



MÁSTER UNIVERSITARIO EN INGENIERÍA INDUSTRIAL

TRABAJO FIN DE MÁSTER

Development of the business model for a startup and
conception of its MVP

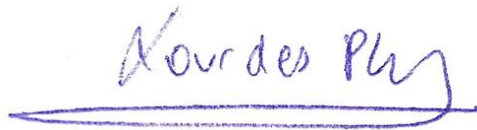
Autor: Lourdes Platero de Heredia

Director: Hadrien Bonato - Bape

New York

Declaro, bajo mi responsabilidad, que el Proyecto presentado con el título *Development of the business model for a startup and conception of its MVP* en la ETS de Ingeniería - ICAI de la Universidad Pontificia Comillas en el curso académico 2023/2024 es de mi autoría, original e inédito y no ha sido presentado con anterioridad a otros efectos.

El Proyecto no es plagio de otro, ni total ni parcialmente y la información que ha sido tomada de otros documentos está debidamente referenciada.



Fdo.: Lourdes Platero de Heredia

Fecha: 26/08/2024

Autorizada la entrega del proyecto

EL DIRECTOR DEL PROYECTO

Fdo.: Hadrien Bonato - Bape

Fecha: 30/08/2024





MÁSTER UNIVERSITARIO EN INGENIERÍA INDUSTRIAL

TRABAJO FIN DE MÁSTER

Development of the business model for a startup and
conception of its MVP

Autor: Lourdes Platero de Heredia

Director: Hadrien Bonato - Bape

New York

DESARROLLO DEL MODELO DE NEGOCIO DE UNA START UP Y CONCEPCIÓN DE SU MVP

Autor: Lourdes Platero de Heredia

Director: Hadrien Bonato - Bape

RESUMEN DEL PROYECTO

Palabras clave: In-store analytics, retail, computer vision, MVP, start-up, YOLOv8

1. Introducción

El proyecto se centra en el desarrollo del modelo de negocio y la concepción de un MVP para Hollia, una startup diseñada para salvar la brecha entre la comprensión de los clientes en entornos de *retail* físicos y digitales. A medida que las empresas se enfrentan a retos para adaptarse a las cambiantes expectativas de los consumidores, Hollia tiene como objetivo proporcionar una solución integral que integre IA, visión por ordenador y análisis de datos para ofrecer información en tiempo real sobre el comportamiento de los clientes en los espacios físicos de venta al por menor.

1.1. Genesis de la idea

La idea de Hollia surgió del reconocimiento de la brecha significativa que existe en la forma en que las empresas entienden y monetizan las interacciones con los clientes en espacios físicos y *online*. Mientras que las plataformas digitales ofrecen herramientas sofisticadas para seguir y analizar el comportamiento de los clientes, el entorno de *retail* físico no lo tienen, dependiendo de métodos tradicionales como estudios observacionales, encuestas y análisis de datos de ventas.

1.2. Estado de la cuestión

El estado de la técnica en este ámbito pone de relieve la creciente importancia del *analytics* en tienda como subconjunto diferenciado de la analítica del comercio *retail*. Se prevé que el mercado mundial de análisis en tienda alcance los 12.600 millones de dólares en 2029, impulsado por los avances en IA y las soluciones basadas en la nube. Los principales actores de este mercado aprovechan la IA y el aprendizaje automático para proporcionar datos y perspectivas en tiempo real. A pesar de estos avances, desafíos como la privacidad de los datos, la complejidad de la implementación y los altos costos asociados con estas tecnologías siguen siendo barreras significativas.

2. Definición del Proyecto

Los objetivos del proyecto son dos

1. Estratégico: Realizar un estudio de mercado exhaustivo, centrándose en Francia como país de fundación de la start-up, en Europa como primer mercado de expansión y después en el mundo. Esbozar un plan de negocio a dos años.

2. Técnico: Contribuir al desarrollo del MVP mediante la creación de código para la detección y seguimiento de clientes, así como establecer las bases para futuros *dashboards* de análisis de clientes.

3. Descripción de la start-up y del MVP

3.1. Misión, visión y valores

La misión de Hollia es cerrar la brecha entre la comprensión de los clientes en entornos físicos y digitales, ofreciendo una solución analítica completa adaptada a los espacios comerciales. Hollia aspira a convertirse en el proveedor líder de análisis para tiendas minoristas, transformando el modo en que las empresas se relacionan con sus clientes físicos mediante el uso de tecnologías punteras de IA y análisis de datos. Los valores fundamentales de Hollia hacen hincapié en la innovación, un enfoque centrado en el cliente que prioriza la facilidad de uso y el acompañamiento total, y un compromiso con políticas de privacidad y normas éticas sólidas.

3.2. Descripción del producto

La solución de Hollia incluye una red de cámaras conectadas y su instalación y un panel de control fácil de usar, que permite a las empresas obtener información precisa sobre el tráfico de personas, la evolución de los recorridos, la demografía y el comportamiento y sentimiento de los consumidores. Además, Hollia planea incluir un chatbot de consulta, donde los clientes pueden obtener recomendaciones personalizadas basadas en los datos recopilados.

3.3. Descripción de las tecnologías

El proyecto aprovecha bibliotecas y marcos accesibles en internet para lograr una detección y un seguimiento precisos de objetos en tiempo real, cruciales para el MVP de Hollia. Utilizando YOLOv8 para la detección de objetos y BYTETracker para el seguimiento multiobjeto, el sistema identifica y supervisa a las personas en secuencias de vídeo, almacenando datos para análisis empresariales. La biblioteca de Supervision realiza la extracción de fotogramas, la anotación y la conversión de resultados. La estructura del código del MVP está diseñada en torno a cinco cuestiones: detección de personas en áreas específicas, definición de zonas dentro del fotograma de vídeo y recuento de personas dentro de esas zonas, medición del tiempo que pasan los individuos en esas zonas, seguimiento del movimiento de las personas a través de las distintas zonas y exportación de los datos recogidos en un formato accesible para su posterior análisis.

4. Resultados

4.1. Análisis externo

El análisis externo del entorno del proyecto revela varios factores clave que influyen en la estrategia de mercado de Hollia. El análisis PESTEL destaca un entorno político favorable, especialmente en Francia, donde iniciativas gubernamentales como La French Tech fomentan la innovación en IA. Los avances tecnológicos en IA y aprendizaje automático son fundamentales para mantener una ventaja competitiva. Los factores legales, incluidas las

estrictas regulaciones de privacidad de datos como GDPR, desempeñan un papel importante en la configuración del marco operativo.

El análisis de las cinco fuerzas de Porter indica un mercado fragmentado y emergente con una rivalidad competitiva moderada. La amenaza de nuevos competidores es mayor debido a las escasas barreras tecnológicas, por lo que es crucial ganarse la lealtad de los primeros usuarios. El éxito de Hollia depende de factores clave como una sólida protección de la intimidad y el cumplimiento de la normativa, la oferta de una solución completa e integrada, el mantenimiento de unos costes de implantación bajos, la orientación al cliente, la oferta de una amplia gama de funciones y la agilidad para responder a los cambios del mercado. El análisis de la competencia revela que Hollia opera en un entorno competitivo que incluye empresas especializadas en el análisis de tiendas minoristas mediante visión por ordenador, empresas de seguridad que ofrecen cámaras de vigilancia con IA y empresas centradas en métodos no visuales de análisis de clientes.

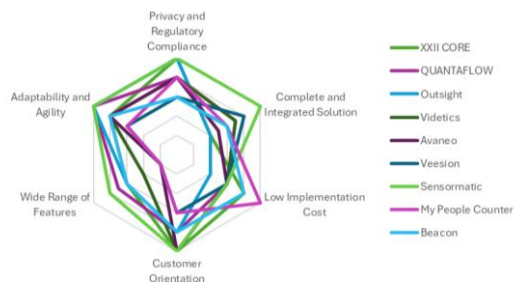


Figure 1: Analisis de factores de exito de competidores

4.2. Análisis interno

El análisis interno de las operaciones de Hollia revela varios puntos fuertes, como una tecnología avanzada, una solución completa que integra a la perfección hardware y software, y un estricto cumplimiento de la normativa sobre privacidad. Sin embargo, la empresa también se enfrenta a debilidades como los elevados costes de implantación y la dependencia de proveedores tecnológicos. Las oportunidades incluyen el creciente mercado de la IA y el fuerte apoyo gubernamental, mientras que las amenazas consisten en recesiones económicas, presión competitiva y preocupaciones por la privacidad de los datos. El análisis de la cadena de valor muestra que las operaciones de Hollia se apoyan en un fuerte desarrollo tecnológico, un aprovisionamiento eficiente y una gestión eficaz de los recursos humanos, basada en una gran atracción de talentos y una cultura y desarrollo profesional atractivos. El análisis de la visión basada en los recursos (VBR) identifica los recursos clave de Hollia, como su red de cámaras conectadas, el software y los algoritmos patentados, los cuadros de mando analíticos centralizados y un servicio de chat basado en datos, como valiosos, raros, difíciles de imitar y no sustituibles, lo que proporciona a la empresa una ventaja competitiva sostenible.

4.3. Estructura del Código

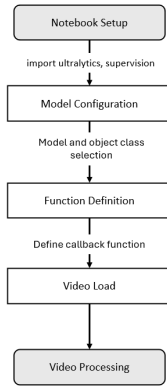


Figure 2: Estructura del código

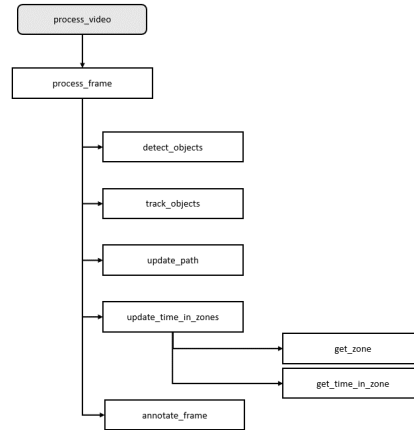


Figure 3: Estructura de la función callback de procesamiento de vídeo

5. Conclusiones

El Business Model Canvas (BMC) desarrollado para Hollia esboza una estrategia clara para crear valor, gestionar las relaciones con los clientes y generar ingresos. El análisis económico proyecta un fuerte crecimiento para Hollia, y se espera que la empresa alcance el punto de equilibrio en el segundo año de funcionamiento. La orientación a las grandes cadenas minoristas y a los organizadores de eventos se considera un motor clave del éxito, aprovechando las capacidades analíticas avanzadas de Hollia para ofrecer soluciones personalizadas y escalables que satisfagan las necesidades de estos clientes. El proyecto concluye que Hollia está bien posicionada para capitalizar la creciente demanda de análisis en tienda, siempre que siga innovando y manteniendo su ventaja competitiva en un mercado en rápida evolución

DEVELOPMENT OF THE BUSINESS MODEL FOR A STARTUP AND CONCEPTION OF ITS MVP

Author: Lourdes Platero de Heredia.

Supervisor: Hadrien Bonato-Bape.

ABSTRACT

Keywords: In-store analytics, retail, computer vision, MVP, start-up, YOLOv8

1. Introduction

The project centers on the development of the business model and the conception of a MVP for Hollia, a startup designed to bridge the gap between understanding customers in physical and digital retail environments. As businesses face challenges in adapting to evolving consumer expectations, Hollia aims to provide a comprehensive solution that integrates AI, computer vision, and data analytics to offer real-time insights into customer behavior in physical retail spaces.

1.1. Genesis of the idea

The idea for Hollia emerged from the recognition of a significant gap in how businesses understand and monetize interactions with customers in physical spaces compared to online environments. While digital platforms offer sophisticated tools for tracking and analyzing customer behavior, the physical retail environment has lagged, relying on traditional methods like observational studies, surveys, and sales data analysis.

1.2. State of the art

The state of the art in this domain highlights the growing importance of in-store analytics as a distinct subset of retail analytics. The global market for in-store analytics is projected to reach USD 12.60 billion by 2029, driven by advances in AI and cloud-based solutions. Key players in this market leverage AI and machine learning to provide real-time data and insights. Despite these advancements, challenges such as data privacy, the complexity of implementation, and the high costs associated with these technologies remain significant barriers.

2. Project definition

The objectives of the project are twofold:

1. Strategic: Conduct comprehensive market research, focusing on France as the country where the start-up is founded, on Europe as the first market of expansion and on then the world. Sketch a two-year business plan.
2. Technical: Contribute to the development of the MVP by creating code for customer detection and tracking, as well as establishing the foundations for future customer analysis dashboards.

3. Start-up and MVP description

3.1. Mission, Vision and Values

Hollia's mission is to bridge the gap between understanding customers in physical and digital environments by offering a complete analytics solution tailored for retail spaces. Hollia envisions becoming the leading provider of in-store retail analytics, transforming how businesses engage with their physical customers through the use of cutting-edge AI and data analytics technologies. Hollia's core values emphasize innovation, a customer-centric approach that prioritizes user-friendliness and full accompaniment, and a commitment to strong privacy policies and ethical standards.

3.2. Product description

Hollia's solution includes a network of connected cameras and its installation and an easy-to-use dashboard, enabling businesses to gain precise insights into foot traffic, paths evolution, demographics and consumer behavior and sentiment. In addition, Hollia plans to include a consulting chatbot, where customers can get personalized recommendations based on the data they collect.

3.3. Description of technologies

The project leverages advanced libraries and frameworks to achieve precise real-time object detection and tracking, crucial for Hollia's MVP. Using YOLOv8 for object detection and BYTETracker for multi-object tracking, the system identifies and monitors people in video streams, storing data for business analytics. The Supervision library simplifies frame extraction, annotation, and result conversion. The code structure of the MVP is designed around five critical issues: detecting people in specific areas, defining zones within the video frame and counting people within those zones, measuring the time spent by individuals in these zones, tracking the movement of people across different zones, and exporting the collected data in an accessible format for further analysis.

4. Results

4.1. External analysis

The external analysis of the project environment reveals several key factors influencing Hollia's market strategy. The PESTEL analysis highlights a supportive political environment, particularly in France, where government initiatives like La French Tech encourage AI innovation. Technological advancements in AI and machine learning are critical for maintaining a competitive edge. Legal factors, including stringent data privacy regulations like GDPR, play a significant role in shaping the operational framework.

Porter's Five Forces analysis indicates a fragmented and emerging market with moderate competitive rivalry. The threat of new entrants is heightened by low technological barriers, so winning the loyalty of early adopters is crucial. Hollia's success depends on key factors such as robust privacy and regulatory compliance, offering a complete and integrated solution, maintaining low implementation costs, being customer-oriented, providing a wide

range of features, and staying agile in response to market changes. Competitor analysis reveals that Holliia operates within a competitive landscape that includes companies specializing in in-store retail analytics using computer vision, security companies offering AI-powered surveillance cameras, and firms focusing on non-visual methods of customer analysis.

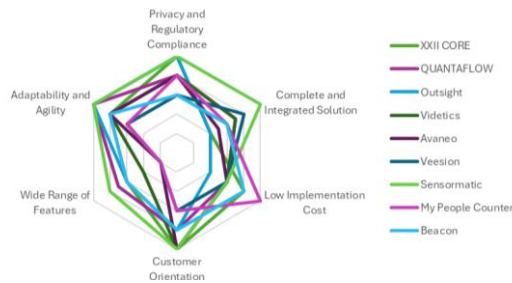


Figure 4: Competitor's main key success factors

4.2. Internal analysis

The internal analysis of Holliia’s operations reveals several strengths, including advanced technology, a comprehensive solution that integrates hardware and software seamlessly, and strict compliance with privacy regulations. However, the company also faces weaknesses such as high implementation costs and dependence on technology providers. Opportunities include the growing AI market and strong government support, while threats consist of economic downturns, competitive pressure, and data privacy concerns. The value chain analysis shows that Holliia’s operations are supported by strong technological development, efficient procurement and effective human resources management, based on high talent attraction and attractive culture and career development. The Resource-Based View (RBV) analysis identifies Holliia’s key resources, such as its network of connected cameras, proprietary software and algorithms, centralized analytics dashboards, and a data-driven chatbox, as valuable, rare, difficult to imitate, and non-substitutable, providing the company with a sustainable competitive advantage.

4.3. Code structure

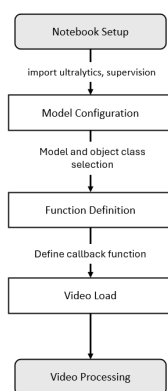


Figure 5: Code structure

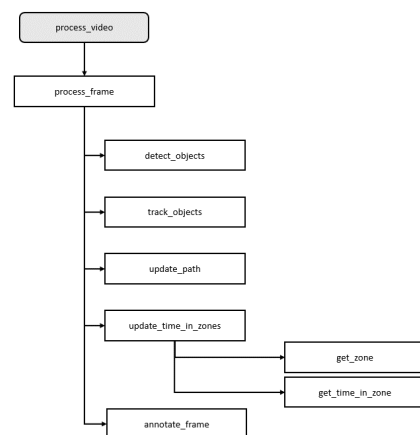


Figure 6: Video processing callback function structure

5. Conclusions

The Business Model Canvas (BMC) developed for Hollia outlines a clear strategy for creating value, managing customer relationships, and generating revenue. The economic analysis projects strong growth for Hollia, with the company expected to break even by the second year of operation. The focus on targeting large retail chains and event organizers is seen as a key driver of success, leveraging Hollia's advanced analytics capabilities to offer customized, scalable solutions that meet the needs of these clients. The project concludes that Hollia is well-positioned to capitalize on the growing demand for in-store analytics, provided it continues to innovate and maintain its competitive edge in a rapidly evolving market.

Index

1	<i>Introduction</i>	6
1.1	State of the art of customer Understanding Techniques	6
1.2	Motivation	7
1.3	Objectives	8
1.4	Alignment with SDGs	8
1.5	Work Methodology	10
1.5.1	<i>MVP Development Methodology</i>	10
1.5.2	<i>Business Model Design Methodology</i>	10
2	<i>Business Model</i>	13
2.1	Mission, Vision and Values.....	13
2.2	State of the Art	14
2.2.1	<i>Current situation of the Retail Analytics</i>	14
2.2.2	<i>Current situation of Retail</i>	17
2.2.3	<i>Current situation of the AI market</i>	20
2.3	Market Size and addressable market	22
2.3.1	<i>Top-Down approach: Market size given retail analytics studies and reports</i>	22
2.3.2	<i>Bottom up approach Market size given retailers spent</i>	23
2.4	External Analysis	24
2.4.1	<i>General Environment: PESTEL Analysis</i>	24
2.4.2	<i>Competitive Environment: Porter´s 5 forces</i>	29
2.4.3	<i>Key Success Factors Analysis</i>	35
2.4.4	<i>Strategic groups analysis</i>	39
2.4.5	<i>Detailed study of competitors</i>	40
2.4.6	<i>Competitive landscape summary</i>	63
2.5	Internal Analysis.....	65
2.5.1	<i>SWOT</i>	65
2.5.2	<i>Value Chain</i>	68
2.5.3	<i>Resource-Based View (RBV) Analysis</i>	71
2.6	Business Model Canvas.....	75
2.6.1	<i>Value Proposition</i>	76

2.6.2	<i>Partners</i>	76
2.6.3	<i>Activities</i>	77
2.6.4	<i>Ressources</i>	77
2.6.5	<i>Channels</i>	77
2.6.6	<i>Relationships</i>	78
2.6.7	<i>Customers</i>	78
2.6.8	<i>Costs</i>	79
2.6.9	<i>Revenues</i>	79
2.7	<i>Economic Analysis</i>	81
2.7.1	<i>Price strategy</i>	81
2.7.2	<i>Revenue Analysis: target clients</i>	82
2.7.3	<i>Economic Projection Example</i>	82
3	<i>MVP Development</i>	84
3.1	<i>Description of Technologies</i>	84
3.1.1	<i>Video Processing for Object Detection and Tracking</i>	84
3.1.2	<i>Choice of Libraries</i>	86
3.2	<i>MVP Development</i>	87
3.2.1	<i>People detection and tracking</i>	87
3.2.2	<i>Issue 2: Zone Segmentation</i>	94
3.2.3	<i>Issue 3: Count the time taken by a person in an area</i>	96
3.2.4	<i>Issue 4: Store the evolution of a person</i>	100
3.2.5	<i>Issue 5: Data Export</i>	103
1	<i>References</i>	107
Annex I	<i>110</i>	

Figure Index

Figure 1:.....	12
Figure 2: Retail analytics global market size.....	15
Figure 3: Europe´s Retail Analytics market size	15
Figure 4: Worldwide in-store and e-commerce sales and forecast.....	19
Figure 5: Private investment in AI by geographic area, 2013-2023 (AI Index, 2024).....	20
Figure 6: Companies ‘biggest concerns about computer vision (Lindahl).....	31
Figure 7: Hardware production price variation wrt last year in USA	33
Figure 8: Barriers for companies to develop their own computer vision models (Lindahl)	34
Figure 9: XXII CORE Dashboard demo	41
Figure 10: XXII Core KSF	43
Figure 11: Quantaflow's products.....	44
Figure 12: Quantaflow AI Profiling dashboard.....	44
Figure 13: Quantaflow AI counting phone Dashboard	45
Figure 14: Quantaflow KSF	46
Figure 15: Outsight´s offer	47
Figure 16: Outsight's dahsboard demo	48
Figure 17: Outsight KSF	50
Figure 18: Videtics dashboard demo	50
Figure 19: Videtics KSF.....	52
Figure 20: Avaneo's offer	53
Figure 21: Avaneo KSF.....	54
Figure 22: Veesion product offer.....	55
Figure 23: Veesion KSF	57
Figure 24: Sensormatic demo	58
Figure 25: Sensormatic KSF.....	60
Figure 26: MyPC KSF.....	61
Figure 27: Beacon KSF	63
Figure 28: competitors analysis chart.....	64

Figure 29: Value Chain for Software Product Delivery (Lee, 2015)	68
Figure 30: Hollia's BMC chart.....	80
Figure 31: Bounding box annotation (Subramanyam, s.f.)	85
Figure 32: IoU matrix	89
Figure 33: Results at frame 1 for custom issue 1	90
Figure 34: Results at frame 2 for custom issue 1	90
Figure 35: Results at frame 1 for issue 1	93
Figure 36: Results at frame 1 for issue 1	94
Figure 37: Issue 2 results frame 1.....	95
Figure 38: Issue 2 results frame 2.....	96
Figure 39: Rectangle's centroid.....	98
Figure 40: Issue 3 results frame 1.....	99
Figure 41: Issue 3 results frame 2.....	99
Figure 42: Issue 4 results frame 1.....	102
Figure 43: Issue 4 results frame 1.....	103
Figure 44: IoU explanation (Huynh, s.f.)	111
Figure 45: Dice coefficient explanation (Huynh, s.f.).....	112

Schemes Index

Scheme 1: Code for custom issue 1	88
Scheme 2: Code for issue 1	91
Scheme 3: Callback function in issue 1	92
Scheme 4: Issue 3 code scheme	97
Scheme 5: Code scheme for issue 4	101
Scheme 6: Variable time_in_zones structure	102

Tables Index

Table 1: Issue 4 results for zone management.....	104
Table 2: Issue 4 results for people evolution.....	105

1 INTRODUCTION

Companies face constant challenges in adapting to the changing expectations of consumers, who interact with them in both physical and digital environments. In the latter, adaptation is easy due to the inherent digital nature of online transactions, where each customer movement and interaction is automatically tracked. This allows websites to justify audience data to brands or agencies that advertise on them and e-commerce platforms to better understand their clients, enabling them to make changes and test quickly, offering a holistic and continuous understanding of customer behavior. However, understanding physical clients remains a challenge for many companies, and the advancements made in this area are much smaller despite the enormous potential for information to be collected and the room for improvement that still exists.

In an effort to bring physical clientele closer to businesses, Hollia was created. Its ambition is to help businesses understand their physical customers by providing an all-in-one analytics solution through a network of cameras, artificial intelligence, and an easy-to-use dashboard. In practical terms, Hollia seeks to automate and simplify the physical observation of the public by providing accurate indicators of foot traffic, demographics, and consumer behavior and well as consulting services through a custom LLM chatbot. This startup is still in the concept stage but already has support in France from the emlyon business school incubator and abroad by AI Entrepreneurs at Berkeley & Free Ventures Accelerator.

1.1 STATE OF THE ART OF CUSTOMER UNDERSTANDING TECHNIQUES

Currently, the common techniques for understanding physical customers in the retail and events sectors are rudimentary and manual. These include observational studies, surveys, traffic counting, and sales data analysis. With the advent of machine learning, and

video analytics in particular, traditional retailers can use video analytics to easily understand who their customers are and how they behave.

Many open-source algorithms (accessible to everyone) can recognize faces and determine key characteristics of individuals, such as gender and age, as well as tracking the paths that allow the analysis of navigation routes to detect walking patterns. All this represents a potential for information gathering that retailers can leverage to improve the user experience, optimizing the placement of items to maximize sales and enhance the customer experience, just as is done in e-commerce.

Some companies have already taken advantage of this technology to start developing solutions that provide consumer information in physical spaces. However, none of them are addressing this issue as Hollia intends to do. Existing companies either focus on other segments (but their products could be quickly adapted to ours) or do not offer the level of detail that Hollia does.

1.2 MOTIVATION

The motivation of this startup is based on the need to bring data analysis to real life. With this, Hollia aims to help retailers and organizers of fairs and events to understand their customers and thus improve their physical spaces, products, and services, and increase operational efficiency, thereby improving customer satisfaction and increasing sales. Hollia wants to fill an existing need in the market that has not yet been satisfied by any company to date. It wants to bring companies closer to their physical customers in 2 ways: by providing a quantitative analysis of what happens in their stores in real time and a consulting service through a chatbot using 3 layers of LLM. The motivation for this master's Thesis is to help in the development of this startup, both technically and in business aspects. On the strategic side, we intend to put a name and numbers to this idea through the realization of a solid 2-year business model. On the technological side, to help the development of the mvp on the customer detection and tracking side and to lay the foundations of what will be in the future the customer analysis dashboards.

1.3 OBJECTIVES

The aim of this project is to contribute to the development of Hollia, both in technological and strategic aspects. Hollia's mission is to help companies understand their physical customer base by providing an all-in-one analysis solution via a network of connected boxes, artificial intelligence and an easy-to-use dashboard. On the technical side, this study involves working on the conception of an MVP through the development, testing, and integration of new data export functionalities as well as the analysis of human behavior, using live videos captured by the prototype, employing techniques of AI and computer vision. Research and experiments are conducted to continuously improve system performance. On the strategic side, a 2-year strategic plan is devised, as well as evaluating the product through value-added measurement and designing the process for attracting initial customers.

1.4 ALIGNMENT WITH SDGs

Hollia's business model and technological solution align with several of the United Nations Sustainable Development Goals (SDGs), especially those related to Industry, Innovation, and Infrastructure (SDG 9), Sustainable Cities and Communities (SDG 11), and Responsible Consumption and Production (SDG 12)

- SDG 9: Industry, Innovation, and Infrastructure

Hollia contributes to this goal by driving innovation through the development of new technologies that enhance business efficiency and customer experience. By integrating AI and advanced analytics into physical retail environments, Hollia supports the infrastructure of the retail industry to become more adaptive and data driven.

- SDG 11: Sustainable Cities and Communities

Hollia's technology helps businesses optimize their physical spaces in ways that reduce waste and improve energy efficiency. For example, data collected on customer traffic and behavior can inform better store layouts, efficient lighting and heating usage, or optimized staffing schedules, all contributing to a more sustainable operation that aligns with building sustainable communities.

- SDG 12: Responsible Consumption and Production

By providing detailed analytics on consumer behavior, Hollia enables businesses to better understand demand patterns, which can lead to more efficient inventory management and reduced waste. For instance, knowing which products are popular or understanding shopping behaviors can help stores stock more accurately, minimizing surplus and reducing the environmental impact associated with overproduction and waste.

- Ethical Practices and Privacy

While not directly an SDG, maintaining ethical standards and protecting consumer privacy are essential to sustainable business practices. Hollia ensures compliance with data protection laws and ethical guidelines, fostering trust and promoting sustainable business practices.

- Cross-cutting Contributions

Hollia's approach also indirectly supports other SDGs by promoting more efficient resource use (energy, space) and could contribute to economic growth and employment by providing insights that help businesses thrive in competitive environments.

By aligning its operations with these global goals, Hollia not only contributes to a more sustainable future but also positions itself as a leader in ethical and sustainable technology deployment in the retail sector.

1.5 WORK METHODOLOGY

1.5.1 MVP DEVELOPMENT METHODOLOGY

The aim of this section of the work is to obtain code that can be presented as an MVP, scalable, easily maintainable, and easy to read, following the programming standards described in the "Coding Mindset" developed by the *Broad Institute of MIT and Harvard* (Diana Chien, s.f.). New functionalities will be implemented on this code as the startup grows and customer requirements change. Following this philosophy, the code is developed iteratively, adding functionalities one by one and building on previous versions.

Before development begins, the final characteristics of the product should have been defined, helping to shape the way the code was going to be built. Four steps (issues) are defined, allowing for intermediate deliverables and validated versions of the code to continue being built. Keeping the final Figure of the code in mind enables the creation of modular, generic and scalable code. Although the initial intent is to build with the next issue in mind, both the structure of the variables and the definition of auxiliary functions have changed from one issue to another. This section explains the main characteristics of each version or issue that led to the final version of the product and justifies the choices made along the way.

- Issue 1: Detect a person in an area. The goal of this issue is to locate existing people in real time, highlight them in the video and count them.
- Issue 2: Define a zone within the Figure and count the people in it.
- Issue 3: Count the time taken by a person in an area. The goal is to define several zones and count the people within them and the time they spend there.
- Issue 4: Store the evolution of a person. The goal is to save the path of a person, see which zones they have been in, and how much time they have spent in a well-structured database.
- Issue 5: Data export. The goal is to manage to export information in an excel spreadsheet in an easy way.

1.5.2 BUSINESS MODEL DESIGN METHODOLOGY

1.5.2.1 Retail Analytics vs In-store Analytics

Retail analytics is the process of providing analytical data on inventory levels, supply chain movement, consumer demand, sales, and other key performance indicators (KPIs), which are essential for making informed marketing and procurement decisions. Retail analytics employs data from a range of sources, including online sales, mobile sales, and in-store sales. It utilizes this data to gain insight into customer behaviors patterns and trends, optimize product and store layouts, forecast trends, and enhance overall retail performance.

In-store analytics is focused on the analysis of customer behavior, sales, and operational effectiveness within the physical store environment. This encompasses monitoring customer movements within the store, evaluating the efficacy of product placements and promotional displays, gauging customer interactions with products, and assessing the overall in-store experience. Technologies such as sensors, cameras, and Wi-Fi tracking are frequently employed to gather data.

Hollia forms part of the in-store analytics offering, but as a new discipline, there is currently less data available, which makes it challenging to estimate market sizes and shares. In estimating market sizes and shares, this work compares retail data from analytics, rather than from in-store analytics. The primary reason for this is Hollia Analytics' ability to operate outside the physical environment. This solution enables the integration of the virtual environment through omnichannel strategies or the analysis of the impact of advertising in physical media. Hollia's influence extends beyond the physical, making the limitation of in-store analytics alone an understatement.

1.5.2.2 France, EU and North America

Since the common point of the founders is France, the external analysis carried out in this study focuses on this country at first, then it is extended to Europe and, in some cases and if

appropriate, information from North America is added, since this would be the third horizon to be explored.

1.5.2.3 Business plan design procedure

As learnt in the subject of “Creation, organisation and management of companies”, the strategic plan of the company will be designed following a methodology of analysis, formulation and implementation, although the implementation part will not be carried out. First, the objectives as well as the mission, vision and values will be established. Afterwards, an internal analysis will be carried out in parallel. Finally, a strategic plan will be drawn up. This will include a financing plan.

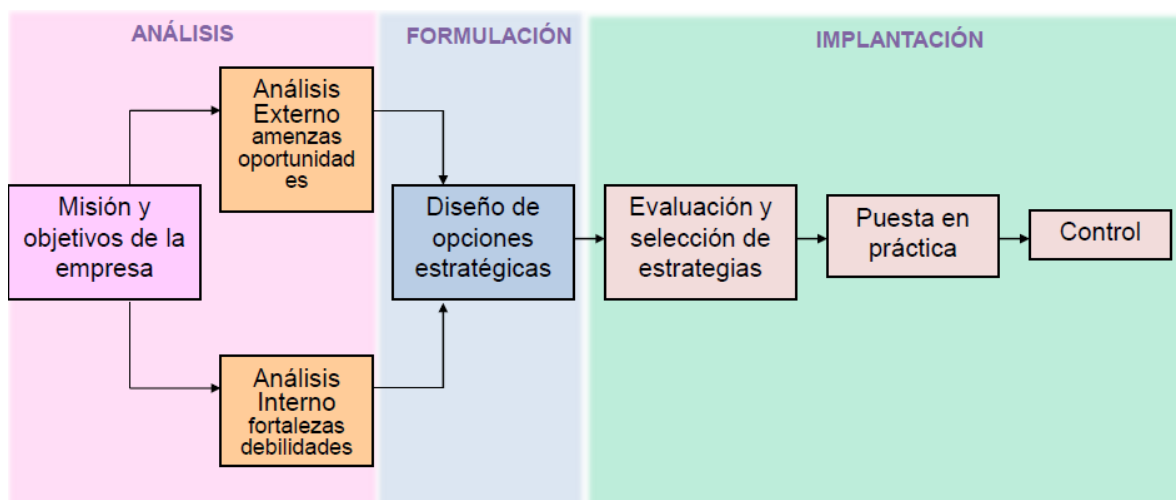


Figure 7: Business plan design procedure (Universidad Pontificia Comillas, 2024)

2 BUSINESS MODEL

2.1 MISSION, VISION AND VALUES

Retail organizations undergoing digital transformation primarily emphasize the monetization of their audience and customer insights. This market presents significant growth potential, particularly considering advertisers' increasing demand for more effective advertising strategies. However, there is currently a lack of automated tools capable of accurately tracking visitors and customers. Publicly accessible venues often face challenges in data collection, and those seeking to leverage the limited data available must possess advanced data analysis skills. In the contemporary digital era, visitor analysis has become a critical necessity rather than a mere option. Our goal is to empower physical venues to bridge the technological gap that has emerged over the past decade.

Hollia aims to bridge the gap between physical and digital customer understanding by providing businesses with a comprehensive analytics solution. From traffic patterns to waiting times, Hollias knows that every aspect of a retailer's business provides valuable information that can be used to make strategic decisions. The solution Hollia includes:

- a network of connected cameras
- an easy-to-use dashboard, enabling businesses to gain precise insights into foot traffic, demographics, and consumer behavior
- a consulting chatbot, where customers can get personalized recommendations based on the data they collect.

This way, Hollia intends to become the leading provider of in-store retail analytics, transforming the way businesses interact with their physical customers by leveraging cutting-edge AI and data analytics technologies. Hollia takes care of all the steps that separate the store and the customer, from the installation of the cameras to the decision-making process by providing both metrics dashboards to consultant's chatbot.

2.2 STATE OF THE ART

2.2.1 CURRENT SITUATION OF THE RETAIL ANALYTICS

Retail analytics is the strategic use of data gathered from various retail environments to optimize marketing efforts, manage inventory and enhance the shopping experience. This sector employs sophisticated technologies, including artificial intelligence, machine learning, and big data analytics, to process and analyze customer data. These technologies facilitate the understanding of shopper behaviors, preferences and trends in real time, thereby enabling retailers to make informed decisions.

Previously, retail analytics were conducted using basic methods such as direct customer feedback and sales performance tracking. However, the digital transformation has resulted in a shift towards more dynamic and precise analytics techniques. The current state of the retail analytics market is characterized by rapid advancements and innovation, driven by competition with e-commerce entities that offer personalized shopping experiences based on detailed consumer insights.

The advent of the pandemic further accelerated this transition, as retailers were compelled to adapt swiftly to evolving consumer behaviors and disrupted supply chains. Retail analytics have become a crucial tool in adapting to these new conditions, assisting stores in managing everything from foot traffic to real-time inventory optimization. For instance, numerous retailers have altered their layouts to facilitate efficient shopping and minimize contact, utilizing data analytics to determine optimal product placements.

While the advantages are evident, challenges such as data privacy, the cost of technology implementation, and the intricacy of data systems persist. However, ongoing technological advancements are progressively mitigating these barriers, enhancing the accessibility and efficacy of retail analytics.

As the retail landscape continues to evolve, the demand for comprehensive retail analytics solutions is expected to grow. Retailers are increasingly recognizing the value of real-time data in making informed decisions about store layout, inventory management, and

marketing strategies. It is anticipated that the total market share will reach USD 6.33 billion by 2024, with North America exhibiting the most rapid growth and Europe currently representing the largest market (Mordor Intelligence, 2024). The retail analytics market in Europe is also projected to grow significantly, with an expected compound annual growth rate (CAGR) of 20.76% from now until 2029. This growth is driven by increased investments in AI-based tools for supply chain management and customer behavior analysis, as well as the widespread adoption of data-driven retail strategies. Most of this growth is likely to be captured by France, whose retail sector is one the biggest and where tech start-ups are the most incentivized. The most important players that fall make up this market in this category are big non-specialized companies like Oracle, Salesforce and IBM.



Figure 8: Retail analytics global market size



Figure 9: Europe's Retail Analytics market size

2.2.1.1 Focus on the in-store analytics market

In-store analytics represents a distinct and specialized subset of retail analytics, focusing on the behavior and interactions of customers within a physical retail environment. While the term "retail analytics" encompasses the collection and analysis of data from a multitude of retail channels, including both online and offline sources, the term "in-store

analytics" is more narrowly focused on the brick-and-mortar aspect. In-store analytics provides insights into how customers navigate through stores, interact with products, and make purchasing decisions. This transition from a broader retail analytics perspective to the specific applications of in-store analytics provides the foundation for understanding the current market dynamics and growth potential in this emerging field.

The market for in-store analytics is undergoing rapid expansion, with the global market size projected to reach approximately USD 4.26 billion in 2024 and USD 12.60 billion by 2029, representing a compound annual growth rate (CAGR) of approximately 24.23% (Mordor Intelligence, 2024). In North America, the market is particularly robust due to the high uptake of sophisticated analytics technologies and cloud computing, which has enabled retailers to optimize their operations and enhance customer experiences. Additionally, Europe, particularly countries such as France and Germany, is witnessing considerable expansion, due to the mounting necessity for superior customer service and the intensifying competition from e-commerce.

In terms of trends, there is a growing emphasis on cloud-based analytics solutions, which offer the advantages of scalability and real-time data processing. Furthermore, the incorporation of artificial intelligence (AI) and augmented reality (AR) into in-store analytics is becoming increasingly prevalent, equipping retailers with sophisticated tools to analyze customer behavior and enhance engagement. The necessity for superior customer service and optimized shopping experiences continues to be a pivotal driver for market expansion across these regions.

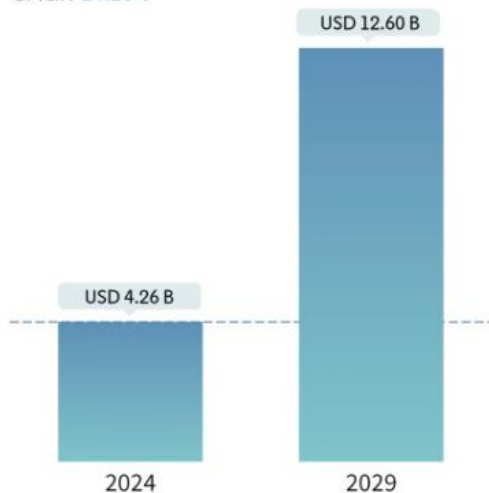
Notable players in the market include Capgemini SE, RetailNext Inc., Happiest Minds Technologies, Capillary Technologies, and Thinkinside SRL. These companies are focusing on innovations and partnerships to expand their market presence and offer more comprehensive solutions.

Projections indicate that by 2031, the global market could reach up to USD 16.4 billion, with significant contributions from both North America and Europe.

In-store Analytics Market

Market Size in USD Billion

CAGR 24.23%



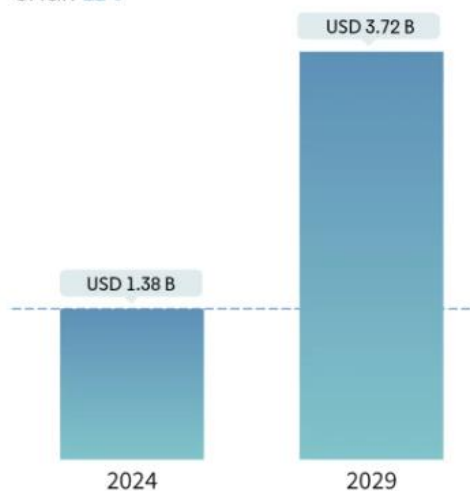
Source : Mordor Intelligence



NA In-Store Analytics Market

Market Size in USD Billion

CAGR 22%



Source : Mordor Intelligence



Figure 10: In store analytics global market size

Figure 11: In store analytics north American market size

2.2.2 CURRENT SITUATION OF RETAIL

2.2.2.1 In-Store Retail

The in-store retail market continues to thrive, with significant contributions from regions like North America and Europe. In 2024, the global retail market is estimated at around USD 31.31 trillion, with North America and Europe being key players. The retail market in Europe, valued at EUR 4.07 trillion in 2023, is projected to grow at a CAGR of over 3% from 2023 to 2028. France, in particular, represents a substantial portion of the European market, with its retail sector continuing to expand due to increased consumer spending and economic stability.

The pandemic forced approximately 190,000 stores to close just within the first week of April, affecting around half of U.S. retail surface. (Retail After COVID-19, s.f.) This led to a dramatic shift towards online shopping, with U.S. online sales jumping 49% compared to the previous year (Logic, s.f.). As the pandemic receded, there was a resurgence in in-

store shopping. In May 2022, in-store sales surged by 13.4%, outpacing the 2.2% growth in online retail sales compared to the previous year. A clear example of that is Macy's, whose CEO (Jeffrey Gennette) stated in a call with analysts in May 2022: "We saw a notable shift in consumer shopping behavior between channels, with better-than-expected sales in stores and lower-than-expected digital sales" (Gennette, s.f.).

In the post-pandemic era, while e-commerce continues to grow, there has been a notable rebound in in-store shopping as consumers return to physical stores. This resurgence is driven by a renewed appreciation for the tactile and social aspects of shopping that online experiences cannot replicate. Retailers are now focusing on enhancing the in-store experience by leveraging data analytics, personalized marketing, and immersive technologies like augmented reality (AR) to attract and retain customers.

Trends show that omnichannel retailing is significantly impacting the market. Retailers are increasingly integrating online and offline experiences to cater to consumer preferences for seamless shopping experiences. This trend is particularly strong in North America and Europe, where retailers are investing heavily in technology to enhance in-store experiences through digital tools like mobile apps, AI-driven recommendations, and personalized services.

2.2.2.2 E-commerce

E-commerce continues to gain ground over in-store shopping, driven by the convenience of shopping from anywhere and the extensive use of data and cookies to personalize the shopping experience. Although e-commerce can be believed to be the fastest growing channel since pandemics, truth is that, despite seeing a high spike on activity in 2020, new normality brought costumers back to the stores, The World Economic Forum reported that e-commerce was expected to grow by nearly 20% in 2020. E-commerce platforms use cookies to track user behavior, preferences, and purchase history, allowing them to offer personalized recommendations and targeted advertisements. This level of personalization is difficult for traditional brick-and-mortar stores to match.



Figure 12: Worldwide retail and e-commerce sales and forecast

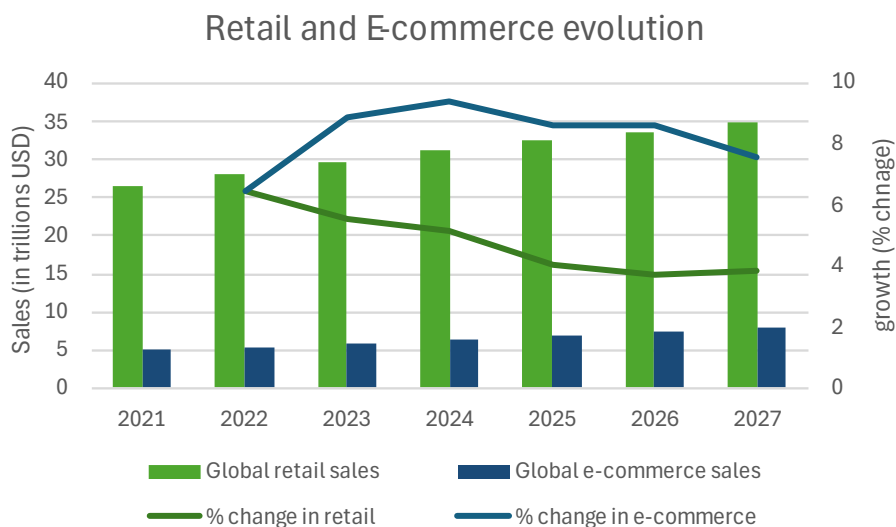


Figure 13: Retail and E-commerce evolution

2.2.3 CURRENT SITUATION OF THE AI MARKET

The Artificial Intelligence (AI) market remains a vibrant and dynamic sector, experiencing significant growth and diversification. In 2024, the European AI private investments size reached 11 B\$ highlighting Europe’s willingness to keep up with USA and China trends.

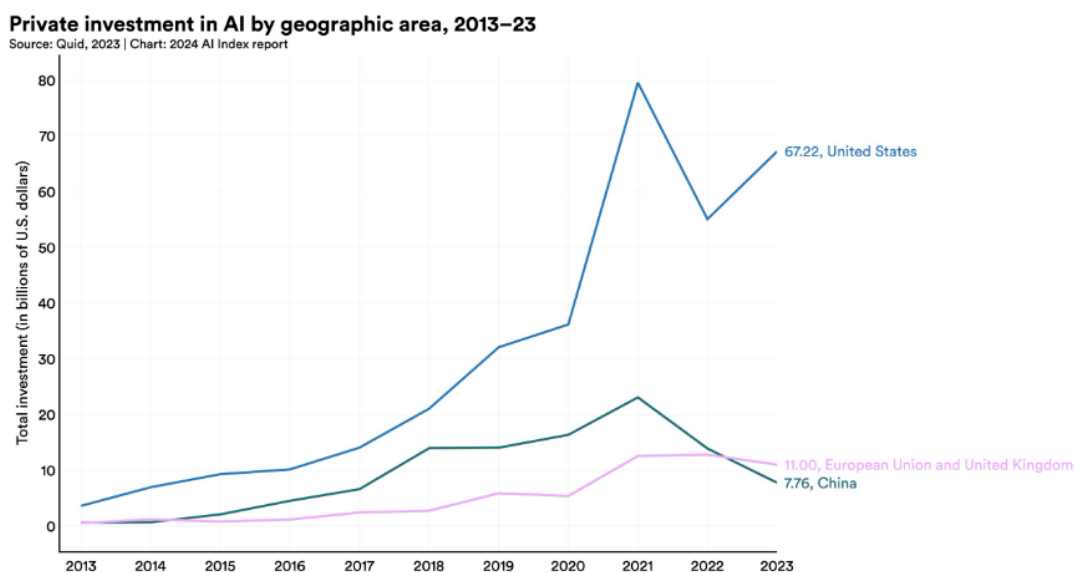


Figure 14: Private investment in AI by geographic area, 2013-2023 (AI Index, 2024)

2.2.3.1 General Investments in AI in 2024

Artificial Intelligence (AI) continues to be a critical area of interest for both investors and businesses worldwide. Investors are increasingly targeting AI companies and startups, recognizing the sector's potential for high returns and transformative impact.

- Investments by Investors in AI Startups and Companies: 2023 saw AI startups globally attract over \$65 billion in funding, signaling robust investor confidence despite a slight decrease from the 2021 peak. (AI Index, 2024)
- Corporate Investments in AI: Companies are increasingly integrating AI technologies to enhance operational efficiencies and customer engagements. Investments are particularly noticeable in sectors like healthcare, automotive, and finance, where AI drives innovations from diagnostics to customer service solutions.
- Current Market Size and Speculations about a Bubble: The AI market reached approximately \$184 billion in 2024 (AI Index, 2024). While this rapid growth has led some to speculate about a bubble, the sustained rate of innovation and application across various sectors suggests a solid foundation rather than a speculative bubble

2.2.3.2 Computer Vision Market

The computer vision market, a crucial segment of AI, is experiencing rapid growth. The computer vision market size was estimated to be around \$17.25 billion in 2024 (Mordor Intelligence). There are some variations in the exact 2024 market size figures across different sources, but most peg it in the range of \$17-26 billion. The market is projected to grow at a CAGR of around 17-18% during 2024-2029. (Mordor Intelligence)

Key drivers in these investments include increasing adoption across industries like automotive, retail, healthcare for quality inspection, automation.

2.3 MARKET SIZE AND ADDRESSABLE MARKET

Two different approaches are used to determine market size:

- Top-Down Approach: Use industry reports to estimate the total market size and then apply filters like geography and economic conditions to narrow down to the addressable market.
- Bottom-Up Approach: Estimate potential customer base and average spending on similar solutions to calculate the potential market size.

2.3.1 TOP-DOWN APPROACH: MARKET SIZE GIVEN RETAIL ANALYTICS STUDIES AND REPORTS

Given the nascent state of the market, there is a paucity of extant literature. Furthermore, the existing reports lack specificity regarding the underlying hypotheses or, in some cases, appear to be in contradiction with one another. In light of these limitations, our objective is to estimate the size of the market on a global, European, and French basis. A report by Mordor Intelligence indicates that the global market size in 2024 is projected to reach 6.33 billion USD (Mordor Intelligence, 2024), exhibiting a compound annual growth rate (CAGR) of 4.23% until 2029. Subsequently, a TechSiResearch report indicates that the European market is valued at 1.6 billion USD in 2024 and is projected to reach 4.19 billion USD at a 20.76% compound annual growth rate (CAGR), thereby becoming the dominant market globally, surpassing North America (TechSiResearch, 2024). It is possible to estimate the French contribution to these figures by considering a number of factors, including the country's economic proportion in Europe, its retail market size, digital and technology adoption, and the presence of major retailers and retail technology companies. In 2022, France's GDP was approximately 16.72% of the EU's total economic output (World Economic Forum, 2023). Given this significant proportion, using around 15% as an estimate for France's contribution to the European retail analytics market is reasonably justified, reflecting its economic stature within the EU. Thus, the market size numbers are given in the following table.

<i>in Billion USD</i>	2024	2029	CAGR
Global	6,330	7,790	4,2%
Europe	1,633	4,194	20,8%
France	0,327	0,839	

Table 1: Retail Analytics market size

It can be concluded that the actual market size in France can be valued around 327 million USD. This market is large, specially when it comes to comparing it with the numbers and sizes of competitors in it.

2.3.2 BOTTOM UP APPROACH MARKET SIZE GIVEN RETAILERS SPENT

In 2023, total retail sales in France were projected at €521 billion, while the total retail sales for Europe's five major economies (France, Germany, Italy, Spain and the UK) combined were expected to reach €2.3 trillion. These figures reflect a considerable level of economic activity within the French and broader European retail markets.

According to a Gartner survey of marketing managers, listed companies spend around 11% of their total sales on marketing (Oneupweb, s.f.). Furthermore, it is recommended that 5-6% of total sales revenue should be allocated to market research, analytic tools and services, e-commerce technology or similar spending. If, at most, 20% of this portion was dedicated to retail analytics, and 50% of that to in-store retail analytics, that would lead to a market size upper bound of 2,6 million USD in France and 6.7 billion USD in Europe:

$$521 \text{ B\$} \cdot 5\% \cdot 20\% \cdot 50\% = 2.6 \text{ B\$}$$

$$2,300 \cdot 5\% \cdot 20\% \cdot 50\% = 6.7 \text{ B\$}$$

In France, the 10 largest retailers account for 47% of revenues, while the top 20 account for 63%. This means that, for instance, if we were to obtain a contract for any of the top 10 and, given the initial assumptions, allocate 5% to this type of activity and 20% specifically to retail analytics and half of that to in-store, we would obtain at least 78.5 million euros.

$$3.927 \text{ B\$} \cdot 5\% \cdot 20\% \cdot 50\% = 78.5 \text{ M\$}$$

This is proof of how big and profitable this market can be.

Rank	Retailer	Turnover (Billion USD)
1	E.Leclerc	57,12
2	Carrefour	44,863
3	Les Mousquetaires	43,4945
4	Système U	28,441
5	Auchan	20,587
6	Casino	17,85
7	Lidl	17,85
8	Cora	6,1285
9	Metro	4,641
10	Aldi	3,927
11	Decathlon	16,898
12	FNAC Darty	9,282
13	Bricomarché (Les Mousquetaires)	8,687
14	Systeme U	8,687
15	Leroy Merlin	8,568
16	Boulangier	8,092
17	Conforama	7,259
18	Intermarché	6,902
19	Sephora	5,831
20	Norauto	4,403
Total		329,5

2.4 EXTERNAL ANALYSIS

2.4.1 GENERAL ENVIRONMENT: PESTEL ANALYSIS

The PESTEL analysis is a strategic framework used to identify and evaluate the external macro-environmental factors that can impact Hollia's business operations and strategic planning. By examining Political, Economic, Social, Technological, Environmental, and Legal factors, this analysis provides a comprehensive understanding of the external landscape in which Hollia operates. This section will explore how these external factors influence Hollia's market dynamics, regulatory compliance, technological innovation, and overall business strategy, thereby guiding informed decision-making and ensuring long-term sustainability in the competitive in-store analytics market.

2.4.1.1 Political

- **Government Support for AI:** Many governments are increasingly investing in AI and technology development. Policies that support innovation could benefit Hollia through grants, subsidies, and a favorable business environment.
- **French tech environment:** In France, initiatives like La French Tech and events like Vivatech play crucial roles in promoting AI innovation. La French Tech provides a supportive ecosystem for startups, offering resources, networking opportunities, and financial support. Vivatech, one of Europe's largest technology conferences, highlights the latest innovations and connects startups with investors, partners, and policymakers, fostering a collaborative environment for technological advancement.

2.4.1.2 Economic

- **Economic Downturns:** Economic instability can affect retailers' budgets for investing in new technologies. Hollia might face challenges in convincing potential clients to adopt their solutions during economic downturns.
- **Investment in Technology:** The rising trend of investment in digital transformation and AI technologies can positively impact Hollia. Businesses are looking to optimize operations and enhance customer experiences, which aligns with Hollia's offerings.

2.4.1.3 Social

- **Changing Consumer Behavior:** Post-pandemic, consumers are returning to physical stores but with higher expectations for personalized and efficient shopping experiences. They expect retailers to offer a completely personalized shopping experience and create a whole ecosystem around them. They demand more and more services in their shopping process. Their growing online shopping habits and the fluidity of channel switching makes them demand more and more channel integration (in-store and e-commerce) through omnichannel shopping experiences.
- **Privacy Concerns:** Increasing awareness and concern about privacy among consumers might make them wary of in-store surveillance and data collection. Transparent communication and stringent privacy measures will be crucial.

2.4.1.4 Technological

- **Advancements in AI and Machine Learning:** Rapid technological advancements in AI, machine learning, and data analytics provide Hollia with opportunities to enhance their product capabilities and stay ahead of competitors. [investments in AI and computer vision]
- **Integration with Existing Systems:** The ability to integrate Hollia's solutions with retailers' existing infrastructure and software systems will be critical for adoption and success.

2.4.1.5 Environmental

- **Sustainability Initiatives:** Retailers are increasingly focusing on sustainability. Hollia can contribute by providing insights that help reduce energy consumption in stores, optimize supply chains, and minimize waste.
- **Eco-friendly Technology:** There is a growing demand for technologies that have a minimal environmental impact. Hollia's hardware has to consider the environmental footprint of its hardware and software solutions by maybe using recycled material. In addition to that, the impact of LLM is the consumption of energy sources is still not quantified but has surely negative impact.

2.4.1.6 Legal

- Data Privacy Regulations: Laws such as the General Data Protection Regulation (GDPR) in Europe and the California Consumer Privacy Act (CCPA) in the USA impose strict guidelines on data collection and storage. Companies and organizations are advised to integrate technical and organizational safeguards into their data processing operations from the beginning. This approach, known as 'data protection by design,' ensures that privacy and data protection are fundamental elements from the start. Additionally, by default, companies should process personal data with maximum privacy considerations, such as limiting the data processed, reducing storage time, and restricting access. This principle, 'data protection by default,' ensures that personal data is not available to an unlimited number of people. (European Commission, s.f.)
- Intellectual Property Rights:
 - o Worldwide:
 - Patent Cooperation Treaty (PCT): Provides a unified procedure for filing patent applications to protect inventions in multiple countries, facilitating global patent protection for Hollia's technological innovations.
 - Berne Convention for the Protection of Literary and Artistic Works: Ensures that works of authorship, including software code, are protected automatically upon creation in all member countries.
 - o European:
 - European Patent Convention (EPC): Provides a legal framework for granting European patents, allowing protection in up to 38 European countries through a single application.
 - European Union Trademark (EUTM): Allows companies to register their trademarks across all EU member states with a single application, protecting Hollia's brand and logo.

- Directive (EU) 2016/943 on the Protection of Trade Secrets: Harmonizes the protection of trade secrets across the EU, providing legal remedies against unlawful acquisition, use, or disclosure.
- EU Software Directive (Directive 2009/24/EC): Provides copyright protection for computer programs, ensuring Hollia's software code is protected as literary works.
- French:
 - French Intellectual Property Code (Code de la propriété intellectuelle): Governs IP rights in France, including patents, trademarks, and copyrights, providing comprehensive protection for Hollia's innovations and branding.
 - Loi Informatique et Libertés: Regulates data protection and privacy, ensuring compliance with GDPR and the protection of data processed by Hollia's network of cameras.

By adhering to these legislations, Hollia can safeguard its technological innovations, software code, and network of cameras, maintaining a competitive edge and ensuring compliance with international, European, and French IP laws.

- Data Protection Regulation: The data processing conducted by Hollia is fully compliant with the General Data Protection Regulation (GDPR) and the French Data Protection Act ("Informatique et Libertés"), as it aims to obtain statistical results through the aggregation and anonymization of data. Hollia has adopted a "privacy by design" (Intersoft consulting, s.f.) approach throughout the design and development phases to meet the requirements of the Commission nationale de l'informatique et des libertés (CNIL). Specifically, source images are processed and deleted within one second, while the resulting analyses are aggregated and anonymized into statistical data within 2.5 seconds. This ensures that it is impossible to identify or authenticate any individual. The sole purpose of the data processing is to calculate, display, and share statistics with clients. Subsequent decisions are based on anonymized data, not directly on the personal data of filmed individuals. In accordance with current regulations, Hollia has conducted a Data Protection Impact

Assessment (DPIA), which has been validated by the CNIL. This ensures compliance with GDPR and the French Data Protection Act.

2.4.2 COMPETITIVE ENVIRONMENT: PORTER'S 5 FORCES

2.4.2.1 *Competitive Rivalry:*

- Number of competitors and degree of concentration:
 - There are some players in the market, such as companies focused on optimizing operation that include some computer vision solutions for stores or surveillance companies are beginning to include retail analytics functionalities to offer a wider range of products. The latter can be the most harmful ones as they have a long and strong presence in the market and have already gained the client's trust.
 - It is important to point out that most of the companies that claim to have retail analytics solutions based on live camera analysis are still in the development stage of their products. This highlights the idea that being fast in this market is important, as clients have already expressed their needs, and some competitors have already taken them into consideration.
- Market growth rate
 - The in-store analytics industry is experiencing rapid growth, driven by increasing demand for real-time data and advanced analytics. According to Allied Market Research, the global in-store analytics market was valued at \$2.1 billion in 2019 and is projected to reach \$5.3 billion by 2027, growing at a compound annual growth rate (CAGR) of 15.2% (Octopart). This growth is fueled by the need for retailers to enhance customer experiences and operational efficiency through data-driven insights. The pandemic has accelerated the adoption of these technologies as businesses seek to understand shifting consumer behaviors and preferences.
- Level of differentiation

- The degree of differentiation in the in-store analytics market is high, as companies strive to distinguish themselves through unique technological capabilities and specialized solutions.
- For example, Capillary Technologies integrates omnichannel data to provide real-time dashboards and personalized customer experiences (CapillaryTech)
- Videtics and Quantaflow differentiate themselves with their advanced use of IP cameras and 3D imaging technologies, respectively (Videonetics) (softwebsolutions).

2.4.2.2 Threat of New Entrants:

The threat of new entrants in the in-store analytics sector is high for many reasons:

- Low Technological Barriers: With the rapid advancement and widespread availability of AI and machine learning technologies, the barriers to developing in-store analytics solutions have significantly decreased. Many tools and frameworks are open source, reducing the initial cost and expertise needed to enter the market.
- Growing Market Demand: The increasing demand for data-driven insights in retail and other physical environments makes this sector highly attractive. New companies see significant opportunities for growth and revenue in providing advanced analytics solutions to meet this demand.
- Availability of Venture Capital: The tech startup ecosystem is robust, with many venture capital firms willing to invest in promising AI and data analytics startups. This financial support lowers the barriers to entry for new companies looking to develop and scale their in-store analytics solutions. For instance, only in France tech startups raised a total of €8.4 billion across 410 deals (Djurickovic, 2024).
- Modular Components and Outsourcing: New entrants can leverage modular hardware components and outsourcing for software development. They can source cameras, sensors, and even AI capabilities from third-party providers, which reduces the need for in-house development and lowers initial setup costs.
- Data security concerns: According to Panasonic Research, Data security is the biggest concern that keeps most companies from deploying their own computer

vision tools (Lindahl), as the following chart shows. It can be hard to navigate through ethical questions and data privacy legislation. In addition, their constant changes make this environment very volatile. Having strong values and a robust comprehension of the law is important to be successful in this business.

- Brand presence and client relationship: There is a high barrier for new entrants when it comes to establishing a strong brand presence and building trust with retailers are crucial, which can be challenging for new entrants. It is therefore important to enter the market rapidly and start building strong relationships.

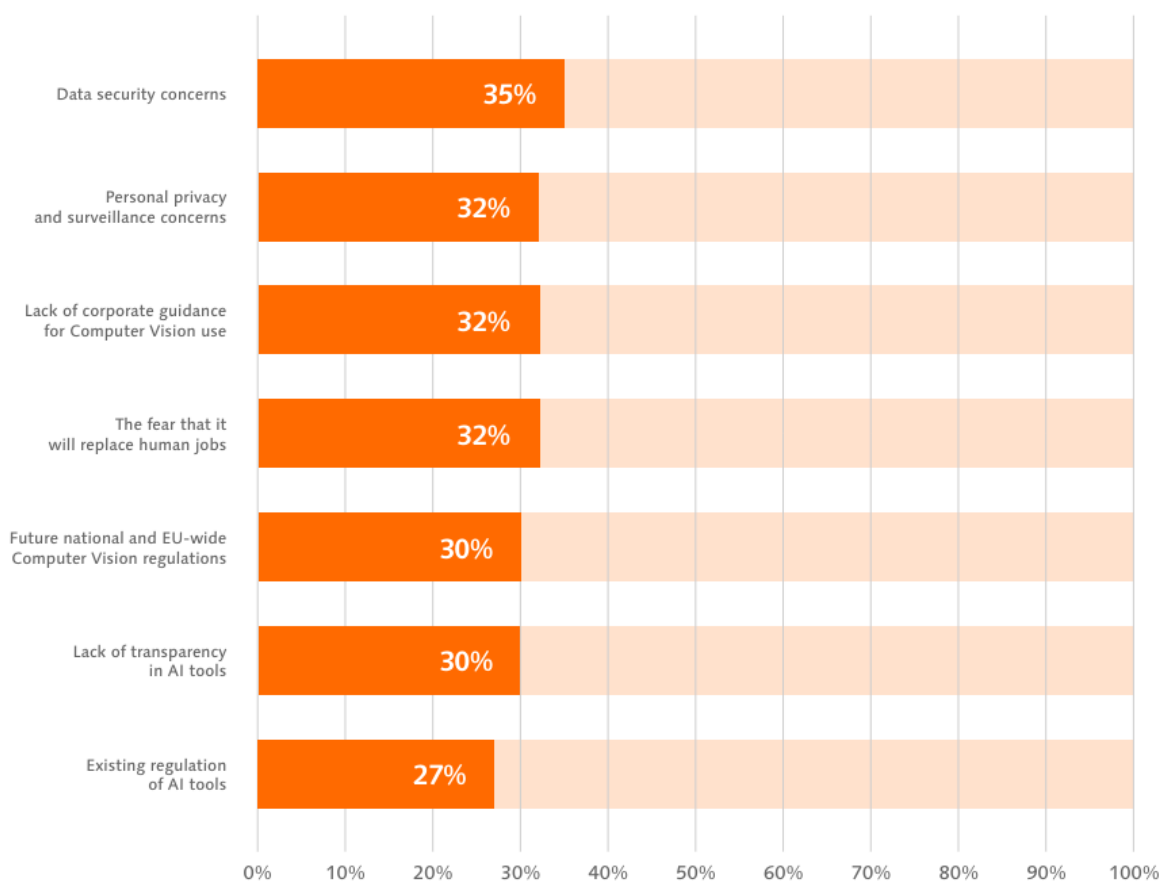


Figure 15: Companies 'biggest concerns about computer vision (Lindahl)

2.4.2.3 Bargaining Power of Suppliers:

Suppliers can be split into 2 categories: software and hardware suppliers. Although both bargaining power is considered to be low, the past few years have proven this market to be very volatile, especially because of demand and geopolitical tensions:

- Availability of Multiple Suppliers: Companies in the in-store analytics market can source hardware components such as cameras and sensors from a variety of global suppliers, reducing dependency on any single supplier. This diversification diminishes the bargaining power of individual suppliers.
- Financial Suppliers: Hollia now has a base of financial backers to help it financially and ‘prestige’ suppliers that will help its credibility and importance in the sector. If they stop providing support before Hollia has made a name for itself and has other sources of funding, they will jeopardise its stability, so its power is high.
- Availability of AI Libraries and Pre-trained Models: The widespread availability of AI libraries and pre-trained models from sources like TensorFlow, PyTorch, and OpenAI reduces dependency on specific AI suppliers. These open-source resources allow companies like Hollia to leverage cutting-edge AI technologies without needing proprietary solutions, thereby reducing the bargaining power of suppliers in the AI domain. The extensive community support and continuous updates for these libraries and documentation further enhance their value and accessibility.
- Global Supply Chain Dynamics: Recent years have seen significant disruptions in global supply chains due to events such as the US-China trade war, the COVID-19 pandemic, and geopolitical tensions. These disruptions have led to increased prices and reduced availability of electronic components, including those used in in-store analytics systems. For instance, semiconductor prices saw a notable increase due to supply chain challenges, and this trend is expected to continue into 2024.
- Component Availability: While there has been a general improvement in the availability of electronic components, certain categories, such as passive components and power products, have experienced ongoing shortages. This imbalance between supply and demand gives suppliers in these specific categories more leverage over buyers (Octopart). Additionally, the complexity of integrating advanced AI and IoT

technologies requires high-quality components, which can be scarce and thus increase supplier power.



Figure 16: Hardware production price variation wrt last year in USA

(Federal Reserve Bank of Saint Louis, s.f.)

2.4.2.4 Bargaining Power of Buyers:

The bargaining power of buyers in the in-store analytics market is medium to high:

- Number of available options in the market: On the one hand, there is a rising number of players in this market, so retailers and event organizers have increasingly more options for analytics solutions, making them more price-sensitive and demanding. They seek comprehensive, customizable solutions that can be seamlessly integrated with their existing systems. It is therefore important to continuously innovate and offer superior value propositions, such as enhanced data accuracy and actionable insights, to retain and attract clients.
- Cost and Scarcity of tech talent: A recent Panasonic connect European research on sheds lights on what is keeping companies to develop their own computer vision solutions: cost and scarcity of tech talent. “These two common issues are interconnected; there is always a lag between the introduction of new technology and the development of a sufficient

number of people with the necessary engineering skills to use and maintain it. Employees in both customer organizations and third-party support providers who have experience with computer vision technology quickly become highly sought after, leading to increased salaries. This makes it challenging to retain talent and results in a shortage of internal expertise and external support.” Only big retail players can develop their own solution and even for them it is sometimes difficult to train and retain tech talent, which is increasingly in demand. According to a recent study carried out by an HLB survey, 45% of big retailers believe that lacking digital transformation skills could be the largest barrier to adopting AI (HLB Survey, s.f.). As a result, companies are increasingly looking to outsource these services or buy existing small start-ups as opposed to developing their own solutions themselves.

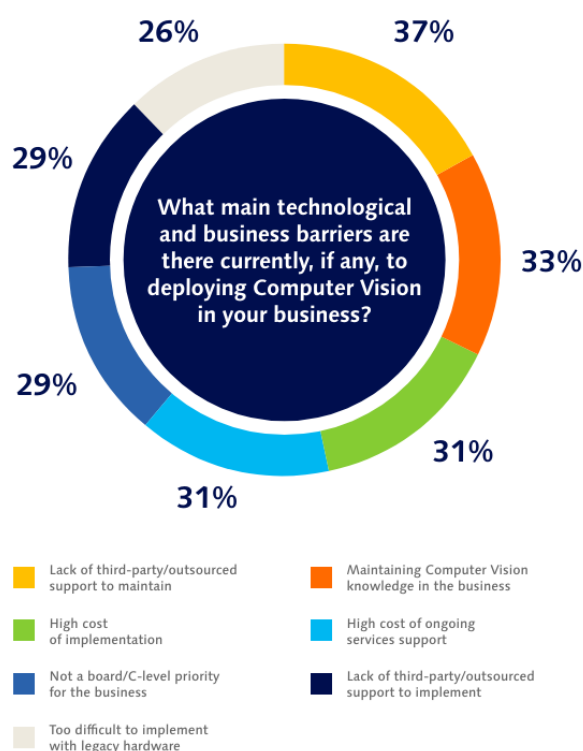


Figure 17: Barriers for companies to develop their own computer vision models (Lindahl)

2.4.2.5 Threat of Substitutes

As this is a very new market, Hollia could itself be considered the “substitute”. Apart from traditional methods (which are theoretically not a substitute) there are very few players that could threaten this market. If omnichannel was to be considered as rival for only in-store analytics and Hollia was not able to integrate its business model and product with the opportunities that omnichannel brings, it could indeed be considered as a threat:

- **Traditional Methods:** The primary substitutes for in-store analytics are traditional methods like manual observation, surveys, and basic sales data analysis. While these methods have been used for decades, they lack the precision and real-time capabilities of modern analytics solutions. These techniques pose less of a threat because retailers are becoming increasingly aware of the use of AI in their business. Indeed, a recent HLB survey, indicates that retail leaders are “highly focused on identifying appropriate use cases for AI, such as customer analytics (42%), process automation (37%), and sales and marketing (32%)” (HLB Survey, s.f.)
- **Industry Trends:** The rise of omnichannel retailing further blurs the lines between online and offline shopping experiences. Retailers increasingly aim to provide a unified customer experience across all channels, leveraging in-store data to complement online insights. This trend emphasizes the need for comprehensive analytics that can bridge the gap between physical and digital customer interactions. Solutions like those provided by Capillary Technologies and RetailNext integrate in-store data with a whole experience of customer loyalty analytics to create a holistic view of customer behavior.

2.4.3 KEY SUCCESS FACTORS ANALYSIS

Key success factors (KSF), also known as Critical Success Factors (CSF), are crucial competencies for a company in its market, ensuring that it achieves its objectives and remains competitive with its competitors. The key to success against competitors is to do more with less, that is, to maximize the results of the company's KSF while minimizing

effort, expense and risk. However, mastering a key success factor alone is not enough to gain an advantage over competitors. Competitors may be at or above the company's level. To gain a competitive edge, superior mastery is essential. (Facon, s.f.)

After conducting a comprehensive market analysis, including PESTEL evaluations, a holistic understanding of the in-store analytics market has been developed. This thorough examination has allowed to identify the following Key Success Factors (KSFs) that are crucial for Hollia's success:

1. Privacy and regulatory compliance
2. Complete and integrated solution
3. Low implementation cost
4. Customer orientation
5. Wide range of features
6. Adaptability and agility

2.4.3.1 Privacy and regulatory compliance

Ensuring data privacy and regulatory compliance is paramount for both customers and legal authorities. On the one hand, it is crucial to be compliant with the authorities so that our business does not get shut down or get into legal battles that, in addition to diminishing the Figure of the business, would result in high legal advisory costs. On the other hand, it is crucial to keep clients satisfied for two reasons: the fear of legal restrictions and ethical dilemmas. Clients are increasingly aware of and concerned about data privacy issues, and their trust hinges on knowing that their data is handled responsibly. Therefore, it is crucial for Hollia to interpret, apply, and communicate these regulations effectively to its clients. This involves providing clear explanations and assurances about how data is collected, processed, and protected. Additionally, Hollia must articulate a strong mission, vision, and set of values centered around ethical data practices. This reassures clients that Hollia is not only legally compliant but also committed to upholding the highest standards of privacy and data protection.

2.4.3.2 Complete and integrated solution

A comprehensive, end-to-end solution is essential in this market. Many businesses can develop computer vision models or buy video surveillance cameras, but few can integrate these technologies into a seamless system that provides actionable business insights. Hollia's solution, from camera installation to analytical advice, ensures clients receive clear, actionable measures without getting overwhelmed by data. This full-service approach allows customers to outsource the entire process, reducing the need for in-house expertise and training.

Implementing computer vision models and retail analytics is particularly challenging with legacy hardware and untrained teams. Older systems often lack the processing power and integration capabilities required for advanced AI development. It is therefore important to offer both the cameras with the integrated network connection and the trained algorithms. This means that clients do not have to worry about the compatibility and performance issues that typically arise with legacy systems. By providing a complete solution, business do not need to invest in costly infrastructure upgrades or hire specialized technical staff.

Hollia's system is designed to be plug-and-play, allowing for quick deployment and immediate benefits. This ease of implementation is a significant competitive advantage in a market where many potential customers are hesitant to adopt new technologies due to the perceived complexity and cost.

2.4.3.3 Low implementation cost

A low implementation cost is crucial to success in the in-store analytics market. One significant barrier for clients in developing their own solutions is the expense associated with training teams and purchasing new hardware. Having a high implementation cost would present a similar obstacle, discouraging potential customers from adopting the solution.

To overcome the skepticism often found at the C-suite level regarding AI and computer vision technologies, it is essential to provide either demo versions or maintain low implementation costs. This approach allows customers to quickly see the value created by

the product without a substantial upfront investment. In a subscription pricing option, clients who would do not perceive immediate value, could easily unsubscribe, mitigating their concerns about long-term commitments. Often, reluctance to develop AI in-house stems from uncertainty about its success; a low-cost, low-risk option helps bridge this gap and promotes wider adoption of offerings.

2.4.3.4 Customer orientation

Customer orientation is a cornerstone of the retail analytics sector where tailored solutions are paramount. While vigilance in large spaces is a significant market, particularly for security purposes, the retail analytics sector remains less crowded, presenting an opportunity to stand out by offering customized solutions.

Retail clients seek detailed data and actionable insights to inform their decision-making processes. They are experts in their respective fields and expect their analytics providers to match their level of sophistication. Understanding the unique needs of each client and delivering solutions that address those specific requirements is vital. This can be done by maintaining close relationships with clients and continuously adapting its offerings to meet their needs, ensuring high levels of customer satisfaction and loyalty. This client-centric approach not only differentiates Hollia from competitors but also builds long-term partnerships based on trust and mutual success. The fact that Hollia already has a strong relationship in the fairs market is a good starting point.

2.4.3.5 Wide range of features

Ensuring a wide range of features is critical for Hollia's competitive edge. Analyzing as many data points as possible not only maximizes the utility of the system but also provides a comprehensive overview of customer behavior and store operations. This extensive data collection is a powerful selling point, serving as a key performance indicator (KPI) that clients can use to compare Hollia's capabilities against those of competitors.

A broad spectrum of features enables more accurate and nuanced insights, which are invaluable for making informed business decisions. By offering detailed analytics on various

aspects such as foot traffic, demographic profiles, and customer sentiment, one can deliver deeper, more precise insights. This level of detail can differentiate a specialized company from a generic a poorly packaged one.

The most important features to provide are the following:

- Flow
- Behaviour
- Demographics
- Emotions

2.4.3.6 Adaptability and agility

In a rapidly evolving market, the ability to adapt and respond quickly to new trends and customer needs is critical.

The technology landscape, especially in the realm of AI and computer vision, is characterized by constant innovation. New improved hardware and AI models are frequently introduced, each offering improved capabilities and performance metrics. It is therefore important to stay at the forefront of these advancements to maintain the highest accuracy in their analytics, which is a crucial key performance indicator (KPI) for their clients. To achieve this, it is imperial to monitor the market for the latest hardware and software updates.

In addition to that, it is important to have good innovation management and a strong culture of change. Agile methodologies, such as Scrum and Kanban, facilitate continuous improvement and flexibility and enable to swiftly incorporate feedback and make necessary adjustments to products. The use of Agile development processes ensures rapid iteration and deployment of new features, allowing the company to stay ahead of competitors and meet client demands effectively.

2.4.4 STRATEGIC GROUPS ANALYSIS

When analyzing a diversified competitive landscape, it is easy to identify subsets of competitors who share similar strategic characteristics that are stable over time, and who

stand out from other groups with different characteristics. These are known as strategic groups. When analyzing Hollia's competitive landscape, 5 different strategic groups have been identified:

1. In-store retail analytics companies that use computer vision: These companies focus on leveraging computer vision technology to analyze customer behavior, foot traffic, and demographics within physical retail spaces. Their solutions typically include a network of cameras and advanced AI algorithms to provide real-time insights and actionable data.
2. Security companies offering AI-powered security cameras: These companies provide security solutions enhanced with AI to improve surveillance capabilities. Their offerings often include advanced features such as person counting, movement detection, and anomaly recognition.
3. Companies offering counting solutions: These companies specialize in technologies and services aimed at accurately counting people or objects within a given area. Their solutions are often used for managing store occupancy, analyzing traffic patterns, and improving operational efficiency.
4. Companies that study the behavior of individuals in physical sites without the use of images: These companies analyze consumer behavior in physical locations through alternative methods such as Bluetooth, Wi-Fi tracking, and other non-visual technologies.

2.4.5 DETAILED STUDY OF COMPETITORS

The KSF and strategic groups identification have provided us with a good framework to analyze competitors and compare them to Hollia. The following will be divided into strategic groups and KSF will be compared.

2.4.5.1 In-store retail analytics companies that use computer vision

2.4.5.1.1 XII CORE

XXII specializes in advanced AI solutions, providing technologies that focus on understanding and analyzing human behavior through video analytics. They work extensively in the retail analytics space, offering insights into customer behavior, store operations, and more.

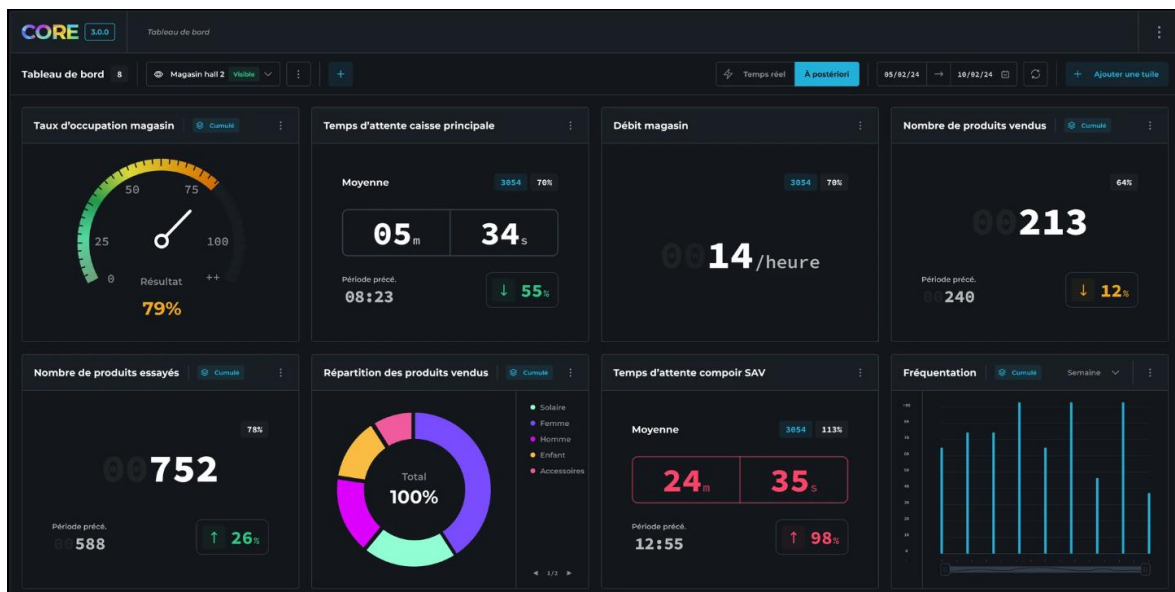


Figure 18: XXII CORE Dashboard demo

- Privacy and Regulatory Compliance: XXII emphasizes a commitment to privacy and ethics, particularly highlighting their adherence to GDPR principles and implementing privacy by design and by default approaches to ensure data protection. It uses an approach of privacy by design et by default and has an Ethics manifesto on their website.
- Complete and Integrated Solution: XXII appears to offer a robust retail analytics solution that integrates seamlessly with existing systems. Their platform is designed to connect various data points from the physical retail environment to assist in decision-making, though detailed specifics on the complete chain from camera to decision advice aren't clearly detailed.
 - o Network of cameras set up: No
 - o Easy to use dashboard: Yes

- Decision making advice: No
- Low Implementation Cost: The pricing information suggests a scalable solution depending on the store size with clear monthly rates, which includes equipment and commissioning. Prices start from 390€ per month for small spaces up to 250m², suggesting an attempt to keep implementation costs manageable for different business sizes.
- Customer Orientation: The platform provides a dashboard that is described as easy to use and designed to provide instant access to relevant data, which indicates a strong customer-oriented approach. In addition, these can be manually modified easily by the client. The availability of demos and detailed customer support options also supports their customer-centric model.
- Wide Range of Features: XXII's retail analytics solution covers a wide range of features including:
 - Flow: The platform offers capabilities to manage and compare data from points of sale, suggesting tools for traffic management.
 - Behaviour: The analytics include insights into customer behavior at points of sale.
 - Demographics: There's mention of categorizing customer groups, which might imply demographic segmentation.
 - Emotions: Not available
- Adaptability and Agility: The company seems agile and adaptable, evidenced by their varied solutions across different retail environments and the modular, scalable pricing structure. This would allow for quick adjustments to different client needs and market changes. Nevertheless, the low ratio of businessmen/engineers in their teams may suggest that the company can be good at listening to client's expectations but might take time to deliver the promised results (opinion).

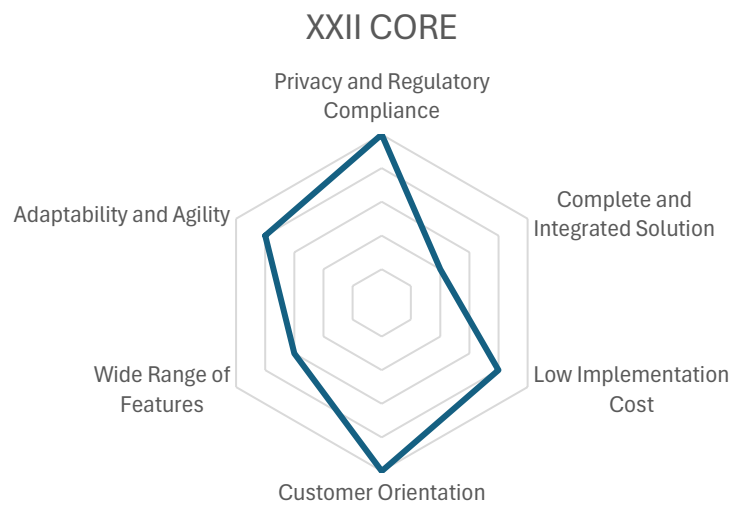


Figure 19: XXII Core KSF

2.4.5.1.2 Quantaflow

Quantaflow is a French company specializing in people counting and analytics using AI and proprietary 3D camera technology. They focus on providing in-depth visitor counting, profiling and mapping, but the latter does not seem to be deployed yet. Their Profiling tool includes age and gender demographics. Their solutions enable targeted marketing and operational strategies by analyzing detailed visitor data.

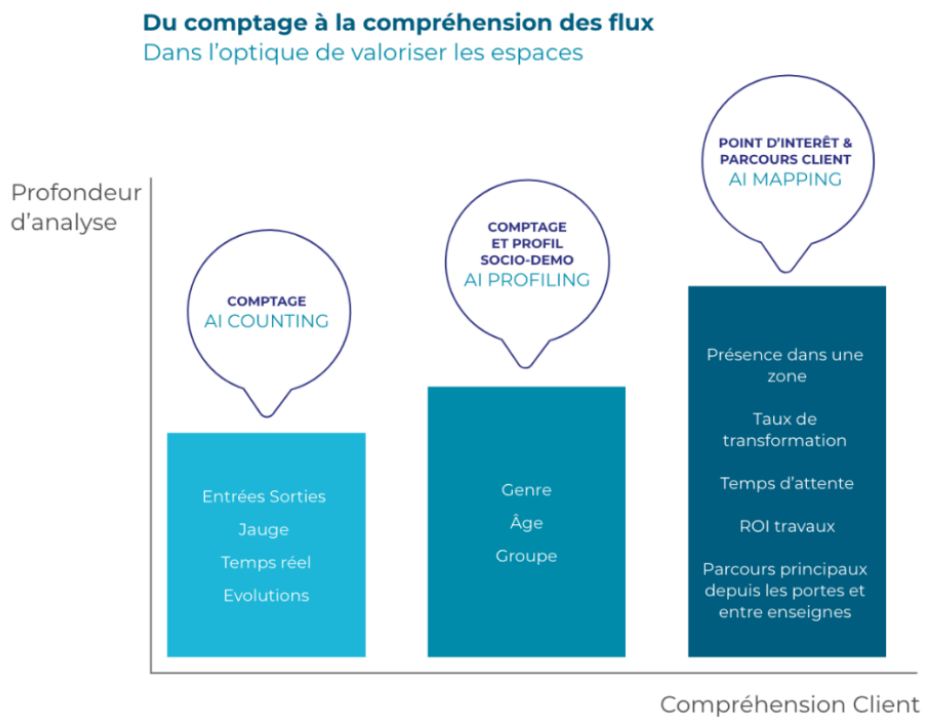


Figure 20: Quantaflow's products

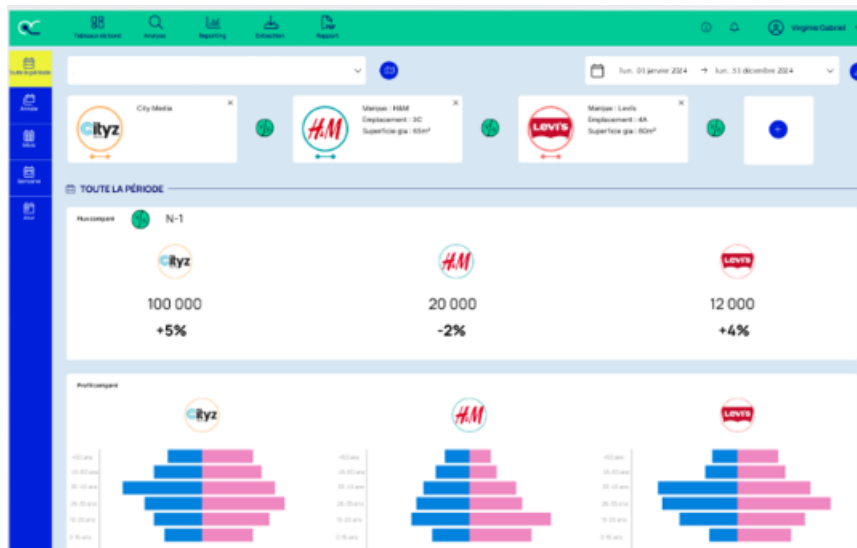


Figure 21: Quantaflow AI Profiling dashboard

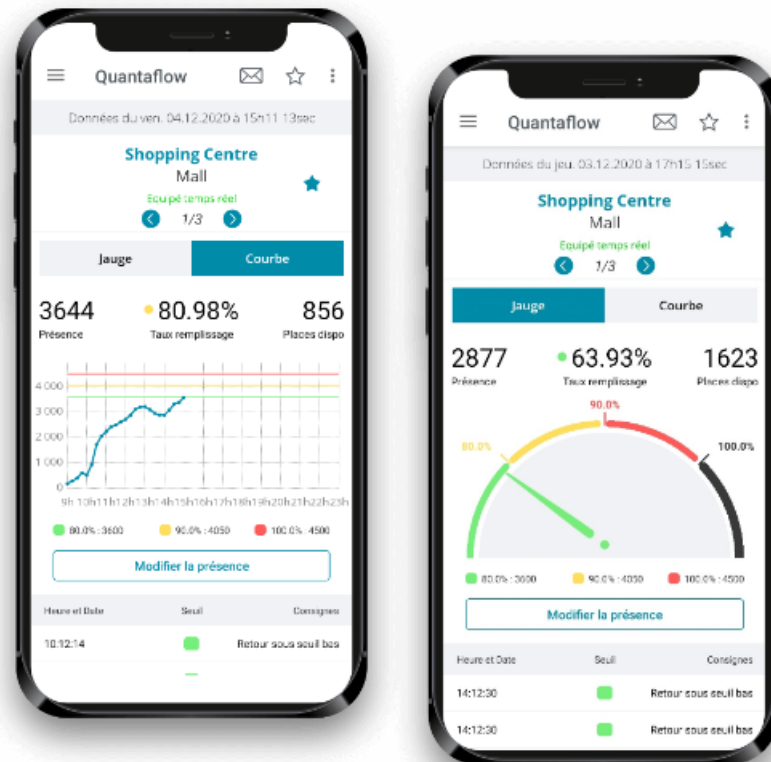


Figure 22: Quantaflow AI counting phone Dashboard

- Privacy and regulatory compliance: Quantaflow collects anonymous data in real-time using 3D sensors positioned in commercial sites, and their technology is compliant with GDPR standards. Nevertheless, the hardware stocks data for 1 year, which may arise data privacy issues in the long run.
- Complete and integrated solution: Quantaflow offers a comprehensive solution from data collection through 3D sensors to decision advice via their consulting division. The company offers their own sensors installation, operation and maintenance.
 - o Network of cameras set up: Yes
 - o Easy to use dashboard: Yes
 - o Decision making advice: No

- Low implementation cost: Before the installation, the field must be studied, then the sensors are placed and finally the system can operate. This company uses complex 4D sensors which might suggest high implementation costs.
- Customer orientation: Quantaflow focuses on shopping centers and surrounding areas, helping them to manage and market their commercial spaces more effectively.
- Wide range of features:
 - Flow: They count and qualify visitor flows with 99% reliability certified by *Bureau Veritas* and *Deloitte*.
 - Behavior: Not explicitly mentioned, but they do analyze footfall data.
 - Demographics: Provides data on visitors' age and gender (AI profiling)
 - Emotions: Not available
- Adaptability and agility: Quantaflow operates in France and internationally, suggesting some level of adaptability. They also offer solutions for various types of commercial spaces (shopping centers, city centers, retail parks). Quantaflow is part of Quanteo Group, which has 200 employees across more than 50 countries, which suggests that they have access to capital but may have lost their agility. The development of 3 different products suggest that they have good adaptation skills.

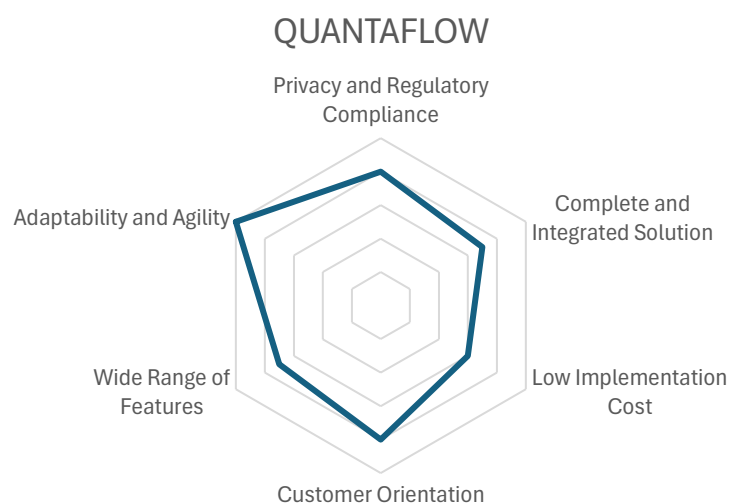


Figure 23: Quantaflow KSF

2.4.5.1.3 Outsight

Outsight specializes in processing spatial data through LiDAR technology to create real-time 3D perception solutions. Their technology is used across various industries including automotive, aerospace, and smart city applications, providing critical data for navigation, monitoring, and planning.

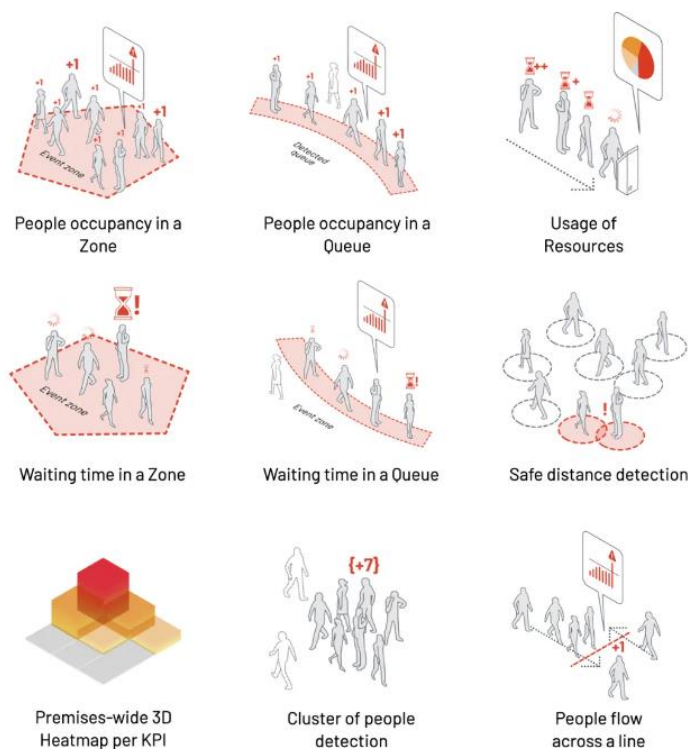


Figure 24: Outsight's offer



Figure 25: Oversight's dashboard demo

- Privacy and Regulatory Compliance: Oversight adheres to stringent privacy regulations, complying with the GDPR and the French Data Protection Act. They prioritize data privacy by using 3D LiDAR sensors that inherently do not collect any personally identifiable information, ensuring that data processing is privacy-focused from the outset. Laser light, unlike cameras, doesn't recognize people.
- Complete and Integrated Solution: Oversight provides a solution that processes 3D LiDAR data to create actionable insights through a user-friendly dashboard. Their system integrates data from various sensors to deliver real-time analytics and KPIs, making it a holistic solution for data-driven decision-making. They don't build their own cameras but they buy them from vendors which suggests that their offer is not complete.
 - o Network of cameras set up: No
 - o Easy to use dashboard: Yes
 - o Decision making advice: No
- Low Implementation Cost: Oversight works with vendors to create the camera network, which suggests that the implementation can take long and might end up

- being expensive. In addition, this suggests that the clients must have a good knowledge of LiDAR technologies in order to choose the good provider
- Customer Orientation: Outsight demonstrates a strong customer focus, offering tailored solutions and ensuring that their systems are easy to use and accessible via web dashboards. They also provide detailed information and support to help customers understand and utilize their technology effectively
 - Wide Range of Features:
 - o Flow: The technology supports detailed people and vehicle flow monitoring, providing extensive traffic and movement analytics
 - o Behaviour: Behaviour analysis is possible through the tracking and classification of objects and individuals in various settings
 - o Demographics: Not available
 - o Emotions: Not available
 - Adaptability and Agility: The technology is highly adaptable, supporting various applications from smart city management to industrial safety. The flexibility of Outsight's software, combined with its capability to integrate with multiple LiDAR sensors, underscores its adaptability and scalability across different industries and use cases

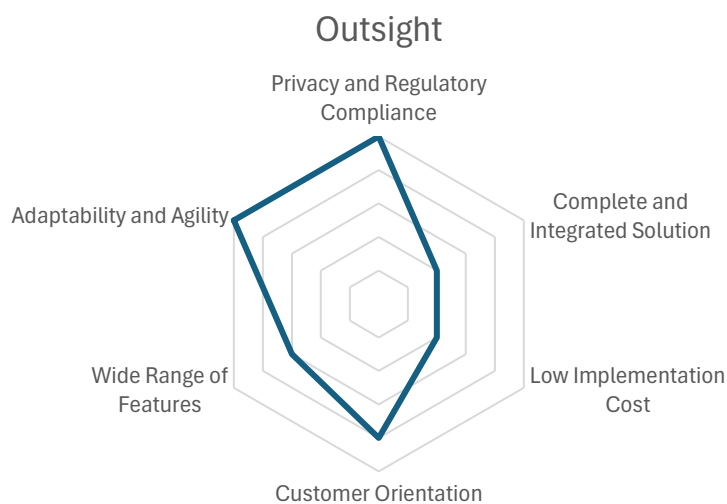


Figure 26: Outsight KSF

2.4.5.2 Security companies offering AI-powered security cameras

2.4.5.2.1 VIDETICS

Videtics is known for its video analytics technology, which includes monitoring and analyzing video footage for security purposes as well as for traffic and behavioral analysis in public and retail environments.



Figure 27: Videtics dashboard demo

- Privacy and Regulatory Compliance: Videtics emphasizes privacy and ethical considerations in their solutions. Their products include features like anonymization and dynamic blurring to respect the privacy of individuals, which aligns with privacy protection and regulatory compliance and addresses clients concerns about transparency.
- Complete and Integrated Solution: Videtics offers a comprehensive video analytics solution that appears to include everything video to actionable insights. Their platform integrates with existing systems to provide real-time statistics and alerts, which supports decision-making in smart city and private facility management but does not provide any installation set up.
 - Network of cameras set up: No
 - Easy to use dashboard: Yes
 - Decision making advice: Yes
- Low Implementation Cost: Specific details about the implementation cost are not readily available on their website, making it difficult to determine the affordability of their solution without direct inquiry. Nevertheless, they are easily adaptable to already existing cameras which can be beneficial to customers already having them.
- Customer Orientation: Videtics seems to place a strong focus on user experience, offering intuitive interfaces and training to ensure ease of use. This indicates a customer-oriented approach, ensuring that clients can effectively utilize their analytics platform.
- Wide Range of Features: Videtics' platform provides various features including:
 - Flow: Their system supports the management of people and vehicle flow in monitored areas.
 - Behaviour: The platform analyzes behavior patterns within the monitored environments.
 - Demographics: Not specified.
 - Emotions: Not specified.

- Adaptability and Agility: The system's design to integrate with existing infrastructure and its emphasis on real-time data and alerts suggest that Videtics is adaptable and capable of addressing diverse and dynamic analytical needs.

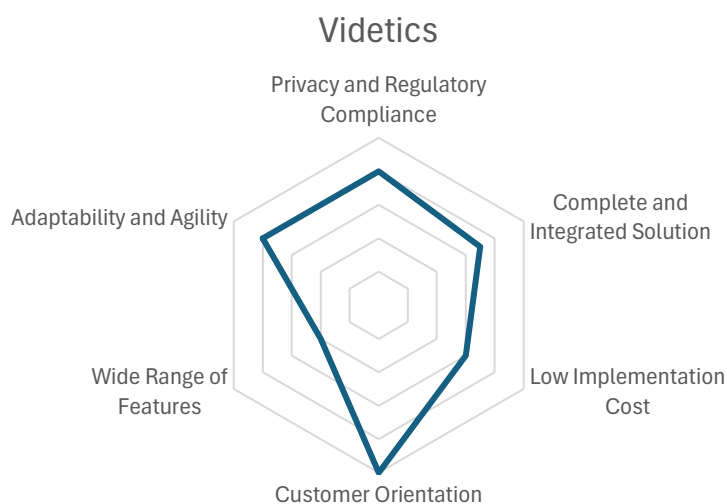


Figure 28: Videtics KSF

2.4.5.2.2 Avaneo

Anaveo is a French company that operates within the security and surveillance sector. Their main domain of expertise includes the design, implementation, and maintenance of comprehensive security solutions. These solutions often incorporate advanced video surveillance systems, access control, and intrusion detection, tailored to meet the specific safety and security needs of various commercial, industrial, and individual clients.

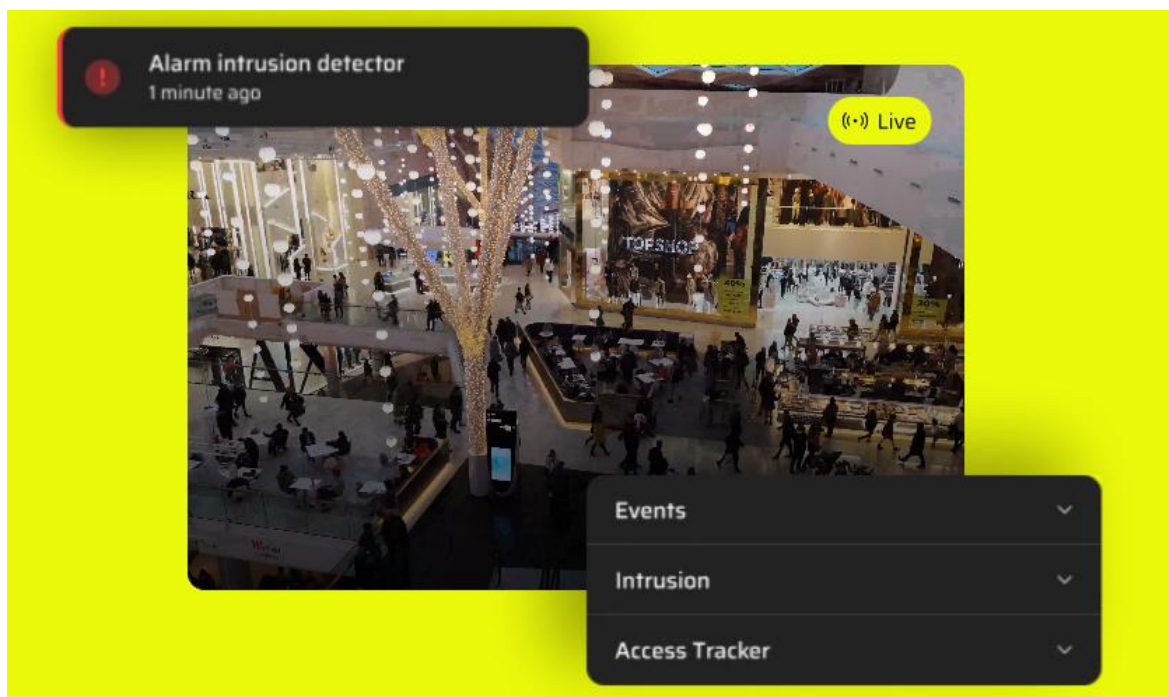


Figure 29: Aveneo's offer

- Privacy and Regulatory Compliance: Aveneo adheres to standard privacy policies, mentioning the use of cookies and the aim to understand site usage to enhance user experience. However, specific details on regulatory compliance, especially concerning video surveillance data, were not explicitly found.
- Complete and Integrated Solution: Aveneo specializes in a broad range of security solutions including video surveillance, which can be integrated into comprehensive security systems. This suggests a capability to provide integrated solutions from hardware installation to security management.
 - o Network of cameras set up: No
 - o Easy to use dashboard: Yes, but poorly packaged
 - o Decision making advice: Yes, but poorly packaged and only very precise information
- Low Implementation Cost: The cost of implementation is not directly mentioned, so the affordability of their solutions would require direct inquiry.
- Customer Orientation: Aveneo appears to be highly customer-focused, offering several customized solutions and maintenance services to meet specific client needs.

- Wide Range of Features:
 - Flow: Not included, only precense. They are developing a path optimization which suggests that they might also implement retail analytics in the medium-long term.
 - Behaviour: Only suspicious gestures
 - Demographics: Not included
 - Emotions: Not included
- Adaptability and Agility: The company shows adaptability through its diverse security solutions tailored to various sectors, suggesting they can respond flexibly to different customer requirements.

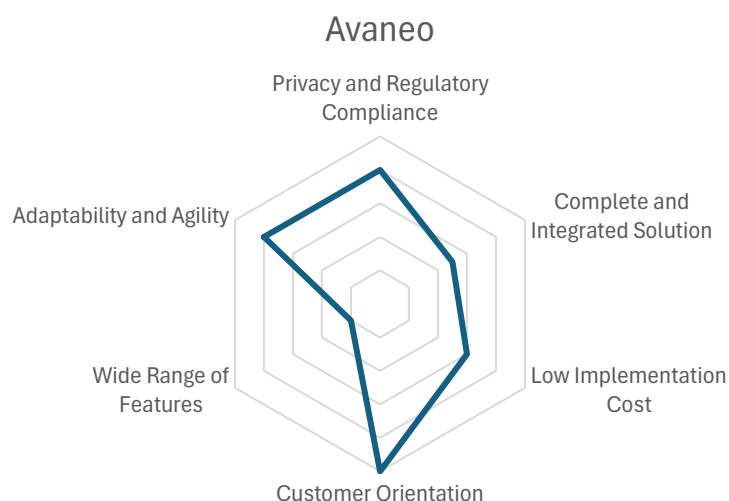


Figure 30: Avaneo KSF

2.4.5.2.3 Veesion

Veession is a French company that specializes in security, focusing primarily on artificial intelligence to enhance video surveillance systems. Launched in 2018, Veession's main expertise lies in its innovative use of gesture recognition technology, which is designed to detect suspicious movements and shoplifting behaviors in real-time through existing camera systems. This AI-based approach allows retailers and other businesses to significantly reduce shrinkage and improve security without the need to replace their current surveillance

infrastructure. Veesion markets its technology as compatible with all types of cameras, emphasizing ease of integration and operational efficiency in preventing theft.

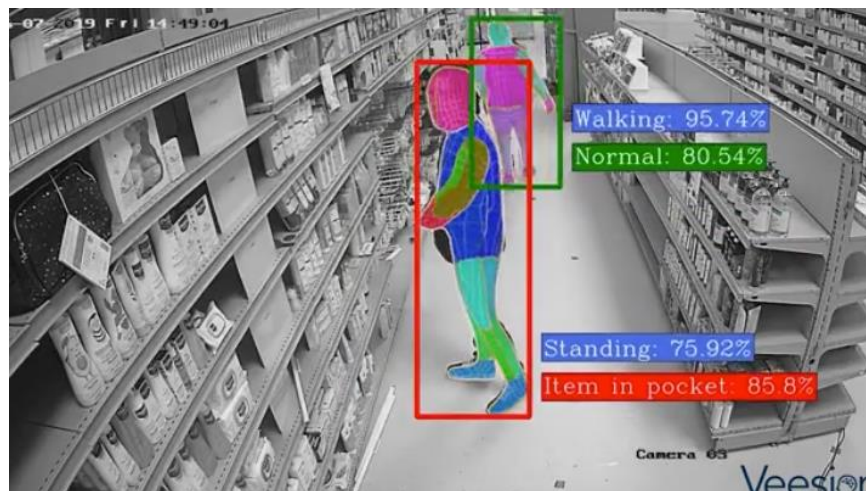


Figure 31: Veesion product offer

- Privacy and Regulatory Compliance: Veesion is committed to privacy and regulatory compliance, particularly in alignment with the General Data Protection Regulation (GDPR). Nevertheless, they can keep images for up to 30 days and allow facial recognition. The images can only be seen by employers but the company itself cannot ensure that this is respected.
- Complete and Integrated Solution: Veesion offers a sophisticated AI-driven solution that integrates gesture recognition with real-time video analysis. Their system is designed to identify suspicious behaviors efficiently, which aids in enhancing security measures in retail environments without infringing on privacy. They don't offer camera sets and installation, nor consulting, which means that the solution is incomplete.
 - o Network of cameras set up: No
 - o Easy to use dashboard: No, only chat with notifications on dangerous activities

- Decision making advice: Yes, but poorly packaged and only on security matters
- Low Implementation Cost: The implementation cost of Veesion's system is marketed as being low due to its compatibility with existing surveillance infrastructure. Retailers can deploy Veesion's software without the need to invest in new cameras or hardware, which significantly reduces upfront costs. The AI software is installed on a computational server that connects to current video recorders, facilitating a quick setup often completed in less than 30 minutes.
- Customer Orientation: Veesion strongly focuses on enhancing the retail experience by reducing losses from theft, which can directly benefit store operations and profitability. Their system provides real-time alerts and video notifications to store managers or security personnel, enabling immediate response to incidents. The solution aims to not only detect but also deter shoplifting, thereby improving the overall shopping environment.
- Wide Range of Features:
 - Flow: Not available
 - Behaviour: Only detects suspicious behaviors, such as potential shoplifting actions.
 - Demographics: Not available
 - Emotions: Not available
- Adaptability and Agility: Veesion's software exhibits high adaptability and agility, as it can be quickly integrated with any existing video surveillance system, regardless of the camera brand or model. This versatility allows it to be deployed in various retail settings, from small stores to large supermarkets, adapting to different security needs and layouts without extensive customization.

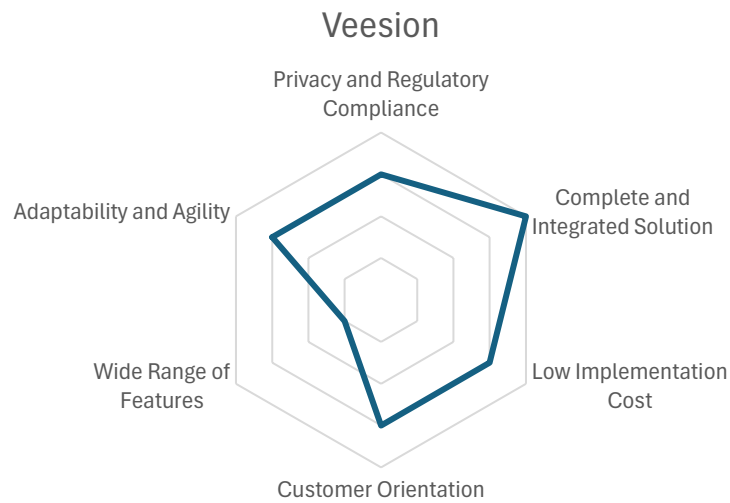


Figure 32: Veesion KSF

2.4.5.2.4 Sensormatic

Sensormatic Solutions, part of Johnson Controls, operates primarily in the retail solutions sector, specializing in loss prevention and operational improvement technologies. Their main domain of expertise includes electronic article surveillance (EAS), inventory intelligence, and real-time analytics to enhance shopper experience and store performance. Sensormatic integrates advanced technology, data, and analytics to provide comprehensive, scalable solutions for retailers worldwide, aiming to improve operational efficiency and customer satisfaction.

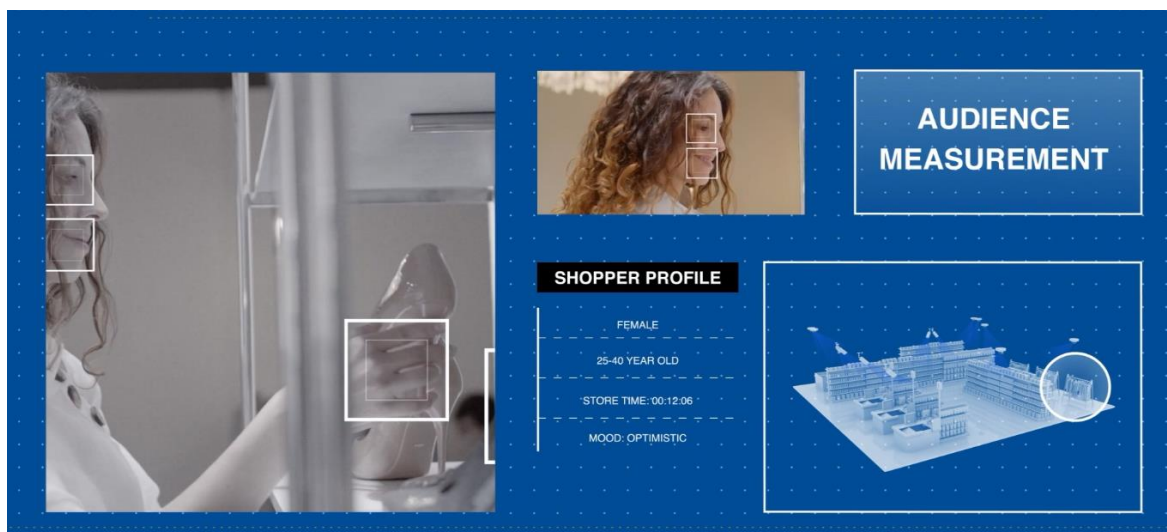


Figure 33: Sensormatic demo

- Privacy and Regulatory Compliance: Sensormatic complies with major data protection regulations such as the General Data Protection Regulation (GDPR) and other applicable laws. Their systems are designed to ensure that data handling respects privacy norms, which is critical for deployment in regions with stringent data privacy laws.
- Complete and Integrated Solution: Sensormatic offers a robust solution spanning from hardware (sensors) installation to actionable insights through their Sensormatic IQ platform. This platform integrates data from various sources, providing retailers with comprehensive analytics that inform decision-making, ranging from loss prevention to customer engagement strategies. Nevertheless, their retail analytics product needs a camera to operate, and Sensormatic does not manage its manufacturing or installation.
 - o Network of cameras set up: No
 - o Easy to use dashboard: No, only chat with notifications on dangerous activities

- Decision making advice: Yes, but poorly packaged and only on security matters
- Low Implementation Cost: While specific cost details are not publicly disclosed, Sensormatic's use of existing retail infrastructure and modular solutions suggests an approach designed to minimize the financial impact of new system installations. Their solutions are adaptable to different retail environments, which can potentially reduce the need for extensive customization and associated costs.
- Customer Orientation: Sensormatic is highly customer-centric, offering easy to use and customizable dashboards that meet diverse retailer needs. Their portfolio includes solutions for inventory intelligence, loss prevention, and shopper insights, all designed to enhance operational efficiency and improve the customer shopping experience.
- Wide Range of Features:
 - Flow: Can count people in zones
 - Behaviour: Not available
 - Demographics: Gender and age
 - Emotions: Sensormatic aims to analyze emotions in order to better predict theft and analyse customer satisfaction
- Adaptability and Agility: Sensormatic's solutions are noted for their flexibility and scalability, crucial for adapting to the rapidly changing retail landscape. Their technology is designed to integrate seamlessly with a variety of hardware and software systems, ensuring that they can meet the evolving needs of global retailers effectively.

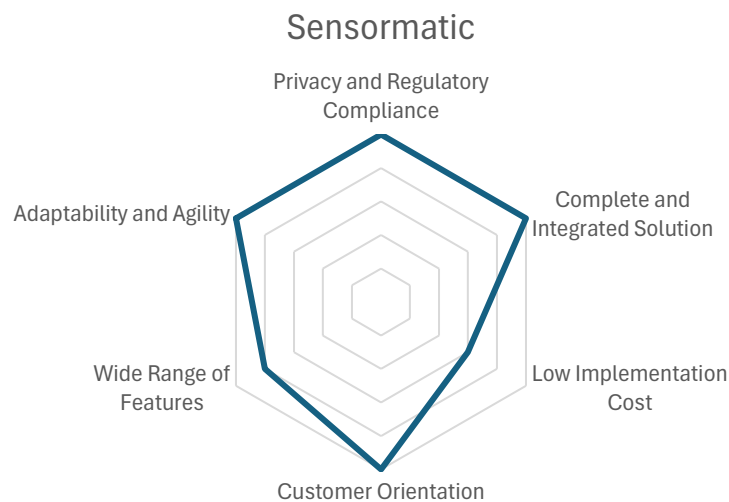


Figure 34: Sensormatic KSF

2.4.5.3 Companies offering counting solutions

2.4.5.3.1 My People counter

- Privacy and regulatory compliance: MyPC uses anonymous people counting technology, which suggests compliance with privacy regulations. However, specific details about regulatory compliance are not explicitly mentioned in the search result.
- Complete and integrated solution: MyPC offers a range of people counting solutions, including hardware (sensors) and software for data analysis. They provide an all-in-one solution that covers data collection, analysis, and reporting.
 - o Network of cameras set up: Yes
 - o Easy to use dashboard: Yes, but limited to count of people
 - o Decision making advice: No
- Low implementation cost: MyPC emphasizes its cost-effectiveness. They mention that their solutions are designed to be affordable for businesses of all sizes.

- Customer orientation: MyPC caters to various industries, including retail, museums, libraries, and public spaces. They offer customizable solutions to meet specific customer needs.
- Wide range of features:
 - o Flow: Yes, MyPC provides visitor counting
 - o Behavior: Not available
 - o Demographics: Not available
 - o Emotions: Not available
- Adaptability and agility: MyPC offers various types of counters (thermal, 3D, video) and can integrate with existing systems. This suggests a degree of adaptability to different environments and requirements.

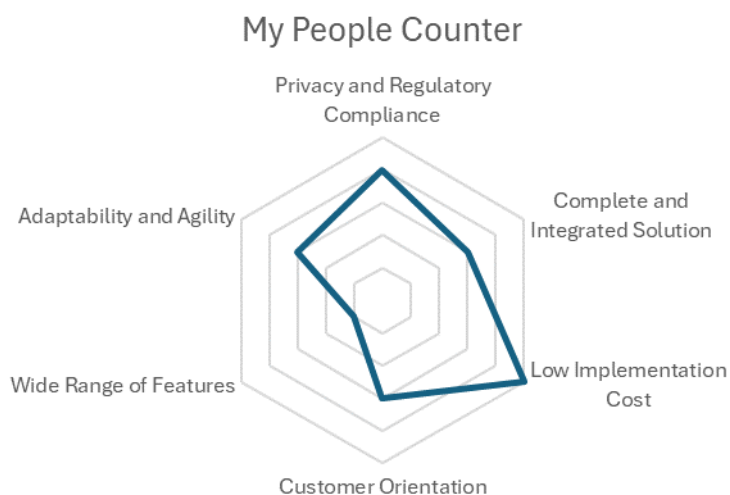


Figure 35: MyPC KSF

2.4.5.4 Companies that study the behavior of individuals in physical sites without the use of images

2.4.5.4.1 Beacon

Beacon technology utilizes small Bluetooth devices that transmit signals to nearby smart devices, enabling location-based services in retail and other sectors. These beacons can push

notifications, assist in navigation, provide personalized ads, and collect data to enhance customer experiences. They work with mobile applications where users must opt-in to interact, ensuring privacy and compliance with data protection regulations. This technology is used extensively in retail to improve marketing efforts and operational efficiency by analyzing customer behavior and traffic flow.

- Privacy and Regulatory Compliance: Beacons, using Bluetooth Low Energy, require opt-in from users for interactions, aligning with GDPR principles by needing user consent to send notifications and collect data.
- Complete and Integrated Solution: Beacons integrate with mobile applications to deliver contextual advertisements and information, offering a seamless blend of physical and digital marketing strategies.
- Low Implementation Cost: Beacons are relatively inexpensive, ranging from 5 to 100 euros, although additional costs may be incurred for mobile application development.
- Customer Orientation: The technology enhances customer experiences by providing targeted content and improving service through personalization and convenience.
- Wide Range of Features:
 - Flow: Monitors and analyzes customer traffic patterns within a venue.
 - Behaviour: Tracks how users interact within a physical space.
 - Demographics: Could potentially gather demographic data through integration with mobile apps but regulation may not allow
 - Emotions: Not available
- Adaptability and Agility: Beacons are versatile and can be used across various sectors including retail, public transportation, and events, adapting to different business needs and environments.

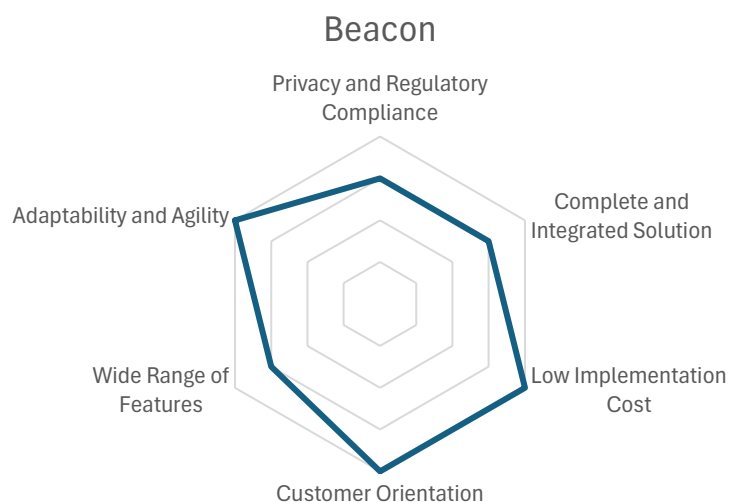


Figure 36: Beacon KSF

2.4.6 COMPETITIVE LANDSCAPE SUMMARY

The competitive landscape in the AI-powered retail analytics and security solutions sector includes companies like XXII, Quantaflow, Oversight, Videtics, Avaneo, Veesion, Sensormatic, My People Counter, and Beacon. These companies offer a range of services from video analytics, people counting, and behavior analysis to comprehensive security systems. Key features across these companies include privacy and regulatory compliance, integration with existing systems, customer-oriented solutions, and adaptability to various environments.

Main competitor's KSF

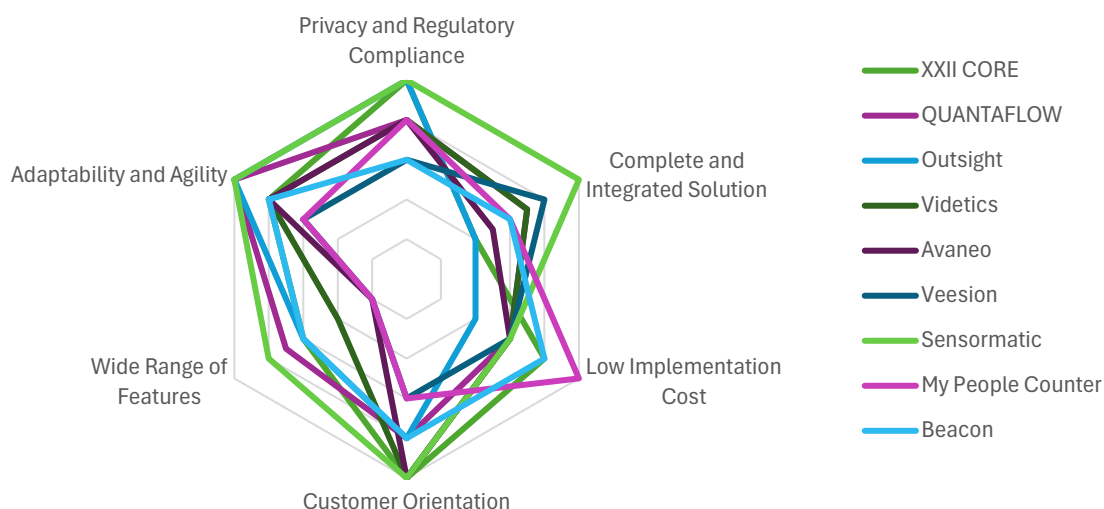


Figure 37: competitors analysis chart

Key Differentiators:

- **Competitive Differentiation:** Hollia needs to emphasize its specialized analytics capabilities to differentiate itself from older surveillance companies and newer tech-focused competitors. Highlighting unique selling points like faster and less intrusive installation processes or advanced analytics features could attract clients looking for innovative solutions. In addition, it has been demonstrated that no competitor offers such a wide range of features as Hollia and very little covers all the process, from the data to the decision.
- **Technological Adaptability:** Given that many competitors highlight their ability to integrate with existing camera systems, Hollia should also consider compatibility with pre-existing infrastructure in retail environments. This adaptability can be a strong selling point, especially for businesses that want to avoid the high costs and inconvenience of new hardware installations. Hollia could explore providing cameras only when clients request them, like in temporary setups like fairs or events and for clients who don't have security cameras.
- **Pricing Strategy:** Exploring flexible pricing options based on the use of existing cameras in stores can be beneficial. This approach could appeal to retailers who are

cost-conscious and wish to leverage their current investments in surveillance systems. Competitive pricing should also consider the scale of deployment, with tiered pricing models based on space size or required features, as seen with some competitors.

- Customer-Centric Approach: Ensuring that the analytics dashboard and customer service are top-notch will help in retaining and attracting customers. Demonstrating a deep understanding of customer needs and providing effective, easy-to-use solutions will enhance Hollia's value proposition in a competitive market. Some competitors give the opportunity to clients to customize their dashboards on their own, making them more aware of the possibilities ahead of them and taking customer needs to the next level. As clients wouldn't even have to ask for changes they can do by themselves, latency created when sending a modification request and its processing would disappear

It is important to point out that surveillance companies have carved a niche in the retail analytics market due to their longstanding presence. These companies are now offering products that are even more tailored to the market than those of direct competitors. It is crucial for Hollia to stay ahead by leveraging its specialization in analytics to provide superior service. Additionally, exploring pricing options for utilizing existing store cameras, if available, could be advantageous. The temporary nature of fairs, which often lack pre-installed security cameras, presents a unique opportunity for Hollia to offer quick installation solutions. However, for clients with pre-existing cameras, unnecessary installation could be seen as a hassle.

2.5 INTERNAL ANALYSIS

2.5.1 SWOT

2.5.1.1 Strengths

- Advanced Technology: Hollia leverages AI and machine learning technologies to provide precise and real-time analytics. This includes the use of the latest trained models

like Yolov8 for enhanced accuracy and speed. The talented and curious engineers behind Hollia's product ensure that it offers the best possible product.

- Comprehensive Solution: Offers a complete package from data collection through a network of connected cameras to an easy-to-use dashboard and a consulting chatbot. This end-to-end solution simplifies the implementation process for clients. This a clear competitive advantage from competitors, who only provide help in part of the process, leaving their customers alone to figure out how to integrate it in their business.
- Privacy Compliance: Hollia ensures data privacy by processing and anonymizing data within seconds, which complies with GDPR and the French Data Protection Act ("Informatique et Libertés"), gaining customer trust and avoiding legal issues. As has been seen above, data privacy concerns are one of the most important reasons why retailers and event organisers are reluctant to develop their own solution.
- Wide Variety of Insights: Provides detailed insights into foot traffic, demographics, and consumer behavior, enabling retailers to make informed strategic decisions and optimize operations.

2.5.1.2 Weaknesses

- High Implementation Costs: The initial setup costs for hardware and software can be high, potentially deterring smaller retailers from adopting the solution. In order to gain the first customers, it is important to develop a robust MVP, building along the way is not possible.
- Dependency on Technology Providers: Reliance on external suppliers for hardware components like cameras and sensors can lead to supply chain disruptions and affect product delivery timelines. This also applies to the open-source libraries that are currently used.
- Wait Times: the long lead times for manufacturing, shipping to hollia and then shipping to the customer makes Hollia slow to respond to its customers' needs, which can lead to other competitors getting ahead of the curve.
- Implementing the solution in physical spaces: At the moment, there is no staff to install the camera network, so if someone places a large order (cameras for many stores located

in different places) or the customers are far away, this can lead to long waiting times, which leads to customer dissatisfaction and high travel costs.

- Resource Intensive: The need for continuous R&D to stay ahead in technology can strain resources, particularly for a startup with limited funding.
- Scalability Challenges: As a small startup, scaling operations to meet growing demand can be challenging, particularly in terms of manufacturing and logistics. The long t

2.5.1.3 Opportunities

- First player: Although there are already other players in this young market, none of them has the same vision and product as Hollia. Potential clients have already expressed their need for a solution like the one Hollia offers and being the first one to address it can help Hollia rapidly gain customer trust.
- AI Landscape: As Iñaki Berenguer (CoverWallet cofounder and CEO) states: “In order to succeed in the start-up world, one must surf a big wave. AI is clearly the wave to surf now”. Surfing the AI wave is clearly one big strength
- Market Growth: The in-store analytics market is rapidly growing, with a projected value of \$5.3 billion by 2027, driven by the need for real-time data and advanced analytics in retail (Bosch Security).
- Government Support: Increasing government investments in AI and technology development offer opportunities for grants and subsidies to support Hollia’s growth.
- Post-Pandemic Retail Trends: As consumers return to physical stores with higher expectations for personalized experiences, there is a growing demand for in-store analytics to optimize shopping experiences.
- Sustainability Initiatives: Retailers focusing on sustainability can use Hollia’s insights to reduce energy consumption and minimize waste, aligning with broader environmental goals.

2.5.1.4 Threats

- Regulatory Changes: Stringent data privacy regulations like GDPR and potential new regulations can impose additional compliance costs and operational constraints.

- Economic Downturns: Economic instability can affect retailers' budgets for investing in new technologies, making it challenging to secure new clients during downturns.
- Competitive Pressure: The market is highly competitive with numerous players like Datakalab, Videtics, and Quantaflow offering similar solutions. Continuous innovation is necessary to maintain a competitive edge.
- Data Privacy Concerns: Increasing awareness and concern about privacy among consumers might make them wary of in-store surveillance and data collection, impacting the adoption rate.

2.5.2 VALUE CHAIN

Professor Thomas Lee, PhD and MBA, adapts the famous Michael Porter's value chain to the Software Product Delivery, which is far more adapted to this company. This framework will be used to structure the analysis of Holliá's value chain. In figure [X] lies the so-called Value Chain for Software Product Delivery (Lee, 2015):



Figure 38: Value Chain for Software Product Delivery (Lee, 2015)

2.5.2.1 Primary activities

- Research: Hollia's focus is to incorporate disruptive technologies and achieve significant improvements in accuracy, speed (to avoid latency in real-time processing) and variety of features. Hollia uses the latest trained models (Yolov8) and aims to re-train them to incorporate new features. There is also a strong focus on keeping up with the latest trends in computer vision in order to stay ahead of any competitor who could be potentially to get to develop a better performing product.
- Product Management: Hollia uses Monday for good product management, to ensure good communication between all the people who contribute to the development of this start up. Everyone is informed about the next objectives, deadlines and responsables.
- Development: An Agile methodology is used, based on 1-week sprints. The integration of the different parts of the code and the management of the objectives are done in GitLab.
- Release: As Holia is a small start-up, all the release side is in the hands of one person, the co-founder and IT expert. Having a holistic and technical vision of the product, the co-founder makes sure to assemble all the parts, integrate them into the existing architecture and check the correct functioning of it. He manages the relationship with the customer so that at the time of release, customers can come to him and have their questions answered quickly, but they will also be relieved to see that the person they have trusted to handle the project knows the product so well.

2.5.2.2 Support activities

- Firm infrastructure: The business is managed by the 2 founders, who manage their areas of expertise in the firm. Equipped with a strong engineering background, Hadrien oversees the technical aspects of the business. On his side, Louis manages the legal aspects of it as well as all the business management decisions that affect data. As it has been seen, managing well the data privacy is key in this business. Together, they both manage the strategic and commercial side of the business. The fact that Hollia is still a small business gives it great flexibility and a low WRC that allows it to adapt itself quickly in this rapidly changing market. In the future, there will be tech interns to help

develop and maintain the code. Hollia is looking for young and dynamic talent as it fits with the dynamics of the start up and offers in return an unparalleled experience and mentoring programme. Other positions such as infrastructure manager, accountant and sales team will be added at a later stage. In a later expansion, the management base is enlarged and new support functions such as human resources, accountants and lawyers are added.

- Human resource management: At Hollia, HR is managed by Hadrien and Louis, with a strategic focus on attracting top talent in computer vision, AI, and IT infrastructure by leveraging the growing interest in AI and entrepreneurship. A commitment to fair compensation is demonstrated by offering salaries in the upper market range, along with variable rewards for exceptional performance. Flexibility is prioritized, with options for remote work and adaptable hours to ensure a healthy work-life balance. Team cohesion is strengthened through regular team-building activities, fostering strong relationships essential for innovation and collective success. Talent attraction and retention are further supported by implementing share and stock option programs for managers, with plans to extend these initiatives to all employees, ensuring equitable value distribution. A culture of innovation drives continuous personal and professional development, encouraging boldness and curiosity as key drivers of growth. The HR policy is designed to support employee development, performance, and engagement, contributing to a sustainable and prosperous future.
- Technology development: This is a core strength for Hollia. The company is mainly focused on research and development, focusing on incorporating new technologies and achieving significant improvements in accuracy and feature variety. By using the latest trained models (YOLOv8) and aiming to re-train them, Hollia demonstrates a commitment to cutting-edge technology. The strong focus on keeping up with the latest trends in computer vision further reinforces their technological edge
- Procurement: Hollia's procurement activities involve sourcing high-quality hardware components and software tools necessary for product development and deployment. Initial design was done by Bobitech and a co-founder. Bobitech SAS in Haute Loire handles the plastic parts manufacturing using ABS, while the ESP32CAM is sourced from a supplier in China. Currently, Hollia does not have a dedicated supplier for

electrical parts but plans to retain a good supplier once found. The production initiation phase takes 6 months, followed by 3 weeks for continuous production. Bobitech oversees the logistics, sending materials for fabrication in Portugal and Tunisia and final assembly in France to maintain the "Made in France" label. The cameras are then delivered directly to Hollia and subsequently distributed to clients. Effective procurement strategies include negotiating favorable terms with suppliers, ensuring a steady supply of essential components, and maintaining cost efficiency. Additionally, procurement involves sourcing services and tools that support development and operational activities, ensuring that the company can scale and meet client demands without disruption.

2.5.3 RESOURCE-BASED VIEW (RBV) ANALYSIS

The Resource-Based View (RBV) framework helps analyze a company's internal resources and capabilities to determine its potential for achieving a sustainable competitive advantage. According to RBV, resources must be Valuable, Rare, Inimitable, and Non-substitutable (VRIN) to provide a sustainable competitive edge. Here's how Hollia's resources and capabilities align with these criteria:

2.5.3.1 *Tangible Resources*

1. Network of Connected Cameras:

- a. Valuable: Enables real-time data collection and detailed customer insights, crucial for retailers to optimize store operations and enhance customer experiences.
- b. Rare: While camera networks are common, Hollia's integration of advanced AI and machine learning for analytics is unique.
- c. Inimitable: The specific integration of hardware and proprietary software can be challenging for competitors to replicate.
- d. Non-substitutable: While alternative data collection methods exist (e.g., manual counting, beacons), none offer the comprehensive, real-time analytics provided by Hollia's camera network. The integration of video analytics with AI-driven insights provides a level of detail and immediacy that is difficult to substitute.

2. Software and Algorithms:

- a. Valuable: Provides accurate and actionable insights into customer behavior, which can significantly enhance decision-making. It can also help to understand customer traction better at fairs and events.
- b. Rare: Although the models and AI algorithms are open source, the integration of them is unique. The integration of a wide range of features, the further re-train of the model and the chatbot are unique features.
- c. Inimitable: Continuous updates and retraining of models, along with the integration of privacy measures, make it difficult to replicate.
- d. Non-substitutable: The unique blend of AI-driven insights and data privacy features offers distinct advantages that are hard to replace with other technologies.

3. Dashboards

- a. Valuable: The dashboard's intuitive design allows users to easily access and interpret complex data, enhancing decision-making and operational efficiency. It provides a centralized platform for viewing a wide range of analytics, from foot traffic to demographic data, enabling retailers to make informed decisions.
- b. Rare: Combines multiple data features (dwell, paths, zone analysis, feelings...) and types of analytics (e.g., real-time foot traffic, demographic analysis) in one interface, which is not commonly found in competing solutions.
- c. Unimitable: In order to duplicate this dashboard, competitors should have access to a wide variety of data features, which they don't. In addition, the user experience of the dashboard, developed through user feedback and continuous improvement, is difficult for competitors to replicate.
- d. Non-substitutable: The ability to provide a holistic view of in-store analytics in a single platform is difficult to replace with other tools that might only offer partial insights. The dashboard's capability to provide real-time updates ensures timely decision-making, a feature that standalone static reports cannot match.

4. Chatbot:

- a. Valuable: Hollia offers personalized insights and recommendations based on the data collected, helping retailers to implement more effective strategies. It provides immediate assistance and answers to client queries, improving customer satisfaction and engagement.
- b. Rare: Available solutions in the market either offer a generic NLP which is not linked to the client's data, only offer data and don't attend their clients in their decision-making process or are consulting services that can make recommendations based on data but don't do it in real time.
- c. Inimitable: The specific integration of the chatbot with Hollia's analytics platform, enabling it to draw from a wide range of data points to provide informed responses, is challenging for competitors to replicate.
- d. Non-substitutable: The only way to combine the 3 affore mentioned characteristics (data-driven, insightfull and real time) is Hollia's one. Other solutions can only satisfy 2 of the 3.

2.5.3.2 Intangible Resources

5. Anchoring in the Sector:

- a. Valuable: having a first anchor point in the events sector (events organized by the Bonato family) allows us 2 things. On the one hand, having a first client gives us legitimacy and can serve as a success story to attract more clients. On the other hand, by the nature of your business, you have contacts that can open doors to new clients.
- b. Rare: Few startups have the opportunity to work with high-profile clients early on, giving Hollia a unique selling proposition. This partnership sets Hollia apart from competitors who may struggle to gain such initial traction and credibility in the market.
- c. Inimitable: The specific relationship and endorsement from the Bonato family are difficult for competitors to replicate. This connection, built on trust and proven performance, provides Hollia with a distinctive edge that cannot be easily imitated. The bespoke nature of these relationships and the tailored

analytics solutions developed for event environments create a competitive moat.

- d. Non-substitutable: The benefits derived from this sector anchoring are unique and cannot be easily substituted by other resources. The combination of credibility, networking opportunities, and real-world application in a high-stakes environment offers a value that alternative strategies would struggle to match. This anchor point solidifies Hollia's market position and paves the way for sustainable growth and competitive advantage.

6. Technical Expertise and Human Capital:

- a. Valuable: Skilled team members drive innovation and maintain product quality.
- b. Rare: Expertise in AI, machine learning, and computer vision is highly sought after.
- c. Inimitable: The combination of skills, experience, and organizational culture is unique.
- d. Non-substitutable: High levels of technical knowledge and expertise are essential and cannot be easily replaced.

2.5.3.3 Capabilities

7. Talent Attraction:

- a. Valuable: Attracting top talent with expertise in AI, machine learning, and computer vision significantly enhances Hollia's ability to innovate and maintain a competitive edge. Founders' education from prestigious universities provides credibility and access to a vast network of potential hires and collaborators, which is crucial for attracting high-caliber talent.
- b. Rare: The founders' backgrounds from esteemed institutions such as Berkeley are rare and lend a unique prestige that attracts skilled professionals interested in joining a reputable and promising startup. The current high interest in AI development and entrepreneurship creates a competitive environment where attracting top talent is increasingly rare in other sectors.

- c. Inimitable: The unique networks and connections developed through prestigious universities are difficult for competitors to replicate. These relationships can lead to exclusive opportunities for recruitment and partnerships.
- d. Non-substitutable: The quality of talent attracted by Hollia's reputation and network cannot be easily substituted by other means. Skilled professionals with a passion for AI and innovation are critical to driving the company's success. The environment of continuous innovation and learning at Hollia, supported by its talented workforce, provides a unique culture that enhances productivity and creativity, which is difficult to substitute.

2.6 BUSINESS MODEL CANVAS

The BMC serves as a strategic management tool that provides a clear, visual overview of the building blocks needed to bring Hollia's innovative in-store analytics solutions to market successfully.

The preceding sections have established a robust foundation. The company presentation outlined Hollia's mission to bridge the gap between digital and physical customer understanding, and its vision to revolutionize in-store analytics through cutting-edge AI and machine learning technologies. The external analysis, including PESTEL and Porter's Five Forces, highlighted the macro-environmental factors and industry dynamics influencing Hollia's strategic decisions. A detailed competitor analysis, along with an assessment of key success factors and strategic group determination, provided insights into the competitive landscape. The internal analysis, through SWOT and value chain examination, identified Hollia's strengths, weaknesses, opportunities, and threats, while the Resource-Based View (RBV) emphasized the unique resources and capabilities driving Hollia's competitive advantage.

With this extensive groundwork in place, the BMC will integrate these insights to articulate how Hollia creates, delivers, and captures value. Each element of the BMC—ranging from

customer segments and value propositions to key resources and revenue streams—will be explored in detail to highlight Hollia's strategic approach to achieving its business objectives. This section will demonstrate how Hollia's comprehensive, integrated solutions, adherence to privacy regulations, customer-centric approach, and agile development processes coalesce to form a robust business model designed for sustainable growth and long-term success.

2.6.1 VALUE PROPOSITION

Hollia's value propositions are designed to meet the needs of modern businesses looking for comprehensive and efficient analytics solutions. The complete and integrated solution offered by Hollia ensures that clients have all the tools they need in one place, from camera installation to decision-making support. This integration simplifies processes and enhances effectiveness. The easy, cheap, and quick setup of Hollia's systems means that businesses can start benefiting from the solution without significant upfront costs or disruptions. Hollia provides a wide range of insights, including foot traffic, demographics, customer behavior, and emotional responses, giving businesses a comprehensive understanding of their operations and customers. Additionally, consulting services are available to offer personalized recommendations and immediate assistance through an integrated chatbot, helping businesses optimize their operations and improve customer experiences.

2.6.2 PARTNERS

Hollia's key partners form the backbone of its business operations, ensuring both the quality and efficiency of its product offerings. Bobitech is a pivotal partner responsible for the manufacturing of plastic parts and the assembly of Hollia's products, ensuring that all components meet the high standards required for precision and durability. Additionally, Hollia collaborates with hardware suppliers located in China, which are managed internally to maintain a streamlined supply chain. AI Entrepreneurs at Berkeley and the Free Ventures Accelerator provide invaluable mentorship, resources, and networking opportunities, which are crucial for the growth and development of an early-stage startup. The emlyon Business

School Incubator offers significant business development support, helping Hollia refine its business model and strategy. These partnerships collectively enable Hollia to maintain high production quality, innovate continuously, and grow strategically in a competitive market.

2.6.3 ACTIVITIES

Hollia engages in several critical activities that drive its business forward. Research and development (R&D) is at the forefront, with a focus on utilizing AI and computer vision to detect various human features and improve system performance and accuracy. This is complemented by comprehensive data processing and analysis activities, which provide easy-to-use and insightful dashboards that help clients make informed decisions. Additionally, Hollia places a strong emphasis on customer support, offering consulting services and real-time insights through a custom LLM chatbot. This ensures that clients receive immediate assistance and can maximize the value derived from Hollia's solutions. These activities are essential for developing advanced products, delivering superior customer service, and maintaining a competitive edge in the market.

2.6.4 RESSOURCES

The key resources of Hollia are instrumental in delivering its value propositions. The network of connected cameras provides real-time data collection, which is crucial for accurate and timely analytics. Advanced software and algorithms ensure that the insights derived from the data are both accurate and actionable, helping clients make better decisions. Hollia's skilled team, with expertise in AI, machine learning, and computer vision, is a critical asset that drives innovation and continuous improvement. Partnerships and networks, particularly with prestigious institutions and business incubators, offer additional support and opportunities for growth. These resources collectively enable Hollia to offer a comprehensive and integrated solution to its clients.

2.6.5 CHANNELS

Hollia employs multiple channels to reach its customers effectively. Direct sales are a key channel, with the company engaging directly with retailers and event organizers to sell its solutions. An online presence is maintained through digital marketing and online

platforms, which help Hollia reach a broader audience and increase visibility. Additionally, Hollia leverages partnerships with business incubators and accelerators to gain introductions and referrals, expanding its network and customer base. The company also actively participates in fairs and other events to promote its products and engage with potential clients. These diverse channels ensure that Hollia can reach its target customers efficiently and effectively.

2.6.6 RELATIONSHIPS

Hollia focuses on building long-term partnerships by maintaining strong relationships with its clients. This is achieved through a robust customer feedback loop, ensuring constant satisfaction and addressing any issues promptly. Compliance with privacy regulations is crucial to building trust, as it delivers consistent value through the detailed analytics provided. The company also capitalizes on its initial customer base from the founders' family network, using their satisfaction as a foundation to build credibility and attract new clients.

2.6.7 CUSTOMERS

Hollia targets two primary customer segments: retailers and event organizers. Retailers are looking to better understand their customer base to customize their offers, optimize in-store operations, and enhance the overall customer experience. By providing detailed analytics on foot traffic, demographics, and customer behavior, Hollia helps retailers make data-driven decisions to improve store layouts, product placements, and marketing strategies. On the other hand, event organizers need reliable attendance and client conversion metrics to justify business success for their clients and improve event layouts and attendee experiences. Hollia provides these insights through its advanced analytics, enabling event organizers to optimize their event spaces and enhance visitor satisfaction.

Hollia first emphasizes on the most important chains having large surface shops. This way, the customer acquisition cost is minimized, as a single shop will enable the installation of a large number of cameras in the same store and potentially the deployment of this service in other stores of the same chain.

2.6.8 COSTS

The main costs for Hollia include manufacturing and logistics expenses associated with hardware production, assembly, and shipping. Additionally, there are costs related to cloud services for delivering the dashboard and chatbot services to clients. By managing the camera manufacturing, setup, and maintenance internally, Hollia keeps its operational costs low. This cost-effective approach allows the company to offer affordable solutions to its clients, facilitating widespread adoption and ensuring the sustainability of its business model. Other support functions can be cost-intensive as well as legal, to keep up with regulations, R&D, to keep systems up to date and increase their performance, accuracy, and sales, since the first clients are the hardest to get (0 to 1).

2.6.9 REVENUES

Hollia generates revenue through a subscription model, offering monthly subscriptions for access to the analytics dashboard and chatbot services. Additionally, there are one-time fees for the initial setup fees for hardware cameras. This approach follows a 'printer strategy,' where the initial hardware is sold cheaply to attract customers, with ongoing revenue generated from the subscription services. This model ensures a steady revenue stream while encouraging clients to adopt and continue using Hollia's comprehensive analytics solutions.



Figure 39: Hollia's BMC chart

2.7 ECONOMIC ANALYSIS

Taking into account all the previous analysis, Holli's pricing strategy is determined, and potential revenues are calculated. Then, this is compared with the market size to verify if these revenues are realistic or not.

2.7.1 PRICE STRATEGY

- Cost of materials: Board, sensors, USB programming adapter, cables, transformer, antenna, enclosure: 40\$
- Cost of assembly: 31.5\$ (estimating 90 minutes of assembly and inspection and a 25\$/hour rate, all costs included)
- Cost of waste: 7.9\$ assume a 5% defect rate for rework or scrap
- Total cost of cameras: 79.4\$
- Cost of installation: a network takes 20 minutes to install, and each camera adds 10 minutes. The typical wage for this technical work is between 50 to 100\$.

In a conservative scenario, the amortization length for these cameras is around 2 years, and supposing that each temporary camera will be used by a client a month, each camera is amortized by 36 customers, resulting in a cost of 2.25 \$ per client.

Given that some of our clients would like to use this resource temporarily and other are temporary clients for nature (events sector), 2 different offers are available:

- Short program: < 7 days usage:
 - o Upfront cost: 100\$ installation cost per camera
 - o Basic option: 50\$/day/camera
 - o Demographic analysis: 15\$/day/camera
 - o Sentiment analysis: 15\$/day/camera
- Permanent program:> 7 days usage
 - o Upfront cost: 150\$ installation cost per camera
 - o Basic option: 100\$/month/camera
 - o Demographic analysis: 20\$/month/camera

- Sentiment analysis: 20\$/month/camera

2.7.2 REVENUE ANALYSIS: TARGET CLIENTS

In France, the total retail area is 73 M sqm according to INSEE and is distributed as follows:

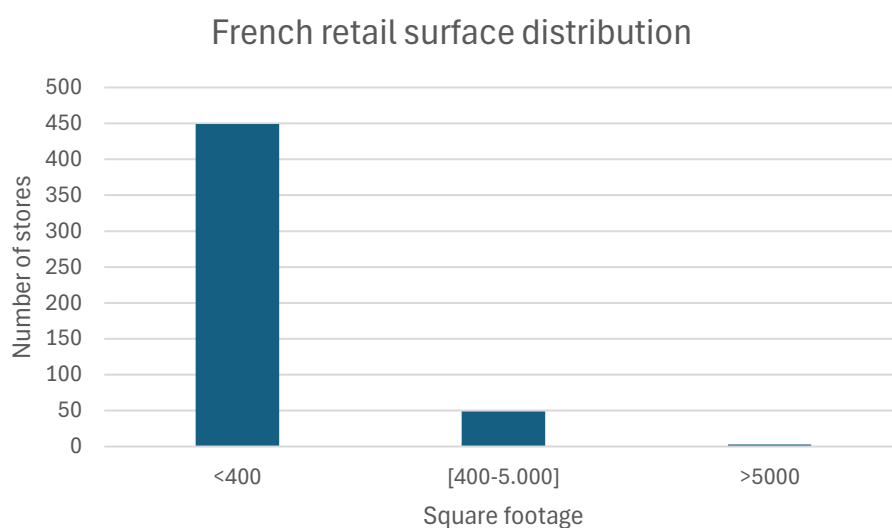


Figure 40: French retail surface distribution

The median surface is 1.145 sqm and the average is 2.020 sqm. As the most cost-effective clients are the largest ones, Hollia will aim at the second and third category, that means, at stores bigger than 400 sqm, which represent more than half of the surface but less than 10% of the stores. As surface means revenue and number of store means cost, it is natural that Hollia focuses on those 2 segments.

2.7.3 ECONOMIC PROJECTION EXAMPLE

A number of target shops have been located taking into account a series of criteria such as: belonging to a large chain, large surface area, good income and geographical location. The number of customers corresponds to the number of chains or brands. With this, it has been possible to estimate the number of cameras, assuming that enough cameras are

installed to cover half of the shop and that one camera covers a surface of 500 m². With this, the number of cameras and the associated variable costs are calculated. For the fixed costs, the human resources plan detailed in the internal analysis has been followed and a high salary range has been taken. In addition, marketing costs have been budgeted at 11% of sales and material and licensing costs have been budgeted in proportion to the number of cameras.

This leads to a good financial projection, which starts with losses but quickly turns positive in the second year.

	2025	2026	2027
Income	47.875,00 €	531.165,00 €	1.590.125,00 €
Server cost	-4.182,00 €	-59.284,33 €	-204.030
Cost of camera	-4.049,40 €	-39.144,20 €	-134.980,00 €
Profit	39.643,60 €	432.736,47 €	1.251.114,67 €
Wages and withholding	-48.000,00 €	-374.000,00 €	-886.000,00 €
Marketing cost	-5.266,25 €	-58.428,15 €	174.913,75 €
Licenses	-66.300,00 €	-110.500,00 €	-44.200,00 €
Material	-143.700,00 €	-239.500,00 €	-95.800,00 €
	-223.622,65 €	-349.691,68 €	400.028,42 €

Table 2: Economic Analysis

	2025	2026	2027
Permanent clients			
number of clients	3	8	13
number of surfaces	4	59	192
total surface covered	28.600	65.000	122.200
number of cameras sold	38	493	1.700
Short term clients			
number of clients	2	3	3
number of surfaces	2	3	3
total surface covered	19.500	58.500	58.500
number of cameras rented	20	59	59

Table 3: revenue analysis

3 MVP DEVELOPMENT

3.1 DESCRIPTION OF TECHNOLOGIES

Computer vision is a subfield of artificial intelligence that enables computers to interpret and make decisions based on visual data. It involves the development of algorithms and models that can process, analyze, and understand images and videos. (“swetha(w)-av-presentation-How Computer Vision Has Changed ... - SlideShare”) Computer vision techniques are widely used in various applications, including object detection, Figure classification, facial recognition, surveillance and autonomous vehicles. Currently, there are numerous open-source computer vision models, pre-trained and with easy-to-use APIs. This makes it much easier for Hollia to rapidly develop a high-quality MVP to present to the first customers.

3.1.1 VIDEO PROCESSING FOR OBJECT DETECTION AND TRACKING

In the scope of this project, the main goal of computer vision programming is to accurately identify and track people within a video stream and stock it in an easily manipulable database from which business dashboards will be built. The main steps in this process include frame extraction, object detection, object tracking, annotation and information extraction.

1. Frame Extraction: breaking down the video into individual frames for analysis.
2. Object detection: identification and localization of objects within the frame.

This involves recognizing what objects are present and determining their positions, typically through bounding boxes. A bounding box is a rectangle that surrounds an object, that specifies its position, class (eg: car, person) and confidence (how likely it is to be at that location) (Subramanyam, s.f.). The following figure provides an example of a bounding box.



Figure 41: Bounding box annotation (Subramanyam, s.f.)

Modern object detection techniques often leverage deep learning models, such as Convolutional Neural Networks (CNNs) and variants like YOLO (You Only Look Once) and SSD (Single Shot MultiBox Detector) (Single Shot MultiBox Detector), to achieve high accuracy and real-time performance. As explained in the introduction, the technique used in this project is YOLO. YOLO models are known for their speed and accuracy in detecting objects in real-time. YOLOv8, the latest iteration, further enhances these capabilities with improved architecture and training techniques.

3. Object tracking: monitoring the positions of objects across consecutive frames in the video.

The goal is to maintain the identity of each object as it moves through the scene, even when it is partially or temporarily occluded. Object tracking algorithms can be broadly classified into two categories: single-object tracking (SOT) and multiple-object tracking (MOT), the latter naturally being the one used in this project.

4. Annotation: annotating frames with bounding boxes, labels, and other markers that help in visualizing the tracked objects.

5. Information Extraction: arranging data in an efficient and handy structure to derive meaningful data from the detected and tracked objects. In the scope of this project, people and time counting and zone segmentation will be developed. With these 2 features and proper data extraction, multiple analysis can be performed.

3.1.2 CHOICE OF LIBRARIES

In this section, we will delve into the specific technologies and libraries used to implement the video processing steps:

- Extraction of frames, annotation of detections and conversion of detection results for visualization: Supervision
- Object detection: YOLOv8 model, from Ultralytics
- Object tracking: BYTETracker

3.1.2.1 Supervision Library

Supervision is designed to streamline the process of video annotation and analysis. It provides higher-level abstractions for handling video frames, making it easier to implement object tracking, annotation, and visualization. Supervision is often preferred over OpenCV since it usually requires less code to achieve complex tasks and for the quality of its documentation.

Key Features:

- Video Frame Extraction: Facilitates the extraction of frames from a video file for processing.
- Annotation Tools: Offers utilities for drawing bounding boxes, labels, and trace lines on video frames.
- Detection Conversion: Converts detection results from various object detection models into a unified format.

3.1.2.2 YOLO (You Only Look Once) Model

Ultralytics has gained considerable recognition for its role in developing the YOLO (You Only Look Once) series of object detection models. These algorithms employ convolutional neural networks (CNNs), which are neural networks that utilise a convolutional operation on the input matrix. The designation "YOLO" is derived from the algorithm's capacity to process the Figure as a whole, through the various layers of the network, which enables it to achieve significantly shorter detection times than other currently available models. This makes it particularly well-suited to applications where real-time detection is essential. The latest iteration, YOLOv8, introduces new features and improvements that enhance performance, flexibility, and efficiency. (“Object Tracking with YOLOv8 and Python - PyImageSearch”) (Raha, s.f.).

3.1.2.3 ByteTrack Library

This code uses ByteTrack (Zhang, 2021), a multi-object tracker. ByteTrack is particularly known for its ability to handle occlusions and re-identify objects when they reappear after being temporarily obscured.

Key Features:

- Track Activation Threshold: Determines the confidence level required to activate a new track.
- Lost Track Buffer: Specifies the number of frames an object can be missing before it is considered lost.
- Minimum Matching Threshold: Sets the minimum threshold for matching detections to existing tracks.

3.2 MVP DEVELOPMENT

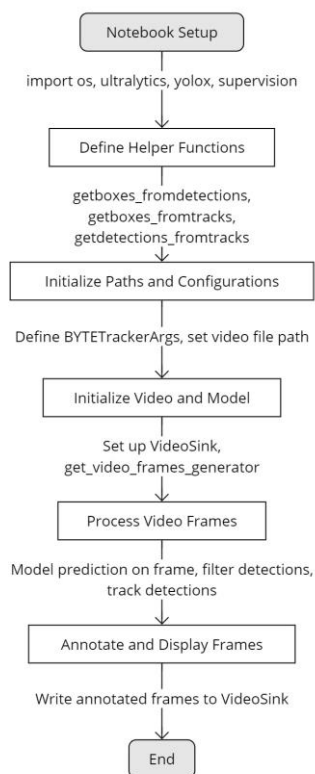
3.2.1 PEOPLE DETECTION AND TRACKING

3.2.1.1 Issue 1: Custom tracking development

Initially, the aim was to develop highly customized code with well-established library versions. As this is a cutting-edge topic, these libraries are constantly evolving, which can lead to conflicts between libraries and versions. Since this version of the code establishes the foundation of what the product will be, having custom code without being subject to library variations was desired. The libraries used to solve this first version are Ultralytics YOLOv8.0.119 and Supervision 0.1.0 by Roboflow.

3.2.1.1.1 Code

The resulting code has the following structure:



Scheme 1: Code for custom issue 1

Some relevant functions of the code are explained below:

- getboxes_fromdetections: converts Detections objects into a format that can be consumed by the BYTETracker for tracking, combining bounding box coordinates and

confidence scores into a single array. It horizontally stacks the bounding box coordinates and the confidence scores, creating an array where each detection is represented by its bounding box coordinates and confidence score.

- getboxes_fromtracks: prepares tracking data by extracting bounding box coordinates from each STrack object and converting them into a NumPy array to make it suitable for the format suitable for a function called match_detections_with_tracks function
- getdetections_fromtracks: matches detections with existing tracks (previous detections) using Intersection Over Union (IoU) to associate detected objects with their corresponding tracks. It calculates the IoU between the bounding boxes of the detections and tracks. The result is an IoU matrix where each element represents the IoU between a detection and a track (figure represents the IoU matrix). Then, it iterates over the IoU matrix to find the best matching track for each detection based on the highest IoU value. If a match is found, the corresponding track ID is assigned to the detection.

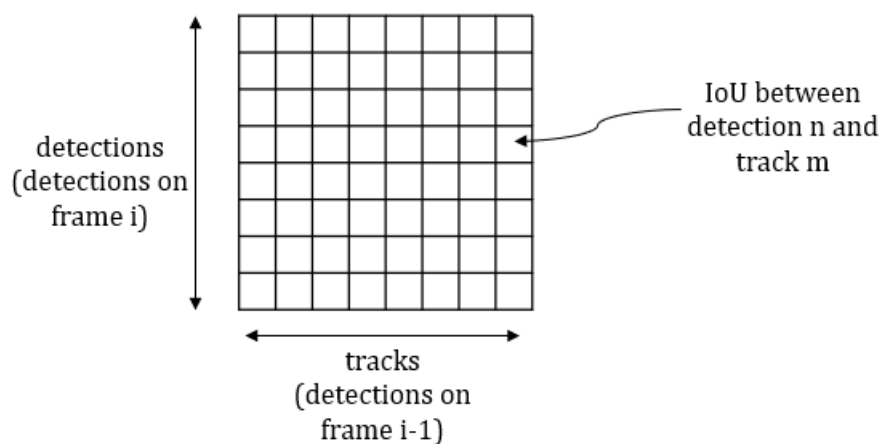


Figure 42: IoU matrix

3.2.1.1.2 Results

The results obtained from this code from 2 consecutive frames are the following:

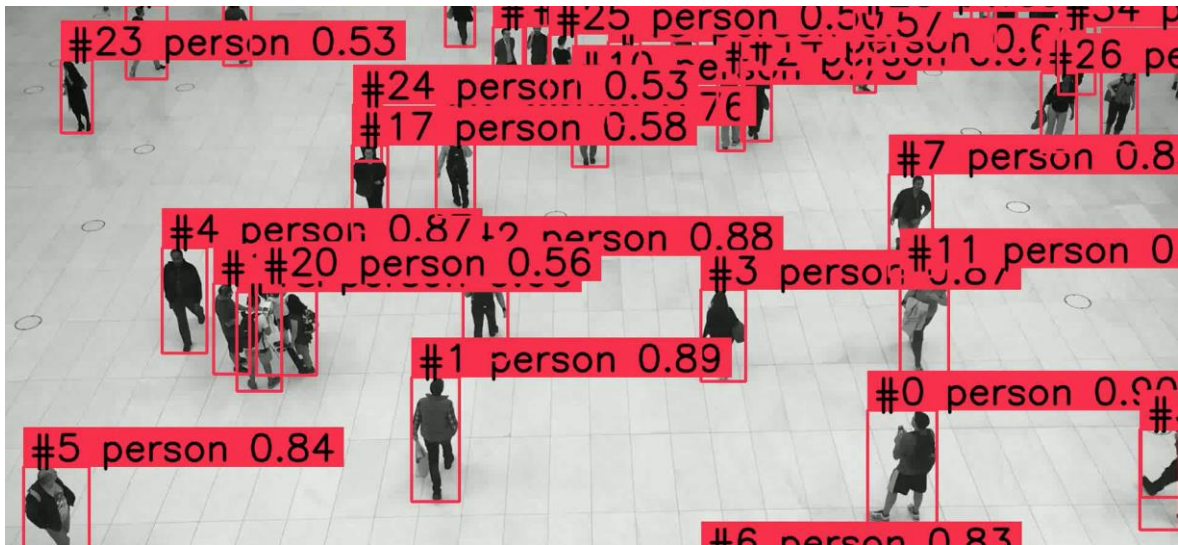


Figure 43: Results at frame 1 for custom issue 1



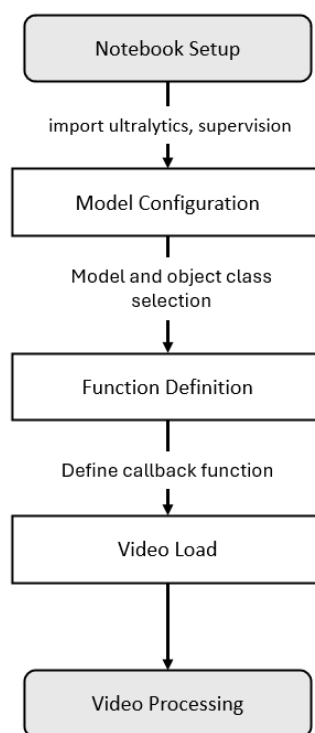
Figure 44: Results at frame 2 for custom issue 1

3.2.1.1.3 Analysis of results

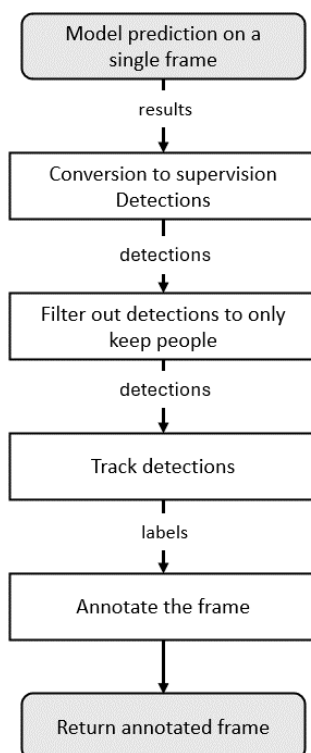
The model is inaccurate in tracking the objects when it comes to assigning each detection to its track. Considering these results, it is deemed necessary to resort to the latest updates of the libraries and use the latest versions of the functions they offer. This will increase the product's dependency on the existing libraries but will provide faster and easier development.

3.2.1.2 Issue 1: Code relying on existing libraries

Considering the above results, a code is developed that relies more on existing libraries. The ByteTrack library is used to track people through space. The structure of the code is as follows:



Scheme 2: Code for issue 1



Scheme 3: Callback function in issue 1

The assignment of everyone within a given frame to a corresponding track is no longer conducted manually; rather, it is now accomplished using the bytetrack library, which has been demonstrated to possess a high degree of reliability.

3.2.1.2.1 ByteTrack inicialiation

The BYTETrackerArgs class is a data class that defines the parameters for the tracker:

```
tracker_args = BYTETrackerArgs(  
    track_thresh=0.3,  
    track_buffer=25,  
    match_thresh=0.7,  
    aspect_ratio_thresh=2.5,  
    min_box_area=2.0  
)  
  
byte_tracker = BYTETracker(tracker_args)
```


Where:

- track_thresh: is the threshold for initializing a new track. Detections with confidence scores above this threshold are considered for tracking.
- track_buffer: defines the number of frames to keep a track alive without updates. If a track does not get updated for track_buffer frames, it is considered lost and will be removed.
- match_thresh: the matching threshold for associating detections with existing tracks using the Intersection Over Union (IoU) metric.
- aspect_ratio_thresh: threshold used to filter detections based on their aspect ratio. Detections with an aspect ratio (height/width) greater than this threshold are discarded.
- min_box_area: sets the minimum area of the bounding box for a detection to be considered valid.

3.2.1.2.2 Results

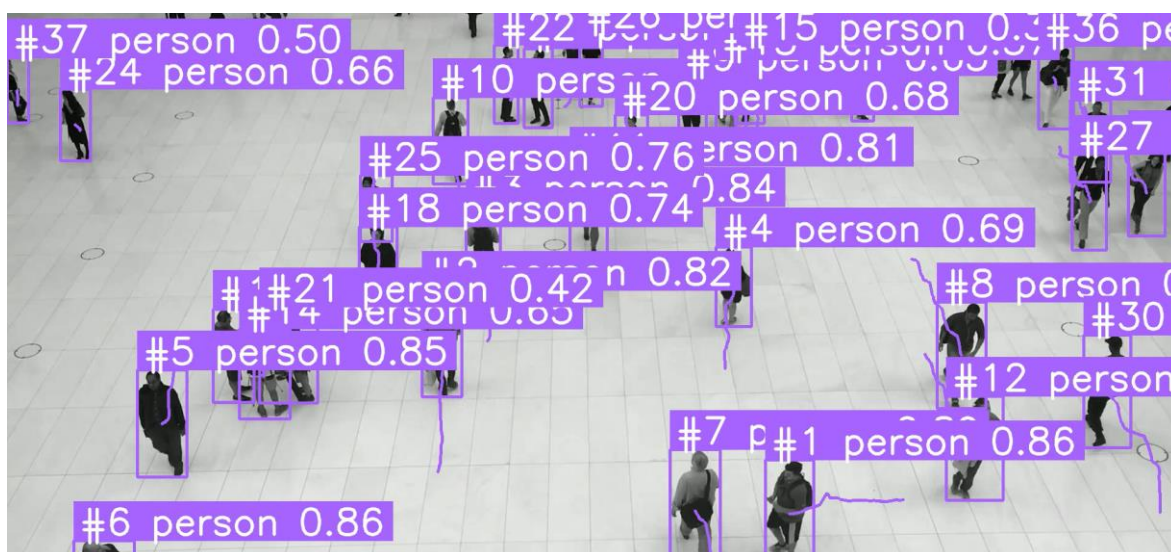


Figure 45: Results at frame 1 for issue 1



Figure 46: Results at frame 1 for issue 1

In this test, most individuals are correctly identified, and the assigned paths are also accurate. Furthermore, the tracking issues that were previously observed have been resolved. This functional version can now be used as a foundation for incorporating new features into the code and improving overall accuracy.

3.2.2 ISSUE 2: ZONE SEGMENTATION

The aim of this issue is to create zones in the Figure and count the number of people in the image. This is done using the PolygonZone class provided by the supervision library. This has both a method for counting detections within a zone (trigger method) and the corresponding annotation elements. Parts of the code used to create, count and annotate 1 zone are detailed below:

```

polygon = np.array([
    [500, 300],
    [1250, 300],
    [1250, 800],
    [500, 800]
])

polygon_zone = sv.PolygonZone(polygon=polygon)
zone_annotator = sv.PolygonZoneAnnotator(zone=polygon_zone, color=sv.Color.WHITE,
    thickness=2, text_thickness=2, text_scale=2)

```

Inside the callback function:

```
annotated_frame = zone_annotator.annotate(  
    scene=annotated_frame)  
  
# Update counters  
polygon_zone.trigger(detections=detections)
```

3.2.2.1.1 Results



Figure 47: Issue 2 results frame 1

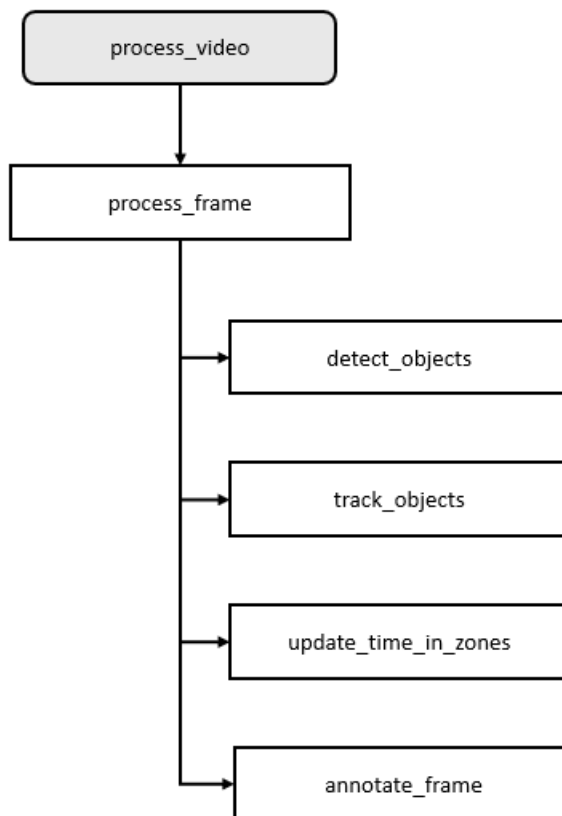


Figure 48: Issue 2 results frame 2

The results are satisfactory as the people are identified, the tracking is good and the count in the zone is accurate, although the default configuration does not allow to determine up to which level of intersection between the zone and the bounding box is considered inside or outside. The latter will be considered when developing issue 3. Furthermore, it remains to be seen whether the management of several zones is easy to implement or whether the code structure will have to be changed to be able to do so.

3.2.3 ISSUE 3: COUNT THE TIME TAKEN BY A PERSON IN AN AREA

Counting time in a zone requires a slight change in the structure of the code, defining more support functions and making the code more modular.



Scheme 4: Issue 3 code cheme

Another significant alteration that is implemented in this issue is the use of the *cv2* library instead of *supervision* for the purpose of identifying the presence of an individual within a given area. This approach, which is more manual, provides greater flexibility in managing presence and time, and yields results that are comparable to those obtained using the *supervision* library. Now, to determine whether a person is in a zone, its centroid is calculated. If it is in the zone, the person is in the zone. By not using the method offered by *supervision*, the sensitivity to presence can be changed in the future if the centroid is no

longer a desired indicator, even using a % intersection between the zone and the bounding box, for example.

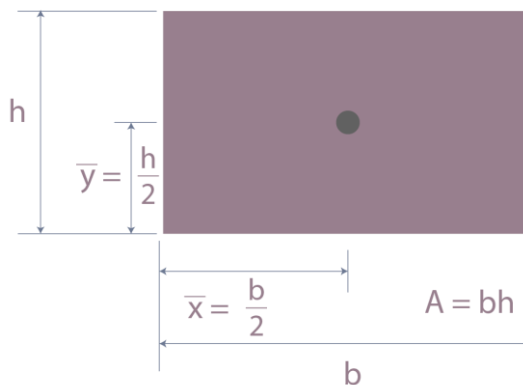


Figure 49: Rectangle's centroid

To calculate the time, the frame rate is used. Each time the person is detected in the frame, the time variable is incremented by one over the frame rate ($1/\text{frame_rate}$). A variable, `time_in_zones`, is created that stores the time associated with each `track_ID` that enters the zone. This variable is not defined within the auxiliary functions, so it can be exploited in the main and is close to the data management model we wish to achieve.

```
def update_time_in_zones(tracked_detections, time_in_zones, polygon):
    for detection in tracked_detections:
        bbox, _, confidence, class_id, tracker_id, metadata = detection

        # Calculate centroid from bbox
        centroid = np.array([(bbox[0] + bbox[2]) / 2, (bbox[1] + bbox[3]) / 2])

        # Check if the centroid is inside the polygon using cv2.pointPolygonTest
        if cv2.pointPolygonTest(polygon, tuple(centroid), False) >= 0:
            if tracker_id not in time_in_zones:
                time_in_zones[tracker_id] = 0
            time_in_zones[tracker_id] += 1 # Increment time by 1 frame duration
```

3.2.3.1.1 Results

Both time and area management are successfully carried out. In this example, the label that previously contained the precision now contains the person's time in a zone.



Figure 50: Issue 3 results frame 1



Figure 51: Issue 3 results frame 2

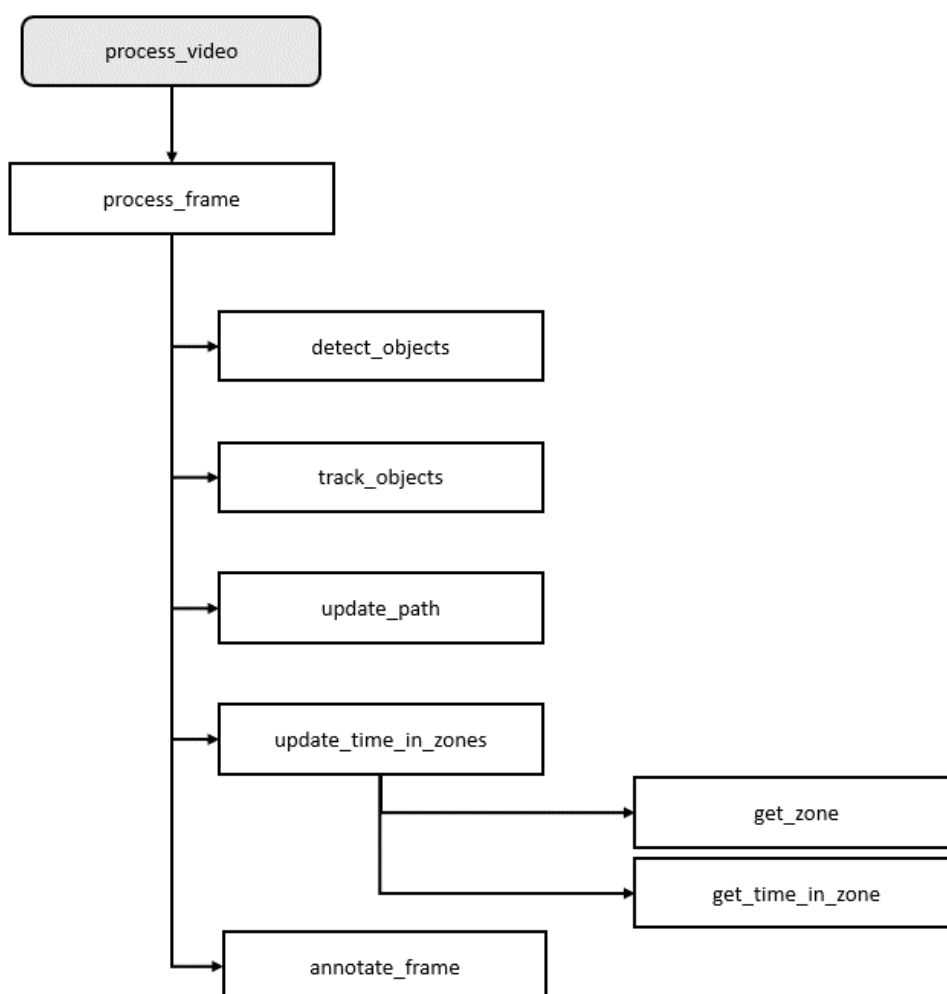
The variable `time_in_zones` return the following information, which is in line with the information displayed on the video:

```
Time spent by each person in the zone (in seconds):
Tracker ID 2: 3.90 seconds
Tracker ID 3: 2.63 seconds
```

```
Tracker ID 4: 3.57 seconds
Tracker ID 10: 0.10 seconds
Tracker ID 18: 5.73 seconds
Tracker ID 11: 5.67 seconds
Tracker ID 25: 6.13 seconds
Tracker ID 7: 4.83 seconds
Tracker ID 20: 5.57 seconds
Tracker ID 38: 4.83 seconds
Tracker ID 43: 0.17 seconds
Tracker ID 9: 4.13 seconds
Tracker ID 44: 4.97 seconds
Tracker ID 39: 4.93 seconds
Tracker ID 50: 3.10 seconds
Tracker ID 57: 1.10 seconds
```

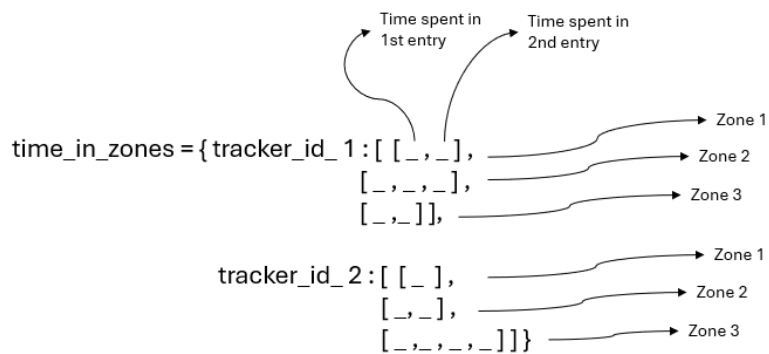
3.2.4 ISSUE 4: STORE THE EVOLUTION OF A PERSON

The aim of this latest issue is to store the evolution of a person within the enclosure. At the moment, the data stored is the time spent by each person in each zone each time it enters. To be able to store this information, it is necessary to redefine the way in which the variables are structured to approach the database model that will be exported in issue 5. In this issue we do not add new functionalities, but the code is cleaned up and made even more modular so that the management of the variables is done in a more controlled way. Thanks to the development of the 3 previous issues, a deep knowledge of the libraries has been achieved, which allows to manipulate these libraries with great ease. This change makes it possible, for example, to manage several zones at the same time. The new code has the following structure:



Scheme 5: Code scheme for issue 4

The variable that stores the evolution of a person is `time_in_zones` and is a dictionary of lists of lists, where each key is the ID of a person and the value is a list of N-dimension, where N is the number of defined zones. Each value in the list is in turn a list containing the duration of each person in the zone each time he/she enters. If, for example, 3 zones are defined and a person enters zone 1, stays 3 seconds, goes to zone 2, stays 2 seconds and then returns to zone 1, where he stays 4 seconds, the list will have the form: `[[3,1], [4],[0]]`. In addition, to detect the change of zones or the appearance of an ID for the first time, another dictionary is used in which each key is the ID of each person, and the value is the zone in which it was in the previous frame.



Scheme 6: Variable time_in_zones structure

3.2.4.1.1 Results

The results obtained are satisfactory. As can be seen in the following illustrations, the count, time and number of entries in a zone is accurate.



Figure 52: Issue 4 results frame 1

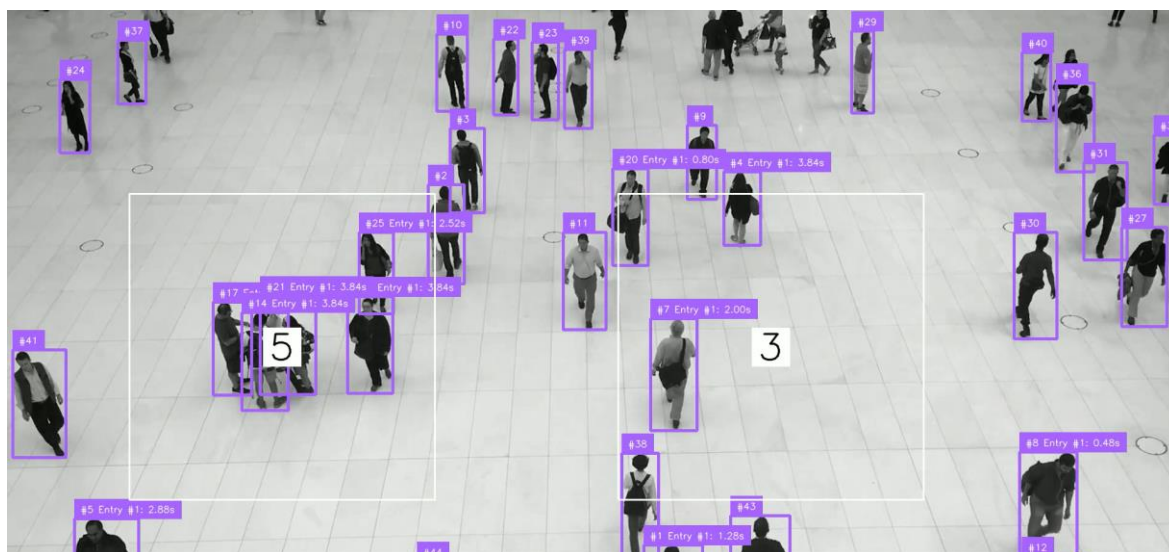


Figure 53: Issue 4 results frame 1

3.2.5 ISSUE 5: DATA EXPORT

The aim of this issue is to export the data obtained in an Excel sheet. This data is exported in two sheets within the same file. The first sheet contains the time and number of entries per zone and person, while the second sheet contains the coordinates (x,y) of each person detected in the video. The structure of this code is the same, adding new libraries at the end of the code to create these databases.

3.2.5.1.1 Results

The results obtained are shown in the following 2 tables. Both the entries and exits of each zone as well as the evolution of each person through the video are saved as a successful zone.

Tracker ID	Zone	Entry Number	Time Spent (s)
1	2	1	3,2
2	1	1	4,24
2	2	1	1,16
8	1	1	1,24
8	2	1	0,32
10	1	1	1,88

11	1	1	4,68
11	2	1	2,76
13	1	1	0,32
18	1	1	3,08
18	2	1	3,2
25	1	1	5,08
25	2	1	3
3	1	1	4,56
12	2	1	1,6
20	1	1	5,76
20	2	1	2,96
7	1	1	4,76
7	2	1	2,84
5	2	1	2,16
4	1	1	5,16
9	1	1	5,04
9	2	1	2,6
38	1	1	4,8
38	2	1	2,72
43	1	1	3,88
43	2	1	2,16
44	1	1	4,8
44	2	1	2,6
39	1	1	5,16
39	2	1	1,68
30	1	1	2,04
41	2	1	0,52
50	1	1	0,52
50	2	1	2,72
47	1	1	1,28
57	2	1	2,28
61	2	1	1,84
53	1	1	1,08
52	1	1	1
71	2	1	0,48

Table 4: Issue 4 results for zone management

Tracker ID	X	Y
1	1467,214	795,6176

1	1461,591	796,2612
1	1459,095	796,2429
1	1457,446	795,4543
1	1454,032	795,759
1	1452,635	796,2524
1	1451,704	796,4048
1	1446,071	797,5523
1	1443,875	797,9093
1	1442,735	798,4073
1	1441,495	798,127
1	1438,597	798,2437
1	1431,548	798,2823
1	1428,306	797,7821
1	1421,694	797,0883

Table 5: Issue 4 results for people evolution



UNIVERSIDAD PONTIFICIA COMILLAS
ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)
MÁSTER UNIVERSITARIO EN INGENIERÍA INDUSTRIAL

1 REFERENCES

AI Index. (2024). *Artificial Intelligence Index Report 2024*. HAI Stanford University Human-Centered Artificial Intelligence.

Birritella, T. (s.f.). Obtenido de FIU Business: <https://business.fiu.edu/academics/graduate/insights/posts/why-retailers-will-bounce-back-to-a-new-reality-after-the-pandemic.html>

Diana Chien, P. C. (s.f.). *Broad Institute of MIT and Harvard*. Obtenido de <https://mitcommlab.mit.edu/broad/commkit/coding-mindset/#Intro>

Djurickovic, T. (26 de March de 2024). *10 French startups to watch in 2024*. Obtenido de <https://tech.eu/2024/03/26/10-french-startups-to-watch-in-2024/>

European Commission. (s.f.). *Directorate-General for Communication*. Obtenido de https://commission.europa.eu/law/law-topic/data-protection/reform/rules-business-and-organisations/obligations/what-does-data-protection-design-and-default-mean_en

Facon, P. (s.f.). *Le Coin des Entrepreneurs*. Obtenido de <https://www.lecoindesentrepreneurs.fr/facteurs-cles-de-succes-definition-identification/#facteur-cl%C3%A9-de-succ%C3%A8s>

Federal Reserve Bank of Saint Louis. (s.f.). Obtenido de <https://fred.stlouisfed.org/series/PCU332510332510#>

Gennette, J. (s.f.). *CNN*. Obtenido de <https://www.cnn.com/2022/06/16/business/online-shopping-stores-retail/index.html>

HLB Survey. (s.f.). *Retailers look to AI to face macro risks*. Obtenido de Retail Sector Outlook – HLB Survey of Business Leaders 2024:

[https://www.hlb.global/insights/survey-of-business-leaders/2024/retail-sector- University of Alabama, members of the Delta Zeta outlook/](https://www.hlb.global/insights/survey-of-business-leaders/2024/retail-sector-University-of-Alabama-members-of-the-Delta-Zeta-outlook/)

Huynh, N. (s.f.). *Medium*. Obtenido de https://medium.com/@nghihuynh_37300/understanding-evaluation-metrics-in-medical-image-segmentation-d289a373a3f

Intersoft consulting. (s.f.). *GDPR*. Obtenido de Privacy by design: <https://gdpr-info.eu/issues/privacy-by-design/>

Lee, T. (2015). Value Chain for Software Product Delivery. Obtenido de <https://www.linkedin.com/pulse/value-chain-software-product-delivery-thomas-lee/>

Lindahl, M. (s.f.). *Visions of the Future: How Computer Vision Technology is Transforming Industries*. Panasonic Research. Obtenido de <https://eu.connect.panasonic.com/sites/default/files/media/document/2024-04/Visions%20of%20the%20Future%20-%20How%20Computer%20Vision%20Technology%20is%20Transforming%20Industries.pdf>

Logic, G. (s.f.). *Retail After COVID-19: How Innovation is Powering the New Normal*. Obtenido de <https://www.globallogic.com/insights/blogs/retail-after-covid-19/>

McKinsey & Co. (s.f.). Retail reset: A new playbook for retail leaders. Obtenido de <https://www.mckinsey.com/industries/retail/our-insights/retail-reset-a-new-playbook-for-retail-leaders>

Mordor Intelligence. (s.f.). *Computer Vision Market Size & Share Analysis - Growth Trends & Forecasts (2024 - 2029) Source: https://www.mordorintelligence.com/industry-reports/computer-vision-market*.

Raha, A. R. (s.f.). Obtenido de PyImageSearch: <https://pyimagesearch.com/2024/06/17/object-tracking-with-yolov8-and-python/>

Retail After COVID-19. (s.f.). Obtenido de CDI World: <https://cdi-world.com/en-us/retail-after-covid-19/>

Rezatofighi, H. a. (2019). Generalized Intersection over Union. *The IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*.

Subramanyam, V. S. (s.f.). *Analytics Vidhya*. Obtenido de Medium: <https://medium.com/analytics-vidhya/basics-of-bounding-boxes-94e583b5e16c>

tasq.ai. (s.f.). Obtenido de Jaccard index (IoU): <https://www.tasq.ai/glossary/jaccard-index-iou/#:~:text=Dice%20Coefficient%2D%20The%20Dice%20coefficient,between%20expected%20and%20true%20values.>

Zhang, Y. a. (13 de October de 2021). ByteTrack: Multi-Object Tracking by Associating Every Detection Box. *Proceedings of the European Conference on Computer Vision (ECCV)*. Obtenido de <https://arxiv.org/abs/2110.06864>

ANNEX I

- **IOU explanation**

In order to track a person throughout the video, it is necessary to find a way to relate the detections of one frame to those of the next frame. To do this, IoU is employed. IoU is a performance metric used to evaluate the accuracy of annotation, segmentation and object detection algorithms. It quantifies the overlap between the predicted bounding box and the actual bounding box to tell if a prediction is good. In this study, it is used to know if a detection corresponds to the same object as the previous detection. If a detection overlaps with another detection one frame earlier, this means that it is the same object but one instant before the previous detection.

Intersection over Union (IoU), also known as the Jaccard index, is the most popular evaluation metric for tasks such as segmentation, object detection and tracking (Rezatofighi, 2019). It measures the overlap between the predicted bounding box and the ground truth bounding box. IoU is a widely accepted standard in the computer vision community (partly thanks to its invariance to the scale (Rezatofighi, 2019)), facilitating comparison with other research and products.

The formula for IoU is:

$$IoU = \frac{\textit{Area of Union}}{\textit{Area of Overlap}}$$

- Area of Overlap is the area where the predicted bounding box and the ground truth bounding box intersect.
- Area of Union is the total area covered by both the predicted bounding box and the ground truth bounding box, excluding the area of overlap.

Mathematically, it is expressed as:

$$IoU = \frac{|A \cap B|}{|A \cup B|}$$

Where $|A \cap B|$ is the intersection area and $|A \cup B|$ is the union area of the predicted bounding box A and the ground truth bounding box B.

A visual explanation is provided in picture [XX]

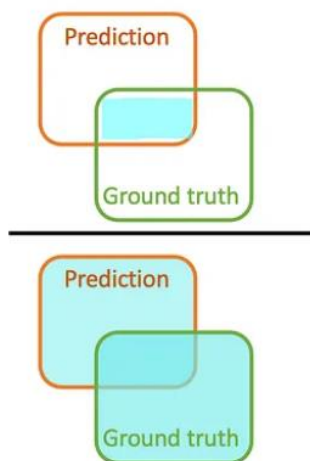


Figure 54: IoU explanation (Huynh, s.f.)

- **Dice Coefficient**

The Dice Coefficient, also known as the Sørensen–Dice index or F-1 score, is similar to IoU but places more emphasis on the overlap between the predicted and ground truth regions. The formula for the Dice Coefficient is:

$$\text{Dice Coefficient} = \frac{2 \cdot |A \cap B|}{|A| + |B|}$$

Where $|A|$ is the area of the predicted bounding box, $|B|$ is the area of the ground truth bounding box and $|A \cap B|$ is the area of overlap between the predicted and ground truth bounding boxes. A visual explanation is provided in picture [XX]

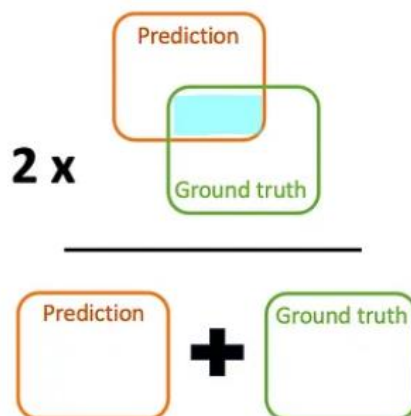


Figure 55: Dice coefficient explanation (Huynh, s.f.)

The Dice Coefficient is often used in medical imaging and other applications requiring a high degree of overlap precision. While similar to IoU, it may not be as widely recognized in general object detection tasks (tasq.ai, s.f.).