Haute Ecole

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Higher education of the long type at the university level

Libra scale

An inventory tracker for the F&B industry

Thesis presented by:

Anthony Mady

For obtaining a:

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Promoter:

Dr. Marine Falize

Boulevard Brand Whitlock 6 - 1150 Bruxelles

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Acknowledgment:

First and foremost, I would like to express my gratitude to ICHEC for the incredible opportunity it has provided me. I come from Lebanon, a country that has endured many crises, making it challenging for students to find opportunities domestically. ICHEC made it possible for me to pursue this prestigious experience, enabling me to kickstart my future and restoring my hope for great achievements. I will forever cherish this memory and will proudly share the good name of ICHEC, just as this institution has placed its trust in me

Next, I would like to thank my promoter, Doctor Falize, for listening to my idea and agreeing to guide me throughout my journey of thinking, writing, and refining my thesis. Your insights and support have been invaluable, and I deeply appreciate the time and effort you have dedicated to helping me succeed.

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I would like to express my heartfelt gratitude to my parents for their unwavering support throughout my career. Their guidance, encouragement, and unconditional belief in me have been invaluable, regardless of the choices I've made or the paths I've taken.

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List of Abbreviations:

ICHEC	Institut Catholique des Hautes Études Commerciales.
POS	Point of sale
F&B	Food and beverage
FMCG	Fast moving consumer goods
RFID	Radio frequency identification
SKU	Stock keeping unit
MVP	Minimum viable product
mm	Millimeter
Wifi	Wireless fidelity
ERP	Entreprise ressouce planning
UX	User experience
SaaS	Softawre as a service

Introduction:

Who am I?

I'm Anthony Mady, currently pursuing a masters at ICHEC[1] in international business management. I come from Lebanon; a small country off the coast of the Mediterranean Sea. I have had the opportunity to get some professional experience prior to my masters. I occupied junior positions in marketing, software development and logistics.
All of these small experiences did not really mean much to me at the time, but the sum of all the acquired skills from them, lead me to be writing today about Libra.

Fast-forward to June of 2024; I am on summer break in Brussels, searching for an internship. I find a rather fun establishment that is hiring a data analyst intern. The place is called "Woodcutter"; an entertainment venue where you can throw axes at targets and share drinks with friends.
Woodcutter has 7 branches in total; "Brussels, Antwerp, Frankfurt, Berlin, Hamburg, Cologne and Bonn" spread between Belgium and Germany.
At the time of my onboarding, the management had just taken the decision to implement a new ERP in all their venues; 'ODOO".
As soon as I joined, I started getting familiar with the ERP system. There were many modules on the software but a few were integral to monitor and generate revenue for the company.

To name a few of the modules I took interest in; "POS[2], Inventory, Accounting, Manufacturing".

An odd thing that I found out when I joined, was the lack of standard procedures for inventory management. Branches were not supervised and each venue just operated on a self-governance basis, where no data was trackable, comparable or relevant.

I proceeded to have meetings with F&B[3] managers to try understand their current methods, their vision towards the future of the process, and what they think can be improved.

To follow up on that I organized a meeting with the Chief Operating Officer, Manuela Chica, we decided that my main task for the internship was to have an up and running standard inventory process, that revolves around Odoo and is able to generate relevant data for all branches.

Inventory process

In this part, I will go in detail about how the whole inventory process at Woodcutter entails, that way we will have a general overview and a way to analyze and implement our product later in the study.

[1] ICHEC: Institut Catholique des Hautes Études Commerciales.
[2] POS: Point of sale; the interface which is used to take orders from clients.
[3] F&B: Food and beverage

Inventory sheet

An inventory management document using an Excel sheet to streamline the process. Employees start by exporting key data from Odoo, including the product name, unit cost, and quantity on hand. This data reflects the theoretical inventory, which is updated in real-time with sales and orders recorded in Odoo. Once the data is exported, employees manually count the physical inventory and enter the results into the Excel sheet.

The sheet is designed to automatically cross-check the theoretical inventory with the physical count, highlighting any discrepancies between the two. These differences are typically caused by human error, such as miscounts or mistakes in recording sales. By automating the comparison, the process allows for quick identification and resolution of any inventory issues.

Figure 1: Screenshot of the inventory reconciliation Excel sheet, showing the Odoo exported data and the automated comparison between theoretical and physical inventory.

Difference adjustment:

This step involves reconciling any discrepancies between your system's theoretical inventory and the physical inventory. This could happen for various reasons such as:

- Human error in counting stock.
- Shrinkage (loss due to damage, theft, or expiration).
- Stock misplacement or incorrect categorization.
- System errors (such as incorrect data input or misupdates in stock levels).

Reconciling these differences is crucial because it ensures that your inventory records reflect the actual stock on hand, which directly impacts supply chain management, purchasing, and financial reporting. For instance, if your theoretical inventory is higher than the physical inventory, it could lead to over-ordering and excess stock costs. On the other hand, if the theoretical inventory is lower, you might face stockouts, which could lead to missed sales or customer dissatisfaction.

Replenishment:

The process of ordering new stock to refill your inventory based on the adjusted theoretical inventory levels.

Once the stock discrepancies have been addressed and the theoretical inventory matches the actual physical stock, the next step is to restock items that are running low.

This step is crucially linked to the rest of the process as restaurants and bars have limited storage space and a high turnover on high demand product. So an accurate replenishment would ensure to:

- **Avoid stockouts**: Timely replenishment ensures that you don’t run out of popular products, which can lead to missed sales and customer dissatisfaction.

- **Optimize storage space**: It helps maintain optimal stock levels, preventing both stockouts and overstocking, which can be costly and lead to wasted storage space or inventory obsolescence.
- **Improve supply chain efficiency**: It ensures that suppliers are ordered from at the right times, keeping the supply chain running smoothly and preventing unnecessary delays or backorders.

Timing:

In order to have reliable data, stock counts can only happen when the POS module on the ERP system have closed sessions and no sales are being done. In other terms, it is mandatory to have the inventory data exported once the shop is closed and no stock movements are done.

This measure ensures accuracy by preventing transactions that could alter inventory levels during counting. This avoids double counting or missing items, provides a fixed reference point for reliable comparison, minimizes errors or fraud, and simplifies reconciliation.

Randomized control tests:

Even with a process that looks tight on paper, mistakes can happen from both customer and supplier side. To keep track of that, staff are asked to always cross-check the orders that are received from the supplier in order to have data on what is going in, and not basing ourselves on the data provided by the supplier on the invoice.

Another measure that is implemented is random stock count requests through-out the month. This means that the manager will get a notified to initiate a stock count and submit the data on a random operational day, to get a sample of what a daily stock movement looks like.

Context

I started by implementing the process in two branches as a trial; Brussels and Antwerp. I quickly found out that overtime, differences between the theoretical inventory and the physical inventory started to shrink just by having a system overseeing the quantities and implementing accountability over the numbers. But reaching a clean slate, where all products are perfectly matched and accounted for was hard to achieve.

I had a few problems ahead; human error; which is a natural consequence of human management and something that I have to adapt to and accept in my line of work. Another problem which amplified the differences was variety.

As mentioned previously, I started the process as a trial in Brussels and Antwerp. Brussels is a relatively big branch with a lot of variety in drinks served; ranging from beers, soft drinks and cocktails. It is worthy to note that Brussels inventory contains 93 products compared to Antwerp's 50 products; an 86% larger inventory.

And based on Thonemann, U. W., & Bradley, J. R. (2002); "If setup times are significant, the

effect of product variety on cost is substantially greater". And Brussels proved it right, as the inventory was very diverse, this always caused inconsistencies and conflicts in numbers.

Figure 2: Screenshot of the inventory reconciliation Excel sheet in Brussels; showing inconsistencies highlighted differences in red.

To compare with Antwerp's branch, which is relatively smaller in size, the inventory there does not contain a big variety of drinks, and that translates directly into the inventory sheet results and the differences portrayed on it.

Figure 3: Screenshot of the inventory reconciliation Excel sheet in Antwerp; showing limited inventory differences in green.

My business idea:

Given the dynamic nature of inventory management and the intricate steps required to maintain accurate stock counts, human error becomes an inevitable factor in this aspect of business. As a result, the objective shifts from striving for a flawless inventory count with no discrepancies to establishing a semi-reliable process that serves as a stabilizing mechanism one that helps keep numbers in check and quantify losses. Additionally, these stock variations pose significant accounting challenges for business owners, further emphasizing the need for a structured and consistent approach to inventory reconciliation.

On a small scale, these issues might be bearable, but once inventory grows in variety to cater to customers' different tastes and expectations, the margin of error tends to increase as well. To put things in perspective, the Brussels inventory we previously addressed had a weekly average difference value of **€421.45**. That is not a small amount of money coming out of pocket.

Figure 4: Chart showing the 2024 weekly inventory difference value in the Brussels inventory.

Based on these numbers, the idea of Libra was born. I wanted a product that could accurately generate a live feed of the quantities available in the inventory. This would eliminate the need for manual counting, which is outdated in the current age of technological advancement, and would more accurately pinpoint when and where the error occurred.

I had several ideas in mind regarding the design of the product and the technology required to develop a reliable prototype. However, before making any definitive decisions, I prefer to first explore innovative inventory management approaches used in other industries. By studying these existing solutions, I can learn from their experiences and ensure that the market has not already addressed the problem I am trying to solve.

Objectives of this Study

Inventory management is not a newly encountered problem, it has been a problem to solve in many industries. But due to the relatively low profitability of the F&B market, no innovative solution has been found for it. So, as businesses increasingly adopt ERP systems like Odoo, questions arise about their effectiveness in reducing inventory discrepancies. This study will benefit any bar, restaurant or entertainment venue that aims to hold a tight grip on its product backlog and awareness of what comes in and out of its warehouse. This study explores these challenges by developing a standardized inventory product tailored for multi-branch venues

and addressing its effectiveness once implemented and what can be the theoretical outcomes from such a device.
Many other industries implement solutions that are tailor made for them and suit their lines of operations.
But for the F&B sector, we are dealing with unitary products and FMCG[4] that render solutions from other industries obsolete due to the scale and fluidity of the quantity turnover. That is why for the most part, F&B establishments have relied on manual counting and reconciliation between physical and theoretical stocks to keep track of what they have.

My approach through-out this paper, will be to first explore other technologies that have been used in other industries to solve the inventory management problem in the Literature review. That will give me a rough estimate on what aspects of their approach can translate into my study.

Following that, I'll be able to proceed with defining the methodology for my study, precising what kind of data I will be basing myself on and the research methods used to collect and analyze it.
After that part I will be able to firmly start with my business plan, detailing the business idea along with blueprints, the prototype, pricing models and financial projections.

I will then proceed to conclude this paper with a firm decision , basing myself on all the empirical data and research I have done that answers to the question;
Can Libra tackle the age old F&B inventory conundrum and prove itself to be efficient?

Origin of the Libra Concept

The idea for Libra was born directly from my internship experience at WoodCutter. Working closely with inventory systems, staff, and management across multiple branches allowed me to witness first-hand the gaps in the existing processes. What started as curiosity quickly turned into a deeper understanding of the operational pressure faced by employees and the inaccuracies that arose as a result. Observing repeated errors in stock counting, order reception, and system reconciliation made it clear that a smarter, automated approach was needed. These real-life challenges laid the foundation for envisioning Libra; a solution designed to solve the exact problems I was encountering daily. Rather than being a theoretical concept, Libra is a response to real issues experienced on the ground, shaped by practical experience and supported by continuous observation.

Literature review

For my literature review I want to initially explore where other industries stand on inventory management; more precisely; how did they approach the issue with bigger profits and ability to develop a better process.

Then I Would want to dive into the world of funding, specially crowdfunding for similar scale projects. This would allow to shape a rough idea of the path to take in order to secure funding and have a physical working prototype in the future.

[4] FMCG: fast moving consumer goods.

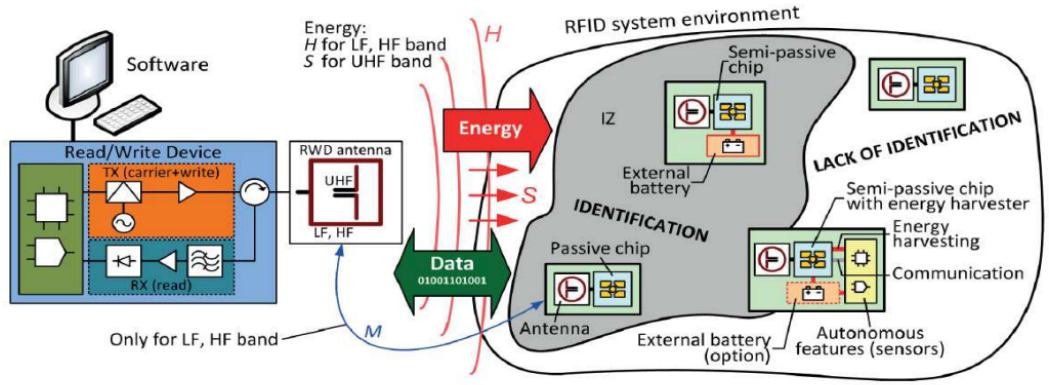
Next would be a look into sustainability and how to make sure the product that we are developing is future proof and as environmentally friendly as possible. That way we will be sure to have all stakeholders satisfied with the final product.

And finally to learn from the past and make sure I am able to capitalize on previous entrepreneurial experience I will also look into common start-up failures and what are good ways to steer clear of falling into them by applying solutions found in my research.

Other industries solutions:

RFID (Radio Frequency Identification):

"The acronym RFID (Radio Frequency Identification) stands for a modern technique of wireless identification of objects (Finkenzeller, 2010), which at the present stage of development is frequently used in automated processes in various sectors of economic activity". (Chudy-Laskowska, 2018)



Source: Jankowski et.al., 2016

Although RFID technology offers benefits across numerous industries, its use in the food and beverage F&B sector for inventory counting faces various difficulties. A major concern is the interference and inaccuracy experienced when reading RFID tags, especially in the presence of liquids and metal packaging. Radio waves utilized in RFID systems have difficulty penetrating environments with high moisture levels, leading to misreads or inability to detect tagged items. Moreover, food items frequently use metal packaging, which further interferes with signal transmission, resulting in inaccurate inventory counts. These technological constraints render RFID less efficient for food and beverage inventory management when compared to conventional barcode systems or hybrid approaches that utilize optical scanning.
A further notable drawback is the elevated expense of implementation relative to other tracking techniques. The cost of RFID tags, particularly those needed for operation in extreme storage conditions like freezers or humid environments, can be a significant barrier for numerous companies in the food and beverage industry. In addition, the requirement for dedicated RFID readers and system integration raises the total expenditure. Numerous food and beverage companies function with slim profit margins, rendering the cost-benefit assessment unappealing when evaluating RFID implementation for inventory tracking. In comparison, barcodes and QR codes present a significantly reduced cost per unit while maintaining dependable tracking

features.

Finally, regulatory and safety issues impede the implementation of RFID in food and beverage inventory management. There are worries about data security and possible health hazards linked to extended exposure to radio frequency signals in food storage settings.

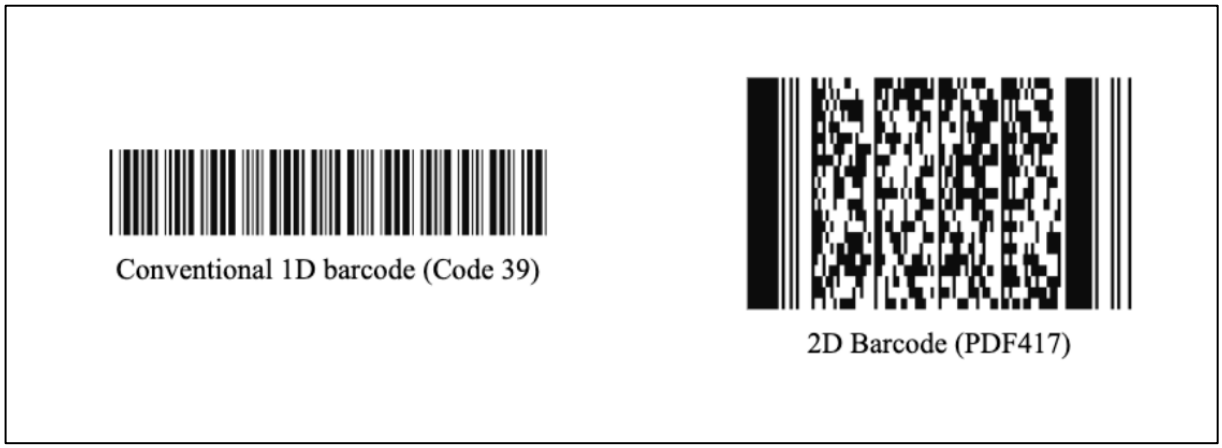
Considering these factors, F&B companies frequently discover it more feasible to utilize traditional, cost-effective methods like barcoding and manual inventory checks instead of implementing RFID for inventory control.

Figure 5: Advantages and disadvantages of modern RFID technologies.

Barcode technology

Barcodes have become an essential component of modern commerce, serving as the unquestioned global standard for product identification and tracking **(Wyld, 2006, p. 157)**. Traditional barcoding, integrated with the Universal Product Code (UPC), underpins billions of scans worldwide every day. Despite its widespread adoption, some argue that barcoding technology is outdated.

Yet, barcoding is not stagnant; it is evolving. The emergence of **two-dimensional (2D) barcodes** marks a significant advancement in the Auto-ID family, addressing the limitations of traditional barcoding. Unlike conventional barcodes that store data in a single horizontal dimension, 2D barcodes encode information both horizontally and vertically, allowing them to hold exponentially more data while remaining compact and easily scannable.

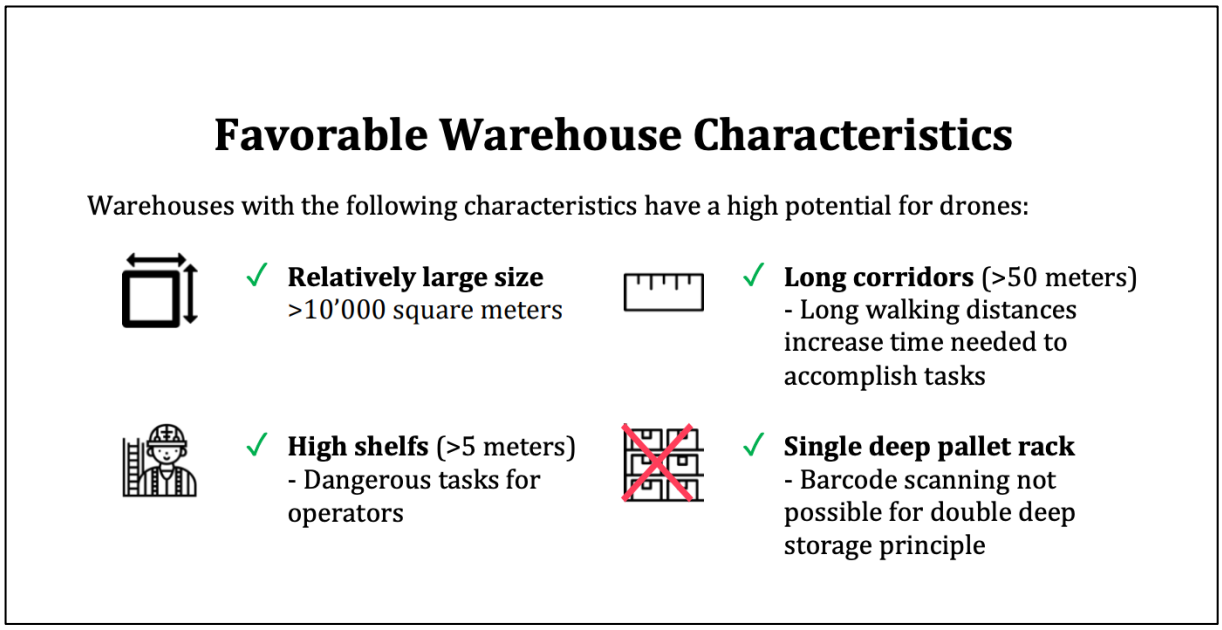


Barcode technology is an excellent tool for efficiently tracking inventory, tracking check-ins and check-outs, and distinguishing between similar parts with precision, yet its reliance on manual input and scanning accuracy still leaves room for occasional errors in inventory management.

Drones warehouse operations

“The use of drones in warehouses has been increasing over the past years. Large warehouses are aiming to increase efficiency by investing more in automation and robotics. This is not without precedence since the cost of warehousing operations account for 30% of the total costs in logistics. Furthermore, difficulty to attract skilled labors, increasing demand for customer services and the rise of e-commerce have intensified the need to further increase efficiency in warehouse operations.”

So, drones coupled with RFID technology discussed previously seems to be a great match for eliminating human errors and automating inventory management. But all of this does not come without disadvantages. Drones require a certain preset warehouse layout.

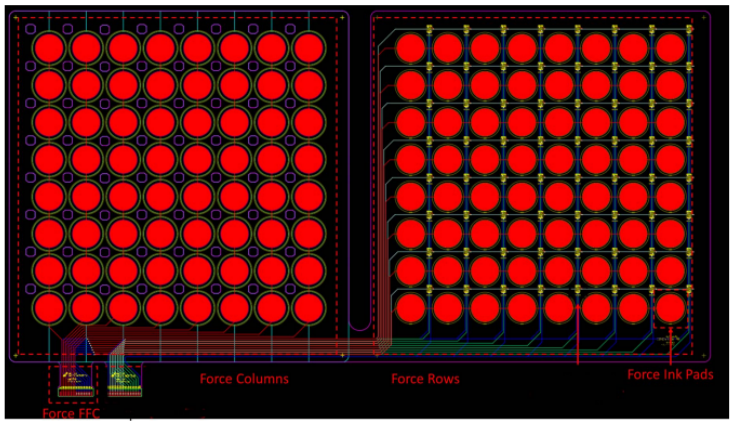


In our case we are looking for a solution for the F&B industry, in other word, small restaurants that have limited space for their inventory which is not suitable for a drone. At Woodcutter Brussels our Inventory room, where we keep all the packaged food and beverages, the total surface area was around 3 sqm. That would not suit the preferred warehouse characteristics to run an inventory management drone.

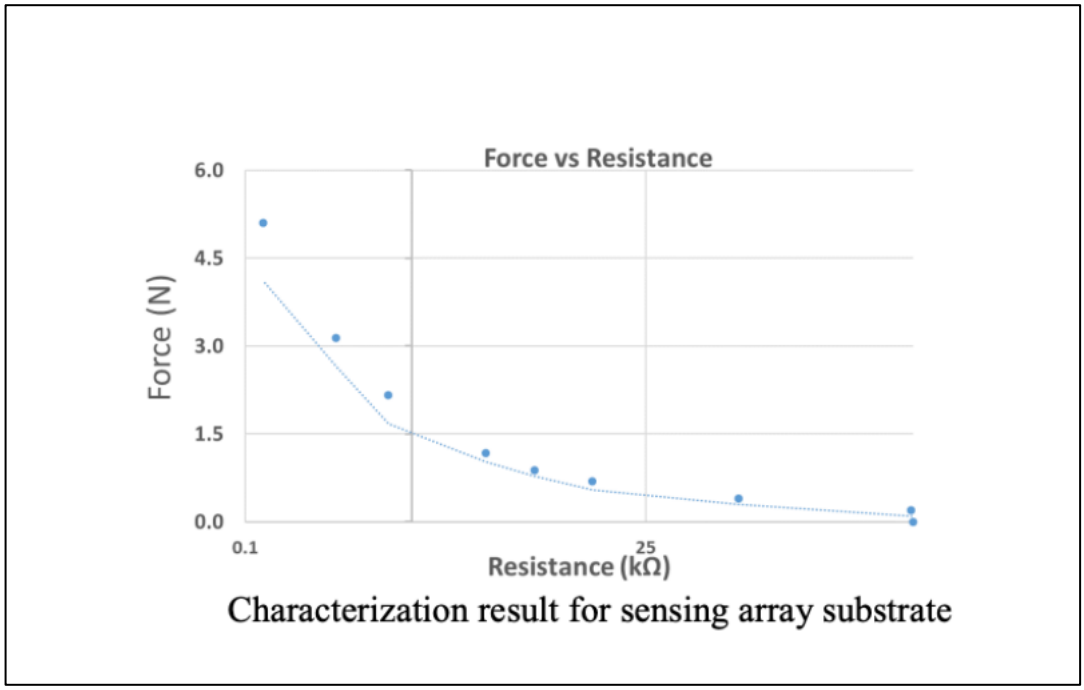
Pressure Sensing Array System

"This system consists of a small scale 8 x 8 sensing array substrate and a circuit readout module with graphical user interface display in the form of tablet application. The figure below shows the schematic block diagram for the proposed pressure sensing system. The sensing array substrate is designed to be placed onto the existing retail shelve. Information on the items placed on the shelve will be manually input into the system. Next, initial calibration of the item will be conducted with using the sensing substrate. Data will be stored in the database. After completion of the initializing and setting up of the database for the different product types and SKU[5], the pressure sensing system is ready for real-time monitoring of the products on shelves."

[5] SKU: Stock keeping unit



The pressure sensing array system is the most comparable solution I have found during my research that seeks to address the same issue as Libra. Though, it is important to mention that the array function using pressure-based algorithm which can only sense unitary missing products on shelves with a max of 64 products per array. The array uses a sensor node with a multimeter that measures using Force and resistance to determine if a product is on the pressurised plate or if it is empty.



Characterization result for sensing array substrate

The way the array functions places limitations on the inventory capacity as it would limit the storage capacity and handicap the space and stacking ability of crates. With Libra I aim to provide the same accuracy and value that the pressure plated array illustrated above provides, with the flexibility and accuracy.

Start-up funding:

Investor selection

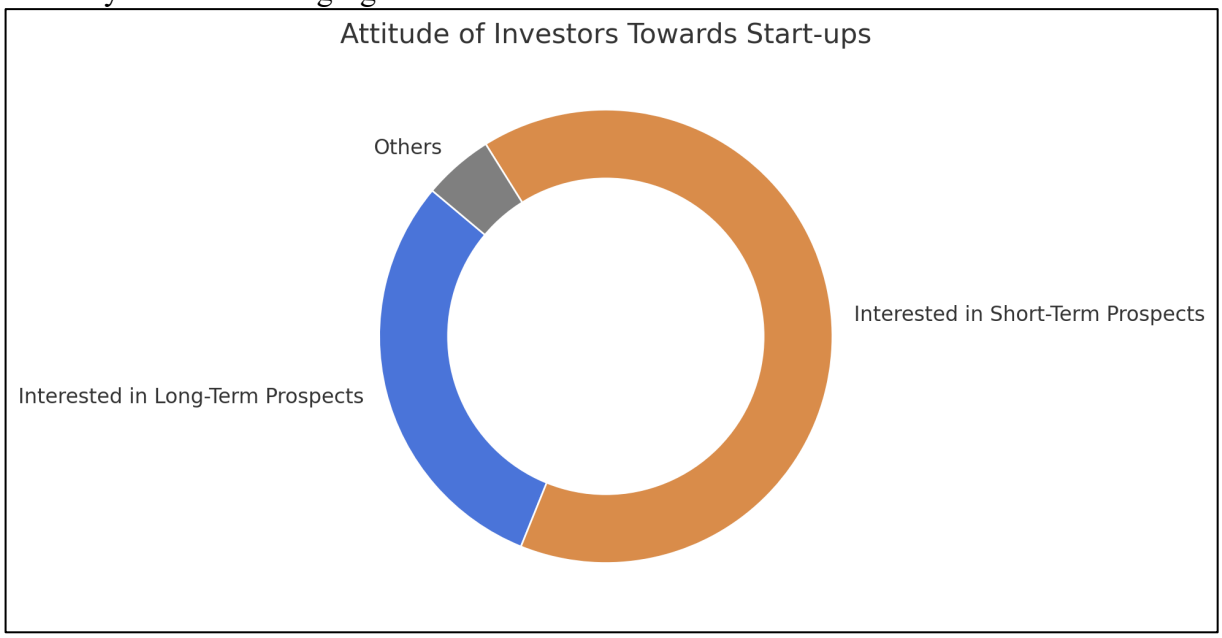
"Nothing can be said to be certain, except for death and taxes", This is what Benjamin Franklin mentioned while describing the constitution of the United Stated of America. But when we want to talk about start-ups, funding is added to the list of certainty.

“A business without a funding source will crumble under the weight of its own loans. Funding is the foundation on which every start-up thrives.” (Garg & Shivam, 2017).

During 2021, I helped founding a start-up named Qriptal in the Cryptocurrency industry. The idea was to start small with a training website that recruits good prospects as traders in order to eventually grow into a hedge fund that can generate return to depositors through the recruited prospects.

The other founders I worked with were students at renowned business schools, **ESSEC**[6] and **LBS**[7], where we had numerous venture capitalists reach out to us after funding competitions and cohorts with other start-ups. The position we took was a more conservative approach where we avoided very aggressive investors. “It is observed that the survival rate of the start-ups once they are exposed to the outside world is really low. They somehow manage to accumulate their initial funding but are unable to execute their plans due to lack of planning.” (Garg & Shivam, 2017). We were aware that we were not ready to go to the market. We did not have a reliable product that we can hit the market with. Venture capitalists saw that and still were ready to enter investments talks.

This attitude demonstrates the intent that these investors have. A study was done in Garg & Shivam’s paper related to the Attitude of investors towards start-ups. You can see the results of the study in the following figure.



“A trend was observed in their strategies. Maximum investors we talked to were interested in short term prospects that the start-ups offered. The main reason for this can be the recent boost in the number of emerging start-ups in the market. Obtaining a start-up as a mode of investment is no longer a worry. The investors now want to try new markets explored by the start-ups and hence are concerned only in their immediate developments.” (Garg & Shivam, 2017).

Based on the data here, Libra’s approach towards funding will be more conservative at first. I will make sure be wary of investors that do not have the long-term vision of our products on

[6] ESSEC: École Supérieure des Sciences Économiques et Commerciales.
[7] LBS: London Business School.

the market. As I am looking to provide a paradigm shifting product that will have its place on the market and not a short-term market buzz.

Industry selection based on industry:

In the dynamic landscape of startup funding, the selection of investors based on their industry expertise has emerged as a crucial factor for entrepreneurial success. This topic is particularly relevant for startups as they navigate the challenging process of securing funding and strategic partnerships. The right industry-aligned investor can provide not only capital but also valuable insights, networks, and operational expertise that can significantly accelerate a startup's growth trajectory. A study by Hsu (2004) found that entrepreneurs are often willing to accept lower valuations from more reputable venture capital firms, suggesting that the perceived value of industry expertise and connections outweighs pure financial considerations. This underscores the importance of selecting investors based on their industry credibility and network.

Hellmann and Puri (2002) demonstrate that venture capital backing is associated with a significant reduction in the time to bring a product to market, especially for innovator firms. This finding suggests that industry-specific investors can provide strategic value that extends far beyond mere financial support, potentially offering critical advantages in competitive markets.

In my case, Libra would be based in Brussels and will look first to expand in the Belgian F&B market. A primary interest I have is in the F&B manufacturers; like “Belgian Beer export” and “Stella Artois” approaching the big market suppliers would present a very good partnership possibility.

These suppliers hold a big market share in the Belgian Horeca[8] scene. An investment from a big supplier will net Libra the necessary funds and market expertise to understand the different shareholder requirements that would make the scale as easy to integrate with the Belgian market standard as possible. The requirements that I might think of are; the standard dimensions of crates, the average inventory space and average order size from different sized companies. All this data could be capitalized on and used to maximize the chances of success of Libra on the market.

Sustainability aspect

Sustainable Product Design: The Role of Modularity

Sustainable product design is a critical approach in addressing environmental concerns, resource efficiency, and product longevity. Among various strategies, modular design has emerged as a key principle in achieving sustainability by enabling products to be easily repaired, upgraded, or customized, thereby extending their lifecycle and reducing waste (Bakker et al., 2019).

[8] Horeca: Hotel, Restaurant, and Café/Catering

Defining Modularity in Sustainable Design

Modularity refers to the design strategy where a product is composed of interchangeable or separable components, allowing for ease of maintenance, repair, and upgrades (Lopes et al., 2021). This principle contrasts with traditional linear design models, where products are built as monolithic units that often lead to premature obsolescence. By integrating modularity, manufacturers can create customizable and adaptable products that align with circular economy principles (Ellen MacArthur Foundation, 2020).

Environmental and Economic Benefits of Modular Design

Several studies highlight the environmental advantages of modularity. Telenko and Seepersad (2018) argue that modular products significantly reduce electronic and material waste, as consumers can replace only the faulty components rather than discarding entire products. This extends product life cycles and minimizes landfill contributions. Similarly, research by Den Hollander et al. (2017) suggests that modularity supports a closed-loop economy, where components can be efficiently disassembled and recycled.

From an economic standpoint, modular products present a cost-effective solution for both consumers and manufacturers. Baldwin and Clark (2000) introduced the concept of modular architectures, demonstrating that businesses adopting modularity benefit from reduced production costs, simplified maintenance processes, and increased market flexibility. In industries such as consumer electronics and furniture, modularity has proven to enhance customer engagement and brand loyalty, as users are more likely to invest in products they can personalize and upgrade over time (Stahel, 2019) .

Challenges and Limitations of Modular Sustainability

Despite its advantages, modularity presents design and logistical challenges**.** Kirchherr et al. (2018) highlight that modular components require standardization, which can limit innovation and increase initial production costs. Furthermore, some industries, such as automotive and medical devices, face regulatory constraints that restrict modular adaptations due to safety and performance requirements (Bocken et al., 2016).

Another concern is the consumer behavior paradox while modularity promotes sustainability, some users may still opt to replace entire products rather than repairing or upgrading components (Mugge et al., 2017). This underscores the need for educational initiatives and incentive programs to encourage sustainable consumption practices.

Modularity in Practice: Case Studies

Several companies have successfully implemented modularity in sustainable product design:

- **Fairphone**: A modular smartphone designed for easy repair and component replacement, reducing electronic waste.
- **IKEA**: Modular furniture systems that allow consumers to customize and expand their setups, enhancing product longevity.
- **Patagonia**: Their modular outdoor gear enables users to repair and upgrade components rather than replacing entire products.

Modularity in Libra's design

Libra has the potential to be extremely environmentally friendly by implementing modularity in it concept design. Libra will not only consist of a scale that is dropped on the ground waiting to be used. Hard steel frames will be bolted to the ground where the scale can be slipped in and out. This would ensure that the scale is in a fixed perfectly horizontal position. That way we are sure that all the collected data is measured under the same conditions and we can easily swap out faulty scales for new ones to ensure modularity.

Common start-up failure reasons

Start-ups play a crucial role in innovation and economic growth, but their success rates remain low. Research indicates that approximately 90% of start-ups fail within the first five years (CB Insights, 2021). Understanding the common reasons behind these failures is essential for entrepreneurs to mitigate risks and enhance sustainability. This section explores key factors contributing to start-up failures, including market misalignment, financial mismanagement, team-related challenges, operational inefficiencies, and external factors.

Lack of Market Demand

One of the most cited reasons for start-up failure is building a product that has no real demand. Studies by (Blank, 2013) emphasize the importance of customer validation and market research before launching a product. Many start-ups develop solutions based on assumptions rather than actual market needs, leading to low adoption rates.

For example, research by CB Insights (2021**)** found that 42% of failed start-ups cited lack of market need as their primary reason for failure. A notable case is Juicero, a well-funded start-up that developed an expensive juicing machine, only to realize that consumers could achieve the same results manually without the costly device. This highlights the necessity of early-stage market testing and customer feedback loops.

Financial Mismanagement and Cash Flow Problems

A lack of financial planning**,** revenue streams**,** and funding misallocation can cripple even the most promising start-ups. Many entrepreneurs underestimate operating costs and overestimate early revenue growth, leading to unsustainable burn rates (Gompers et al., 2020).

According to a Harvard Business Review (2020) study, 82% of start-ups fail due to cash flow problems. Start-ups that fail to secure additional funding or generate sufficient revenue struggle to cover operational expenses. For instance, Quibi, a short-form video streaming service, burned through $1.75 billion in funding but failed to generate sustainable revenue due to poor market positioning and excessive spending.

Weak Business Model and Lack of Scalability

A flawed business model can prevent a start-up from achieving long-term success. Entrepreneurs often fail to define a clear monetization strategy, leading to unscalable operations and low-profit margins (Ries, 2011).

A prime example is Pets.com, which collapsed due to an unsustainable cost structure, where logistics and customer acquisition costs outweighed revenue. Similarly, start-ups that rely solely on funding rounds without a viable path to profitability often struggle to survive once investor support diminishes.

Poor Team and Leadership Issues

Start-ups require a strong, adaptable team to navigate challenges. Many failures stem from leadership conflicts, lack of expertise, and ineffective decision-making (Wasserman, 2012). CB Insights (2021) reports that 23% of start-ups fail due to team-related issues, including:

- **Misalignment among co-founders**
- **Lack of industry experience**
- **Poor hiring decisions**
- **Failure to delegate responsibilities**

A well-known example is Zirtual, a virtual assistant company that collapsed overnight due to poor financial planning and a leadership structure that failed to anticipate rapid cost increases.

Ineffective Marketing and Customer Acquisition

Even a well-designed product can fail without a strong marketing strategy. Start-ups often underestimate the challenges of customer acquisition costs **(CAC)** and fail to develop sustainable growth strategies (Kotler & Keller, 2016).

For instance, Color Labs, a photo-sharing start-up, raised $41 million but failed to attract users due to unclear messaging and lack of product-market fit. Effective start-ups prioritize growth hacking techniques, social proof, and strategic partnerships to scale efficiently.

Operational Challenges and Product Execution Failures

Operational inefficiencies such as supply chain issues, poor product development, and technical failures can lead to start-up demise. Lean operations and agile methodologies are essential to adapt quickly and improve product-market fit (Maurya, 2016).

A notable case is Theranos, which promised revolutionary blood-testing technology but ultimately collapsed due to overpromising and underdelivering on technical capabilities. This underscores the importance of realistic product roadmaps, testing, and iterative development.

External Factors: Economic and Regulatory Challenges

Start-ups also fail due to external challenges, such as economic downturns, regulatory hurdles, and unforeseen crises (Gans et al., 2019). Factors include: Market shifts and competitor disruptions, governmental policies and legal restrictions and global economic crises (e.g., COVID-19 pandemic impact on small businesses).

Start-up failures conclusion

Start-up failures often stem from a combination of internal missteps and external pressures. At libra we can improve our survival odds by conducting thorough market research, maintaining

financial discipline, building strong teams, and developing scalable business models. By learning from past failures, founders can create more resilient and adaptable businesses in an increasingly competitive landscape.

Reflection on my Literature Review

When I set out to write the literature review, I wanted to explore a variety of topics that I believed were essential to building Libra. Each section I included was chosen based on the real questions I had during the early stages of developing the idea. I didn't want to just create a solution; I wanted to understand the wider picture: how others have approached similar problems, what has worked, and where things often go wrong.

The first area I focused on was inventory technology in other industries, such as RFID and barcode systems. I was curious to see how far automation had already gone in sectors that rely on speed and accuracy. Through this research, I realized that while these tools are impressive, they often fall short in the F&B world due to environmental conditions and cost. That insight pushed me to consider how Libra could be designed to be more practical, affordable, and tailored to the needs of bars and restaurants.

I also dug into funding strategies. I've seen other startups struggle after bringing in investors who didn't fully believe in the long-term vision. So, when I read about the pros and cons of crowdfunding and strategic investment, it helped me clarify what kind of financial path I want Libra to take. I learned that it's better to grow steadily with the right support than to chase big funding too early without a proven product.

Modularity and sustainability were also topics that really spoke to me. I've always liked the idea of building something that lasts, and reading studies on modular design confirmed that this was the right direction. The more I learned, the more it made sense that Libra should be something that can be updated and repaired, not just replaced.

Lastly, learning about why startups fail helped me stay grounded. It reminded me that no matter how good an idea sounds, execution is everything. I now pay more attention to the details, making sure Libra is something real people can use, not just a concept on paper.

Overall, the literature review wasn't just a background exercise for me, it became a personal learning journey. It shaped the way I thought about the product, the business, and the kind of founder I want to be. It helped me connect theory to the real-world problems I saw during my internship, and gave me the tools to build something that matters.

Methodology

Research Approach

This study adopts a mixed-method research approach, integrating quantitative, qualitative and direct observation methodologies to evaluate the effectiveness of Libra in improving inventory accuracy in the Food & Beverage (F&B) sector. This approach is chosen to ensure a comprehensive understanding of the impact of Libra by combining numerical data with managerial insights.

Quantitative Analysis: Focuses on numerical data such as inventory discrepancies, financial losses due to shrinkage, and efficiency improvements before and after Libra's implementation.

Qualitative Analysis: Captures insights from employees, managers, and decision-makers regarding the usability, challenges, and benefits of the Libra system.

Direct observations: Allows me to share my personal obseravations captured while on site to support my research.

By combining these methods, this study aims to provide robust empirical evidence on the effectiveness of Libra in resolving inventory management inefficiencies.

Research Design

To assess Libra's efficiency, an experimental research design is implemented. The study will compare inventory discrepancies before Libra and test out Libra's prototype results based on testing data using control and test groups.

Pre-Test Phase: Baseline data collection of inventory discrepancies in selected venues.

Test phase: Implementation of Libra using test data control to determine how the inner software will process the scale readings.

Post-Test conclusion: Analysis of post-implementation inventory data to measure improvements.

Data Collection Methods

Primary Data Sources

Inventory Discrepancy Reports:
Weekly reconciliation sheets comparing theoretical vs. physical inventory before and after Libra's implementation.
Financial impact assessments of inventory shrinkage over a three-month period.

Employee & Manager Survey:
To make sure Libra is solving a real problem that the industry faces, a simple survey will be give to the F&B managers, operation managers and shareholders to check their point of view on the inventory checks and Libra's unique selling proposition.

Key Performance Indicators (KPIs)

The study will measure Libra's effectiveness by looking at a few key factors. It will track how much inventory discrepancies decrease over time, how much money is lost due to inventory issues before and after using Libra, and how much time is saved on stock counting and data entry.

Ethical Considerations

This research follows ethical guidelines by keeping all employee and branch data private, making sure no specific details are shared publicly. Participation in surveys and interviews is completely voluntary, and everyone involved will give their consent. The results will be shared honestly, without any bias, to show the real impact of the study.

Conclusion

By employing a mixed-method approach, this methodology aims to comprehensively evaluate Libra's impact on inventory management. Through quantitative metrics and qualitative insights, this study will provide empirical evidence on whether Libra can effectively reduce inventory discrepancies, optimize F&B operations, and contribute to the broader field of automated inventory solutions in the hospitality industry.

Quantitative analysis:

To understand the effectiveness of Libra in solving inventory issues, several key performance indicators were calculated across all weekly inventory records at the WoodCutter Brussels branch. These KPIs aim to evaluate the overall quality of inventory tracking and quantify how manual errors impact financial outcomes. The three selected KPIs are: Discrepancy Rate**,** Shrinkage Rate**,** and Error Frequency Rate**.**

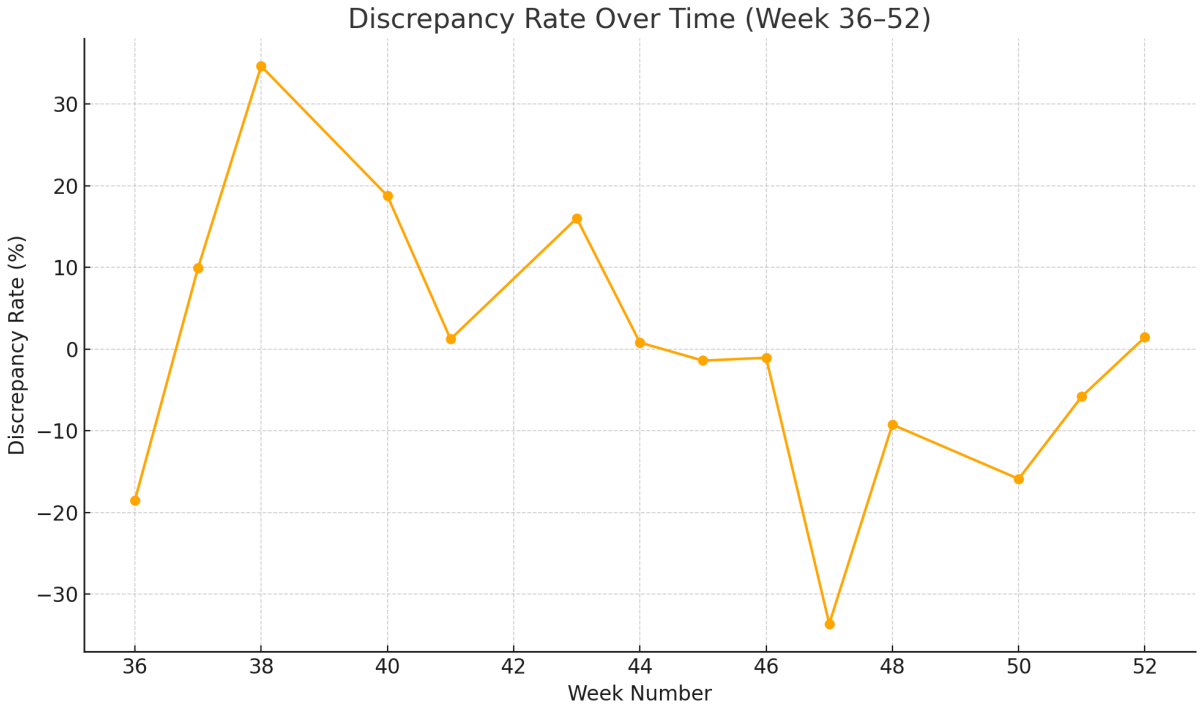
Discrepancy Rate (%)

Discrepency rate measures the percentage of stock that is either missing or in excess when comparing theoretical (ODDO) and physically counted inventory.

Formula:

$$Discrepency\ rate = \left(\frac{\sum(Total\ discrepency\ units)}{\sum(Theoretical\ inventory)}\right) * 100$$

Result: Over the observed period from Week 36 to Week 52, the discrepancy rate fluctuated between -9.4% and +49.4%, showing notable inconsistencies in stock accuracy. A negative rate suggests that the counted inventory was higher than expected, possibly due to stock that wasn't logged in the system or mistakes during data entry. On the other hand, high positive rates indicate missing items, which could result from undercounting, theft, or unrecorded consumption.



The graph above tracks the weekly discrepancy rate. It is clear that in most weeks, the rate is nowhere near 0%, which would represent perfect accuracy. This highlights how unreliable manual inventory counting can be, and where Libra could add real value by keeping discrepancies consistently low through automation and live tracking.

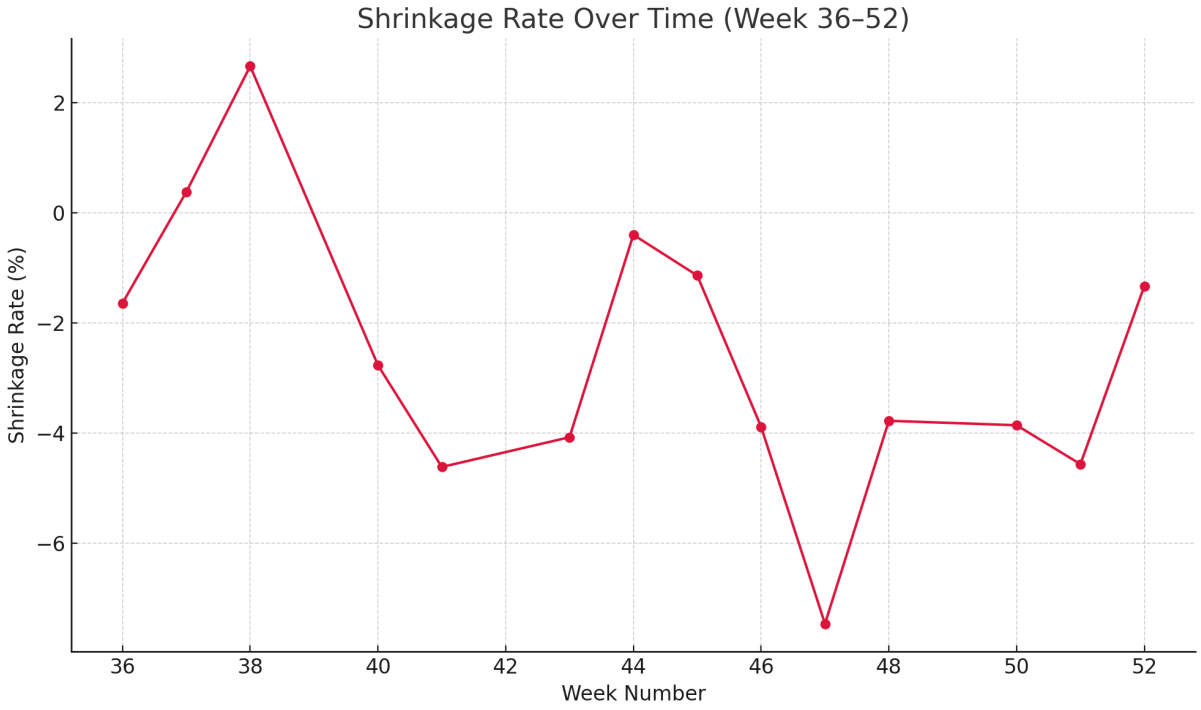
Shrinkage rate(%)

Shrinkage rate shows how much of the total inventory value is lost due to discrepancies. This gives a clear financial picture of how much money is being lost every week because of inventory errors.

Formula:

$$\boldsymbol{Shrinkage\ rate} = \left(\frac{\sum(\boldsymbol{Difference\ value})}{\sum(\boldsymbol{Theoretical\ inventory\ value})}\right) * \mathbf{100}$$

Result:
In the observed period, shrinkage rates ranged from -10.7% to +19.1%. Positive percentages indicate real financial losses caused by missing items or inaccurate counts. These losses can directly affect profit margins, especially for venues like WoodCutter that rely heavily on beverage sales. Negative values, on the other hand, may reflect stock that was overcounted or not registered properly in the ERP system.



The graph above clearly shows that some weeks had significant shrinkage, with certain spikes pointing to inventory mismanagement. These financial inconsistencies further highlight the need for a more reliable and automated solution like Libra, which can help businesses reduce these losses by giving accurate, real-time visibility into stock levels.

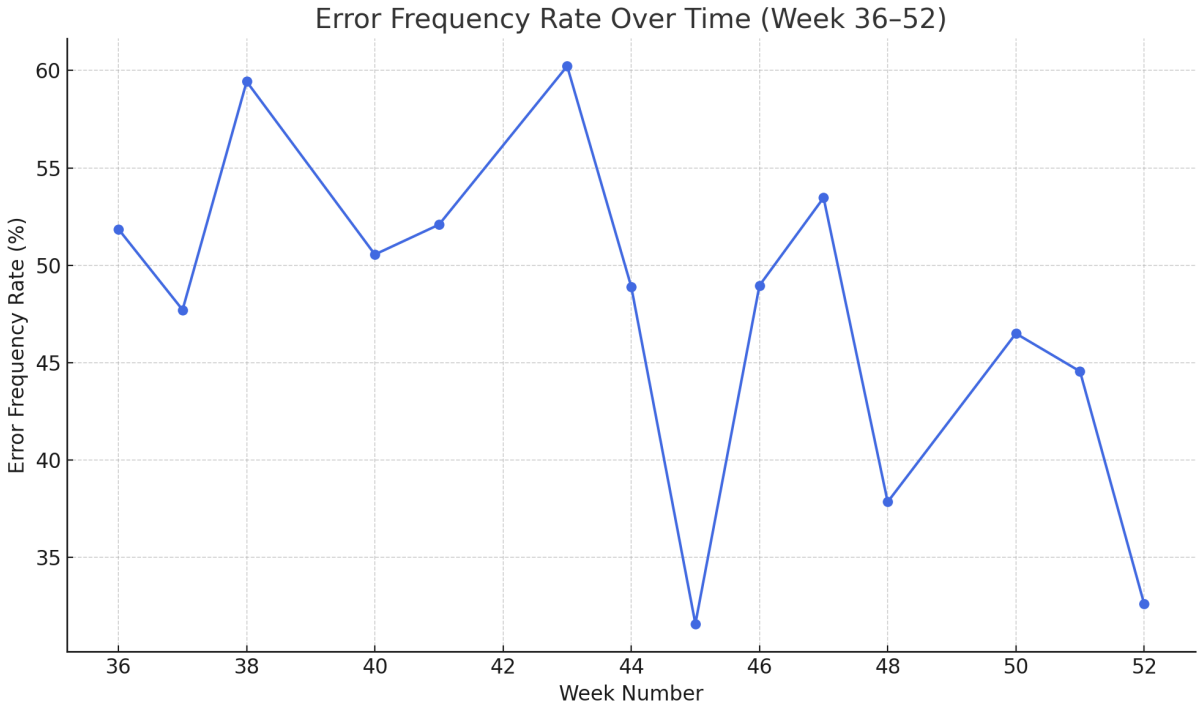
Error frequency rate (%)

The error frequency rate shows how often products had any kind of discrepancy during inventory checks. It gives an idea of how widespread the issue is, by calculating the percentage of products that were not correctly matched between what was expected and what was actually counted.

Formula:

$$Error\ frequency\ rate\ (\%) = \left(\frac{Number\ of\ products\ with\ errors}{Total\ \ products\ counted}\right) * 100$$

Result:
Throughout the recorded period, the error frequency rate remained consistently high, ranging between 39.5% and 53.4%. This means that in some weeks, more than half the products had discrepancies. Such a high error rate shows that manual inventory counting is not reliable and introduces a large margin of error in everyday operations.



The graph above shows that these errors are not isolated to one or two weeks they are a constant issue. This supports the idea that Libra could play a major role in reducing these errors by automating the process and ensuring better control over stock data.

Conclusion

The analysis of the current inventory management process shows clear signs of inconsistency, financial loss, and a high rate of human error. Discrepancies between the system's expected stock levels and the physical counts were a regular occurrence. These mismatches not only affect stock accuracy but also lead to a direct financial impact, making it difficult for managers to trust their numbers or make informed decisions.

What stands out most is how often products are miscounted or mishandled, even with regular stock checks in place. This level of unreliability highlights the limitations of manual inventory methods, especially in fast moving environments like bars and entertainment venues.

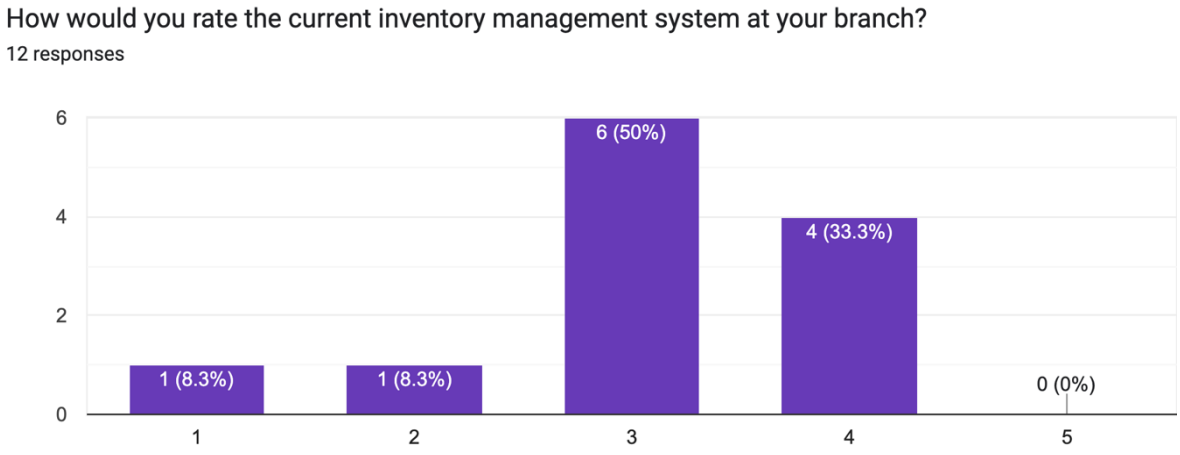
Libra presents a practical solution to these issues. By automating the inventory process and providing real-time data, it reduces the chance for human error, increases accuracy, and helps businesses keep tighter control over their stock. In the long run, this can lead to better decision-making, less waste, and a more efficient way of running operations.

F&B managers survey

To support the quantitative findings and gain deeper insights into the real world challenges of inventory management, a qualitative approach was also adopted. A short survey was distributed to 12 managers across WoodCutter's seven branches, including F&B managers, operations managers, and venue leads. These individuals are directly involved in inventory-related tasks and play a key role in how stock is managed, tracked, and controlled at their respective locations.

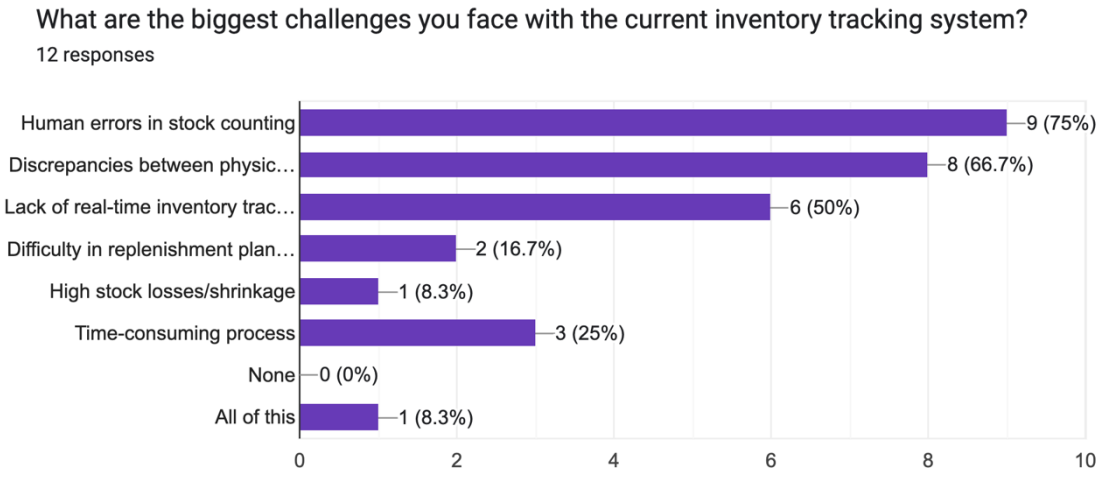
The purpose of the survey was to understand their experiences, frustrations, and expectations regarding the current system, as well as to gather their opinions on the potential of a new solution like Libra. By analyzing their responses, this section aims to shed light on the human side of the problem what the numbers alone cannot show. Their feedback offers valuable context on the operational difficulties faced by staff and highlights the practical needs that Libra could help meet.

General Satisfaction with Current System



On average, respondents rated the existing inventory management process 3 out of 5, reflecting a neutral to slightly dissatisfied stance. This suggests that while some elements may be functioning adequately, many gaps still exist in terms of accuracy, time efficiency, and overall reliability.

Challenges Faced



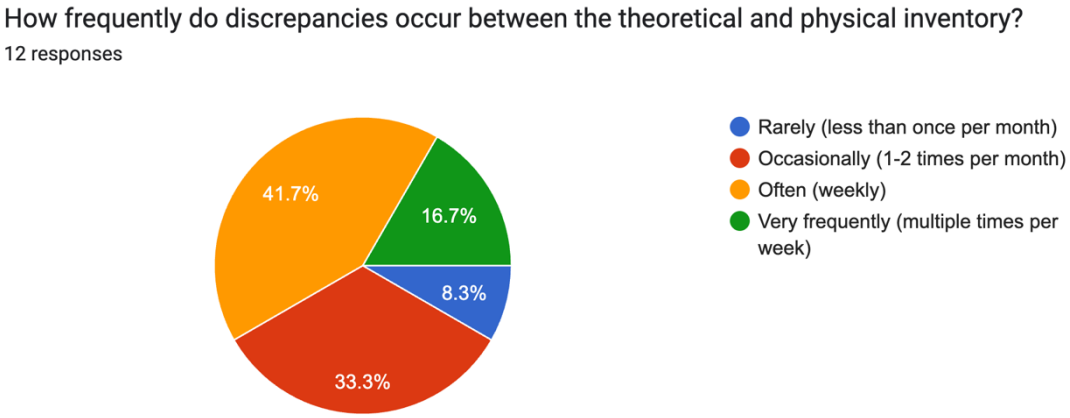
The most common issues raised were:

- Human errors during stock counting
- Frequent discrepancies between physical and theoretical inventory
- Lack of real-time visibility
- Time-consuming reconciliation processes

These responses clearly reflect the pain points seen in the quantitative data and highlight the day-to-day operational burden caused by manual inventory systems.

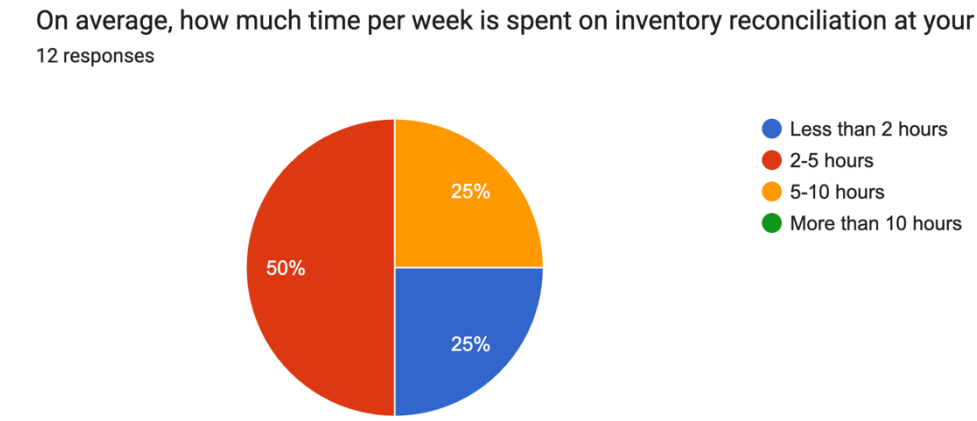
Furthermore, no branch reported not facing any issues which clearly showcases the regularity of human error and innacuracy of the data.

Frequency of Errors



A majority of managers indicated that inventory discrepancies occur either weekly or multiple times per week. This frequency reinforces the idea that the current process is not sustainable for long-term accuracy and contributes to ongoing operational friction.

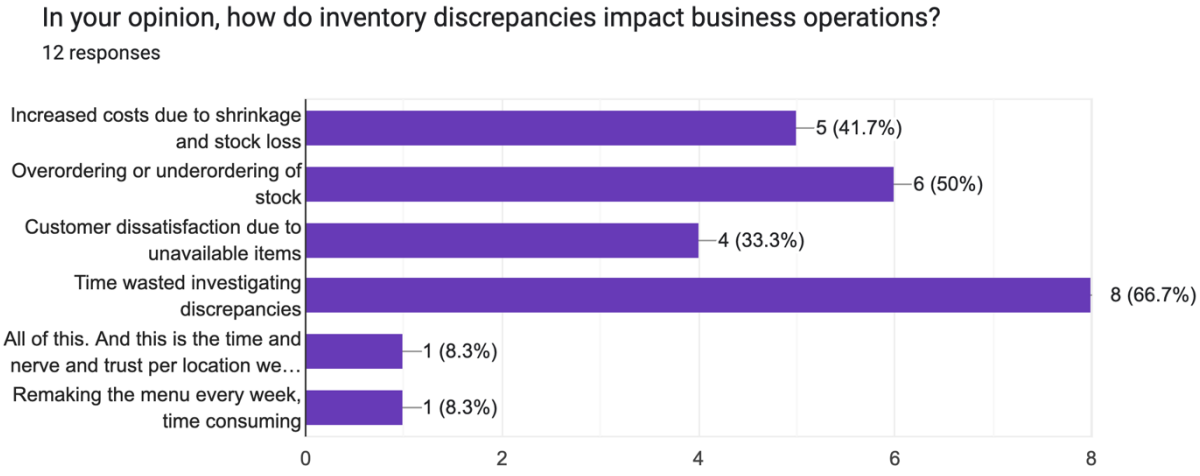
Time Commitment for Inventory Checks



One of the key questions in the survey asked managers to estimate the amount of time they spend each week handling inventory tasks. Most respondents indicated that the process typically takes between 2 to 5 hours per inventory cycle, depending on the size of the branch and the number of products to count. Some managers noted that this time could extend even further during busy weeks or when discrepancies are discovered and need to be resolved.

This highlights how time-consuming manual inventory tracking can be, especially when it requires constant double-checking and reconciliation. The amount of time spent is not just a labor cost it also takes staff away from more valuable or customer-facing tasks. Automating this part of the process with Libra could significantly reduce the time investment required, freeing up resources and improving operational efficiency.

Operational Impact

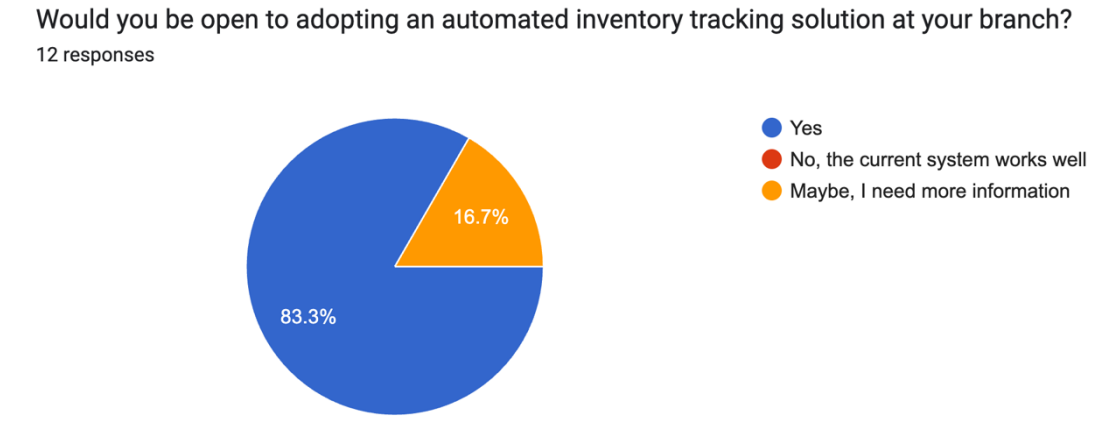


When asked how these discrepancies affect business performance, the most common responses included:

- Overordering or underordering of stock
- Wasted time investigating inconsistencies
- Customer dissatisfaction due to stockouts
- Increased financial loss from shrinkage

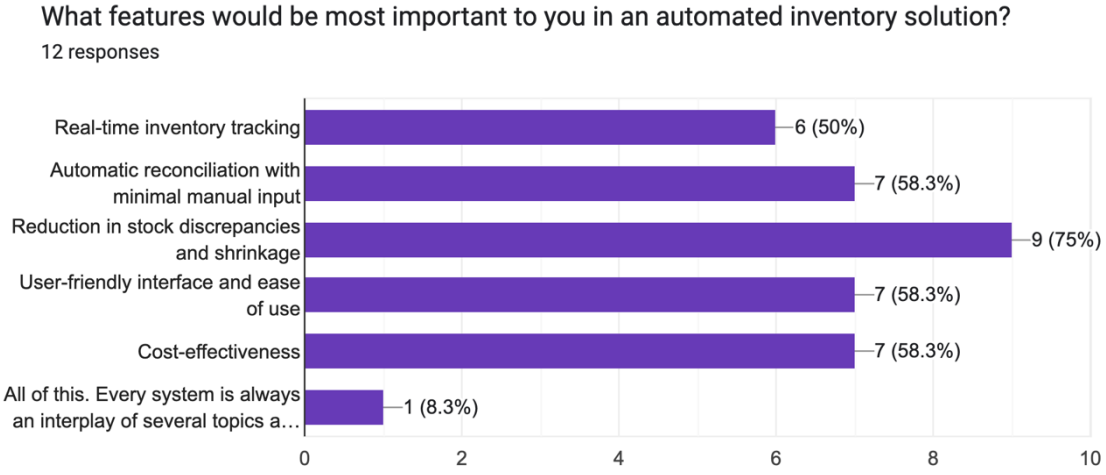
Some managers even described the process as damaging to staff morale and trust between branches due to conflicting data.

Interest in Automation



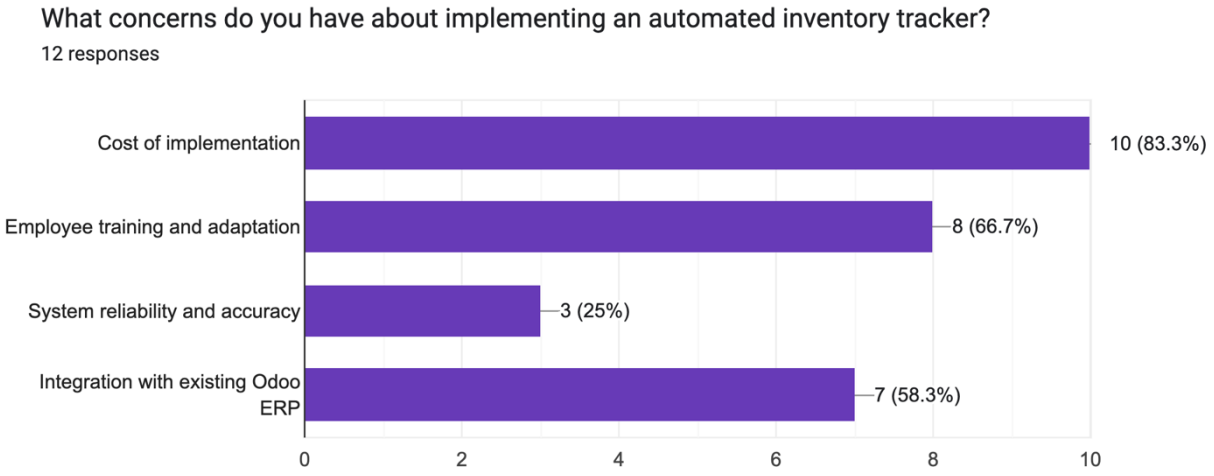
Most respondents (9 out of 12) expressed a willingness to adopt an automated inventory tracking system. The rest were open to the idea but requested more information before making a final decision.

Key Features Requested



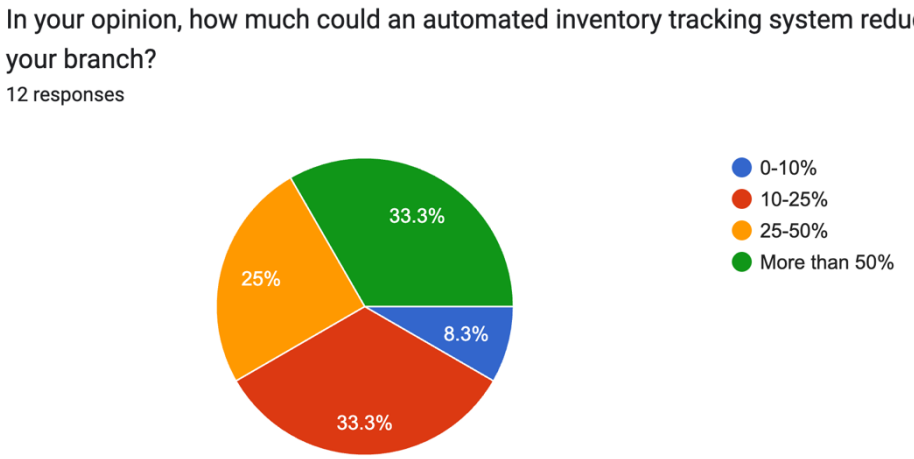
Managers expressed a strong interest in features that would make the inventory process faster, easier, and more reliable. Among the most requested were real-time inventory tracking, automatic reconciliation that requires minimal manual input, and user-friendly interfaces that are easy for staff to use without extensive training. Cost-effectiveness was also highlighted as a key consideration, along with the ability to reduce shrinkage over time. Overall, the responses show a clear desire for simplicity and time-saving solutions so long as the system is easy to adopt and doesn't introduce new complications into daily operations.

Main Concerns



While the interest in automation was generally high among respondents, several important concerns were brought up. Managers voiced worries about the cost of implementation, the potential resistance from employees who may be hesitant to adapt to new systems, and the need for proper training. There were also questions about how well Libra would integrate with existing ERP platforms like Odoo, as well as whether the system would be reliable and accurate enough to trust for daily operations. These concerns are reasonable and should be carefully addressed during Libra's rollout, especially in terms of onboarding support and ensuring technical compatibility.

Expected Impact of Libra



Most managers believed an automated solution like Libra could reduce discrepancies by anywhere from 10% to over 50%**.** This shows strong optimism about its potential impact especially given the current pain points.

Qualitative data

Interview with Alin

I spoke with Alin Iordache, one of the shareholders of WoodCutter, one-on-one to enhance the qualitative component of this research. Alin played a key role in the company's early logistics and infrastructure and has a wealth of practical expertise with operational systems. His technical expertise, particularly with regard to using hardware tools, was quite helpful when talking about the evolution and constraints of Libra's prototype.

Throughout our discussion, Alin provided valuable insights into the workings of scale sensors and the mechanical difficulties involved in creating a system such as Libra. The majority of smart scales, he clarified, include sensors of varying quality. While some sensors are designed for bigger goods (in kilograms) and prioritize load capacity above fine accuracy, others are developed to weigh light objects with exceptional precision (in grams). According to Alin, the behavior of each sensor varies based on its use case and settings. Trying to develop a single, standardized product that must accommodate a variety of inventory weights across various F&B establishment types is made more difficult by this variation.

Alin also brought up a crucial topic regarding scale longevity. He cautioned that leaving a weight on the scale all the time for long periods of time can cause wear and tear on the sensors. This may eventually result in a drift in the baseline calibration of the sensor, producing readings that are not correct. Given that Libra is made to hold beverage crates on the scale for days at a time, this information is particularly pertinent to the device. Thus, it becomes crucial to prepare

for recalibration or sensor replacement and take long-term durability into consideration while designing a product.

A summary of the interview with Alin

Two important technical issues that need to be fixed as Libra develops were highlighted in the conversation with Alin. To guarantee accuracy across a range of products, the sensor type must first be chosen to correspond with the weight category of the inventory being tracked. Second, extended static pressure on sensors can cause deterioration and eventual failure, emphasizing the necessity of modular sensor replacement or periodic recalibration. These findings support the significance of creating a reliable, long-lasting product and offer insightful guidance for Libra's future development phases.

These limitations will be further discussed in a dedicated part following the business plan further down in the study.

Direct observations:

During my internship at WoodCutter, I had the opportunity to observe the day-to-day inventory management practices across branches. These first-hand observations revealed recurring operational challenges that reinforced the need for an automated solution like Libra.

One of the most noticeable problems was the reconciliation process between the theoretical inventory registered in Odoo and the actual physical inventory. Employees were often required to count stock manually, a task that became highly error-prone due to fatigue, repetition, and time pressure. As the same process was repeated weekly, I witnessed numerous human errors that led to mismatches in the data.

Libra, by automating the tracking through precision sensors and physics-based measurement, would theoretically solve almost all of these issues; eliminating the need for manual stock counting and drastically reducing the opportunity for mistakes.

Another key issue I observed was related to the process of receiving supplier orders. Employees frequently failed to verify the exact quantities received before entering the data into Odoo. This meant that any discrepancy between what was ordered and what was actually delivered went unnoticed, directly leading to inaccurate inventory records.

Libra would address this by logging exact crate weights as soon as deliveries are placed onto the scale, flagging any deviations from expected values immediately and ensuring that only accurate data enters the ERP system.

Lastly, I noted a third recurring issue: the occasional failure to register sales at the point of sale. This typically occurred during peak hours, when employees were overwhelmed with customer demands and managing several tasks at once. Products were sometimes handed to customers without being logged in the cash register, which further contributed to inventory inconsistencies.

These direct, on-the-ground observations support the argument that Libra addresses not just technical inefficiencies, but also very real, human challenges present in busy, high-turnover environments like WoodCutter.

Business plan

Value Proposition

Libra is a cutting-edge inventory management solution designed to revolutionize stock tracking in the Food & Beverage industry. By leveraging real-time weight-based tracking technology, Libra eliminates the need for manual counting, reducing human error, shrinkage, and inventory discrepancies. The system seamlessly integrates with existing ERP solutions like Odoo, providing businesses with accurate, automated stock control that enhances operational efficiency and financial oversight. Libra's primary goal is to help bars, restaurants, and entertainment venues optimize inventory management, reduce waste, and improve profitability.

Management Team

Libra is led by a team of experienced professionals with diverse expertise in technology, logistics, and business management:

Anthony Mady (Founder & CEO) – Background in international business management and hands-on experience in logistics and project management.

Lama Keyrouz (CTO) – A full time software engineer at the dutch multinational company "Booking.com", currently completing her masters in artificial intelligence.

Joe Daou (CFO) – Originally a civil engineer, that took intrest in the financial markets and ended up as a Back office consultant at the multinational company "Murex".

Anthony Mady (Marketing & Sales Lead) as this will be a start-up, no one would be a better fit to represent the product than me as I would have all the needed details and selling points that a customer might enquire about.

Pretotype

In this section, I will illustrate my vision for Libra, starting with the physical prototype and the rationale behind each design choice. I will then explore the back-end, providing a preview of the algorithm and operating software that will process data from the scale and present the final results. Keep in mind that this represents a Minimum Viable Product (MVP) and not the final version.

Physical pretotype

When I started thinking about what Libra would look like, I was imagining all the components fitting around the scale as I thought it was the centerpiece of Libra. After further reflection I noticed that even the scale must be built around what is being measured to get the most accurate data possible. In our case, Libra will initially be weighing down beverage crates.

In Belgium the most popular beverage crates are 24x33cl crates with the following standard specifications (Schoeller Allibert, n.d.).

Product specifications	
Product reference	4249013
Maximum outer length (L)	400 mm
External maximum width (W)	300 mm
Maximum external height (H)	270 mm
Net weight (Kg)	2.1 kg
Operating temperature range	-20 °C - 40 °C

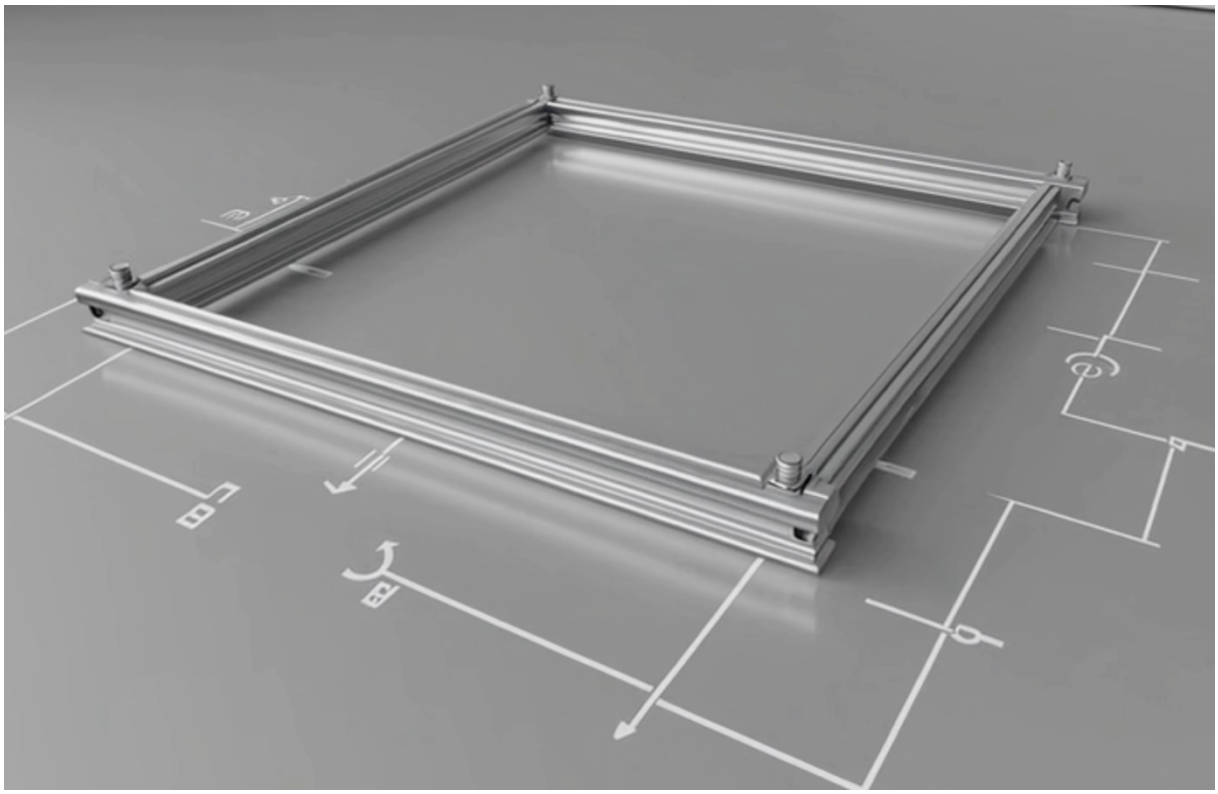
In this study we will use the following specifications as a standard to be able to sketch out a working Libra prototype.

Prototype components

I will first start my naming all the individual components that make up a full libra prototype and the reason behind all the design details. I will also attach blueprints for the first prototype and 3D renders to help visualise what the end product would look like. I will follow that by laying out what the algorithm will look like and explain the reasoning behind every decision taken. I will also go through a simplistic dashboard interface that will help owners keep a live feed of their inventory numbers.

Libra's base

At Libra, we value accurate relevant data. The main purpose is to mitigate any outside factors that could cause innacuracy in the numbers. That is why the base of the scale will be stainless steel chasis in order to secure the scale in place.



Picture generated by ChatGpt showing the 904L stainless steel chasis with the bolts in the corners of the frame.

The chasis will be manufactured with 904L stainlesss steel. This type of steel is anti-corrosion, which is perfect for its purpose as it might get in contact with humid environments. The chasis's main purpose is to hold the scale in a perfect horizontal level as the floor tiles might hold some imperfections and inclinations. It also ensures that the scale is secrured in one location during restocking on top of the scale or normal operations.

The frame's dimensons will be 401 mm[9] in legnth, 301 mm in width and 10mm in height. The additional millimeter on the length and width ensures that the scale can comfortably fit in the frame. A layer of rubber lining to the inner face of the chasis will be placed in order to ensure a stable fit and preent direct metal to metal contact.

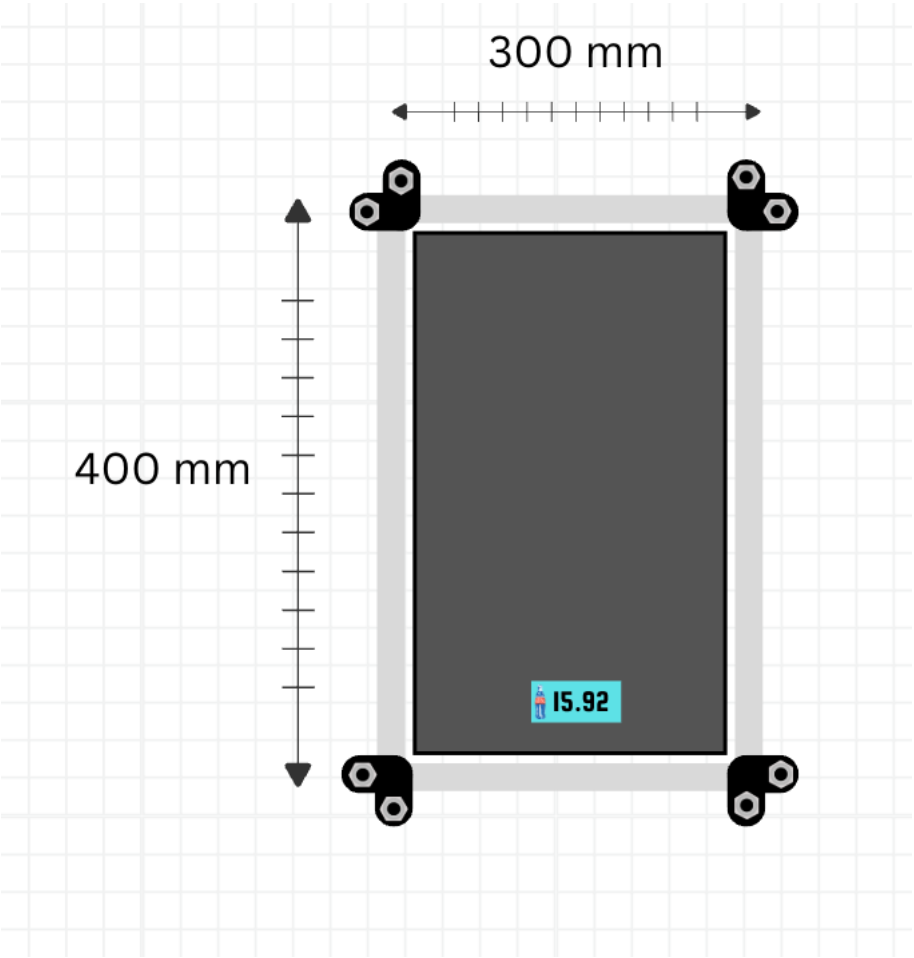
The chasis also plays a role in modularity, where scales can easily be swapped in and out of the steel frame in case of malfunction. This will ensure a sustainable approach and limit technological waste.

Libra's scale

Once the Chasis is bolted to the ground, the Libra scale can then be slipped into the stainless steel frame ensuring a levelled tight placement.The scale's dimensions will be 400 mm in length, 300 mm in width and 9 mm in height. The scale will be secured in the frame tightly based on the accurate measurements takes and the rubber linning on the inside of the frame.

[9] Mm: millimeter

The scale itself will be an ordinary smart scale, which will be able to accurately measure the weight of crates and bottles. The smart scale also comes equiped with a small digital screen to give any needed updates to the branch manager.
When it comes to data transfer, the scale will use Wifi[10] to transfer the required data to the mobile application and provide the manager with an accurate live feed of his inventory levels.



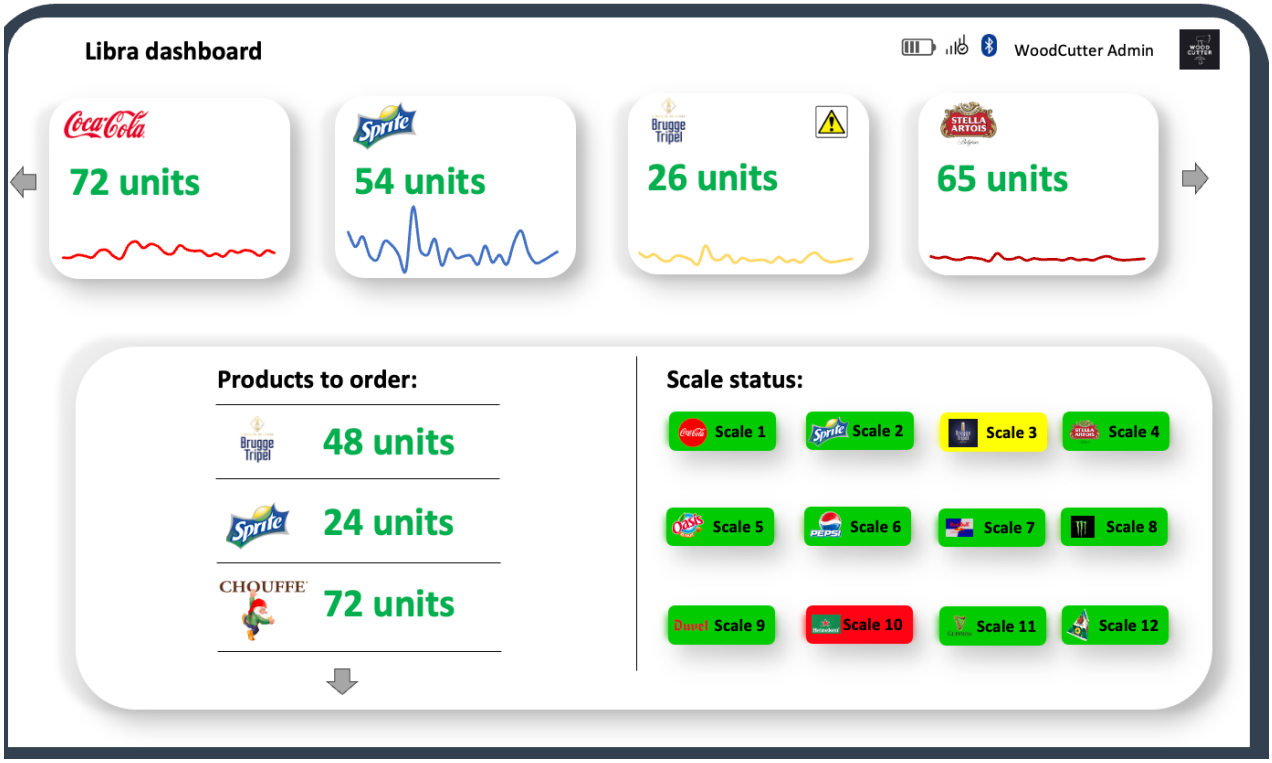
Picture designed on Canva.com showing the Chasis steel frame in gray, the black rubber outline and the dark grey scale in the middle with a blue digital screen.

Libra's dashboard pretotype

Once Libra has been installed correctly in the inventory room and given access to the WIFI, it will then be setup and connected with an administrative device to ensure the flow of information is secure and provided to the appropriate representative.

The dashboard will include a multitude of different metrics that provide insights into the inventory numbers. Based on the numbers, the user will be able to set minimum allowed quantities, track the daily restock rate or create jis own dashboard from a list of differnet key performance indicators.

[10] WIFI: Wireless fidelity.



Each product can will be tracked with a live unit feed and a curve showing the historic level of inventory; watching for spikes can help spot trends and ordering patterns.

The dashboard will also show a list of products that are running low and prompts you to sub,it a purchase order. A feature that can be enabled, is automatic ordering, once a product hits a preset minimum quantity; it will proceed to send a custom email to the provider and placing a purchase order on the appropriate ERP[11] system.

On top of that, you can also track indiviual status of all the scales in order to check-up on their performance. The different light colors will alert the administrator in case of a minor issue (yellow light) or a critical issue (red light). A yellow light issue can be solved by submitting a ticket to the Libra support team or following the Libra documentation on our website. A red light issue will notify our maintenance team which will contact the manager of the location to book a date to come and repair the installation for the damaged scale.

Libra's usage and data processing

In order for Libra to display the number of units for each product, a dedicated scale must be installed for each brand of beverage. The installation process will be done by a special team trained by Libra. Once the process is done; the administrator can proceed to connect his device to the scales and start the initiation process.

Libra will ask that the administrator to help it familiarise the system with the product it will be tracking. The system will first ask to name the product it will be measuring; for the sake of our example we will take product "Spirte" as an example.

[11] ERP: Entreprise ressouce planning

After naming the product, the scale will ask of you to place 3 different Sprite bottles, one at a time on the scale in order for it to register the average unitary weight of a bottle of Sprite. Following that step the scale will ask you to introduce an empty standard crate so the scale can register the average weight a crate will register on the scale. Libra will then ask the administrator to register how many units of Sprite does the standard crate hold.

Once all of the information above is provided to Libra, the algorithm is then able to calculate the number of units in real-time using the following approach:

1. **Total Measured Weight (W total)** - The real-time weight detected by the scale.
2. **Crate Weight Deduction (W crate)** - The system subtracts the registered empty crate weight from the total weight.
3. **Unit Count Calculation (N)** - The remaining weight is divided by the recorded unitary bottle weight (W unit) to determine the number of units.
4. **Rounding & Accuracy Adjustments** - The algorithm applies rounding functions to accommodate small variations due to condensation, packaging inconsistencies, or measurement fluctuations.

Step	Formula	Explanation
1. Detect total weight	W_{total}	The scale measures the total weight of the items placed on it.
2. Subtract crate weight	$W_{remaining} = W_{total} - W_{crate}$	The system removes the known weight of an empty crate.
3. Calculate unit count	$N = \frac{W\ remaining}{W\ unit}$	The remaining weight is divided by the weight of a single bottle to determine the unit count.
4. Round & validate	$N\ final = round(N)$	The result is rounded to ensure it reflects a whole number of bottles.

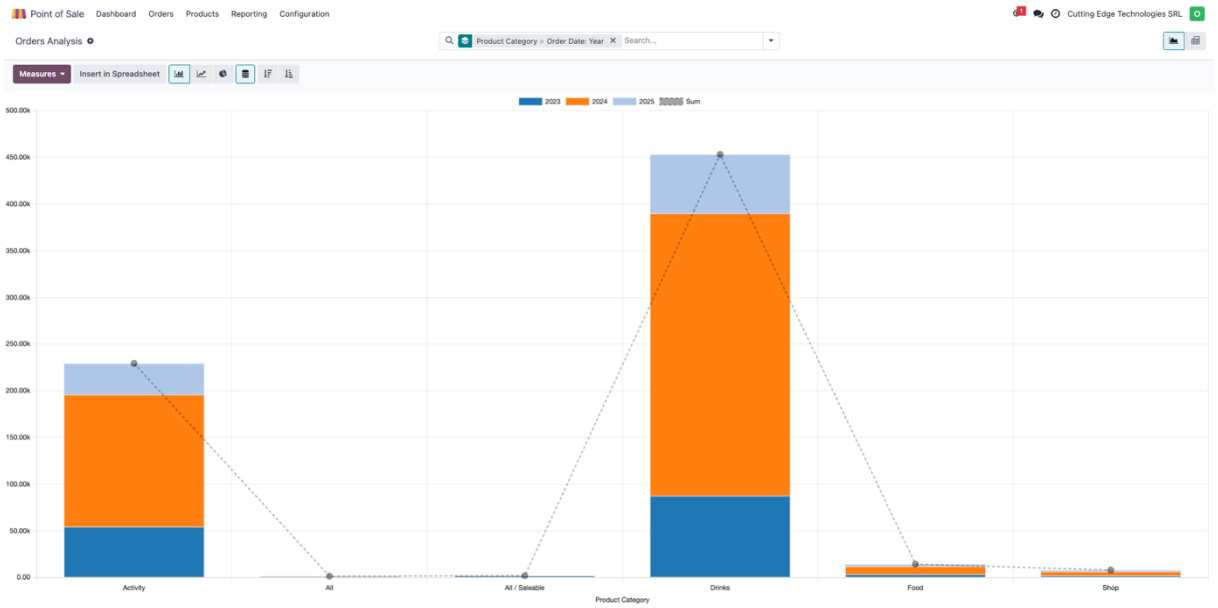
This algorithm allows Libra to provide precise real-time inventory tracking without requiring manual counting. The system continuously updates its calculations, ensuring that stock levels are always accurate and minimizing human error in inventory management.

Market and Competition

Market Overview:

The global F&B industry faces persistent challenges in inventory management, with businesses losing significant revenue due to inaccurate stock tracking, over-ordering, and shrinkage. Libra will aim to solve these issues in the market around the small and medium level establishments that rely on beverages as a source of income.

Let us take WoodCutter as an example, the core attraction is the axe throwing activity; but once you look at the sales data, you can notice that the biggest source of revenue comes from the drinks category of the POS rather than the activity category.



Target Market:

Libra will first focus on the Belgian market, where small and medium-sized businesses in the food and beverage industry face daily challenges with inventory management. Many of these establishments rely heavily on drinks as a main source of income, even if their core business is something else. A good example of this is WoodCutter, even though it is known for axe throwing, most of the revenue actually comes from drink sales, not the activity itself. This shows how important it is to manage beverage inventory correctly. Libra is especially useful for bars, restaurants, and entertainment venues where stock turnover is high and errors in tracking can lead to major losses. It also fits well with businesses that have more than one location and want to manage their inventory in a more consistent and standardized way. By starting in Belgium, Libra can prove its value in a real-world market before expanding further.

Competitive Landscape:

Libra competes with traditional inventory tracking methods (manual counting, barcode scanning) and existing ERP solutions. However, most current systems lack real-time tracking and require labor-intensive reconciliation. Libra's weight-based tracking system offers a unique competitive advantage by eliminating manual input errors and providing real-time insights into stock levels.

Key Competitors:

Traditional inventory methods (Excel sheets, manual stocktaking) – Time-consuming, error-prone.

RFID-based solutions – Expensive, unreliable in F&B environments due to interference from liquids and metals.

POS-integrated stock tracking (e.g., Odoo, Square, Toast) – Limited automation, requires manual reconciliation.

While Libra brings a new approach to inventory management in the F&B sector through weight-based real-time tracking, it is important to acknowledge that there are already several companies working to solve similar issues in different ways. These existing solutions mainly focus on digital tracking, manual stock input, or ingredient-based management. For example, Oracle offers a restaurant inventory management software as part of its Simphony POS system, helping businesses reduce waste and control stock levels. MarketMan is another platform that helps restaurants manage food costs and supplier relationships using cloud-based tools. WISK focuses on bars and restaurants by offering a system that tracks inventory levels and automates reordering. Backbar offers a simplified inventory management system that integrates with sales data. Another key player is Lightspeed, which provides real-time ingredient tracking and inventory automation. It's also worth noting that Odoo, a Belgian company, offers an ERP system with built-in inventory management features, which is already used by several businesses across Belgium.

Although these systems provide valuable tools, most still rely heavily on manual entry or barcode scanning. Libra's unique value lies in its ability to automate inventory tracking through real-time weight data, minimizing human input and improving accuracy. This differentiation positions Libra to fill a gap in the Belgian market where small and medium-sized venues need simple, reliable, and low-maintenance inventory solutions.

Marketing and Sales Strategy

Marketing Approach:

Libra's marketing strategy will begin with a strong focus on B2B outreach, particularly within the Belgian F&B sector. As part of the early-stage launch, I will personally take on the sales role by directly visiting bars, restaurants, and entertainment venues. These on-site visits will allow for meaningful conversations with managers and business owners, giving me the chance to understand their specific inventory challenges and introduce Libra as a tailored solution. A key part of this approach will be demonstrating the working prototype and sharing real-life results from test branches, such as WoodCutter. To encourage adoption, Libra will be offered with free installations and a trial period, reducing barriers to entry and giving businesses a hands-on experience with the system before committing financially.

In parallel, content marketing will be used to build Libra's credibility and educate the market. This includes writing thought leadership articles, blog posts, and whitepapers on topics like inventory shrinkage, ERP integration, and automation in the F&B industry. Case studies from early adopters will be published to show measurable benefits and reinforce the value of Libra. These materials will also serve as useful tools during sales conversations and presentations.

Trade shows and industry events will also play a key role. Libra will be showcased at food, beverage, and hospitality expos in Belgium, such as Horeca Expo in Ghent. Attending these events will allow Libra to be presented directly to decision-makers in the industry, generate brand awareness, and collect valuable feedback from a wider audience. Participation in technology summits may also help position Libra as an innovative product within the growing market of foodtech and smart hospitality tools.

The digital marketing strategy will focus on reaching business owners online through search engine optimization, targeted social media campaigns (especially on LinkedIn and Facebook), and pay-per-click advertising. These efforts will be designed to drive traffic to Libra's website, where visitors can learn more about the product, book demos, or request a trial. A simple landing page will be developed to convert interest into direct contact or trial sign-ups.

To accelerate market penetration, Libra will also implement a referral and partnership program. Early adopters and satisfied clients will be encouraged to refer other businesses in exchange for benefits such as discounts or extended free use. In addition, partnerships with ERP consultants, beverage suppliers, and hospitality associations will be explored to widen Libra's reach and credibility. These partners can act as multipliers by promoting Libra to their networks or bundling it with existing services.

Together, these channels form a comprehensive marketing and sales approach that combines direct relationship building with broader brand awareness efforts. This strategy is especially suitable for a product like Libra, which requires trust, visibility, and hands-on experience to be properly appreciated.

Sales Strategy:

The sales strategy for Libra is designed to encourage adoption by reducing risk for first-time users while offering flexible pricing models that can grow with the customer's needs.

The first phase will revolve around a pilot program, which allows select businesses to try Libra with no upfront cost. These businesses will receive a fully installed Libra system at their location, along with support and training to help them get started. This approach is meant to showcase the product's value in a real-world setting and gather early testimonials and usage data. The goal is to convert trial users into long-term paying customers by letting the results speak for themselves.

Once the trial phase ends, Libra will transition users into a subscription-based pricing model. This will involve a monthly SaaS (Software as a Service) fee that includes access to the Libra software platform, customer support, and system updates. Hardware such as the scales and chassis will be offered through a leasing option, keeping the upfront investment low for small and medium-sized businesses. This model is designed to be both affordable and scalable.

For larger businesses with several locations, Libra will offer enterprise licensing. These plans will be tailored to each client's needs and may include volume-based discounts, additional onboarding support, and integration with existing ERP systems. This allows Libra to serve multi-branch businesses that require a more centralized and standardized inventory solution.

By combining free trials, flexible pricing, and scalable licensing options, Libra's sales strategy is positioned to support fast adoption while adapting to the different operational sizes and budgets of its clients.

Business System and Organization

Operational Model:

Product Development: Libra's operational model is built around efficiency, reliability, and scalability, with a strong focus on product development and customer experience. The core technology including the hardware and software is developed internally to ensure full control over quality and system integration. The hardware consists of a compact digital scale with embedded weight sensors, designed to fit into a custom steel chassis for easy installation and modularity. Once tested and finalized, hardware production will be outsourced to specialized manufacturing partners to scale efficiently without compromising cost or consistency. On the software side, Libra's system includes a smart algorithm that processes real-time weight data, detects inventory levels, and provides users with clear insights through a simple interface connected to the business's ERP system.

Customer Support: Libra will provide multi-level customer support to make sure clients always have help when they need it. A dedicated remote support team will handle inquiries through email, phone, and a ticketing system, offering assistance with setup, daily use, and software-related questions. For more serious technical issues especially those related to the physical hardware Libra will deploy on-ground maintenance staff. This team will handle hardware replacements, recalibrations, and other technical repairs when needed. This two-tier system ensures quick response for simple issues and reliable service for more complex needs.

Sales & Distribution: Libra's sales and distribution model will combine direct outreach with strategic partnerships. Direct sales will be led by the internal team, starting with personal visits to bars, restaurants, and entertainment venues across Belgium. This hands-on approach helps build relationships and allows for live demonstrations of the product. At the same time, Libra will work to build partnerships with local ERP consultants, POS system providers, and beverage suppliers. These partners can act as resellers or promoters of Libra, helping expand its reach into new regions and customer segments. Hardware will be shipped directly to clients, with support teams coordinating installation as part of the onboarding process.

This operational structure ensures Libra is equipped to scale efficiently while keeping its core values of reliability, service, and innovation intact.

Organizational Structure:

While Libra's leadership team is responsible for guiding the company's strategic direction, the successful operation of the business also relies on a well-organized structure with clearly defined roles across departments.

Executive Leadership includes the CEO, CTO, COO, CFO, and Marketing Lead. This group oversees the company's overall strategy, major decisions, and long-term goals. As Libra is a start-up, the leadership team will be highly involved in day-to-day operations, especially during the initial growth phase.

Product Development Team will consist of engineers, software developers, and UX[12] designers. Their task is to ensure that the Libra scale and software are functioning smoothly,

[12] UX: user experience

remain user-friendly, and are regularly updated to meet customer feedback and evolving needs. The engineers will focus on optimizing the sensor technology and chassis integration, while developers will improve the algorithm and data processing. UX designers will ensure the platform is intuitive and accessible for non-technical users in the F&B sector.

Sales & Customer Success Team plays a critical role in market penetration and client satisfaction. Business development representatives will actively seek out new opportunities, while account managers will maintain ongoing relationships with clients. The support specialists will manage onboarding, provide training, and help users with software or operational questions. This team ensures that each client has a positive experience from first contact through daily use.

Operations & Finance Team ensures that everything runs efficiently behind the scenes. Logistics and supply chain professionals will manage the sourcing and distribution of Libra's hardware, making sure installations are done on time and stock levels of components are maintained. Financial analysts will monitor budgets, manage company cash flow, and help plan for sustainable growth.

Together, this structure allows Libra to function like a well-oiled machine, with each department playing a key role in delivering a reliable, scalable, and high-quality product to the market. The organization will remain flexible in its early stages, allowing for quick adjustments as the company learns from its first clients and scales up operations.

Opportunities and Risks

Opportunities:

Libra enters the market with several strong opportunities that could significantly support its growth and long-term relevance. These opportunities not only offer potential for commercial expansion but also create space for strategic collaborations and innovation.

One of the most important advantages is Libra's first-mover advantage. At present, there are no widely adopted solutions that offer real-time, weight-based inventory tracking specifically tailored for the food and beverage sector. Most competitors rely on traditional barcode scanning, manual input, or RFID systems, all of which come with limitations in accuracy and practicality especially in environments with liquids, varying packaging, and rapid stock turnover. Libra's approach is unique in that it automates stock tracking without human input and without relying on packaging identifiers. Being the first product in this niche allows Libra to shape market expectations and set new industry standards.

Another major opportunity lies in scalability beyond the F&B industry. While the product is initially designed for bars, restaurants, and entertainment venues, the technology behind Libra can be adapted to other sectors where small, trackable units are stored and moved in large quantities. For example, in retail settings, Libra could track items like cosmetics or health products. In pharmaceuticals, it could be used to monitor drug inventories where precision and loss prevention are critical. This scalability makes Libra not just a single-purpose product but a platform that could be expanded over time to serve a much larger market.

There is also a promising opportunity in forming partnerships with ERP providers such as Odoo, Toast, Lightspeed, and others. Since many businesses already use these systems to

manage operations, integrating Libra with them could make adoption much smoother. For ERP companies, such a partnership adds value to their own software; for Libra, it increases visibility and trust. These collaborations would allow businesses to synchronize sales data and inventory levels seamlessly, reducing data fragmentation and improving overall operational efficiency.

Lastly, Libra supports a strong sustainability narrative, which is becoming increasingly important in today's business environment. By providing real-time, accurate stock data, Libra helps businesses avoid over-ordering and reduce inventory waste particularly in the case of perishable goods like drinks. This aligns with broader environmental goals and can be a key selling point when pitching to socially conscious businesses or applying for sustainability-focused grants and funding. In the long run, reducing food and beverage waste not only saves money for businesses but also contributes to a more sustainable supply chain.

These opportunities together position Libra as more than just a product it becomes a platform for innovation, industry collaboration, and environmental responsibility. Leveraging these strengths strategically could accelerate its market presence and secure a long-term place within and beyond the F&B sector.

Risks & Mitigation Strategies:

While Libra presents a strong opportunity for innovation in inventory management, the path to market adoption is not without challenges. Like any new product, it must navigate both internal and external risks. Identifying these risks early and preparing effective mitigation strategies will be key to Libra's successful development and deployment.

One of the main risks is adoption resistance from potential users. Many small and medium-sized businesses in the F&B sector rely on familiar manual systems or simple digital tools, and may be hesitant to change their current workflows. For some, adopting a new technology may feel overwhelming or risky. To reduce this barrier, Libra will focus heavily on direct outreach and hands-on demonstrations. By offering a no-cost pilot program and supporting installations with onboarding sessions, businesses can see the value of Libra before making a financial commitment. This approach also builds trust, making it easier for managers and staff to embrace the new system.

Another potential issue is hardware malfunction. Since Libra relies on physical devices that must operate reliably in busy, often chaotic hospitality environments, there's always a chance of technical failure. To address this, Libra will implement strict quality testing protocols before distribution and will include an optional maintenance plan that provides on-site support for larger issues. Replacement parts will also be made available quickly through the support network, ensuring minimal disruption to operations.

Market competition is another factor to consider. Although Libra has a unique value proposition with its real-time, weight based inventory system, other companies may enter the space with similar features. To stay ahead, Libra must continuously innovate, particularly by improving its algorithm, user interface, and integration capabilities. Forming early partnerships with leading ERP platforms like Odoo or Toast will also provide an edge, making Libra more appealing to businesses already using these tools and positioning it as a complementary rather than competing product.

Finally, funding challenges may pose a threat to early development and market expansion. As a hardware-based startup, Libra faces higher upfront costs compared to purely software-based businesses. To manage this, Libra will adopt a conservative funding approach, seeking support from strategic investors who understand the long-term vision and value of the product. Additionally, crowdfunding platforms may be used to attract early adopters and generate financial support while building community interest and awareness.

By preparing for these risks with thoughtful, proactive strategies, Libra can reduce the impact of potential setbacks and build a stronger foundation for growth and long-term success.

Financial Planning and Financing

Estimated Cost Structure and Break-Even Analysis

In order to assess Libra's financial viability, a detailed breakdown of the cost structure and a break-even analysis were developed based on current market prices for electronic components and standard marketing practices in early-stage startups.

Hardware Cost Breakdown (Per unit)

The Libra scale is composed of widely available electronic components including a load cell sensor, a microcontroller (such as Arduino Nano or ESP8266), an amplifier module, and basic connectivity modules. The approximate cost per unit for these components is summarized below:

Component	Estimated Cost (EUR)
Load Cell Sensor	€5.00
HX711 Amplifier Module	€2.00
Microcontroller (e.g., Arduino)	€5.00
Wi-Fi Module (e.g., ESP8266)	€3.00
Power Supply and Cables	€5.00
Enclosure and Mounting Materials	€10.00
Total Hardware Cost	**€30.00**

Additional Operational Costs (Per unit)

To ensure product readiness for delivery, several additional costs are incurred. These include packaging, labor, and quality control. A breakdown of these variable operational costs is as follows:

Operational cost category	Estimated Cost	Why This Amount Was Used
Packaging Materials	€2.00	Includes a small cardboard box, foam padding, and labeling. Based on typical startup logistics.

Operational cost category	Estimated Cost	Why This Amount Was Used
Assembly Labor	€5.00	Hand-assembled units in early batches typically cost €4–€8 in labor depending on region.
Quality Assurance (QA)	€3.00	Time spent testing calibration, connectivity, and functionality (~10–15 min per unit).
Shipping & Handling	€5.00	Domestic flat-rate parcel shipping + handling fees. May decrease with volume shipping.
Total operational cost	€15.00	

Combining hardware and operational costs, the **total variable cost per unit** is estimated at approximately **€45.00**.

Marketing and Sales Overhead

To successfully launch Libra and penetrate the market, initial marketing and branding efforts are required. These are considered fixed costs and include:

Marketing Activity	Estimated Cost (EUR)
Website Development	€5,000.00
Branding and Logo Design	€2,000.00
Promotional Materials	€3,000.00
Online Advertising Campaigns	€10,000.00
Public Relations and Outreach	€5,000.00
Total Marketing Costs	**€25,000.00**

Break-Even Point Calculation

To assess the financial sustainability of the project, I proceeded with a break-even analysis using the following formula:

Break-Even Point (Units) = Fixed Costs / (Selling Price per Unit - Variable Cost per Unit)

And based on the previous costs breakdown:

- **Fixed Costs**: €25,000.00
- **Selling Price per Unit**: €100.00
- **Variable Cost per Unit**: €45.00

This results in:

Break-Even Point = €25,000 / (€100 - €45) = 455 units

Based on the results; Libra must sell approximately **455 units** to cover all fixed and variable costs and reach the break-even point with arevenue of €45,500.00

This sales target is both realistic and attainable within the first year of commercial launch, especially given the potential for bulk orders from multi-branch establishments.

Revenue Model:

Libra's revenue model is designed to be both flexible and scalable, allowing businesses of different sizes to adopt the system with minimal friction. The pricing strategy takes into account the number of scales a business needs, the level of support required, and whether they choose to buy hardware outright or subscribe to additional services.

The core of the model is based on a one-time hardware purchase combined with optional monthly services. Businesses can purchase Libra scales in pre-defined packages: 1, 5, 15, 30, or 50 units. Each package comes with a fixed installation fee and a one-time hardware cost**.** As seen in the pricing structure, a single-scale setup starts at €200 excluding customer support, while larger packages such as the 50-scale option are priced at €6500 in total. These prices allow Libra to remain competitive and accessible to both small venues and multi-branch operators.

Libra offers a free dashboard across all packages, giving users real-time access to their inventory data without additional costs. For smaller installations (1 to 5 scales), optional customer support is available at €100/month. This includes remote assistance through email, phone, and ticketing systems. For larger installations (15+ scales), premium support is included by default at no extra cost. This tiered system allows businesses to decide how much support they need depending on the scale of their operations.

Libra F&B tracker

Pricing plan

	1 SCALE	5 SCALES	15 SCALES	30 SCALES	50 SCALES
Installation fee	€100	€400	€800	€1000	€1500
Hardware	€100	€500	€1500	€3000	€5000
Customer support (optional)	€100/month	€100/month	FREE	FREE	FREE
Dashboard	FREE	FREE	FREE	FREE	FREE
Total	€200	€900	€2 300	€4 000	€6 500

For enterprise-level clients, Libra provides custom pricing through enterprise licensing agreements**.** These are specifically designed for large chains, hospitality groups, or

entertainment venues operating across multiple locations. This approach allows for discounts based on volume and long-term contracts, while also offering tailored onboarding and integration services.

In addition to hardware and support fees, Libra also generates revenue through consulting and integration services.These services include custom ERP integrations (e.g., Odoo or Toast), training sessions for staff, and on-site calibration or system upgrades. This stream of income supports deeper engagement with clients while ensuring the Libra system is aligned with each business's operational workflow.

Together, this revenue model allows Libra to serve a wide range of customers, from small independent bars to large multi-site hospitality groups, while generating recurring income through support services and long-term relationships.

Estimated Cost Breakdown and Profitability

To better understand Libra's business model, a detailed breakdown of the scale's production cost and potential profitability has been calculated. These figures are based on publicly available market prices of electronic components and estimated operational costs associated with low-volume hardware startups.

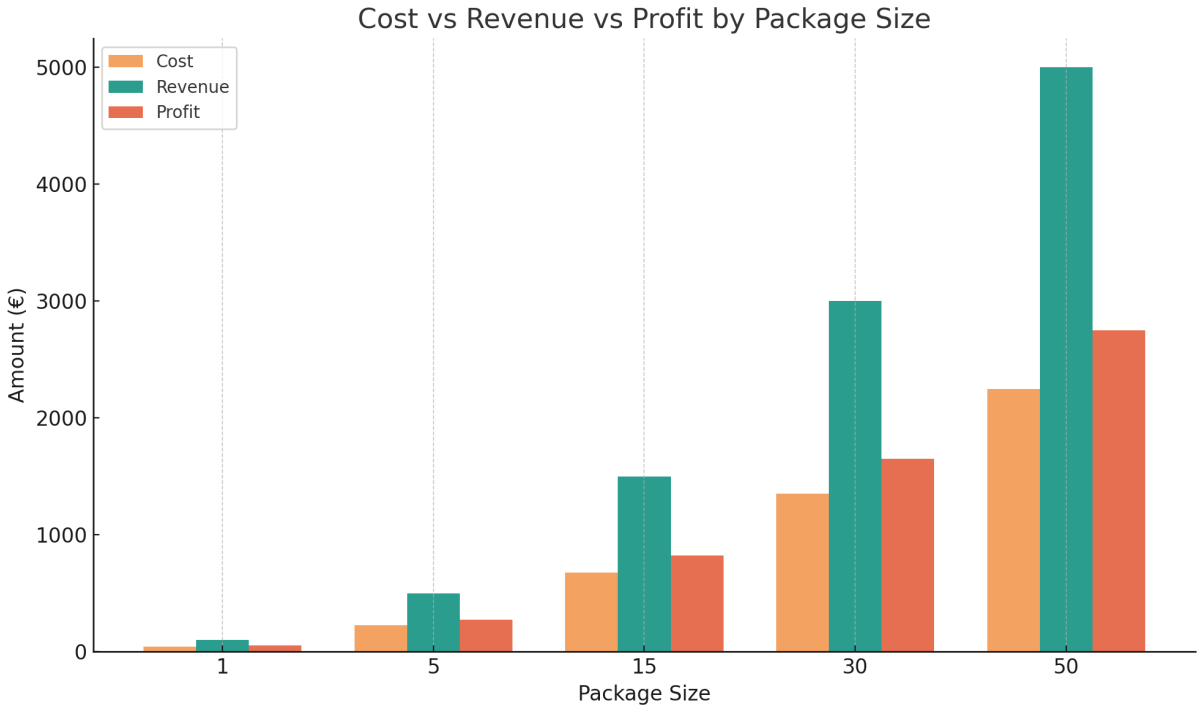
The Libra smart scale is composed of a load cell sensor, HX711 amplifier, a microcontroller (such as Arduino Nano or ESP8266), power modules, a compact display screen, a durable metal enclosure, and a mounting chassis. Based on current sourcing estimates, the total hardware component cost per unit is approximately €30. When additional costs for packaging, assembly labor, quality control, and shipping are included, the total variable cost per unit reaches around €45.

The scale is currently priced at €100 per unit in its standard pricing model. This leads to an estimated gross profit margin of approximately 55% on each unit sold. Even when accounting for overhead and optional customer support costs, the core hardware remains a high-margin product.

In bundled sales packages (e.g., 5, 15, or 50 scale deals), economies of scale allow logistics and handling costs to be streamlined, maintaining a margin between 50% and 60%, depending on the number of units and support services offered.

In addition to hardware, an installation fee provides a secondary revenue stream to cover travel and labor, allowing hardware profits to remain intact.

As production scales and components are purchased in bulk, the manufacturing cost per unit is expected to decrease by 15%–20%, further boosting profit margins. This buffer supports continued investment into R&D, marketing, and customer support without compromising the product's affordability or value proposition in the F&B market.



Projected Financials (First 3 Years):

Libra's financial projections are built on a phased growth strategy that begins with product development and testing, followed by national expansion and then international scaling. These projections are based on realistic market penetration goals and take into account the pricing structure, production costs, and service margins discussed previously.

Year 1: Product Development and Pilot Programs

The first year will focus on developing the minimum viable product (MVP), completing initial hardware builds, and piloting Libra in operational environments like WoodCutter. Most of the early units will be offered either free of charge or at a significantly reduced price to gather feedback and demonstrate value to potential customers. As such, revenue generation will be modest and mostly driven by a few early adopters who upgrade to paid packages by the end of the pilot phase.

Estimated revenue is expected to fall between €30,000 and €50,000, based on early sales of smaller packages (1-scale and 5-scale kits). Expenses during this period will include R&D, prototyping, design revisions, marketing content creation, and customer support setup. The aim is to reach operational break-even by the last quarter (Q4), supported by early positive traction and proof-of-concept success.

Year 2: National Expansion (Belgium)

In Year 2, Libra's focus will shift to commercializing the product throughout Belgium. With the scale design validated and production process standardized, the sales strategy will target bars, restaurants, and entertainment venues. Assuming an average sale size of 5 to 15 scales per venue, priced at €900 to €2,300 per package, the company is expected to onboard over 100 clients during the year.

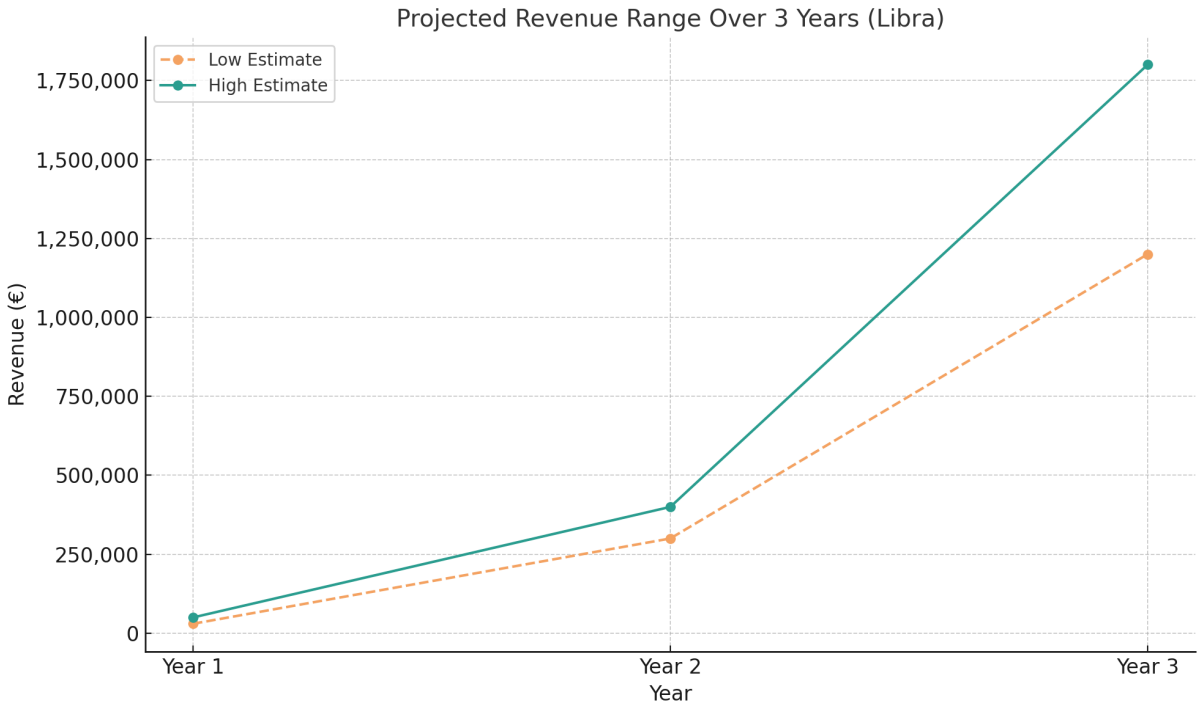
With this projection, Libra anticipates reaching between €300,000 and €400,000 in revenue for Year 2. Costs will increase due to staffing customer support, handling logistics at scale, expanding marketing, and enhancing back-end infrastructure. However, with growing recurring revenue from optional customer support services and increased market credibility, the company expects to achieve profitability by Q3 or Q4.

Year 3: International Expansion (Germany and Netherlands)

Building on the success in Belgium, Libra plans to enter two major international markets: Germany and the Netherlands. These countries not only have strong F&B industries but are also early adopters of technology-based efficiency tools. The expansion will be supported by ERP partnerships, distributor agreements, and local service teams.

The goal for Year 3 is to double the client base, introducing larger-scale deals (30- and 50-scale bundles) priced at €4,000 and €6,500 respectively. These higher-value deals, particularly from franchise groups or multi-branch chains, are projected to drive revenue between €1.2 million and €1.8 million.

Though operating costs will rise due to international logistics, localization efforts, and added workforce, Libra's revenue model is expected to remain profitable. Economies of scale in hardware manufacturing and increasing revenue from maintenance and integration services will ensure financial sustainability.



These projections show Libra's potential not only as a tech solution in a niche market, but also as a scalable business model capable of generating consistent, long-term income.

Funding Strategy:

To support the development and launch of Libra, a diversified funding strategy will be pursued. This approach reduces reliance on a single source of capital while increasing the startup's resilience and access to strategic networks. The aim is to secure early financial support to build and refine the product, validate it in the market, and position the company for future scaling.

The first step will be raising seed funding through angel investors and venture capital firms that specialize in early-stage hardware and B2B SaaS[13] startups. These investors often bring not only funding, but also valuable insights, mentorship, and connections. Given Libra's relevance to hospitality tech and foodtech, investors that have previously funded inventory management, restaurant ERP tools, or automation products will be targeted.

In parallel, Libra will explore crowdfunding platforms such as Kickstarter or Indiegogo. These platforms can help attract early adopters in the F&B community and create awareness around the brand. Crowdfunding also provides market validation, allowing Libra to refine its messaging and pricing based on real customer interest. Additionally, successful campaigns on these platforms often attract further investment from larger backers and institutional investors.

A critical part of Libra's funding roadmap involves applying for EU grants and public innovation support. The European Union provides several programs that are highly relevant to Libra, particularly under its Horizon Europe framework. This includes the European Innovation Council accelerator, which supports startups working on breakthrough innovations with market-creating potential. Libra could also benefit from Digital Europe Programme funding, which promotes the adoption of digital technologies in small and medium-sized enterprises. These programs offer non-dilutive funding, which means Libra can secure capital without giving up equity an important consideration for long-term ownership and growth.

Finally, Libra will pursue strategic partnerships with large players in the F&B and ERP ecosystems. For instance, collaboration with beverage suppliers or ERP service providers could include co-financing deals or joint marketing campaigns. These partners benefit from promoting a tool like Libra to their own clients, while Libra gains both financial support and market access. This route offers more than just capital it opens doors to new customer pipelines and provides validation from trusted names in the industry.

Through a mix of private investment, community engagement, public grants, and strategic alliances, Libra will be able to build a solid financial foundation and accelerate its go-to-market strategy.

Conclusion

Libra aims to disrupt the outdated inventory management practices in the F&B industry by providing a seamless, automated, and highly accurate tracking solution. With a clear value proposition, a strong market need, and a scalable business model, Libra has the potential to become a game-changer in inventory optimization. By addressing key risks and leveraging emerging opportunities, the company is well-positioned for long-term success.

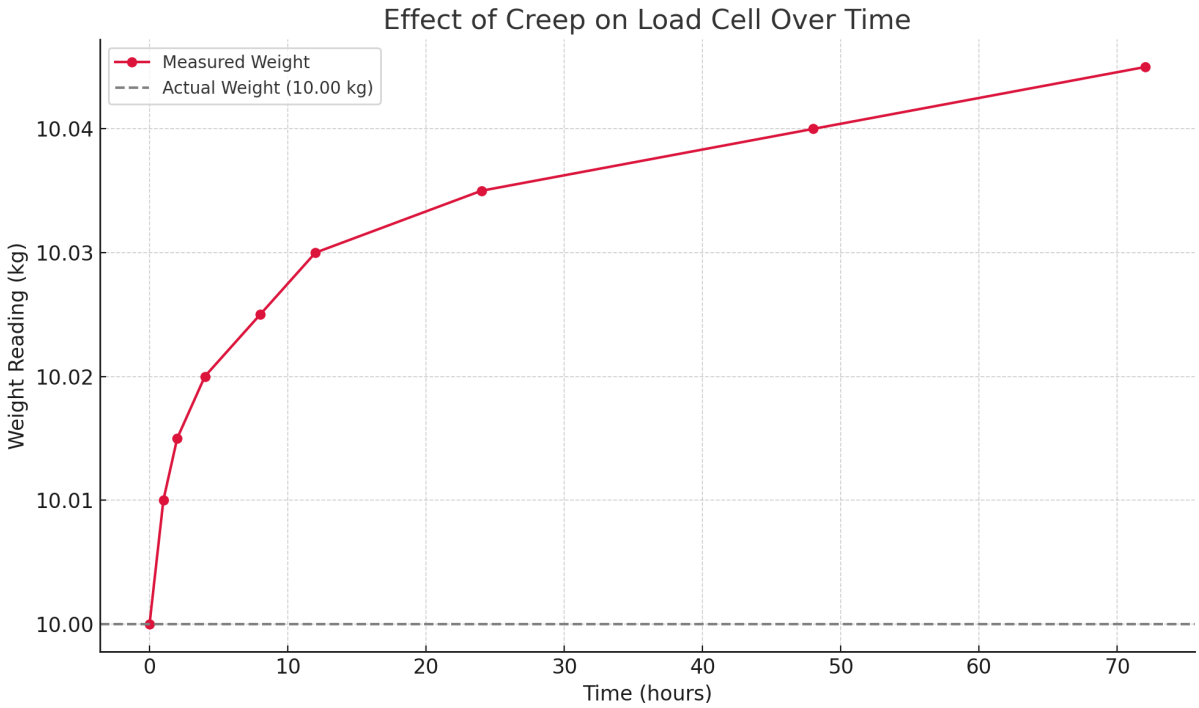
[13] SaaS: Software as a service

Limitations

While Libra introduces a new approach to inventory tracking through real-time weight measurements, there are inherent technical limitations that could impact the system's reliability or feasibility in certain operational conditions.

Sensor creep

One of the primary challenges is sensor creep, a known phenomenon in load cell technology. Creep occurs when a constant weight is left on a scale for an extended period, causing the sensor to slowly drift from its original reading, even though the actual weight has not changed. This happens due to the mechanical and electrical properties of the strain gauges inside the load cell, which are slightly altered over time under prolonged pressure. For example, if a crate of beer is left sitting on a Libra scale for several days, the scale might initially read 10.00 kg, but over time it could gradually display 10.05 kg or more, without any change in the actual load. This deviation, although small, can lead to false inventory counts, especially in environments where precision matters.



Research from Marsden Weighing Systems confirms that creep can significantly impact measurement accuracy, particularly in industrial and commercial settings where weight remains static for long periods. This is a notable concern for Libra, as most beverage crates may stay on the scale continuously until depleted. Mitigating this issue would require either regular recalibration or the integration of higher-end load cells that include creep compensation features, which may increase the overall hardware cost.

Sensor weight range

Another limitation relates to the precision of weight detection at low stock levels. In general, there are two primary types of weighing scales: those designed to measure in grams with high sensitivity; commonly found in laboratories or used for small retail items, and those built for kilograms, like standard household or industrial scales, which are less sensitive to small variations but better suited for heavier loads. Libra's use case primarily involves tracking beverage crates, which often weigh between 5 to 25 kilograms when full, making kilogram-based load cells the logical choice.

However, as the inventory in a crate decreases; such as when only one or two bottles remain, the total weight may drop into a range where kilogram-based sensors struggle to detect changes accurately. At this point, the scale may either not register the weight correctly or display fluctuating readings. This presents a practical issue in maintaining precise inventory visibility throughout the full stock cycle.

To overcome this, Libra would need to engineer a custom hybrid scale that integrates both gram and kilogram-range sensors. This solution would involve developing a software algorithm capable of switching or blending readings from both sensors depending on the active weight range. For example, the system could rely on the kilogram sensor for standard crate loads, and once the detected weight drops below a certain threshold, it could automatically defer to the gram-accurate sensor for more refined detection. This synergy between the two sensor types would allow Libra to maintain a high level of precision across all inventory states, from full to nearly empty.

This engineering challenge introduces complexity in both hardware design and software development but could be a key differentiator in Libra's ability to offer unmatched accuracy in the F&B inventory space.

Libra's software prototype

Along with the physical scale that will be measuring the weight of the products, we need a software that will receive the scale readings and process them and display them for the end user. That is why we have worked on a software that will help the user navigate and monitor the inventory room's performance.

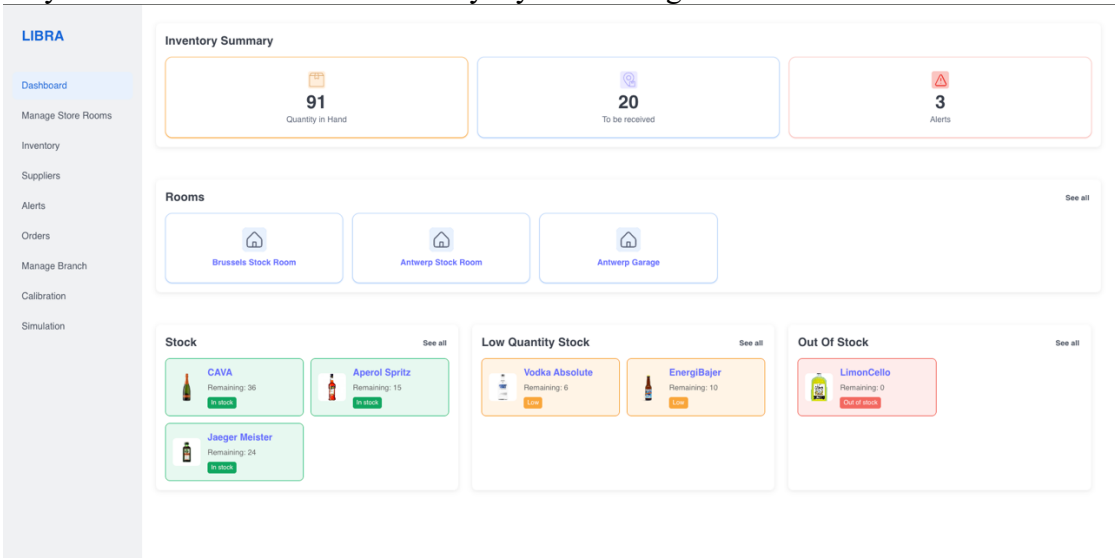
The work that will be presented in the subsequent part was a team effort between Libra's CTO Lama Keyrouz and myself. Lama worked on coding and creating the whole software from scratch. I helped with the vision, business rules and quality assurance testing to make sure the software behaved as exepected.

The Libra software was based on the pretotype that was mentionned previously on this thesis.

Dashboard

Libra software prototype is developed as a web version locally hosted for the moment as the platform is still under development and quality assurance testing. Upon lauching you will be

greeted with the dashboard which we decided to leave simplistic and straight to the point with only the most relevant KPIs for everyday monitoring.



Above is the dashboard showcasing the total unitary products on hand, unitary products to be received and alerts that refelect anything from low stock, no stock, to calibration issues with the hardware.

Right under the first three KPIs we can observe the inventory rooms we have setup in different branches. We will have a dedicated section to showcase the relevance of such a feature in the subsequent paragraphs.

Next we have a three card setup sshowcasing to the user the status of all the present products based on quantities synthesised from scale readings. The minimum allowed quantity threshold for different products are set while creating the products so Libra can display the products in the correct groups in the dashboard and send the relevant alerts.

Stock rooms management

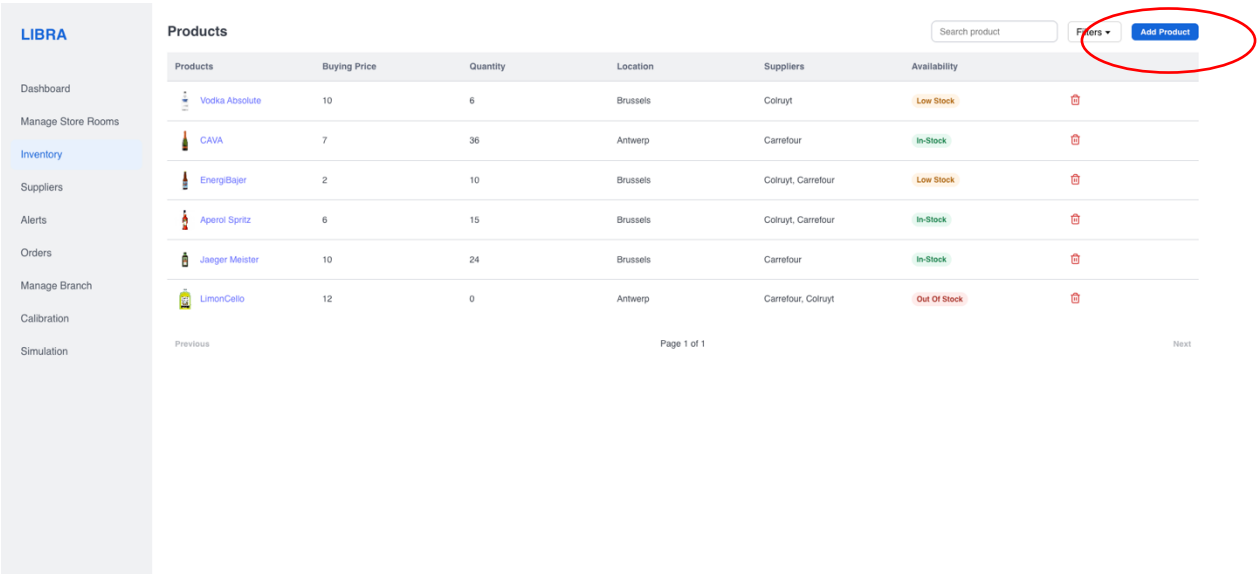
In store room management we wanted to create a directory where you can visually see all the inventory rooms in all branches. That would help in the long distance management of the inventory room as it gives a birds-eye view of the inventory rooms with a possibility of personal customisation of where each scale is placed in the room.

The picture above provides a better representation of what the inventory room management looks like. This feature will allow the user to customise the invetory room based on how to invetory room lookslike physically which will help the software understand where the scales are placed in the room and which one is showing any kind of calibration error.

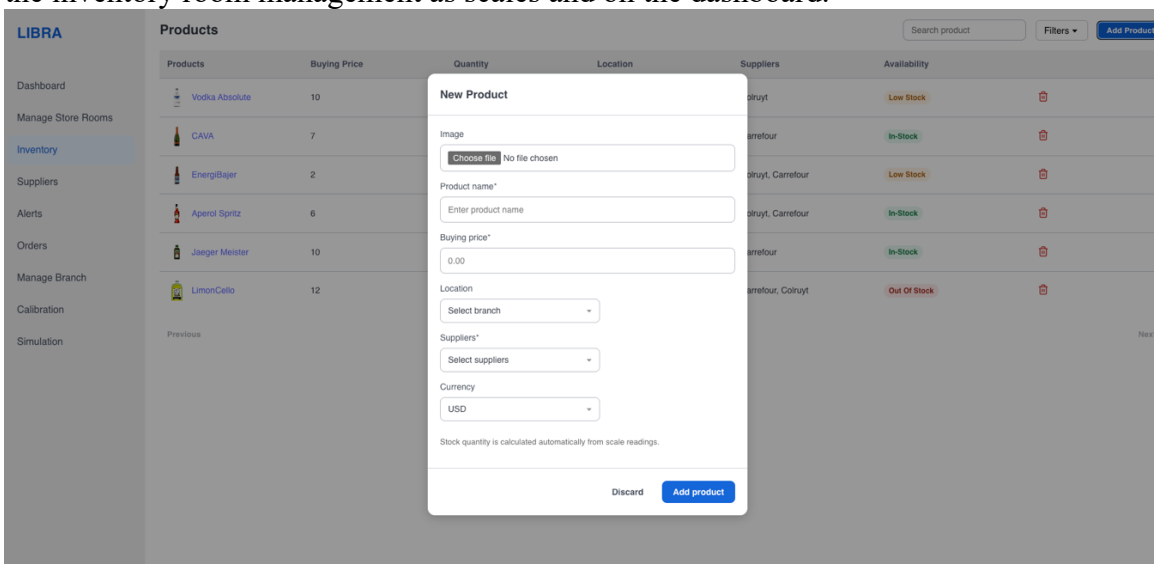
Inventory products

In this section of the software, the user can populate Libra with all the products that are ordered to the branch with crucial product details like:

- Product name
- Unitary price
- Location: Appropriate branch
- Suppiler(s): Can have multiple
- Availability: (In-Stock, Low Stock, Out Of Stock)



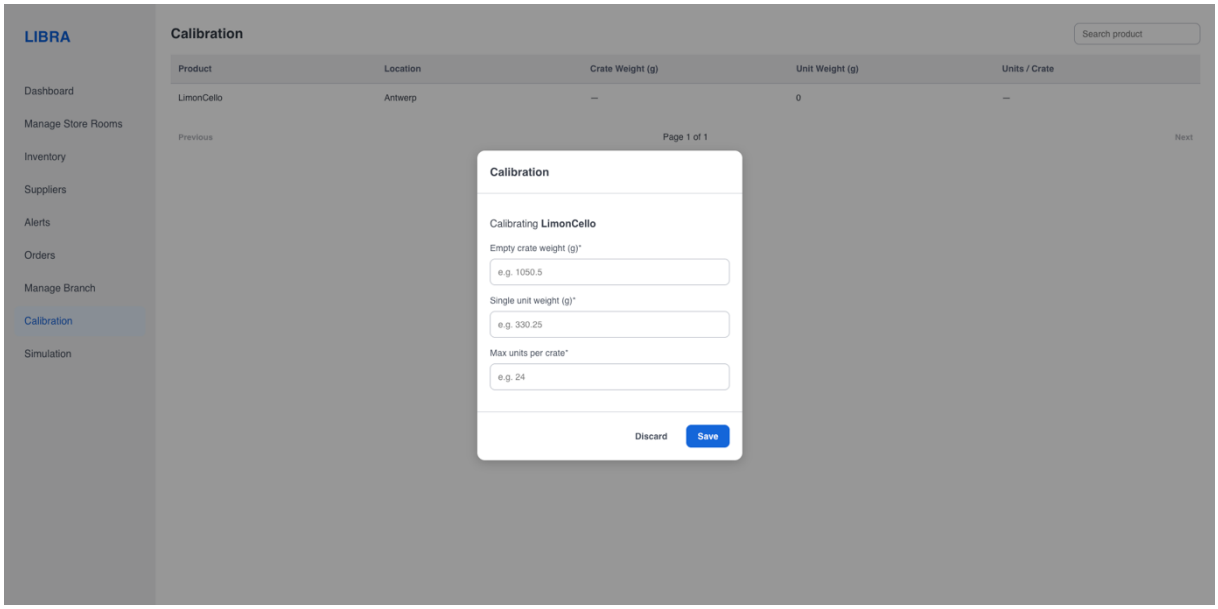
Using the “Add Product” button at the top right corner, the use is able to get the information card to provide the relevant product details. This process enables the products to show up on the inventory room management as scales and on the dashboard.



Calibration

In this section, the user will inpu the most important details that will be coupled with the hardware readings in order to determine the live uniatry product count. As discussed previously in the thesis we have integrated the mathematical reasoning in the software in order to determine the product count based on 4 metrics:

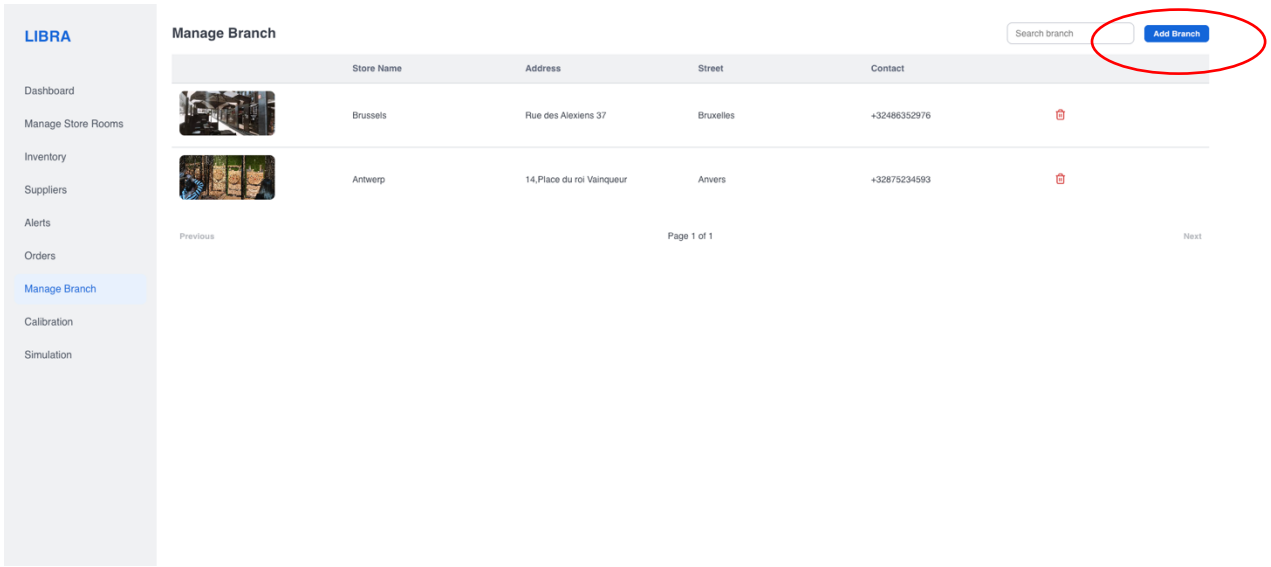
- Net crate weight
- Single unit weight
- Max units per crate
- Libra scale weight reading



Based on these metrics, Libra will be able to display the proper product count on the dashboard and alert the user in case or Low or no stock left.

Multi-branch management

A functionality that I insisted on adding is a multibranch management option. This is a needed option in fracnhises that have more than one branch and want to manage all their inventory on one platform while keeping it organised.

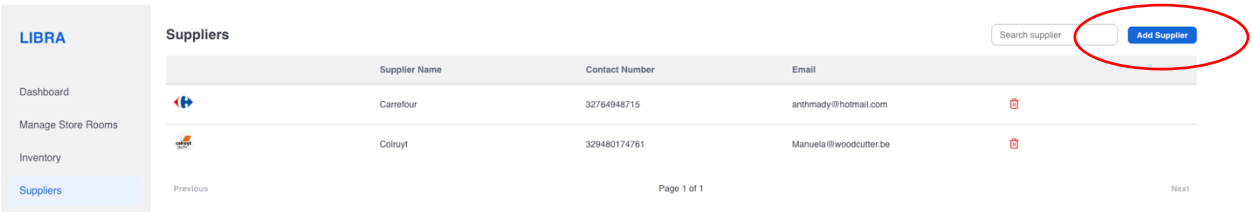


That is why Libra gives the user the possibility to create different branches and assigning each Inventory room, scale and product to a different branch. This will allow the user to have a holistic view over all the branches under his management.

Suppliers and orders

In an effort to make Libra the user's one stop inventory management tool we have also added the possibility for the user to define his suppliers along with the contact information and what products each supplier covers. This information allows the user to place and track orders directly from the Libra interface.

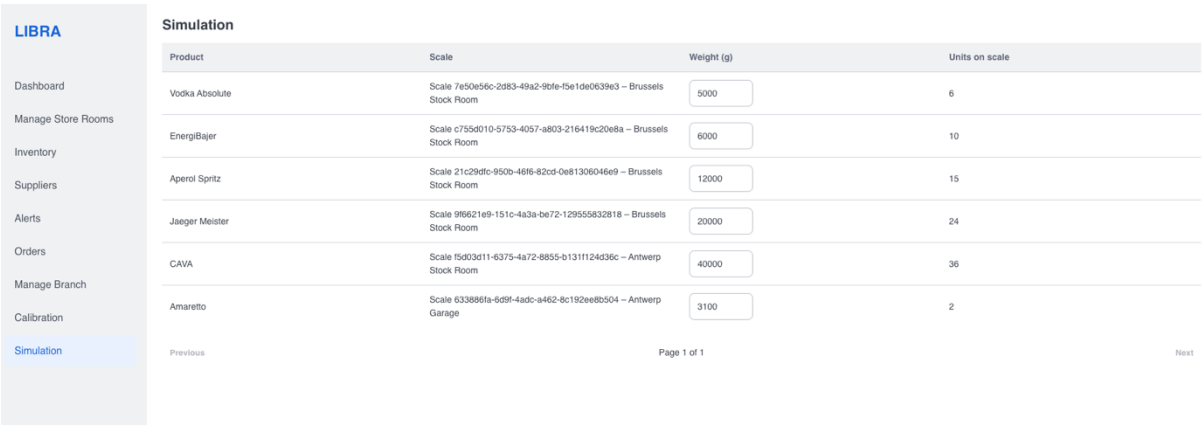
The whole process begins by defining the name and contact information of the supplier. Then whenever the user reaches the product entry point, There is an option to allocate each product to a certain supplier or a group of them.



Once the suppliers are defined and assigned to proper products, then the user can proceed to place orders from the appropriate suppliers directly on the Libra platform.This feature is what allows for the "To be received" KPI to be shown on the dashboard.

Simulation

A simulation section is being worked on right now. The goal is to have a manual input section where a user can enter a theoretical wight to act as a scale reading in order to test out the software and check if the result. Once the hardware prototype is finalized and the Wi-Fi integration is fully operational, the simulation input will be seamlessly replaced by live scale data. The Wi-Fi module will transmit real-time weight readings from the Libra device directly to the software interface, creating a complete closed-loop system for live inventory tracking.



This approach ensures that both software and hardware can be developed in parallel without dependency delays. It accelerates the overall development timeline, provides early opportunities for user feedback, and significantly reduces the risk of unexpected performance issues at the time of full system integration. Moreover, having a functional simulator will remain valuable even after deployment, as it can be reused for future system training, testing

new features, or onboarding clients who want to familiarize themselves with Libra's functionalities before fully installing the hardware.

Conclusion

This thesis set out to address a persistent operational challenge in the Food & Beverage industry: the inefficiencies and inaccuracies of manual inventory management. Through the development of Libra, a real-time weight-based inventory tracking solution, I aimed to respond to the real-world problems I witnessed during my internship at WoodCutter. During this experience, I observed firsthand how human error, lack of standardization, and outdated processes caused frequent stock discrepancies and financial shrinkage.

Libra was designed to directly tackle these issues by combining a modular hardware platform with an intuitive software solution. Through the mixed-method research approach, I was able to validate the need for such a system. Quantitative analysis of weekly inventory data and qualitative feedback from F&B managers confirmed that manual inventory processes often result in inaccuracies, inefficiencies, and significant operational costs.

The technical limitations identified throughout this thesis, particularly regarding sensor creep and the limited sensitivity of kilogram-based scales at low stock levels, highlight important engineering challenges. However, potential solutions have been proposed, such as implementing hybrid sensor designs and software recalibration protocols, offering clear strategies to strengthen Libra's technical resilience.

Financial analysis based on realistic cost sourcing and pricing strategies demonstrated that Libra is a commercially viable product. With an attainable break-even point and structured growth targets starting with Belgium and expanding into international markets such as Germany and the Netherlands, Libra has a strong foundation for sustainable scaling. The addition of a software simulation module strengthens the development process by allowing early-stage testing and demonstrations, further reducing technical risk before full hardware deployment.

Reflecting on this journey, it becomes clear that innovation often comes not from reinventing entire systems, but from observing recurring operational challenges closely and designing pragmatic, user-centered solutions. Libra is rooted in real needs observed in the F&B sector and supported by thorough research, making it highly relevant to today's operational challenges. Its principles of modularity, automation, transparency, and user-friendliness give it the potential to be expanded beyond hospitality into other industries requiring precise inventory control.

Looking ahead, the next steps for Libra include finalizing the hardware prototype, fully integrating software and hardware, conducting wider pilot programs, and securing strategic funding for expansion. While the project has demonstrated strong potential, the identified limitations present important challenges that will need to be carefully addressed before Libra can move forward toward a successful and scalable market launch.

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ChatGPT prompts used in order to complete this thesis:

“Can you help me refine and structure of the methodology section I wrote for my thesis?”

Used to improve the clarity and academic structure of an existing draft based on fieldwork and proposed research. (this *prompt was used for various sections of this thesis).*

“Assist me in drafting a 10-question survey, based on questions I developed, to present to managers at WoodCutter about their inventory system.”

Prompt used to polish and organize survey questions already outlined.

“Help me organize and expand the business plan sections I’ve outlined, such as value proposition, market analysis, and financial planning.”

Prompt used to enhance the structure and coherence of content I had already conceptualized.

“I have a rough prototype concept for Libra. Help me turn it into a clearer technical description and generate a simple visual illustration.”Request to clarify and visualize an existing hardware idea.

“Based on my outlined costs and component list, help me format a detailed financial analysis and calculate approximate margins.”

Used to turn gathered cost research into a structured business model breakdown.

“Assist me in visualizing my financial data by creating graphs for cost, revenue, and profit per package size and over time.”

Helped present existing figures in a visual format for clarity and impact.

“I’ve written a draft conclusion. Help me improve its flow and make sure it connects well to my earlier sections.”

Prompt used to strengthen and rephrase a conclusion based on existing content and research insights.

“Generate APA references for sources I found and used in my thesis.”

Prompt used for accurate formatting of sources already gathered.

“I described a manual simulation feature in the software. Help me write a structured paragraph to explain this clearly.”

Based on an idea already developed for my prototype testing phase.

“I researched crate weights for scale calibration. Can you confirm or help me rephrase the weight estimate for a full 24-bottle crate?”

Used for validating existing research and presenting it in clear technical language.