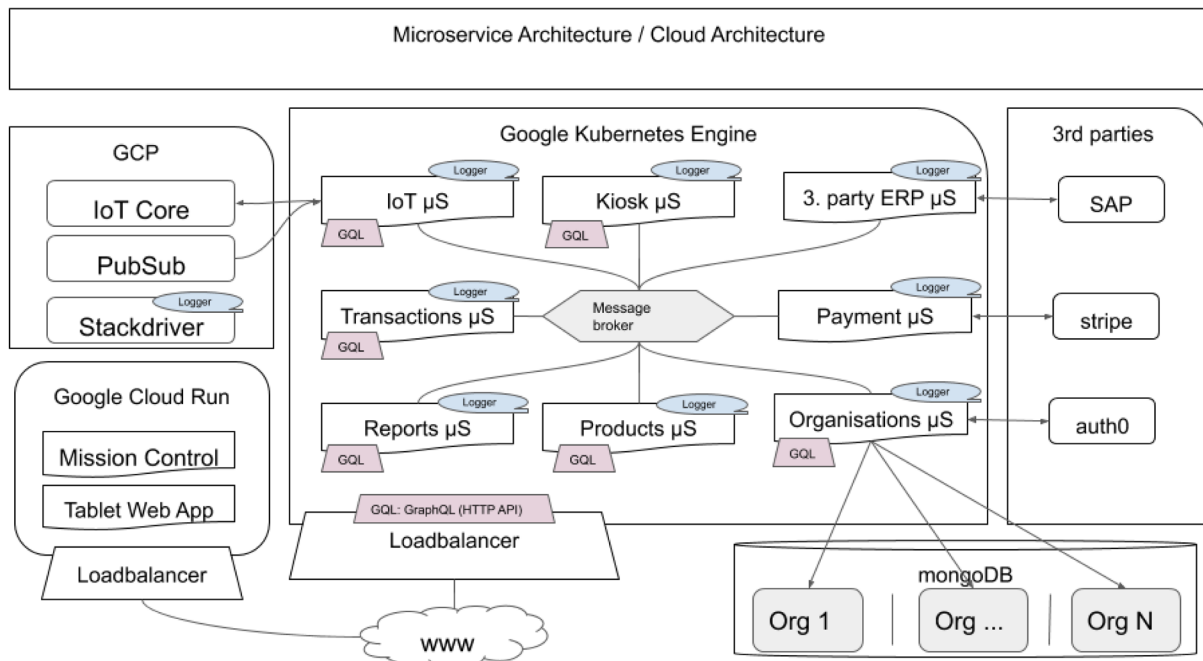
User Stories

Users:

As a user, I want to be able to quickly check out of the store without needing to wait in line or scan each product.
As a user, I want to be able to see the total cost of my purchase in real-time as items are added to my cart.
As a user, I want to be able to select payment methods from my mobile device and have the payment processed automatically.
As a user, I want to be able to receive a receipt on my phone when I check out.
As a user, I want to be able to leave the store without needing to show any form of identification.
As a user, I want to be able to view the items that I have added to my cart in real-time.
As a user, I want to be able to receive discounts and promotions based on my purchase history.
As a user, I want to be able to receive a notification when an item I desire is available in the store.
As a user, I want to be able to save my shopping list and have it applied when I check out.

Store Managers:

As a store manager, I want to be able to track the customer's purchase history in real-time.
As a store manager, I want to be able to easily modify the checkout process for different customers (change of payment methods).
As a store manager, I want to be able to customize the checkout process for different stores.
As a store manager, I want to be able to set up loyalty programs for customers.
As a store manager, I want to be able to track how many customers are using the automated checkout system.
As a store manager, I want to be able to apply discounts to certain customers automatically.
As a store manager, I want to be able to monitor customer activity in the store.
As a store manager, I want to be able to deploy the automated checkout system across multiple stores.
As a store manager, I want to be able to provide customer service via the automated checkout system.
As a store manager, I want to be able to quickly generate reports on customer purchase history.

Store Navigation:

Smart Store uses computer vision to create maps of the store and identify customers' locations within the store. This allows customers to easily navigate the store and locate the items they need.

Item Management:

Smart Store uses computer vision and Smart Kiosk to monitor inventory levels and identify when items are running low or need to be restocked. This helps store personnel efficiently manage inventory levels and keeps shelves stocked with the items customers need.

Product Recognition:

Smart Store uses computer vision to identify products the customers take and accurately categorize and add them to the virtual shopping cart. This helps customers to have only the products that they bought and ensures accurate pricing.

Customer Identification:

Smart Store uses computer vision to identify returning customers and personalize their shopping experience. This allows customers to quickly access their account information, purchase history, and any personalized offers.

Safety and Security:

Smart Store uses computer vision to monitor customers' movements and detect any suspicious activity. This helps keep customers safe and secure while shopping.

Bill of Material and Costing:

The overall development given by the stakeholders is **50,000 Euros**. The following is the BOM for the store;

TOTAL					€49,379.04
Sr. No.	Part Name	Description	Quantity	Cost/unit	Total Cost
1	Container		1	€22,360.10	€22,360.10
2	Display Screen		4	€100.00	€400.00
3	Payment System		2	€566.20	€1,132.40
4	Emergency System		1	€38.20	€38.20
5	Door System		2	€206.00	€412.00
6	Interior Lights		1	€200.00	€200.00
7	Exterior Lights		1	€200.00	€200.00
8	Ventilation System		1	€500.00	€500.00
9	Power box		1	€406.00	€406.00
10	Camera for Security		2	€66.00	€132.00
11	Smart Fridge - Slave		7	€1,371.36	€9,599.52
12	Smart Fridge - Master		1	€1,497.25	€1,497.25
13	Open Shelf		2	€650.79	€1,301.57
14	CV-DS		1	€8,200.00	€8,200.00
15	Misc		1	€3,000.00	€3,000.00
TOTAL					€49,379.04

Further Development:

The Container needs to be redesigned to fit the new German transport regulations;

Paragraf 32 StVZO (Section 32 of the German Road Traffic Licensing Regulations) pertains to the dimensions and mass of vehicles. According to this, the maximum permissible dimensions for vehicles (without obtaining a special permit) are:

Width: 2.55 meters
Height: 4 meters

Length: For single motor vehicles, the maximum length is 12 meters. For motor vehicles with a trailer, the maximum length is 18.75 meters.

For containers being transported by trucks, the size of the container itself must adhere to these restrictions when loaded onto the vehicle, and the overall weight must not exceed the legal weight limit for the vehicle. If your container exceeds these dimensions, a special permit would likely be needed.

The system with backend needs to be integrated with the container and the computer vision software.

The container design needs to be developed further to incorporate more sustainable approach to Power consumption and waste management.

The container needs to be made accessible with fire resitant material in case of a mishap and also need to compile with fire and health safety regulations.

The web application for the interaction at the entrance and exit needs to be developed and integrated with system.

Rigourous System and software testing needs to be done along with User Experience Testings.

Smart interior Lighting system needs to be developed to prevent unnecessary consumption of power.

Need to final the vendors and supplier for all the components and to make assembly and user manuals for different levels of users like Assembler, Maintaneance Guy, Replinesher and Client installation guides.

The stakeholders would like to release the finished product after testing in the market by the end of this Financial Year of **2023-2024.**

References

Figures:

Bibliography

Articles

https://www.shine.cn/news/metro/2109295849/
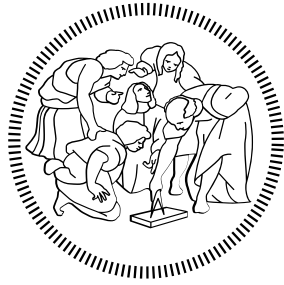https://rarehistoricalphotos.com/keedoozle-automated-store-pictures1949/
https://www.patrickvankleef.com/2017/10/11/how-smart-stores-will-improve-the-customer-shopping-experience/
https://www.pickhvac.com/hvac-duct/cfm-calculator/
https://blog.denleigh.co.uk/what-are-standard-door-sizes-in-metric-and-imperial
https://www.livello.com/blog

Sitography

https://www.amazon.de/Amcrest-IP-Revolver-PoE-Kamera-8-mm

https://www.risto-shop.de/Buerocontainer

https://www.pod-space.co.uk/pods/lite-pod

https://www.expandable-trailers.com/products/expandable-container-chassis/

https://www.alibaba.com/product-detail/Shop-Shelf-S-Display-Rack-Steel_1600498109167.html

https://www.lumenxl.de/modernes-einphasiges-schienensystem-von-15-metern.html

https://www.otto.de/suche/wandventilator

https://wpig-iotsolutionaggregator.wpgholdings.com/eng/solution/detail/Cloudpick-Autonomous-Store-Cas

https://www.cyberport.de/pc-und-zubehoer.html

https://www.amazon.de/Waterproof-Elektromagnetisches-Magnetschloss-Elektrischer-Hostcontroller

https://www.wolkdirekt.com/burg-waechter-ts-2000-v-_-5737945.html

https://www.wasserman.eu/en-ie/

https://www.livello.com/

https://www.zabka.pl/o-zabce

https://www.getboxy.co/

POLITECNICO
MILANO 1863