

**DB RAIL ACADEMY
INTERNATIONAL CERTIFICATION IN MANAGEMENT OF RAIL AND
METRO RAIL SYSTEMS**

TURNOUT TRAINING

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Abstract

It is a consensus that integration between the various areas of a company is an essential factor for the achievement of corporate goals. This is an increasingly evident statement in companies, especially when the scenario is analyzed from the VUCA concept.

We noticed that in our company there are many opportunities to develop this aspect. One of the items of the Strategic Planning of the São Paulo Metro is an Integrated Communication Plan.

Based on concepts addressed during the "Management of Rail & Metro Systems" Training, we plan a training for managers aligned with the "Get to Know Your Subway" Strategic Planning Program.

This training addresses a permanent way equipment, specifically the Turnout, from the points of view of Operation and Maintenance. It will be given to managers of Maintenance, Operation and Commercial Departments and has as main objectives:

- Integrate the managers' vision.
- Discuss technical and operational aspects of equipment.
- Record accumulated technical knowledge.
- Structure training model that can be offered to other railway companies later.

Keywords: Training, integration, permanent way, turnout, VUCA

Resumo

É consenso que integração entre as diversas áreas de uma empresa se apresenta como fator essencial para o alcance de metas corporativas. Trata-se de uma afirmação cada vez mais evidente nas empresas especialmente quando o cenário é analisado a partir do conceito VUCA.

Notamos que em nossa empresa há muitas oportunidades para desenvolver esse aspecto. Um dos itens do Planejamento Estratégico do Metrô de São Paulo é um Plano de Comunicação Integrado.

Com base em conceitos tratados durante o Treinamento “Management of Rail & Metro Systems” planejamos um treinamento para gestores alinhado com o Programa “Conheça Seu Metrô” do Planejamento Estratégico.

Esse treinamento aborda um equipamento de via permanente, especificamente o Aparelho de mudança de via, sob os pontos de vista de Operação e Manutenção. O treinamento será ministrado a gestores das gerências de Manutenção, Operação e Comercial tem como principais objetivos:

- Integrar a visão dos gestores.
- Discutir aspectos técnicos e operacionais do equipamento.
- Registrar o conhecimento técnico acumulado
- Estruturar modelo de treinamento que possa ser oferecido a outras empresas do setor ferroviário posteriormente.

Palavras-chave: Treinamento, integração, via permanente, aparelho de mudança de via, VUCA

1. Metro Sao Paulo

The Companhia do Metropolitano de São Paulo - Metrô was formed on April 24, 1968. It is controlled by the State Government of São Paulo under the management of the State Secretariat of Metropolitan Transport (STM). He is responsible for the operation and expansion of the subway network and the planning of passenger transportation in the Metropolitan Region of São Paulo.

The metro network of the city of São Paulo consists of 6 lines, totaling 101.1 km long and 89 stations, through which more than 5 million passengers pass daily. The Line 4-Yellow is operated by Via Quatro (private concession) system since 2010. It has 11.4 km of extension and 10 stations.

Line 5-Lilac was operated under concession by Via Mobilidade on August 4, 2018. It has 20 km and 17 stations.

In 2017, the metro network reached the 1.3 billion passenger mark, and the São Paulo Metro was responsible for the transportation of 1.1 billion of these passengers, standing out worldwide for the results achieved in the production and quality of the service provided in public passenger rail transport.

Most of the maintenance of the Rolling Stock and Permanent Way of the Metro São Paulo is carried out by the company's own employees, according to maintenance procedures and plans prepared by the company's engineering areas.

In March 2019, with the creation of the Commercial Directorate and New Business and Services Management, it was possible to start exploring and accelerating new markets in Brazil and abroad, through the sale of products and services , with expertise and know-how in the various areas of Transport and Urban Mobility, including the concession of metro and railway lines.

1.1. Company mission

Offer public transport with quality and cordiality, through a network that is getting closer and closer to taking people further and further.

1.2. Company vision

To remain as the preferred transport option in the metropolitan region of Sao Paulo, offering quality services and increasingly attentive to the needs of the citizen.

It is with promptness, cordiality and respect that we will make people's travel an even more pleasant experience.

1.3. Economic Sector

The company was formed in the form of a mixed-capital company on April 24th, 1968, two years after being created through Municipal Law No. 6988/66.

In view of the need for large volumes of resources for the expansion of the subway network, the Municipal Executive, through Municipal Law No. 8,830, of December 12th, 1978, gave up maintaining the controlling interest in Metro Sao Paulo giving the Government an opportunity of the State of Sao Paulo to carry out various investments necessary for the expansion of the network through the subscription of shares by the Finance of the State of Sao Paulo and the Metropolitan Planning Company of Greater São Paulo - EMPLASA.

In 2018, Metro Sao Paulo, guided by the Finance Secretariat - CODEC, followed what was published in Law No. 13,303 / 2016, paragraph 1 of article 91, which provides: "mixed capital companies that have capital closed on the date of its entry into force may be transformed into a public company, upon redemption of all shares held by private shareholders".

Therefore, the totality of the shares of the shareholders considered to be private was made and, therefore, the Company's capital stock is composed only of public shareholders.

2. Hypotheses

Managing a mass transit system like the Metro of São Paulo is not an easy task.

The operational scenario of operation, maintenance and commercial administration changes at very rapid speed and with uncertain destination, providing multiple answers to the same question.

One of the topics of study in the Management of Rail & Metro Systems training was the VUCA world perspective.

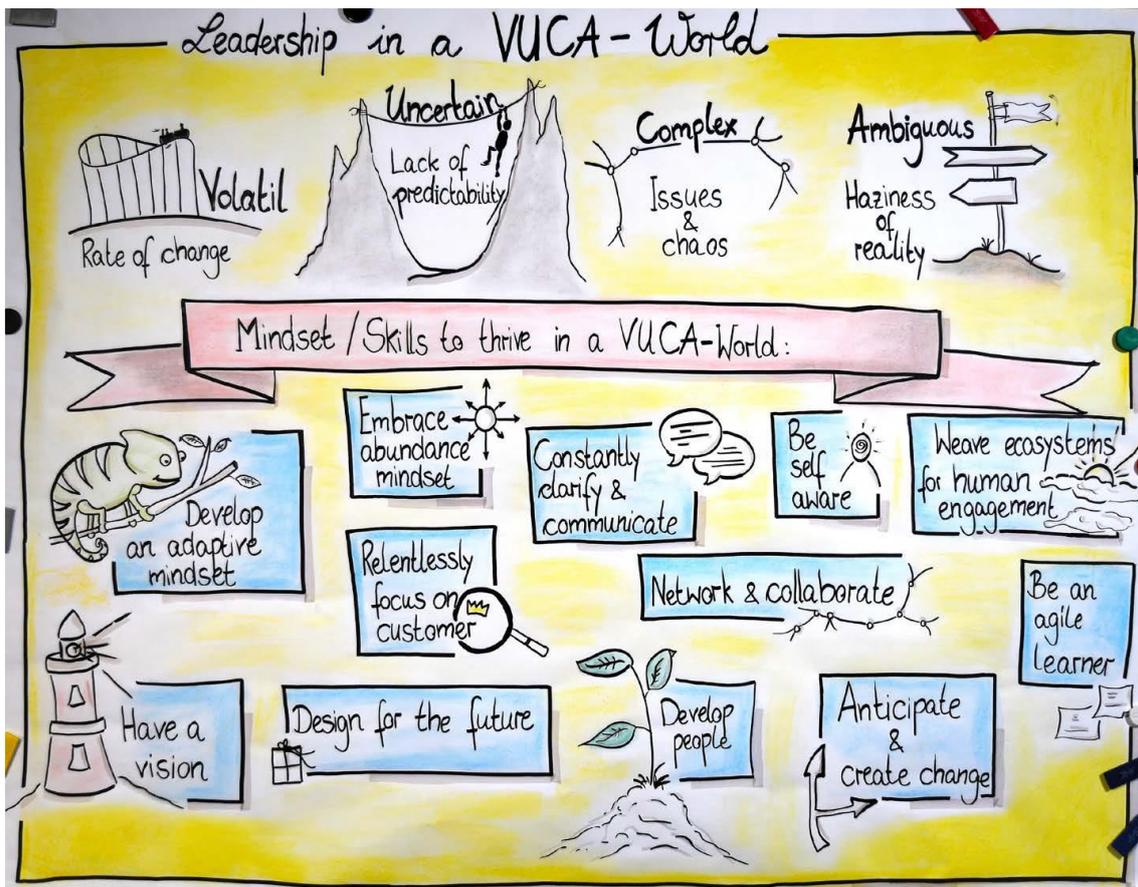


Fig. 1: Slide presented in module 6 of the training

We present below an analysis of operation, maintenance and commercial administration of Metro of São Paulo according to VUCA world perspective.

2.1.Operation, maintenance and commercial administration of Metro Sao Paulo from the perspective of VUCA concept

2.1.1.Volatility

2.1.1.1.Operation

The evolution of technology is progressing so fast that concepts that were so ingrained, are now obsolete. Nowadays "Digital" is not only a competence, but it is a mental model.

It is the speed at which changes occur and their impacts. Currently, nothing is permanent and the technologies, preferences, trends and certainties are fickle and highly changeable.

What was one way yesterday, tomorrow is another. And this volatility makes the business world very challenging. This characteristic indicates the magnitude of the changes, which can be bigger and more surprising.

The culture steeped in decades needs to adapt quickly to trends in innovation, fast processes and smart solutions, reducing costs.

Many professionals think they are qualified, when in reality they are not. They need constant reviews to adapt to the planning and the unexpected. The search for Knowledge requires that the professional seeks multiple knowledge, not just being stuck in his area of training and performance.

In this sense, and in our passenger transport business, proactivity and immediate response time are essential for the smooth running of the business.

In the past, for example, we had four employees for four different activities, today we have a multifunctional employee for all activities, for the price of one, and intelligent equipment that operates automatically or remotely. If there is a problem, it is promptly resolved.

Team integration is the result of good leadership that creates teams that share knowledge, help each other, work for the good of the business.

Companies need to create new organizational models and offer constant adaptation. The purpose reaches the corporate world with an intensity never seen before.

It is necessary to develop leaders with resilience and the ability to reinvent themselves, to adapt quickly in the face of change can positively transform the action in progress.

Team integration is the result of good leadership that creates teams that share knowledge, help each other, work for the good of the business.

Attention points:

- Modern systems that do not speak to old systems.
- Ensure that knowledge reaches all frontline employees.
- Ensure prompt response to technical and operational problems.
- Act proactively, anticipating problems and taking preventive measures.
- Have multifunctional employees, who know how to work on all equipment since their initial training.
- Ensure a routine of updating training to keep employees always up to date.

New analytical systems applied:

- Facial recognition
- Counting people
- Crossing lines
- Intrusion detection

- Forensic Analysis

2.1.1.2.Maintenance

For many years the maintenance of the São Paulo Metro has worked based on stability concepts and few changes.

Preventive processes, that are based on calculated obsolescence time, were the most applied.

However, the evolution of electronic components brought new railway maintenance options.

Modernization became a keyword from the 2000s onwards.

It is possible to state that from that time the concept of volatility became part of the maintenance.

The needs of the railway clients change very fast and the maintenance have to adapt itself to this volatility.

2.1.1.3.Commercial Administration

Volatility refers to the speed with which changes have been taking place in the market. This can be easily seen with changes in consumer behavior in the face of the digital revolution.

Today's customer is more interested in the shopping experience than the price, and can switch to the competition at any time.

In addition, we experience new trends and technologies with much more agility than a few years ago.

Thus, the characteristics of a product or service may become obsolete and lose its attractiveness. Therefore, it is necessary to adjust quickly and constantly to the new demands of this volatile market.

Metro Sao Paulo is always looking to the future, trying to anticipate trend and develop new technologies in order to be continue being an outstanding company.

2.1.2.Uncertainty

2.1.2.1.Operation

Technology is demanding from everyone flexibility to adapt to what is new, to adapt to unthinkable scenarios.

A clear example is the pandemic we are going through, where people have suddenly had to reinvent themselves in their way of living and working.

Some "uncertain conclusions" we can highlight.

2.1.2.1.1.Pandemic and the new normal

On normal days, in the period before the pandemic, people left the house in the morning for work or studies, and at the end of the day they returned to their homes. There was still free time for lunch, and they made trips for personal matters.

This normal movement of people, during working days, generated a passenger demand of more than 5 million passengers for the subway system, in the São Paulo Metro alone more than 3.8 million trips.

The world has readjusted, offices have been moved into the home. shopping, studies have adapted to the internet, and large cities powered by large mobility systems are depleted. We had an 85% drop in travel in April and in November we reached almost 50% of our normal demand.

The main questions today are:

- Is it possible to recover what was lost?
- How long will this take?
- Will we have the same demand again someday?

All answers, for now, are uncertainties.

But the operating costs are real, so there is no choice but to accept that the new normal is really normal from now on. And make the necessary adjustments to ensure the survival of the business.

The saying goes: "It is in difficulty that the opportunity arises."

Consultancies are on the rise, this is our business.

The doubts, indecision and inaccuracies typical of a context in which knowledge is usually incomplete. That is why it is increasingly difficult to raise future scenarios based on past events. We have difficulty seeing where we are going and what is the next step. We do not know, for sure, what will happen tomorrow. A few years ago, it would be a little easier to make predictions, that is, to look ahead and identify what the company would look like in the future. Today it is very difficult to make predictions precisely because of these uncertainties. The future is difficult to predict.

2.1.2.2.Maintenance

Predictability is one of the main positive characteristics that are necessary in a railway company.

In despite of the VUCA scenario, we still work in the maintenance seeking the highest possible predictability index.

The monitoring of equipment and the adoption of predictive maintenance methods are the natural result of this need.

Another point of uncertainty is that nowadays is necessary to look constantly to the strategy of the competitors.

2.1.2.3.Commercial Administration

As this scenario is totally unpredictable, it also becomes uncertain. The strategies outlined at the time of the Business Plan or Business Model Canvas, for example, may need rapid changes if the market changes abruptly.

Although strategic planning is essential for marketing, there is no guarantee that the external and internal scenario will always be the same. The insecurity of this volatile world causes a scenario of uncertainty in companies, making it difficult to accurately predict the future.

Metro Sao Paulo is a governmental company, so it's mandatory to have a solid planning, both short and long term. Once you deal with public money you must be as efficient as possible and without good planning it is impossible.

2.1.3.Complexity

2.1.3.1.Operation

It is the difficulty of understanding the result of the interactions of the innumerable variables of a given situation, challenge or problem. It is common to find contexts that have multiple aspects or elements whose interdependent relationships are incomprehensible or confusing. The answers to the world are very difficult as the

relationships are different. We cannot say that there is only one correct answer, but there are several possible answers for situations. This characteristic shows that there are several internal and external factors that can affect the business and that, many times, are out of the manager's control.

In Brazil, the culture of human warmth is highly valued in face-to-face service, in monitoring events, in prompt responses to operational problems and equipment reestablishment.

It is a culture that is difficult to change or break. This culture impacts permanent OPEX, which could easily be replaced by CAPEX.

See the example of a real study. In the same place inside the station we have an access signposted "Avenida Paulista exit on the left", and a station agent station, if the passenger needs information about the exit, culturally, he will look at the sign, and will ask the agent if the exit to Avenida Paulista is to the left, to certify what is written on the sign, or will not even look at the sign.

Now, if in the same place, we remove the security post, and keep the sign, culturally, the passenger will look at the sign and, even so, will look for an employee to confirm that it is written on the sign.

The conclusion is that the passenger satisfaction assessment is very impacted if there is no human warmth in the relationship, even if the information was provided by other means. This impact of extreme cultural quality has an impact on satisfaction surveys, concession contracts, sensational journalism, social media, and soon on operating costs, because these indicators are essential for the continuity of management.

So, we conclude that culture is a high factor of complexity. Understand them and answer them, or lose them all.

2.1.3.2.Maintenance

The modernization of the systems brings a lot of new interdependent systems.

The old simple systems are now modernized or connected to a lot of other complex systems.

In the past all the maintenance professionals could be specialists in one System.

This complexity besides the need of save resources, practically obligate the multi-functionality of the professionals.

2.1.3.3.Commercial Administration

Decisions cannot be made by isolated analysis. Thus, actions related to economic and political factors, for example, can impact social and cultural issues.

Thus, it is necessary to have a systemic view of the positioning of the business in the market and understand what impacts the company may suffer as a result of the reactions of stakeholders.

This complex system in which we live requires that the Marketing professional has a linear knowledge about all areas related to the product or service.

Selling services to the external public is new in at Metro Sao Paulo. It started, as said in the introduction, in March, 2019. We are still creating processes and studying the market and the competitors to define our business model.

2.1.4.Ambiguity

2.1.4.1.Operation

Ambiguity, in turn, is due to situations in which we have little predictability of passenger expectations. An example is the presence of street vendors inside trains and stations.

We often take security actions against the illegal trade in goods within the system. However, we perceived in our ombudsmen an assessment that showed many unfavorable and favorable opinions regarding our actions.

We also realized that this ambiguous perception reflected in our passenger satisfaction assessments, having a negative impact.

So, we carried out a satisfaction survey and we noticed this ambiguity more clearly. See the result below.

Survey on street vendors in the system:

- I don't see any security problems or inconvenience - 44%
- Both. This is a security issue or nuisance - 19%
- This is just a nuisance - 29%
- This is just a security issue - 8%

Based on it, we concluded that almost 50% of respondents are in favor of illegal trade within trains and stations.

We started an awareness campaign in all our social media and publicity panels.

We decided to continue with the fight against irregular trade and absorb the negative impact of the satisfaction assessment. To avoid increasing the problem within the system.

2.1.4.2.Maintenance

The concept of ambiguity in the maintenance is strictly related to the uncertain scenario.

It is possible to say that the nature of the maintenance is ambiguous.

Because to keep the system running sometimes the maintenance must stop it.

Another aspect where ambiguity can be noted is, for example the generation conflicts in the maintenance teams.

The younger maintenance professionals analyze the challenges of maintenance processes in a total different perspective.

While the most experienced professionals normally are trying to adapt the consolidated methods to the new tendencies, the new generation think that all needs to be totally changed.

Certainly, these two perspectives have pros and cons that must be always considered in maintenance management.

2.1.4.3.Commercial Administration

Ambiguity deals with the consequences caused by all the previous characteristics. Because we live in a volatile world, with an uncertain and complex scenario to understand, we can have several different interpretations. The proof of this is the excess of information we have.

While the demand for content brings valuable guidance and information, too much data can also cause confusion, creating even more doubts about which decision to make.

Metro Sao Paulo uses the same workforce to both internal and external jobs. The priority is the internal tasks, but it's necessary to improve processes and methods to have people available to meet external demands.

3. Training ideas

3.1.Characteristics of the Turnouts of Metro of Sao Paulo

3.1.1.Definition

Turnout is a mechanical equipment installed on the rails. Its function is to allow that rolling stock to move from one track to another. It also can be called switch.

It consists basically of three distinct parts:

- Needles
- Crossing
- Connecting rails

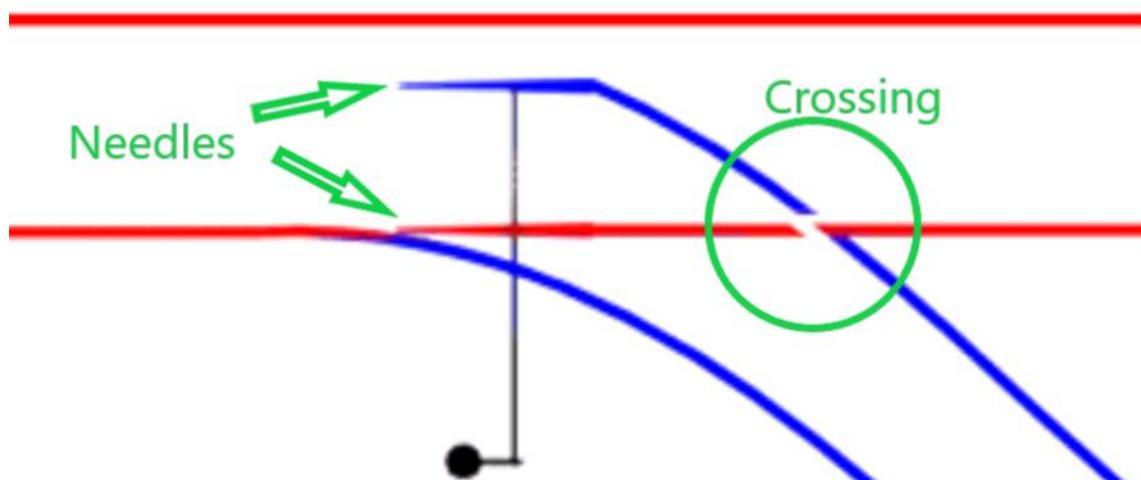


Fig. 2: Schematics model of turnout (Source: the authors)

3.1.2. Standards

3.1.2.1. UIC – Union International des Chemins de Fer

There are UIC-60 Standard turnouts installed in the lines 1, 2, 3 4 and 5 of the Metro.

These turnouts are manufactured with UIC Standard rails of 60 kg/m and Zu 1-60 Standard rails (for the needles).

There are traditional UIC turnouts with “fixed frogs” and also with “mobile frog”.



Fig. 3: Turnout UIC Standard (Source: Metro Sao Paulo)

3.1.2.2.AREMA – American Railway Engineering and Maintenance-of-Way

In the yards of maintenance of the São Paulo Metro there are installed turnouts according to the AREMA standard.

These turnouts are manufactured with TR-57 rails (this is a Brazilian nomenclature that means a 57 kg/m rail).

The crossing region (called frog) is cast in manganese steel.

3.1.2.3.Model M – Metro/Cobrasma Company

In the 1980s, imports were very restricted and expensive in Brazil.

For this reason, Metro Engineering Department, in partnership with the company “COBRASMA S/A”, designed and developed this turnout model M (Metro), using only components available in the national industry.

Regarding to the construction form, the model M turnouts are manufactured with TR-57rail and TR-52 rail (these one only for the needles). The frogs are manufactured with TR-57 rails and with the core is cast in manganese steel.



Fig. 4: Turnout model “M” (Source: Metro Sao Paulo)

3.1.3.Maintenance

There is a specific maintenance program to turnouts in the Metro of São Paulo. We use all the technologies that are available and economic possible:

- On foot Inspection
- Geometric inspections
- Specific preventive actions
- Dye penetration tests
- Ultrasonic inspection
- Predictive monitoring techniques



Fig. 5: Turnout ultrasonic inspection (Source: Metro Sao Paulo)

3.2.Integration Importance

3.2.1.Corporative Management Systems

In the 1990s, Metro of São Paulo started a consistent process to achieve the ISO 9000 certification.

The reasons for this project can be named in this slide of the International Certification in Management of Rail and Metro Rail Systems:



Systematic management helps to cope successfully with various requirements

Why should a company implement a management system?

- Fundamental orientation to a company's policy and targets
- Effectiveness and efficiency of processes
- High transparency through clearly defined responsibilities
- Stabilization and improvement of procedures
- Prevention of tortious acts of employees and manager
- Increase of customer confidentiality
- Requirements of the market (=competitive position) or of authorities (=legal certainty)
- Compliance with documentation duties

Fig. 6: Slide from Module 5 - Business Skills, HR & Ergonomic (Source: Deutsche Bahn AG – DB Rail Academy)

Currently Metro Sao Paulo is certified according to the Standards below:

Quality	Environmental	Safety and Health
 <p>QUALIDADE SGQ ISO 9001</p>	 <p>AMBIENTAL SGA ISO 14001</p>	 <p>SEGURANÇA E SAÚDE OCUPACIONAL SGSSO</p>

Fig. 5: Metro Sao Paulo Certified Standards (Source: Metro Sao Paulo)

These certifications are controlled by an Integrated Management System, which is essential to the managers.

It allows a complete view of the performance of each certification in the same perspective and of the interdependence and interferences between the different managing systems.

Departments of the Company

The integration between the departments has many advantages:

- Makes decisions go faster
- Makes decisions more assertive
- Improves the working environmental

The search of competitive advantages is the main function of the managers. Metro of São Paulo is a company founded more than 50 years ago.

Certainly, it is a company that presents the main characteristics of a successful fiftieth business:

- Experienced professionals with solid and great technical knowledge
- The accumulated knowledge is professional's "possession"
- A very strong and entrenched organizational culture
- Independent and self-sufficient departments
- Difficulty in accepting organizational changes

All these characteristics together difficult the integration between the departments.

3.3.Internal Communication Importance

There are different definitions of communication:

"It is the process of passing information and understanding from one person to another. Therefore, all communication influences at least two people: the one who sends the message and the one who receives it" (CHIAVENATO)

"It is a process of social interaction, through signs and sign systems, product of human activities. Men in the communication process express their needs, aspirations, criteria, emotions, etc." (GONZÁLEZ)

"Communication is the exchange and flow of information and ideas from one person to another; it involves a sender transmitting an idea, information, or feeling to a receiver." (U.S. ARMY)

Each company can have its own concept of communication that can be totally different from other competing companies.

Nowadays all companies should be concerned about various aspects of communication:

- Internal communication
- With the costumers
- With the society
- With shareholders

The new technologies have facilitated communications.

On the other hand, this larger volume of data circulating brings greater responsibility with the messages that are effectively being transmitted.

A structured and viable communication plan is required.

This communication plan must be perfectly aligned with the company's goal planning and at the same time must consider and as far as possible, respect the company's organizational culture.

3.4.Purpose of the Training

3.4.1.Motivation

Analyzing the important necessary points explained previously in this paper:

- Integration between departments
- Internal communication
- Sharing and recording the accumulated knowledge
- Increasing additional revenues

We realized that a training could contemplate these points and in an objective perspective contribute to improve them.

3.4.2.Scope and Limitations

The central point of the training is the turnout:

- Technical and maintenance characteristics
- Operational aspects
- Costs and administrative perspective

Turnout is one example among various options. The idea is that this project remains a pilot and that it can be replicated for all the other systems and equipment that make up the Metro system.

3.4.3.Target and Objectives

The target audience are the managers of the Operational, Maintenance and Commercial Departments of the Metro of São Paulo.

Our main objective is to disseminate or know the parts that make up the Metro system, in order to assist managers in the decision-making process.

Initially the training has been planned to be in a presence mode, but because of the pandemic scenario, we are planning to do it in a remote model.

As for measuring results, we know that it is a difficult task, because it is knowledge.

One way to verify the results achieved is to do a survey, at the end of the training, with basic questions about the equipment. If the answers are correct, we can say the result is positive.

Another way is to monitor the equipment's failure history. If, in the medium or long term, there is a reduction in the history of failures, it can be inferred that the management decision process was more assertive and contributed to this reduction.

4. Risk Analysis

In order to evaluate the risks of our project, we decide to use the SWOT analysis. Important to say that this method was very used throughout the course, during several different modules.

SWOT Analysis is one of the simplest and at the same time useful tools that a company has at its disposal to understand the environment in which it operates and to create the base of information necessary to plan its future based on its strengths and weaknesses.

The term SWOT is the acronym for Strengths, Weaknesses, Opportunities and Threats. In addition to being a tool commonly used in Strategic Planning, we can also use it on a daily basis to map challenges and opportunities for the company.

The group came up with the following aspects:

Strengths

- Technical knowledge
- Qualified and available instructors
- Demonstration equipment
- Metro brand recognition

Weaknesses

- Process speed
- Labor cost

Opportunities

- Rail sector expansion
- Increased knowledge

Threats

- Many direct competitors
- Competitor's price

Organizing them on the matrix, we have:

	Positive factors	Negative factors
Internal factors	Technical knowledge Qualified and available instructors Demonstration equipment Metro brand recognition	Process speed Labor cost
External factors	Rail sector expansion Increased knowledge	Many direct competitors Competitor's price

Fig. 6: SWOT Matrix (Source: the authors)

Considering there are more positive than negative factors, we recommend the project as feasible, from risks point of view. Also, positive aspects are really strong and, because of this, the negative ones are acceptable. Negative aspects must be monitored and, if they become stronger, strategies must be developed according to the current scenario.

5. Project Plan/Implementation Plan

Those are the dates (estimated and already done) and status of the phases of our project:

Phase	Deadline	Status
Consolidate the idea and concept of the training	2020/May	Concluded
Show the idea to managers	2020/Jun	Concluded
Receive the approval from managers	2020/Jul	Concluded
Prepare the training material	2020/Dec	In progress
Schedule the training	2121/Jan	Scheduled
Publicize the training	2121/Feb	Scheduled
Provide the training	2121/Mar	Scheduled
Review the material	2121/Apr	Scheduled
Analyse the possibility to offer to other companies	2121/May	Scheduled

Tab. 1: Project Plan/Implementation Plan (Source: the authors)

6. Resources

The human resources that will be applied are internal and can be seen below:

Activity	Professional	Time invested (h)
Collect preliminary information	Engineer	10
Take pictures	Technician	40
Prepare the slides	Engineer	40
Provide training	Engineer	8
	Total	98

Activity	Professional	Time invested (h)	Unit. Cost (R\$)	Total Cost (R\$)	Total Cost (USD)*
Collect preliminary info	Engineer	10	R\$ 192	R\$ 1.919	355
Take pictures	Technician	40	R\$ 63	R\$ 2.526	467
Prepare the slides	Engineer	40	R\$ 192	R\$ 7.676	1.421
Provide training	Engineer	8	R\$ 192	R\$ 1.535	284
Total		98		R\$ 13.657	2.529

*exchange rate: \$5,40

It is important to say that the content and application of the training will be carried out by employees of the company, which reduces costs with specialized professional hiring.

7. Final Considerations

As demonstrated throughout this work, the turnout training project is properly aligned with Metro Sao Paulo's strategies.

Likewise, the diffusion of technical knowledge to the company's strategic level is something that will bring managers closer to the operational reality. This knowledge should help them in their decision making.

From the point of view of feasibility, the project proved to be acceptable, as demonstrated by the risk analysis. In addition, one must consider the highly skilled workforce that Metro Sao Paulo has at its disposal.

As next steps, we suggest that, once the internal stage of training is completed, studies of the external stage should be initiated, with the Commercial Directorate, culminating in the development of a product to be marketed with operators in the railway and metro-rail sector, inside and outside of Brazil.

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