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ASSETS AND MAINTENANCE SHARED SERVICES BUSINESS PLAN

PLANO DE NEGÓCIOS PARA SERVIÇOS COMPARTILHADOS DE ATIVOS E MANUTENÇÃO

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Final Educational Project presented to ITL/SEST/SENAT as part of the necessary requirements to obtain the International Certification in Management of Rail and Metro Rail Systems

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ABSTRACT

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Based on the actual scenario, where mass transportation modes have been heavily impacted due to social distancing and home office, which drastically reduced people mobility inside and between cities, railways operators around the world should reinvent themselves to continue providing that essential service to a share of the society that still needs to move around.

Besides that, operators should also be prepared for the economic recovery, dealing with the fact that demand turnaround will not be to the same levels as before the COVID-19 pandemic. A new reality is established, and railway transport operators need to adapt, especially in the search for cost reduction opportunities, guaranteeing the quality and safety of the service.

Observing the existing infrastructure in the city, an opportunity for synergy and services demand consolidation has been identified in MetrôRio and SuperVia, exploring the best knowledge and structure of each operator and making a better use of the operational and intellectual assets, leading to services exchange, and best market prices.

In the context of this new reality, the topic proposed for the final educational project is to develop an Assets and Maintenance Shared Services Business Plan, using existing infrastructure and expertise in the actual railway operators in Rio de Janeiro and surrounding, while optimizing the utilization of idle capacity and resources.

For that, the agile methodology will be suggested, as it is an innovative approach for this market that may suffices the need for short term gains, as the various stages of the business plan will be developed as each new opportunity is identified. Some opportunities have already been identified in wheel machining and track inspection car, for example, and a business plan will be detailed on these topics.

Keywords: Rail transit. Maintenance. Assets management. Sharing economy. Agile method.

RESUMO

PLANO DE NEGÓCIOS PARA SERVIÇOS COMPARTILHADOS DE ATIVOS E MANUTENÇÃO

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Com base no cenário atual, onde os meios de transporte de massa foram fortemente impactados pelo distanciamento social e home office, que reduziram drasticamente a mobilidade das pessoas dentro e entre as cidades, as operadoras de ferrovias em todo o mundo devem se reinventar para continuar fornecendo esse serviço essencial para uma parcela da a sociedade que ainda precisa se mover.

Além disso, as operadoras também devem estar preparadas para a recuperação econômica, lidando com o fato de que a recuperação da demanda não atingirá os mesmos níveis de antes da pandemia da COVID-19. Uma nova realidade se estabelece e os operadores de transporte ferroviário precisam se adaptar, principalmente na busca por oportunidades de redução de custos, garantindo a qualidade e segurança do serviço.

Observando a infraestrutura existente na cidade do Rio de Janeiro, uma oportunidade de sinergia e consolidação da demanda de serviços foi identificada no MetrôRio e na SuperVia, explorando o melhor conhecimento e estrutura de cada operadora e aproveitando melhor o patrimônio operacional e intelectual, levando à troca de serviços e os melhores preços do mercado.

No contexto desta nova realidade, o tema proposto para o projeto educacional final é desenvolver um Plano de Negócios para Serviços Compartilhados de Ativos e Manutenção, utilizando a infraestrutura e expertise existentes nas atuais operadoras metroferroviárias do Rio de Janeiro e entorno, otimizando a utilização da capacidade e dos recursos ociosos.

Para tanto, será sugerida a metodologia ágil, por se tratar de uma abordagem inovadora para este mercado que pode suprir a necessidade de ganhos de curto prazo, pois as várias etapas do plano de negócios serão desenvolvidas a cada nova oportunidade identificada. Algumas oportunidades já foram identificadas em usinagem de rodas e carros de inspeção de via, por exemplo, e um plano de negócios será detalhado sobre esses tópicos.

Palavras-chave: Transporte Coletivo sobre Trilhos. Manutenção. Gestão de Ativos. Economia Compartilhada. Método Ágil.

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AAR	Association of American Railroads
ACF	Annualised Cash Flows
AGETRANSP	Agência Reguladora dos Serviços Públicos Concedidos de Transportes Aquaviários, Ferroviários e Metroviários e de Rodovias do Estado do Rio de Janeiro (Regulatory Agency for Public Services granted for Water, Rail, Metro and Road Transport)
ART	Anotação de Responsabilidade Técnica (Technical Responsibility Term)
B2B	Business-to-business
B2C	Business-to-consumer
C2C	Consumer-to-consumer
CBA	Cost-benefit analysis
COVID-19	Coronavirus Disease 2019
CPE	Collective Protective Equipment
CREA	Conselho Regional de Engenharia e Agronomia (Regional Counsil of Engineering and Agronomy)
HCMBOK	Human Change Management Body Of Knowledge
IBGE	Instituto Brasileiro de Geografia e Estatistica (Brazilian Institute of Geography and Statistics)
INMETRO	Instituto Nacional de Metrologia, Qualidade e Tecnologia (National Institute of Metrology Standardization and Industrial Quality)
IQS	Índice de Qualidade do Serviço (Level of Service Index)
IRR	Internal Rate of Return
MetrôRio	Concessão Metroviária do Rio de Janeiro S.A.
NPV	Net Present Value
P2P	Peer-to-peer

PNAD	Pesquisa Nacional por Amostra de Domicílios (National Household Sample Survey)
PPE	Personal Protective Equipment
RBC	Rede Brasileira de Calibração (Brazilian Calibration Network)
RMRJ	Região Metropolitana do Rio de Janeiro (Rio de Janeiro Metropolitan Area)
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SuperVia	Supervia Concessionária de Transporte Ferroviário S.A.
SWOT	Strengths, Weaknesses, Opportunities, and Threats

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CHAPTER 1. INTRODUCTION

Based on world's economy current condition, which was heavily impacted by the new coronavirus SARS-CoV-2, population in general is relearning to live. This includes leaving aside non-essential habits, living with less and getting around as little as possible, due to social distancing requirements.

As lockdowns effectively reduced mobility in larger cities, technology played an important role in maintaining the economy, supporting this whole process. Sharing economy gained strength, as driver apps replaced public transit and delivery apps helped people avoid going to establishments for purchases of essential products.

These changes also affected collective purchases websites, product exchanges websites, car sharing and online sale of products and services in general. All entrepreneurs needed to reinvent themselves. Including, thus, railways transit operators, as passenger ridership plummeted.

Figure 1 – SuperVia train during peak hour, as COVID-19 pandemic affected ridership (Source: PEIXOTO, Domingos. Agência O Globo)

1.1 Research Results

In this whirlwind of changes, a significant share of the economic active population has discovered that they can carry out their work activities or studies from home, as shown on Figure 2 (IBGE, 2020). Even with the ease of isolation measures, there are still no signs whatsoever of a general reduce of this trend, as old barriers related to remote work have been already torn down at the very beginning of the pandemic.

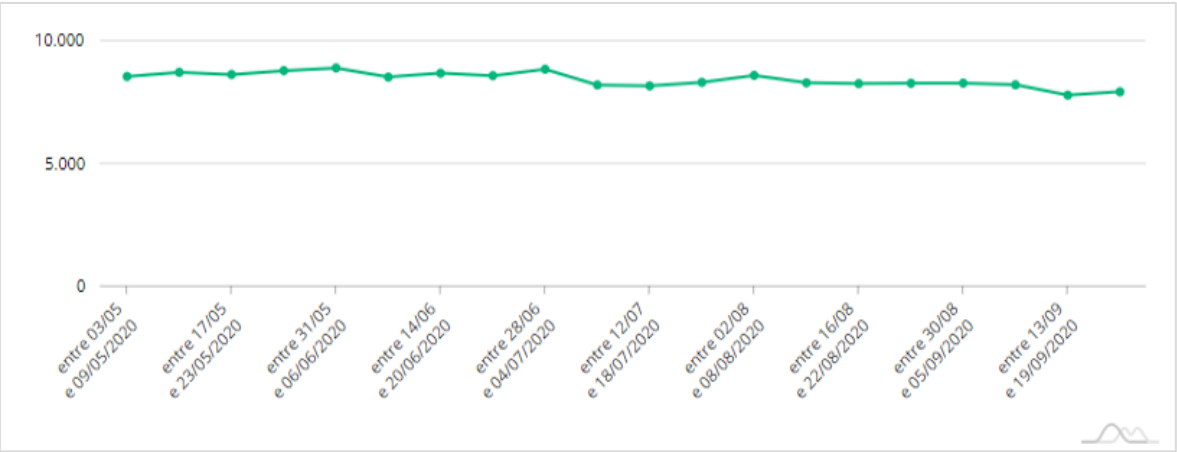


Figure 2 – Graph showing that an average of 8 million people are working remotely in Brazil (Source: PNAD COVID-19 – IBGE, 2020).

This situation is even more acute on major cities like Rio de Janeiro, since 58% of the 8.4 million Brazilian home office workers are located in the southeast of the country, according to the report “Home office is a new indicator of economic inequality in Brazil” (FOLHA DE SÃO PAULO, 2020).

This report points out the main reasons for this concentration, listing as the main cause the economic development of these regions, in addition to other factors such as education level, conditions of access to technology and internet signal.

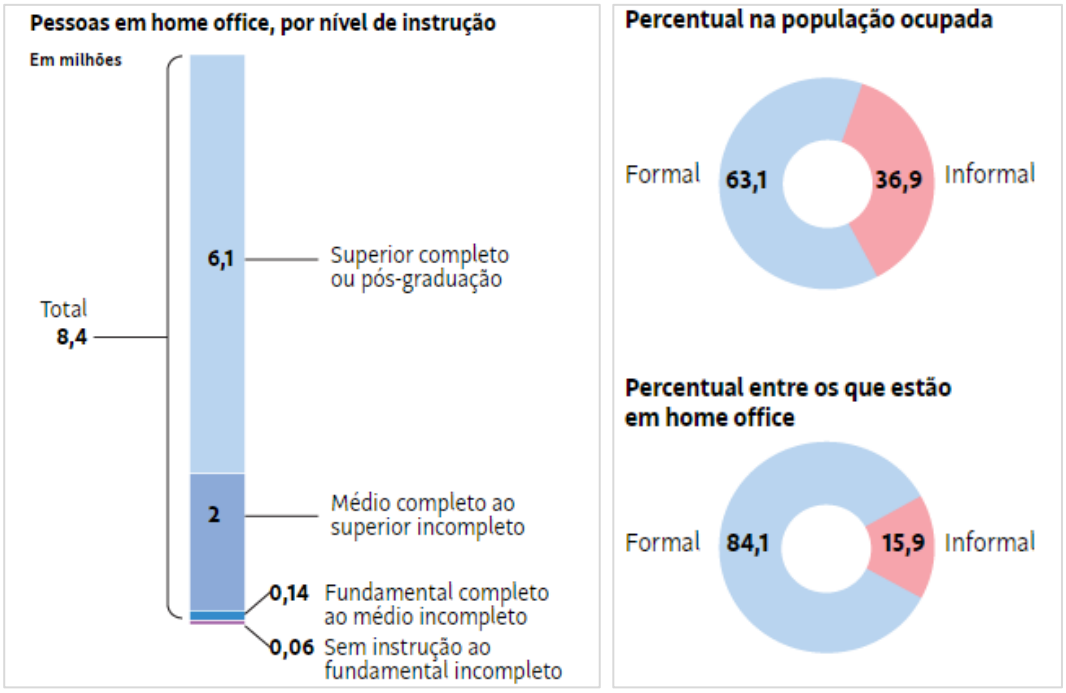


Figure 3 – Graphs showing the inequality of home office workers distribution, regarding level of education and formal/informal employement (Source: FOLHA DE SÃO PAULO, 2020)

This trend directly affects MetrôRio and SuperVia, which are the private rail operators in Rio de Janeiro Metropolitan Area, being the concession holders since 1998, when both contracts were awarded.

Whilst the 57-km subway network operated by MetrôRio serves 41 stations in the city of Rio de Janeiro, the 270-km urban train service operated by SuperVia serves 104 stations in the cities of Duque de Caxias, Nova Iguaçu, Nilópolis, Mesquita, Queimados, São João de Meriti, Belford Roxo, Japeri, Magé, Paracambi and Guapimirim, in addition to the capital itself.

Official data from the operators[1], which are regulated and supervised by Agetransp, shows that both companies transported a total of 1.5 million passenger per workday in 2016. However, these numbers have plummet up to an astonishing 80% drop in the first weeks of the COVID-19 pandemic, and nowadays both operators have a combined ridership of 742 thousand passenger per workday, almost reaching the 50% threshold, as shown on Figure 4.

[1] Official websites for the main rail operators in RMRJ: MetrôRio – www.metrorio.com.br and SuperVia – www. supervia.com.br.

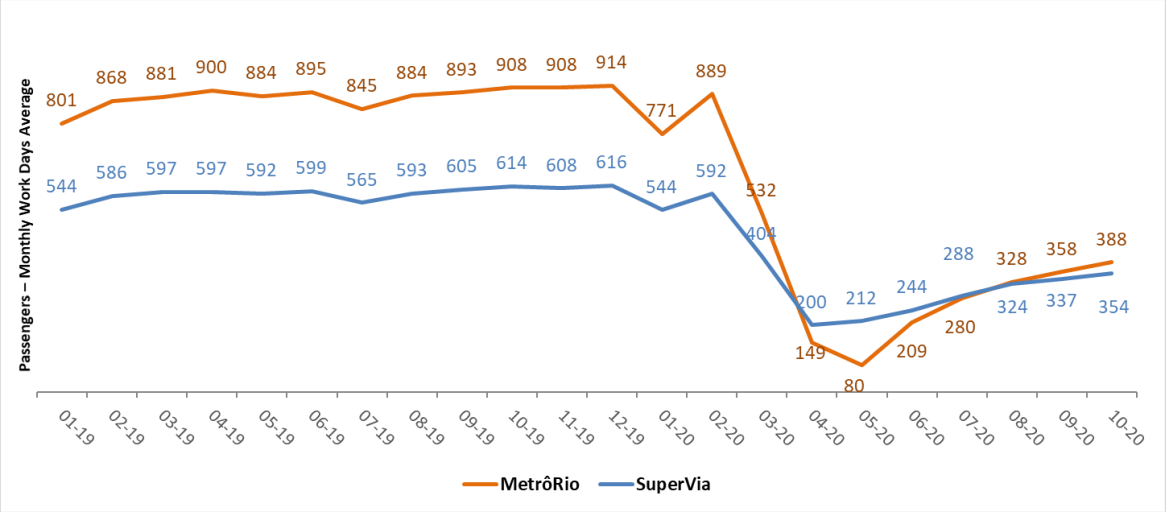


Figure 4 – Graph showing the slow recovery of passenger demand in both MetrôRio and SuperVia (Source: Internal data, 2020)

These numbers also show us that MetrôRio experienced a more steep decrease than SuperVia at the beginning of the pandemic. This can be explained as the subway network serves wealthier portions of the cities, whose inhabitants are more prone to work from home than low-skilled workers, which are the majority of SuperVia commuters.

As a matter of fact, IQS surveys applied by both companies prior to COVID-19[2] shown that 81% of SuperVia passengers are situated on income classes D and E, with and average income below 4 minimum salaries (>695 USD per month), while on MetrôRio these passengers accounts for only 5% of total ridership (Figure 5).

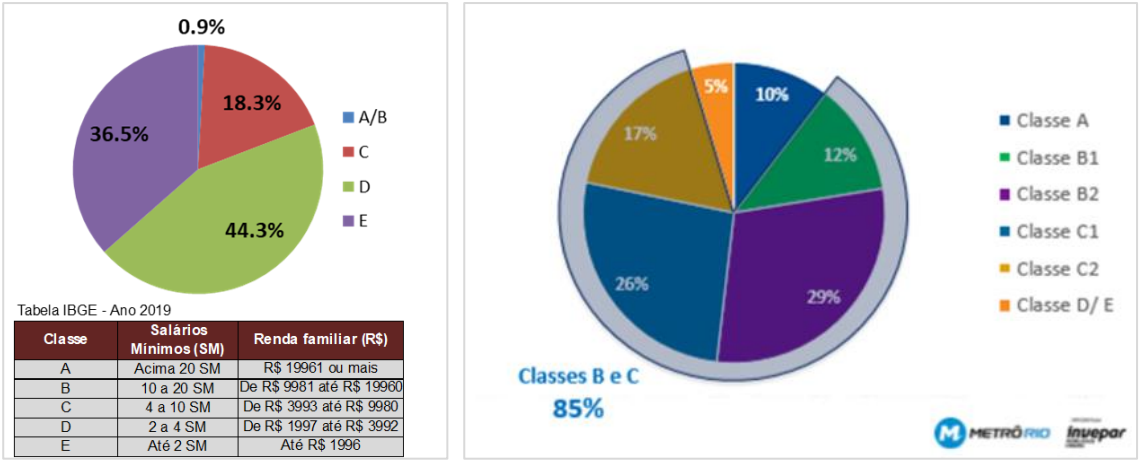


Figure 5 – Income classes comparison between SuperVia (left) and MetrôRio (right), according to the category sets defined by IBGE (Source: SUPERVIA, 2019 / METRÔRIO, 2019)

This difference is also prominent on private vehicle possession, as 47% of MetrôRio passengers also have their own car, besides taking the subway, while on SuperVia approximately 32% of the passengers have their own car/motorcycle. In a pandemic

[2] MetrôRio IQS Survey applied on Mar/2019 and SuperVia IQS Survey applied on Dec/2019.

where people want to avoid social contact as much as possible, individual transport poses itself as a major advantage for those who can afford it.

What both operators have in common, regarding demand demographics, is that the majority of the passengers are workers, usually commuting back and forth from work to home. On MetrôRio 85% of the passengers have a job occupation (Figure 6), while on SuperVia this number goes up to 91% of the survey sample (Figure 7).

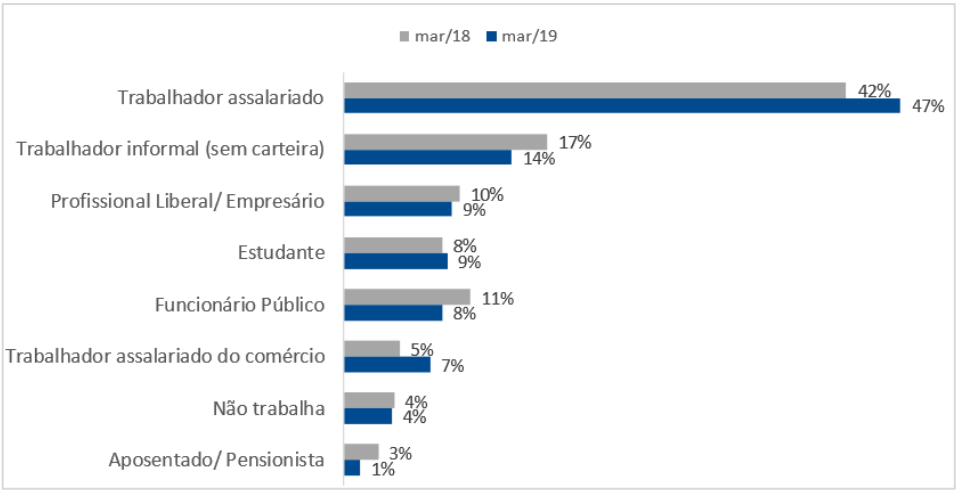


Figure 6 – Occupational profile among MetrôRio passengers, according to IQS Survey (Source: METRÔRIO, 2019).

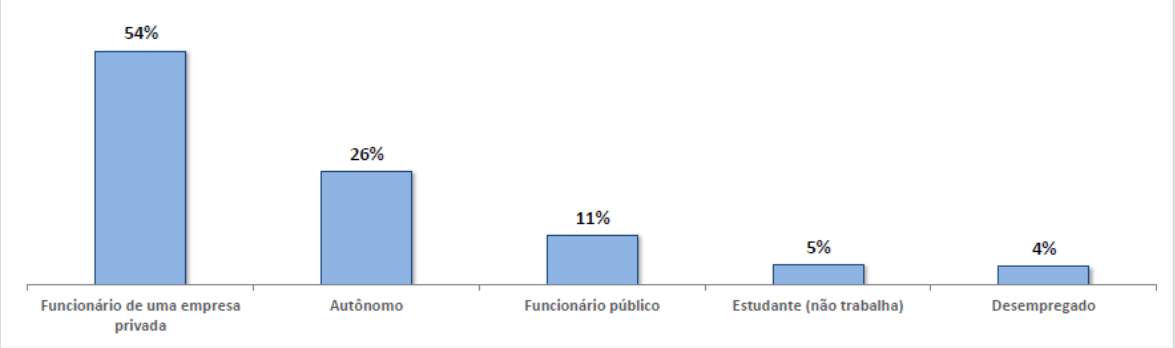


Figure 7 – Occupational profile among SuperVia passengers (Source: SUPERVIA, 2019).

This means that, besides eventual behavioral aspects regarding social distancing, passenger ridership on both systems is also being affected by the general economic activity reduction, as business bankrupts and citizens lose their jobs due to lockdowns and travel restrictions.

In addition, if on a national level figures for employment are recovering on a steady pace, Rio de Janeiro has seen a decrease in job availability levels that were already in a low, because of an economic crisis stretching from 2016. For transit operators this is a worst-case scenario, as commuters simply do not have a trip desire anymore, thus nothing can be done to shift their trips from one mode to another.

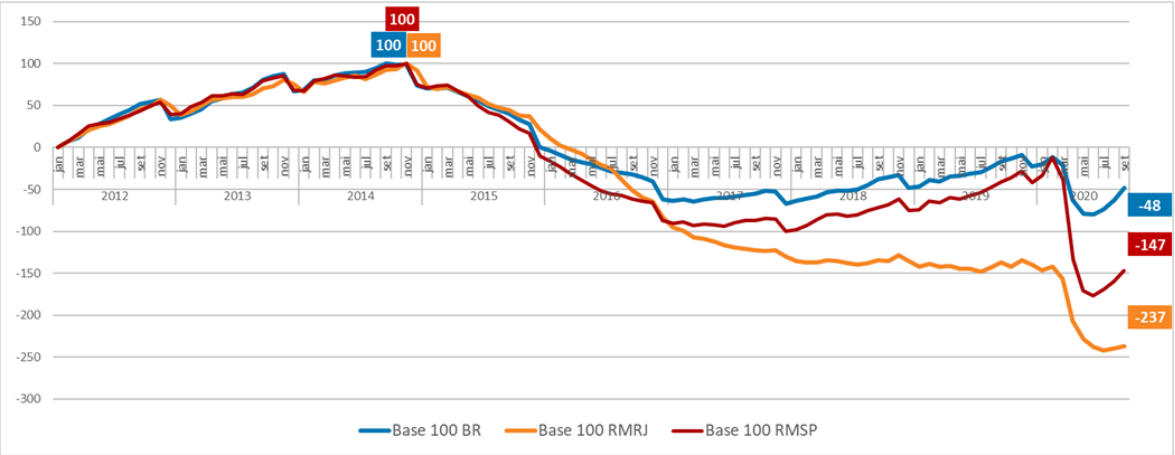


Figure 8 – Cumulative Job Balance (Base 100): Brazil - BR x Rio de Janeiro Metropolitan Area - RMRJ x São Paulo Metropolitan Area - RMSP. (Source: CAGED - IBGE, 2020)

1.2 Hypotheses

The business plan proposed on this Educational Project is based on two main hypotheses: the decrease in rail transit passenger ridership as a new reality, and sharing economy as a solution for transit operators that are seeking for innovative ways to endure in this brave new world.

1.2.1 Decrease in ridership as a long-lasting new reality

With an updated -4.81% projection for Brazilian GDP in 2020, no one knows what are going to be the real effects of the upcoming economic crisis, and how will be the pace of recovery from it.

Most possible outcomes suggests that the negative economic effects should be transitory, with GDP, economic activity and jobs being gradually restored with the cooling of the crisis (except on the dread L-Shaped recovery, of course, as shown in Figure 9).

However, whilst the effects decrease of jobs depletion on rail transit ridership almost certainly is temporary, not the same can be said about behavioral changes that may arise after the COVID-19 pandemic.

MetrôRio IQS survey, for example, showed that in 2019 the majority of its passengers were already users of ridesharing apps such as Uber, 99 (Didi Chuxing) and Moobie, that are now being praised as a safe way to move around.

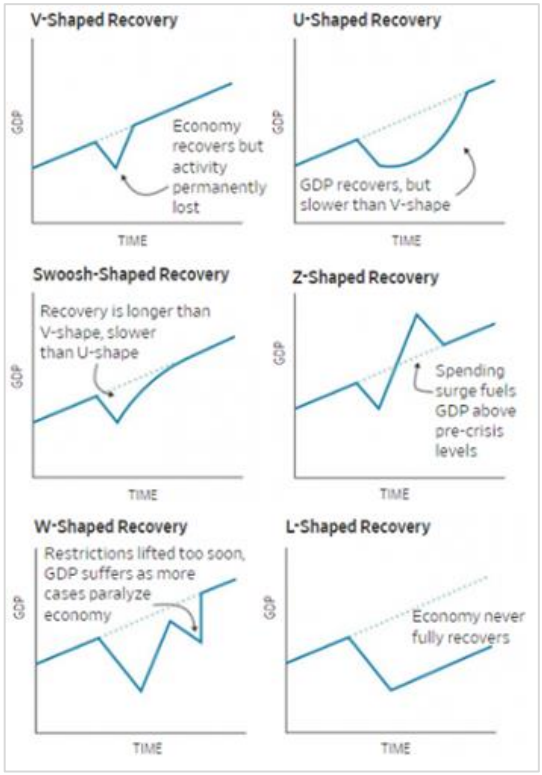


Figure 9 - Shapes of an economic recovery (Source: Brookings Institution, n.d.)

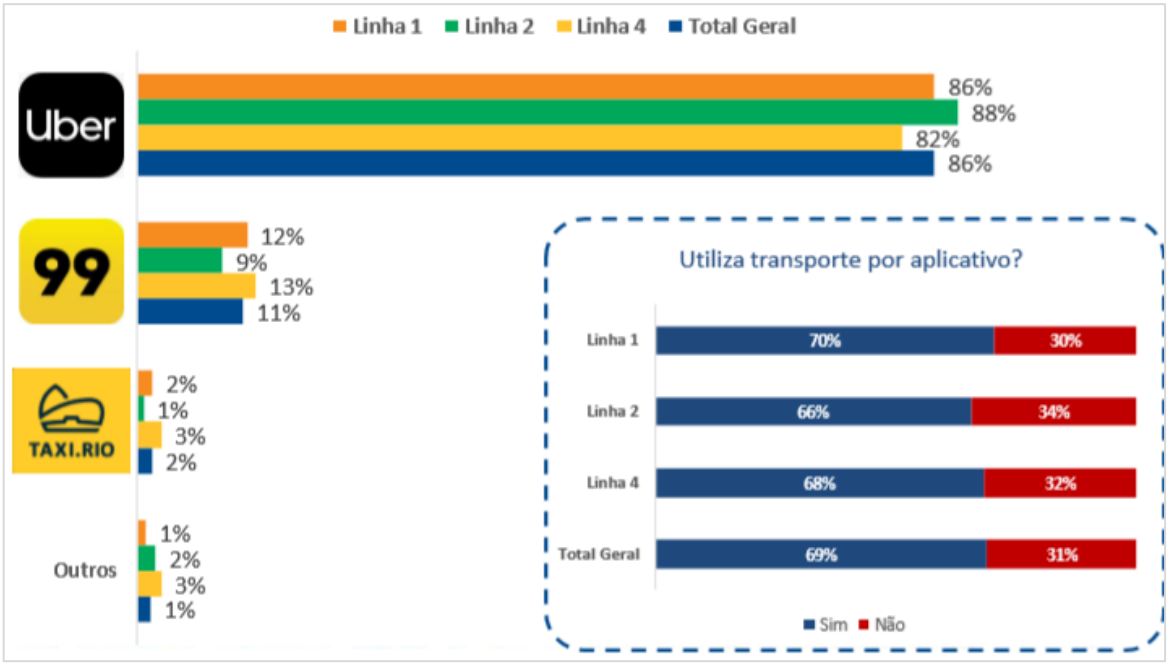


Figure 10 - Ridesharing apps usage on MetrôRio, according to the March/2019 IQS Survey (Source: METRÔRIO, 2019)

Depending on how long it might take for develop an effective vaccine against the SARS-CoV-2, is it possible that passengers get so used to avoid heavy haul transit that a permanent shift towards smaller, individual transport might happens.

Even for SuperVia, whose passengers have smaller budgets and rides longer distances, this behavior changes may also jeopardize commuters ridership. On one hand, digital revolution is already a reality, with 97% of the passengers having access to internet, despite their social condition, as show on Figure 11.

On the other side, if nowadays most low-skilled employees can't perform their tasks from home, wealth and educational increase will always poses itself as a constant threat for the upcoming future, as these commuters achieve better work conditions and tend to quit using rail transit. Maybe shifting to home office, maybe now being able to buy their private car/motorcycle.

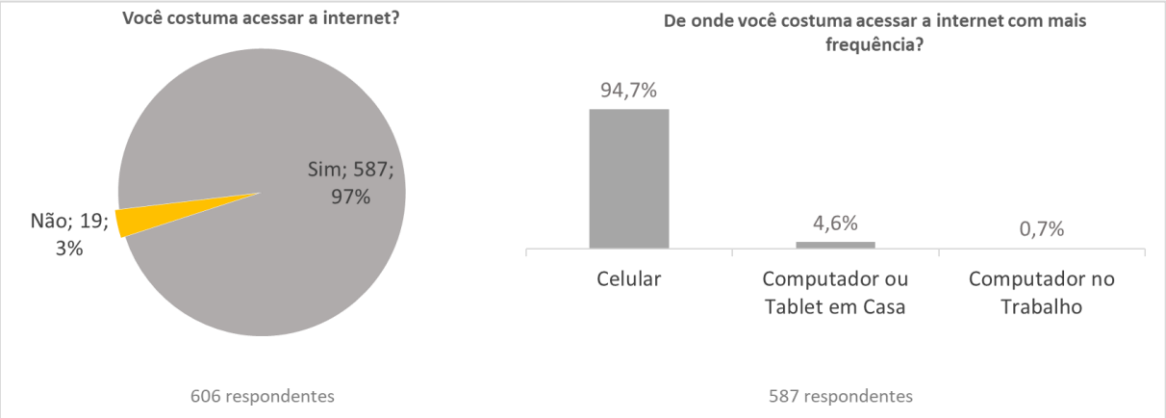


Figure 11 –Internet Connectivity among SuperVia Passengers. (Source: Bancarization and Technology Survey, 2019)

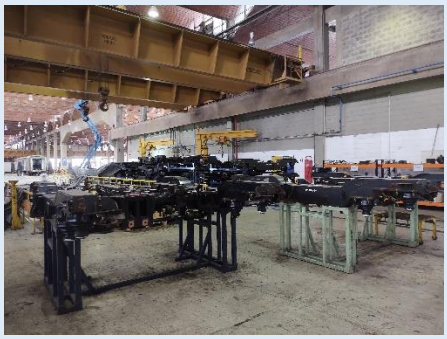
In view of the data explained above, the current and future condition of rail transit in the city of Rio de Janeiro and its surroundings is critical, and business maintenance of the public-private partnership will require many negotiations to equalize the situation and the future of companies in this field.

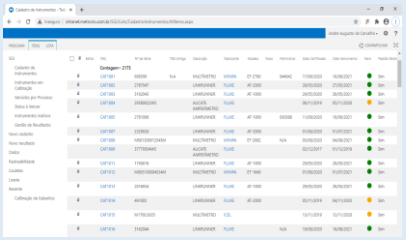
1.2.2 Sharing economy as a solution

The pandemic has brought on the table a severe need for cost reduction and restructuring measures. In search of efficiency, when it comes to passenger transportation business in Rio de Janeiro, it is possible to observe that there are synergies, mainly in the maintenance areas of these companies.

Each company has an infrastructure and a team dedicated to the maintenance and management processes of the assets, as can be evidenced by the photos shown in Table 1. For performing such tasks MetrôRio has a team with 214 people, while SuperVia has a headcount of 340 rolling stock maintenance personnel.

Table 1 – List of main maintenance services performed on MetrôRio and SuperVia (Source: Internal data)

Service Description	MetrôRio	SuperVia
Bogie maintenance		
Engine maintenance		
Wheel Profiling		

Service Description	MetrôRio	SuperVia
Wheel lathe		-
Instruments calibration Management System		-
Automated Track Inspection	-	

Coexistence of several work assignments in both operators suggests a window of opportunity for economies of scale in shared maintenance services, which would result in efficiency increase and cost reduction. Sharing economy would allow MetrôRio and Supervia to share with each other their idle capacity and resources on an on-demand basis, always with an eye on sustainability (PWC, 2015).

1.3 Generate Ideas

According to BELK (2007), when sharing, two or more people/organizations enjoy the inherent benefits of owning a shared object, such as dividing costs. It is possible to share physical objects such as a workshop or an asset, as well as other more abstract ones, such as knowledge or relationships. In short, sharing implies voluntary lending, sharing, and use of resources that, primarily, are collectively owned.

In fact, MetrôRio and SuperVia have a long history of interchange, as both systems intersects in Rio de Janeiro downtown area, close to Central do Brasil station. Also located in that region we have the main maintenance center for MetrôRio, as well as a secondary workshop for SuperVia called São Diogo (as its main maintenance center is located further in the suburbs, in Deodoro neighborhood).

As both systems share the same 1,600mm broad gauge, an interconnection track connecting both systems is available close to Cidade Nova station, allowing trains to change from MetrôRio to SuperVia and vice versa on special occasions. Thus, assets and services sharing between the operators should not be a difficult task.

Figure 12 – Location of MetrôRio Maintenance Center and SuperVia's São Diogo Workshop, with special focus on the interconnection tracks between the systems (Source: Google Maps)

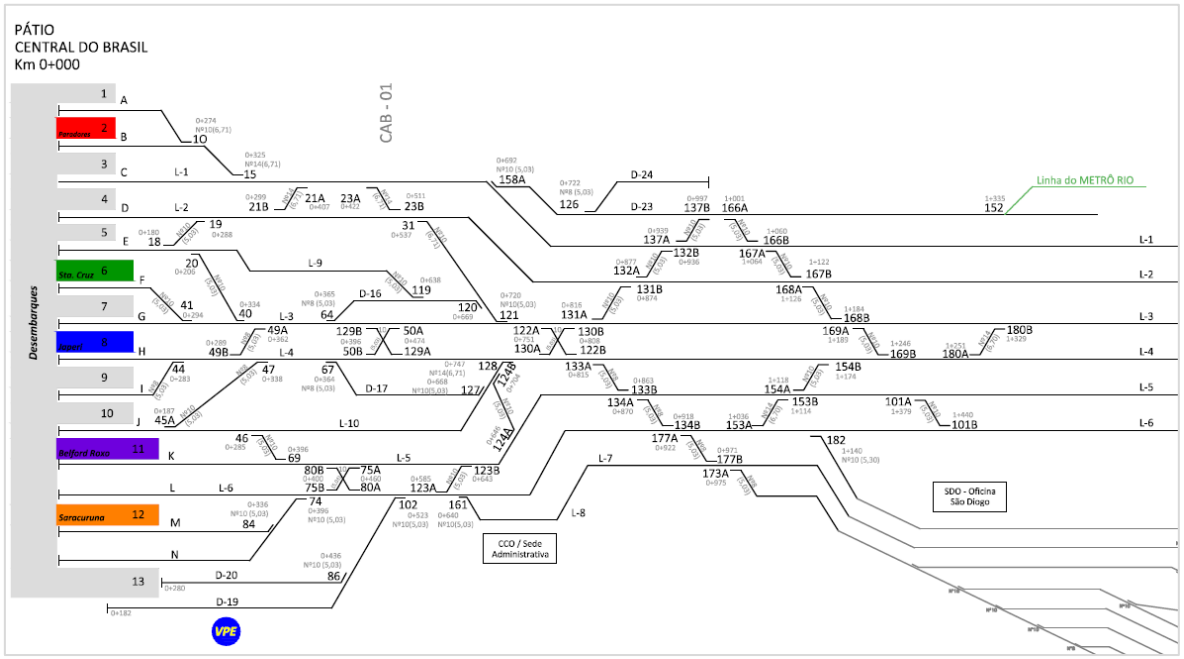


Figure 13 – Central do Brasil track schematics for SuperVia, with the interconnection track with MetrôRio highlighted in green in the upper right (Source: Internal data)

Going further, at MetrôRio there is already an ongoing initiative to centralize component recovery services and workshop services, which aims to consolidate demands from all areas of the company and thereby generate synergy in hiring or even the internalization of services contracted by different areas.

For that, agile methodology of project and change management was adopted, making the implementation by delivery cycles and in this case by specific

components or services. As the project progresses, centralizing the management of various components, one of the stages of each cycle is the technical and financial feasibility analysis.

At this stage it could be seen that many of the consolidated demands would continue to have the service performed through subcontracting, having demand consolidation as a main gain, providing greater predictability for market submission. Even for services where internal know-how is available, demand consolidation had shown greater financial viability.

Based on the centralized services for instrument calibration, for example, the gains for demand consolidation are expressive as shown below.

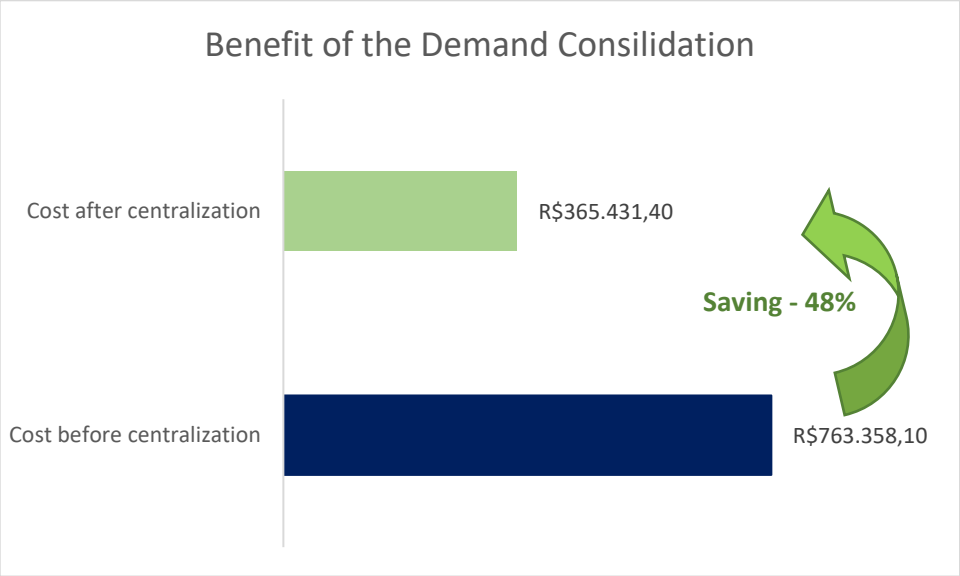


Figure 14 – Benefits of demand consolidation (Source: Internal data)

As observed in the simulation below, if demand increases about 30%, then payback time for the centralization investments reduces from 7 years to 1 year.

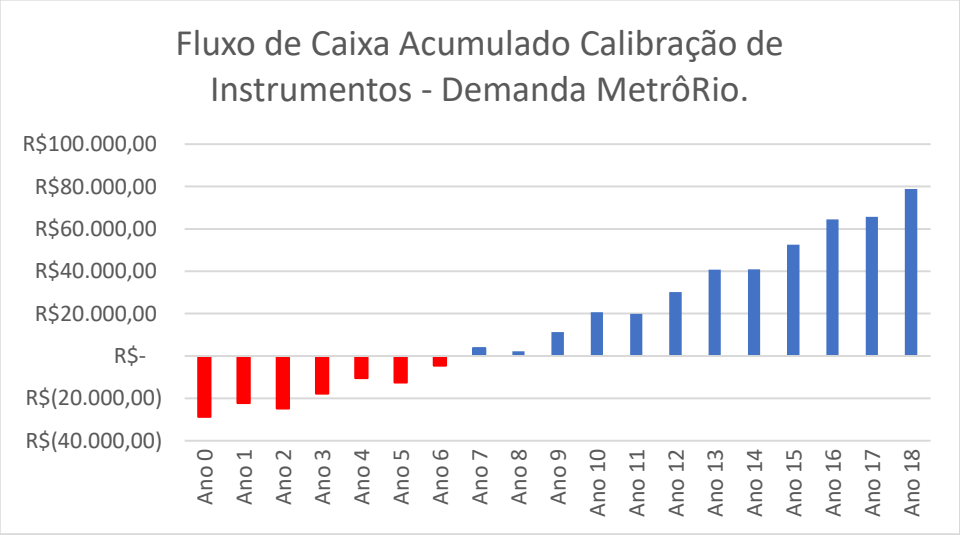


Figure 15 – Cumulative Cash Flow for Instruments calibration – Base Scenario (Source: Internal data)

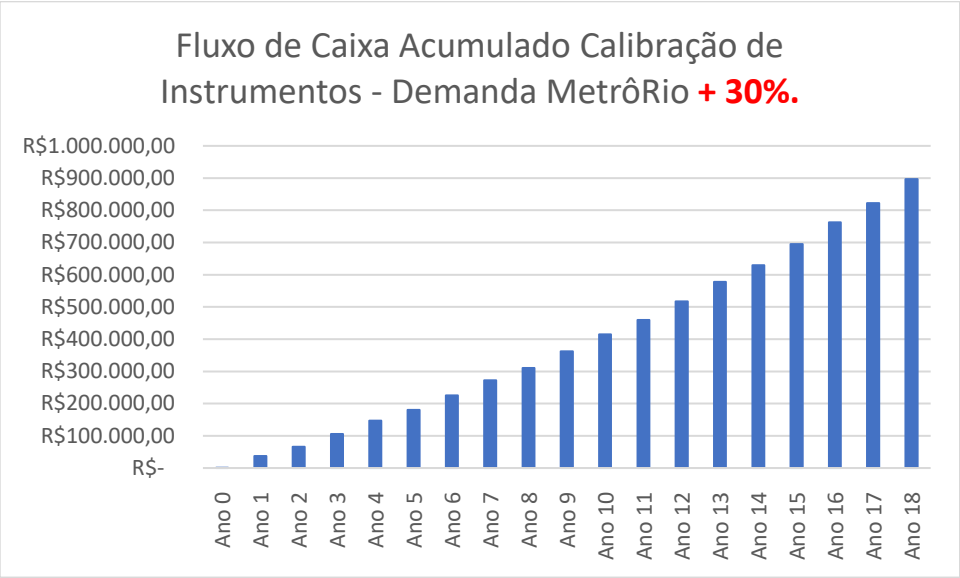


Figure 16 – Cumulative Cash Flow for Instruments calibration – Demand +30% Scenario (Source: Internal data)

Table 2 – Instruments calibration scenario comparison concerning NPV, IRR, ACF and payback time (Source: Internal data)

Demand	MetrôRio	MetrôRio + 30%
NPV	R$ 5.487,41	R$ 299.242,63
IRR	13,29%	101,46%
ACF (19 years)	R$ 78.787,94	R$ 896.722,91
PAYBACK	7 Years	1 Year

This brief analysis led to the understanding that searching for greater services demand, by joining forces and maybe attracting other customers from the market, would result in economies of scale that would make the internalization of services possible, thus reducing costs and even generating ancillary revenue.

CHAPTER 2. PRELIMINARY REMARKS

The preliminary remarks for this work begins with a brief review of the main Theoretical Foundation for and Agile Business Plan, on Section 2.1. Then, Section 2.2 presents a walkthrough on the Theoretical Background regarding Sharing Economy, the specific subject of this essay, including both critical and literature reviews.

2.1 Theoretical Foundation

This section prepares the theoretical ground for this Educational Project. Items 2.1.1 and 2.1.2 introduces Agile Methodology concepts, whereas Item 2.1.3 defines important terms relating to Business Model Canvas and Financial and Economic Feasibility Studies.

2.1.1 Agile methodology

The agile methodology is a model and a philosophy alternative to the traditional project management, with the objective to enhance the services and products development, as fast and frequent as the client needs.

By this innovative project management approach, it´s possible to increase interactions, make efficient processes and bring agility to workflow, and has been adopted by different team and areas in addition to information technology where did it came from.

Many companies still use the Waterfall Methodology, the most traditional one to manage projects, developed at the year 1970, following sequential steps one after another.

With the software industry growth, some delay problems surges, and was necessary look for new solutions, with gains of agility and adaptability required by customers.

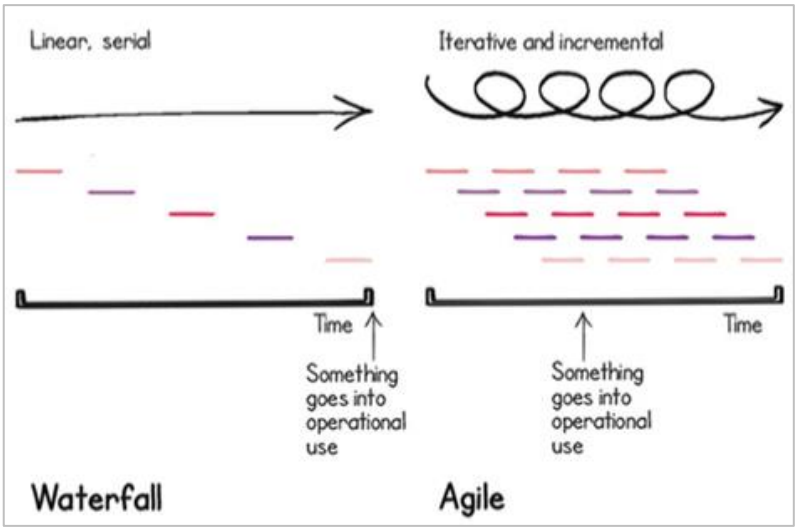


Figure 17 – Difference between waterfall and agile methodologies (Source: Change Management Strategic Plan)

Based on that market needs a programmers group published the Agile Manifesto, which consist in (BEEDLE, 2001):

We are uncovering better ways of developing
software by doing it and helping others do it.
Through this work we have come to value:

Individuals and interactions over processes and tools

Working software over comprehensive documentation

Customer collaboration over contract negotiation

Responding to change over following a plan

That is, while there is value in the items on
the right, we value the items on the left more.

And the twelve principles behind the Agile Manifesto Values (BEEDLE, 2001):

We follow these principles:
Our highest priority is to satisfy the customer
through early and continuous delivery
of valuable software.

Welcome changing requirements, even late in
development. Agile processes harness change for
the customer's competitive advantage.

Deliver working software frequently, from a
couple of weeks to a couple of months, with a
preference to the shorter timescale.

Business people and developers must work
together daily throughout the project.

Build projects around motivated individuals.
Give them the environment and support they need,
and trust them to get the job done.

The most efficient and effective method of
conveying information to and within a development
team is face-to-face conversation.

Working software is the primary measure of progress.

Agile processes promote sustainable development.
The sponsors, developers, and users should be able
to maintain a constant pace indefinitely.

Continuous attention to technical excellence
and good design enhances agility.

Simplicity the art of maximizing the amount of work not done is essential.

The best architectures, requirements, and designs emerge from self-organizing teams.

At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Following the agile principles, with focus on generate values to the clients, matching with business needs, the projects should be implemented in cycles and in each cycle contain releases generated by the iterations or sprints, looking back to the existing backlog, prioritizing and planning according to the clients and business needs.

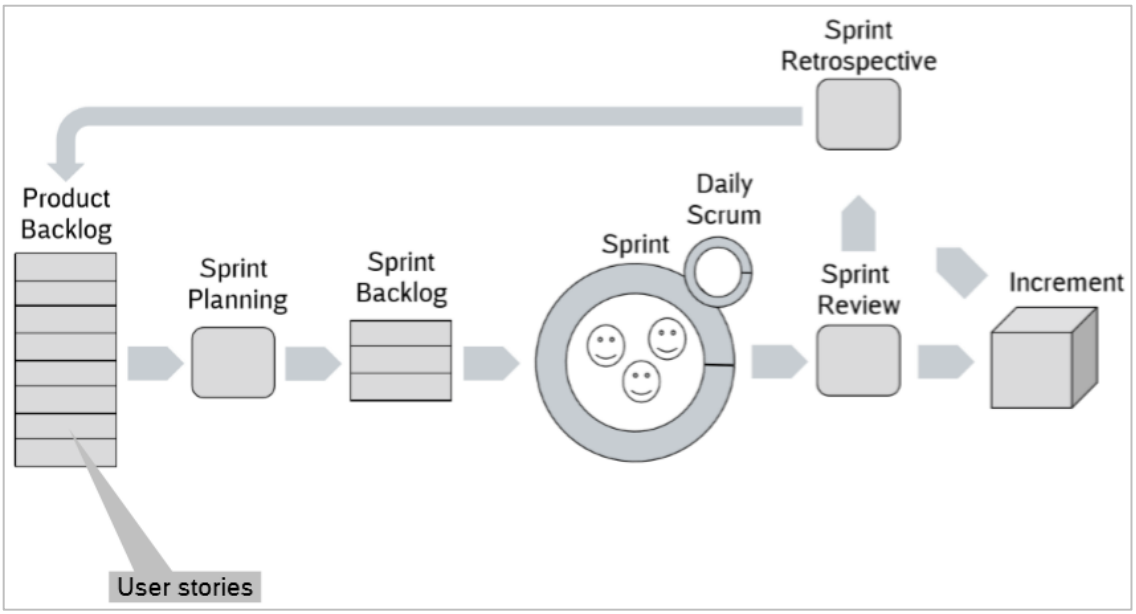


Figure 18 – Agile framework (Source: DEUTSCHE BAHN AG, 2019)

Is there different agile frameworks, the one showed above, suggest use the scrum master, and can be adapted to companies reality. Very important is the increment step, after the sprint review, which makes every cycle with better releases and sprints, adding more value for the clients.

2.1.2 Change Management: HCMBOK to Agile

According to HCMBOK to Agile 2019, the Cynefin framework classifies problems into five contexts defined by the nature of the casual relationship. For of the contexts; clear, complicated, complex and chaotic, requires leaders to diagnose situations and then act with the appropriate responses for the context. The fifth context, disorder, applies when there is no clarity as to which of the other four contexts is predominant.

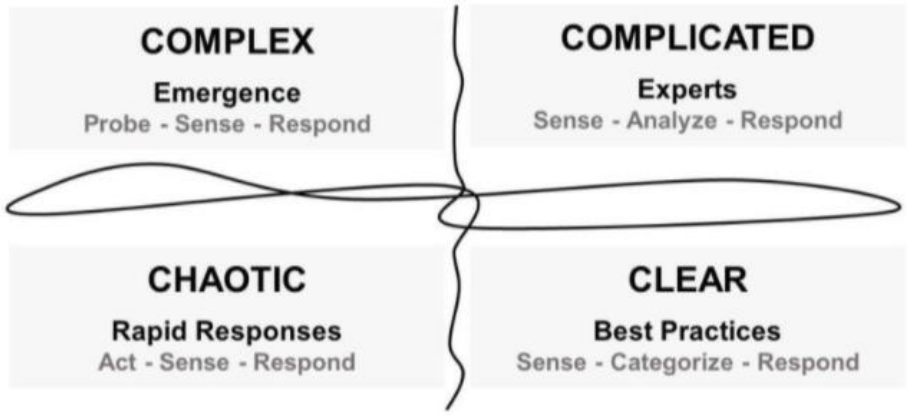


Figure 19 – Cynefin framework for decisions making (Source: HCMBOK to Agile, 2019)

While a complicated context present at least one right answer, in the complex context, this cause and effect relationship cannot be established. In this domain, the understanding necessary to solve a problem does not come from the past, but from the future.

While the previous domains establish rules and standards to make the environment fail-safe, here the role of the leader or manager will be to create a safe environment to fail. An environment for experimentation and the search for an emerging pattern, which will arise from the connection between the people involved in the search for the answer. This is the domain in which the correct sequence for solving a problem is: Prove, Feel and respond.

Considering the complex context in this case is not only technical, since is not possible to predict what the feasibility study will point out, the current SLA is not clearly defined and the processes in some cases are not documented, but also in relation to the human response as the change touches on issues like status, power and ego.

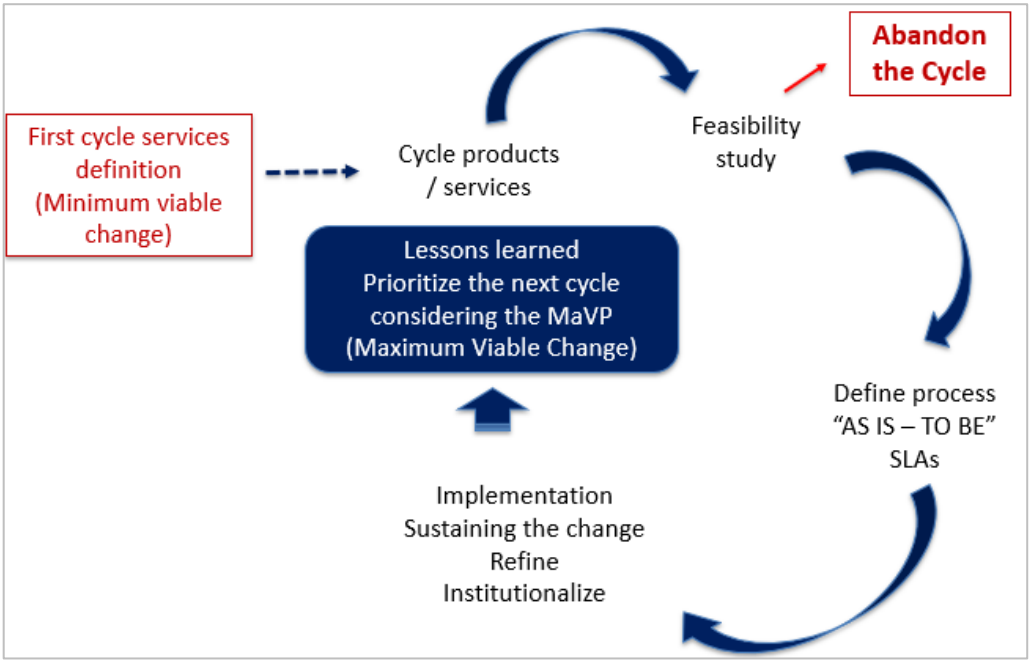


Figure 20 – Cycles definitions (Source: Internal data)

The strategic change management defined to this first cycle is to reconcile business needs with Minimum Viable Change - MVC and define what goes into this release and sprint.

Searching for this minimum viable change, following the Agile principles, was done through empathy and a participatory process involving different areas of the two companies.

It is suggested to develop the project in three stages as shown below:

Sensitize: Develop the Leadership Alignment and Mobilization Workshop in two stages:

1. Management team and board to align the leaders who will form the project management committee;
2. Team of coordinators to mobilize other leaders in a participatory manner.

Plan: Develop the Change Managemente Strategic Plan

Support during the Implementation and Sustainability stages of changes: Support in person and remotely, on a regular basis and / or on demand, the leaders who will drive the changes.

According to HCMBOK, a Change Management Strategic Plan should be composed by the following topics:

- Preliminary diagnosis;
- Purpose and Objective of the Program;
- Stakeholder mapping and classification;
- Definition of the organizational structure of the project - Committees, Council, Project management etc.;
- Elements of the organizational culture that can be used to boost stakeholder engagement or that must be adjusted or eliminated to reduce antagonisms;
- Antagonism factors that need to be reversed or isolated;
- Engagement factors that can influence stakeholders;
- Communication planning;
- Support model for the post-implantation stage (sustaining changes);
- Goals and metrics for evaluating the project after its completion (sustaining stage);
- Action plan (tactical and operational) integrated with the project plan;
- Considering that the project was redirected to development with Agile / Adaptive methodology, the action plan is described in the specific part where we deal with the methodology and its artifacts (Prioritization Matrix);
- Risks and mitigation actions in relation to issues related to the human factor;
- Planning the Leadership Alignment and Mobilization Workshop.

2.1.3 Economic and financial feasibility

According to CECCONELLO (2008), the economic and financial feasibility analysis of a project takes place by comparing investments with active operating profits, and consequently generating cash for the business. The result of this analysis can be positive or negative and guided by predefined parameters that contemplate the maximum acceptable return period for the necessary investment, the minimum expected rate of return and if the return value is greater than zero.

ROCHA (2009) points out that the feasibility study consists of establishing several scenarios in order to identify which option is the most advantageous for shareholders. Therefore, we seek to find a solution that will generate greater revenues, in the shortest possible time and with reduced costs, always taking into account realistic sales and cost estimates.

BERNARDI (2011) states that the economic viability of a project is usually calculated through the return speed (Payback), internal rate of return (IRR) and net present value (NPV). There is a need to quote the attractiveness rate, which defines what the investor intends to return with the project, and is used to discount the project's cash flow. According to GITMAN (2010), these indicators can be defined as follows:

Payback: represents the time required for a company to recover the initial investment in the project from the cash inflows provided by it. The decision criteria is based on the definition of the maximum acceptable payback period. If the calculated payback period is shorter than the estimated one the project is accepted, otherwise it is rejected.

Net Present Value (NPV): it is found by subtracting the initial investment of the project from the sum of the present value of cash inflows, discounting from these the rate of capital cost (discount rate), or even the minimum rate of attractiveness of the venture required by the partners. The cost of capital rate is the minimum return that the project must provide in order to keep the company's value in the market unchanged. If the NPV is equal to zero or positive, the project is accepted, otherwise, it is rejected.

Internal Rate of Return (IRR): it consists in finding the discount rate that makes NPV zero (when the value of cash inflows equals the amount invested). In other words, it is the annual rate of return obtained if a company invests the capital in the project. If the discount rate is higher than the cost of capital, or the minimum attractiveness rate defined by the company, the project is accepted, otherwise, it is rejected.

Break Even Point (BEP): is the sales level, in physical units or in monetary value, at which the company operates without profit or loss. Break-even analysis or cost-volume-profit analysis is used to determine the level of operations required to cover all operating costs and assess the profitability associated with different levels of sales. The BEP (quantity) is calculated by dividing the Fixed Monthly Costs and Expenses by the Unit Contribution Margin (Selling Price minus Variable Costs and Expenses). The Financial Break-even point ($) is calculated by dividing the Fixed Monthly Costs and Expenses by the % Contribution Margin.

2.2 Theoretical Background

This section proposes a deeper dive on the main theoretical background of this Educational Project, understanding the main aspects of Sharing Economy and how it could be applied to Rail Transit.

2.2.1 Definition of Sharing Economy

Society is undergoing many transformations, as it faces environmental problems, economic crises and excessive consumption. At the same time, social networks and the internet are booming. In this context, the Sharing Economy arises as a fast growing social and economic system, based on the sharing of human, physical or intellectual resources.

Sharing economy is an economic model that is commonly defined as a peer-to-peer (P2P) based activity of acquiring, providing, or sharing access to assets and services, often facilitated by a community-based on-line platform (YARAGHI & RAVI, 2017). The most famous companies of this kind are Uber, Airbnb, 99/Didi Chuxing, BlaBlaCar, Couchsurfing, Moobie, Yellow/Grin, Rappi, Ifood, among others.

Sharing economy companies are spreading throughout a growing number of sectors, upturning whole industries within the space of a few years and significantly disrupting traditional businesses. According to PwC (2015), the power and importance of the sharing economy is well illustrated by the fact that between 2000 and 2015 more than 200 startups following a sharing-based model received investment totaling 11.5 billion dollars

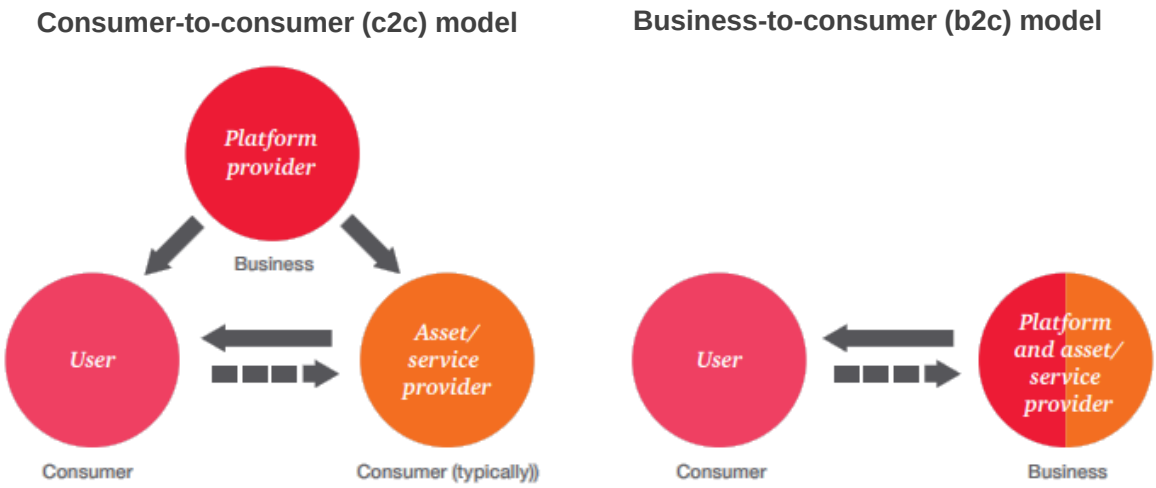


Figure 21 – Traditional arranges of sharing economy business models, with provision of services shown in solid arrows and flow of money in dashed arrows (Source: PWC, 2015)

The main traditional arranges of sharing economy business model can be distinguished in terms of the parties participating in the exchange or transaction. Thus, the most common are between consumers (c2c), in which demand and supply side interact with each other with the intermediation of a third company; and

between business and consumers (b2c), in which the company is both platform and asset/service provider at the same time.

Much less developed is the concept of b2b sharing economy, even though it has been laying around for years. Instead of consumers trading goods and services, the b2b sharing economy is when businesses share services and assets among each other, unlocking the value pent up in underutilized assets.

According to Dan Slagen, former chief marketing officer for *Alignable*, "Sharing resources streamlines companies, enabling them to operate faster with less red tape, as well as allowing them to react quickly to market changes in a less expensive and more efficient manner. Additionally, companies only have to pay for what they need, which facilitates greater efficiency and drives a higher bottom line" (BROOKS, 2017).

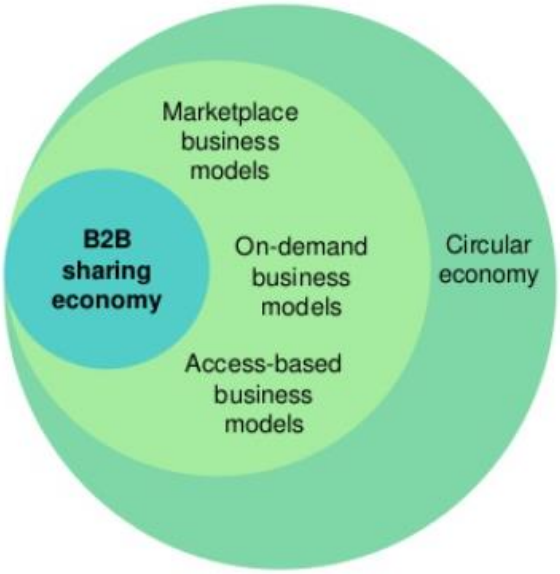


Figure 22 – Business model linkages for b2b Sharing Economy (Source: DEMARY, 2015)

While initially b2b sharing focused on services similar to those offered by b2c companies, with companies like WeWork and a business version of Uber itself, now it encompasses a wider range of services, such as:

- Phone systems;
- Office space;
- Software;
- Data storage;
- Loans;
- Payroll;
- Hiring;
- Website hosting;
- Etc.

In general, the use of the sharing economy is generally a rational economic decision from two perspectives: on one side, users that do not have to invest in expensive

assets; on the other side, providers of the service can use their idle assets to earn extra income.

Indeed, PwC (2015) states that one of the main reasons for the success of the sharing economy companies is the considerable cost advantage resulting from their economies of scale. In other worlds, it means that global players entering the local market have a lower fixed cost ratio for their services than local participants.

According to JAHROMI & ZHANG (2019), sharing has its own benefits, which acts as an incentive for both resource suppliers and consumers in the sharing economy. However, the sharing process has its own costs that may be considered as a deterrent for sharing economy participants.

2.2.2 Critical Review

In most cases legislature is still unready for sharing economy companies, which usually have a complex operating model, raising many regulatory problems. In terms of taxation and employment, for example, the sector is in a grey zone, in a way that these is no perfect solution for their regulation.

If on one hand the regime that applies to traditional players is automatically inapplicable to sharing economy companies in most cases, on the other total bans do not appear to be sensible, as in many situation companies managed to circumvent these with legal loopholes (PWC, 2015).

Nonetheless, sharing economy could vastly benefit the economy if given the appropriate regulation, different from the existing ones. After all, an unregulated environment is often the main competitive advantage of these companies; therefore traditional regulation could endanger their business model.

Another aspect that should be considered is that if the potentially shared hard asset is industry-specific. In these cases, b2b sharing could be more difficult, making it difficult to intervene in well-established processes with a sharing concept, especially in larger companies. In these cases, legal gaps are also a critical factor, such as insurance problems (ESCHBERGER, 2020).

Finally, one should consider that from a governance standpoint, some companies could have reservations about sharing with direct competitors. In addition, excess capacity is usually viewed critically, being interpreted as a sign of a company's poor economic situation instead of a sharing opportunity of this idle capacity.

2.2.3 Scope and Limitations

As it is an innovative scope, and therefore of complex nature, Agile Methodology has been chosen to guide the process of implementing a b2b sharing economy partnership related to the exchange of services between MetrôRio and SuperVia.

Thus, for this work, the scope is limited to initial run of the first agile cycle, which consists on signing a swap contract by both parties. This contract should deal the provision of Geometry Inspection service by SuperVia in Maria da Graça yards,

Maintenance Center and MetroRio lines 1, 2 and 4, as a counterpart to the machining of 160 railway wheels (40 bogies).

Due to the aforementioned regulatory/tax issues, the idea for this pilot business model is to propose a direct tradeoff between both companies, without any cash flow involved initially, as it will be detailed on Chapter 3.

2.2.4 Literature Review

According to PETRINI, FREITAS & SILVEIRA (2017), the boundaries between collaborative consumption and shared economy in academic literature are broad and unclear, as much of what is described as sharing economy is not, in fact, sharing, as it usually involves ownership transfer or monetary compensation.

These kind of relationships is what is called collaborative consumption, which the authors say that can be understood as a "slice" of the sharing economy that consists in the set of services that allows private and commercial owners of specific resources to make them available to others.

Based on that, PETRINI et al identified 11 major characteristics of sharing economy/collaborative consumption, after performing an extensive literature review on the subject, as shown on the table below.

Table 3 – Main characteristics of sharing economy and collaborative consumption found in literature, with the inclusion of the b2b market structure (Source: Adapted from PETRINI, FREITAS e SILVEIRA, 2017)

Characteristics	Occurrence	Reference
Platform Type	Interfering	Botsman and Rogers, 2010; Hamari et al., 2015
	Intermediary	
Sharing Model	Access	Belk, 2010; Botsman and Rogers, 2010; Bardhi and Eckhardt, 2012
	Transfer	
Sharing Type	Renting	Belk, 2010; Botsman and Rogers, 2010; Corciolani and Dalli, 2014; Hamari et al., 2015
	Lending	
	Swapping	
	Donating	
	Gifting	
	Purchasing used goods	
Market Structure	Peer-to-peer (P2P)	Schor, 2014
	Business-to-peer (B2P)	
	Business-to-business (B2B)	-
Sharing Nature	Experimental	Bardhi and Eckhardt, 2012
	Functional	

Characteristics	Occurrence	Reference
Financial Transaction	Present	Bardhi and Eckhardt, 2012; Schor, 2014; Hamari et al., 2015
	Absent	
Sharing Duration	Short Term	Bardhi and Eckhardt, 2012
	Long Term	
Consumer Anonimity	Possible	Bardhi and Eckhardt, 2012
	Impossible	
Consumer Involvement	Low	Bardhi and Eckhardt, 2012
	High	
Political Influence	Low	Bardhi and Eckhardt, 2012; Laamanen, Wahlen, Campana, 2015
	High	
Collective Innovation	Oriented	Kozinets, Hemetsberger and Schau, 2008
	Concentrated	

The proposed arrangement between MetrôRio and SuperVia would fit as follows, according to the literature review:

- Platform type: Interfering, since both parties will handle all the financial/legal aspects of the transaction;
- Sharing model: Access (without any transfer);
- Sharing type: Lending (of services);
- Market structure: b2b;
- Sharing nature: Functional, as there will be a direct experience with the services;
- Financial transaction: Absent;
- Sharing duration: Short term, considering the full life-cycle of a railway;
- Consumer anonymity: Impossible;
- Consumer involvement: High;
- Political influence: N/A
- Collected Innovation: Oriented.

CHAPTER 3. BUSINESS PLAN DEVELOPMENT

This chapter aims to develop a brief business plan sketch for the scope defined on Item 2.2.3, regarding the proposal of a b2b sharing arrangement between MetrôRio and SuperVia companies.

3.1 Cost Benefit Analysis

Cost–benefit analysis (CBA) is a systematic approach to estimate the strengths and weaknesses of alternatives. It is usually used to determine the options that provide the best approach to achieving benefits while preserving savings. According to MISHAN (1976), the use of cost-benefit analysis is justified because it provides a means for examining the overall impacts on the operating environment caused by a single actor.

An important tool that might be used to develop a simple CBA is the the SWOT Analysis Matrix, which is consolidated from the identification of the strengths and weaknesses related to the internal environment of companies, and the analysis of opportunities and threats related to the external environment where they are located (BIAGIO e BATOCCHIO, 2012).

A SWOT analysis of the services exchange was designed, as shown on Table 4, to describe how the proposed business model is relevant to the market and to companies in general.

Table 4 – SWOT analysis of the services exchange business plan between MetrôRio and Supervia (Source: Authors)

Internal Environment	**Forces** • Cash flow savings • Technical knowledge • Existing infrastructure • Service quality • Vicinity between both companies • Cost reduction • Economy of scale • Investments in adequacy rather than in acquisition	**Weaknesses** • Reinvestment of 25% of the considered revenue (MetrôRio) • Priorities planning and scheduling • Companies involved in high tax rates
External Environment	**Opportunities** • Specialization of each company • Division of tasks • Maximizing the use of existing infrastructure and know-how	**Threats** • Imposition of governmental tax rule for services exchange • Risk of discontinuity of payroll tax exemption, changing from 2% on revenues to 20% of the entire payroll • Unavailability of assets in the event of an accident

3.2 Risk Analysis

Risk identification is defined by MITRE (2007) as being the process of determining risks that could potentially prevent the program, enterprise, or investment from achieving its objectives. According to the SWOT analysis previously presented, the proposed business plan involves three major risks, which can be weighted as follows:

Table 5 – Risk Assessment for services exchange business plan between MetrôRio and Supervia (Source: Authors)

Risks	Impact	Probability
Imposition of governmental tax rule for services exchange	**2**	**2**
Discontinuity of payroll tax exemption	**1**	**3**
Unavailability of assets in the event of an accident	**3**	**1**

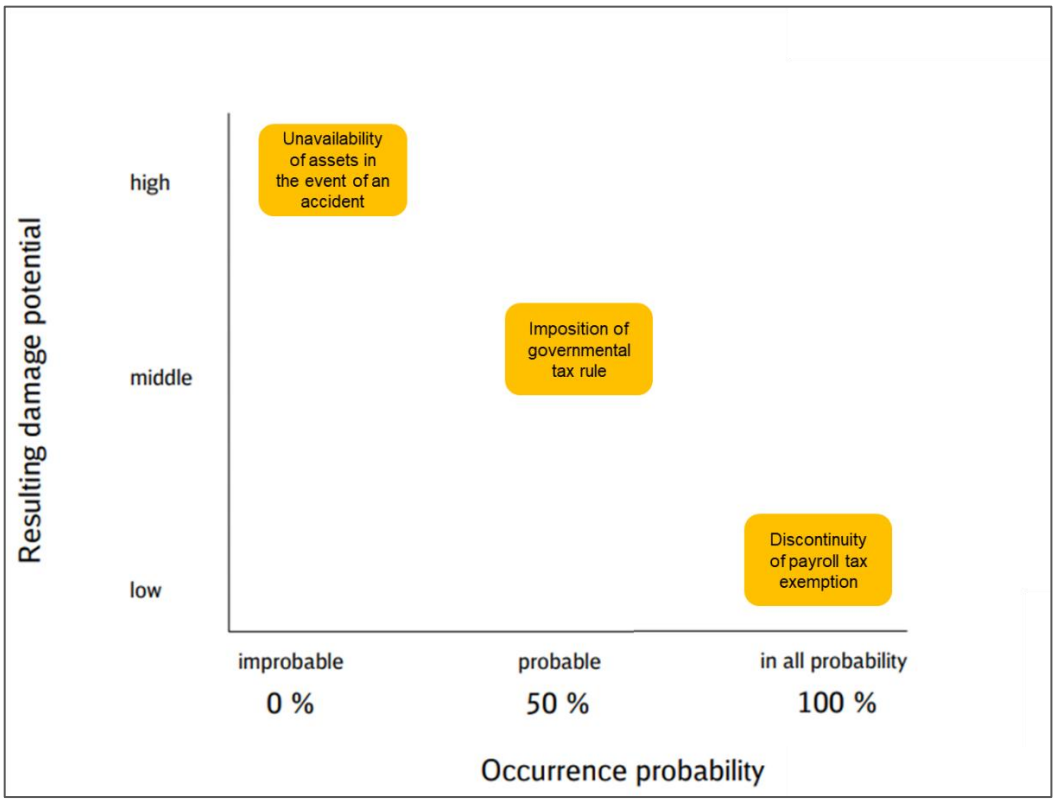


Figure 23 – Impact x Probability Matrix (Source: Authors)

3.3 Project Plan / Implementation Plan

According to DORNELAS (2011), the Business Plan is a document used to plan an enterprise or business unit, with the objective of defining the strategy for future action and testing the viability of an idea. According to him, “when the development of the business plan starts with an analysis of the opportunity, the process becomes clearer for the entrepreneur, since in many cases the business plan will be used to analyze the viability of an idea. Understanding the difference between idea and opportunity is crucial for the business plan to become, in fact, a useful document for the entrepreneur."

A prior stage to the full deployment of a Business Plan is to develop a Business Model Canvas. According to OSTERWALDER (2014), a Business Model Canvas is a tool used to clarify the understanding of the customer's profile and identify the benefits that can be created in products and services to attract them, according to their profile. Through this tool, the value map and the customer profile are generated.

Table 6 – Business Model Canvas (Source: Authors)

<table>
<tr>
<td rowspan="2">Key Partners
• MetrôRio
• Supervia
• Other rail operators</td>
<td>Key Activities
• Inspection vehicle passing
• Results interpretation
• Issuance of technical reports
• Wheel reprofiling
• Diameter equalization between wheelsets
• Issuance of technical reports</td>
<td rowspan="2">Value Propositions
• Easy logistics
• Lower financial disbursement
• Qualified teams
• Modern equipment with the latest technology</td>
<td>Customer Relationships
• Commercial departments
• Legal departments
• Directly between maintenance departments</td>
<td rowspan="2">Customer Segments
• MetrôRio
• Supervia
• Other rail operators</td>
</tr>
<tr>
<td>Key Resources
• Skilled workforce
• Wheel lathes
• Inspection vehicle
• Equipment transportation</td>
<td>Channels
• Technical visits
• Maintenance teams</td>
</tr>
<tr>
<td colspan="3">Cost Structure
• Investments
o Equipment setup
• Direct Costs
o Fixed
Man-hour cost
Annual equipment overhaul
o Variable
Electricity
Diesel
Corrective Maintenance
• Indirect Costs
o Central administration
o Financial costs
o Taxes</td>
<td colspan="2">Revenue Streams
• Services exchange
• Credit generation
• Cash reduction</td>
</tr>
</table>

Considering the generated business model canvas for the b2b sharing economy proposal, below follows the proposed Implementation Plan, considering the scopes for the services to be executed by MetrôRio and Supervia.

3.3.1 SuperVia Service Implementation Plan

SuperVia Trens Urbanos proposed services scope consists in providing laser inspection services for permanent track superstructure using instrumented equipment, such as Inspection Vehicle, for the detection of track geometry defects, according to the standardized safety parameters for correcting and maintaining the MetrôRio tracks.

Through a team specialized in carrying out railroad inspections on track geometry at the Permanent Track Department, SuperVia will be responsible for the delivery and presentation of four reports, which are track geometry report, exception (defects) report, curve reports and rail profiles reports.

Defect parameterization will be carried out as follows:

1) Values of vertical and horizontal wear of rails with angles of 45 ° and 90 ° degrees with provision of reports in pdf format as well as generation of the respective wear graphs;
2) Face angle values in the wheel/rail contact, more specifically, in the gauge line;
3) Issue of reports and parameterization of defects;
4) Left and right rail alignment values;
5) Longitudinal and transverse leveling values of the left and right rails;
6) Track bend values;
7) Track torsion values;
8) Superelevation values at curves;
9) Static track gauge values;
10) Track axis values;
11) Software and training for reporting and defect parameterization;
12) Final inspection report in .pdf or .xls format.

After the execution of the first inspection along the MetrôRio tracks and the delivery of assessment reports on the conditions of the track geometry, Supervia, based on them, will provide training for technicians regarding the interpretation of results, with total 4 hours / classes needed to complement this event.

3.3.1.1 Equipment

Inspections and measurements of the track geometry will be performed using an Inpection Car with ENSCO Rail onboard technology, as follows:

Figure 24 – EM-80 Inspection Vehicle (Source: Internal data)

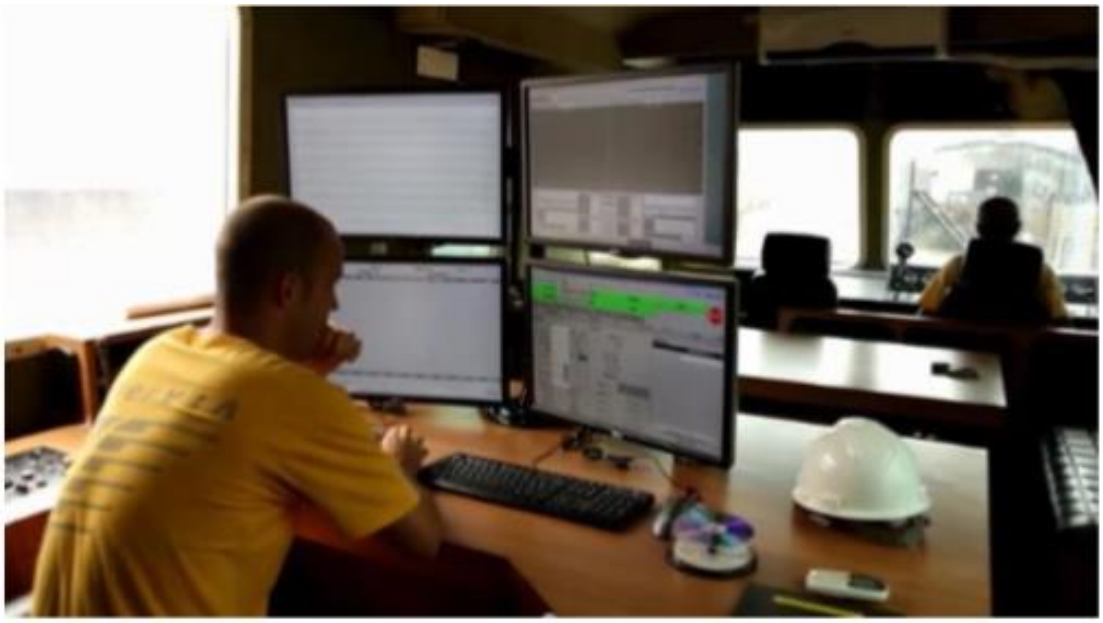


Figure 25 – ENSCO Rail onboard technology (Source: Internal data)

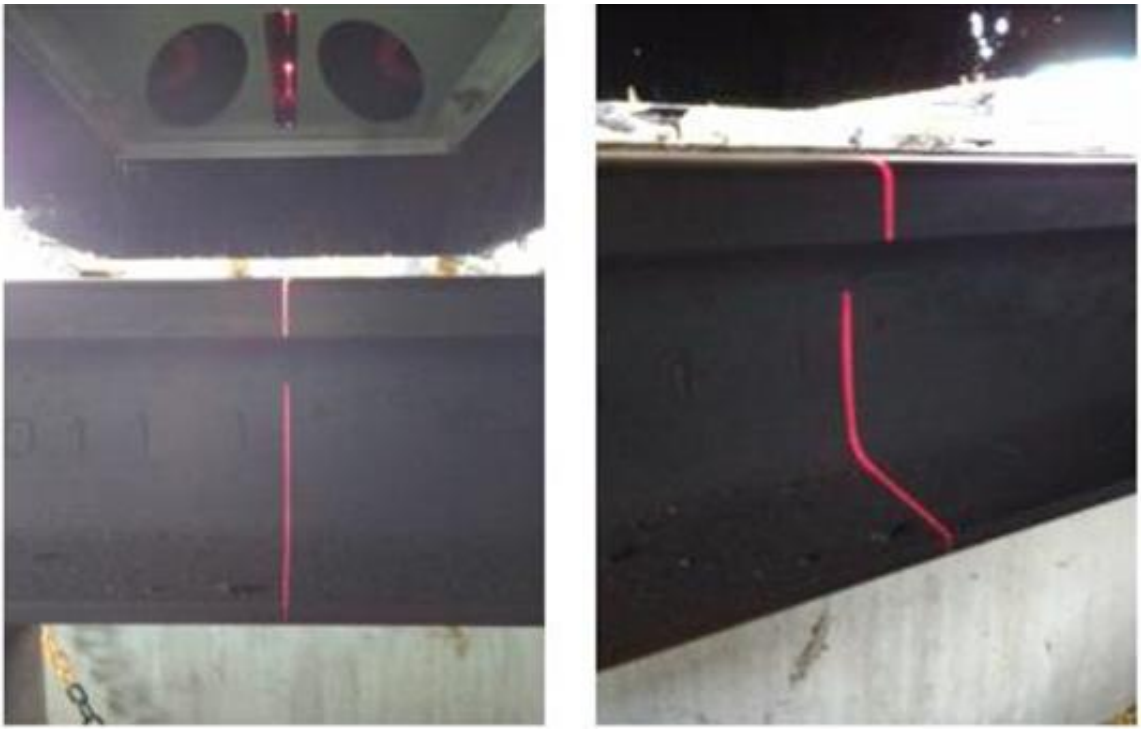


Figure 26 – Track profile measurement with Laser-type optical sensors (Source: Internal data)

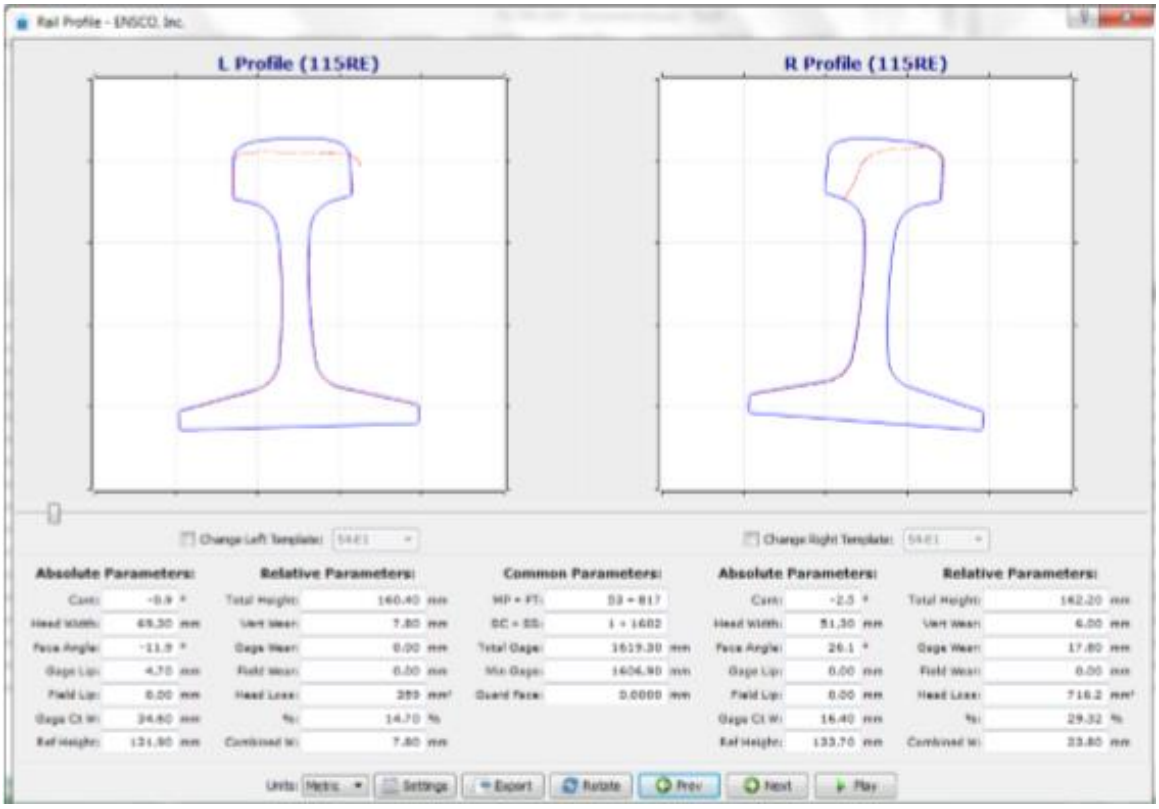


Figure 27 – Reports with horizontal / vertical wear and face angle (Source: Internal data)

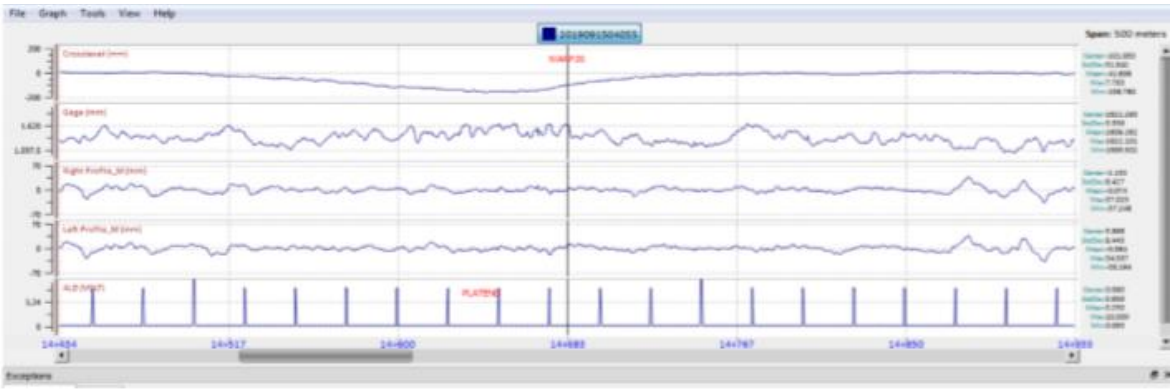


Figure 28 – Graphical reports with track geometry (Source: Internal data)

Exception | Curve

Source	KM	M	Item	Value	Length	Class Test	Class Met	Severity	Track	Latitude	Longitude
TGMS	13	460	Twist 10	38.4	133	3	1	Urgent	1	-22.831790	-43.290244
TGMS	13	662	Platform Start			3			1	-22.831051	-43.292137
TGMS	13	881	Platform End			3			1	-22.829565	-43.293628
TGMS	14	960	Up Kilometer	14		3			1	-22.828870	-43.293923
TGMS	14	346	Signal			3			1	-22.825894	-43.295189
TGMS	14	428	Platform Start			3			1	-22.825185	-43.295486
TGMS	14	642	Platform End			3			1	-22.823330	-43.296313
TGMS	14	684	Warp 20	51.8	14	3	1	Urgent	1	-22.823000	-43.296529
TGMS	15	967	Up Kilometer	15		3			1	-22.820861	-43.298245
TGMS	15	448	Platform Start			3			1	-22.817318	-43.300687
TGMS	15	678	Platform End			3			1	-22.815175	-43.300928
TGMS	15	851	Signal			3			1	-22.813587	-43.301048

Figure 29 – Reports with track geometry parameters (Source: Internal data)

Table 7 – Reports with kilometer identification, line characteristics and date of inspection (Source: Internal data)

Maracana - L 1 to Saracuruna - L C

KM	M	Parameter	Value	Length	Speed	TSC	LC	PC	Track	Peak Lat/Long	
13	460	Twist 10	38.39	133	45	E	1	3	1	-22.831790	-43.290244
13	662	Platform Start			44	B		3	1	-22.831051	-43.292137
13	881	Platform End			42	C		3	1	-22.829565	-43.293628
14	960	Up Kilometer	14.00		42	T		3	1	-22.828870	-43.293923
14	346	Signal			26	T		3	1	-22.825894	-43.295189
14	428	Platform Start			29	T		3	1	-22.825185	-43.295486
14	642	Platform End			38	B		3	1	-22.823330	-43.296313

Table 8 – Parameters recommended by the FRA for maintaining the track according to the maximum allowed speed, used as a reference for inspections with the Control Car (Source: Internal data)

PARÂMETROS DE MANUTENÇÃO - FRA					
Classe da Via (mm)	Classe 1	Classe 2	Classe 3	Classe 4	Classe 5
Velocidade	Até 24 km/h	Até 48 km/h	Até 97 km/h	Até 129 km/h	Até 145 km/h
Variação de Flecha para corda de 20 m	127	76	44	36	16
Variação de Alinhamento tangente para corda 20 m	128	76	44	36	19
Variação Nivelamento Longitudinal Tangente corda 20 m	76	70	57	51	32
Superelevação máxima Espiral curva corda 10 m	89	76	51	38	25
Variação Nivelam. Transversal Tangente e Curva entre 20 m (warp - empeno)	76	51	44	32	25
Variação Nivelam. Transversal na Espiral de curva entre 10 m (twist - torção)	44	38	32	25	19
Abertura Máxia de Bitola Estática (sem carga)	1632	1632	1632	1625	1613
Fechamento Máximo de Bitola	1587	1587	1587	1587	1587
Variação Rápida de Bitola em 5 m (estática)	34	31	23	18	13

3.3.1.2 Involved Personnel

Supervia is responsible for providing qualified labor, composed of specialists and technicians properly trained to perform the contracted services, and must present their employees for work on a daily basis, duly uniformed and carrying all the PPEs / CPEs inherent to their activities.

Supervia will appoint the chief technician for the service, registered with CREA, with the presentation of the corresponding ART (Technical Responsibility Term).

Supervia will present at the beginning of the inspections the valid Calibration Certificate of the equipment accredited (accredited) by INMETRO with proper traceability at RBC (Brazilian Calibration Network).

Following is a technical chart with the professionals responsible for the inspection of the track geometry with the EM-80 Control Car:

- 2 Civil Engineers
- 1 Surveyor Engineer
- 1 Production Engineer
- 1 Maintenance Technician
- 1 Maintenance Officer

3.3.1.3 Service Scheduling

First inspection cycle, to be carried out in 2020, will include all of MetrôRio tracks, comprising Line 1 (34,224 meters), Line 2 (49,236 meters) and Line 4 (26,572 meters), totaling 110,032 meters, including the yards for the parking of trains and maintenance yards (approximately 20,000 meters). The second inspection cycle, on the other hand, will only cover Line 2 (49,236 meters).

Table 9 – Physical schedule including a period of 12 months for carrying out the inspection cycles (Source: Internal data)

CRONOGRAMA FÍSICO DE INSPEÇÃO DO CARRO CONTROLE NO METRÔ RIO											
	2020			2021							
	Out	Nov	Dez	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago
LINHA 1											
LINHA 2											
LINHA 4											
PÁTIOS											

Track services will be scheduled between 00:40 am and 03:30 am, from Monday to Friday, and from 12:40 am to 5:00 am on Sunday or holidays. Preceding this schedule, the vehicle will be ready and prepared for the start of work.

These times includes the transfer from the base to the section where the service is performed, as well as the return to the vehicle's parking place, at the end of the daily workday.

3.3.2 MetrôRio Service Implementation Plan

MetrôRio proposed services scope consists in performing the machining of 160 railway wheels (40 bogies) for SuperVia trains. After receiving the bogies, a dimensional assessment of each wheel will be performed and recorded in a technical report, including the general receiving conditions.

In the inspection, the diameter and the types of existing faults will be evaluated, as well as if there are allowances in each wheel. If any bogie does not present the ideal conditions for carrying out the machining service, it will be informed to SuperVia.

After an evaluation has been carried out and approved, the bogie will be sent to one of the wheel lathes existing at the MetrôRio plant, for machining the wheels. MetrôRio will execute the machining service obeying and complying with the requirements established by the AAR Section G standards, parameters, drawings and SuperVia recommendations.

After the machining is completed, a new inspection will be carried out on the wheels, which will be registered in the final technical report, containing the wheel diameter, tag and final condition of the equipment. After the delivery of the technical report, it will be submitted for evaluation and approval of the service to SuperVia.

MetrôRio is responsible for strictly following dimensional dimensions when executing the machining service, as shown below:

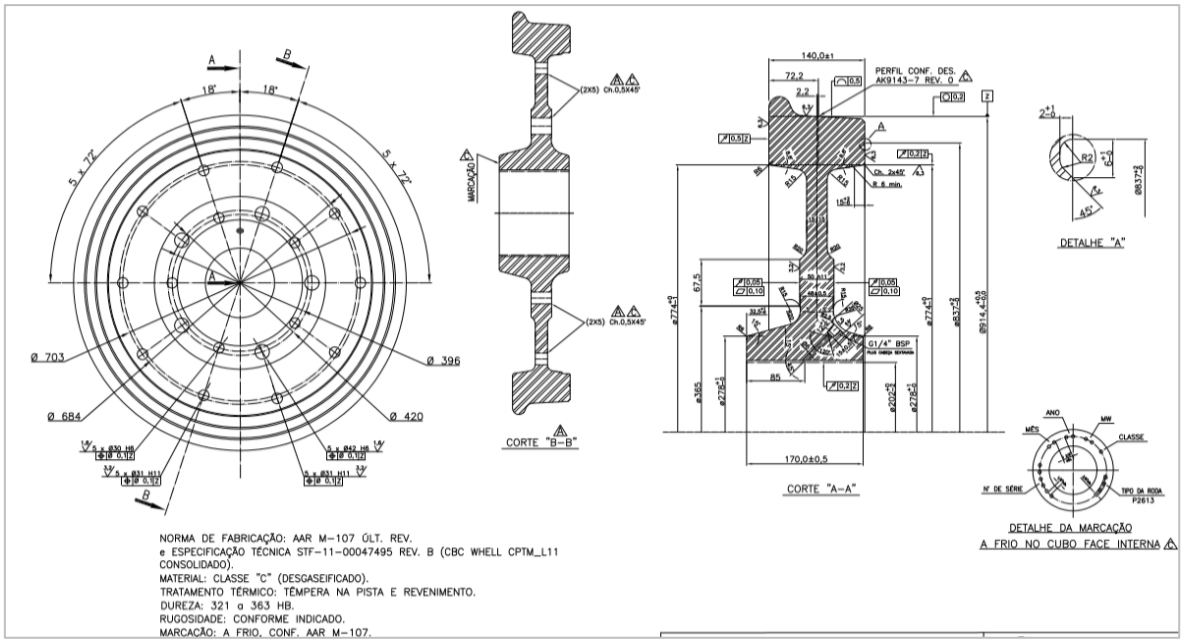


Figure 30 – Drawing Nº EP – 2613 REV. C (Source: Internal data)

3.3.2.1 Equipment

- Profilometer;
- Bandage gauge;
- Wheel diameter measurement instrument
- Wheel lathe;
- Overhead crane;
- Industrial vacuum cleaner.

All equipment for the machining process and quality check of the wheels are in accordance with the equipment specifications, technical requirements of MetrôRio and applicable international standards.

3.3.2.2 Involved Personnel

MetrôRio will supply specialized workforce, according to the qualifications required for the wheel machining activity, aiming at the perfect repair of the supplied equipment, fully complying with the defined deadlines.

- 1 Mechanical Engineer
- 1 Workshop Supervisor
- 2 Maintenance Technicians

The service will be performed at the MetrôRio Maintenance Center, following a pre-defined work plan, aiming to achieve a quality standard according to the client's standards and requirements.

The MetrôRio Maintenance Planning and Control department will schedule the execution of the activity according to the customer's demand and make it compatible with internal demand.

The execution team will monitor the receipt and delivery of the bogies, according to the schedule. After the completion of the activities and the dimensional inspection performed, availability will be informed to schedule the removal of the bogie.

3.3.2.3 Service scheduling

According to the SuperVia schedule, the machining of the bogies will occur per unit or per batch of bogies, with the exception of previously agreed exceptions. If any non-conformity is found in the bogies, it will be necessary to replace the bogie or to grant authorization for the service to be performed.

Table 10 – Machining wheel schedule (Source: Internal data)

Cronograma base - Usinagem de rodas (dias úteis)

Dia 1	Dia 2	Dia 3	Dia 4	Dia 5	Dia 5	Qtde. Semanal
Entrega	4	4	4	4	Reserva	16 rodas (4 truques)

If MetrôRio finds any impediment to the execution of the machining process, SuperVia will be informed immediately together with the reason for the non-execution, which may cause the equipment not to be delivered within the originally agreed term, and may be extended up to 120 days to finalize the service.

The service should take place without impact on MetrôRio's schedules, being carried out from Monday to Friday, from 6:00 am to 11:00 am.

The entrance and collection of bogies in the workshop must be scheduled 48 hours in advance with the MetrôRio Maintenance Planning and Control area.

Road transportation of the bogies shall happen between 6:00 am and 4:00 pm from Monday to Friday.

3.4 Financial Plan

Financial plan calculation considered the same services taxes for the tradeoff, since invoices will be emitted from both companies following the general premises at the table below.

Table 11 – General premises (Source: Internal data)

Charges and Taxes

Taxes	Ano 0	Ano 1	Ano 2	Ano 3	Ano 4	Ano 5
IPCA (IBGE)	3,59%	3,75%	3,50%	4,25%	4,25%	4,25%
MARR	11,19%					
Services city taxes (ISS)	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%
State city taxes (ICMS)	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Federal payroll receipt taxes (CPRB)	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%
Federal Services taxes (PIS e Cofins)	9,25%	9,25%	9,25%	9,25%	9,25%	9,25%
Profit taxes IRPJ / CSLL	34,00%	34,00%	34,00%	34,00%	34,00%	34,00%

Financial analysis was done separately for each company, considering six years of planning results.

MetrôRio cumulative cash flow is positive already in the first year, R$63.019,93, as can be seen at table and graphic in the sequence:

Table 12 – MetrôRio Cash Flow calculations (Source: Internal data)

Cash Flow MetrôRio

Entries / Exits	Begining Investment	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Anual Revenue	R$ -	R$ 323.000,00	R$ 335.112,50	R$ 346.841,44	R$ 361.582,20	R$ 376.949,44	R$ 392.969,79
Fixed Costs	R$ -	-R$ 20.505,85	-R$ 21.274,82	-R$ 22.019,44	-R$ 22.955,26	-R$ 23.930,86	-R$ 24.947,92
Variable Costs	R$ -	-R$ 198.024,22	-R$ 205.450,13	-R$ 212.640,88	-R$ 221.678,12	-R$ 231.099,44	-R$ 240.921,17
Investment	-R$ 42.450,00	R$ -	R$ -	R$ -	R$ -	R$ -	R$ -
Net Profit	**-R$ 42.450,00**	**R$ 104.469,93**	**R$ 108.387,55**	**R$ 112.181,12**	**R$ 116.948,82**	**R$ 121.919,14**	**R$ 127.100,70**
Accumulated cash flow	-R$ 42.450,00	R$ 62.019,93	R$ 170.407,49	R$ 282.588,61	R$ 399.537,42	R$ 521.456,56	R$ 648.557,27

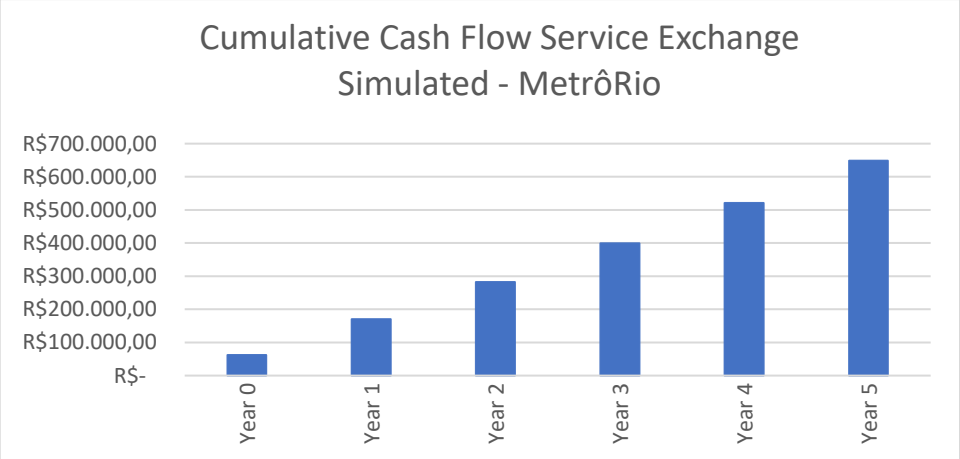


Figure 31 – Cumulative cash flow graph for MetrôRio (Source: Internal data)

Table 13 – Main financial results for MetrôRio (Source: Internal data)

Machining Wheels	
MARR	11,19%
NPV	R$ 436.290,79
IRR	249,67%
ACF	R$ 648.557,27
Payback	1 Year

Considering a positive and expressive net present value (NPV), in addition to the internal rate return (IRR) that outperform the minimum acceptable rate of return (MARR) becomes clear that it's a good business.

In the SuperVia case, cumulative cash flow is also positive already in the first year, with a higher amount of R$ 82.419,89, shown below:

Table 14 – SuperVia Cash Flow calculations (Source: Internal data)

Cash Flow SuperVia

Entries / Exits	Begining Investment	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Anual Revenue	R$ -	R$ 323.000,00	R$ 335.112,50	R$ 346.841,44	R$ 361.582,20	R$ 376.949,45	R$ 392.969,80
Fixed Costs	R$ -	-R$ 17.269,71	-R$ 17.917,33	-R$ 18.544,43	-R$ 19.332,57	-R$ 20.154,21	-R$ 21.010,76
Variable Costs	R$ -	-R$ 180.860,40	-R$ 187.642,67	-R$ 194.210,16	-R$ 202.464,09	-R$ 211.068,82	-R$ 220.039,24
Investment	-R$ 42.450,00	R$ -	R$ -	R$ -	R$ -	R$ -	R$ -
Net Profit	**-R$ 42.450,00**	**R$ 124.869,89**	**R$ 129.552,51**	**R$ 134.086,85**	**R$ 139.785,54**	**R$ 145.726,42**	**R$ 151.919,79**
Accumulated cash flow	-R$ 42.450,00	R$ 82.419,89	R$ 211.972,39	R$ 346.059,24	R$ 485.844,78	R$ 631.571,20	R$ 783.490,99

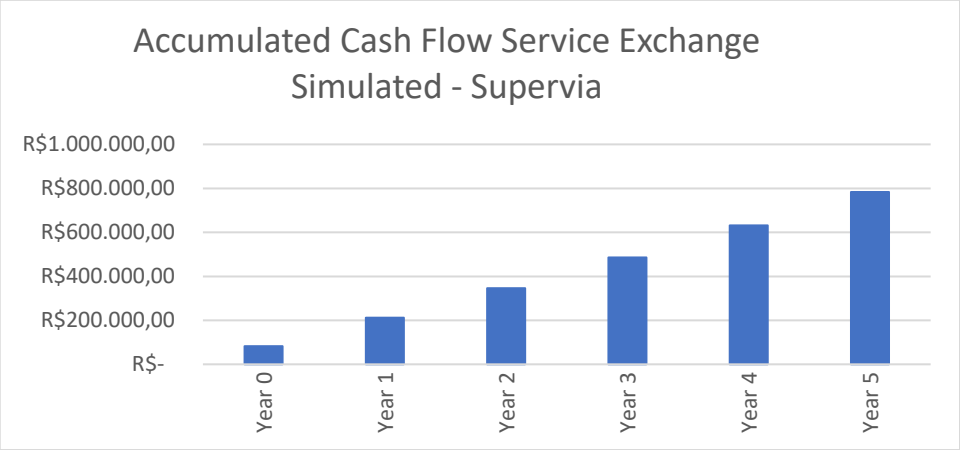


Figure 32 – Cumulative cash flow graph for SuperVia (Source: Internal data)

Table 15 – Main financial results for SuperVia (Source: Internal data)

Inspection Car	
MARR	11,19%
NPV	R$ 529.775,02
IRR	297,80%
ACF	R$ 783.490,99
Payback	1 Year

Also for the SuperVia, the financial indicators represent a great business either, and in the reality with the tradeoff services, less cash from both companies will be expended.

These financial analyses for the first sprint shows that the sharing economy can bring excellent results when implemented in scale.

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ANNEX I – CALCULATION LOG

ANNEX I.I – BUDGET TABLE (METRÔRIO)

invepar

QQP - Quadro de Quantidades e Preços

Objetivo: Serviço de Usinagem de 160 rodas (40 truques) - SUPERVIA

ORÇAMENTO TOTAL	R$ 323.000,00
SUBTOTAL CUSTOS INDIRETOS	R$ 161.699,95
SUBTOTAL CUSTOS DIRETOS	R$ 161.300,05

DESCRIÇÃO CUSTOS DIRETEOS	ORÇAMENTO			
	UNID.	QTDE	PREÇO UNITÁRIO (R$)	PREÇO TOTAL (R$)
RECURSOS HUMANOS:	**TRUQUES**	**40**	-	R$ 14.062,27
Oficial de Manutenção III	*HORAS*	*200,00*	*R$ 33,21*	*R$ 6.642,26*
Tecnico de Manutenção I	*HORAS*	*200,00*	*R$ 37,10*	*R$ 7.420,01*
INSUMOS:	**MÊS**	**2**	-	R$ 13.600,00
EPI / Uniforme	*MÊS*	*2,00*	*R$ 300,00*	*R$ 600,00*
Limpeza	*MÊS*	*2,00*	*R$ 100,00*	*R$ 200,00*
Pastilhas	*UNID.*	*80,00*	*R$ 120,00*	*R$ 9.600,00*
Implementos (cintas)	*UNID.*	*4,00*	*R$ 800,00*	*R$ 3.200,00*
MANUTENÇÃO DE EQUIPAMENTOS:	**TRUQUES**	**40**	-	R$ 48.893,58
Oficial de Manutenção II	*HORAS*	*10,00*	*R$ 31,52*	*R$ 315,21*
Tecnico de Manutenção III	*HORAS*	*10,00*	*R$ 41,41*	*R$ 414,09*
Viagem programação torno koltec	*UNID.*	*1,00*	*R$ 2.450,00*	*R$ 2.450,00*
Programação torno koltec	*VB*	*1,00*	*R$ 40.000,00*	*R$ 40.000,00*
Revisão anual torno	*%*	*29%*	*R$ 20.000,00*	*R$ 5.714,29*
ENERGIA DOS EQUIPAMENTOS:	**TRUQUES**	**40**	-	R$ 84.744,20
Torno de Rodeiros	*HORAS*	*200,00*	*R$ 405,69*	*R$ 81.138,00*
Ponte Rolante descarga dos truques	*HORAS.VIAGEM*	*10,67*	*R$ 175,50*	*R$ 1.872,00*
Ponte Rolante movimentação truque	*HORAS*	*6,67*	*R$ 175,50*	*R$ 1.170,00*
Aspirador	*HORAS*	*20,00*	*R$ 28,21*	*R$ 564,20*

DESCRIÇÃO CUSTOS INDIRETOS	UNID.	Aliquota	VALORES EM REAIS (R$)
COMPOSIÇÃO DO BDI:	**%**	**100,25%**	**R$ 161.699,95**
Administração Central	*%*	*8,00%*	*R$ 12.904,00*
Custo Financeiro	*%*	*1,45%*	*R$ 2.338,85*
Seguro	*%*	*0,00%*	*R$ -*
Garantias	*%*	*0,00%*	*R$ -*
Margem de Incerteza	*%*	*0,00%*	*R$ -*
Tributos Municipais (ISS)	*%*	*5,00%*	*R$ 16.150,00*
Tributos Estaduais (ICMS)	*%*	*0,00%*	*R$ -*
Tributos Federais (CPRB)	*%*	*2,00%*	*R$ 6.460,00*
Tributos Federais (PIS e Cofins)	*%*	*9,25%*	*R$ 29.877,50*
Margem de Contribuição Bruta (ML+ IRPJ + CSLL)	*%*	*29,09%*	*R$ 93.969,60*
Margem de Contribuição Bruta (ML+ IRPJ + CSLL) sem CL 8ª	**%**	**100,00%**	**R$ 93.969,60**
IRPJ / CSLL	*%*	*34,00%*	*R$ 31.949,66*
Margem de Contribuição Líquida	*%*	*66,00%*	*R$ 62.019,94*
Lucro Líquido	**%**	**19,20%**	**R$ 62.019,94**

ANNEX I.II – COSTS / INVESTMENTS BREAKDOWN (METRÔRIO)

Custos diretos

DESCRIÇÃO CUSTOS DIRETEOS	UNID.	QTDE	TOTAL (R$)
RECURSOS HUMANOS:	TRUQUES	40	R$ 14.062,27
INSUMOS:	MÊS	2	R$ 13.600,00
MANUTENÇÃO DE EQUIPAMENTOS:	TRUQUES	40	R$ 48.893,58
ENERGIA DOS EQUIPAMENTOS:	TRUQUES	40	R$ 84.744,20

Mão-de-Obra / Custo fixo

Item	Qtd	Valor serviço
Técnico de Manutenção	1	R$ 7.420,01
Oficial de Manutenção III	1	R$ 6.642,26
Oficial de Manutenção II	0,06	R$ 315,21
Tecnico de Manutenção III	0,06	R$ 414,09
Viagem programação torno koltec	1	R$ 2.450,00
Programação torno koltec	1	R$ 40.000,00
Revisão anual torno	0,29	R$ 5.714,29
		R$ 62.955,85

Custos Variáveis

***Custo atual para envio de calibração externa - Entrará como 'receita' do Projeto**

Item	Quantidade	Custo por serviço
Administração Central	0,08	R$ 12.904,00
Custo Financeiro	0,0145	R$ 2.338,85
ENERGIA DOS EQUIPAMENTOS:	40	R$ 84.744,20
INSUMOS:	2	R$ 13.600,00
Tributos Municipais (ISS)	1	R$ 16.150,00
Tributos Estaduais (ICMS)	1	R$ -
Tributos Federais (CPRB)	1	R$ 6.460,00
Tributos Federais (PIS e Cofins)	1	R$ 29.877,50
IRPJ / CSLL	1	R$ 31.949,66
		R$ 198.024,22

Receita Anual (considerada a troca pelo carro controle)

Inspeção Carro Controle 2020 - Proposta SPV			
1ª Inspeção		2ª Inspeção	
Linha 01	34.224	Linha 02	49.236
Linha 02	49.236		
Linha 04	26.572		
Pátio	20.000		
Total KM	130.032	Total KM	49.236
R$ 234.287,97		R$ 88.712,03	
Total Proposta:		R$ 323.000,00	

INVESTIMENTOS

Instrumentos de Calibração

Item	Investimento Inicial
Viagem programação torno koltec	R$ 2.450,00
Programação torno koltec	R$ 40.000,00
Total	R$ 42.450,00

ANNEX I.III – COSTS PER YEAR (METRÔRIO)

CUSTOS

Usinagem de 160 rodas (40 truques)

Item	Ano 0	Ano 1	Ano 2	Ano 3	Ano 4	Ano 5
Custos Fixos						
Técnico de Manutenção	R$ 7.420,01	R$ 7.698,26	R$ 7.967,70	R$ 8.306,33	R$ 8.659,35	R$ 9.027,37
Oficial de Manutenção III	R$ 6.642,26	R$ 6.891,35	R$ 7.132,54	R$ 7.435,68	R$ 7.751,69	R$ 8.081,14
Oficial de Manutenção II	R$ 315,21	R$ 327,03	R$ 338,47	R$ 352,86	R$ 367,85	R$ 383,49
Tecnico de Manutenção III	R$ 414,09	R$ 429,61	R$ 444,65	R$ 463,55	R$ 483,25	R$ 503,79
Revisão anual torno	R$ 5.714,29	R$ 5.928,57	R$ 6.136,07	R$ 6.396,85	R$ 6.668,72	R$ 6.952,14
Total	R$ 20.505,85	R$ 21.274,82	R$ 22.019,44	R$ 22.955,26	R$ 23.930,86	R$ 24.947,92
Custos Variáves						
Administração Central	R$ 12.904,00	R$ 13.387,90	R$ 13.856,48	R$ 14.445,38	R$ 15.059,31	R$ 15.699,33
Custo Financeiro	R$ 2.338,85	R$ 2.426,56	R$ 2.511,49	R$ 2.618,23	R$ 2.729,50	R$ 2.845,50
Energia dos equipamentos	R$ 84.744,20	R$ 87.922,11	R$ 90.999,38	R$ 94.866,85	R$ 98.898,70	R$ 103.101,89
Insumos	R$ 13.600,00	R$ 14.110,00	R$ 14.603,85	R$ 15.224,51	R$ 15.871,56	R$ 16.546,10
Tributos Municipais (ISS)	R$ 16.150,00	R$ 16.755,63	R$ 17.342,07	R$ 18.079,11	R$ 18.847,47	R$ 19.648,49
Tributos Estaduais (ICMS)	R$ -	R$ -	R$ -	R$ -	R$ -	R$ -
Tributos Federais (CPRB)	R$ 6.460,00	R$ 6.702,25	R$ 6.936,83	R$ 7.231,64	R$ 7.538,99	R$ 7.859,40
Tributos Federais (PIS e Cofir	R$ 29.877,50	R$ 30.997,91	R$ 32.082,83	R$ 33.446,35	R$ 34.867,82	R$ 36.349,71
IRPJ / CSLL	R$ 31.949,66	R$ 33.147,78	R$ 34.307,95	R$ 35.766,04	R$ 37.286,09	R$ 38.870,75
Total	R$ 198.024,22	R$ 205.450,13	R$ 212.640,88	R$ 221.678,12	R$ 231.099,44	R$ 240.921,17
Total Custos	R$ 218.530,07	R$ 226.724,95	R$ 234.660,32	R$ 244.633,38	R$ 255.030,30	R$ 265.869,09

ANNEX I.IV – BUDGET TABLE (SUPERVIA)

supervia Trens Urbanos

QQP - Quadro de Quantidades e Preços

Passagem carro contole L1, L2 e L4 + Patios - 180 km

ORÇAMENTO TOTAL	R$	306.376,96
SUBTOTAL CUSTOS INDIRETOS	R$	215.166,06
SUBTOTAL CUSTOS DIRETOS	R$	91.210,90

DESCRIÇÃO CUSTOS DIRETEOS	ORÇAMENTO			
	UNID.	QTDE	PREÇO UNITÁRIO (R$)	PREÇO TOTAL (R$)
RECURSOS HUMANOS:	Inspeção	40	-	R$ 6.762,95
Tecnico de Manutenção III	*Horas*	*119,51*	*R$ -*	*R$ -*
Tecnico de Manutenção I	*Horas*	*59,76*	*R$ 37,10*	*R$ 2.216,95*
Engenheiro	*Horas*	*40,00*	*R$ 113,65*	*R$ 4.546,00*
INSUMOS:	MÊS	3	-	R$ 7.640,00
EPI / Uniforme	*MÊS*	*3,00*	*R$ 300,00*	*R$ 900,00*
Limpeza	*MÊS*	*3,00*	*R$ 100,00*	*R$ 300,00*
Diesel	*L*	*360,00*	*R$ 4,00*	*R$ 1.440,00*
Outros	*VB*	*1,00*	*R$ 5.000,00*	*R$ 5.000,00*
MANUTENÇÃO DE EQUIPAMENTOS:	TRUQUES	40	-	R$ 76.807,95
Oficial de Manutenção II	*HORAS*	*59,76*	*R$ 31,52*	*R$ 1.883,54*
Tecnico de Manutenção III	*HORAS*	*59,76*	*R$ 41,41*	*R$ 2.474,41*
Viagem suporte técnico	*UNID.*	*1,00*	*R$ 2.450,00*	*R$ 2.450,00*
Setup do equipamento	*VB*	*1,00*	*R$ 40.000,00*	*R$ 40.000,00*
Revisão anual carro controle + itens de desgaste	*%*	*30%*	*R$ 100.000,00*	*R$ 30.000,00*

DESCRIÇÃO CUSTOS INDIRETOS	UNID.	Aliquota	VALORES EM REAIS (R$)
COMPOSIÇÃO DO BDI:	%	235,90%	R$ 215.166,06
Administração Central	*%*	*20,00%*	*R$ 18.242,18*
Custo Financeiro	*%*	*1,45%*	*R$ 1.322,56*
Seguro	*%*	*0,00%*	*R$ -*
Garantias	*%*	*0,00%*	*R$ -*
Margem de Incerteza	*%*	*30,00%*	*R$ 27.363,27*
Tributos Municipais (ISS)	*%*	*5,00%*	*R$ 15.318,85*
Tributos Estaduais (ICMS)	*%*	*0,00%*	*R$ -*
Tributos Federais (CPRB)	*%*	*2,00%*	*R$ 6.127,54*
Tributos Federais (PIS e Cofins)	*%*	*9,25%*	*R$ 28.339,87*
Margem de Contribuição Bruta (ML+ IRPJ + CSLL)	*%*	*38,66%*	*R$ 118.451,80*
Margem de Contribuição Bruta (ML+ IRPJ + CSLL) sem CL 8ª	%	100,00%	R$ 118.451,80
IRPJ / CSLL	*%*	*34,00%*	*R$ 40.273,61*
Margem de Contribuição Líquida	*%*	*66,00%*	*R$ 78.178,19*
Lucro Líquido	%	25,52%	R$ 78.178,19

ANNEX I.V – COSTS / INVESTMENTS BREAKDOWN (SUPERVIA)

Mão-de-Obra / Custo fixo

Item	Qtd	Valor serviço
Tecnico de Manutenção III	119,512	R$ 4.948,82
Tecnico de Manutenção I	59,756	R$ 2.216,95
Engenheiro	40	R$ 4.546,00
Oficial de Manutenção II	59,756	R$ 1.883,54
Tecnico de Manutenção III	59,756	R$ 2.474,41
EPI / Uniforme	3	R$ 900,00
Limpeza	3,00	R$ 300,00
		R$ 17.269,71

Custos Variáveis

***Custo atual para envio de calibração externa - Entrará como 'receita' do Projeto**

Item	Quantidade	Custo por serviço
Diesel	360	R$ 1.440,00
Outros	1	R$ 5.000,00
Revisão anual carro controle + itens de desgaste	0,3	R$ 30.000,00
Administração Central	0,2	R$ 19.231,94
Custo Financeiro	0,0145	R$ 1.394,32
Margem de Incerteza	0,3	R$ 28.847,91
Tributos Municipais (ISS)	0,05	R$ 16.150,00
Tributos Estaduais (ICMS)	0	R$ -
Tributos Federais (CPRB)	0,02	R$ 6.460,00
Tributos Federais (PIS e Cofins)	0,0925	R$ 29.877,50
IRPJ / CSLL	0,34	R$ 42.458,73
		R$ 180.860,40

Receita Anual (considerada a troca pela usinagem de 40 truques)

Objetivo: Serviço de Usinagem de 160 rodas (40 truques) - SUPERVIA	ORÇAMENTO TO	R$ 323.000,00

INVESTIMENTOS

Instrumentos de Calibração

Item	Investimento Inicial
Viagem suporte técnico	R$ 2.450,00
Setup do equipamento	R$ 40.000,00
Total	R$ 42.450,00

ANNEX I.VI – COSTS PER YEAR (SUPERVIA)

Passagem do carro controle Linhas 1, 2 e 4.

Item	Ano 0	Ano 1	Ano 2	Ano 3	Ano 4	Ano 5
Custos Fixos						
Tecnico de Manutenção III	R$ 4.948,82	R$ 5.134,40	R$ 5.314,10	R$ 5.539,95	R$ 5.775,40	R$ 6.020,85
Tecnico de Manutenção I	R$ 2.216,95	R$ 2.300,09	R$ 2.380,59	R$ 2.481,76	R$ 2.587,24	R$ 2.697,20
Engenheiro	R$ 4.546,00	R$ 4.716,48	R$ 4.881,55	R$ 5.089,02	R$ 5.305,30	R$ 5.530,78
Oficial de Manutenção II	R$ 1.883,54	R$ 1.954,17	R$ 2.022,57	R$ 2.108,53	R$ 2.198,14	R$ 2.291,56
Tecnico de Manutenção III	R$ 2.474,41	R$ 2.567,20	R$ 2.657,05	R$ 2.769,97	R$ 2.887,70	R$ 3.010,43
EPI / Uniforme	R$ 900,00	R$ 933,75	R$ 966,43	R$ 1.007,50	R$ 1.050,32	R$ 1.094,96
Limpeza	R$ 300,00	R$ 311,25	R$ 322,14	R$ 335,83	R$ 350,11	R$ 364,99
Total	R$ 17.269,71	R$ 17.917,33	R$ 18.544,43	R$ 19.332,57	R$ 20.154,21	R$ 21.010,76
Custos Variáves						
Diesel	R$ 1.440,00	R$ 1.494,00	R$ 1.546,29	R$ 1.612,01	R$ 1.680,52	R$ 1.751,94
Outros	R$ 5.000,00	R$ 5.187,50	R$ 5.369,06	R$ 5.597,25	R$ 5.835,13	R$ 6.083,12
Revisão anual carro controle	R$ 30.000,00	R$ 31.125,00	R$ 32.214,38	R$ 33.583,49	R$ 35.010,78	R$ 36.498,74
Administração Central	R$ 19.231,94	R$ 19.953,14	R$ 20.651,50	R$ 21.529,19	R$ 22.444,18	R$ 23.398,06
Custo Financeiro	R$ 1.394,32	R$ 1.446,60	R$ 1.497,23	R$ 1.560,87	R$ 1.627,20	R$ 1.696,36
Margem de Incerteza	R$ 28.847,91	R$ 29.929,71	R$ 30.977,25	R$ 32.293,78	R$ 33.666,27	R$ 35.097,09
Tributos Municipais (ISS)	R$ 16.150,00	R$ 16.755,63	R$ 17.342,07	R$ 18.079,11	R$ 18.847,47	R$ 19.648,49
Tributos Estaduais (ICMS)	R$ -	R$ -	R$ -	R$ -	R$ -	R$ -
Tributos Federais (CPRB)	R$ 6.460,00	R$ 6.702,25	R$ 6.936,83	R$ 7.231,64	R$ 7.538,99	R$ 7.859,40
Tributos Federais (PIS e Cofir	R$ 29.877,50	R$ 30.997,91	R$ 32.082,83	R$ 33.446,35	R$ 34.867,82	R$ 36.349,71
IRPJ / CSLL	R$ 42.458,73	R$ 44.050,93	R$ 45.592,71	R$ 47.530,41	R$ 49.550,45	R$ 51.656,34
Total	R$ 180.860,40	R$ 187.642,67	R$ 194.210,16	R$ 202.464,09	R$ 211.068,82	R$ 220.039,24
Total Custos	R$ 198.130,12	R$ 205.560,00	R$ 212.754,60	R$ 221.796,67	R$ 231.223,02	R$ 241.050,00