



**Universidade do Minho**  
Escola de Economia e Gestão

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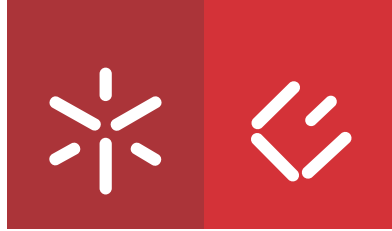
**5G Network at Bosch-Braga:  
A Financial Analysis**

Álvaro Santos Magliocca **5G Network at Bosch-Braga: A Financial Analysis**

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## **5G Network at Bosch-Braga: A Financial Analysis**

Master Project  
Master in Finance

Work performed under the supervision of  
**Professor Gilberto Loureiro**

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## Sumário Executivo do Projeto de Rede 5G da Bosch-Braga

### Resumo

Este documento encapsula a avaliação financeira e a análise estratégica da introdução de uma rede 5G nas operações da Bosch GmbH em Braga. Investiga o potencial desta tecnologia de ponta para revolucionar as capacidades de produção e serviço da empresa, promovendo um ambiente preparado para inovação e eficiência.

A pesquisa utiliza uma abordagem de Fluxo de Caixa Descontado (DCF) para determinar os méritos económicos do projeto. Ao projetar meticulosamente os fluxos de caixa futuros e descontá-los ao seu valor presente, o estudo fornece uma estimativa do Valor Presente Líquido (VPL) e da Taxa Interna de Retorno (TIR), indicadores-chave da solidez financeira do projeto.

A avaliação revela um caso convincente para o projeto, prevendo um VPL robusto, indicativo de um forte potencial para altos retornos. O estudo discute ainda como se espera que uma rede 5G catalise a transição da Bosch-Braga para um modelo de negócio mais orientado para o serviço, proporcionando um fluxo de receitas sustentável enquanto eleva a posição competitiva da empresa na indústria.

Os resultados principais sugerem que o sucesso do projeto depende da gestão metódica das despesas variáveis e da busca agressiva pelo crescimento da receita. Destaca a natureza crucial do planeamento estratégico e de estruturas robustas de gestão de risco para navegar incertezas financeiras e de mercado.

A investigação culmina com recomendações estratégicas que advogam pelo avanço da iniciativa 5G. Aconselha uma estratégia de implementação faseada, sublinhada pelo acompanhamento contínuo e ajuste responsivo às estruturas de custo e condições de mercado. Destaca-se a importância da agilidade e da previsão na capitalização dos avanços tecnológicos para manter a liderança na indústria.

O estudo destaca o alinhamento do projeto com os objetivos estratégicos da Bosch, retratando a rede 5G como um catalisador para o crescimento sustentável. Apresenta um roteiro que equilibra os objetivos financeiros com as perspetivas inovadoras da tecnologia 5G, delineando uma estrutura acionável para a tomada de decisões.

**Palavras-chave:** Avaliação Financeira, Crescimento Estratégico, Eficiência Operacional, Inovação Tecnológica, Vantagem Competitiva.

## **Executive Summary of the Bosch-Braga 5G Network Project**

### **Abstract**

This document encapsulates the financial assessment and strategic evaluation of introducing a 5G network within Bosch GmbH's Braga operations. It scrutinizes the potential for this cutting-edge technology to revolutionize the company's manufacturing and service capabilities, fostering an environment primed for innovation and efficiency.

The research adopts a Discounted Cash Flow (DCF) approach to determining the project's economic merits. By meticulously projecting future cash flows and discounting them to their present value, the study estimates the Net Present Value (NPV) and Internal Rate of Return (IRR), key indicators of the project's financial soundness.

The valuation reveals a compelling case for the project, predicting a robust NPV and a strong potential for high returns. The study further discusses how a 5G network is expected to catalyze Bosch-Braga's transition to a more service-oriented business model, providing a sustainable revenue stream while elevating the company's competitive stance in the industry.

Key findings suggest that the project's success is contingent upon the meticulous management of variable expenses and the aggressive pursuit of revenue growth. It highlights the crucial nature of strategic planning and robust risk management frameworks to navigate financial and market uncertainties.

The investigation culminates with strategic recommendations advocating for the advancement of the 5G initiative. It advises a phased implementation strategy, underscored by continuous monitoring and responsive adjustment to cost structures and market conditions. It underlines the importance of agility and foresight in capitalizing on technological advancements to maintain industry leadership.

The study emphasizes the project's alignment with Bosch's strategic goals, portraying the 5G network as a catalyst for sustainable growth. It lays out a roadmap that balances financial objectives with the innovative prospects of 5G technology, outlining an actionable framework for decision-making.

**Keywords:** Competitive Advantage, Financial Assessment, Operational Efficiency, Strategic Growth, Technological Innovation

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## **Executive Summary**

This project conducts a thorough financial valuation of a 5G network for Bosch GmbH, Braga, a prominent global technology company. In addition to the economic analysis, the project explores the potential strategic benefits of establishing an aftermarket sales service linked to the network and implementing a leasing/renting system for machinery to replace the current spare parts production method.

The success of the leasing/renting system at Bosch Braga is intrinsically linked to the effective implementation of the 5G network, marking a pivotal transformation in operational efficiency and service delivery. The deployment of 5G technology is not merely an upgrade in network infrastructure; it represents a foundational shift towards enabling real-time, high-speed data transmission and connectivity critical for the seamless operation of leased or rented machinery and equipment. This enhanced connectivity ensures that Bosch can offer superior service levels through predictive maintenance, remote diagnostics, and instant software updates, aspects that are crucial for the longevity and reliability of leased equipment. Furthermore, implementing a 5G network facilitates the development of new business models, including as-a-service offerings, by continuously monitoring equipment performance and usage, opening new revenue streams, and strengthening customer relationships by providing value-added services that ensure operational reliability and efficiency.

Consequently, the 5G network acts as a catalyst, augmenting the potential of the leasing/renting system to deliver unparalleled service quality, foster innovation, and drive economic benefits, thereby solidifying Bosch Braga's competitive edge in the market. The proposed implementation plan includes active involvement from stakeholders and support from the legal department to assess potential enhancements in leasing/renting contracts. Resource requirements are also outlined, highlighting the need for additional administrative and technical personnel and funding from headquarters.

The financial valuation is performed using discounted cash flow, and the results indicate that the 5G network holds substantial value for Bosch Braga, with an estimated net present value of €3.0 million for the five years. Additionally, by implementing the production of

the spare parts through a leasing/renting model, we would reduce the manufacturing costs by 30% using the company's workers.

Based on the positive outcomes of the financial analysis and the potential strategic benefits, it is recommended that Bosch Braga proceeds with the development of the 5G network and establishes the aftermarket sales service, basically taking into account the following benefits for Bosch's Braga:

- ✓ Enhanced Operational Efficiency: 5 G's high speed and low latency can significantly enhance machine-to-machine communication, making manufacturing operations more efficient.
- ✓ Improved Quality Control: The 5G network can support advanced quality control systems that require real-time, high-volume data processing.
- ✓ Flexible Production: With the enhanced connectivity that 5G offers, Bosch could implement more flexible and modular production techniques
- ✓ Supply Chain Optimization: 5G can enable better tracking and tracing of supplies throughout the supply chain, offering higher visibility and control.
- ✓ Smart Factory Initiatives: 5G is pivotal for Industry 4.0, where factories become "smart" through full connectivity, artificial intelligence, and extensive use of Internet of Things (IoT) devices.
- ✓ Product Innovation: The data-driven insights gained from a 5G network can foster product design and development innovation.
- ✓ Enhanced Customer Experience: For Bosch's customer service, 5G could enable new ways to interact with customers, such as through augmented reality (AR) or virtual reality (VR) applications.
- ✓ Data Security: The advanced architecture of 5G networks can provide enhanced cybersecurity measures.
- ✓ Remote Operations: 5 G's high reliability and low latency enable better control over remote operations, such as warehousing or logistics.
- ✓ Workforce Empowerment: With high-speed connectivity, Bosch's workforce can access cloud services, data analytics, and AI-driven tools with reduced latency, increasing their productivity and enabling them to make better-informed decisions quickly.

The aftermarket sales service, encompassing maintenance, repairs, spare parts sales, and upgrades for products post-purchase, is crucial in contributing to a company's economic independence. For Bosch, integrating an aftermarket sales service, especially in the context of its 5G network project, can yield substantial economic benefits, as follow:

- ✓ **Steady Revenue Stream:** Aftermarket services provide a continuous revenue stream long after a product's initial sale, helping stabilize cash flows.
- ✓ **High-Profit Margins:** Aftermarket services typically have higher profit margins than selling original equipment.
- ✓ **Customer Retention and Loyalty:** Offering superior aftermarket services helps build long-term customer relationships.
- ✓ **Enhanced Product Life Cycle Management:** Aftermarket services allow Bosch to manage the entire lifecycle of its products more effectively.
- ✓ **Data and Insights for Innovation:** Customer interactions during aftermarket services provide valuable insights into product performance, customer needs, and potential areas for improvement or innovation.

However, it is crucial to acknowledge the various risks and uncertainties that could affect the value of the network, the aftermarket sales service, and the leasing/renting of machinery. These risks encompass technological advances and shifts in the competitive landscape. Despite these potential challenges, the analysis suggests that these initiatives are viable and potentially lucrative investments for Bosch Braga.

This project comprehensively analyzes the financial and strategic potential of implementing a 5G network, establishing an aftermarket sales service, and adopting leasing/renting machinery for Bosch Braga. These findings offer valuable knowledge into the factors that will influence the value of these investments. The outlined implementation plan and resource requirements ensure the successful execution and operation of these initiatives.

**Keywords:** aftermarket service; Capital Budgeting; 5G network; Net Present Value (NPV); Free Cash Flow (FCF); spare parts.

## **1 Introduction**

The emergence of the 5G Network, the fifth technological generation of mobile networks, represents a monumental milestone in the history of technology. Building upon the foundation of Orthogonal Frequency Division Multiplexing (OFDM) technology, also utilized in previous generations, the 5G network introduces unprecedented advancements that revolutionize technological generations.

With its ultra-fast speed, significantly reduced latency, and the ability to support an exponentially increasing volume of data exchange, the 5G network transcends the capabilities of its predecessors. This transformative technology not only facilitates the seamless communication of billions of wireless devices scattered across the globe but also paves the way for the launch of applications and services that were previously unimaginable.

This project explores the financial valuation of the 5G network implementation at Bosch's facility in Braga, traveling the potential strategic benefits and economic viability of such an investment. In addition to evaluating the overall financial feasibility, the project will also examine the specific impact of 5G technology on the manufacturing process of spare parts. By initially exploring the potential of renting/leasing machinery, the project seeks to optimize cost efficiency while improving collaboration and the joint venture working experience, particularly in the context of Airbus and Rolls-Royce.

Furthermore, the project will assess the economic benefits derived from the implementation of an After Market Service linked to the 5G network. From a financial perspective, this analysis will provide insights into the potential enhancement of Bosch's economic figures, considering increased revenue streams and improved operational efficiency.

To conduct a comprehensive analysis, we will calculate the Net Present Value to study the project's economic viability, matching the present value of projected cash inflows with the present value of likely cash outflows over time. Moreover, the legal department at Bosch's

Braga location will critically review the leasing structures to ensure compliance with applicable regulations and evaluate their impact on taxation.

Overall, this project seeks to assess the potential economic and strategic advantages of investing in the 5G network, including implementing an aftermarket sales service and adopting rental/leasing strategies for machinery at Bosch's facility in Braga. For a better understanding of the relevance of this project, we can point out that Bosch has developed a comprehensive portfolio of connected mobility solutions that leverage IoT and AI to improve vehicle efficiency, safety, and convenience. These solutions include predictive maintenance services, automated driving systems, and fleet management software. By analyzing large amounts of data collected from vehicle sensors, Bosch's AI algorithms can predict when parts need replacing or maintenance is required, thereby reducing downtime and repair costs for fleet operators.

By analyzing the financial feasibility and considering additional factors such as joint-venture collaboration, this study aims to contribute valuable insights to support informed decision-making and contribute to Bosch's positioning as a leader in the dynamic landscape of 5G technology.

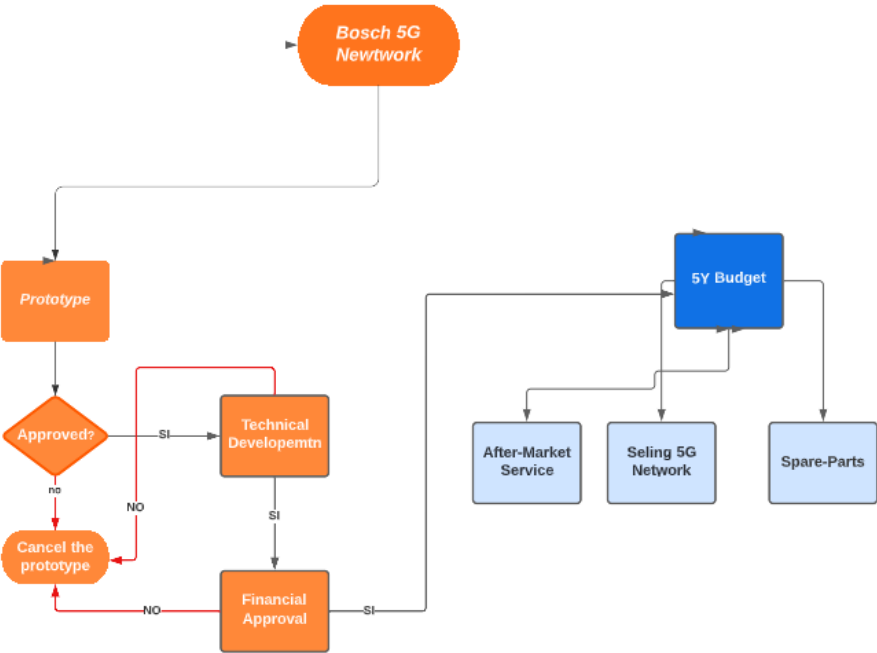


Figure 1 - Project Outline

## **1.1 Company Overview**

The Bosch Group, headquartered in Gerlingen, Germany, is a renowned global technology and services provider. Established in 1886 by Robert Bosch, the company operates across four key fields of activity: Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. With its strong presence as an Internet of Things (IoT) leader, Bosch offers cutting-edge solutions for smart homes, Industry 4.0, and connected mobility. Leveraging its expertise in sensor technology, software, services, and IoT cloud capabilities, Bosch delivers integrated and interconnected solutions across various domains.

Bosch's overarching objective is to seamlessly connect individuals with products and solutions that incorporate artificial intelligence (AI) or have been developed or assembled with its support. With a global presence, including 129 engineering locations, 440 subsidiaries, and regional companies in about 60 countries, Bosch achieved revenues of 88.2 billion euros in 2022. The company's commitment to technological advancement, extensive network, and diverse range of offerings positions Bosch as a critical player in the industry, capable of delivering connected solutions across multiple sectors.

## **1.2 Portugal Facilities**

Bosch has a significant presence in Portugal, with four key locations strategically positioned throughout the country. Established in Lisbon in 1960, the headquarters serves as the central hub for Bosch's operations in Portugal.

The Aveiro location, known as Bosch Thermo Technology, is vital in managing the global residential hot water business within the Bosch Group. This facility specializes in developing and producing innovative residential hot water systems solutions.

In Ovar, Bosch Security Systems focuses on producing cutting-edge security and communication systems, including fire alarms and electronic displays. The facility is dedicated to delivering advanced solutions that enhance safety and security in various environments.

Bosch Car Multimedia, located in Braga, is the largest Bosch facility in Portugal and belongs to the Automotive Electronics division. This location focuses on developing and manufacturing multimedia solutions and car sensors. It also serves as a hub for teams from

other divisions within the Mobility sector, such as Cross-Domain Computing Solutions, Chassis Systems, and Automotive Aftermarket. The Braga facility is further supported by centralized service areas, including CI - Information Systems & Services and GS - Global Services. Notably, approximately 95% of the production from this location is exported, highlighting its significant contribution to Bosch's global operations.

With its extensive footprint in Portugal, Bosch demonstrates its commitment to innovation, advanced manufacturing, and technological leadership, contributing to the country's industrial development and performing a vital role in the global automotive and technology sectors.

### **1.3 Project Overview**

Companies must continually update their operations to meet business needs, remain competitive, and achieve cost reductions. It often entails making significant investments and evaluating new solutions to adapt to evolving industries. Recognizing the importance of staying at the avant-garde of technological advancements, Bosch is actively considering the implementation of a 5G network. This network would enable enhanced process control and provide the flexibility to handle fluctuating volumes based on market trends. By leveraging the capabilities of 5G, Bosch aims to accomplish operational efficiency and gain a competitive edge in the industry. Furthermore, the successful implementation of the 5G network would pave the way for establishing an aftermarket service, providing valuable network support. This initiative would enhance the Braga facility's overall visibility within the Bosch corporation and strengthen the company's position as a leader in adopting advanced technologies.

In addition to the 5G network implementation, Bosch is exploring the possibility of replicating the successful working model established between Airbus and Rolls-Royce, but on a smaller scale. In this model, Rolls-Royce operates a factory within Airbus' facilities to produce their turbines. Drawing inspiration from this collaboration, Bosch proposes a similar approach by renting or leasing specific machinery from its suppliers. Under this arrangement, Bosch would cover all operational costs and maintenance fees while



utilizing its employees to operate the machinery. By using 5G technology, real-time production monitoring and control would be enabled, allowing for efficient management of production levels, identification of failures, and tracking of replacement stock, among other critical factors.

If Bosch Braga decides to expand upon this concept, it has the potential to transform the machinery supplier into a strategic partner. Instead of receiving a fixed amount per piece produced, the partner would be involved in profit-sharing, with a minimum performance threshold linked to maintenance fees. These funds would cover failures or serve other purposes, such as marketing campaigns, fostering a mutually beneficial relationship between Bosch and the machinery supplier. This procedure aligns the interests of both parties, incentivizing increased productivity and profitability. By forging such partnerships, Bosch can create a collaborative ecosystem that drives innovation, promotes shared success, and enhances its overall competitiveness in the market.

## **2 Literature Review**

The field of capital and capital budgeting in financial management has garnered significant attention from researchers in the past five decades. This research has developed numerous theories and models that have played a critical role in defining the capital budgeting field and are influential in financial decision-making.

The last 50 years have seen significant fluctuations and challenges in the financial landscape, including the global financial crisis, changes in currency values, technological advancements, interest rate fluctuations, and shifts in economic and business conditions in international markets. As a result, it is essential to continually reevaluate and reexamine capital budgeting practices, as they play a significant role in investment decision-making. However, the complex nature of capital budgeting and the importance of risk assessment in investment decisions make it difficult to establish a transparent theoretical model and apply it consistently in practice (Arnold & Hatzopoulos, 2000). It is crucial to continue studying and developing new approaches to capital budgeting to ensure that it remains relevant and effective in facing these challenges.

Capital budgeting, or investment appraisal, evaluates and decides on long-term investments, such as acquiring a new venture or building a plant, which requires significant financial resources (Holmes, 1998). These investments, known as capital investments, are expected to generate benefits over more than one year (Peterson & Fabozzi, 2002). Capital budgeting is an important financing tool for long-term investment decisions (Stenzel & Stenzel, 2003). It involves investment screening and selection, proposal development, approval, and authorization (Garrison et al. 2008); (Peterson & Fabozzi, 2002). However, it is crucial to carefully plan and execute capital budgeting decisions as they can have significant financial and cash flow implications if not handled properly (du Toit & Pienaar, 2005).

Discounted Cash Flow (DCF) analysis is an appraisal process used to forecast the value of an investment based on its estimated future cash flows. The technique involves projecting the future cash flows that the investment will likely generate and then discounting them back to

their present value using a discount rate, reproducing the cost of capital and the risk associated with the investment.

The first step is to forecast the investment's cash flows for a period of time, in our case, five years. For a company, this would involve projecting revenues, expenses, working capital requirements, and capital expenditures to determine the firm's free cash flows (FCFs). Since forecasting cash flows indefinitely is not practical, a terminal value is calculated to represent the investment's value at the end of the projection period. The terminal value can be forecasted using the perpetuity growth model (assuming cash flows grow constantly) or the exit multiple approach (based on comparable company analysis).

The discount rate, often referred to as the weighted average cost of capital (WACC), is the rate of return required by investors to compensate them for the risk of the investment. It reflects the opportunity cost of investing capital elsewhere. The WACC is calculated using the cost of equity, the cost of debt, and the company's capital structure.

Future cash flows and the terminal value are discounted back to their present value using the discount rate. This calculation is based on the principle that a dollar today is worth more than a dollar in the future because of its potential earning capacity. The sum of all discounted cash flows and the discounted terminal value equals the total present value of the investment. For a company, this represents its enterprise value (EV). To arrive at the company's equity value, we must subtract the value of debt and add back any cash and cash equivalents.

Given projections uncertainty, a sensitivity analysis is often conducted to understand how changes in key assumptions (net present value, growth rates, discount rate, etc.) impact valuation. The DCF model requires numerous assumptions, including future sales growth, profit margins, the lifespan of the business, and the cost of capital. Therefore, the quality of a DCF analysis hinges on the reasonableness of these assumptions, the data's accuracy, and the methodology's consistency.

In summary, DCF is a powerful tool for assessing an investment's attractiveness. It provides an intrinsic value based on the business's fundamental expectations rather than market pricing or comparative valuations, making it a theoretically robust approach in financial analysis and corporate finance.

Terminal value and salvage value are terms that often come up in the context of the valuation and depreciation of assets. Still, they serve different purposes and are used in other contexts:

Terminal Value:

It is used in a Discounted Cash Flow (DCF) analysis. It represents the present value of a business or project's future cash flows beyond the explicit forecast period. It is a critical part of the DCF, as it typically accounts for a significant portion of the total valuation, based on the assumption that a business will continue indefinitely or be sold at the end of the forecast period.

The terminal value can be calculated using different methods, such as the Gordon Growth Model (assuming perpetual growth at a steady rate) or an exit multiples approach (based on comparable company metrics). Terminal value is forward-looking and speculative, involving predictions about long-term growth rates, business performance, and market conditions.

Salvage Value:

Salvage value is used in the context of depreciation accounting. It is the forecasted residual value of an asset at the end of its useful life. The owner expects to receive it after the asset is no longer helpful for productive purposes and is disposed of or sold. It is a factor in calculating an asset's depreciation expenses. Straight-line depreciation reduces the asset's cost by its salvage value before the annual depreciation expense is determined. Salvage value is typically much more conservative and tangible than terminal value, often based on tangible factors such as residual material value, resale value, or scrap value.

In essence, while the terminal value is a valuation concept used to estimate the future potential of a cash-generating business or project, the salvage value is an accounting concept used to calculate the remaining value of a physical asset. Both valuations estimate the value at the end of a period, but the nature of what they are valuing and the purpose of the valuation are different.

The expected cash flows are typically estimated annually or quarterly and based on assumptions about future revenues, expenses, and other cash flows related to the investment. The discount rate is a rate of return that reflects the time value of money and the risk directly

associated with the investment. It is accustomed to converting future cash flows into their present values and is typically based on the cost of capital or a risk-adjusted discount rate. The terminal value represents the value of the investment at the end of the forecast period and is typically estimated based on a multiple of the terminal year's cash flows.

The NPV method involves a series of calculations to determine the present value of each future cash flow and then sum those present values to the value of the project. The formula for calculating the present value of a cash flow is:

$$NPV = \text{Cash flow}_1 / (1+r)^1 + \text{Cash flow}_2 / (1+r)^2 + \text{Cash flow}_t / (1+r)^t - \text{Initial Investment}$$

*Where:*

*r=WACC*

*t=Number of time periods*

Capital budgeting, the process of making investment decisions with a long-term impact, often involves navigating through a landscape of uncertainties. In such a scenario, more than traditional budgeting techniques such as Payback, NPV, and IRR may be required to evaluate the investment proposal. In the dynamic business environment, factors such as market fluctuations, technological changes, and regulatory shifts can introduce complexity and ambiguity to investment projects. We recognize the inherent uncertainty and employ various techniques to enhance decision-making precision. This discussion focuses on three robust methodologies—Sensitivity Analysis and Scenario Analysis—that provide a nuanced understanding of how projects respond to different uncertainties.

Uncertainty is integral to financial decision-making, creating an environment where outcomes are subject to unpredictable variables. These variables can include interest rates, market demand, production costs, and numerous other factors that shape the success or failure of an investment. Effectively managing uncertainty becomes paramount, as today's decisions can reverberate for years.

Sensitivity analysis is a tool for predicting the outcome of a decision given a specific range of variables. By systematically changing parameters in a model, we can determine the impact of variations on the investment or project's result. It is beneficial in financial modeling to assess risk, providing insight into which variables most affect the bottom line and, thus, where to focus attention.

In a typical sensitivity analysis, the firm would:

- ✓ Identify Key Variables: Determine which variables most impact the financial model. Standard variables include sales volume, price, variable costs, fixed costs, interest rates, and operational efficiencies.
- ✓ Establish a Range: Based on historical data, future projections, and market research, establish a reasonable high and low range for each key variable.
- ✓ Modify the Model: Adjust one variable at a time within the established range, keeping other variables constant, to observe the changes in the outcome. This is known as a "one-at-a-time" (OAT) approach, isolating individual variables' effects.
- ✓ Record Outcomes: Record the model's outcome as each variable is adjusted. Typically, this is done in a data table that correlates the change in variables to the change in key outcomes, such as net present value (NPV), internal rate of return (IRR), or profitability.
- ✓ Analyze Results: Assess how sensitive the model is to changes in each variable. A high sensitivity means that the outcome is highly dependent on that variable, indicating a higher risk if the variable is uncertain or difficult to predict.
- ✓ Present Findings: The results are often displayed using data tables and graphs, which can show the degree of sensitivity in a visual format that is easy to understand. These findings help stakeholders understand potential risks and make informed decisions.
  
- ✓ Conduct Scenario Analysis: Often paired with sensitivity analysis, scenario analysis involves changing multiple variables simultaneously to reflect different "what if" scenarios, such as a best-case, worst-case, and most likely case scenario.

Sensitivity analysis is vital for decision-making because it provides a range of outcomes based on multiple scenarios. This range can help decision-makers understand the potential variability in returns, assess the robustness of their plans, and prepare for various contingencies. In essence, it quantifies uncertainty and helps build strategies that are more resilient to changes in key assumptions.

### **3 Project Description**

#### **3.1 Project Introduction**

The Bosch facility in Braga, Portugal, has emerged as a pivotal site for developing high-quality products within the corporation. Recognizing its exceptional performance, it was selected as one of only three worldwide locations entrusted with developing and implementing 5G network technology. To further support its endeavors and the prototype development, the Bosch facility in Braga pursued financial assistance through the Portugal 2020 program, which offers partial project funding through an international grant fund and additional tax reductions. Focusing on five specific projects, the facility aimed to minimize its capital exposure while continuing its crucial work in developing innovative and advanced technological solutions for the corporation.

One of the proposed projects by Bosch, seeking financial support via the European Regional Development Fund (ERDF), involves the implementation of a 5G network at the Braga facility. This network will enhance process control and monitoring capabilities, increase flexibility in managing production volume according to market trends, and establish aftermarket support services within the corporation. The ERDF grant fund, established by the European Union, is dedicated to supporting projects aligned with the objectives of the ERDF. Each member state's national or regional authorities manage the fund and are responsible for identifying and selecting projects that qualify for funding.

Bosch also explores the possibility of replicating the collaborative working relationship between Airbus and Rolls-Royce on a smaller scale. Like Rolls-Royce having its factory within Airbus's facility for turbine production, Bosch proposes renting or leasing specific machinery from its suppliers, covering operational costs and maintenance fees, and utilizing its personnel for machinery operation. Leveraging the capabilities of 5G technology, both companies can accurately monitor and control production levels, identify failures, track replacement stock, and make real-time adjustments should the proposed contract materialize.



Overall, securing funding from the ERDF enables Bosch to minimize its capital exposure while investing in projects that enhance operational efficiency and competitiveness. It presents a significant opportunity for the company to develop and adapt its industries to meet current business needs, ensuring long-term profitability for its investors. It is important to note that the initial project requirements will be fully funded by Bosch headquarters, with subsequent payments received from the ERDF to reduce the capital loan and associated interest charges. Through strategic financial management and the utilization of ERDF funding, Bosch can drive innovation, foster growth, and effectively mitigate potential risks and weaknesses identified through a SWOT analysis conducted by the headquarters.

### **3.2 Project Definition**

The project assigned for financial evaluation at the Bosch facility in Braga consists of two distinct yet interconnected initiatives. Firstly, Bosch is considering the implementation of a 5G network within its factory premises, which holds significant importance. Apart from providing advanced connectivity, the private Wi-Fi network will effectively mitigate the risk of data theft from external sources. Once the 5G network prototype is successfully developed and tested, Bosch plans to extend this service offering to other factories in Portugal and eventually expand its coverage throughout Europe. Concurrently, Bosch is exploring the establishment of an Aftermarket Service department to provide customers who purchase the 5G network service with predefined service levels of support.

Developing a 5G network within the factory holds immense potential for Bosch. By leveraging the benefits of this technology, Bosch aims to lease or rent spare parts machines to its workers in Braga, utilizing the 5G network to enhance production quality. The project also involves a comprehensive analysis of the legal structure to identify potential improvements. If Bosch can provide a contract draft, it will be a foundation for further modifications and refinements.

The successful implementation of the 5G network at Bosch will pave the way for the development of the aftermarket service department, which will support the installed networks

and create a new source of revenue for the company. This strategic move will reduce Bosch's reliance on funds from the headquarters. Additionally, the aftermarket service department will attract top talent, establishing Braga as a knowledge hub within the corporation. Predictions indicate that 5G networks will carry 35% of mobile traffic by 2024, underscoring the significance of developing an aftermarket service. This development highlights the growing demand for usage-based service models with low latency and real-time capabilities, areas in which the aftermarket service department at Bosch will be well-equipped to excel.

### **3.3 ERDF/Bosch Loan and Prototype Development**

The prototype development for the 5G network in the Bosch factory is a critical undertaking. It aims to create a private Wi-Fi network that eliminates the need for external providers, thereby mitigating the risk of data theft from external factors. This development phase will take approximately three years and involve rigorous testing to ensure the network's reliability, performance, and security. To successfully execute the project, a multidisciplinary team of experts specializing in wireless communication, network architecture, software development, and system integration will collaborate closely. The prototype development's extended timeline reflects the project's complexity and breadth, emphasizing Bosch's commitment to delivering a robust, cutting-edge 5G network solution.

After successfully developing the 5G network prototype, Bosch has strategic plans to offer this advanced service to other factories within Portugal, with the potential for further expansion across Europe. Simultaneously, Bosch is exploring the establishment of an Aftermarket Service department to provide comprehensive support under predefined service levels. To ensure the smooth execution of these initiatives, Bosch will receive 100% of the necessary funding from its headquarters at the project's inception and an initial disbursement of 15% from the ERDF. These funds will be allocated for procuring essential supplies and hiring four engineers during the second to sixth month of the prototype project timeline. Subsequently, the 15% received from the ERDF will be returned to the headquarters to minimize financial costs, and the VAT from the supplies purchased will be converted into the parent company's currency. Bosch will also fulfill a monthly financial interest payment to the parent company, corresponding to an annual yield rate of 8,00% for the intercompany loan.

The seventh month will mark the prototype development and testing phase initiation, with the entire team devoted to this pivotal task.

During the financing period of the European Regional Development Fund (ERDF) project, Bosch, as an eligible participant, can leverage significant tax benefits facilitated by the System of Tax Incentives for Corporate Research and Development (SIFIDE). This specialized program is designed to provide tax incentives to companies actively engaged in eligible research and development (R&D) activities. The tax benefits are calculated based on a multi-step process, commencing with a first-tier discount of 32.5% applied to the total expenses incurred in the tax year, forming the initial calculation base. Subsequently, an additional tax deduction of 50% is factored into the equation. Finally, based on the cumulative result of these calculations, the final tax rate for the project is determined to be 21%.

The implications of these tax benefits in the development of the prototype are of considerable significance to Bosch as they directly affect the amount the company will be obligated to pay in taxes on the Income Tax and the development of the ERDF project. The tax benefits granted through SIFIDE will be applicable for a specific period, encompassing the project's first three years. This timeline aligns precisely with the prototype development phase, during which the tax incentives come into effect, effectively incentivizing the company's investments in research and development during this critical period.

Implementing these tax benefits represents an exceptional opportunity for Bosch to reduce its tax burden and enhance its financial position during the early stages of the ERDF prototype project. The company's strategic decision to participate in eligible R&D activities aligns with its innovation-driven objectives and the broader policy goals of fostering technological advancements and bolstering economic growth within the European region. As a result, Bosch can harness these tax incentives to channel more resources towards its R&D initiatives, further supporting its technological endeavors and enhancing its competitive advantage in the marketplace.

It is essential for Bosch to effectively navigate and comply with the regulatory requirements and criteria outlined by SIFIDE to maximize the benefits available through this tax

incentive program. By doing so, the company can optimize its tax position and ensure that it fully capitalizes on the opportunities presented by the ERDF project, ultimately contributing to achieving its strategic objectives and bolstering its financial performance in the long term.

During the 33rd month of the prototype project, Bosch will commence leasing spare parts machines as a pivotal part of the testing phase. This critical step aims to assess the practical implementation and utilization of the 5G network while providing comprehensive training to the workers in preparation for future process development. Throughout this designated training period, the primary focus will revolve around meticulously evaluating the 5G network's effectiveness and, more importantly, acquainting the workers with the intricacies of the newly integrated processes. As the primary objective during this phase is centered around training and testing the capabilities of the 5G network, productivity expectations are anticipated to be minimal.

In line with this phase's objectives, the primary emphasis will be on diligently gathering real-time reports and data. This invaluable information will be meticulously analyzed to inform and optimize future manufacturing processes. Such a data-driven approach holds immense potential for streamlining operations, enhancing efficiency, and promoting sustainable growth within the company.

It is essential to accentuate that the tax benefits referenced explicitly pertain solely to the financial figures associated with the prototype development project and do not encompass the entirety of the company's operations in Braga. Bosch should exercise vigilance to adhere to the prescribed criteria and regulations stipulated by the applicable tax incentive program during this phase. By doing so, the company can fully capitalize on the available tax benefits to mitigate its tax liability, thus enabling further investments in research and development activities and supporting the project's overarching objectives. Bosch must effectively navigate and optimize the tax incentives available to amplify the project's overall impact and deliver enhanced value to its stakeholders and shareholders.

### 3.4 Capital Expenditure (CAPEX)

Equipment needed to develop the 5G network for Bosch Braga: 66.100,00€. A similar value will be considered as a cost with each 5G network installation or sale- as a reference, we enclose a detail of the items involved:

<b>Inicial Equipments for BOSCH Braga</b>			
Testing PC	1	€	1.100,00
4K Cameras	6	€	3.500,00
HD Cameras	6	€	3.500,00
Microphone	5	€	500,00
Data aquisition systems setup	5	€	1.500,00
High End Computer (GPU)	1	€	3.000,00
Misc HW and test accessories	10	€	1.000,00
<b>CAPEX BOSCH BRAGA</b>		<b>€</b>	<b>66.100,00</b>

Table 1 - Supplies requirements

- Number of employees: seven split into three new professionals, four reallocated from actual Bosch activities. Bosch assigned a cost of €2.500,00 each month, including all labor costs.
- The cost of leasing machines is 2.500,00€ each; three pieces of equipment will start operating during the last three months of the prototype network development to adjust the 5G network and the worker's learning curve on handling the machines.

### 3.5 Business Development – 5Y Budget

After successfully developing the prototype and gaining valuable experience with the functionality of the 5G network, Bosch is poised to establish a comprehensive 5-year strategy for selling the network and producing spare parts based on realistic production demand. A detailed budget has been formulated, considering specific assumptions discussed within the company. This budget will encompass the resources and expertise required to effectively implement and market the 5G network and spare parts production while addressing potential challenges or risks. Through meticulous planning and execution of this strategy, Bosch aims to seize the opportunities presented by the 5G network and position itself as a frontrunner in the

industry. By leveraging its expertise and innovation, Bosch can establish a strong market presence and drive viable growth in the evolving landscape of technological advancements:

- Bosch has made the strategic decision to proceed with mass production of the 5G network and spare parts based on the recommendations of its technical committee. The transition from the prototype phase to a sellable product is estimated to require an investment of 40% of the final development price. Bosch will employ five advanced machines that can manufacture 18.000 units per month to facilitate production at scale, which represents a significant improvement of 30% compared to the previous production stage, which relied on external suppliers. By establishing an in-house production capability, Bosch aims to enhance efficiency, reduce lead times, and ensure a reliable supply of products to meet market demand. This strategic approach will enable Bosch to promptly bring its innovative 5G network and spare parts to consumers, strengthening its position as a leader in the industry.
- Aftermarket service will include a fixed annual fee cost of 45.000,00€ and a profit margin of 5% over the selling price of the 5G network.

The development of aftermarket services and renting/leasing machinery for spare parts represent indispensable facets in the telecommunications industry and the automotive sector, particularly concerning technology security in vehicles. These instrumental services are pivotal for companies, enabling them to offer comprehensive maintenance and repair solutions and ensuring their equipment's seamless functioning and optimal performance. Moreover, temporary access to specialized machinery bolsters operational efficiency and agility, allowing businesses to address technical challenges and swiftly respond to equipment failures.

By making these services readily accessible, companies fortify the trustworthiness and security of telecommunications networks and vehicles. This culminates in an excellent user experience for drivers and end-users, fostering trust and satisfaction in the services provided. As a result, these indispensable services are instrumental in bolstering customer loyalty and cultivating lasting relationships with clients. Moreover, they contribute to the overall reputation and competitiveness of the company in the market.

From a financial perspective, the availability of aftermarket services and spare parts leasing/renting also presents significant opportunities for revenue generation. By offering value-added maintenance and repair solutions, companies can establish a recurring revenue stream from service contracts and enhance the overall profitability of their operations. Moreover, leasing/renting machinery allows businesses to optimize asset utilization and minimize upfront capital investments. As a result, this prudent financial approach contributes to improved cash flow management and supports economic stability.

Additionally, these services benefit the company, end-users, and drivers. The swift resolution of technical challenges and the accessibility of specialized machinery translate into minimized downtime and enhanced user reliability, fostering customer satisfaction and loyalty, encouraging repeat business, and positive word-of-mouth recommendations.

In conclusion, the development of aftermarket services and the availability of renting/leasing machinery for spare parts constitute vital pillars in the telecommunications and automotive industries. These services fortify the security and reliability of technology, contribute to revenue generation, and bolster financial stability. Moreover, by enhancing customer satisfaction and loyalty, these services are pivotal in promoting long-term growth and success for companies operating in these dynamic sectors.

## **4 Project Evaluation**

In this comprehensive section, we aim to elucidate the calculation process's intricacies, the underlying rules, and the methodological frameworks we employed throughout our research. By providing a transparent account of our analytical approach, we aim to bolster the credibility and reliability of our conclusions and recommendations.

To commence, we established a robust and well-defined calculation process to assess the financial and operational aspects under methodical scrutiny. Throughout the evaluation process, we strictly adhered to the pre-established rules and guidelines, maintaining consistency and coherence in our assessments.

Regarding the methodologies applied, we employed a combination of quantitative and qualitative approaches, capitalizing on the strengths of each technique. Quantitative analyses allowed us to derive objective numerical results and accurately assess financial metrics, trends, and projections. Meanwhile, qualitative methods allowed us to explore intricate business strategies, potential risks, and broader implications for decision-making. The integration of both methodologies fostered a holistic understanding of the complex subject matter at hand.

Throughout our exploration, we remained vigilant in acknowledging any limitations or potential biases that could influence our conclusions. By adopting a transparent approach, we aimed to enhance the overall robustness of our research and ensure that our findings accurately reflect the reality of the financial landscape and the industry under scrutiny.

### **4.1 Summary of Units, Costs, and Sales**

Includes relevant information about:

- ✓ The number of units sold for each business unit and their yearly prices, considering inflation rates and the annual growth rate for the 5-year budget.
- ✓ Costs associated with cash payments for inventory purchases, leasing, general and administrative expenses, cloud server costs, services, research, and development.
- ✓ Expenses related to staff, including workers, engineering, and administrative employees.
- ✓ This spreadsheet lets users quickly identify and understand monthly movements and variations in the consolidated 5-year budget.



Operations		Year 1		Year 2			
		UNITS	SALES PRICE/UNIT	UNITS	SALES PRICE/UNIT	UNITS	SALES PRICE/UNIT
	5G network			3	351.923,08 €	4	369.519,23 €
	Spare parts			90.000	19,00 €	90000	19,95 €
	Service				5.099,50		
			month	€			
Cash paid for					- €		- €
	Inventory purchases (spare parts)			90000	17,00 €	90000	17,85 €
	Leasing of machines			5	5.000,00 €	5	5.250,00 €
	General operating and administrative expenses			12	3.500,00 €	12	3.675,00 €
	Testing PC			3	1.100,00 €	4	1.155,00 €
	4K Cameras			18	3.500,00 €	23	3.675,00 €
	HD Cameras			18	3.500,00 €	23	3.675,00 €
	Microphone			15	500,00 €	19	525,00 €
	Data acquisition systems setup			15	1.500,00 €	19	1.575,00 €
monthly	Cloud server months Aws or Azure / EDGE			48	1.000,00 €	60	1.050,00 €
	High End Computer (GPU)			3	3.000,00 €	4	3.150,00 €
	Misc HW and test accessories			30	1.000,00 €	38	1.050,00 €
	R&D			12	16.320,00 €	12	17.136,00 €
	Cost of services			3	255,00 €	3,75	267,75 €
Staff	Administrative			24	1.450,00 €	24	1.522,50 €
	Engineering			84	2.900,00 €	84	3.045,00 €
	Factory Staff			84	1.170,00 €	84	1.228,50 €
	AfterMarket			24	2.900,00 €	36	3.045,00 €

Table 2 - Quick view of the units considered in the project

## 4.2 Income Statement of the Project

The income statement of the project is crucial since it provides valuable insights into a company's financial performance during a specific period. It presents the company's revenues, costs, and expenses, calculating its net income or loss, thus assessing its financial health and performance.

In the scope of our project, we conducted an exhaustive analysis of the company's financial performance, specifically focusing on the revenues and expenses associated with the 5G network, spare part production, and aftermarket services. Our analysis involved calculating the annual revenues generated by these operations and determining the corresponding expenses incurred. Using these figures, we calculated the net income before taxes, income tax expenses, and income from continuing operations.

The project's income statement is a dynamic financial snapshot that reveals the economic performance over a specified period. It is a comprehensive document that delineates the revenues, expenses, and, ultimately, the net income generated by the project; meticulous attention has been devoted to crafting a robust Income Statement that encapsulates the intricacies of financial operations.

Revenue	Year 1	Year 2	Year 3	Year 4	Year 5
5G network	703.846,15 €	1.385.697,12 €	1.818.727,46 €	2.387.079,80 €	3.133.042,23 €
Spare parts	1.710.000,00 €	1.795.500,00 €	1.885.275,00 €	1.979.538,75 €	2.078.515,69 €
Service	117.288,50 €	610.410,15 €	1.264.589,55 €	2.181.580,89 €	2.980.945,06 €
<b>Total Revenues</b>	<b>2.531.134,65 €</b>	<b>3.791.607,27 €</b>	<b>4.968.592,01 €</b>	<b>6.548.199,44 €</b>	<b>8.192.502,98 €</b>
Expenses					
Inventory purchases (spare parts)	1.530.000,00 €	1.606.500,00 €	1.686.825,00 €	1.771.166,25 €	1.859.724,56 €
Leasing of machines	25.000,00 €	26.250,00 €	27.562,50 €	28.940,63 €	30.387,66 €
Testing PC	3.300,00 €	4.331,25 €	5.684,77 €	7.461,25 €	9.792,90 €
4K Cameras	63.000,00 €	82.687,50 €	108.527,34 €	142.442,14 €	186.955,31 €
HD Cameras	63.000,00 €	82.687,50 €	108.527,34 €	142.442,14 €	186.955,31 €
Microphone	7.500,00 €	9.843,75 €	12.919,92 €	16.957,40 €	22.256,58 €
Data aquisition systems setup	22.500,00 €	29.531,25 €	38.759,77 €	50.872,19 €	66.769,75 €
Cloud server months Aws or Azure / EDGE	48.000,00 €	63.000,00 €	675.000,00 €	885.937,50 €	1.162.792,97 €
High End Computer (GPU)	9.000,00 €	11.812,50 €	15.503,91 €	20.348,88 €	26.707,90 €
Misc HW and test accessories	30.000,00 €	39.375,00 €	51.679,69 €	67.829,59 €	89.026,34 €
Cost of services	765,00 €	1.004,06 €	1.317,83 €	1.729,65 €	2.270,17 €
Administrative (direct operation)	34.800,00 €	36.540,00 €	57.550,50 €	60.428,03 €	42.299,62 €
Engineering	243.600,00 €	255.780,00 €	345.303,00 €	241.712,10 €	211.498,09 €
Factory Staff	98.280,00 €	103.194,00 €	108.353,70 €	130.024,44 €	136.525,66 €
AfterMarket	69.600,00 €	109.620,00 €	153.468,00 €	161.141,40 €	169.198,47 €
General operating and administrative expenses	42.000,00 €	44.100,00 €	46.305,00 €	48.620,25 €	51.051,26 €
R&D	195.840,00 €	205.632,00 €	215.913,60 €	226.709,28 €	238.044,74 €
<b>Total Expenses</b>	<b>2.486.185,00 €</b>	<b>2.711.888,81 €</b>	<b>3.659.201,87 €</b>	<b>4.004.763,11 €</b>	<b>4.492.257,29 €</b>
<b>EBITDA</b>	44.949,65 €	1.079.718,45 €	1.309.390,15 €	2.543.436,33 €	3.700.245,69 €
Depreciation	- 13.220,00 €	- 13.220,00 €	- 13.220,00 €	- 13.220,00 €	- 13.220,00 €
<b>EBIT</b>	31.729,65 €	1.066.498,45 €	1.296.170,15 €	2.530.216,33 €	3.687.025,69 €
Income tax expense	- 6.663,23 €	- 223.964,68 €	- 272.195,73 €	- 531.345,43 €	- 774.275,40 €
<b>Net Income of the Project</b>	<b>25.066,43 €</b>	<b>842.533,78 €</b>	<b>1.023.974,42 €</b>	<b>1.998.870,90 €</b>	<b>2.912.750,30 €</b>

Table 3 - Project Income Statement

Based on the table attached, we can reach the following primary conclusions:

- The ratio of expenses against revenues shows a positive trend, starting at 98,22% in the first year and reaching 54,83% in the last year.
- If we analyze the net income margin (Net income/total revenues), the project shows a positive tendency, starting with a negative 0.99% and attaining 35.55% in the fifth year.
- The Gross profit margin defined as Gross Profit/Total Revenues\*100 shows a significant improvement starting at 1,78% in year one and reaching 45,17% in the last year, which means a very effective cost management by Bosch.

### 4.3 Working Capital

Working capital is a vital financial metric that evaluates the portion of a company's current assets that are not cash or cash equivalents, offset by its current liabilities that are not short-term debt.

This metric indicates a company's liquidity and ability to fulfill short-term obligations, such as paying suppliers and vendors, without relying on external borrowing.

Working capital encompasses the difference between a company's current assets (excluding cash and cash equivalents) and its current liabilities (excluding short-term debt). Current assets include accounts receivable, inventory, and prepaid expenses, which represent future cash inflows, while current liabilities comprise accounts payable, accrued expenses, and deferred revenue, which represent future cash outflows. The resulting figure reflects the company's net investment in its operating cycle, which means the time required to convert inventory into cash.

Assessing a company's working capital can provide insights into its efficiency in managing short-term assets and liabilities. This metric indicates the company's ability to handle unexpected cash requirements and highlights its financial position in managing working capital. Companies must manage their working capital to ensure smooth operations, meet financial obligations, and maintain economic stability.



**Non-Cash Working Capital Calculation**

Operating Assets and Liabilities	0	1	2	3	4	5
Accounts Receivables	- €	210.927,89 €	315.967,27 €	414.049,33 €	545.683,29 €	682.708,58 €
Inventories	- €	127.500,00 €	133.875,00 €	140.568,75 €	147.597,19 €	154.977,05 €
Accounts Payable	€	150.172,08 €	163.085,23 €	227.692,34 €	261.343,97 €	303.636,62 €
Working Capital	- €	188.255,80 €	286.757,04 €	326.925,75 €	431.936,51 €	534.049,01 €
<b>Change in non-cash working Capi</b>	<b>188.255,80 €</b>	<b>98.501,23 €</b>	<b>40.168,71 €</b>	<b>105.010,76 €</b>	<b>102.112,50 €</b>	

Table 4 - Working Capital Calculation

The consistent positive change in working capital over the five years indicates a strategic decision to invest more in current assets. This positive trend suggests intentionally building inventory and other initiatives to support future growth.

It is essential to assess its impact on liquidity, ensuring the company maintains adequate liquidity to cover short-term obligations, considering that we have a negative free cash flow for the first two years.

It will be important that Bosh establish monitoring mechanisms to track the ongoing impact of working capital decisions. If necessary, they must be prepared to adjust strategies based on evolving business conditions and performance metrics. By identifying potential risks associated with the positive change in working capital, we can propose risk mitigation strategies; this proactive approach ensures that the project remains resilient to unforeseen challenges.

#### **4.4 Free Cash Flow of the Project**

In this section, we present a comprehensive five-year cash flow model, commonly known as a business plan, meticulously developed to scrutinize and evaluate the profitability of three critical lines of business: spare parts production, 5G network implementation, and aftermarket services. This robust model facilitates a detailed and rigorous independent analysis of each line of business while also providing valuable insights into their collective impact on the overall profitability of the facility. By considering diverse factors, the model delves into the potential revenue streams stemming from the sale of the 5G network service and aftermarket services and the synergistic effects arising from the convergence of technical expertise with the facility's capabilities.

With a strategic objective of capitalizing on the expertise of the esteemed plant engineers in Braga, the business plan aims to establish the facility as a pivotal competence center for Europe, spearheading the management of novel projects, prototypes, and developmental endeavors. By synergizing the best and brightest teams across the company, the facility in Braga endeavors to position itself as a hub of excellence and innovation, thereby ensuring the seamless execution of projects and fostering an environment of continuous growth and sustained profitability.

Throughout the development of the business plan, we placed utmost importance on transparency and collaboration. Close collaboration with experts and stakeholders from relevant fields and industries enriched the analysis and lent further credibility to our findings. Moreover, we critically examined potential risks and uncertainties that might influence the outcomes and incorporated appropriate risk mitigation strategies to ensure prudent decision-making.

Years		0	1	2	3	4	5
<b>(+) Revenues</b>							
	5G network	- €	703.846,15 €	1.385.697,12 €	1.818.727,46 €	2.387.079,80 €	3.133.042,23 €
	Spare parts	- €	1.710.000,00 €	1.795.500,00 €	1.885.275,00 €	1.979.538,75 €	2.078.515,69 €
	Service	- €	117.288,50 €	610.410,15 €	1.264.589,55 €	2.181.580,89 €	2.980.945,06 €
	<b>Total</b>	- €	<b>2.531.134,65 €</b>	<b>3.791.607,27 €</b>	<b>4.968.592,01 €</b>	<b>6.548.199,44 €</b>	<b>8.192.502,98 €</b>
<b>(-) Variable Expenses</b>							
	Inventory purchases (spare parts)	- €	- 1.530.000,00 €	- 1.606.500,00 €	- 1.686.825,00 €	- 1.771.166,25 €	- 1.859.724,56 €
	Leasing of machines	- €	- 25.000,00 €	- 26.250,00 €	- 27.562,50 €	- 28.940,63 €	- 30.387,66 €
	Testing PC	- €	- 3.300,00 €	- 4.331,25 €	- 5.684,77 €	- 7.461,25 €	- 9.792,90 €
	4K Cameras	- €	- 63.000,00 €	- 82.687,50 €	- 108.527,34 €	- 142.442,14 €	- 186.955,31 €
	HD Cameras	- €	- 63.000,00 €	- 82.687,50 €	- 108.527,34 €	- 142.442,14 €	- 186.955,31 €
	Microphone	- €	- 7.500,00 €	- 9.843,75 €	- 12.919,92 €	- 16.957,40 €	- 22.256,58 €
	Data aquisition systems setup	- €	- 22.500,00 €	- 29.531,25 €	- 38.759,77 €	- 50.872,19 €	- 66.769,75 €
	Cloud server months Aws or Azure / EDGE	- €	- 48.000,00 €	- 63.000,00 €	- 675.000,00 €	- 885.937,50 €	- 1.162.792,97 €
	High-End Computer (GPU)	- €	- 9.000,00 €	- 11.812,50 €	- 15.503,91 €	- 20.348,88 €	- 26.707,90 €
	Misc HW and test accessories	- €	- 30.000,00 €	- 39.375,00 €	- 51.679,69 €	- 67.829,59 €	- 89.026,34 €
	Cost of services	- €	- 765,00 €	- 1.004,06 €	- 1.317,83 €	- 1.729,65 €	- 2.270,17 €
	Administrative (direct operation)	- €	- 34.800,00 €	- 36.540,00 €	- 57.550,50 €	- 60.428,03 €	- 42.299,62 €
	Engineering	- €	- 243.600,00 €	- 255.780,00 €	- 345.303,00 €	- 241.712,10 €	- 211.498,09 €
	Factory Staff	- €	- 98.280,00 €	- 103.194,00 €	- 108.353,70 €	- 130.024,44 €	- 136.525,66 €
	AfterMarket	- €	- 69.600,00 €	- 109.620,00 €	- 153.468,00 €	- 161.141,40 €	- 169.198,47 €
	<b>Total</b>	- €	<b>- 2.248.345,00 €</b>	<b>- 2.462.156,81 €</b>	<b>- 3.396.983,27 €</b>	<b>- 3.729.433,58 €</b>	<b>- 4.203.161,28 €</b>
<b>(-) Fixed Expenses</b>							
	General operating and administrative expenses	- €	- 42.000,00 €	- 44.100,00 €	- 46.305,00 €	- 48.620,25 €	- 51.051,26 €
	R&D	- €	- 195.840,00 €	- 205.632,00 €	- 215.913,60 €	- 226.709,28 €	- 238.044,74 €
	<b>Total</b>	- €	<b>- 237.840,00 €</b>	<b>- 249.732,00 €</b>	<b>- 262.218,60 €</b>	<b>- 275.329,53 €</b>	<b>- 289.096,01 €</b>
<b>(-) Total Expenses</b>		- €	<b>- 2.486.185,00 €</b>	<b>- 2.711.888,81 €</b>	<b>- 3.659.201,87 €</b>	<b>- 4.004.763,11 €</b>	<b>- 4.492.257,29 €</b>
<b>EBITDA</b>		- €	<b>44.949,65 €</b>	<b>1.079.718,45 €</b>	<b>1.309.390,15 €</b>	<b>2.543.436,33 €</b>	<b>3.700.245,69 €</b>
<b>(-) Depreciation</b>		- €	- 13.220,00 €	- 13.220,00 €	- 13.220,00 €	- 13.220,00 €	- 13.220,00 €
<b>EBIT</b>		- €	<b>31.729,65 €</b>	<b>1.066.498,45 €</b>	<b>1.296.170,15 €</b>	<b>2.530.216,33 €</b>	<b>3.687.025,69 €</b>
<b>(-) Tax 21%</b>		- €	- 6.663,23 €	- 223.964,68 €	- 272.195,73 €	- 531.345,43 €	- 774.275,40 €
<b>EBIT(1-t)</b>		- €	<b>25.066,43 €</b>	<b>842.533,78 €</b>	<b>1.023.974,42 €</b>	<b>1.998.870,90 €</b>	<b>2.912.750,30 €</b>
<b>(+) Depreciation</b>		- €	- 13.220,00 €	- 13.220,00 €	- 13.220,00 €	- 13.220,00 €	- 13.220,00 €
<b>Cash Flow</b>		- €	<b>38.286,43 €</b>	<b>855.753,78 €</b>	<b>1.037.194,42 €</b>	<b>2.012.090,90 €</b>	<b>2.925.970,30 €</b>
<b>(-) Changes in Working Capital</b>		- €	- 188.255,80 €	- 98.501,23 €	- 40.168,71 €	- 105.010,76 €	- 102.112,50 €
<b>(-) CAPEX</b>		- €	- 66.100,00 €	- €	- €	- €	- €
<b>FREE CASH FLOW</b>		- €	<b>- 254.355,80 €</b>	<b>- 60.214,81 €</b>	<b>815.585,07 €</b>	<b>932.183,66 €</b>	<b>1.909.978,40 €</b>
							<b>3.460.019,31 €</b>

Table 5 - Free Cash Flow & EBITDA

As we progress through this master's degree project, the business plan is an indispensable tool to guide strategic decision-making, allowing for a systematic and well-informed evaluation of different scenarios and options. By combining financial acumen with industry insights, the business plan can pave the way for transformative growth, enhanced profitability, and establishing the Bosch facility in Braga as a leading force in innovation and excellence within the European market.

The process is the following:

- ✓ Income from Operations:
  - We calculated the annual income the three product lines generated for five years and determined the accumulated total. The trend is approximately 1.735.548,06€ on average for the whole project period.
  - Total expenses, compared as a ratio of total revenues, started at 98% and reduced at the end of the fifth year to 54%, indicating a favorable financial

situation for the firm compared to the income increase, predicting the availability of resources for Bosch.

- ✓ The net cash flow from operations is a crucial indicator of the project's financial performance over time. In the first year, the net cash flow may be relatively low due to the initial stages of the project, including product development and revenue collection. However, starting from the second year, the net cash flow demonstrates a notable increase, indicating a strong and profitable performance. As the project progresses, the net cash flow from operations stabilizes, reflecting the growth and sustainability of the business. The increasing percentage trend further highlights the positive trajectory and potential for long-term profitability over the five years.
- ✓ Investment activities: This item reflects the investment required to build the 5G network in the Braga facility. All other related purchases for the 5G network are considered stocks for selling purposes.
- ✓ Depreciation is essential in financially evaluating the 5G network implementation equipment. In this case, a linear depreciation method was applied over five years. Given the equipment's high technological nature, the value of the assets is expected to decrease steadily over time. No salvage value was considered in the depreciation calculations, as the rapid pace of technological advancements in the industry necessitates the complete replacement of the equipment at the end of its useful life. By accounting for depreciation, the financial analysis accurately reflects the ongoing costs and the need for future investments in advanced technology to remain competitive.
- ✓ The Earnings Before Interest and Taxes (EBIT) metric is utilized in this project to assess the company's profitability. EBIT measures the company's earnings before deducting interest expenses and income taxes, providing a clear view of its operational performance. By excluding the effects of financing and tax decisions, EBIT allows a more accurate evaluation of the company's core business operations. In the first year of the project, the EBIT results are negative, which is to be expected during the initial stages of production and when accounts receivable payments are outstanding. However, starting the second year, the project demonstrated a positive financial performance, with an average EBIT of 1.722.328,06€. This EBIT indicates that the project has the potential to generate consistent profitability and contribute positively to the company's overall financial performance.

- ✓ The income tax for this project was calculated based on the current tax rate of 21%, as determined by the Portuguese government at the time of the project. This rate represents the percentage of taxable income the company must pay in income tax. By applying the appropriate tax rate, the project's financial model accounts for the income tax expenses incurred by the company over the five years. Tax rates may vary over time, and any changes in the tax rate need to be considered for accurate projections and financial analysis.
- ✓ The net cash flow is a critical financial measure that assesses the cash generated or consumed by a business during a specific period. It reflects the company's ability to create positive cash flow, vital for reaching financial obligations, reinvesting in the industry, and distributing returns to shareholders. The net cash flow is measured by subtracting cash outflows, such as operating expenses, capital expenditures, and debt repayments, from cash inflows, such as revenue from sales and financing activities. In the context of this project, a thorough analysis of the company's net cash flow was conducted over five years. The study indicated that the company had an adverse net cash flow in the first year but improved significantly in subsequent years, averaging a positive net cash flow of 1,166,000.00€. This positive trend indicates a solid financial future for the project. Net cash flow analysis is crucial in financial evaluations as it provides valuable insights into a company's cash generation capacity and calculating ability to meet financial obligations. The accompanying figure of the statement further illustrates the numeric conclusions for a better understanding of the project's cash flow dynamics.

Analyzing figures, we can observe the following conclusions:

- The project experienced negative Free Cash Flow in the early years (Year 1 and Year 2) but turned positive in subsequent years.
- Changes in Working Capital and CAPEX play a significant role in determining Free Cash Flow.
- Year 2 shows a notable increase in Free Cash Flow due to sales development for the three lines of products.
- By Year 5, Free Cash Flow reaches a substantial positive value, indicating improved financial performance.

- 5G Network and Spare Part contribute 36% of total revenues.
- In variable expenses, inventory purchases represent 53% of this total, followed by Cloud server months Aws or Azure / EDGE with 18%.

#### **4.5 Weight Average Cost of Capital**

The Weighted Average Cost of Capital (WACC) is a financial metric representing a company's overall cost of capital. It is calculated by taking the weighted average of the costs of each source of capital, where the weights are determined by the proportion of each source in the company's capital structure. The WACC is a crucial tool in evaluating a company's cost of capital. It is commonly used in capital budgeting decisions to assess the feasibility of investing in new projects or ventures. By considering the price of each source of capital and its relative importance, the WACC provides a comprehensive measure of the average return investors require to finance the company's operations. It serves as a point of reference for evaluating the attractiveness of potential investments and helps companies execute supported decisions about their capital structure and allocation of resources.

The WACC is computed using the following formula:  $WACC = (E/V) * Re + (D/V) * Rd * (1-Tc)$  where E is the market value of the company's equity, V is the market value of the company's total capital (equity + debt), Re is the cost of equity, Rd is the cost of debt, and Tc is the corporate tax rate. The cost of equity is typically measured using the Capital Asset Pricing Model (CAPM), which assesses the expected return on equity based on the risk-free rate, the market risk premium, and the company's Beta. Leverage beta, also known as financial Beta, measures the sensitivity of a firm's equity returns to overall market returns, taking into account the firm's debt level. It is calculated by dividing the firm's unlevered Beta (i.e., Beta without considering debt) by one plus its debt-to-equity ratio. A high leverage beta indicates that a firm's returns are more sensitive to market movements due to its high level of debt. Unlevered Beta, also known as asset beta, measures the sensitivity of a firm's cash flow returns to overall market returns without considering the effect of debt. It is calculated by adjusting the firm's levered Beta (i.e., the Beta that takes into account debt) for the impact of leverage. An unlevered beta of 1 indicates that a firm's cash flow returns align with overall market returns.

Leverage and unlevered Beta are crucial metrics for assessing a firm's risk profile. Leverage beta provides insights into how a company's returns are affected by its level of debt. By dividing the firm's unlevered Beta by one plus the debt-to-equity ratio, leverage beta accounts for the impact of debt



on equity returns. A high leverage beta suggests that a firm's returns are more sensitive to market movements due to its higher debt level, indicating increased risk. On the other hand, unlevered Beta helps understand a firm's returns independent of its debt level. It can be assessed by utilizing the Capital Asset Pricing Model (CAPM) or by analyzing the firm's historical returns compared to the overall market returns. Unlevered Beta measures the firm's inherent risk, excluding the influence of debt. Both leverage and unlevered Beta are essential tools for investors and forecasters to assess and compare the risk profiles of different firms, enabling them to make informed investment decisions.

A high leverage beta indicates that a firm's returns are more sensitive to market movements due to its high level of debt, meaning the firm is riskier and may have a higher potential for financial distress in a market downturn. A high unlevered beta, on the other hand, indicates that the firm's cash flow returns are more volatile than the overall market returns. Leverage and unlevered Beta are essential for investors and analysts when assessing a firm's risk profile. Leverage beta helps understand the effect of debt on a firm's returns, while unlevered Beta helps understand the firm's returns independent of its debt level. A high leverage or unlevered Beta indicates higher risk and may make the firm less attractive. A low leverage or unlevered Beta indicates lower risk and may make the firm more attractive.

The cost of debt is typically measured as the company's after-tax cost of debt, which is the interest rate on the firm's debt multiplied by  $(1-T_c)$ .

It is important to note that the WACC measures a firm's overall cost of capital and not any individual source of capital. It gives an estimate of the return investors expect for providing capital to the company, and it is used as a discount rate for future cash flows in capital budgeting. In summary, the WACC is a widely used financial metric that estimates a company's overall cost of capital by considering the price of each source of capital and the proportion of each source in the company's capital structure. It is an essential tool for companies to assess potential investments and make informed decisions about their capital structure.

To proceed with the WACC calculation, we need to use some inside information about Bosch that was obtained from its financial statement for the year 2022. The nominal tax rate was calculated from the effective tax rate provided in the financial statement using the *Excel formula Nominal*.

The weights of debt and equity were calculated using the total debt and the market capital amounts obtained from the Bosch financial statement being the total debt at 53.36% and the market capital at 46.64%.

Since Bosch GMBH is a private company, no information was obtained regarding its cost of equity, so the next step was to get information from similar industries and adjust it, thus making it as accurate as possible. The risk-free rate was obtained from the Automotive industry data provided in PWC, while the equity risk premium was obtained from Damodaran published data for Germany year 2022, and the Beta was calculated in several steps; where first, we got the Beta for the automotive industry (1.3) from PWC data published in 2022, this Beta was unlevered using the formula  $BUL = bL / (1 + (1 - T)(D/E))$ , where the debt to equity ratio regarding the German Automotive industry was also obtained from PWC published data in 2022, the unlevered Beta had a value of 1.06 which then was used to calculate the levered Beta for Bosch GMBH. For the levered Beta, we used the formula  $BL = bUL(1 + (1 - T)(D/E))$  where the debt to equity ratio was calculated by dividing the market cap over the total debt, values obtained from Bosch's 2022 financial statement got a final value of 1.88.

The final step was to calculate the WACC using the formula mentioned before and the data obtained above; we got a value of 9.36%, which, compared to the 8% interest rate applied for intercompany loans within the company, we can say that. The project offers a higher level of profitability for shareholders. Furthermore, we can say that by utilizing internal funding sources, the firm can secure investment opportunities while avoiding the potential drawbacks of external investment, such as a higher cost of capital; this demonstrates that utilizing the firm's internal resources can be a more beneficial option for shareholders, allowing them to receive a higher return.



Cost of Debt Calculation		2022	
Interest expense	€	4.390.000.000,00	
Short Term Debt	€	29.241.000.000,00	
Long Term Debt	€	24.215.000.000,00	
Pre-Tax Cost of Debt			8,21%
Income Tax Expense	€	1.075.000.000,00	
Income Before Tax	€	2.913.000.000,00	
Nominal Tax Rate			31,82%
Cost of Debt $*(1-t)$			5,60%

Cost of Equity Calculation		2022	
Risk-Free Rate			2,50%
Beta (bottom up Beta)			1,88
Equity Risk Premium			5,94%
Cost of Equity			13,67%

Weight of Debt & Equity Calculation		2022	
Total Debt	€	53.456.000.000,00	53,36%
Market Cap	€	46.727.000.000,00	46,64%
Total	€	100.183.000.000,00	100,00%

WACC	
	9,36%

Table 6 - WACC

## 4.6 Net Present Value

The Discounted Cash Flow (DCF) approach is a valuation technique employed to assess a company's or asset's worth. It entails estimating future cash flows and discounting them back to their present value. The DCF statement is a financial model that calculates a company's or asset's intrinsic value by assessing future cash flows and applying a discount rate to determine their present value. Investors and analysts widely utilize this model to evaluate a company's growth potential and assess its viability. The discount rate, typically represented by the cost of equity or the weighted average cost of capital, accounts for the time value of money and the risk associated with the projected cash flows.

Our initial step involved calculating the project's free cash flow (FCF) to generate the discounted cash flow. This metric serves as an indicator of its financial performance.

In financial project analysis, particularly in corporate finance, Free Cash Flow (FCF) is a pivotal metric for assessing a project's economic health and viability. This measure is critical for making informed investment decisions and is often employed by financial analysts, investors, and corporate strategists.

Free Cash Flow is the surplus cash a business or project generates after covering all operating expenses, taxes, and capital expenditures (CAPEX). It represents the cash available for distribution to investors, debt repayment, or future investments. In other words, it is a company's cash to grow its business, pay down debt, or return value to shareholders.

The free cash flow (FCF) 's net present value was 4.632.254,22€. This FCF showcases the project's potential to generate resources Bosch can utilize to achieve its predefined growth targets.

We calculate the project's Net Present Value (NPV) and Internal Rate of Return using the WACC 9.36% discount rate.

The results are an IRR of 149% (one hundred and fifty percent) and an NPV of 4.632.254,22€.

## NET PRESENT VALUE

OPERATING INPUT DATA	
WACC	9,36%



FCF	0	1	2	3	4	5
EBIT(1-t)	- €	25.066,43 €	842.533,78 €	1.023.974,42 €	1.998.870,90 €	2.912.750,30 €
Depreciation	- €	13.220,00 €	13.220,00 €	13.220,00 €	13.220,00 €	13.220,00 €
Cash Flow	- €	38.286,43 €	855.753,78 €	1.037.194,42 €	2.012.090,90 €	2.925.970,30 €
Changes in Working Capital	-	188.255,80 €	98.501,23 €	- 40.168,71 €	- 105.010,76 €	534.049,01 €
CAPEX	-	66.100,00 €	- €	- €	- €	- €
FREE CASH FLOW	-	<b>254.355,80 €</b>	<b>60.214,81 €</b>	<b>815.585,07 €</b>	<b>932.183,66 €</b>	<b>3.460.019,31 €</b>

DISCOUNT FACTOR	1,00	0,914394	0,836117	0,764541	0,699092	0,639246
PRESENT VALUE	-	254.355,80 €	55.060,08 €	681.924,67 €	712.692,49 €	1.335.250,41 €

NPV OF THE PROJECT	<b>4.632.254,22 €</b>
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IRR OF THE PROJECT	<b>149%</b>
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Table 7 - Net Present Value & Internal Rate of Return

Extensive research and analysis were done. However, we have landed on several critical points about the project. These findings have important implications for Bosch's Braga facility and its importance inside the corporation and demonstrate the value of the technological and financial approach taken in the project. In the following paragraphs, we will summarize our main conclusions and discuss their significance in detail; for such purpose, the main drivers' calculations are presented with their respective conclusions:

- Change in Working Capital:
  - A positive change in working capital throughout the five-year horizon signifies an initial investment requirement in working capital, denoting the allocation of funds to facilitate the project's operational needs, encompassing inventory, receivables, and other current assets. Importantly, this positive change does not indicate a direct recovery during the project's tenure; instead, it implies an anticipation of recouping the invested working capital upon successful completion of the project.
  - A positive change in working capital can be a good sign for a company, as it effectively manages its short-term liquidity and operates efficiently. It can also provide a cushion against unexpected cash flow shortages or other financial challenges.

- However, it is essential to note that a positive change in working capital may not be suitable in all cases. For example, suppose the company has a large amount of inventory or accounts receivable that could be more efficiently managed. In that case, it could be tying up cash that could be used for other purposes, such as investing in the business or returning value to shareholders.
  - Still, other factors, such as the company's growth prospects, profitability, and cash flow, must be considered to fully understand its financial health and determine the correct use of excess working capital to generate additional profitability.
- CF Yearly
    - The projected average annual income growth of 34% over five years is an optimistic and ambitious estimate. Such high-income growth indicates that the company expects substantial revenue increases year after year. It may imply that the company plans to expand its market share aggressively, introduce new products or services, or capitalize on emerging opportunities within the telecommunications and car technology security industries. However, achieving such significant growth can take time and would require successfully executing strategic initiatives, effective marketing, and strong demand for the offered services.
    - On the other hand, the projected average annual expense growth of 16% suggests that the company expects its operating costs to increase gradually but slower than the income. A moderate expense growth rate can be considered prudent, as it allows the company to maintain control over its cost structure while accommodating potential business expansion and investment in research and development. However, the company needs to keep a close eye on its expenses and ensure they align with the expected revenue growth to avoid any negative impact on profitability. While the high-income growth projection presents exciting opportunities, it has inherent risks and challenges. The company must carefully manage its capital and talent resources to handle growth effectively. Additionally, the market and competitive landscape might present unpredictable factors affecting

revenue growth, underscoring the need for agile strategic planning and contingency measures.

- Regarding expenses, the company should focus on efficiency, cost optimization, and prudent financial management to control the pace of cost increases, which may involve negotiating better supplier contracts, investing in process improvements, and implementing cost-saving measures. Well-managed expense growth will sustain healthy profit margins and long-term financial stability. The projected income and expense growth rates indicate the company's ambitious vision for its future. However, it is crucial for the company to continuously monitor and adjust its strategies based on real-time market conditions and performance results. By maintaining flexibility and adaptability, the company can effectively navigate the competitive landscape, capitalize on growth opportunities, and establish a strong and sustainable position within the industry. Regular reviews and evaluations of the financial projections and comparisons with actual performance will enable the company to make data-driven decisions and refine its strategies accordingly.
- 5Y Cash Flow Statement
  - Free Cash Flow shows a negative start from a minus 254.355,80€ to a positive one of 2.211.802,54€, indicating the firm's ability to generate better income than expenses.
  - The only CAPEX considered is 66.100,00€, the investment required to develop the 5G network in Braga.
- Discounted Cash Flow
  - Analyzing the free cash flow to the firm projection, which is a measure of financial performance that represents the net amount of cash generated by a firm after accounting for expenses and capital expenditures, the results reflect the amount of money that is available to all funding providers, including debt holders, preferred stockholders, common stockholders, etc.
  - The IRR was calculated assuming the company's resources at the WACC were utilized. Under this option, we obtained 150%, which sounds more than reasonable because the calculations assumed compounded benefits.

- In the case of NPV, we utilized the same criteria as the IRR and presented a result of 4.632.254,22€, indicating that the project is expected to create value for the company. Therefore, after accounting for the time value of money and the company's cost of capital, the project's cash flows are expected to exceed its initial investment and operating costs, generating a net positive return for the company. A positive NPV reinforces the viability and attractiveness of the project as it contributes positively to the company's overall financial health.

## 5 Dealing with Uncertainty

### 5.1 Sensitivity Analysis

Sensitivity analysis is a pivotal and robust tool within finance, examining the potential impacts that alterations in critical variables can exert on financial models or investment verdicts. This analytical approach seeks to unravel the intricate interplay between changes in independent variables and their consequential effects on specific dependent variables, all within a predefined set of assumptions. The primary objective of this analysis is to discern critical variables based on their discernible influence on Net Present Value (NPV).

The following assumptions were considered in certain variables to evaluate their impact on the NPV.

Assumptions	% Change	% Change	Rank	Output	Driver	(%)
Revenue growth +/- 10%	-0,198019578	19,80%	1	7,31%	WACC +/- 2%	7,31%
Variable Expenses +/- 10%	0,298080663	29,81%	2	19,80%	Revenue growth +/- 10%	19,80%
WACC +/- 2%	0,073109099	7,31%	3	29,81%	Variable Expenses +/- 10%	29,81%

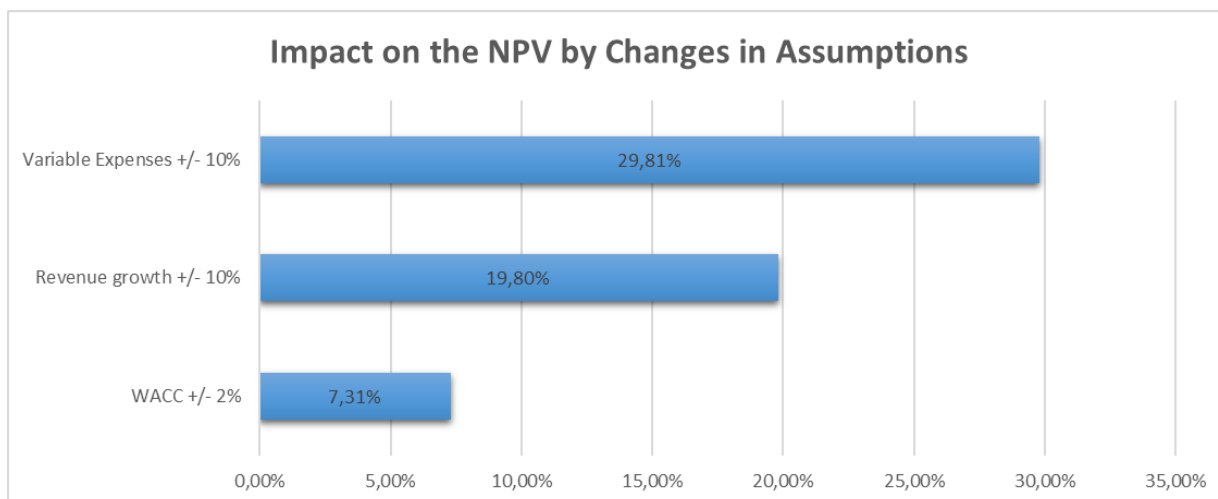
Table 8 - Change assumptions

Assumptions:

The previous graphic shows that:

- A variation of +/-2% in the WACC represents a +/-7,31% variation in the NPV.
- A change of +/- 10% in the variable expenses represents a change in the NPV of 29,81%.
- If the Revenue Growth changes to +/- 10%, the NPV will change to 19,80%.





Graphic 1 - Variable assumptions

The NPV sensitivity analysis assesses the impact of various factors, such as sales growth, variable expenses, and WACC, on the NPV of the investment project. This analysis helps understand how sensitive the NPV is to changes in these variables and provides insights into the risk and uncertainty associated with the investment decision.

NPV Sensitivity		Sales Growth				
		12,0%	22,0%	32,0%	42,0%	52,0%
WACC	5,36%	€ 3.304.572,70	€ 4.202.554,54	€ 5.272.607,01	€ 6.537.497,77	€ 8.021.479,29
	7,36%	€ 3.084.130,61	€ 3.915.587,62	€ 4.904.977,82	€ 6.073.093,38	€ 7.442.078,00
	<b>9,36%</b>	€ 2.883.318,38	€ 3.654.524,08	€ <b>4.570.937,20</b>	€ 5.651.578,56	€ 6.916.701,40
	11,36%	€ 2.699.985,96	€ 3.416.509,68	€ 4.266.762,34	€ 5.268.173,29	€ 6.439.297,51
	13,36%	€ 2.532.256,97	€ 3.199.054,57	€ 3.989.207,30	€ 4.918.711,82	€ 6.004.594,55

Revenue growth		Variable Expenses		WACC	
Change	NPV	Change	NPV	Change	NPV
0,00%	€ 4.570.937,20	0,00%	€ 4.570.937,20	0,00%	€ 4.570.937,20
-10,00%	€ 3.654.524,08	-10,00%	€ 5.950.422,15	-2,00%	€ 4.904.977,82
10,00%	€ 5.651.578,56	10,00%	€ 3.191.452,24	2,00%	€ 4.266.762,34

Table 9 - Sensitive Analysis

The objective of this sensitivity analysis is to evaluate the impact of changes in key variables, including WACC, revenue growth, and variable expenses, on the Net Present Value of the proposed 5G network project for Bosch Braga.

#### Methodology:

The analysis independently modifies each variable to observe the effect on the project's NPV. The original assumptions establish a base case NPV of €4.570.937,20.

### Variables Analyzed:

WACC: The discount rate representing the project's risk and cost of capital.

Sales Growth: The year-on-year percentage increase in sales revenue.

Revenue Growth: The percentage increase in total revenue may include sales and other income.

Variable Expenses: The costs vary directly with the production or service provision level.

### ✓ Analysis Findings:

#### ○ WACC Sensitivity:

- Increasing WACC from 5.36% to 13.36% reduces the NPV progressively from €8.021.479,29 to €6.004.594,55 at 52% sales growth, highlighting the project's sensitivity to financing costs and risk perception.

#### ○ Revenue Growth Sensitivity:

- A 10% decrease in revenue growth results in an NPV of €3.654.524,08, while a 10% increase leads to an NPV of €5.651.578,56, showcasing the importance of maintaining or increasing the company's revenue streams.

#### ○ Variable Expenses Sensitivity:

- A 10% reduction in variable expenses significantly improves the NPV to €5.950.422,15, while a 10% increase drops the NPV to €3.191.452,24, underscoring the impact of cost control on the project's value.

Rank and Output Driver: The project's NPV is most sensitive to the WACC (7.31% change when the WACC changes by 2 %), followed by variable expenses (30.18% change), and least sensitive to changes in revenue (20.05% change),.

The following conclusions can be obtained: The project demonstrates substantial sensitivity to operational efficiencies, particularly variable expenses, suggesting that cost management strategies will be crucial for maximizing NPV. Revenue growth significantly influences the project's financial success, emphasizing the need for robust sales strategies and market presence. While the changes in WACC have the highest impact on NPV, which highlights that the effect of WACC on a project involves various aspects, and implementing strategies aimed at lowering the cost of financing as well as managing the risks associated with the company are variables that Bosch Braga cannot control.

## 5.2 Scenario Analysis

Scenario analysis is a technique used in finance to analyze the potential outcomes of a given decision or policy. It is commonly used to explore and understand the risks associated with a conclusion and identify potential opportunities. Scenario analysis involves creating a range of scenarios based on different assumptions and then using these scenarios to evaluate the possible impacts of a decision or policy. The analysis results can help decision-makers assess other options' feasibility, identify success strategies, or determine which option would produce the most favorable outcome. For the case of our project, we created the base scenario based on sales discussed with Bosch's Braga. For the worst and best scenarios, we estimated a 15% (fifteen percent) of upper and low variation related to all costs and expenses associated with the three lines of products; selling prices show no variations. Analyzing EBITDA results between the worst and best scenarios, we reached a difference of about four million euros that we can extrapolate to the final net income. Even though it is relevant, it will not impact the project at a range of present doubts about its profitability.

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
<b>(+) Revenues</b>						
5G network	- €	703.846,15 €	1.385.697,12 €	1.818.727,46 €	2.387.079,80 €	3.133.042,23 €
Spare parts	- €	1.710.000,00 €	1.795.500,00 €	1.885.275,00 €	1.979.538,75 €	2.078.515,69 €
Service	- €	117.288,50 €	610.410,15 €	1.264.589,55 €	2.181.580,89 €	2.980.945,06 €
<b>Total</b>	- €	<b>2.531.134,65 €</b>	<b>3.791.607,27 €</b>	<b>4.968.592,01 €</b>	<b>6.548.199,44 €</b>	<b>8.192.502,98 €</b>
<b>(-) Variable Expenses</b>						
Inventory purchases (spare parts)	- €	1.759.500,00 €	1.847.475,00 €	1.939.848,75 €	2.036.841,19 €	2.138.683,25 €
Leasing of machines	- €	28.750,00 €	30.187,50 €	31.696,88 €	33.281,72 €	34.945,80 €
Testing PC	- €	3.795,00 €	4.980,94 €	6.537,48 €	8.580,44 €	11.261,83 €
4K Cameras	- €	72.450,00 €	95.090,63 €	124.806,45 €	163.808,46 €	214.998,60 €
HD Cameras	- €	72.450,00 €	95.090,63 €	124.806,45 €	163.808,46 €	214.998,60 €
Microphone	- €	8.625,00 €	11.320,31 €	14.857,91 €	19.501,01 €	25.595,07 €
Data acquisition systems setup	- €	25.875,00 €	33.960,94 €	44.573,73 €	58.503,02 €	76.785,22 €
Cloud server months Aws or Azure / EDGE	- €	55.200,00 €	72.450,00 €	776.250,00 €	1.018.828,13 €	1.337.211,91 €
High End Computer (GPU)	- €	10.350,00 €	13.584,38 €	17.829,49 €	23.401,21 €	30.714,09 €
Misc HW and test accessories	- €	34.500,00 €	45.281,25 €	59.431,64 €	78.004,03 €	102.380,29 €
Cost of services	- €	879,75 €	1.154,67 €	1.515,51 €	1.989,10 €	2.610,70 €
Administrative (direct operation)	- €	40.020,00 €	42.021,00 €	66.183,08 €	69.492,23 €	48.644,56 €
Engineering	- €	280.140,00 €	294.147,00 €	397.098,45 €	277.968,92 €	243.222,80 €
Factory Staff	- €	113.022,00 €	118.673,10 €	124.606,76 €	149.528,11 €	157.004,51 €
AfterMarket	- €	80.040,00 €	126.063,00 €	176.488,20 €	185.312,61 €	194.578,24 €
<b>Total</b>	- €	<b>2.585.596,75 €</b>	<b>2.831.480,33 €</b>	<b>3.906.530,76 €</b>	<b>4.288.848,62 €</b>	<b>4.833.635,47 €</b>
<b>(-) Fixed Expenses</b>						
General operating and administrative expenses	- €	48.300,00 €	50.715,00 €	53.250,75 €	55.913,29 €	58.708,95 €
R&D	- €	225.216,00 €	236.476,80 €	248.300,64 €	260.715,67 €	273.751,46 €
<b>Total</b>	- €	<b>273.516,00 €</b>	<b>287.191,80 €</b>	<b>301.551,39 €</b>	<b>316.628,96 €</b>	<b>332.460,41 €</b>
<b>(-) Total Expenses</b>	- €	<b>2.859.112,75 €</b>	<b>3.118.672,13 €</b>	<b>4.208.082,15 €</b>	<b>4.605.477,58 €</b>	<b>5.166.095,88 €</b>
<b>EBITDA</b>	- €	<b>327.978,10 €</b>	<b>672.935,13 €</b>	<b>760.509,87 €</b>	<b>1.942.721,86 €</b>	<b>3.026.407,10 €</b>
<b>(-) Depreciation</b>	- €	<b>15.203,00 €</b>	<b>15.203,00 €</b>	<b>15.203,00 €</b>	<b>15.203,00 €</b>	<b>15.203,00 €</b>
<b>EBIT</b>	- €	<b>343.181,10 €</b>	<b>657.732,13 €</b>	<b>745.306,87 €</b>	<b>1.927.518,86 €</b>	<b>3.011.204,10 €</b>
<b>(-) Tax 21%</b>	- €	<b>72.068,03 €</b>	<b>138.123,75 €</b>	<b>156.514,44 €</b>	<b>404.778,96 €</b>	<b>632.352,86 €</b>
<b>EBIT(1-t)</b>	- €	<b>271.113,07 €</b>	<b>519.608,38 €</b>	<b>588.792,43 €</b>	<b>1.522.739,90 €</b>	<b>2.378.851,24 €</b>
<b>(+) Depreciation</b>	- €	<b>15.203,00 €</b>	<b>15.203,00 €</b>	<b>15.203,00 €</b>	<b>15.203,00 €</b>	<b>15.203,00 €</b>
<b>Cash Flow</b>	- €	<b>255.910,07 €</b>	<b>534.811,38 €</b>	<b>603.995,43 €</b>	<b>1.537.942,90 €</b>	<b>2.394.054,24 €</b>
<b>(+) Changes in Working Capital</b>	-	216.494,18 €	113.276,42 €	46.194,01 €	120.762,37 €	117.429,38 €
<b>(-) CAPEX</b>	-	76.015,00 €	- €	- €	- €	- €
<b>FREE CASH FLOW</b>	-	<b>292.509,18 €</b>	<b>369.186,48 €</b>	<b>488.617,37 €</b>	<b>483.233,05 €</b>	<b>1.420.513,52 €</b>
						<b>3.008.210,60 €</b>

Table 10 - Scenario Analysis – Worst Case

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
<b>(+) Revenues</b>						
5G network	- €	703.846,15 €	1.385.697,12 €	1.818.727,46 €	2.387.079,80 €	3.133.042,23 €
Spare parts	- €	1.710.000,00 €	1.795.500,00 €	1.885.275,00 €	1.979.538,75 €	2.078.515,69 €
Service	- €	117.288,50 €	610.410,15 €	1.264.589,55 €	2.181.580,89 €	2.980.945,06 €
<b>Total</b>	- €	<b>2.531.134,65 €</b>	<b>3.791.607,27 €</b>	<b>4.968.592,01 €</b>	<b>6.548.199,44 €</b>	<b>8.192.502,98 €</b>
<b>(-) Variable Expenses</b>						
Inventory purchases (spare parts)	- €	1.300.500,00 €	1.365.525,00 €	1.433.801,25 €	1.505.491,31 €	1.580.765,88 €
Leasing of machines	- €	21.250,00 €	22.312,50 €	23.428,13 €	24.599,53 €	25.829,51 €
Testing PC	- €	2.805,00 €	3.681,56 €	4.832,05 €	6.342,07 €	8.323,96 €
4K Cameras	- €	53.550,00 €	70.284,38 €	92.248,24 €	121.075,82 €	158.912,01 €
HD Cameras	- €	53.550,00 €	70.284,38 €	92.248,24 €	121.075,82 €	158.912,01 €
Microphone	- €	6.375,00 €	8.367,19 €	10.981,93 €	14.413,79 €	18.918,10 €
Data acquisition systems setup	- €	19.125,00 €	25.101,56 €	32.945,80 €	43.241,36 €	56.754,29 €
Cloud server months Aws or Azure / EDGE	- €	40.800,00 €	53.550,00 €	573.750,00 €	753.046,88 €	988.374,02 €
High End Computer (GPU)	- €	7.650,00 €	10.040,63 €	13.178,32 €	17.296,55 €	22.701,72 €
Misc HW and test accessories	- €	25.500,00 €	33.468,75 €	43.927,73 €	57.655,15 €	75.672,39 €
Cost. of services	- €	650,25 €	853,45 €	1.120,16 €	1.470,21 €	1.929,65 €
Administrative (direct operation)	- €	29.580,00 €	31.059,00 €	48.917,93 €	51.363,82 €	35.954,67 €
Engineering	- €	207.060,00 €	217.413,00 €	293.507,55 €	205.455,29 €	179.773,37 €
Factory Staff	- €	83.538,00 €	87.714,90 €	92.100,65 €	110.520,77 €	116.046,81 €
AfterMarket	- €	59.160,00 €	93.177,00 €	130.447,80 €	136.970,19 €	143.818,70 €
<b>Total</b>	- €	<b>1.911.093,25 €</b>	<b>2.092.833,29 €</b>	<b>2.887.435,78 €</b>	<b>3.170.018,55 €</b>	<b>3.572.687,09 €</b>
<b>(-) Fixed Expenses</b>						
General operating and administrative expenses	- €	35.700,00 €	37.485,00 €	39.359,25 €	41.327,21 €	43.393,57 €
R&D	- €	166.464,00 €	174.787,20 €	183.526,56 €	192.702,89 €	202.338,03 €
<b>Total</b>	- €	<b>202.164,00 €</b>	<b>212.272,20 €</b>	<b>222.885,81 €</b>	<b>234.030,10 €</b>	<b>245.731,61 €</b>
<b>(-) Total Expenses</b>	- €	<b>2.113.257,25 €</b>	<b>2.305.105,49 €</b>	<b>3.110.321,59 €</b>	<b>3.404.048,65 €</b>	<b>3.818.418,69 €</b>
<b>EBITDA</b>	- €	<b>417.877,40 €</b>	<b>1.486.501,77 €</b>	<b>1.858.270,43 €</b>	<b>3.144.150,79 €</b>	<b>4.374.084,29 €</b>
<b>(-) Depreciation</b>	- €	<b>11.237,00 €</b>	<b>11.237,00 €</b>	<b>11.237,00 €</b>	<b>11.237,00 €</b>	<b>11.237,00 €</b>
<b>EBIT</b>	- €	<b>406.640,40 €</b>	<b>1.475.264,77 €</b>	<b>1.847.033,43 €</b>	<b>3.132.913,79 €</b>	<b>4.362.847,29 €</b>
<b>(-) Tax 21%</b>	- €	<b>85.394,48 €</b>	<b>309.805,60 €</b>	<b>387.877,02 €</b>	<b>657.911,90 €</b>	<b>916.197,93 €</b>
<b>EBIT(1-t)</b>	- €	<b>321.245,92 €</b>	<b>1.165.459,17 €</b>	<b>1.459.156,41 €</b>	<b>2.475.001,90 €</b>	<b>3.446.649,36 €</b>
<b>(-) Depreciation</b>	- €	<b>11.237,00 €</b>	<b>11.237,00 €</b>	<b>11.237,00 €</b>	<b>11.237,00 €</b>	<b>11.237,00 €</b>
<b>Cash Flow</b>	- €	<b>332.482,92 €</b>	<b>1.176.696,17 €</b>	<b>1.470.393,41 €</b>	<b>2.486.238,90 €</b>	<b>3.457.886,36 €</b>
<b>(-) Changes in Working Capital</b>	-	<b>160.017,43 €</b>	<b>83.726,05 €</b>	<b>34.143,40 €</b>	<b>89.259,15 €</b>	<b>453.941,66 €</b>
<b>(-) CAPEX</b>	-	<b>56.185,00 €</b>	- €	- €	- €	- €
<b>FREE CASH FLOW</b>	-	<b>216.202,43 €</b>	<b>248.756,87 €</b>	<b>1.142.552,77 €</b>	<b>1.381.134,26 €</b>	<b>2.999.443,27 €</b>

Table 11 - Scenario Analysis – Best Case

Financial Metric	Worst Case Scenario	Best Case Scenario	Diference
Free Cash Flow (FCF)	- 292.509,18 €	- 216.202,43 €	76.306,75 €
Net Present Value (NPV)	4.689.208,48 €	8.840.938,47 €	4.151.729,99 €
Internal Rate of Return (IRR)	150%	200%	50%
Return over Investment (ROI)	-18,78%	24,68%	43,46%
Liquidity Position	Strained	Strong	N/A
Profitability	Decreased	Increased	N/A
Cash Flow Stability	Volatile	Stable	N/A

Table 12 - Scenario Analysis

In the worst-case scenario

- FCF turns negative due to decreased revenues and increased expenses, indicating financial strain.
- EBIT(1-t) declines due to reduced profitability and higher tax burdens, impacting overall financial performance.
- NPV decreases as the projected cash flows fail to meet investment expectations, resulting in diminished value creation.
- IRR decreases due to lower cash flows and reduced investment attractiveness, signaling diminished return potential.
- Cash flow stability is volatile, characterized by fluctuations in cash flows and heightened financial uncertainty, posing challenges in cash flow management.

- ROI decreases, reflecting diminished returns relative to the initial investment, posing challenges for capital recovery.
- The worst-case scenario leads to a strained liquidity position due to negative cash flows, challenging meeting short-term financial obligations.
- Profitability declines as lower revenues and increased expenses erode profitability margins, impacting overall financial health.

In the best-case scenario

- FCF exhibits strong growth, driven by robust revenue expansion due to increased sales and efficient cost management practices.
- EBIT(1-t) experiences significant growth, driven by increased revenues and improved operational efficiency.
- NPV significantly increases, reflecting exceptional value creation and superior investment returns.
- IRR increases significantly, highlighting exceptional investment performance and compelling return prospects.
- ROI improves significantly, offering attractive returns on the initial investment and maximizing capital appreciation.
- The liquidity position is strengthened by robust cash flows and improved financial performance, enhancing flexibility.
- Cash flow stability is robust, supported by solid revenue streams and efficient cost structures, enhancing financial resilience and risk mitigation capabilities.

The comparison highlights the significance of scenario analysis in evaluating the project's financial resilience and performance across different operating environments. By assessing multiple scenarios, Bosch gains insights into the project's sensitivity to market fluctuations and ability to withstand adverse conditions while capitalizing on favorable trends. Scenario-based analysis should inform strategic decision-making to optimize resource allocation, mitigate risks, and maximize value creation, ensuring long-term financial sustainability and stakeholder value enhancement.

## **6 Conclusions/recommendations**

Throughout our finance project, we gained valuable insights into the challenges of implementing a financial solution within a corporate setting. Additionally, during this journey, we learned a lot working with Bosch's management about the difference between the academic idealization of a project and reality inside a firm, where different points of view fight against corporate governance and sector interest about which deal need to be developed and by whom. Our core objective was to create a tool for Bosch's management in Braga to successfully implement their vision for aftermarket services and demonstrate the benefits of implementing a 5G network.

### **6.1 Conclusions:**

- **Financial Viability:** Through meticulous analysis and calculation, it is evident that the proposed project holds significant financial viability. The rigorous assessment of various financial metrics, including Net Present Value (NPV) and Internal Rate of Return (IRR), indicates that the project offers favorable returns on investment. This conclusion is further reinforced by the sensitivity analysis, which demonstrates the project's resilience to changes in critical variables.
- **Strategic Alignment:** The project aligns strategically with Bosch's objectives, particularly in leveraging advanced technology such as 5G to enhance productivity and competitiveness. By investing in aftermarket services and embracing innovative solutions, Bosch Braga positions itself as a center of excellence within the corporation, contributing to overall corporate growth and market leadership.
- **Risk Management:** Efficient risk management strategies are essential for mitigating potential challenges and uncertainties associated with the project. While the analysis indicates favorable outcomes, it is imperative to remain watchful and proactive in identifying and addressing rising risks. Handling risk includes continuous monitoring of market dynamics, regulatory changes, and technological advancements to ensure adaptability and resilience.
- **Value Creation:** The project's ability to generate value extends beyond financial metrics. By investing in 5G technology and aftermarket services, Bosch Braga enhances its operational efficiency, customer satisfaction, and market reputation. The project not only drives revenue growth but also strengthens Bosch's competitive position and long-term sustainability.

- Opportunities for Growth: The successful implementation of the project opens up opportunities for further growth and expansion. Leveraging the 5G network and aftermarket services, Bosch Braga can explore additional revenue streams, such as selling services to third parties or expanding into new markets. This diversification strategy enhances Bosch's resilience to market fluctuations and strengthens its position as an industry leader.

## **6.2 Recommendations:**

- Continuous Monitoring and Evaluation: Robust monitoring and evaluation mechanisms should be established to ensure the project's ongoing success. Regular reviews of key performance indicators, business courses, and customer response will provide valuable insights into the project's performance and enable timely adjustments to strategies and tactics.
- Given the project's sensitivity to sales growth and variable expenses, it is recommended that Bosch implements enhanced risk management practices, including regular market analysis and cost control mechanisms.
- Investment in Talent and Training: Human capital drives project success. Talent development and training programs will provide employees with the necessary skills and knowledge to utilize 5G technology effectively and deliver high-quality aftermarket services. This investment enhances operational efficiency and fosters a culture of innovation and continuous improvement.
- Strategic Partnerships and Collaboration: Collaboration with external partners, including suppliers, technology providers, and industry associations, can amplify the project's impact and accelerate its implementation. By leveraging external expertise and resources, Bosch Braga can access new markets, technologies, and opportunities for innovation, driving sustainable growth and competitiveness.
- Customer-Centric Approach: Maintaining a customer-centric approach is essential for driving demand and satisfaction with aftermarket services. By understanding customer needs, preferences, and pain points, Bosch Braga can tailor its offerings and service delivery to maximize value and differentiate itself from competitors. Regular

communication and feedback mechanisms will enable Bosch to stay active and responsive to changing customer expectations.

- **Investment in Research and Development:** To sustain long-term competitiveness and innovation, allocating resources to research and development initiatives is recommended. This investment will drive continuous product and service innovation, ensuring that Bosch Braga remains at the forefront of technological advancements and market trends. By raising a culture of experimentation and exploration, Bosch can identify new opportunities for growth and differentiation.
- **Sustainability and Corporate Responsibility:** As a responsible corporate citizen, Bosch should prioritize sustainability and corporate responsibility in project implementation, which includes minimizing environmental impact, promoting ethical business practices, and contributing to local communities. By aligning with sustainable development goals and industry best practices, Bosch can enhance its reputation, attract top talent, and build long-term value for stakeholders.
- **Quickness and Adaptability:** Agility and adaptability are critical to success in a rapidly changing business landscape. Bosch Braga should embrace a culture of agility, empowering employees to innovate, experiment, and respond effectively to changing market conditions. This flexibility will enable Bosch to seize new opportunities, mitigate risks, and maintain a competitive edge in the industry.
- **Regular Communication and Stakeholder Engagement:** Transparent communication and active engagement with stakeholders, including employees, customers, investors, and regulators, are essential for building trust and fostering collaboration. By maintaining stakeholders informed and involved throughout the project lifecycle, Bosch can gain valuable insights, address concerns, and build strong relationships that drive mutual success.

### **6.3 Limitations:**

- **Market and Economic Assumptions:** Sensitivity analyses highly depend on the initial market and economic assumptions. If these assumptions are based on uncertain or volatile market conditions, the resulting analysis could be highly variable.



- **Static Variables:** Often, in financial models, certain variables are held constant while others are varied. This doesn't always reflect the interconnectedness of financial variables in real-world scenarios where changes in one area can lead to changes in another.
- **Data Availability and Reliability:** The analysis is limited by the availability and reliability of the data. Historical data might not be available for all desired variables, and projections are inherently uncertain.
- **Exclusion of Non-Financial Factors:** Sensitivity analysis typically focuses on financial variables and may not account for non-financial factors that could impact the project, such as regulatory changes, technological disruptions, or shifts in consumer behavior.
- **Lack of accessibility to financial tools:** Financial tools are paramount in project valuations, and their scarcity may lead to oversimplifying the analysis.

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