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Theme

Identifying urban transport risks : a study on tramway of ouargla

Discuss on: 18 /06 /2022

In front of the jury composed of:

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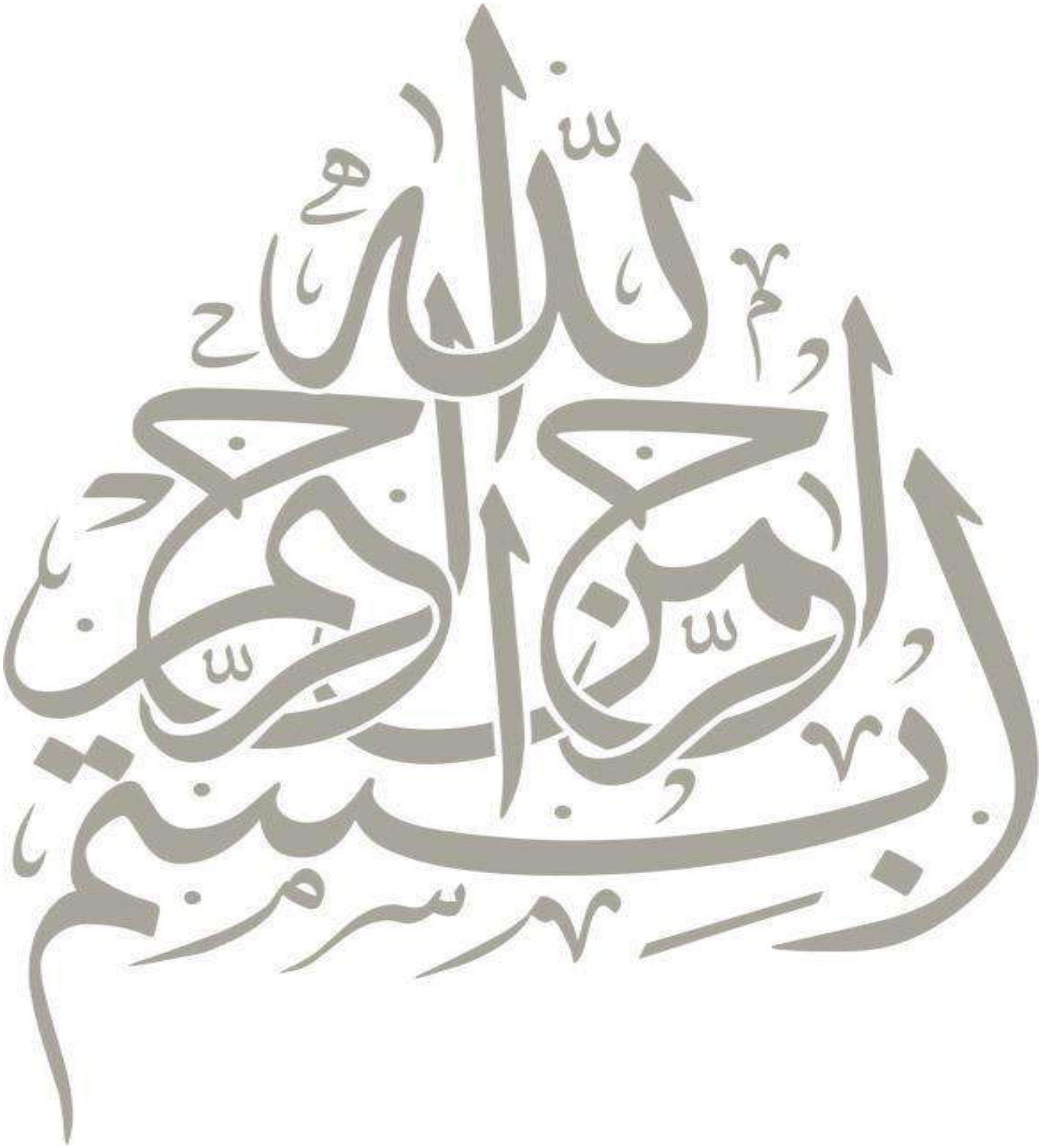
بسم الله الرحمن الرحيم

I dedicate this Thesis…

To my dear parents and to the whole family…

To all those who are dear to me…

To my friends…

To my teachers…

To all who helped me in this thesis…

Acknowledgement

Praise be to Allah... Allah the merciful, who has endowed us with will, courage, strength, and patience to be able to continue in the most difficult times ... To have helped us to overcome all obstacles, as well, allowing us to complete this modest work.

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ملخص

تلعب إدارة المخاطر دورا رئيسيا في جميع المجالات الاقتصادية وما يصاحبها من أنشطة. وهو النهج التقني الحديث وأحد المجالات التي عرفت في نطاق مفهوم السلامة والأمن. وعلاوة على ذلك، فهو يشمل عملية تقييم المخاطر والسيطرة عليها ومتابعة كل ما يتعلق العمل، سواء على المدى الطويل أو القصير، وكذلك المباشر أو غير المباشر، وبعبارة أخرى، أنه يعتبر أحد أهم الركائز لتحقيق السلامة والأمن، كما هو الحال بالنسبة لتحليل الحوادث، الذي أصبح مهما جدا في نهج السلامة لأنه يوفر تصحيحات وتوصيات محددة الهدف تمكننا من تحقيق العثور على حلول هادفة، والتي بدورها تساعدنا على حل المشاكل المتعلقة بالعيب المدروس

الإشكالية التي أثارتها هذه الرسالة هي التعرف على مخاطر ترام ورقلة ، وتقديم التوصيات لتجنبها.

كلمات مفتاحية: تحديد المخاطر ، السلامة ، ترام ورقلة

Abstract

Risk management plays a major role in all economic fields and their accompanying activities. It is the modern technical approach and one of the areas that have been known within the scope of the safety and security concept. Moreover, it includes the process of risk assessment, controlling, and following up everything related to work, whether in the long or short term, as well as direct or indirect, in other words, that it is considered one of the most important pillars for achieving safety and security, as is the case for accident analysis, which has become very important in the approach of safety because it provides targeted corrections and recommendations that enable us to find purposeful solutions, which in turns help us to solve troubles related to the studied defect.

The problematic raised by this letter is to identify the dangers of the tram and Ouargla, as well as to make recommendations to avoid them.

Keywords: identifying risks, Safety, tramway of Ouargla

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Abbreviation's List

AC	**A**lternating electric **C**urrent
Ac.T.O	**A**ccidents involving **T**ime **O**ff
Ac.w.S	**A**ccidents without **W**ork stoppage
CN	**C**arrier **N**acelle
DC	**D**irect electric **C**urrent
EMA	Metro of Algiers Company
ESB	**E**mergency **S**top **B**utton
F.Ac	**F**atal **A**ccidents
FR	**F**requency **R**ate
HSE	**H**ealth, **S**afety and **E**nvironment
HVS	**H**igh **V**oltage **S**ubstations
ISO	**I**nternational **O**rganization for **S**tandardization
MB	**M**otor **B**ogies
MN	**M**otor **N**acelle
N.D.L	**N**umber of **D**ays **L**ost
OCL	**O**verhead **C**ontact **L**ines
PCC	**C**entralized **C**ommand and **C**ontrol Station
PPE	**P**ersonal **P**rotectiv**e** **E**quipment
QMRS	Quality, Risk control, System
RATP	Autonomous Paris Transport Authority
RS	**R**ectification **S**ubstations
S.Ac	**S**evere **A**ccidents
SR	**S**everity **R**ate
TCSP	Specific Site Public Transport
TGV	High-speed trains
VPL	**V**oltage **P**resence **L**ight

Glossary

Danger

A situation that has some power/potential to cause damage to people, property or theenvironment **[A].**

Risk

(a): It is the manifestation of the danger as a result of an accidental event, it is characterized by:

- ⇨ The severity of its effects.
- ⇨ The likelihood that it will occur.

(b): A combination of the probability of damage and its severity **[A].**

Damage

Physical injury or injury to health affecting persons either directly or indirectly as a consequence ofdamage to property or the environment **[A].**

Dangerous situation

A situation in which a person is exposed to one or more dangerous phenomena **[A].**

Gravity

Measurement of the consequences of an accident **[A].**

Accident

(a): An unwanted event that results in damage to people, property or the environment, and the company in general **[A].**

(b): Unintended and incidental events or chain of events causing damage **[A].**

Prevention

Prevention is the set of measures to avoid as far as possible the manifestations of a risk and to limitits effects **[A].**

Protection

Measure to reduce the severity of risks **[A].**

Safety

Absence of unacceptable risks **[A].**

Residual risk

Risk remaining after all preventive measures have been taken **[A].**

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General Introduction

Achieving safety is important in all aspects of life in general and in the fields of economy in particular, whereas the industrialized world is by far the most important due to the risks associatedwith it at higher rates than others to prevent or reduce workplace accidents and occupationaldiseases.Otherwise, this does not mean that safety is not necessary for other areas, such as trafficaccidents, where the number of deaths due to traffic accidents may reach the number of deaths dueto industrial causes or exceed, which makes this a reason for the need to follow safety proceduresin this area.

The most important technological revolution of modern times is the technological revolution in thetransport sector. Moreover, in the 20th century, famous means of transportation from railways, roadtransport, shipping, and air transport have witnessed unprecedentedtechnologicaldevelopments inhuman history, followed by complexities, whether technical or otherwise.Besides, transport is seenas the sensitive nerve in the economic and social entity nationwide as the effective means ofachieving continuous communication between the different points of the economic and productiveprocess, so the transport sector has seen a lot of interest and development.But despite its economic,social, or development returns, it lacks overall safety because traffic accidents are constantlyincreasing. Consequently, the transport system needs to be economically, socially, andenvironmentally sustainable, to meet the demand for expansion and sustainable development.

Currently, the road transport situation is under increasing criticism compared to other means due toits significant negative impact on the environment and public health. Road traffic accidents havebeen and continue to be a major contributor to human and economic costs.Therefore, for the sakeof sustainable development prospects, the attraction of rail transport has increased, which has beencharacterized by widespread developments in the level of its means due to the quality of masstransport it offers and the undeniable advantages it offers :reducing car congestion in cities,affordable transport costs in the face of high car fuel prices, high airfares, transportation time aswell as a low level of environmental pollution.

In fact, the tramway is one of the main means of rail transport that has contributed to improving thequality of targeted public transport, as such means have become a key component of economicprogress because of its returns on the physical and development side, as well as the social return ofindividuals, the public and institutions alike.

Moreover, the latter has received greatattention in the world, mainly because of its continuousdevelopment and radical changes, making it a way to attract traffic customers.Effectively, this typeof transport is one of the safest transportation in the world compared to other transportation, thanksto successive improvements in the safety system at its level, which remains the main concern in thisarea of dangerous activities, Further, where accidents can cause significant damage to the systemand the environment, and cause a large number of victims, and ensuring safety is the most sought,as accidents can occur, Therefore, controlling these risks is necessary to avoid various accidents,which include both risk identification and forecasting, and, on the other hand, reducing these risksby working on ways to reduce their occurrence, and mitigating their consequences through meansof avoidance and risk protection.

1. Problematic

In Algeria, which is one of the developing countries, a return to rail transport in major cities wasimperative, due to the inability of road transport infrastructure and poor quality of service (congestion, high travel time, discomfort, etc.) and also contributing to meeting and improving transport needs. Hence, it has implemented several projects to promote public rail transport, throughthe construction of tramway lines in major cities as well as working to disseminate this type oftargeted transport throughout the country. However, the tramway safety management systemadopted by the operator, regardless of shortcomings, has been somewhat strict with regard to safetyprocedures, the lack of a culture of safety among employees at the company level is a major reasonfor hindering its implementation, resulting in many professional accidents and public accidents,often due to lack of respect for traffic laws by the general public.

Given the importance of the topic, we have highlighted it through this modest work in a comprehensive manner and tried to identify the risks associated with tramway transport and how to avoid it.

2. Objectives of the study

The main objective of this study is to identify risks related to the Tramway of ouargla transport system and to control these risks. On the other hand, we are interested in suggesting a number of preventive measures that are seen to be very important to avoid exposure to these risks.

3. Structure of the thesis

The present manuscript of the current study is subdivided into four chapters:

- **The first chapter** presents an overview of urban transport and railway transport. Besides, it describes everything related to the Tramway.

- **The second chapteris** devoted to the theoretical background including all concepts andmethods related to safety, in order to pave and facilitate the application of railway safety.

- **The third chapteris** dedicated to give a brief presentation of SETRAM Company, wherewe actually implement the present study. In relation to this, it focuses on Ouargla tramwaywhich is our study's concern.

- **The four chapter,** We have identified risks at SITRAM and given recommendations to avoid them.

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1.1 INTRODUCTION

Rail transport has become the most common mode of transportation worldwide. Moreover, trams are becoming one of the most popular rail transportation tools for a variety of their benefits. Briefly, it is quite useful for people to escape from traffic by using it. As well, this chapter also reviews information relating to urban transport in general and to railways and trams in particular. First, we will shed light on the definition of urban transport and then the definition of rail transport and its different modes. Then, we are going to define the tramway, as well as its historical background. Next, we will examine the operating principle of the tram and its components. Finally, we will close the chapter with the benefits and the facilities tramway provides to people.

1.2 General information on urban transport

Since the existence of man on earth, he has used different means of mobility such as animals and wind and hydraulic energy. Thus, he switched to the 03-wheeled trolleys. But, transport experienced a rapid development at the beginning of the 19th century by the appearance of rail transport in the year 1830 in England **[1]**. In 2008, according to the United Nations, the world population in urban sites is 50% and it should increase strongly by 2030 to reach 60%, which requires an increase in means of transport. The international community is giving increased attention to public and individual transport in urban and suburban areas, as it is very necessary to meet its daily needs **[2]**.

1.2.1 Definition of urban transport:

Urban transport is a combination of mass and individual transport that works and allows for ensuring and facilitating people's movements within large urban agglomerations .

1.2.2 The different urban transport modes:

The types of transport used in Algeria can be classified into two categories

1.2.2.1 Road transport:

This category of transport is important up to now because it is characterized by low fares by comparing with rail transport. However, these improprieties are multiple due to noise and travel time is very long (See Figure 1.1) **[3] [4]**

Figure 1.1: Road Transportation

1.2.2.2 Rail Transportation:

Railway transport is a guided transport system, which is made up of infrastructure called a railway line, serving to transport passengers and goods **[6].**

Figure 1.2: Rail Modes

1.3 General information on rail transport

Rail transport is carried out on railways, it results from the association of two inventions, the rail, and the locomotive, and it consists of specialized infrastructure, rolling stock, and operating procedures most often involving humans. On one hand, rail transport was at the heart of the industrial era, playing a central role in the economic development of countries in Europe, North America, and Japan. On the other hand, it was the first major innovation in land transport technology and provided the catalyst for a series of important changes in chartering and passenger movements. **[3].**

1.3.1 Definition of railway transport:

This means of transport is essential in view of their advantage and quality of service by comparing it with road transport. It is characterized by the following advantages: High capacity of passenger and freight transport, lack of congestion of the road and compliance with deadlines, good safety. But it suffers from certain disadvantages such as the railway network is limited and high rates compared with road transport **[3] [4].**

1.3.2 Means of rail transport:

The rail system includes **[1]:**

a. The train: trains are used for intercity travel. There are several types of trains:

1. **Freight train:** Transport of goods, consisting of one or more vehicles and possibly closed vehicles moving loaded or empty;
2. **Passenger train:** Passenger transport, consisting of one or more passenger vehicles;
3. **Common train:** Consisting of passenger and cargo vehicles; **[5]**

There are two types of power supply: diesel trains and electricity trains. **[3].**

b. High-speed trains (TGV): (TGV "train a grand vitesse"): They are trains which run at more than 250 km / hour mainly on dedicated tracks and with specialized vehicles **[3].**

c. The Subway: It is an underground urban railway most often, on a viaduct sometimes, rarely on the ground, it is designed to constitute a network allowing the transport of a large number of travelers within an urban area. By means of vehicles on rails with external control, in a space totally or partially in a tunnel and entirely reserved for this use. This mode of transport is guided on its own full site, without crossing with any other mode of transport or pedestrian access. **[3].**

d. The tramway: It is a form of urban or interurban public transport running on railways equipped with flat rails and which is installed on its own site or embedded using grooved rails in the road network, it is generally at electric traction. **[3].**

1.4 General information on the tramway

The tram is a qualified rail transport with its many positive virtues, it has undoubtedly became one of the most suitable public transport systems (TCSP) for cities around the world; indeed, it represents the best solution to serve sectors with an average population and major urban axes. It is a flexible and reliable way to improve the quality and efficiency of public transit. **[6]**

1.4.1 Definition of the tram:

The tramway is a form of urban or interurban public transport running on a flat rail railway and generally with electric traction, mainly used for urban transport **[W1].**

The word Tramway designates a railway line formed by 2 parallel rails on which circulate steel wheeled vehicles performing an urban passenger transport service. Then, by extension, the electric traction transport vehicle circulating on these rails, often embedded in the roadway, and guided by them **[W2, W3].**

1.4.2 Historical background:

The first tramway line was built in France in the Loire, the tramway then developed in many European cities (London, Berlin, Paris, Milan, etc.). Faster and more comfortable than the buses (running on the carriageways), the trams have a high operating cost due to the animal traction. This is why the mechanical traction is rapidly developed: steam from 1873, compressed air (Mékarski system) and superheated water (Francq system) from 1878, then electric tramways from 1881 (presentation of electric traction by Siemens at the international exhibition in Paris).

In the United States, the first steam streetcar was used in Philadelphia in 1875. These steam trams had about 40 seats, weighed about sixteen tons and had a traction power of 200 to 300 tons on a slope.

The first electric tram was operated in Sarajevo (Austro-Hungarian Empire) in 1885, while in Switzerland the first line (Vevey Montreux-Chillon) was opened on the Vaudoise Riviera in 1888. In France, a tram was placed in Clermont-Ferrand in 1890 **[7].**

1.4.2.1 The first electric trams:

At the Berlin Industrial Exhibition in May 1879, Siemens experimented with a first electric tramway. In May 1881, Siemens and Halske commissioned the world's first electric tramway in Gross Lichterfelde, near Berlin on a 2.5 km in length. It is operated by small motor coaches with open platforms under a voltage of 1000 volts supplied by the 2 rails. The motor placed under the body, actuates the axles by cables. The speed reached is 40 km / h.

At the same time, an electric accumulator tram is being tested in Paris between Montreuil and Place de la Nation. In the spring of the same year, during the Electricity Exhibition in Paris, Siemens and Halske experimented with their first electric tramway with an overhead socket on a line of about 500 meters connecting the Place de la Concorde to the Palais de l ' Industry which then occupies the site of the Grand Palais. From 1883, the first electric trams appeared in regular service in Vienna, Frankfurt am Main and Offenbach.

From these years, the electric tram will develop rapidly at world levels. In 1888, 33 new lines stretched over 210 km, operated by 265 cars **[7].**

1.4.3 The operating principle of the tramway:

Trams are generally designed to run on 750 Volts continuous current. Their acceleration and deceleration capacities allow them to offer attractive travel times while serving as many stations as possible. Trams have a maximum speed of 80 km/h. In order to carry current (750 V DC), overhead contact lines (OCL) are used. The OCLs are anchored to posts that delineate the platform. Upon these OCLs, the tram pantograph will rub in order to provide it with the electricity it needs to move. The pantograph is mounted on the tram's roof. It is the responsible to collect the current that feeds the tram **[W3].**

1. **Overhead contact line (OCL)**
2. **Pantograph**
3. **Support cable**
4. **Anchoring in building facade**
5. **Anchoring in building facade**

Figure 1.3 – The train's electrical system

1.4.4 Tramway system components:

The tramway, and like specific site public transport, requires a special infrastructure and specific mode of operation.

1.4.4.1 Fixed equipment:

The fixed materials are:

- The railroad;
- Set of modern traction power generation equipment.

1.4.4.1.1 The tramway track:

The essential function of the track is to ensure the mechanical continuity of the track which supports the rolling stock and provides guidance under conditions of maximum safety and acceptable comfort. The railroad track has two sub-assemblies: the concrete platform and the rails connected to a support **[7].**

1.4.4.1.2 Energy Supply:

Although various propulsion systems are, in principle, possible (diesel, gas), electric traction, by external power supply, remains the universal mode of urban trams because of the technical and ecological advantages which characterize it: low operating noise level, absence total air pollution and greenhouse gas emissions, unrivaled performance in terms of acceleration, braking by regenerative energy, reduced maintenance, longevity of equipment and vehicles, etc. **[7].**

1.4.4.2 Moving equipment:

It includes all vehicles, engines or trailers, designed to move on the rail.

1.4.4.2.1 The components of the train-set :

The train of the tram is bidirectional, it comprises the following components **[8]**

- Driving cabin
- Motorized platform
- Carrying platform
- Suspended body.

1.4.6 Benefits & Costs of tramway:

1.4.6.1 Benefits of tramway:

- The tram is part of a great deal of attention in favor of sustainable development, improvement of the quality of life, the environment and the ease of movement for the inhabitants in a fast way and in more comfortable conditions.
- Trams are precise and regular, and have a higher loading capacity than buses, where this possibility of long lengths makes it possible, to offer a throughput of up to 7,000 passengers per hour and per direction, i.e. 3 to 4 times higher than that of a line operated by articulated road vehicles.
- The electric tram does not pollute the atmosphere. **[6]**

1.4.6.2 Negatives of tramway:

- The upkeep and maintenance are heavy due to an important infrastructure.
- A tram cannot go around obstacles. A small obstacle can therefore block the traffic of the tram.
- In the event of public demonstrations (political parades, strikes, etc.), the tram proves to be a prime target to be easily blocked, causing significant inconvenience (unlike buses).
- The investment cost is high compared to the bus, which can also be designed on its own site.
- The construction of the infrastructure requires work that hinders residents and traffic.
- The work to put in place the infrastructure necessary for the tram requires rethinking the layout of public spaces and its distribution.

- The speed is slow compared to the metro and the flow is lower: around 7,000 passengers per hour at most against more than 12,000 for the metro.
- Hollow rails are dangerous for cyclists when they share the same roadway as the tram. **[W: 4, 5, 6]**

1.5 CONCLUSION

All in all, the tramway is one of the main means of improving the quality of railway transport, which has been a major component of the economic progress of what the railway achieves, whether material or developmental, as well as the social return of individuals and public institutions alike. Moreover, the latter has received great attention in the world, mainly thanks to its constant development and radical changes, which made it a means to attract traffic customers.

In this chapter, we have tried to give an overview of rail transports including its definition and its means. Moreover, we highlighted everything related to the tramway, from its definition and its historical background. Next, we presented the operating principle of the tram, then, we highlighted its components. We described, on the one hand, the tramways' fixed equipment, which is the tramway track and energy supply. On the other hand, we dealt with its rolling stock, which is the components of train-set then finally, we presented the benefits and Negatives of the tramway.

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1.1 Introduction

Railway transport; such as Subway and tramway; has witnessed a noticeable development these lastyears. It has become the most efficient transportation means that people prefer to use the mostbecause of its usefulness and practicality. More importantly, it is assumed that railway safety playeda crucial role in the prosperity of this development and it was a guiding principle in its enhancement.Consequently, this mode of transport nowadays is considered to be one of the safest means in theworld. In this chapter, we will give an overview of the important concepts related to our study.Firstly, we will explain the distinction between safety and security by defining them. Next, we will attempt todefine the risk concept, and in relation to this, the risk classification .Furthermore, we are going to describe the accident management system. Finally, we close thechapter with safety linked to railways, and in connection with this, safety and securityin the transport sector, the concept of rail safety, safety elements, the rail risk process.

2.2 The distinction between security and safety

We can distinguish between the two terms based on our understanding of their definition because itshows us the scope of both.

a. Safety

Safety is defined as the absence ofunacceptable risk, injury, or harm to human health, directly or indirectly resulting from damage toequipment or theenvironment, during the course of activity **[9].**

b. Security

Security refers to the protection of individuals, organizations, and properties against external threatsthat are likely to cause harm. **[W7].**

2.3 The risk concept

According to (ISO 31000) risk is defined as « effect of uncertainty on objectives», these objectivescan have different aspects such as financial, health and safety, and environmental goals and canapply at different levels such as strategic, organization-wide, project, product and processThe probability of occurrence of a potential accident and the severity of damage caused by theseaccidents are the two elements that identify the concept of risk**[10].**

2.3.1 The risk classification

Numerous risk classifications have been proposed in the literature and industrial practice. The mostimportant of them are included in the following classification:

⇨ Risks are classified according to the effects resulting from the event.

⇨ Risks classified according to the criterion of the nature or the origin of the potentially unfavorable event.

⇨ Risks classified according to the type or nature of the economic result resulting from the event.

⇨ Property risks: they relate to destruction, damage, the disappearance of the property with theresulting costs, and loss of earnings.

⇨ Personal risks: events involving physical risks for people. **[6]**

2.4 The accident management system

An accident management system is a system or method designed to help companies:

- Accident report: a method for recording all events (accidents, incidents, etc.).
- Risk assessment and its consequences: A method of classifying each event according to its risks.
- Incident Investigations and Root Cause Analysis: Conducts accident investigations and rootcause analysis.
- Recommendations and corrective actions: promote the ability of leaders to make recommendations, formulate and execute corrective actions, and monitor each action as it is being taken.
- Event history: the historical record of events that may happen in this organization.**[6]**

2.5 Railway Safety

2.5.1 Safety and security in the transport sector

In this research work, we are interested in the safety related to the operation of public transport, inparticular the tramway, which face many challenges to ensure safety and security and satisfactionand comfort to his clients.

Where these two concepts: safety and security and in addition to reliability, represent the basis ofquality factors according to Maslow's pyramid, which highlights on quality factors in publictransport.

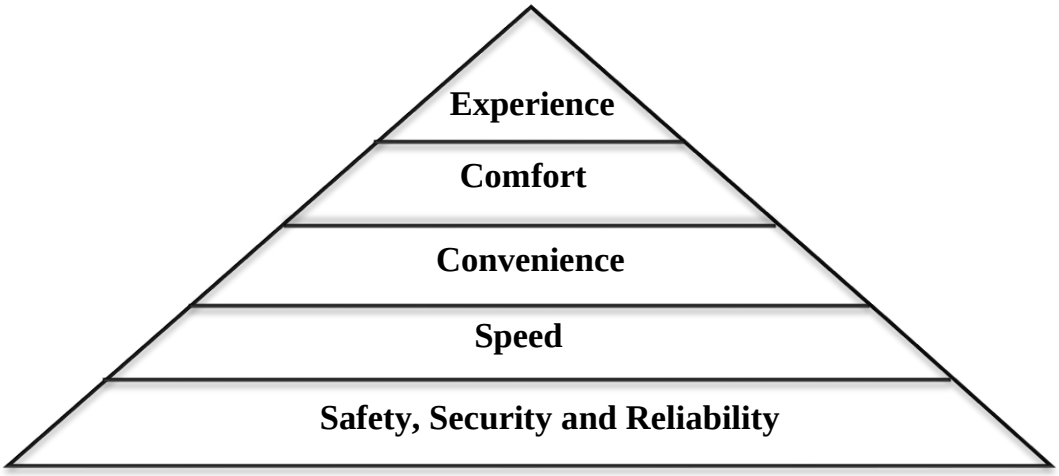

Figure 2. 1 Maslow Pyramid of quality factors in public transport [11].

➢Quality components: safety, security, reliability and speed form the base of the pyramid, representing most important requirements set by the public transport customers. The lower part of this pyramid shows the components that must be sufficient without doubt. Concerning the two upper parts (comfort and experience), they show the satisfiers which are additional quality aspects.

Transport safety and security are different issues, because safety is associated with risk whilesecurity is associated with uncertainty or they focus on very different types of risks. “Safety risks”originate from unintended failures, errors or misfortunes whereas “security risks” originate fromdeliberate or malicious attempts to disrupt, disable or destroy.

The term “security” is the prevention of unlawful interference with passengers and transportinfrastructure and must give users confidence in the use of transport, while term “safety” refers tothe methods and measures to protect people from the risks directly related to and arising fromtransport **[11]**

2.5.2 The concept of the rail safety

Rail safety is a set of human and technical resources that make it possible to avoid rail accidentsand reduce their consequences, through the regulation, management and technological developmentof all forms of rail transport. The rail system is a system affected by various stochastic influences.These are, for example, human error, unforeseen failures and various combinations of adverseconditions that can adversely affect the safety of various parts, or even the entire rail system.Furthermore, rail safety in urban areas and in particular the tramway is the average concern of publicrail transport operators. It is the responsibility of the operator taking charge of the operation of thetramways and the management of the infrastructure. Today, the separation of the operation andmanagement of the infrastructure has created other elements that must be taken into account. In fact,it is essential to control internal risks, but it is also necessary to integrate the risks shared with otheractors in the urban environment. **[6].**

2.5.3 Safety Elements

Safety of a railway system is dependent on the balance of following three elements:

- **Human**
- **Machine**
- **Environment.**

Neglecting one of the elements may cause a system imbalance as result of negative externality andthus interrupt the operation execution. The goal of optimization of Safety Elements systems(Human, Machine and Environment**)** is to ensure wellbeing of humans and prevent any injuriescaused by accidents **[12].**

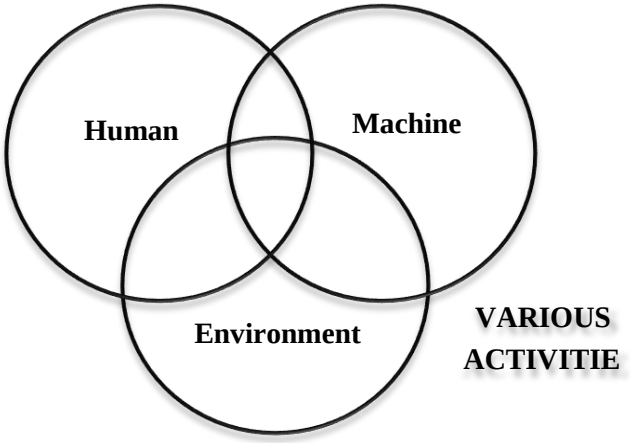

Figure 2. 2 Safety Elements [12]

- **Human**: railway system includes all persons directly connected to the rail vehicle.
- **Machine**: means railway vehicle which may under certain circumstances disrupt the functionality of the railway system. The circumstances may be bad technical condition, derailing of the vehicle and others
- **Environment**: is another element of railway system, which directly influences safety of the system.

2.5.4 Components of the rail safety system

Railway safety system is characterized by three basic components. These are: Safetyindicators,Safety goals and Safety method **[12].**

✦ **Safety indicators**: They are information regarding the railway system safety which allowscomparing the system safety level to the safety goals. They represent parameters definingthe railway safety level. Safety indicators comprise the system elements. The indicators areserious incidents, accidents where lives were lost, and others. Based on the above mentionedindicators, the safety goals are set.

✦ **Safety goal**: It represents a minimum safety level expressed by acceptable risks which haveto be reached by all elements of the railway system. The goal is to maintain the safety of thewhole system via minimization of risks.

✦ **Safety method:** It is a set of methods that must be implemented to achieve the requiredsafety and thus achieve the objectives set.

2.5.5 The rail risk process

The risks existing in the railway system can affect either a unique individual (individual risk), or several people (collective risk), or the system (rolling stock and infrastructures), or the environment.

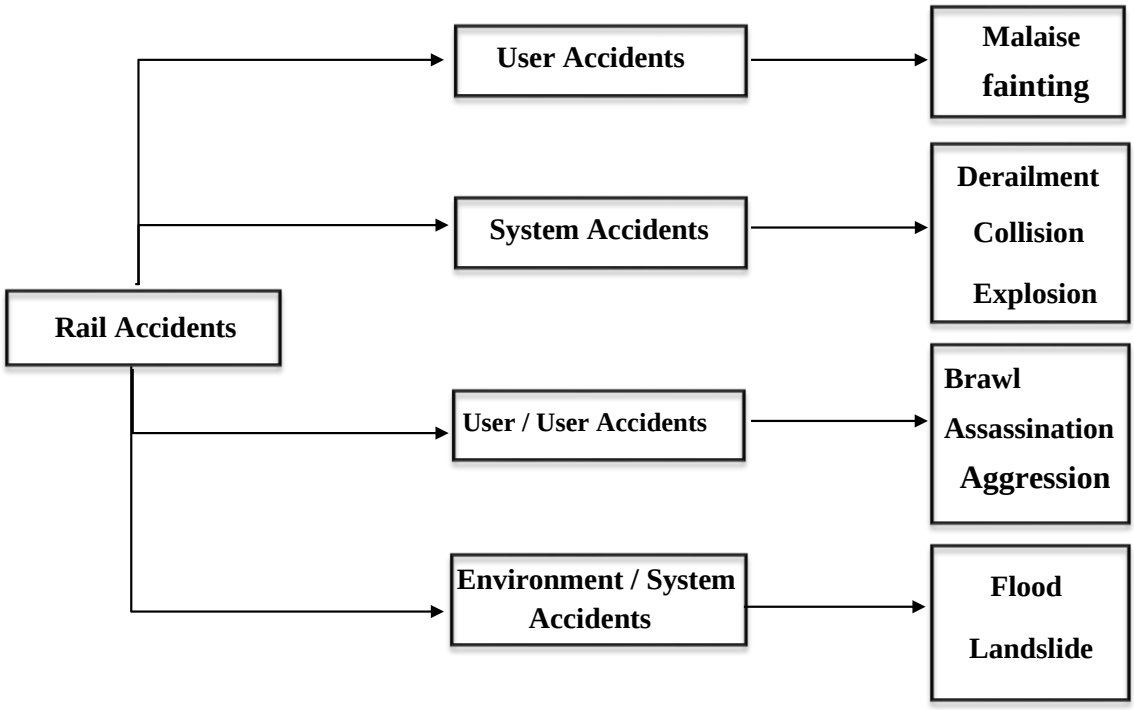

Figure 2. 3 Classification of the various accidents in the railway system [13]

The four categories in (Figure 2.3) are described as follows:

· **User Accidents:** They are associated with the damage caused to one or more users locatedwithin the system when no problem of operation of the system has occurred and no actionof this user or users has been detected.

· **User/Useraccidents:** They are associated with the damages to users caused by other users

· **System Accidents:** They are associated with damage to the system and to users or personnelin an accident initiated by the system itself.

- **Environment /System accidents:** They are associated with damage to the system and usersduring environmental conditions known as natural disasters.**[13].**

2.6 Conclusion

Each system has the possibility of being violated. Therefore, it is important to address the issue ofraising the safety of the railway system with the priority of preventing serious accidents using the latest scientific and technological developments.In this chapter, we have tried to give an overview of the important concepts we are interested todefine in our study. Firstly, we explained the distinction between safety and security. Next, we attempted to define the risk concept, and in relation to this, the riskclassification . Furthermore, we described the accident management system.Finally, we dealt with the safety linked to railways, and in connection with this, safetyand security in the transport sector, the concept of rail safety, safety elements, the rail risk process, and the risk assessment in a rail system.

Chapter 3

Presentation of the Company

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3.1 Introduction

The transport sector has witnessed remarkable development globally and in Algeria in particular over the past five years, driven by the desire to generalize and develop the rail transport sector as much as possible at the national level to ensure economic and social growth. Moreover, among the major projects launched by Algeria to improve the transport sector and modernize public transport in urban or inter-city areas is the tramway. Besides, in Algeria, only one operating leader company is currently present in Algerian cities, this company is SETRAM .

In this chapter, we will give a brief presentation of SETRAM Company, where we actually implement the present study, as well, we will present the quality policy of the company. Besides, we will shed light on Ouargla operational unit including its organizational, as well, the details of the rail line of Ouargla tramway, besides, we are going to examine the rolling stock of Ouargla tramway, and also the operating energy of Ouargla tramway. We will close the chapter with the electrical safety management of Ouargla tramway.

3.2 STREAM company presentation

SETRAM is the result of an agreement between the Metro of Algiers Company (EMA) and the Autonomous Paris Transport Authority (RATP).

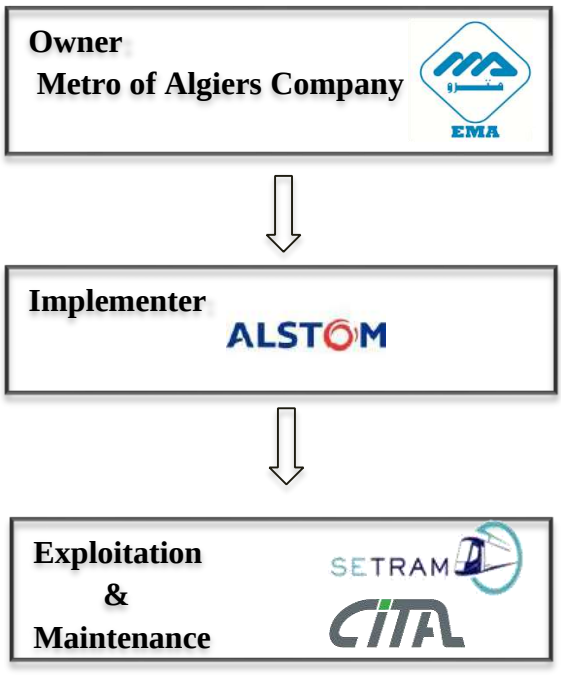


Figure 3.1 Partner Organization [14]

In addition, SETRAM operates and maintains tram lines in Algeria. Currently, it operates all tram lines in Algeria, with its headquarters in Algiers. The company operates six tram lines in six states (Figure …), and aims to make tram transportation more popular in the country.

Figure 3. 2 State tram operating [14]

As well, SETRAM aims to:

- Provide a high-quality transportation service where safety, comfort, regularity, and cleanliness are essential;
- Assist Algerians in the adaptation phase to this new mode of transport and to embed it in their travel habits,
- Position itself as a reference in Africa and around the world **[14]**.

3.3 Quality policy of SETRAM

SETRAM has a strict quality policy that contains a program to achieve its goals, which has also enabled it to obtain a quality certificate in 2018.

SETRAM's quality policy is based on the following objectives:

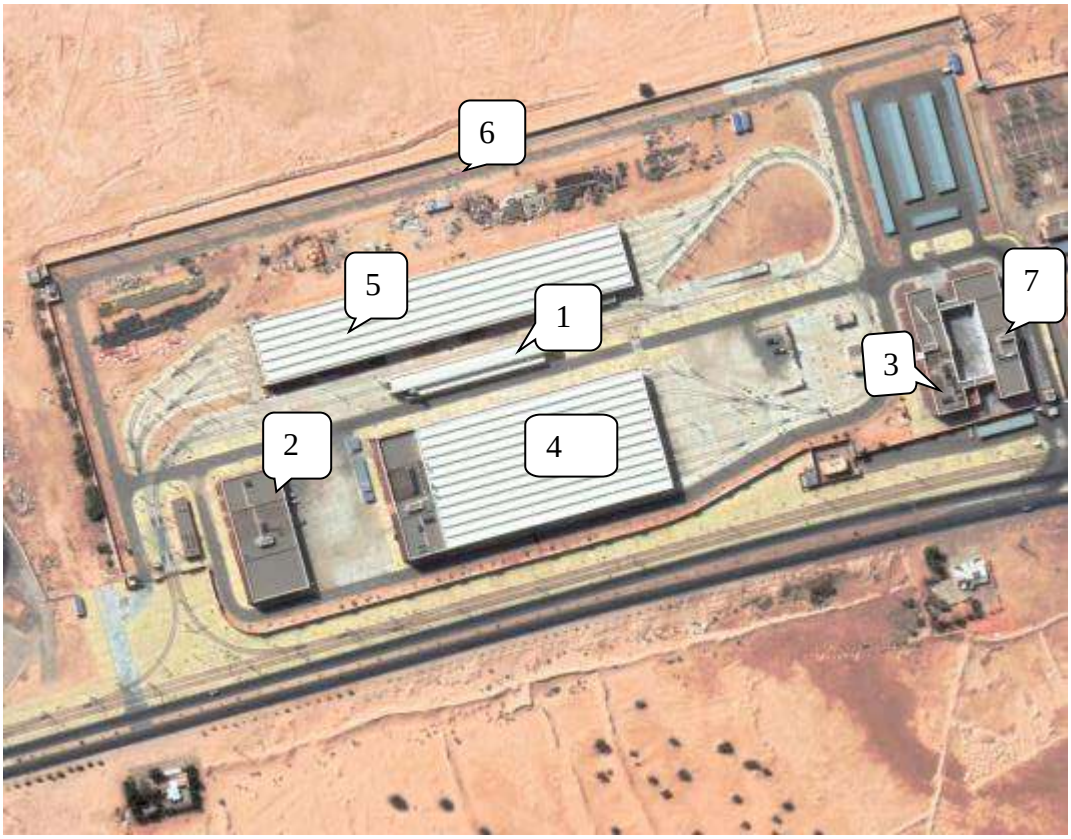
- **Axis 1** Adapt governance and organization.
- **Axis 2** Developskills.
- **Axis 3** Strengthen the operational fundamentals.
- **Axis 4** Takes into account the customer and communicates

With its quality policy and certification, SETRAM confirms its objective of satisfying all of its customers, namely the Algiers Metro Company and tram users, through a quality offer. Further, it meets the highest standards of reliability, adherence to all requirements, and operational methods.

Equally important, SETRAM is currently developing an integrated policy as well as implementing an effective program to achieve an integrated management system **[14].**

3.4 Presentation of Ouargla operational unit

Ouargla SETRAM branch is the fifth line in this organization, and it is a sub-unit of the parent company based in Algiers, as it is the case with all subsidiaries in other states; so all services provided by the unit and all its levels are an extension of the objectives, vision, and mission of the parent organization. That's why we find only 2 directions in Ouargla SETRAM unit, and the rest are just services.**[14].**



1. The service station
2. Fixed installations maintenance building
3. **C**entralized **C**ommand and **C**ontrol Station
4. The maintenance hail
5. Covered storage
6. The test track
7. Administrative building

Figure 3.3 CITAL Company sites in Ouargla [14]

3.4.1 Organizational of the operational unit

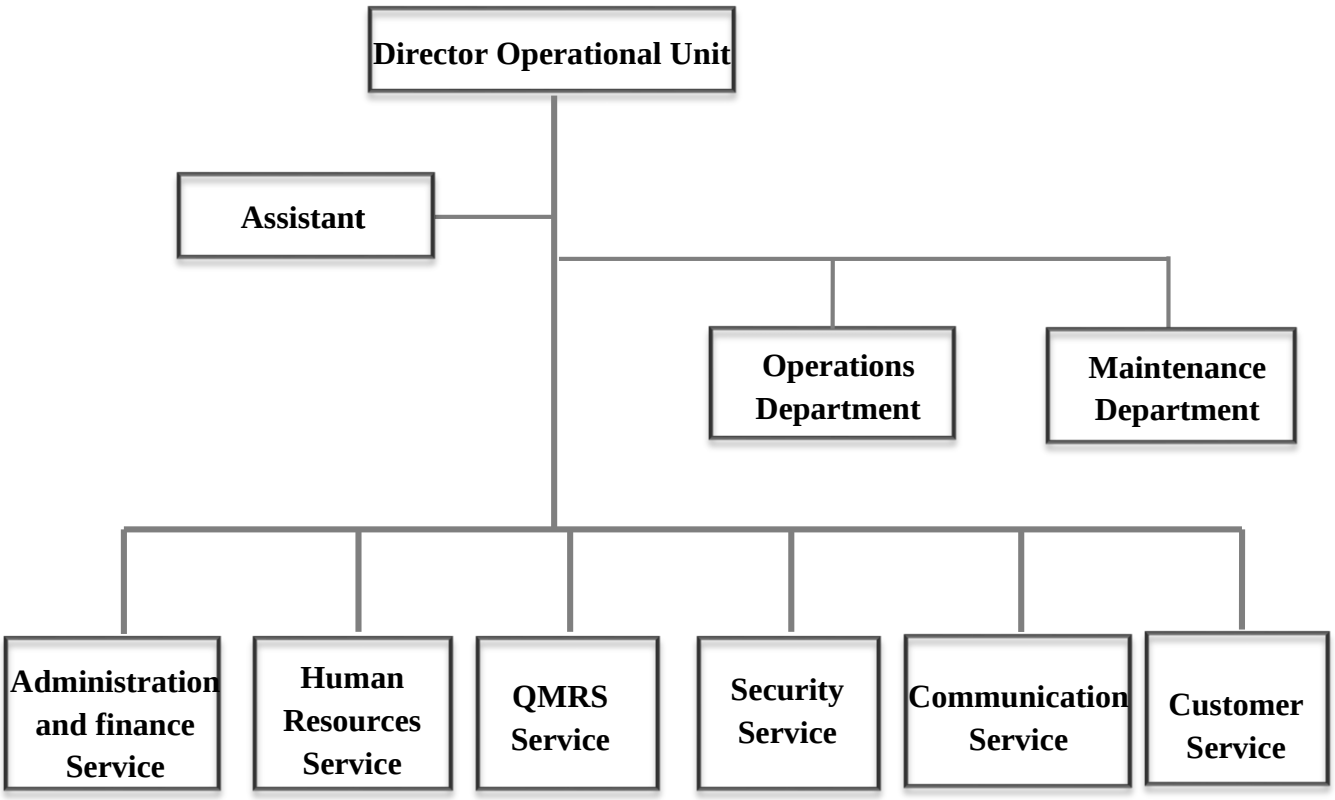


Figure 3. 4 Organizational chart of the operational unit [14]

3.4.1.1 Organizational of the QMRS Service

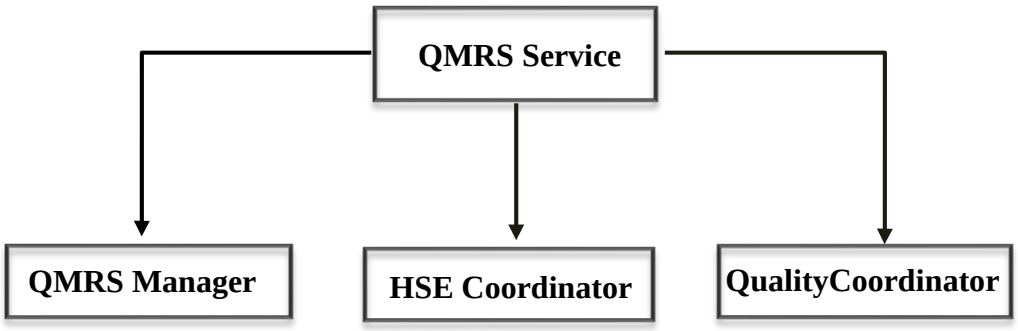


Figure 3. 5 Organizational chart of the QMRS Service [14]

3.4.2 The rail line of Ouargla tramway

Commissioned on 20 March 2018, Ouargla tram is the very first tram in the desert, besides, designed to withstand the extreme weather conditions associated with the proximity of the desert.

3.4.2.1 The line

Ouargla tramway system consists of a double-track line of about 9.6 kilometres in length.

- Way 1 (WI) from CHENINE KADDUR to SID ROUHOU
- Way 2 (W2) from SIO ROUHOU to CHENINE KADOUR

And consists of 16 stations as well as a sweeper, a maintenance center (MC), and storage vaults. Moreover, this line is traveled by a fleet of Citadis 402 ALSTOM train-sets electrically powered by an overhead line. Additionally, Ouargla Tramway contributes significantly to meeting the traffic needs of urban and suburban areas in the state [14].

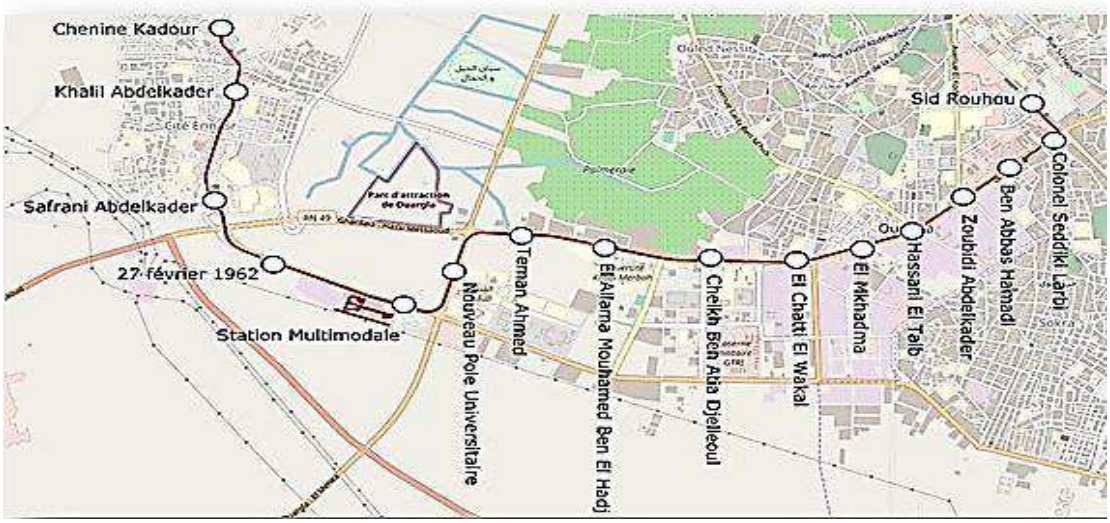


Figure 3. 6 The line plan of Ouargla Tramway [14]

3.4.3 Rolling stock of Ouargla tramway

Ouargla tramway is equipped with 23 Citadis 402 type train-sets built by Alstom and assembled by Cital in Annaba, Algeria. In addition, the capacity of a tram is 414 passengers. In order to withstand the particularly difficult climatic conditions, linked to the proximity of the Sahara desert, the Ouargla tramway is adapted to the day and night temperature variations of this Saharan region known for its extreme climatic conditions. Indeed, the train-sets have been designed to withstand more than 49 °, dust, and sand, the windows are covered with protective films to protect passengers from the sun. Besides, Ouargla Tramway is also equipped with a high-performance reinforced air conditioning system adapted to Saharan summer temperatures **[14].**

3.4.3.1 Characteristics of Ouargla Tram Type (Alstom Citadis 402)

Citadis 402 vehicles with a fully low floor. They are of the bidirectional type. Their operation is in a single unit. The vehicles are air-conditioned and have 6 double access doors and 2 single doors on each side. Additionally, all the doors are equipped with a fixed overhanging threshold with an adjustable part to limit the nominal horizontal gap to the right of the doors to promote accessibility for people with reduced mobility. Also, the length of the vehicles is approximately 45 m and its passenger capacity is 302 people in normal load. Furthermore, this type of trains are made up of 7 articulated modules resting on 4 bogies

including 3 motors. The motor bogies are specifically located under the end boxes, known as drive units 1 and 2 (M1 and M2), and an intermediate box called motor nacelle (MN). Then, the carrier bogie is installed under one of the central boxes known as the carrier nacelle (CN). Finally, between each power unit and nacelles (power unit and carrier) are inserted suspended boxes **[W8].**

3.4.4 The Operating energy of Ouargla tramway

SONELGAZ is the national company in Algeria which is responsible for electricity production and transmission **[14].**

The company has several subsidiaries in the energy sector, including:

- The SPE : Power Generation Company
- The GRTE: Electricity Transmission Grid Management

GRTE is responsible for transmitting electricity to STREAM substations, which are:

- High voltage substations (HVS)
- The RS (rectification substations)
- The overhead contact line (OCL)

3.4.4.1 Distribution

- The SONELGAZ (GRTE) network supplies the HVS with 60 kV alternating
- The PHT supplies the SETRAM Sub-Stations (RS) with 30 kV alternating
- The RSs supply the Overhead Contact Line (OCL) with voltage 750 V direct current; (The Ouargla tram line have a 5 rectification substations (RS)
- The trams capture energy on the OCL due to the pantograph.
- To improve reliability and ease of operation. A line is divided into electrical sections, which are themselves divided into subsections.

A line is divided into electrical sections between two substations.

- Energy management is managed by the PCC, by regulators **[14].**

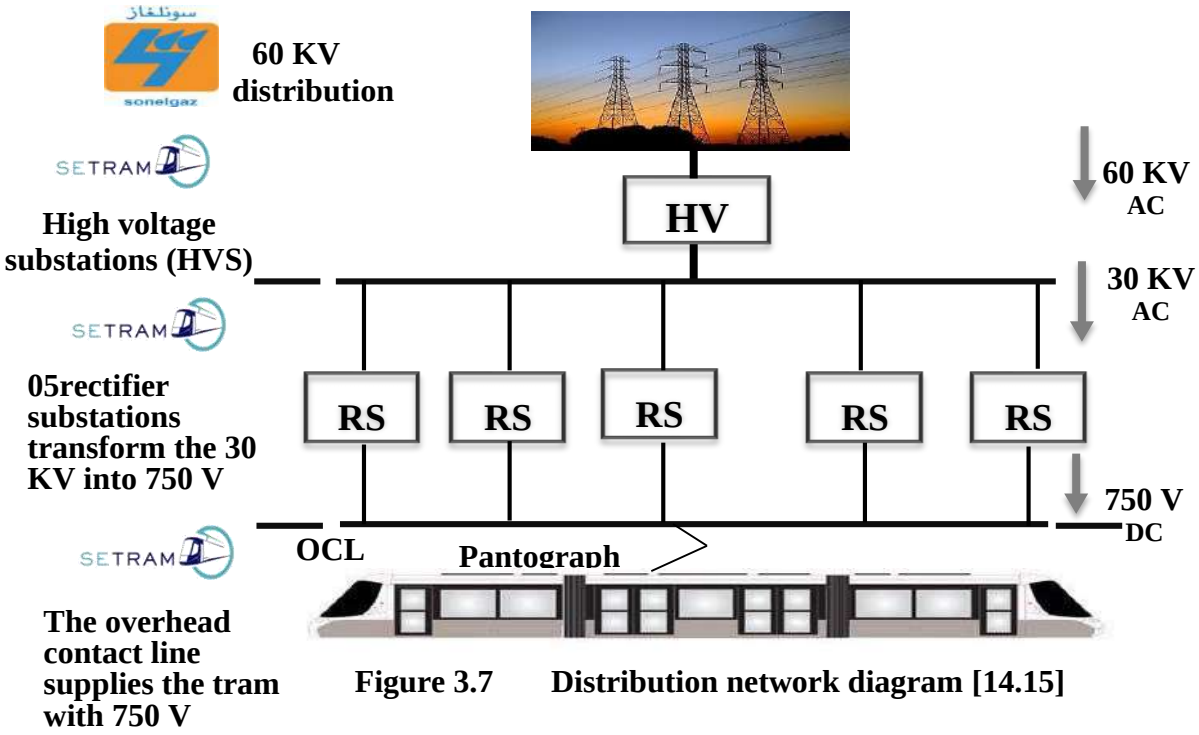


Figure 3.7 Distribution network diagram [14.15]

3.4.5 Electrical Safety Management

3.4.5.1 Voltage presence light (VPL)

As a safety principle, the OCL is always considered energized.

A voltage presence light (VPL) is installed in the electrical section of a train set to indicate the presence of electricity in that section and is monitored by the driver **[14].**

Figure 3.8 VPL device .

3.4.5.2 Emergency shutdown

The power supply system is equipped with emergency shutdown devices:

The “Emergency Stop Button” (ESB) is located at the PCC (operated by the regulator) or at the depot **[14].**

Figure 3.9 ESB device .

3.5 Conclusion

To conclude, this chapter is dedicated to give a brief presentation of SETRAM Company, Moreover, we presented the quality policy of the company. Besides, we shed light on Ouargla operational unit including its organizational and the organizational of the QMRS service in particular, as well, the details of the rail line of Ouargla tramway. Besides, we examined the rolling stock of Ouargla tramway, and also the operating energy of Ouargla tramway. In the end, we presented the electrical safety management of Ouargla tramway.

PRACTICAL AXIS

Chapter 4

Summary

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4.1 Introduction

Safety at work is a factor that must be taken into consideration. Moreover, during accidentsSometimes unavoidable, it is necessary to take into account the risks associated with activity and take necessary measures to protect employees. Therefore, SETRAM contains a fileAnd an external program to achieve and ensure the safety of all workers and the environment andequipment.

In this chapter, we will highlight all the risks categorized byCompany, we will determine the risks of maintenance operations. Besides the risks related to the tramway, we will present the basic rules for safe maintenance. As well as a number of recommendations proposed to avoid accidents associated with the tramway.

4.2 Different risks associated on STREAM's activities

All potential risks in the company have been classified and identified to facilitate risk management which largely depends on risk assessment.

Table 4.1 Different risks associated on STREAM's activities

Field	Risks related to each field
	• Risk of falling
Handling / Traffic	• Risk associated with manual handling • Risk associated with mechanized handling • Risk associated with traffic and movement • Risk associated with collapse and falling objects
Chemistry / Biology	• Toxic risk. • Risk of fire, explosion. • Biological risk. • Risk related to lack of hygiene.
Equipment	• Risk related to electricity. • Risk related to machines and tools.
Ambient Environment	• Risk related to noise. • Risk related to vibrations. • Related risk thermal environments. • Risk related to radiation. • Risk related to light environment

Organization	• Risk related to the intervention of an external company. • Risk related to the organization of work.

Source: Company document, SETRAM.

4.3 The tramway risks

The risks existing in the tramway can affect either a unique individual (individual risk), or several people (collective risk), or the system (rolling stock and infrastructures), or the environment.

- **User Accidents:** They are associated with the damage caused to one or more users locatedwithin the system when no problem of operation of the system has occurred and no actionof this user or users has been detected (Malaise,fainting …).
- **User/Useraccidents:** They are associated with the damages to users caused by other users (brawl, assassination., aggression …).
- **System Accidents:** They are associated with damage to the system and to users or personnelin an accident initiated by the system itself. (Derailment, Collision, Explosion …).
- **Environment /System accidents:** They are associated with damage to the system and usersduring environmental conditions known as natural disaster (Sandstorm …) **[13].**

4.4 Risk assessment application for maintenance operations

4.4.1 Basic rules for safe maintenance

1. Planning Maintenance must start with proper planning. Starting with doing a risk assessment aswell, workers should be involved in this process.
2. Making the workplace safe. The work area needs to be secured by preventing unauthorizedaccess, by using barriers and signs, for example. The area also needs to be kept clean and safe, withpower locked-out, moving parts of machinery secured, temporary ventilation installed, and saferoutes established for workers to enter and exit the work area.
3. Use of appropriate equipment. Indeed, Workers involved in maintenance tasks should have theappropriate tools and equipment, as well, they must also have appropriate personal protectiveequipment (PPE).

4. Working as planned. Safe work procedures have to be communicated and understood by workersand supervisors and applied correctly. The work should be monitored so that the agreed safe systemsof work and Jobsite rules are observed.

5. Final check. The maintenance process needs to end with checks to make sure that the task hasbeen completed, that the machine under maintenance is in a safe condition, and that all wastematerial that has been generated during the maintenance process has been cleaned away. When allis checked and declared safe, then the task can be signedoff, and supervisors and other workers canbe notified [W9].

4.4.2 Identification of hazards and risk assessment during maintenance operations

Table 4. 2 The risks related to the operation maintenance of Ouargla tramway

Danger	Risks	Effects	Preventative measures
Movement on congested, uneven or slippery ground	Fall on the same level	Pain, Sprains, Bruises, Wounds, Fracture	Wear safety shoes Delimit travel and traffic areas Regularly clean the site
Business trips	Road risk	Accidents road it can lead to: - Major injuries -Paralysis / disabled -Dead	- Respect the rules of the road - The vehicle must be maintained regularly - Regular medical monitoring of the driver

Responsible position	Stress and intellectual fatigue	Pain and tension (in the jaws, neck or back), asthenia (general state of fatigue), difficulty falling asleep, awakenings at night, dizziness	Medical monitoring. - Regularly take recovery leave. - Have a healthy lifestyle (practice a - sporting activity, balanced diet, sleep, avoid stimulants ...)
Screen work	Visual constraint	Disturbances in attention and concentration, disturbed mood	- Ergonomic layout of the workstation - Take 5-minute breaks
Movement on foot Work that requires standing	Imbalance, Repetitive movements, Joint constraints, Frequent walking	Muscle fatigue, Circulatory disorders	Take breaks of 5 to 10 minutes every two hours

Presence of dust Sand wind	Frequent andprolonged inhalation of dust	Allergies	- Use dust masks in the presence of large amounts of dust
The presence of dust from the work		chronic lung disease and asthma Occupational diseases (1)	- Water the soil regularly
Manual handling of equipment and materials	Poor adaptation of the task (handling in the wrong method) Falling objects	Pain, Muscle fatigue,trauma, injuries	- Raise awareness and train workers in manual handling techniques. - The maximum load to be carried must not exceed 25 kg - Bulky loads must be carried by at least 2 people
High traffic or access	Fall from height	- Major injuries - Paralysis / disabled - Dead	- Use compliant scaffolding, platforms and ladders - Use safety harnesses - Make workers aware of work at height and more specifically on the use of safety harnesses

Movement in an area of vehicles, machinery, moving mass	-Risk of overturning by machine/vehicle -Risk of a vehicle/machine with a pedestrian collision -Falling load	- Crushing - Major injuries - Dead	- Make a traffic plan by delimiting the pedestrian / vehicle traffic zones - Make workers aware of this plan

Work in restricted space	Shock, head hit	Pain, Injuries and Bruises	Wear the safety helmet
Outdoor work	Heat and bad weather Sun glare	Sunstroke or heat stroke Unconsciousness skin infections	- Arrange working hours to avoid major heat waves - Wear PPE
Power tools powered by multi-level patched cables	Electrification or electrocution	-Third degree burns -Death	- Prohibit the use of a noncompliant power tool - Raise workers' awareness of the electrical risk
Use of hand tools (sledgehammer, pincers, pliers, hammer ...)	crush, cut, puncture, perforation , Sectioning and Shearing	shallow cuts, pricks, Injuries, wounds	- Use safety gloves - Check and control hand tools
Storage of Chemicals	-Fire and explosion risks -Risk of contact, by falling or overturning of products -Risk of inhalation of vapors, aerosols, -Risk associated with accidental spillage and	-Chemical burns -Poisoning -Respiratory tract irritation -Environmental pollution - Considerable material damage -Serious injuries	- Chemicals must be stored according to safety rules (product compatibility) - Use gloves and a respiratory mask when handling these products - The storage room must be ventilated and Ensure the worker is competent

	degradation of packaging.	-Death	to handle chemicals
Storage of heavyequipment at height	Falling objects	-Crushing -Serious injuries -Death	- Store heavy and bulky equipment on the lower shelves - Use a compliant stepladder to access the upper shelves
Use of electric tools	Vibrations	Osteoarticularpathologies of the upperlimbs	- Wear ear muffs, safety gloves and safety glasses - Check and control theequipment regularly - Regular medical follow-up
	Noise	Deafness	
	Sectioning and Shearing	Wounds, cuts	
	Shrapnel flying.	Eye injury due to Projected particles	
Welding	Electrization Electrocution	Burns Death	- Wear job-specific PPE (inaccordance with the PPE staffing procedure)

Source : HAKEM Nesrine , « Safety Analysis of Ouargla Tramway » , Mémoire de licence, université KasdiMerbahouargla, 2021

4.5 Recommendations

Below is a set of suggested recommendation guidelines to reduce the risk of an accident and toimprove the work environment in general :

As for the aggressions accidents, which constitutes the largest percentage, it is necessary:

- To intensify security and working in groups;
- To reduce conflicts with travellers;
- Be calm when any disagreement arises with one of the travellers;
- Call for security intervention in the event of an increase in skirmishes;
- To deal sensitively and patiently with passengers to avoid any skirmishes that may cause accidents;

As well, for the rest of the other accidents and to improve the work environment to ensure a goodperformance free of any injuries or accidents, we suggest the following:

- The data of each accident must be recorded and periodic statistics on the causes of accidentsmust be established, which helps to determine prevention measures;
- Improving workers' physical and psychological conditions by limiting the duration of workand daily rest periods. And combating the speed of work, to avoid fatigue and boredom, whichincrease work accidents;
- Paying attention to the training of employees, given that training is a reason for developingthe capabilities and skills of workers, which contributes to improving their performance andavoiding mistakes or accidents;
- Training the supervisory workers on the means of preventing accidents, holding periodic

security meetings, which help in identifying occupational hazards, and providing workerswithall information related to any potential danger to which they may be exposed.

- Teaching workers the habits of security precaution and drawing the attention of newcomersto work, through publications, updates, and advertisements, which generates in them a spiritof precaution.**[6].**

4.6 Conclusion

In conclusion, in this chapter, we first presented the risk ratings related to SETRAM, then we touched on the maintenance risks in addition to the risks associated with the tramway.

We also presented the rules for safe maintenance and recommendations to avoid accidents associated with the tram.

General conclusion

Summary

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General conclusion

With the rapid growth and development of the transport sector, particularly in the field of publictransport, it has become necessary to enhance the safety of these facilities by developing new andeffective strategies that my rise the chance to reduce accidents through a serious control of variousrisks and a wise implementation of safety techniques .

As a result, we have decided to carry out this case study in order tostudy the safety systemimplemented in ouargla tramway.

Work done

This thesis dealt with several important aspects and all of them aimed at enhancing safety at thehighest levels

We devoted our efforts to giving an overview of rail transport, as well as going into detail aboutthe tram system to be fully aware of the focus ax of our thesis.

In the second chapter, we introduced concepts related to safety.

In the third chapter, we attempted to give a brief presentation of setram company and presenteddetails about ouargla tramway.

In the fourth chapter of our thesis, under the practical component, we dedicated our efforts to dotwo tasks: the first was to present the risks of maintenance operations and the risks related to a tramway, which was essential to determine and eliminate risks, we also introduced basic rules for safe maintenance.as well, we've provided asmany recommendations as possible to keep away from the accidents related to a tramway

Synopsis

This research reveals that the importance of safety must be emphasized inall economic and other activities, moreover, achieving it requires controlling all work-related risksand studying them in detail and in-depth so as to prevent any occurrence of accidents, whether onthe worker level, the customer, or work environment level that was represented in both internal andexternal facilities. As a result of its achievement, the institution's work will run smoothly, theservices provided will be of high quality, and all the defined objectives will be met through theinstitution's mission and vision.

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