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Title

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Application: Tébessa airport.

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ABSTRACT

Airports are considered as most vital national infrastructure. The facility is often considered strategic for any country as it ensures the transportation of people and goods on regional, national, and international scales. Airport infrastructure design, construction, and management are strictly bounded by the NRPR (norms, rules, practices, and recommendations) of the International Civil Aviation Organization (ICAO). Airport administrators are faced with difficulties in accessing technical information related to the Airport that is usually archived in hard documents files, technical notes, and drawing plans. Decision-making is mostly delayed by difficulties in accessing technical information that remains a complicated duty, as it is linked to administrative permissions and restraints.

Building information modeling (BIM) is a new modeling concept, applied to the construction world that could be defined as a digital representation of a facility's physical and functional characteristics. All the technical information related to the project can be easily consulted, and shared by planners, designers, constructors, operators, and maintainers to provide fast and reliable information for decision-making throughout the facility's life cycle.

In this project, an attempt was made to introduce the BIM concept with its most recent developments. A deliverable BIM model is proposed herein, developed specifically for an airport facility (Aerodrome of Tébessa, Algeria), to support its operations and facilities management and enable the engineering team to visualize most airport's main elements through interactive facility maps, find relevant data more quickly, and to minimize operations downtime. The proposed approach would inevitably facilitate decision-making, streamlines processes, and contributes to the successful delivery and efficient management of the Airport.

Keywords: Modeling, BIM, ICAO, NRPR, Aerodrome, Tebessa Airport.

Résumé

Les aéroports sont considérés comme des infrastructures nationales vitales. Ces installations sont souvent stratégiques pour tout pays, car elles assurent le transport de personnes et de marchandises à l'échelle régionale, nationale et internationale. La conception, la construction et la gestion des infrastructures aéroportuaires sont strictement encadrées par les NRPR (normes, règles, pratiques et recommandations) de l'Organisation de l'Aviation Civile Internationale (OACI). Les administrateurs d'aéroport sont confrontés à des difficultés d'accès aux informations techniques relatives à l'aéroport, qui sont généralement archivées dans des dossiers de documents papier, des notes techniques et des plans. La prise de décision est souvent retardée en raison des difficultés d'accès à ces informations techniques, qui représentent une tâche complexe étant donné les autorisations administratives et les contraintes associées.

Modélisation de l'information de construction (BIM) est un nouveau concept de modélisation appliqué au monde de la construction, qui peut être défini comme une représentation numérique des caractéristiques physiques et fonctionnelles d'une installation. Toutes les informations techniques liées au projet peuvent être facilement consultées et partagées par les planificateurs, les concepteurs, les constructeurs, les opérateurs et les mainteneurs afin de fournir des informations rapides et fiables pour la prise de décision tout au long du cycle de vie de l'installation.

Dans ce projet, une tentative a été faite pour introduire le concept du BIM avec ses développements les plus récents. Un modèle BIM livrable est proposé ici, développé spécifiquement pour une installation aéroportuaire (Aérodrome de Tébessa, Algérie), pour soutenir ses opérations et la gestion des installations et permettre à l'équipe d'ingénierie de visualiser la plupart des principaux éléments de l'aéroport grâce à des cartes interactives, trouver rapidement des données pertinentes et réduire les temps d'arrêt des opérations. L'approche proposée faciliterait inévitablement la prise de décision, rationaliserait les processus et contribuerait à la livraison réussie et à la gestion efficace de l'aéroport.

Mots-clés : Modeling, BIM, ICAO, NRPR, Aerodrome, Tebessa Airport.

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ملخص

تعتبر المطارات بنية تحتية وطنية حيوية. غالبًا ما تكون هذه المرافق استراتيجية لأي بلد، حيث إنها تنقل الأشخاص والبضائع إقليمياً ووطنياً ودولياً. يخضع تصميم وإنشاء وإدارة البنية التحتية للمطار بشكل صارم للمعايير والقواعد والممارسات والتوصيات(NRPR) الصادرة عن منظمة الطيران المدني الدولي (ICAO). يواجه مديرو المطار صعوبات في الوصول إلى المعلومات الفنية المتعلقة بالمطار، والتي يتم أرشفتها عادةً في مجلدات من المستندات الورقية والملاحظات الفنية والخطط. غالبًا ما يتأخر اتخاذ القرار بسبب الصعوبات في الوصول إلى هذه المعلومات التقنية، والتي تمثل مهمة معقدة نظرًا للتراخيص الإدارية والقيود المرتبطة بها.

نمذجة معلومات البناء (BIM) هو مفهوم نمذجة جديد، يطبق على عالم البناء الذي يمكن تعريفه على أنه تمثيل رقمي للخصائص المادية والوظيفية للمنشأة. يمكن بسهولة الرجوع إلى جميع المعلومات التقنية المتعلقة بالمشروع ومشاركتها من قبل المخططين والمصممين والصانعين والمشغلين والصيانة لتوفير معلومات سريعة وموثوقة لاتخاذ القرار طوال دورة حياة المرفق.

وفي هذا المشروع، جرت محاولة لإدخال مفهوم BIM مع آخر تطورات المشروع. يُقترح هنا نموذج BIM قابل للتنفيذ، تم تطويره خصيصًا لمرفق المطار (مطار تبسة في الجزائر)، لدعم إدارة عملياته ومرافقه وتمكين فريق الهندسة من تصور معظم العناصر الرئيسية للمطار من خلال خرائط المرافق التفاعلية، والعثور على البيانات ذات الصلة بسرعة أكبر، وتقليل وقت التوقف في العمليات. ومن شأن النهج المقترح أن ييسر حتما اتخاذ القرارات، ويبسط العمليات، ويسهم في نجاح تنفيذ المطار وإدارته بكفاءة.

الكلمات المفتاحية: النمذجة، ، BIM، ICAO، NRPR، المطارات. ، مطار تبسة.

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List of Abbreviations

BIM	Building Information Modeling
NRPR	Norms, Rules, Practices and Recommendtions
3D	Three-Dimensional
ICAO	International Civil Aviation Organization
NBIMS	National Building Information Modeling Standard
FAA	Federal Aviation Administration
CAD	Computer-aided Design
GSA	General Services Administration
MSDS	Material Safety Data Sheet
NEPA	National Environmental Policy Act
LEED	Leadership in Energy and Environmental Design
CDE	Common Data Environment
MEP	Mechanical, Electrical, and Plumbing
IFC	Industry Foundation Class
AIR	Asset Information Requirements
AIM	Asset Information Model
AEC	Architecture, Engineering, and Construction
ITU	International Telecommunication Union
WHO	World Health Organization
WMO	World Meteorological Organization
ACI	Airports Council International
IFALPA	International Federation of Air Line Pilots' Associations International Federation of Airline Pilots
IAOPA	International Council of Aircraft Owner and Pilot Associations
GASP	The Global Aviation Safety Plan
SARPs	Standards and Recommended Practices
AC	Asphalt Concrete
ATB	Asphalt-Treated Base
UTG	Untreated Gravel
OLS	Obstacle Limitation Surfaces
QFU	Qualified Flying Instructor
PCN	Pavement Classification Number

CHAPTER 1: Introduction

CHAPTER 1

Introduction

1.1. BIM technology: A new concept for the construction industry

Digital technologies are transforming the way we design, construct, and operate buildings and infrastructure projects. One such technology that has gained significant attention in recent years is Building Information Modeling (BIM). BIM is a digital approach to designing and managing projects that involve the creation and use of a detailed 3D model that contains information about the physical and functional characteristics of a building or infrastructure asset.

The model is enriched with data and information about the project's different components, such as structural elements, systems, equipment, and materials, and can be used throughout the entire lifecycle of the project, from design and construction to operations and maintenance. BIM facilitates collaboration, communication, and information exchange between stakeholders, such as architects, engineers, contractors, owners, and operators, improving project outcomes, reducing costs, and increasing sustainability.

The utilization of Building Information Modeling (BIM) has become increasingly prevalent in the architecture, engineering, and construction industry. One key aspect of BIM is the creation of a deliverable BIM model, which provides a digital representation of a facility's physical and functional characteristics. This model serves as a valuable tool for decision-making throughout the lifecycle of a project, offering a range of benefits to stakeholders involved in design, construction, and operation.

Despite the advantages offered by a deliverable BIM model, some challenges need to be addressed to ensure its effective implementation. One significant challenge is the complexity of generating a comprehensive and accurate BIM model. The process involves gathering data from various sources, coordinating multiple disciplines, and ensuring the integration of diverse information into a cohesive model. This complexity can pose difficulties in terms of time, resources, and expertise required to create and maintain a high-quality deliverable BIM model.

Another challenge lies in the interoperability of BIM models across different software platforms and project stages. The seamless exchange of information between stakeholders can be hindered by incompatible file formats, inconsistent data standards, and limited collaboration capabilities. This can lead to inefficiencies, errors, and data inconsistencies, undermining the collaborative potential of BIM and hindering effective decision-making.

Furthermore, the adoption of a deliverable BIM model may face resistance within the industry. Some professionals may be hesitant to embrace digital transformation and adapt their workflows and practices to fully leverage the capabilities of BIM. This resistance can be rooted in a lack of awareness, training, or concerns about the initial investment required for BIM implementation.

Addressing these challenges requires a multi-faceted approach, including standardized processes, improved interoperability standards, enhanced training and education, and greater industry collaboration. By overcoming these obstacles, the industry can unlock the full potential of a deliverable BIM model, leading to improved project outcomes, cost savings, and enhanced facility management throughout the lifecycle of a project.

1.2. BIM applied to the airport’s project

Airports are considered as most vital national infrastructure. The facility is often considered strategic for any country as it ensures the transportation of people and goods on regional, national, and international scales. Airport infrastructure design, construction, and management are strictly bounded by norms, rules, practices, and recommendations of the International Civil Aviation Organization (ICAO). Airport administrators are faced with difficulties in accessing technical information related to the Airport that is usually archived in hard documents files, technical notes, and drawing plans. Decision-making is mostly delayed by difficulties in accessing technical information, which remains a complicated duty, as it is linked to administrative permissions and restraints.

Based on the available literature related to the recent development of the BIM, the concept could be applied to the modeling of an airport facility: The airport of Tébessa (East of Algeria) is considered as a physical model to develop a deliverable BIM. This digital tool would help), to support its operations and facilities management and enable the engineering team to visualize most airport’s main elements through interactive facility maps, find relevant data more quickly, and minimize operations downtime.

1.3. Data collection and objectives

The objective of this work is to provide a deliverable BIM for the Airport of Tébessa, which will assist airport managers in decision-making. This study would also support the understanding of available opportunities, benefits, and value related to engaging in a digital presentation of the airport.

Information used in this study was acquired mainly through a review of the related literature, site visits to the airports, technical data, files, and drawings provided by the technical department (DTP de la wilaya de Tébessa, Service des Bases Aériennes),), and interviews with airport technical operators and engineers.

CHAPTER 2: Building Information Modeling

CHAPTER 2

Building Information Modeling

2.1. INTRODUCTION

The United States National BIM Standard (NBIMS) defines building information modeling (BIM) as multi-dimensional, intelligent facility information (NBIMS 2015). In 2012, a general survey of owners, architects, engineers, constructors, and owners revealed the BIM adoption rate to be 71%, compared with 28% in 2007, a 75% growth surge in five years (McGraw-Hill 2012). BIM is increasingly being applied by organizations, including airports, to facilitate the process of planning, design, procurement, construction, operation, and maintenance of facilities (FAA 2015a; NBIMS 2015). Because BIM adoption is relatively new, a non-sector-specific BIM Planning Guide for Facility Owners was released in 2013 to assist organizations (Penn State 2013). [3]

In this section, the current state of the art in BIM applications to provide insight related to the emergence of BIM in airports is presented, it provides a general description of BIM, a summary of literature about BIM in airports, and an overview of the study's methodology and survey results.

2.2. Building Information Modeling Description

2.2.1. What Is BIM?

NBIMS version 3 (2015) defines BIM as an acronym describing three separate but linked functions. The first function is described by building information modeling, which is a business process for generating and leveraging building data to design, construct, and operate a building during its life cycle.

The second function is described by building an information model. According to NBIMS (2015), a building information model is a digital representation of a building's physical and functional characteristics that serves as a shared knowledge resource for information about a facility. The third definition—for which the acronym BIM is rarely used—is building information management, which combines the first two functions to organize and control the business process of building information modeling by utilizing the information in the building information model to enhance the sharing of information over the entire life cycle of an asset. [3]

2.2.2. The Origins of BIM

Before BIM came into fruition, traditional blueprints and drawings helped to express different information about a specific building plan. Visualizing exact dimensions and more particular requirements was not an easy task in the borders of this 2D approach, especially as models changed.

When CAD (Computer-aided Design) became popular, the digitalizing of previously paper-based construction plans came to life. CAD turned 3D and solved one more problem – adding the third dimension to enable more realistic-looking construction plans.

Then along came BIM – a new process that takes 3D to new heights by adding information and cooperation into the basic BIM meaning.

BIM itself works with specific components called BIM objects. BIM objects are the fundamental components of a BIM model, with each of them having specific geometry and unique data. The change in one of these objects results in changes to the entire model to accommodate the sudden difference in parameters, allowing BIM models to be more accurate throughout the entire construction process. These subsequent changes are making it that much easier for experts in various fields – architects, engineers, designers, contractors, and so on – to participate in the construction process without disturbing someone else’s work. [1]

2.2.3. The Components of BIM technology:

To fully grasp the comprehensive definition of BIM, we need to delve into its name, "Building Information Management." Let's explore each component in succession:

- Building: The term "building" encompasses not only traditional structures with walls and a roof but extends to diverse domains such as infrastructure, landscaping, and civil engineering. BIM's applicability goes beyond conventional buildings, embracing a wide range of projects. This highlights the fundamental purpose of BIM as a process aimed at constructing something tangible.
- Information: The inclusion of "information" in the process is what imbues BIM with its "smart" capabilities. Each project involves a multitude of data and information types. The essence of BIM lies in consolidating this diverse information, making it accessible, and enabling real-time management. BIM facilitates the aggregation and organization of project data in a cohesive manner.
- Modeling: The concept of modeling implies constructing the entire project virtually before commencing physical construction. BIM modeling entails creating a detailed and efficient

virtual representation of the building or project from the ground up. The model serves not only as a reference during the construction phase but also continues to be valuable for building owners long after the construction process concludes. It provides a comprehensive and reliable resource for ongoing facility management.

By comprehending the interplay between "building," "information," and "modeling" in BIM, we gain a holistic understanding of its purpose. BIM encompasses the construction process, efficient information management, and the creation of virtual models that extend beyond construction, benefiting various stakeholders throughout the project's lifecycle.

2.3. BIM in the Facility Life Cycle

Facility owners use BIM as a decision-making tool to support the creation and management of assets across a facility’s life cycle (GSA 2016). During the feasibility, planning, and development phase, BIM provides owners with information about the current state of the facility and generates information for analysis. During design and construction, BIM primarily supports information capture, communication, coordination, and construction. During the operations phase, BIM supports the performance monitoring of a facility and its systems. For an owner, full life-cycle BIM use requires an enterprise BIM approach, which involves implementation at the organizational level. Project-level BIM is implemented on a project-by-project basis only. Both approaches are supported by technology and methods that include multiple stakeholders, processes, and tasks. Although enterprise BIM focuses on streamlining business operations, establishing a consistent working environment, and increasing work effort devoted to value-added tasks (i.e., decreasing effort for non-value-added tasks) across an organization’s operations, project-level BIM is limited to improving the processes of facility design and construction through reduced initial cost or shortened construction time (Smith and Tardif 2009). Enterprise BIM also supports asset management, the “strategic approach to the optimal capital and operational spending on assets to ensure control of cost and risk, asset life, performance, and stakeholder satisfaction” (Shoolestani et al. 2015). Figure 2.1 provides an example (schematic) of BIM use throughout the facility life cycle. [3]

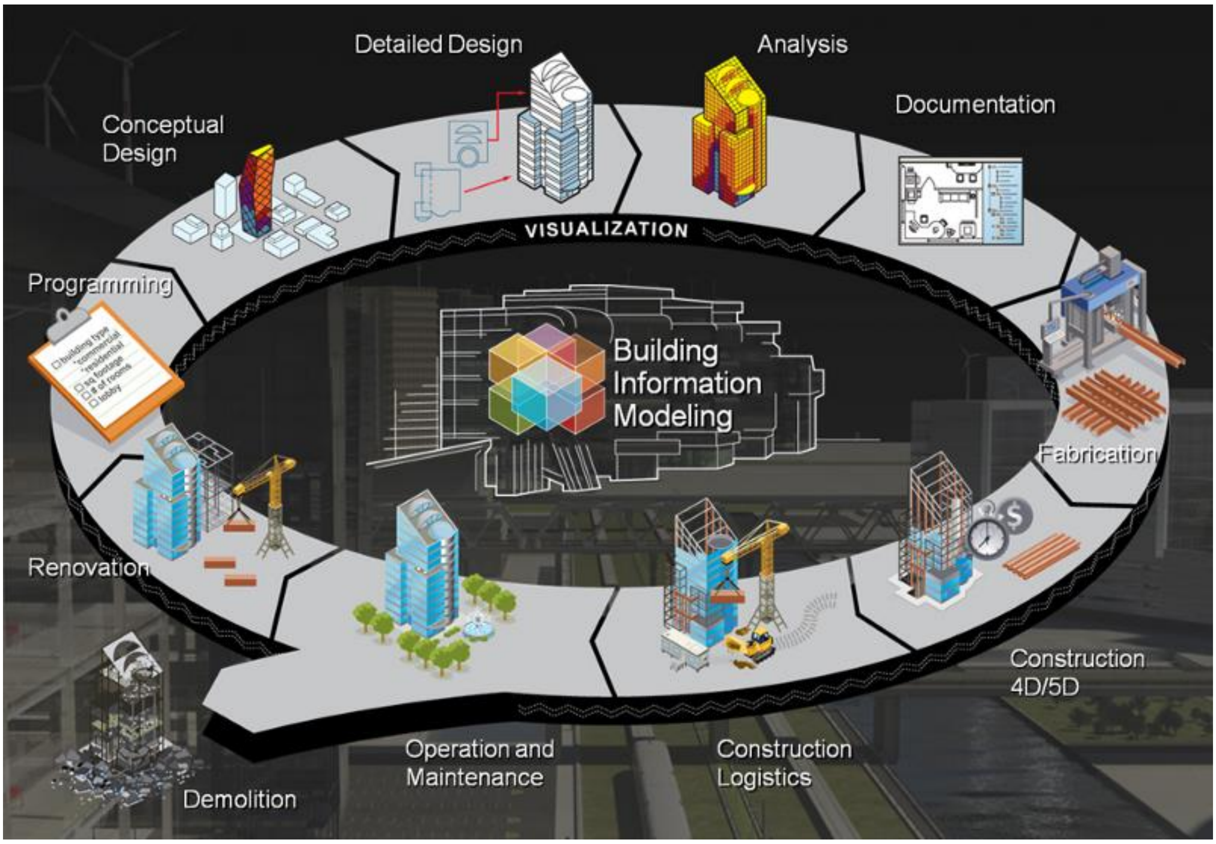


Fig 2.1: BIM implementation through building lifecycle. [18]

2.4. BIM Users/Stakeholders in an Organization

BIM users in an organization are classified by discipline and by the facility's life-cycle phase for which they input or consume BIM information (Smith and Tardif 2009). A facility's life cycle begins at the feasibility, planning, and development phase, and typical stakeholders may include the owner, planner, architect, and constructor. The second phase of design and construction may include the owner, designers, engineers, cost estimators, consultants, general contractors, subcontractors, fabricators, suppliers, manufacturers, facility managers, and code officials. Operations and maintenance is the third phase of a facility's life cycle and may include the owner, facility managers, maintenance personnel, occupants, space manager, security manager, network manager, and first responders. Renewal is the final phase and may include the owner, recyclers, and archivists. A more comprehensive list of stakeholders and their associated uses of BIM can be found on page 23 of NBIMS version 1, part 1 (2007). [3]

2.4.1. List of stakeholders and their associated uses of BIM [13]

- Owners. High-level summary information about their facilities.
- Planners. Existing information about the physical site(s) and corporate program needs.

- Realtors. Information about a site or facility to support purchase or sale.
- Appraisers. Information about the facility to support the valuation.
- Mortgage Bankers. Information about demographics, corporations, and viability.
- Designers. Planning and site information.
- Engineers. Electronic model from which to import into design and analysis software.
- Cost and Quantity Estimators. Electronic model to obtain accurate quantities.
- Specifiers. Intelligent objects from which to specify and link to later phases.
- Attorneys and Contracts. More accurate legal descriptions to defend or on which to base litigation.
- Construction Contractors. Intelligent objects for bidding and ordering and a place to store gained information.
- Sub-Contractors. Clearer communication and the same support for contractors.
- Fabricators. Can use intelligent models for numerical controls for fabrication.
- Code Officials. Code-checking software can process models faster and more accurately.
- Facility Managers. Provides product, warranty, and maintenance information.
- Maintenance and Sustainment. Easily identify products for repair parts or replacement.
- Renovation and Restoration. Minimizes unforeseen conditions and the resulting cost.
- Disposal and Recycling. Better knowledge of what is recyclable.
- Scoping, Testing, and Simulation. Electronically build the facility and eliminate conflicts.
- Safety and Occupational Health. Knowledge of what materials are in use and MSDS.
- Environnemental and NEPA. Improuve information for environnemental impact analysis.
- Plant Operations. 3D visualization of processes.
- Energy and LEED. Optimized energy analysis is more easily accomplished and allows for more review of alternatives, such as the impact of building rotation or relocation on site.
- Space and Security. Intelligent objects in 3D provide a better understanding of vulnerabilities.
- Network Managers. A 3D physical network plan is invaluable for troubleshooting.
- CIOs. The basis for better business decisions and information about existing infrastructure.
- Risk Management. Better understanding of potential risks and how to avoid or minimize them.
- Occupant Support. Visualization of the facility for wayfinding (building users often cannot read floor plans).
- First Responders. Minimize loss of life and property with timely and accurate information.

2.5. Information Sharing in BIM:

Information about how different BIM objects and models are shared within a specific environment called CDE (Common Data Environment). The data that has been transferred within the CDE is called an information model. These models can be utilized at any stage of the construction process, from planning and initial project set-up to the final stages of the construction and even the renovation phase.

This in-depth approach to the information in the first place is based on one of the founding principles of BIM – the importance of "I", meaning "Information", in BIM's definition. A lot of people tend to agree that the most important and useful feature of BIM is the information that's being exchanged since it's not just some data that's used only once – it's actionable in its own right.

Various specialists can use that data to reduce coordination mishaps, provide useful insights for the future, express the needed intent for the construction in question, improve the overall accuracy of the project, and so much more than that. [1]

2.6. BIM Levels – from 0 to 6D:

BIM levels are utilized for different purposes for different types of projects. Different level of BIM represents a particular level of "maturity" starting from level 0 to 6. The purpose of BIM levels is to incorporate relevant and exact information along with the BIM model throughout the design-build process. [19]

Different levels of BIM are described below to be utilized effectively:

- BIM Level 0: No Collaboration with CAD drawings:

Level 0 represents 2D drawings that contain relevant information using computer-aided design software. Project stakeholders share hardcopy of files, drawings, documents, etc., therefore, the BIM level is considered as no or, zero collaboration.

- BIM Level 1: 2D Drawings and 3D digital models:

Utilizing conceptual 2D drawings 3-dimensional CAD models are prepared by multi-trade project teams at the level. Following the CAD standard 3D models are shared through Common Data Environment (CDE), which is commonly managed by the contractors. This BIM level is considered a partial collaboration because project stakeholders independently publish and manage their data.

- BIM Level 2: Multiple 3D models for different project teams on a digital platform:

Architects, designers, structural engineers, MEP engineers, contractors, and other project stakeholders work on 3D BIM models and share data in CDE. The multi-disciplinary project teams may not necessarily work on a single file but use a common file format like IFC (Industry Foundation Class), in Level 2. Collaboration amongst different project teams takes place at this level.

- BIM Level 3: Single work-shared 3D model for different project teams:

Level 3 of BIM represents maximum utilization of a common data environment and full collaboration. Multi-trade project participants work on a single work-shared model that exists in the central location where every project team member has the relevant access to update, review, and markup. The Level 3 approach of BIM is also considered OpenBIM. The level adds value to the entire design-build process through constructability review and resolution, clash detection, BIM coordination, etc.

- BIM Level 4: Additional information on time with shared 3D model:

Level 4 BIM includes an additional component of “time” along with the BIM model. During the preconstruction stage, level-wise construction scheduling considering various building components helps project participants to plan their actions according to the schedule to mitigate the risk of project delay.

- BIM Level 5: Project budget calculation with scheduled 3D model:

Level 5 adds another component of cost estimation along with project scheduling. Precise budgetary information on every building material to be used in a different phase of the construction process helps project owners to track and plan the expense of the project far before the actual construction process begins.

- BIM Level 6: Sustainability analysis added with the cost estimated and scheduled 3D Model:

Level 6 BIM allows project participants to analyze building sustainability and energy consumption before it is built. The level ensures designers consider energy efficiency and sustainability of individual assets along with the cost. The accurate prediction of energy consumption results in sustainable and energy-efficient buildings (Green Building). [19]

The help with the operation and maintenance of the final facility are the main purposes of this kind of model. It’s less commonly used in the UK as something not directly adding another dimension to the overall scale and is often replaced with either Asset Information Requirements or Asset Information Model (AIR and AIM, respectively). [1]

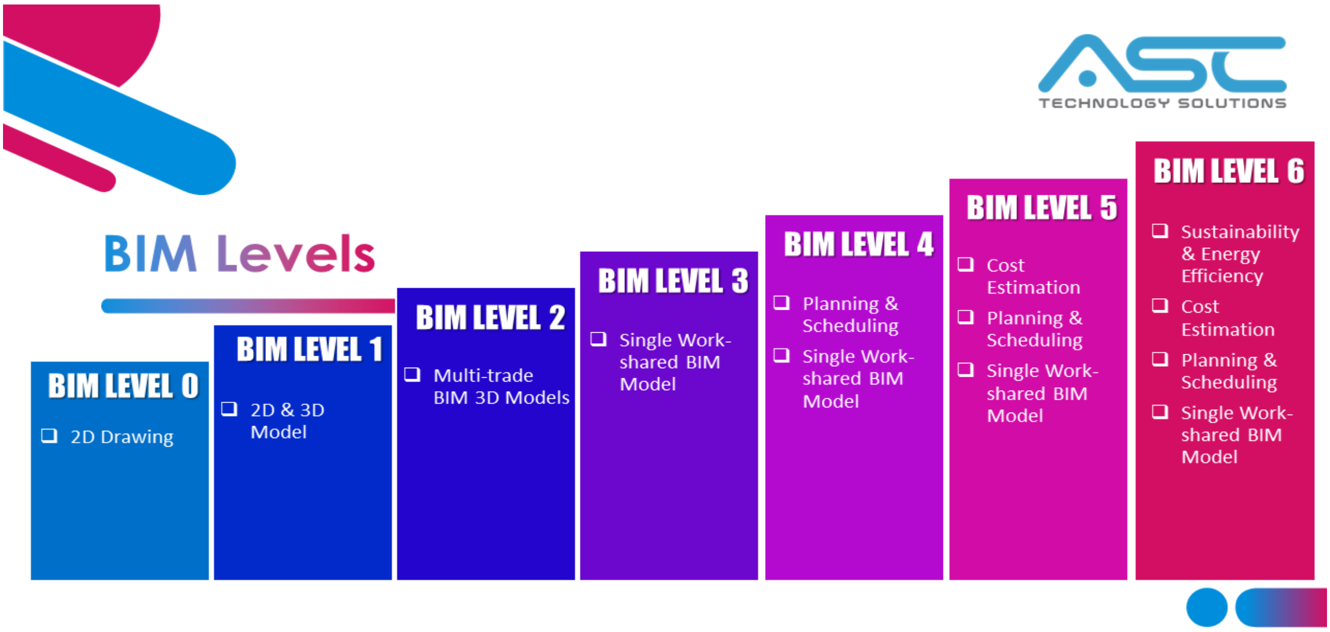


Fig 2.2: BIM levels. [19]

2.7. BIM standards:

Of course, BIM as a whole would not have become this popular and effective without specific standards in place. It is worth mentioning that several countries have region-specific standards when it comes to BIM. Still, it is possible to segregate several standards that are accepted and renowned internationally. These standards define BIM's information structure, BIM processes, and so on. [1]

- **ISO 23386:2020** – "Building Information Modeling and other digital processes used in construction – Methodology to describe, author and maintain properties in interconnected data dictionaries."
- **ISO 16739-1:2018** – "Industry Foundation Classes (IFC) for data sharing in the construction and facility management issues – Part 1: Data schema."
- **ISO 19650-1:2018** – "Organization and digitization of information about buildings and civil engineering works, including building information modeling (BIM) – Information management using building information modeling – Part 1: Concepts and principles."
- **ISO 12006-2:2015** – "Building construction – Organization of information about construction works – Part 2: Framework for classification."

As we have mentioned, some countries use these international standards as the baseline for their BIM regulations. For example, the UK BIM Framework relies on the ISO 19650 series standards to create its ruleset for this specific industry – UK PAS 1192 series. [1]

2.8. BIM Misconceptions

Surprisingly enough, there are a lot of misconceptions going around about BIM, many of which might be the prime factors impacting adoption. Here are some of the largest misconceptions about BIM:

a) BIM is an all-in-one solution that works right out of the box

Although not as widely held as other misconceptions, there exists a belief that BIM software is fully functional right out of the box. While it is true that certain BIM software can be quickly deployed and operational, it's important to recognize that the immediate functionality is typically limited to 3D modeling capabilities.

In reality, BIM is not just about the software itself but entails a transformative construction process. It necessitates the adaptation and modification of existing processes to align with the innovative approach of incorporating information and collaboration into every aspect of the project. Implementing BIM requires significant effort and is by no means an easy undertaking. However, the long-term benefits and rewards justify the investment of time and resources.

b) BIM is just an evolution of CAD as a design tool

While it is true that 3D modeling is a fundamental aspect of BIM, it is crucial to understand the distinction between BIM and traditional CAD software. While 3D modeling is a part of both, BIM offers a wide range of additional features and advantages, such as enhanced interaction, collaboration, project delivery, and leveraging project-specific information.

While you can create a satisfactory 3D CAD model using CAD software, you will not be able to fully harness the benefits and capabilities that BIM provides. BIM encompasses much more than just geometric information and extends to include interaction with the model, collaboration among stakeholders, and utilizing the wealth of available project data.

It is important to differentiate between a 3D model created with CAD software and a BIM object. A CAD model typically consists solely of geometric information and can be created using standard

CAD tools. On the other hand, a BIM object is a 3D representation that contains a wealth of additional information, such as comprehensive technical data.

BIM objects are essential to ensure that the 3D modeling process accurately represents real-life situations. By including detailed technical information, clashes and potential conflicts between different objects can be detected early in the design stage, improving coordination and minimizing issues during construction and operation.

c) BIM is for architects only

This is a common misconception about most “design tools”, not just BIM. A big project a skyscraper in the middle of the city is probably the most obvious example of almost any design tool in the works, but it’s not just that – far from it. “What is BIM in architecture?” is quite a common question, as well. However, it’s much more complicated than that.

One thing that might have added fuel to this fire is that both the construction and architecture industries were the first ones to adopt BIM as a technique, so this might be why everyone thinks BIM can only deal with buildings.

In actuality, BIM can be adapted to work with a large variety of different structures, including road engineering, rail engineering, subway architecture, energy structures, civil engineering, and more. [1]

2.9. Conclusion: Application of BIM

Based on the above introduction, the present work could concern the development of a BIM model for an existing Airport facility. Hereafter, BIM is defined as a digital representation of an Airport’s physical and functional characteristics that serves as a shared knowledge resource for information about a facility.

CHAPTER 3: Deployment of BIM

CHAPTER 3

Deployment of BIM

3.1. Introduction

BIM deployment involves a comprehensive approach, including strategy development, software selection, process redesign, staff training, and ongoing support and maintenance. BIM deployment aims to improve the efficiency and effectiveness of the construction process, from design and planning to construction and maintenance. BIM enables collaboration among all stakeholders involved in a project, including architects, engineers, contractors, and owners, by providing a shared, digital model of the building or infrastructure project.

BIM deployment typically involves the following steps:

a) Developing a BIM strategy that aligns with the organization's goals and objectives.
b) Assessing the organization's current BIM capabilities and identifying gaps.
c) Develop a plan for BIM deployment that includes software selection, process redesign, and staff training.
d) Implementing BIM software and processes, and training staff.
e) Monitoring and evaluating the effectiveness of the BIM deployment, and making necessary adjustments.

BIM deployment can help organizations to reduce errors and rework, improve communication and collaboration, increase project efficiency, and enhance the overall quality of construction projects.

3.2. How BIM Provides a Shared Platform for Communication and Collaboration

The building industry is characterized by its complexity, involving multiple stakeholders with diverse expertise and perspectives. Coordinating their efforts to achieve a common goal can be challenging and has historically led to miscommunication and a lack of collaboration, resulting in cost overruns and delays.

However, the emergence of Building Information Modeling (BIM) has revolutionized the industry by addressing these challenges.

BIM serves as a collaborative platform that enables all stakeholders to have a holistic view of the project and work together more efficiently.

By providing a clear and shared understanding of the project, BIM enhances communication and fosters collaboration among stakeholders, leading to the successful completion of projects. [14]

3.3. Ways How BIM Improves Communications

Enhancing communication in the construction industry through using BIM is a massive goal.
The main theme is how BIM improves communication. Here are my 6 ways that BIM can help our industry:

3.3.1. BIM Provides an Early Digital Representation

BIM, or Building Information Modeling, is a digital representation of a construction project that facilitates coordination and tracks changes over time. Its digital nature enables easy sharing and accessibility, making it a valuable tool for communication among various disciplines involved in a construction project. BIM fosters effective communication within a construction team as well as between different teams working on the same project.

For instance, let's consider a scenario where the electrical team needs to install cables through a wall. In the past, they would have discovered the issue on-site, requested changes, waited for plan updates, and then implemented the changes in the field. However, with BIM, they can proactively examine the model, identify cable routes in advance, and make necessary updates in the virtual design even before reaching the construction site.

This proactive approach offered by BIM leads to cost reduction, and time savings, and minimizes the chances of significant errors and rework during construction. By leveraging BIM, project stakeholders can identify and address potential issues early on, resulting in smoother workflows, improved efficiency, and enhanced project outcomes. [14]

3.3.2. BIM Is Essential For Clash Detection

Clash detection is a valuable feature offered by BIM that greatly contributes to the construction process. It involves automatically identifying potential conflicts that may arise among different trades, systems, or elements within a construction project.

For instance, if the electrical and plumbing plans of a building do not align properly, it can lead to complications during construction. Clash detection plays a crucial role in mitigating such issues by identifying these conflicts at an early stage, thereby preventing costly delays and rework.

To facilitate clash detection, BIM software utilizes 3D modeling to create a virtual representation of the construction project. This enables stakeholders to view the project from various angles and identify potential clashes between different components. By providing a common platform for communication, BIM enhances collaboration and reduces misunderstandings among team members.

Overall, clash detection improves communication, prevents potential conflicts, ensures alignment among teams, and enhances the overall efficiency of the construction process. It enables stakeholders to proactively address issues, make informed decisions, and keep the project on track, ultimately leading to successful project outcomes. [14]

3.3.3. BIM Helps Align Construction With Design

BIM revolutionizes communication in construction by enabling the creation of a shared 3D model that fosters a clear understanding of the design intent among all team members. This enhanced communication ensures that the construction process aligns with the owner's requirements and the intended design.

Furthermore, BIM plays a vital role in identifying potential conflicts between different disciplines at an early stage of the project. By addressing these issues before construction, BIM helps prevent costly delays and rework, saving time and resources.
As a result, BIM has emerged as an indispensable tool for aligning the construction process with the design objectives. Its collaborative nature and ability to proactively resolve conflicts contribute to the smooth execution of projects, promoting efficiency and delivering successful outcomes. [14]

3.3.4. BIM Allows Notification of Changes in Real-time

The utilization of 3D technology fosters enhanced collaboration among architects, engineers, and construction workers, facilitating the visualization of building plans and real-time modifications. In the past, project coordinators relied on 2D drawings to convey their vision, often resulting in misinterpretation, errors, and costly delays. However, with the introduction of BIM, coordinators can generate a comprehensive 3D model accessible to all project stakeholders. This streamlined communication process enables the effective sharing of necessary modifications, leading to improved project outcomes.

By employing BIM, project teams can collectively review and interpret the 3D model, minimizing the chances of miscommunication or misalignment. For instance, if the electrical contractor needs to make alterations to their plans, they can update the shared model, ensuring that all parties have access to the latest information. This harmonized approach eliminates confusion and guarantees that everyone works based on the most current and accurate data, optimizing project efficiency.

In summary, the adoption of 3D modeling through BIM promotes collaboration, mitigates errors, and facilitates real-time communication, resulting in successful project execution and improved overall outcomes. [14]

3.3.5. BIM Can Reduce the Risk of Rework

Rework in construction refers to the need for repetitive construction activities due to errors or omissions in the initial work. It encompasses tasks such as re-drilling holes or even demolishing and reconstructing entire sections of a structure. Rework not only consumes time and resources but also disrupts the overall construction schedule.

By leveraging BIM, construction professionals can effectively minimize rework by ensuring that all stakeholders work from a unified and accurate model. BIM enables the swift identification and rectification of errors or omissions, leading to time and cost savings while mitigating frustrations.

Furthermore, BIM facilitates the creation of virtual simulations for construction projects. These simulations allow for the testing of various scenarios and the identification of potential problem areas even before physical construction commences. As a result, BIM significantly reduces the risk of rework in construction projects.

In summary, the utilization of BIM in construction endeavors aids in avoiding rework by promoting collaboration, accuracy, and early identification of issues. This streamlined approach not only saves time and money but also ensures smoother project execution and timely delivery. [14]

3.3.6. BIM can accelerate Construction Schedule

As previously stated, the creation of a digital 3D model allows for enhanced transparency and visibility throughout the design and construction process, benefiting all involved parties. [14]

3.4. Advantages of BIM

Building Information Modeling (BIM) is a construction project management process that involves creating and managing information. One of the key outcomes of this process is the development of a detailed 3D model that represents the entire built asset digitally, offering a comprehensive view before physical construction begins. The adoption of BIM has significantly impacted the Architecture, Engineering, and Construction (AEC) industry, owing to its numerous advantages. It is crucial to recognize that BIM encompasses more than just the utilization of specialized software; it represents a holistic approach to the design and planning of construction projects.

Furthermore, BIM goes beyond the initial design phases and continues to deliver benefits throughout the project lifecycle, even after construction is complete. Embracing BIM allows for a transformative approach to construction projects, revolutionizing the entire process. [4]

Fig 3.1: benefits of BIM in construction. [4]

The use of BIM and software can enhance all levels of a building project. We have highlighted some of the key advantages of BIM in construction below.

3.4.1. Maximized Efficiency

BIM offers a significant advantage by optimizing the life cycle of construction projects, resulting in improved efficiency. The management and completion of pre-construction and planning tasks become more streamlined and time-effective.

Moreover, BIM facilitates enhanced collaboration and communication among project stakeholders. The accessibility of BIM plans allows professionals from different disciplines to access the latest model whenever necessary. This ensures that everyone works with accurate and up-to-date information, reducing errors and the need for rework caused by outdated or incorrect data. [4]

3.4.2. Reduce Costs and Wastage

BIM software provides contractors and designers with a range of tools to enhance their pre-construction processes, resulting in notable cost savings and waste reduction.

With BIM, contractors can make informed decisions regarding material choices, streamline construction workflows, and minimize human errors during the construction phase. By optimizing the planning stages, BIM aids in reducing material waste, leading to cost reductions for contractors. [4]

3.4.3. Improved Cost Estimates

Utilizing a comprehensive model instead of traditional 2D blueprints allows estimators to achieve significantly more precise results. The use of a 3D model provides greater insights and a deeper understanding of the project, resulting in more accurate and realistic cost estimates. Furthermore, BIM expedites the estimating process by providing easy access to information and tools, thereby saving time.

BIM optimization extends beyond cost estimates, as it also facilitates simplified quantity takeoffs through the use of comprehensive models. [4]

3.4.4. Better Insight into the Project

BIM plans provide a realistic 3D representation of the project, offering enhanced visualization of the outcome. This improved visualization benefits both contractors and clients, allowing them to better comprehend the built asset. The detailed 3D plans also help prevent unnecessary rework by enabling planners to identify potential issues and make necessary changes during the pre-construction phase. This proactive approach saves valuable time and resources that would otherwise be spent on rework. [4]

3.4.5. Communication and Collaboration

BIM is an approach that fosters collaboration by leveraging cloud-based software. This enables seamless communication and collaboration among all project stakeholders, who can access the necessary information and up-to-date models anytime and from anywhere. As a result, unnecessary meetings and work bottlenecks are avoided. All planning stakeholders can simultaneously work on various aspects of the project, with estimates, models, and design notes stored in a centralized location. This allows architects to make instant design adjustments and contractors to modify the model, even when they are off-site. The enhanced communication and collaboration facilitated by BIM lead to a more streamlined and efficient project execution. [4]

3.4.6. Less Risk and Wastage

BIM enhances the safety and risk management of building projects by fostering closer collaboration with contractors. This collaborative approach helps reduce tender risk premiums and provides a comprehensive project overview before construction commencement. Consequently, on-site safety is improved, material wastage is minimized, and miscommunications are reduced. Moreover, the risk of contractors relying on outdated information is eliminated. By leveraging BIM technology and processes, companies can lower insurance costs and mitigate the potential for claims. Therefore, BIM proves highly advantageous in risk mitigation and cost reduction. [4]

3.4.7. Better End Results

The utilization of BIM aims to improve both the planning and construction processes, ultimately leading to a higher standard of building outcomes. By incorporating comprehensive planning with detailed insights, contractors can achieve a superior level of quality in their work. Additionally, the early visualization capabilities provided to architects through BIM enable a greater emphasis on the aesthetics and overall appearance of the building. Consequently, BIM contributes to the creation of built assets that exhibit a higher level of quality. [4]

3.5. Identify Project Goals and BIM Uses

The first step in developing a BIM Project Execution Plan is to identify the appropriate BIM Uses based on project and team goals.

A current challenge and opportunity faced by the early project planning team is to identify the most appropriate uses for BIM on a project given the project characteristics, participants' goals and capabilities, and the desired risk allocations. There are many different tasks, which can benefit from the incorporation of BIM.

These benefits are documented as BIM Uses, and this guide includes twenty-five uses for consideration on a project (see Figure 3-2). The goal of this chapter is to provide a method for identifying appropriate BIM Uses for project implementation.

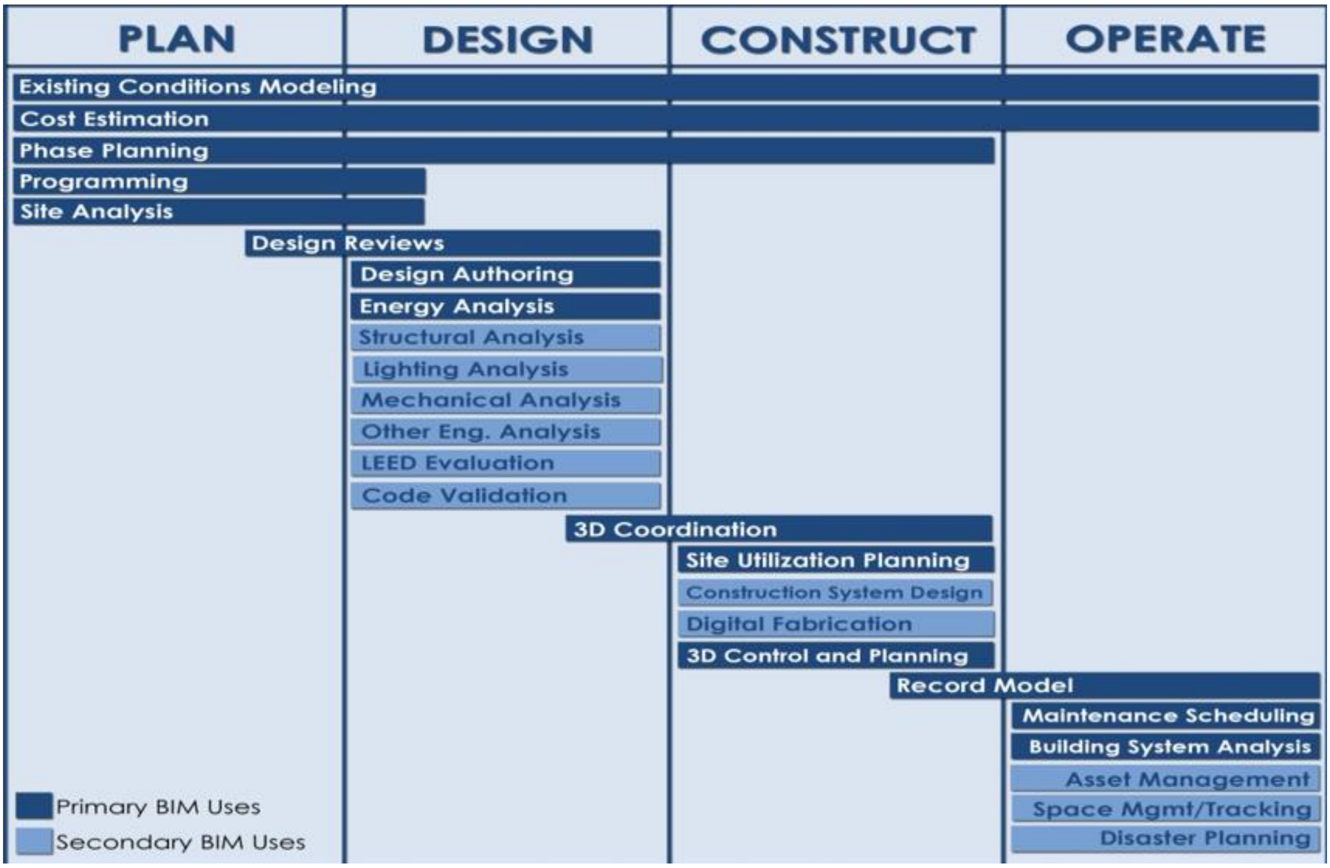


Fig 3.2: BIM Uses throughout a Building Lifecycle (organized in chronological order from planning to operation). [20]

3.6. Defining the BIM Goals for the Project

Before identifying the applications of BIM, the project team needs to establish project goals and their potential alignment with BIM implementation. These goals should be tailored to the specific project, measurable, and focused on enhancing success throughout the facility's planning, design, construction, and operations. One category of goals pertains to overall project performance, such as reducing project schedule duration, minimizing project costs, or enhancing the overall project quality.

For instance, quality goals may involve the creation of a more energy-efficient design through rapid iterations of energy modeling, the generation of high-quality installed designs through detailed 3D coordination of systems, or the development of accurate record models to improve performance modeling and commissioning quality.

Furthermore, goals can also target the efficiency of specific tasks to yield time or cost savings for project participants. These goals encompass using modeling applications to streamline the creation of design documentation, leveraging automated takeoffs for estimating purposes or reducing data entry time into the maintenance system. The aforementioned examples serve as suggestions for potential goals that the project team may consider when determining how to implement BIM on their project. It is crucial to identify specific goals that will serve as motivating factors for BIM implementation, as the list provided is not exhaustive.

3.7. BIM uses a classification system and structure:

Building Information Modeling (BIM) has been defined as the act of creating an electronic model of a facility for visualization, engineering analysis, conflict analysis, code criteria checking, cost engineering, as-built product, budgeting, and many other purposes. To foster better communication within the industry, it is important to define consistent language to describe the focused use of BIM on a capital facility project. A BIM Use can be defined as a method of applying Building Information Modeling during a facility’s lifecycle to achieve one or more specific objectives. [12]

BIM uses can be classified primarily based on the purpose of implementing BIM throughout the life of a facility. In addition to purpose one, several other characteristics can be defined to properly identify and communicate a BIM Use. These purposes and characteristics (see Figure 3.3) can be defined at varying levels depending upon the level of specificity required for different applications of the Uses.

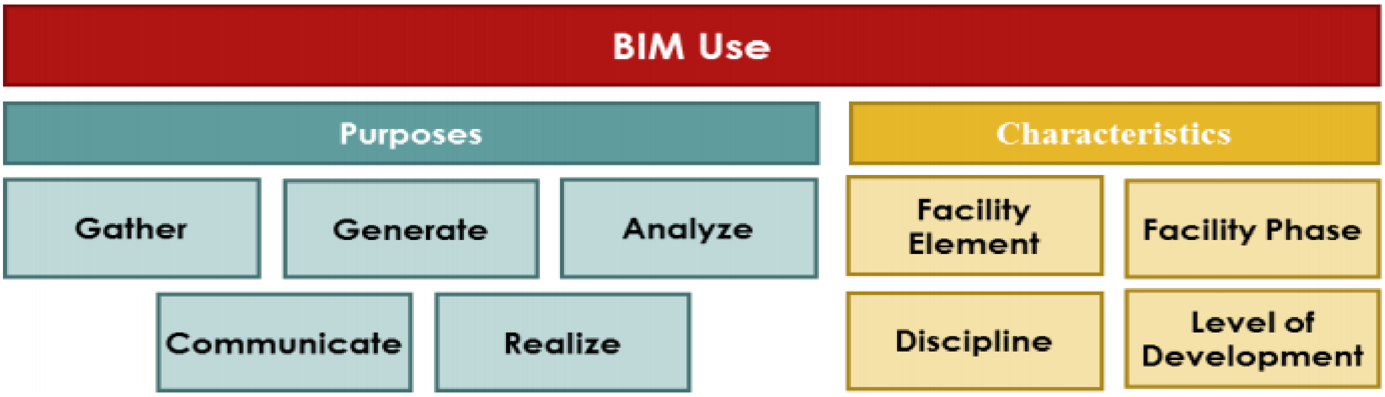


Fig 3.3: The Components of a BIM Use. [12]

The BIM Use Purpose communicates the primary objective of implementing the BIM Use. The BIM Use Purposes, shown in Figure 3.4, fall into five primary categories: gather, generate, analyze, communicate, and realize. Of these primary categories, numerous subcategories further specify the purpose of BIM Use.

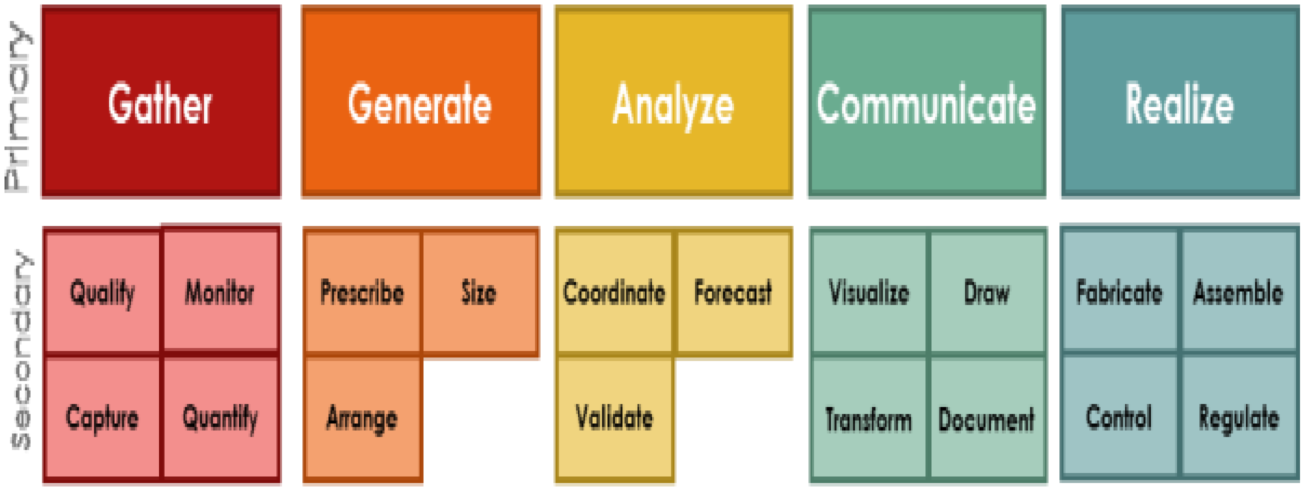


Fig3.4: The BIM Use Purposes. [12]

3.8. The purpose and objectives of BIM

The BIM Use Classification System categorizes BIM Uses based on their main purpose and objective. A BIM Use Purpose refers to the specific goal that is intended to be achieved by utilizing Building Information Modeling throughout the entire lifecycle of a facility. These purposes and objectives for implementing BIM Use are classified into five main groups. [12]

3.8.1. Gather

BIM is commonly utilized to gather information about a facility at different stages throughout its lifespan. Whether it involves quantifying specific elements or assessing the current condition of facility components for effective asset management, BIM plays a crucial role in supporting these activities. These specific objectives of BIM utilization encompass qualification, monitoring, capturing, and quantification. In this primary function of BIM, the main focus is on collecting, gathering, and organizing facility-related information. However, it is important to note that this purpose does not assign meaning or draw inferences from the gathered information; rather, its sole aim is to ensure the systematic collection and organization of data. This initial step often serves as the foundation for a comprehensive set of BIM processes. [12]

a) Capture

BIM is often used to capture geometric and attribute data about a facility. This can be done using several methods and at several points during the life of a facility: the elements of the site before the development of a new facility or the conditions of an existing facility before renovation. Data could be captured using a laser scanner or recorded manually by inputting model and serial numbers into a spreadsheet. The common factor within these purposes of BIM Uses is that data is captured where no data existed prior. However, it is not newly generated information, but rather creating a record of the facility elements that exist.

b) Quantify

In this purpose of BIM Uses, BIM is used for counting or collecting the number of specific facility elements. This purpose is often used as part of the estimating and cost-forecasting process. During the design phase of a facility, quantities maybe be defined broadly, represented by a range, and subject to change. In the construction phase, quantities become more certain, and in the operations phase, quantities of elements can be readily calculated, say for instance. For example, the area of carpet to be replaced or the vacant space, which is available and rentable, the exact area and dimensions should be known.

c) Monitor

BIM can be used to monitor real-time performance data of facility elements and facility activities. This purpose of BIM Uses includes those domain uses in which BIM is implemented to understand the performance of particular facility elements or processes. For example, during the operations phase of a facility, BIM can be used to monitor the temperature of a space. It is for this purpose of BIM Uses where Building Automation System data is integrated with the BIM data. Or in construction, BIM could be used to monitor the productivity of a construction process. It is for this purpose of BIM Uses that dynamic real-time data is collected to support decision-making.

d) Quality

For this BIM Use Purpose, the status of a facility element is tracked. This includes information such as: does this element exist within the facility? How is it working? This BIM Use Purpose tracks facility elements over time. For example, in design, what is the element's level of development? In construction, has the element been fabricated? Is it installed? Is it damaged? During operations, this BIM Use Purpose can collect warranty information on the element and whether or not the element is reaching the end of its useful life.

3.8.2. Generate

Throughout the lifecycle of a facility, numerous disciplines involved in its development generate valuable information. This purpose of BIM Uses encompasses instances where BIM is employed to create or author information about the facility. It involves tasks such as describing, organizing, and sizing facility elements at various stages of development. During the design phase, the design team takes on the primary role of generating information, while subcontractors contribute significantly during the construction phase. In the operations phase, the responsibility for generating information may fall upon those responsible for maintaining and updating the facility. Anytime new information is created, modeled, or authored, it is considered as generated within the context of BIM. This generation of information through BIM facilitates effective collaboration and ensures that accurate and up-to-date data is available for informed decision-making throughout the facility's lifecycle. [12]

a) Prescribe

The prescribing purpose of BIM Uses is used when a generator determines there is a need for a specific facility element. The programmer or architect of the facility may prescribe the need for certain rooms or spaces in the facility. While the mechanical engineer may prescribe the need for a specific HVAC system. The contractor could determine the need for a temporary construction element such as a tower crane, and the operator of the facility may prescribe a specific replacement part for the facility. The element prescribed depends on several factors such as phase, discipline, and level of development.

b) Arrange

The arranging purpose of BIM Uses includes those Uses in which a location or configuration of a facility element is determined. During the planning phase of a facility's life, this could be the arrangement or adjacency of specific spaces within a proposed facility. During the design phase, it could be the general location of the fire protection piping. While in the construction phase, it could include the placement of the hangers that support that piping. This could also be used during the operations phase to determine the placement of furniture systems. In general terms, any time a geometric location of the element is determined, it is arranged.

c) Size

The sizing purpose of BIM Uses is in use when the magnitude of a facility element is determined. Some of those elements during design could include the dimensions of spaces, the shape of a steel beam, or the size of ductwork. During construction, it could include the size of a crane or the thickness of duct insulation. Additionally, during operations, facility managers record the size of replacement parts or modifications to the facility.

3.8.3. Analyze

Certain elements of a facility often necessitate in-depth analysis to assess their suitability and viability. The purpose of analyzing BIM Uses encompasses those instances where a systematic examination of facility elements is required. This purpose includes activities such as coordination, forecasting, and validation. During these BIM Uses, data obtained or generated is transformed into a format that can be effectively utilized for decision-making processes. The analysis of facility elements through BIM not only facilitates informed decision-making but also enables the extraction of valuable insights from the gathered information. [12]

a) Coordinate

The coordinating purpose of BIM Uses is focused on analyzing facility elements to ensure their effective and harmonious relationship with each other. This purpose involves activities such as clash detection, collision avoidance, design coordination, and interference management. The goal is to ensure that all the facility elements work together seamlessly.

During the design phase, coordination involves aligning the design intent of different systems to avoid conflicts and maximize efficiency. This includes coordinating architectural, structural, and MEP (mechanical, electrical, and plumbing) systems. In the construction phase, coordination extends to coordinating fabrication and installation processes to minimize clashes and ensure smooth construction operations.

Even during renovations or facility operations, coordination is vital to ensure that existing systems are not disrupted and that the new changes align with the overall facility design. The purpose of BIM Uses aims to guarantee that the facility elements fit together as planned and that all systems have been thoroughly considered.

By addressing clashes and ensuring coordination, BIM enables better collaboration, reduces rework, and enhances the overall efficiency and functionality of the facility.

b) Forecast

The purpose of BIM Uses encompasses a wide range of applications, and it involves conducting detailed analysis to predict the future performance of the facility and its elements. This purpose involves considering various performance factors such as financial, energy, flow, scenario, and temporal aspects. Each of these factors plays a crucial role in understanding and forecasting the facility's performance.

Financial forecasting involves estimating both the initial construction cost and the life cycle cost of the facility. This helps in assessing the financial viability and long-term sustainability of the project. Energy forecasting focuses on predicting future energy consumption patterns to optimize energy efficiency and identify potential energy-saving measures.

Flow forecasting analyzes the performance of factors like airflow or occupant/crowd circulation within the facility. It helps in ensuring optimal functionality and user comfort. Scenario forecasting involves predicting the facility's performance during emergencies such as fires, floods, or evacuations. This enables effective emergency planning and response.

Temporal forecasting looks at the facility's performance over time, including building degradation and the timing for element replacement. It assists in maintenance scheduling and asset management. By considering these multiple facility variables and conducting performance predictions, BIM Uses contribute to a comprehensive understanding of the facility's performance and support informed decision-making.

c) Validate

BIM Uses serve the purpose of validating facility information to ensure its accuracy and integrity. This validation process involves checking the facility information for logical consistency and reasonableness. The validating BIM Uses can be categorized into three main areas: prescription validation, functionality validation, and compliance validation.

Prescription validation focuses on verifying that the facility incorporates the specified and programmed elements, including the primary components such as spaces or rooms. Functionality validation aims to ensure that the facility is constructible, maintainable, and fit for its intended purpose. It assesses whether the facility will effectively fulfill its design objectives. Compliance validation involves confirming that the facility adheres to relevant codes and standards, including building codes, ADA standards, sustainability criteria, and other applicable regulations.

Whenever facility information developed in other processes undergoes accuracy checks, it falls within the realm of validating BIM Uses. The purpose of validation is to ensure that the facility information is reliable and meets the required standards and specifications.

3.8.4. Communicate

Facilitating effective communication of facility information is a fundamental objective of BIM. The communication aspect of BIM focuses on presenting facility-related data in a format that is easily shareable and exchangeable. This step usually takes place after various other processes, where visualizations, transformations, drawings, or documents are generated to convey information to the next user. The ability to communicate information through BIM is crucial for promoting collaboration, streamlining information sharing, and reducing communication time. It is worth noting that data communication naturally emerges as an inherent outcome of the processes involved in achieving other BIM Uses. [12]

a) Visualize

In the BIM process, there is often a need to convert facility information from one format to another to facilitate its use in different processes or systems. This data translation or transformation enables interoperability between various systems and enables the utilization of legacy data in the current infrastructure. Examples of such data transformation include generating spooling information, creating layout data, and adopting industry-standard formats. It's important to note that this translated data is typically machine-readable rather than human-readable, ensuring seamless integration and compatibility between different software and applications.

b) Draw

Although the ultimate goal may be to eliminate drawings and paper from the industry, currently they still play a significant role. However, BIM greatly enhances the process of creating, detailing, and annotating drawings. BIM allows for a parametric approach to drawing development, where changes made to the BIM model automatically update the corresponding drawings and sheets. Any symbolic representation derived from an intelligent model, such as isometric views, one-line diagrams, and other graphical representations, is considered a drawing. BIM's parametric capabilities ensure that drawings remain synchronized with the underlying model, improving efficiency and accuracy in the documentation process.

c) Document

In some cases, facility data needs to be documented in written narratives or tabular formats. This falls under the documented purpose of BIM Uses, which involves creating a comprehensive record of facility data. These Uses are essential for accurately specifying facility elements and ensuring precise documentation. The outputs of this BIM Use may include specifications, submittals, design schedules, and various reports that capture and communicate facility data effectively.

d) Transform

In the BIM process, there is often a need to convert facility information from one format to another, enabling its use in different processes. This data translation or transformation facilitates interoperability between various systems and enables the utilization of legacy data in the current infrastructure. Examples of this include generating spooling information, creating layout data, and adopting industry-standard formats. The translated data is typically machine-readable rather than human-readable, ensuring seamless exchange and compatibility across different software and tools.

3.8.5. REALIZE

BIM is playing an increasingly crucial role in reducing human intervention in the creation of specific facility elements. One of the primary objectives of BIM Uses is to leverage facility data (BIM data) for the creation and management of physical components within the facility. This objective empowers the industry to fabricate, assemble, control, and regulate various elements of the facility. By harnessing this capability, productivity can be significantly enhanced in both the construction and operation phases of facilities. BIM's ability to automate processes and optimize resource utilization is driving positive impacts on the industry as a whole. [12]

a) Fabricate

BIM is revolutionizing the industry by enabling the creation of facility elements that were previously not feasible without detailed product modeling. The fabricated purpose of BIM Uses involves utilizing facility information to directly manufacture components of the facility. This can include the use of facility information to fabricate structural steel shapes using CNC machines, as well as the fabrication of ductwork or cutting piping. During the design phase, BIM can be employed to rapidly generate prototypes of future facility elements, while in operations, it can be utilized to quickly fabricate replacement parts. By leveraging BIM, the industry can achieve greater efficiency and accuracy in the fabrication process, leading to improved overall project outcomes.

b) Assemble

The assembling purpose of BIM Uses involves utilizing facility information to facilitate the integration of distinct elements within a facility. Although the process still requires some manual intervention, the use of BIM enables a higher level of precision, allowing for the prefabrication of different systems. It also enables the seamless integration of systems that were traditionally separate entities. Common examples of this include curtain wall systems, energy/MEP cores, and restrooms. Through BIM, these elements can be efficiently fitted together to ensure a cohesive and well-coordinated facility.

c) Control

BIM enables the utilization of facility information to actively control equipment operations. The controlling purpose of BIM Uses encompasses those applications where facility information is employed to physically manipulate the operation of executing equipment. Examples of such applications include using facility information to plan the layout of future work within a facility, such as positioning walls or determining the placement of imbeds in composite decks. Additionally, facility information can be used to control executing equipment, such as defining stakeout areas using GPS systems that are integrated with excavating equipment. The ability to control executing equipment through BIM has the potential to pave the way for automated construction sites in the future.

d) Regulate

The utilization of BIM for facility element regulation enables facility operators to optimize their operations. The regulating purpose of BIM uses involves utilizing facility information to guide the operation of specific facility elements. A typical example of this is adjusting the output of an HVAC system based on data collected from a temperature monitor or thermostat. A crucial aspect of this process is the integration of intelligent monitoring systems and the building information model, enabling informed decision-making across the entire system. This purpose of BIM Uses has the potential to drive toward fully automated facility operations in the future.

CHAPTER 4: Application of BIM to a Civil Aerodrome Project

CHAPTER 4

Application of BIM to a Civil Aerodrome Project

4.1. INTRODUCTION

Airports comprise highly complex and fragmented commercial buildings and systems that usher in high-value interactions between people, places, and things. Value creation is a recurring issue in airport projects. Consequently, as a very important economic driver, the life-cycle management of airport projects through design-build-operate phases requires innovative approaches to meet the ever-changing needs of end-users. [10]

In this study, a construction innovation framework is used to analyze the implementation processes of airport BIM from different parties, including the customer, general contractor, consultant, and technology provider. This framework analyzes the BIM implementation process based on various elements, such as factors, inputs, enabling factors, barriers, benefits, and impacts. A multi-party perspective approach is adopted to explore these components for an Algerian airport project.

4.2. Some Famous applications of BIM at Airports

BIM use has been documented at Frankfurt Airport in Germany (approximately 65 million enplanements/year). It implemented BIM in 2003 and developed a centralized database to support its operations and facilities management and enable “engineering, finance, operations, maintenance, security, and emergency response teams to visualize mission-critical facility information through interactive facility maps, to find relevant data more quickly, and to minimize operations downtime” (Shoolestani et al. 2015).

London Heathrow Airport (approximately 73 million enplanements/year) reported using BIM since 2004. A case study was conducted on its BIM use during a 2008 airport terminal project. It reported a high rate of savings directly related to its approach (building SMART UK 2010).

In 2010, Gatwick Airport in London (approximately 38 million enplanements/year) implemented BIM to support its billion-dollar capital improvement program after a transition to private ownership occurred. It aims to integrate BIM with its existing processes and implement BIM in all life-cycle phases. Although it has not completed full BIM implementation, it reports that BIM “has transformed project delivery and asset management” at the airport (Neath et al. 2014).

The Denver International Airport (approximately 53 million enplanements/year) began to implement BIM in 2010 with its Hotel and Transit Center project (Ball 2015). It has since institutionalized BIM and has extended its use to all life-cycle phases of its assets. It expects that its long-term strategy will produce economic returns (Ball 2015).

In 2011, FAA initiated its BIM Implementation Roadmap under its Naval Air Station Brunswick BIM Pilot Project, which was used to demonstrate the benefits of a full BIM implementation (FAA 2015a). FAA has since decided to institutionalize BIM and has been developing its BIM Implementation Plan, along with its BIM Standards, Guidelines, and Infrastructured Documents (FAA 2015a, b). FAA is currently in its pilot projects and solution development phase. The plan is to incrementally integrate BIM functionality related to the facility life cycle into FAA operations: BIM will be implemented in the design and construction phases, then progress to providing access to information to support Facilities Management and Geographic Information Systems capabilities (FAA 2015b).

Little has been published about the status of BIM in airports because it is an emerging technology that is only recently being implemented in airports in North America. Therefore, this study will seek to broadly synthesize existing literature and practice. [3]

4.3. Barriers to Airport BIM Adoption

Some common barriers attributed to BIM adoption, industrywide and cited in this study, are related to (Penn State 2010; Khosrowshahi and Arayici 2012) the following:

- Lack of organizational readiness to change;
- Lack of expertise;
- Greater system complexity;
- Lack of system interoperability
- Lack of industry standards.

All of these issues are inherent to the paradigm shift related to the emerging technology-intensive approach of BIM. [3]

4.4. Ways BIM can be used in a civil aerodrome project

a) Planning and Design: BIM can be used to create a 3D model of the aerodrome facility, including runways, taxiways, aprons, and buildings. The model can be used to simulate different design scenarios and analyze the impact of design changes on the overall project. The model can also be used to identify potential clashes and conflicts between different systems and elements and resolve them before construction.

b) Construction: BIM can be used during construction to manage and track the progress of the project. The model can be used to generate detailed construction drawings and schedules, as well as to coordinate the delivery of materials and equipment. BIM can also be used to monitor and analyze the performance of the project and identify any potential issues that may arise during construction.

4.5. Aerodrome Project Specification

4.5.1. Definition of the Convention on International Civil Aviation (ICAO)

ICAO is funded and directed by 193 national governments to support their diplomacy and cooperation in air transport as signatory states to the Chicago Convention (1944).

Its core function is to maintain an administrative and expert bureaucracy (the ICAO Secretariat) supporting these diplomatic interactions and to research new air transport policy and standardization innovations as directed and endorsed by governments through the ICAO Assembly, or by the ICAO Council which the assembly elects.

Industry and civil society groups, and other concerned regional and international organizations, also participate in the exploration and development of new standards at ICAO in their capacity as ‘Invited Organizations’.

As these stakeholders identify new priorities, the ICAO secretariat convenes panels, task forces, conferences, and seminars to explore their technical, political, socio-economic, and other aspects. It then provides governments with the best results and advice possible as they collectively and diplomatically establish new international standards and recommended practices for civil aviation internationally.

Once governments achieve diplomatic consensus around a new standard’s scope and details, those same 193 countries bring worldwide alignment to their national regulations, helping to realize safe, secure, and sustainable air operations on a truly global basis and then adopt it.

In addition to these core diplomatic and research capabilities, ICAO also serves as a critical coordination platform in civil aviation through its seven Regional Offices.

It also conducts educational outreach, develops coalitions, and conducts auditing, training, and capacity-building activities worldwide per the needs and priorities governments identify and formalize. [16]

4.5.2. The History of ICAO and the Chicago Convention

The Convention on International Civil Aviation, drafted in 1944 by 54 nations, was established to promote cooperation, "create, and preserve friendship and understanding among the nations and peoples of the world."

Known more commonly today as the 'Chicago Convention', this landmark agreement established the core principles permitting international transport by air and led to the creation of the specialized agency which has overseen it ever since – the International Civil Aviation Organization (ICAO). [15]

4.5.3. Not a global regulator

The stipulations ICAO standards contain never supersede the primacy of national regulatory requirements. It is always the local, and national regulations that are enforced in, and by, sovereign states, and which must be legally adhered to by air operators making use of applicable airspace and airports.

Contrary to many dramatic and media portrayals of UN agencies, they do not have any authority over national governments in the areas of international priority they are established for. Critiques of the UN are often rooted in allegations founded on fantastical capabilities and authorities, which sovereign states would never assign to a multilateral organization.

ICAO is therefore not an international aviation regulator, just as INTERPOL is not an international police force. We cannot arbitrarily close or restrict a country's airspace, shut down routes, or condemn airports or airlines for poor safety performance or customer service.

Should a country transgress a given international standard adopted through our organization, ICAO's function in such circumstances, consistent with our core diplomatic capabilities and role, is to help countries conduct any discussions, condemnations, sanctions, etc., they may wish to pursue, consistent with the Chicago Convention and the Articles and Annexes it contains under international law. [16]

4.6. How ICAO Works:

According to the terms of the Convention, the Organization is made up of an Assembly, a Council of limited membership with various subordinate bodies, and a Secretariat. The Chief Officers are the President of the Council and the Secretary-General.

The Assembly, composed of representatives from all Contracting States, is the sovereign body of ICAO. It meets every three years, reviewing in detail the work of the Organization and setting policy for the coming years. It also votes for a triennial budget.

The Council, the governing body that is elected by the Assembly for a three-year term, is composed of 36 States. The Assembly chooses the Council Member States under three headings: States of chief importance in air transport, States, which make the largest contribution to the provision of facilities for air navigation, and States whose designation will ensure that all major areas of the world are represented. As the governing body, the Council gives continuing direction to the work of ICAO. It is in the Council that Standards and Recommended Practices are adopted and incorporated as Annexes to the Convention on International Civil Aviation. The Air Navigation Commission (technical matters), the Air Transport Committee (economic matters), the Committee on Joint Support of Air Navigation Services, and the Finance Committee assist the Council.

The Secretariat, headed by a Secretary General, is divided into five main divisions: the Air Navigation Bureau, the Air Transport Bureau, the Technical Co-operation Bureau, the Legal Bureau, and the Bureau of Administration and Services. So that the work of the Secretariat shall reflect a truly international approach, professional personnel are recruited on a broad geographical basis.

ICAO works in close cooperation with other members of the United Nations family such as the World Meteorological Organization (WMO), the International Telecommunication Union (ITU), the Universal Postal Union, the World Health Organization (WHO), and the International Maritime Organization (IMO). Non-governmental organizations, which also participate in ICAO’s work, include the International Air Transport Association (IATA), the Airports Council International (ACI), the International Federation of Air Line Pilots' Associations International Federation of Airline Pilots Associations (IFALPA), and the International Council of Aircraft Owner and Pilot Associations (IAOPA). [21]

4.7. ICAO Strategic Objectives

In its ongoing mission to support and enable a global air transport network that meets or surpasses the social and economic development and broader connectivity needs of global businesses and passengers, and acknowledging the clear need to anticipate and manage the projected doubling of global air transport capacity by 2030 without unnecessary adverse impacts on system safety, efficiency, convenience or environmental performance, ICAO [17] has established five comprehensive Strategic Objectives:

a) Safety:

Enhance global civil aviation safety. This Strategic Objective is focused primarily on the State's regulatory oversight capabilities. The Global Aviation Safety Plan (GASP) outlines the key activities for the triennium.

b) Air Navigation Capacity and Efficiency

Increase the capacity and improve the efficiency of the global civil aviation system. Although functionally and organizationally interdependent with Safety, this Strategic Objective is focused primarily on upgrading the air navigation and aerodrome infrastructure and developing new procedures to optimize aviation system performance. The Global Air Navigation Capacity and Efficiency Plan (Global Plan) outline the key activities for the triennium.

c) Security & Facilitation

Enhance global civil aviation security and facilitation. This Strategic Objective reflects the need for ICAO's leadership in aviation security, facilitation, and related border security matters.

d) Economic Development of Air Transport

Foster the development of a sound and economically viable civil aviation system. This Strategic Objective reflects the need for ICAO's leadership in harmonizing the air transport framework focused on economic policies and supporting activities.

e) Environmental Protection

Minimize the adverse environmental effects of civil aviation activities. This strategic objective promotes ICAO's leadership in all aviation-related environmental activities and is consistent with the environmental protection policies and practices of ICAO and the United Nations system.

4.8. Chicago convention Annexes

4.8.1. CONSTITUTIVE PROVISIONS OF AN ANNEX

An annex proper consists of the following elements:

- Standards and recommended practices;
- Definitions;
- Appendices, tables, and figures.

The Standards and Recommended Practices which, were adopted by the Council under the provisions of the Chicago Convention, are defined as follows:

a) **Standard:** Any specification relating to physical characteristics, configuration, equipment, performance, personnel, and procedures, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and with which Contracting States will comply. under the provisions of the agreement. If unable to comply, notice to the Board is required under Article 38 of the Agreement.

b) **Recommended Practice:** Any specification relating to physical characteristics, configuration, equipment, performance, personnel, and procedures, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which the Contracting States shall endeavor to comply with the provisions of the Convention.

In the field of technical coordination, a clearly defined task of ICAO, its action results in the publication, for all the technical specialties of air transport, of rules aimed at ensuring throughout the world the uniformity of regulations and methods. For the same specialty, these rules are grouped into a single document, which constitutes an appendix to the Chicago Convention.

The annexes to the Chicago Convention [22] are as follows:

- Annex 1 - Personnel Licensing;
- Annex 2 - Rules of the Air;
- Annex 3 - Meteorological Services
- Annex 4 - Aeronautical Charts;
- Annex 5 - Units of Measurement;
- Annex 6 - Operation of Aircraft;
- Annex 7 - Aircraft Nationality and Registration Marks;

- Annex 8 - Airworthiness of Aircraft;
- Annex 9 - Facilitation;
- Annex 10 - Aeronautical Telecommunications
- Annex 11 - Air Traffic Services;
- Annex 12 - Search and Rescue;
- Annex 13 - Aircraft Accident and Incident Investigation;
- **Annex 14 - Aerodromes;**
- Annex 15 - Aeronautical Information Services;
- Annex 16 - Environmental Protection;
- Annex 17 - Security;
- Annex 18 - The Safe Transportation of Dangerous Goods by Air;
- Annex 19 - Safety Management.

In this chapter, we are interested in annex 14 the most.

4.8.2. Definition of Annex 14

According to the International Civil Aviation Organization (ICAO), Annex 14 is a document that contains Standards and Recommended Practices (SARPs) for the design, construction, and operation of aerodromes. This annex is part of the Chicago Convention on International Civil Aviation, which is an international treaty that establishes the legal framework for the regulation of civil aviation. The purpose of Annex 14 is to promote the safe, efficient, and orderly development of aerodromes, and to ensure that they meet the necessary standards and specifications for aviation operations. The annex covers a wide range of issues related to aerodrome design, including runway dimensions and markings, lighting and visual aids, aerodrome obstacle control, and emergency response procedures. By adhering to the standards and recommended practices outlined in Annex 14, States can ensure that their aerodromes provide a high level of safety and security for all users.

4.8.3. The most common terms are used in Annex 14

a) Aerodrome

A defined area on land or water, including any buildings, installations, and equipment, intended to be used either wholly or in part for the arrival, departure, and movement of aircraft. An aerodrome may include one or more runways, taxiways, parking areas, aprons, and associated facilities for the support of aircraft operations, such as fuel storage and servicing, passenger and cargo handling, and air traffic control. The design, construction, and operation of an aerodrome must comply with the standards and recommended practices outlined in Annex 14 to ensure the safety, efficiency, and regularity of air transport operations.

Fig 4.1 The Cayman Islands Aerodrome. [23]

b) Runways

The runway of an aerodrome is a rectilinear and flat surface specially designed to allow aircraft to take off and land safely. According to Annex 14 of the International Civil Aviation Organization (ICAO), the runway of an aerodrome must be designed and constructed in such a way as to meet strict safety standards, in particular in terms of length, width, resistance, adherence, markings, and beaconing. The dimensions of the runway depend on the type of aircraft that will use it, the maximum take-off weight, and the speed of the aircraft. The runway of an aerodrome may also be equipped with lights and signal lights to facilitate take-off and landing operations, as well as to guide aircraft on the runway. Flight safety largely depends on the quality of the runway and its regular maintenance.

Fig 4.2 Aerodrome runway (Greenville Spartanburg International-Airport GSP). [24]

c) Taxiways

Taxiways are designated areas on an aerodrome used by aircraft for ground movement, other than takeoff or landing. According to Annex 14 of the International Civil Aviation Organization (ICAO), taxiways are designed to provide a safe and efficient means for aircraft to move between the runway, aprons, and parking areas. They are usually marked with specific taxiway signs and markings to indicate the correct route and direction of movement for aircraft. Taxiways must be wide enough to accommodate the largest aircraft using the aerodrome and be constructed to support the weight of these aircraft. In addition, they must be designed to provide adequate clearance from other aircraft, buildings, and obstacles. The design, construction, and operation of taxiways must comply with the standards and recommended practices outlined in Annex 14 to ensure the safety, efficiency, and regularity of air transport operations.

Fig 4.3 Taxiways of Louis Armstrong New Orleans International Airport in Louisiana**.** [25]

d) Parking areas

Parking areas on an aerodrome are designated locations where aircraft can park when not in use. These areas are also known as aprons or ramps. According to Annex 14 of the International Civil Aviation Organization (ICAO), parking areas must be designed and constructed to accommodate the maximum number of aircraft expected to use the aerodrome. They must be located in such a way as to provide easy access to the runway and taxiways and be equipped with appropriate ground handling equipment, such as stairs, fuel trucks, and baggage carts. Parking areas may also be equipped with various services, such as air conditioning, power, water, and sewage systems to support aircraft maintenance and servicing.

The design, construction, and operation of parking areas must comply with the standards and recommended practices outlined in Annex 14 to ensure the safety, efficiency, and regularity of air transport operations.

Fig 3.4: Parking areas of ATATURK airport (Turkey). [26]

e) Movement area

This is part of an aerodrome that is used for take-off, landing, and the circulation of aircraft on the surface and which includes maneuvering air and traffic air

f) Maneuvering air

"Maneuvering air" is a term used in aviation to describe the air that an aircraft flies through during takeoff, climb, descent, and landing. It is also known as "flight path air" or "operational air."

The properties of maneuvering air, such as temperature, pressure, and density, can affect the performance of the aircraft. For example, in warmer temperatures, the air becomes less dense, which can reduce engine performance and lift. Similarly, changes in pressure can affect altitude and airspeed.

To ensure safe and efficient flight operations, pilots must take into account the characteristics of maneuvering air and adjust their flight paths and procedures accordingly. They also rely on weather reports and forecasts to plan their flights and avoid adverse conditions that could affect the quality of the maneuvering air.

g) Traffic air

Traffic air is not a common term used in aviation. You may be referring to "air traffic" which refers to the movement of aircraft in the airspace, including takeoff, landing, and en-route flight. Air traffic controllers who monitor the airspace and provide instructions to pilots to ensure safe and efficient operations manage air traffic.

The term "traffic" is often used in aviation to refer to the number of aircraft or vehicles operating in a particular area. For example, "heavy traffic" may indicate a high volume of aircraft or vehicles in the vicinity of an airport or on a specific air route. The traffic conditions can impact the safety and efficiency of operations, so pilots and air traffic controllers work together to manage traffic flow and minimize the risk of collisions.

h) Hangar

A hangar is an enclosed structure used for the storage and maintenance of aircraft. Hangars can vary in size and shape, from small hangars for light aircraft to large buildings for commercial and military aircraft. Hangars are often constructed of steel or concrete and may be fitted with sliding doors or hinged doors to allow entry and exit of aircraft.

Hangars can protect from weather, damage, and aircraft theft. Hangars can also be equipped with heating, ventilation, and air conditioning systems to maintain ideal conditions for maintenance work and aircraft repairs. Hangars can also be used for the storage of ground support equipment, such as maintenance vehicles, tools, and spare parts.

At airports, hangars are often leased to airlines, private aircraft operators, aircraft maintenance and repair companies, and government agencies.

Fig 4.5 Hangar at the Chateauroux Airport (France). [27]

4.9. AERODROME PAVEMENTS

4.9.1. Introduction

The development of the maneuvering area of an aerodrome involves the construction of pavements specially designed to be able to meet the technical requirements necessary for the evolution of aircraft and specific to the particularities of the aerodromes. Pavement whether specific to a runway, a taxiway, or a parking area, is made up of a set of juxtaposed layers made up of different materials of increasing quality from bottom to top. The choice of the nature of the constituent materials of these different layers generally defines the type of pavement. [9]

4.9.2. Specificities of aeronautical pavements

Compared to road pavements, airfield pavements are distinguished by their functional and structural aspect, which is different and much more important than that of roads. The loads applied to aeronautical pavements can be considerably higher than those of roads. Some aircraft bogies (Boeing 747) can reach 90 tons, while roads are generally designed for the action of an axle load of 13 tons. The intensity of the traffic on an aeronautical pavement is without common measure with that which exists on the roads, not from the traffic frequency point of view but much more from the traffic channeling point of view, also because of their large geometric surfaces and their low slopes, airfield pavements are much more exposed to climatic conditions than road pavements.

Therefore, airport pavements are required to meet the following conditions:

- The very high loading due to the weight of the aircraft requires a greater calculation of pavement thicknesses.
- The longitudinal and transverse profiles of aerodrome pavements must obey a certain regularity required by the mode of evolution on the ground of the aircraft.
- The variation in the frequency of traffic and its dispersion on the maneuvering area, requires special considerations of weighting the loads according to the function of each part of the roadway.
- Airfield pavements must be equipped with surface layers that ensure resistance to the blasts (and heat) released by aircraft engines and the chemical action of fuel.

Maintenance work on airfield pavements requires the total stoppage of traffic on the pavements to be maintained, which implies the need for a robust and safe initial design, which requires a minimum of maintenance during their operation. [9]

4.9.3. Structure of aeronautical pavements

The structure of aeronautical pavements consists mainly of three distinct layers, of increasing quality from bottom to top:

a) **The surface layer or wearing course:** provides a functional role (sealing, good evenness, roughness) and a structural role.
b) **The base layer:** essentially plays a structural role by diffusing and reducing the stresses on the foundation layer and the supporting soil, constituting a good foundation for the surface layer.
c) **The foundation layer:** provides support to the base layer and in particular allows good compaction of the latter, Participates in the distribution of stresses on the supporting soil.

We also note the presence of other additional layers in certain cases of pavements:

a) **A sub-layer:** designed to prevent the rise of water from the water table (anti-capillary role), and to prevent contamination of the upper layers by clay substrate soils (anti-contaminant role).
b) **A capping layer:** The capping layer constitutes a link between the actual earthworks and the pavement. The advantage of having a capping layer is not only to lead to a reduction in the thickness of the pavement, but it meets various purposes: such as the regulation of site traffic, the protection of the under -soil against bad weather, anti-contamination, improvement and homogenization of the bearing capacity of the pavement support and protection against frost.

4.9.4. Type of aeronautical pavements

Depending on the nature of the materials constituting the different layers of the pavement structure, the following four types of pavement can be distinguished:

- **flexible pavements**

it is a pavement whose structure consists of a wearing course and a base layer composed of materials treated with hydrocarbon binders and a foundation layer of untreated materials.

- **Rigid pavement**

A rigid pavement consists mainly of a cement concrete slab and a foundation layer. In this type of pavement, the wearing course and the base course are combined.

- **Composite pavement**

It is a pavement resulting from the reinforcement of a rigid pavement by a flexible pavement. This structure is therefore made up of a wearing course made of materials treated with hydrocarbon binders resting on a cement concrete slab acting as a base course. This cannot be used for new pavements.

- **Semi-rigid pavement**

It is a pavement whose structure is composed of a wearing course made up of materials treated with hydrocarbon binders and a base layer made up of materials treated with hydraulic binders. Aeronautical experience has shown that the use of this type of pavement has several disadvantages, that should be avoided.

In the rest of this manual, only two main categories of aeronautical pavements are considered: flexible pavements and rigid pavements.

4.9.5. Choosing a pavement type

The choice of a pavement type depends on a large number of relative considerations, in particular:

- To construction costs;
- Local material supply conditions;
- To the climate;
- Ground support;
- The possibilities of ensuring suitable and inexpensive maintenance;
- To traffic;
- Execution deadlines;
- Possibilities of work programming;
- Various technical problems;
- To the available technicality of the construction companies.

It is not possible to specify in which case it is necessary to provide a rigid roadway rather than a flexible roadway, however, the choice can only be made after a complete study of the two processes, involving the above-mentioned considerations and taking into account the advantages and disadvantages that each type has.

a) **Benefits of flexible pavement**

- Very easy reinforcement and repairs;
- Absence of seals.

b) **Advantages of a rigid pavement**

- Great hardness;
- Good load distribution in the basement;
- Waterproof, quick drying, easy cleaning;
- Requires fewer materials;
- low maintenance;
- Good resistance to fuels and jet blasts;
- Better visibility (clear complexion).

c) **Disadvantages of flexible pavement**

- More expensive maintenance;
- Poor resistance to fuels and jet blasts;
- Very important foundation;
- less good visibility (dark complexion).

d) **Disadvantages of a rigid pavement**

- Low elasticity;
- Risk of cracking;
- Presence of joints therefore of structural weak points;
- Routine maintenance of relatively expensive seals;
- Difficult repair and reinforcement.

4.9.6. Choosing a pavement constitution

The choice of a pavement constitution is based on structural rules, construction rules, and protection rules. Compliance with its three rules results in the adoption of the following provisions in terms of the choice of pavement composition.

Table 4.1 The different layers of the flexible pavements. [9]

Layer	Composition	Constitution	Abbreviation	Minimum Thicknesses (in cm)
surface layer	Materials treated with hydrocarbon binders	asphalt concrete	AC	5
base layer	Materials treated with hydrocarbon binders	asphalt-treated base	ATB	10
Foundation layer	untreated materials	untreated gravel	UTG	20

Table 4.2. the different layers of the rigid pavements. [9]

Layer	Composition	Minimum Thicknesses (in cm)
surface layer	cement concrete slab	15
Foundation layer	hydraulically bound gravel	20

4.10. Obstacle Limitation Surfaces

Obstacle Limitation Surfaces (OLS) refer to the three-dimensional airspace volumes surrounding an airport, defined by the International Civil Aviation Organization (ICAO), which ensure that obstacles, such as buildings or terrain, do not pose a hazard to aircraft taking off or landing. These surfaces include approach surfaces, Conical Surface, transitional surfaces, and inner horizontal surfaces, and are designed to provide a clear and safe path for aircraft.

4.10.1. Conical surface

The conical surface is a surface inclined upwards and outwards from the contour of the inner horizontal surface.

- **Characteristics:** The boundaries of the conical surface will include:
  - A lower boundary coincides with the contour of the inner horizontal surface.

- An upper boundary is located at a specified height above the inner horizontal surface.

The slope of the conical surface will be measured in a vertical plane perpendicular to the contour of the inner horizontal surface.

4.10.2. The Inner Horizontal Surface

The Inner Horizontal Surface is the surface located in a horizontal plane above an aerodrome and its surroundings.

➢ **Characteristics:** The radius or outer limits of the Inner Horizontal Surface will be measured from one or several established reference points.

The height of the Inner Horizontal Surface will be measured above a designated altitude reference point established for this purpose.

4.10.3. Approach surface

The approach surface is a sloping plane or combination of planes preceding the threshold of the runway.

Characteristics: the approach surface will be delimited by" is the translation of :

- An inner edge of specified length, horizontal and perpendicular to the extension of the runway axis and preceding the threshold by a specified distance ;
- Two lines, starting from the ends of the inner edge, will diverge uniformly at a specified angle from the extension of the runway axis;
- A parallel edge to the inner edge.

The inner edge will be located at the same elevation as the midpoint of the threshold.

The slope(s) of the approach surface will be measured in the vertical plane passing through the runway axis.

4.10.4. Transitional surface

The transitional surface is the complex surface that extends along the side of the runway strip and a portion of the approach surface and inclines upward and outward toward the inner horizontal surface.

➢ **Characteristics:** A transition surface shall be delimited by :

- A lower edge starting at the intersection of the side of the approach surface with the inner horizontal surface and extending along the side of the approach surface to its inner edge, and from there along the edge parallel to the runway axis;

- A upper boundary located in the plane of the inner horizontal surface.

The altitude of a point located on the lower edge will be :

- The altitude of a point located on the lower edge will be equal to the altitude of the approach surface at that point, along the side of the approach surface.
- along the strip, equal to the altitude of the closest point on the axis or its extension.

The slope of the transitional surface will be measured in a vertical plane perpendicular to the runway axis.

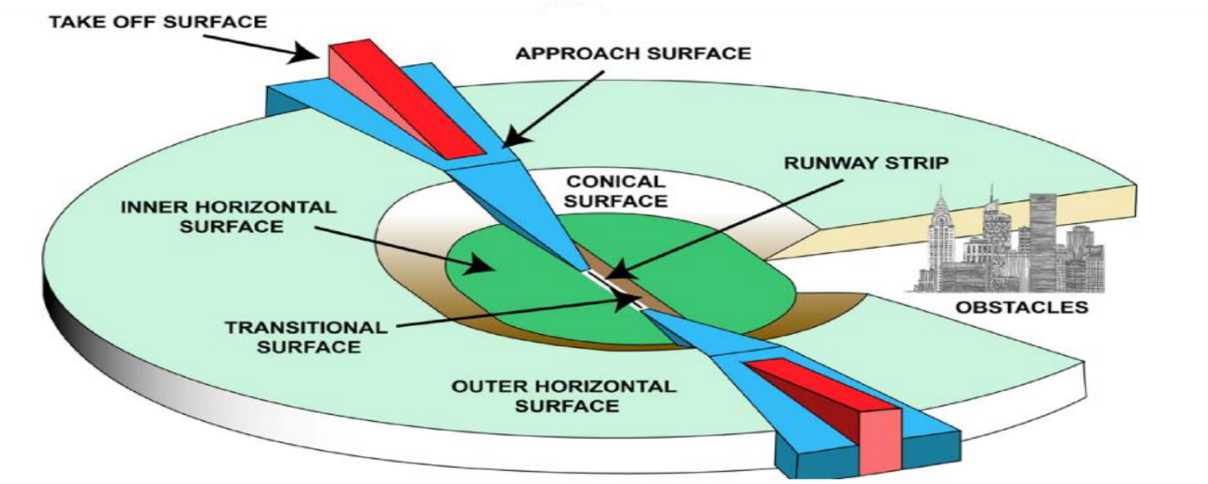


Fig 4.6 Obstacle Limitation Surfaces. [28]

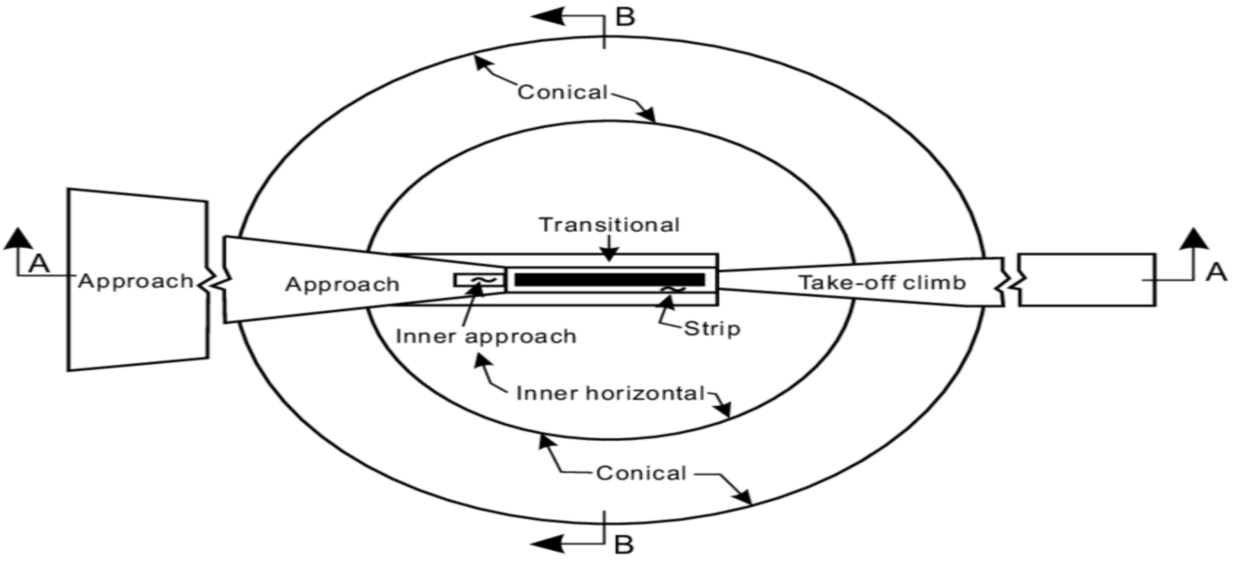


Fig 4.7: Clearways (obstacle limitation surfaces). [29]

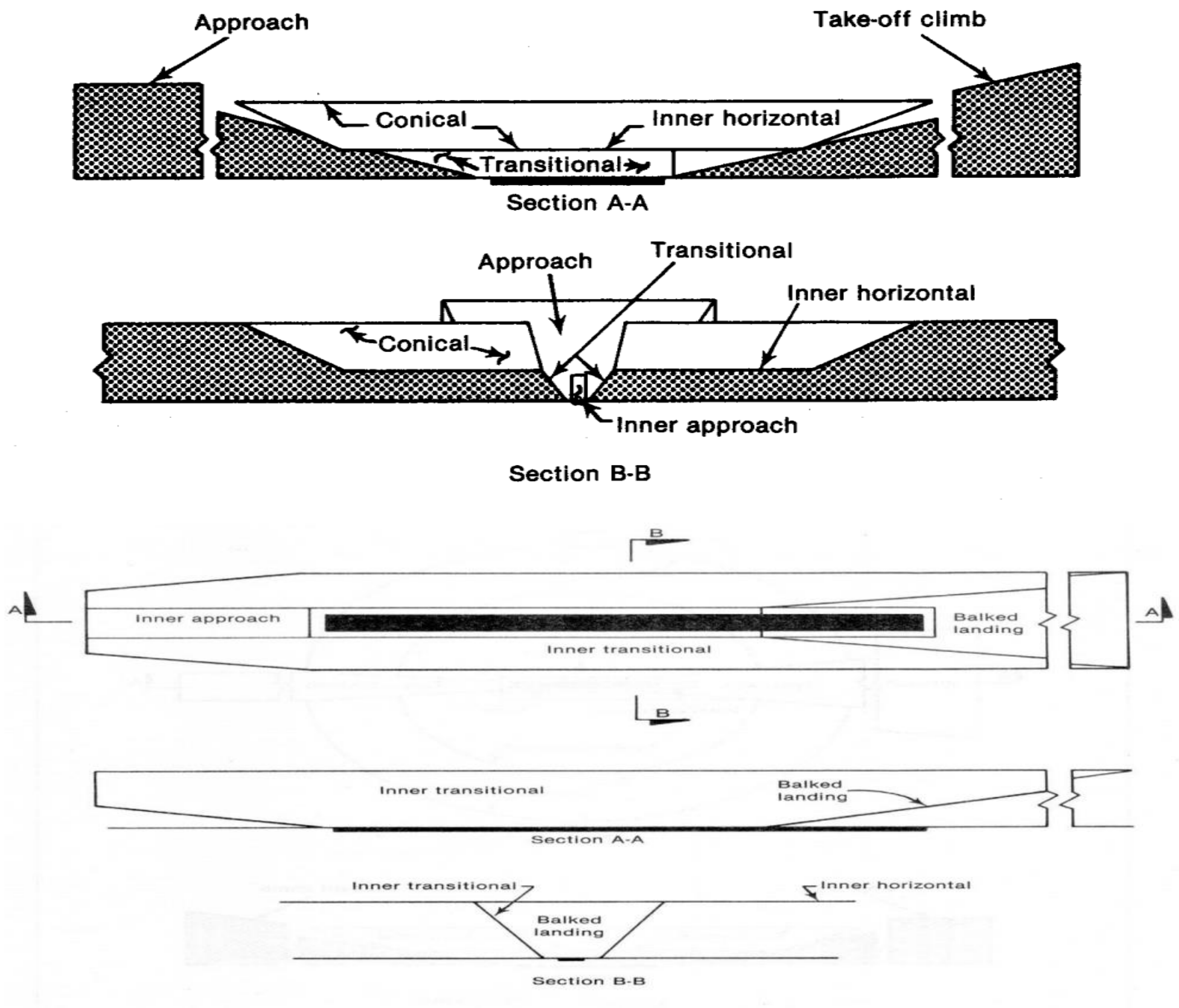


Fig 4.8: Obstacle limitation surface. [29]

4.11. Marking and signage

The construction of an aerodrome always involves the installation of a system designed to facilitate its use by aircraft, by providing pilots with standardized visual markers that complement the radio-electric guidance used for approach. This system is mainly composed of conventional signs and lights with universal characteristics.

The airport must be equipped with a system composed of marking and signaling. The marking itself consists of a set of fixed artificial visual markers used to guide aircraft in their maneuvers. Signaling is a set of signals used to provide clear instructions to aircraft, intended to assist in air traffic control. The entire marking and signaling system is often grouped under the term "marking.

There are two main types of airport marking and signage:

- Daytime marking and signage;
- Nighttime or low-visibility marking and signage.

4.11.1. Daytime marking and signage

a) Identification of the aerodrome

The identification of an aerodrome can be facilitated by inscribing its name in 3-meter high letters, usually in white. This inscription should be placed in a location chosen by the authorities operating the aerodrome, typically in a place visible in all directions above the horizon.

b) Wind direction indicator (or windsock)

It is recommended to equip the aerodrome with at least one wind direction indicator, which serves to provide a general visual indication of the direction and speed of the wind at the surface of the aerodrome. This device is in the form of a fabric cone trunk, at least 3.6 m in length and 0.9 m in diameter, mounted on a wind vane. The indicator must be of a color chosen to make it visible at a height of 300 m above the aerodrome, using a combination of two colors, preferably white and red.

c) landing direction indicator

This indicator consists of a mobile T-shaped element, with the vertical bar indicating the landing direction that the pilot must adhere to. The specifications of this T must comply with the instructions prescribed by ICAO recommendations. This indicator, along with other aeronautical signage panels (Annex 2 to the Chicago Convention), are often grouped in a square, flat, and horizontal surface of at least 9 meters per side.

d) Runway marking

The different markings of a runway are described below:

- **Runway identification markings QFU**

The runway identification marks, called QFU, shall consist of a two-digit number which shall be the whole number nearest to the tenth of the magnetic azimuth of the runway centerline measured from magnetic North in the direction clockwise for an observer looking in the direction of the approach. If the application of the above rule yields a number less than ten, this number shall be preceded by a zero.

A runway is designated by two QFUs, one at each end.

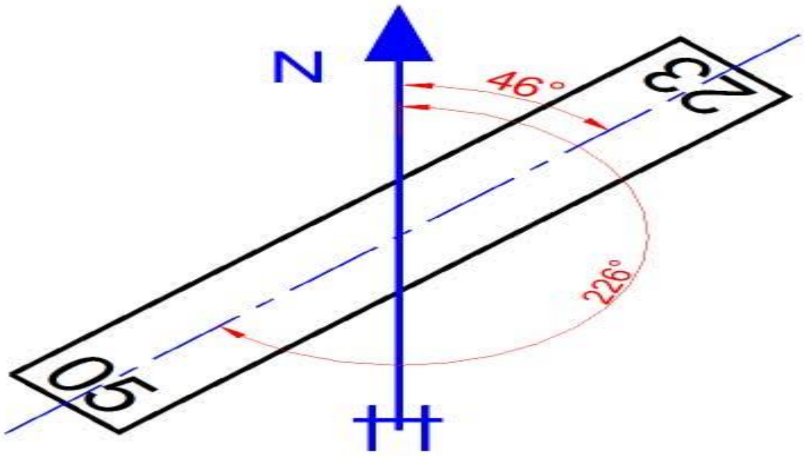


Fig 4.9 Example of determining the runway magnetic headings.

In the case of parallel runways, they are differentiated by an additional letter called a runway identifier letter:

- L if the runway is located on the left (Left);
- R if the runway is located on the right (Right);
- C if the runway is located in the center (Center).

- **blast pad / stop way**

A blast pad, also known as a stopway, is an area located beyond the end of the runway that is specifically designed to enhance safety in case of an aircraft overshooting or aborting takeoff. A blast pad is usually made of paved or specially treated surfaces and is intended to withstand the jet blast or debris generated by an aircraft during takeoff or landing. It provides additional distance for the aircraft to decelerate or come to a stop, minimizing the risk of a runway overrun.

The length and construction of blast pads or stop ways vary depending on the airport and runway specifications. They serve as a safety measure to protect both the aircraft and occupants in the event of an aborted takeoff or landing rollout.

- **Displaced threshold**

A displaced threshold is a portion of the runway that is not available for aircraft landings. It is marked by white arrows pointing toward the runway and is typically located at the beginning of the runway. The purpose of a displaced threshold is to provide a clear area for aircraft to take off without obstructions, such as trees, buildings, or other obstacles, that might be located near the end of the runway.

When a pilot is landing on a runway with a displaced threshold, they will aim to touch down beyond the displaced threshold markings, effectively reducing the usable landing distance. The displaced threshold is not considered part of the available runway length for landing purposes, but it can still be used for taxiing or takeoff.

Displaced thresholds are commonly found in airports where there are obstructions near the runway, or when the runway length is shared with another intersecting runway or taxiway. They are designed to enhance safety by providing additional clearance for aircraft operations.

- **Runway threshold markings**

The ends of each runway must be marked with threshold markings, which define the limits of the runway:

- Location: These markings start 6 meters from the runway's end.
- Characteristics: They will consist of a series of longitudinal stripes of the same dimensions, symmetrically arranged concerning the runway's centerline:
  - Length: 30 meters
  - Width: 1.8 meters
  - Spacing: 1.8 meters (The two stripes closest to the runway centerline will be spaced 3.6 meters apart).
  - Color: White.

- **Runway touchdown zone markings**

Runway touchdown zone markings are a series of transverse stripes located on the runway surface to indicate the touchdown zone for landing aircraft. These markings are typically composed of several pairs of rectangular bars that extend across the width of the runway. They are situated a specific distance from the threshold of the runway and help pilots in determining the touchdown point during landing. The touchdown zone markings are white in color and provide visual references for pilots to ensure safe and precise landings.

- **Runway aim point**

The runway aim point is a specific point along the runway where pilots aim to touch down during a landing. It is typically a designated point located a certain distance from the runway threshold, usually about one-third of the runway length.

The aim point is an important visual reference for pilots during the landing approach. By aiming to touch down at or near the aim point, pilots can optimize the landing distance and touchdown point, ensuring a safe and precise landing. It helps pilots align the aircraft with the runway and provides a consistent reference for landing flare and touchdown.

The aim point is typically marked by visual cues such as painted markings or may be identified based on other visual references on or near the runway, such as runway markings or lighting systems. It is an essential element in maintaining runway safety and efficiency during landings.

- **Runway edge line**

The runway edge line is a continuous line that marks the lateral boundary of the runway. It extends along the entire length of the runway on both sides. The primary purpose of the runway edge line is to provide visual guidance to pilots, indicating the edges of the usable runway surface.

The runway edge line is typically painted white, although in some cases, it may be yellow. It helps pilots maintain proper alignment with the runway during takeoff, landing, and taxiing operations. The line serves as a reference point for pilots to ensure they stay within the designated runway area and helps enhance safety by preventing runway incursions.

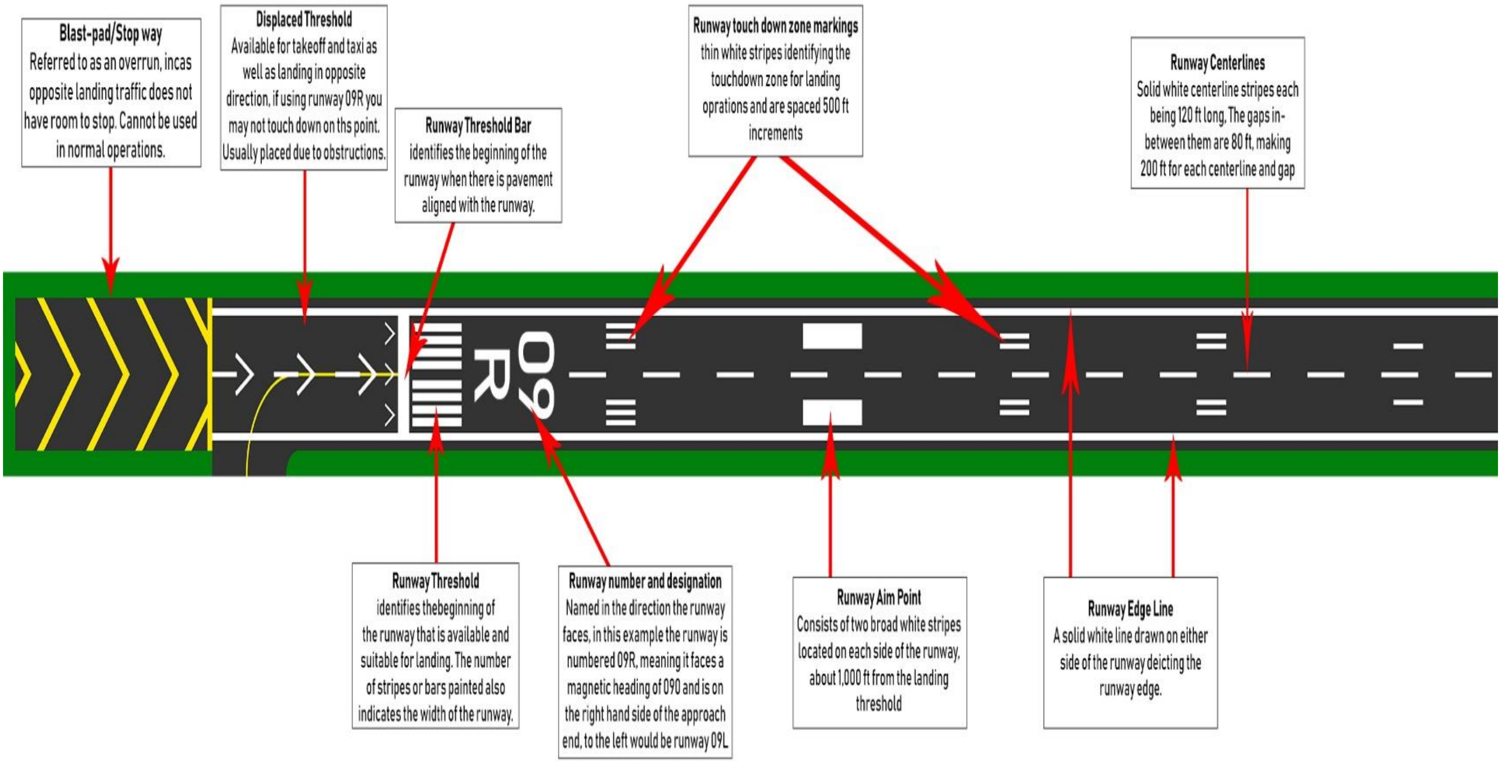
Additionally, the runway edge line assists ground personnel in identifying the edges of the runway and allows for clear visibility of the runway boundaries, especially during low visibility conditions.

- **Runway Centerline Markings**

Runway centerline markings are painted lines that run along the center of the runway, from one end to the other. These markings serve as a visual guide for pilots during takeoff, landing, and taxiing operations. The runway centerline markings are typically a continuous line that extends the full length of the runway. They are usually painted white, although in some cases, they may be yellow. These markings help pilots maintain proper alignment with the center of the runway, ensuring they stay on the correct path during takeoff and landing.

The centerline markings also assist pilots in maintaining proper spacing and clearance when taxiing on the runway. They serve as a reference point for maintaining runway centerline alignment, especially during low visibility conditions or at airports with multiple parallel runways.

The runway centerline markings, along with other visual aids such as runway lights and navigational instruments, play a crucial role in ensuring safe and accurate aircraft operations on the runway



Blast-pad/Stop way Referred to as an overrun, incas opposite landing traffic does not have room to stop. Cannot be used in normal operations.

Displaced Threshold Available for takeoff and taxi as well as landing in opposite direction, if using runway 09R you may not touch down on ths point. Usually placed due to obstructions.

Runway Threshold Bar identifies the beginning of the runway when there is pavement aligned with the runway.

Runway touch down zone markings thin white stripes identifying the touchdown zone for landing oprations and are spaced 500 ft increments

Runway Centerlines Solid white centerline stripes each being 120 ft long. The gaps in-between them are 80 ft, making 200 ft for each centerline and gap

Runway Threshold identifies thebeginning of the runway that is available and suitable for landing. The number of stripes or bars painted also indicates the width of the runway.

Runway number and designation Named in the direction the runway faces, in this example the runway is numbered 09R, meaning it faces a magnetic heading of 090 and is on the right hand side of the approach end, to the left would be runway 09L

Runway Aim Point Consists of two broad white stripes located on each side of the runway, about 1,000 ft from the landing threshold

Runway Edge Line A solid white line drawn on either side of the runway deicting the runway edge.

Fig 4.10: runway markings. [30]

4.11.2. Nighttime or low-visibility marking and signage

Runway night markings, also known as runway lighting, are specialized lighting systems installed along the runway to enhance visibility and aid pilots during nighttime operations. These lighting systems are designed to provide guidance and reference points for pilots during takeoff, landing, and taxiing.

The most common types of runway night markings include:

a) **Runway edge lights:** These lights are located along the edges of the runway and provide a clear visual boundary for pilots, outlining the lateral limits of the runway.

b) **Threshold lights:** These lights are typically installed at the beginning of the runway to indicate the runway threshold during nighttime operations.

c) **Centerline lights:** These lights are aligned with the runway centerline and provide pilots with a visual reference for maintaining runway alignment during takeoff, landing, and taxiing.

d) **Touchdown zone lights:** These lights are usually placed along the runway's touchdown zone, helping pilots identify the correct touchdown point during landing.

e) **Taxiway lights:** In addition to runway markings, there are also specialized lighting systems along the taxiways, including taxiway edge lights and centerline lights, to assist pilots in navigating the airport at night.

These runway night markings play a critical role in ensuring safe and efficient aircraft operations during low-light conditions. They help pilots maintain proper alignment, identify key runway points, and navigate the airport with enhanced visibility, promoting overall aviation safety.

Symbol and color letters	Description
G ●●●● R	Runway threshold / End lights Green (G) / Red (R)
Y ◐ W	Runway edge light (see note 3) Yellow (Y) / White (W)
W ●	Runway edge light White (W)
W ⬟	Runway edge light (in-pavement) White (W)
R ●	Runway threshold / End light Red (R)
B ●	Taxiway edge light Blue (B)
Y ◐ R	Runway edge light at displaced threshold Yellow (Y) / Red (R)
G ◐ Y	Threshold / Runway edge lights at displaced threshold Green (G) / Yellow (Y)
G UNI ◐	Runway threshold light with a unidirectional green (G UNI)

Fig 4.11 Colors Found In Runway Edge Lighting. [31]

4.12. Presentation of the case study

4.12.1. History of the Aerodrome of Cheikh Larbi Tebessi-Tebessa

Tébessa Airport (IATA code: TEE, ICAO code: DABS) is an international airport located in the city of Tébessa in northeastern Algeria. The airport is situated at an elevation of 811 meters (2,661 feet) above sea level and has two runways 11/29 of 3000 meters long (9,842 feet) and 45 meters wide (148 feet) and 12/30 of 2400 meters (7874 feet) long and 30 meters wide (98.5 feet), five taxiways (N1, N2, A, B and C), a parking lot and an airport terminal. The Tebessa airport was built in 1956 by France to house a military airport. The Larbi Tebessi airport, which covers an area of approximately 26 hectares, is classified as a second-class international airport and can accommodate 5 aircraft simultaneously with a capacity of around 45,000 passengers annually. serves both civilian and military purposes and is operated by the Algerian Air Force.

Fig 4.12 The image was taken by google earth pro of the airport of Cheikh Larbi Tebessi-Tébessa.[6]

4.12.2. Presentation of the aerodrome :

- Name of the airport: Tébessa/Cheikh Larbi Tebessi Airport;
- Location: The airport is located 1.35 nautical miles north of the city of Tebessa;
- Class: Second category international airport;
- Status: Civil;
- Altitude: 811m;
- ICAO Classification: 4C.

The aerodrome platform of Tébessa Airport currently includes the following facilities:

- **a)** Runway 11/29: with a length of 3000 meters and a width of 45 meters, equipped with a shoulder of 7.5 meters and a PCN =59F/D/W/T.
- **b)** Runway 12/30: with a length of 2400 meters and a width of 30 meters, equipped with a shoulder of 7.5 meters and a PCN =59F/D/W/T.
- **c)** Taxiway N1: It connects runway 11/29 from the 11-threshold end to the parking lot, passing through the 12-threshold of runway 12/30, with a length of 1358 meters and a width of 25 meters.
- **d)** Taxiway N2: with a length of 1168 meters and a width of 15 meters, equipped with a shoulder of 5 meters.
- **e)** Taxiway A: with a length of 167 meters and a width of 15 meters, ensures the connection between the parking lot and runway 12/30.
- **f)** Taxiway B: with a length of 167.5 meters and a width of 25 meters, ensures the connection between the parking lot and runway 12/30.
- **g)** Taxiway C: with a length of 467 meters and a width of 25 meters, it connects runway 11/29 to the parking lot by crossing runway 12/30.
- **h)** Parking: with a length of 350 meters and a width of 100 meters and a PCN =64F/C/W/T.

Fig 4.13 Runway 12-30 of Tébessa airport.

Fig 4.14 Runway 12-29 of Tébessa airport.

Fig 4.15 Tébessa airport parking.

4.12.3. Design of road pavements

The different road pavements were designed based on the following assumptions:

- critical aircraft B737-800;
- 10 movements per day.

4.12.4. Road pavement structure

a) Runway 11-29

Table 4.3 Runway 11-29 Layers.

pavement structure		real average thickness (in cm)
asphaltic concrete	reinforcement layer	8
bitumen- aggregate		13
asphaltic concrete	existing layers	8
bitumen- aggregate		20
crushed aggregate		30
foundation layer		100

b) Runway 12-30

Table 4.4. Runway 12-30 Layers.

Pavement structure		real average thickness (in cm)
asphaltic concrete	reinforcement layer	8
bitumen-bound graded aggregate		13
asphaltic concrete	existing layers	8
bitumen-bound graded aggregate		20
crushed aggregate		30
foundation layer		100

c) circulation roads N1 and circulation roads N2

Pavement structure		real average thickness (in cm)
asphaltic concrete	reinforcement layer	8
bitumen-bound graded aggregate		13
asphaltic concrete	existing layers	8
bitumen-bound graded aggregate		20
crushed aggregate		30
foundation layer		100

Table 4.5 Circulation roads N1 and circulation roads N2 Layers.

d) Taxiwaysay A, B, and C

Table 4.6 Taxiway A, B, and C Layers.

pavement structure		real average thickness (in cm)
asphaltic concrete	Reinforcement layer	8
bitumen-bound graded aggregate		13
asphaltic concrete	Existing layers	8
bitumen-bound graded aggregate		20
crushed aggregate		30

e) Parking area

Table 4.7 Parking area Layers.

Pavement structure		real average thickness (in cm)
asphaltic concrete	reinforcement layer	9
bitumen-bound graded aggregate		20
asphaltic concrete	existing layers	8
bitumen-bound graded aggregate		25
clayey gravel		30

The chart used for designing the pavements of the Tebessa airport is presented in the following figure:

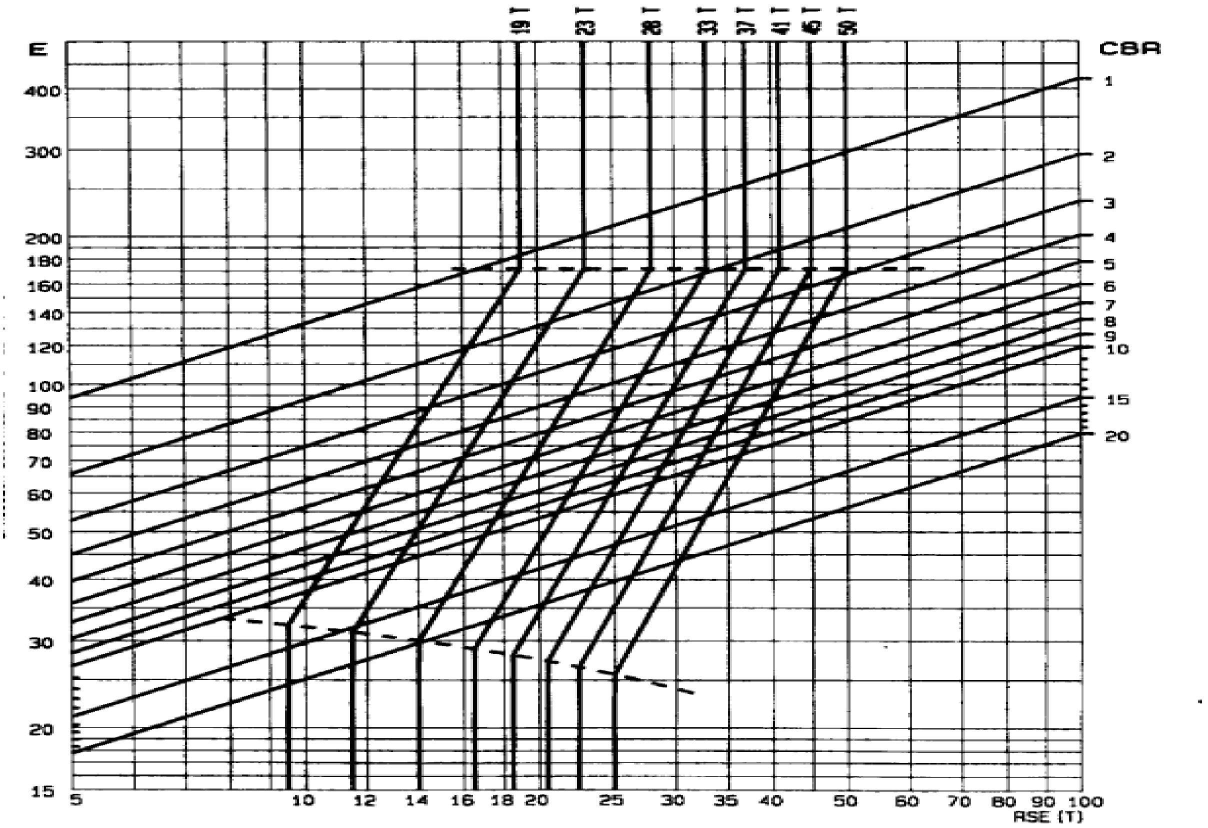


Fig 4.16. Chart established by the technical department of Civil Aviation - January 2006.

4.13. Creation of the BIM Model

Building Information Modeling (BIM) enables the creation of detailed 3D models that can be used to visualize a building's design, construction, and maintenance. Various software tools and applications like Autodesk Revit, SketchUp, or ArchiCAD can be utilized to create such models. These tools provide the ability to develop intricate 3D models with precise details, offering a comprehensive understanding of a building project from initial design through to ongoing management.

Defining a BIM model is a necessary step that needs to be undertaken before its creation.

4.13.1. Define the BIM Model

Defining the BIM model involves establishing the scope of the model and the level of detail required based on the project goals and requirements. Here are some steps to define the BIM model:

- **a)** Identify the Required Components: The first step is to identify the required components of the BIM model based on the project goals and requirements. This may include the building structure, mechanical systems, electrical systems, and plumbing systems, as well as other components such as furniture, fixtures, and equipment.
- **b)** Establish the Level of Detail: Once the required components have been identified, it's important to establish the level of detail required for each component. This may include defining the accuracy and precision of the information, as well as the amount of information required for each component.
- **c)** Define the Data Requirements: The next step is to define the data requirements for the BIM model. This may include specifying the required data fields for each component, such as dimensions, materials, and performance specifications.
- **d)** Determine the Software Requirements: Depending on the project requirements and the required level of detail, it may be necessary to use specialized software tools such as Autodesk Revit, ArchiCAD, Sketchup, or Bentley MicroStation to create the BIM model. It is important to determine the software requirements based on the project goals and the expertise of the project team.
- **e)** Establish Data Standards and Protocols: To ensure that the BIM model can be effectively shared and used by all stakeholders throughout the project lifecycle, it's important to establish data standards and protocols. This may include defining naming conventions, data formats, and file management protocols.

f) Define the Project Timeline: Finally, it's important to define the project timeline for creating the BIM model, including milestones and deliverables. This will help ensure that the project stays on track and that all stakeholders have a clear understanding of the project timeline.

Overall, defining the BIM model involves a comprehensive approach to identifying the required components, establishing data standards and protocols, and defining the project timeline, to optimize the building's design, construction, and management processes.

4.13.2. The main steps in creating a BIM model

Creating a Building Information Modeling (BIM) model involves capturing a wide range of information about a building project, including its physical and functional characteristics and data related to the construction and management of the building throughout its lifecycle. Here are the main steps involved in creating a BIM model:

a) Planning: Before creating a BIM model, it's important to plan out the scope of the project, the level of detail required, and the software and tools that will be used to create the model.

b) Information gathering: The next step is to gather all the relevant information about the building project, including architectural and engineering plans, specifications, schedules, and other data related to the project.

c) Model creation: Once the information is collected, the BIM model can be created using specialized software such as Autodesk Revit, ArchiCAD, or Bentley Micro Station. The model should include all the necessary information about the building's structure, Mechanical, Electrical, and Plumbing (MEP) systems, and data related to materials, equipment, and other components.

d) Collaboration: BIM models can be shared and collaborated on by various stakeholders involved in the project, including architects, engineers, contractors, and facility managers. Collaboration tools such as BIM 360 can be used to facilitate communication and coordination between team members.

e) Data management: BIM models contain a wealth of information that can be used throughout the building's lifecycle, from design and construction to operations and maintenance. To manage this data effectively, it's important to establish data standards and protocols and to use tools such as BIM asset management systems to organize and track information.

Overall, creating a BIM model involves a comprehensive approach to information management, collaboration, and project planning, intending to optimize the building's design, construction, and management processes.

CHAPTER 5: Modeling Digital Model

CHAPTER 5

Modeling Digital Model

5.1. Introduction

Building Information Modeling (BIM) is a powerful process that has revolutionized the way buildings and infrastructure projects are designed, constructed, and managed. At the heart of BIM is the digital model, a 3D representation of the building or project that contains all relevant information about its design, construction, and operation. The digital model in BIM is a collaborative tool that allows all stakeholders, including architects, engineers, contractors, and facility managers, to access and share information in real-time, making the design and construction process more efficient, accurate, and sustainable. In this essay, we will explore the concept of the digital model in BIM, its benefits, challenges, and its impact on the construction industry.

5.2. Definition of the Modeling Tool Sketchup

SketchUp is a professional 3D modeling software architects, engineers, construction professionals, and product designers use to create and modify digital models of physical objects or spaces. Developed by @Last Software and currently owned by Trimble Inc., SketchUp is known for its user-friendly interface and ease of use, making it popular among professionals and hobbyists alike. The software offers a range of tools and functionalities, including drawing and editing tools, 3D shapes, textures, and materials, and the ability to import and export various file formats. It also includes a large library of pre-made 3D models and the ability to import models from other 3D modeling software.

SketchUp offers both a free version, SketchUp Free, and a paid version, SketchUp Pro, which includes additional features such as the ability to export models to different file formats and access to more advanced tools. Professionals can use SketchUp to create accurate and detailed models for applications ranging from conceptual design to construction documentation, thus enhancing their workflow and productivity.

5.2.1. SketchUp in BIM technology

SketchUp can be used in Building Information Modeling (BIM) technology as a modeling tool to create 3D models of buildings and other structures. BIM is a process that involves the creation and management of digital models that contain all the necessary information about a building or infrastructure project. BIM models facilitate collaboration between architects, engineers, contractors, and other stakeholders throughout the design, construction, and operation.

SketchUp's 3D modeling capabilities make it an ideal tool for creating Building Information Modeling (BIM) models, particularly in the early design phases. It allows architects and designers to rapidly and easily create 3D models that can be used to explore various design options and convey ideas to project stakeholders. With its capacity to import and export diverse file formats, such as IFC (Industry Foundation Classes), SketchUp ensures seamless integration with other BIM software and tools, allowing for efficient collaboration and data exchange between team members, SketchUp can also be used in conjunction with BIM software such as Autodesk Revit or Trimble's own Tekla Structures. The SketchUp model can be used as a reference for creating a more detailed BIM model in these software packages. It can also be imported into the BIM model to provide additional context and detail.

Overall, SketchUp can play a valuable role in the BIM process by providing an intuitive and flexible modeling tool that can be used by architects, engineers, and other stakeholders to visualize and communicate design ideas.

5.2.2. Digital model

A digital model refers to a computer-generated representation of an object, space, or system. It is created using specialized software tools and can be manipulated, analyzed, and visualized in a variety of ways. Digital models are widely used in industries such as architecture, engineering, construction, product design, and entertainment to create 3D visualizations, prototypes, and simulations.

Digital models can be created from scratch using software tools like SketchUp or generated from existing physical objects and spaces using 3D scanning or photogrammetry techniques. Once created, digital models can be modified, refined, and optimized to meet specific project requirements.

Digital models can be used for a wide range of applications, including visualization, simulation, testing, and production. They can be used to communicate design concepts and ideas with stakeholders, simulate the behavior of complex systems, and create realistic prototypes and visualizations.

Overall, digital models are a critical tool in modern design and engineering workflows, enabling professionals to create highly accurate and detailed representations of physical objects and systems in a digital environment.

5.2.3. The creation of a digital model of the Tebessa Aerodrome:

Tébessa Aerodrome's digital model was created by first designing the aerodrome in Google Earth Pro and saving it as a KML file. Afterward, the KML file was converted to a DWG file using Global Mapper 20.

Fig 5.1 Two screenshots showing how to draw an aerodrome using Google Earth Pro.

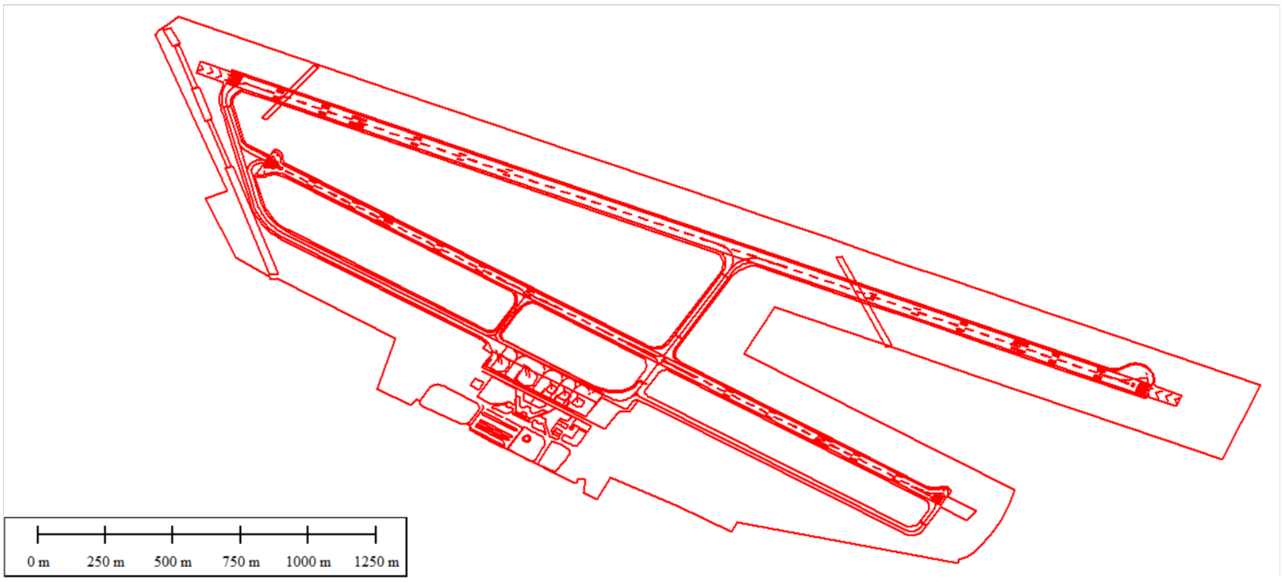


Fig 5.2 Converting KML file to DWG file using global mapper 20.

After obtaining, the DWG file from Global Mapper 20 can be imported into SketchUp for further design and modeling. In SketchUp, the user can create a digital model of the aerodrome by utilizing a variety of tools and features, including drawing and editing tools, 3D shapes, textures, and materials. The imported DWG file can serve as a reference to ensure the accuracy and alignment of the design. In addition, SketchUp allows the user to add details and elements such as buildings, runways, taxiways, and other features of the aerodrome. Once the digital model is complete, it can be exported in various file formats for further analysis, sharing, or use in other software and tools.

The following screenshots showcase the Tebessa Aerodrome model created in SketchUp:

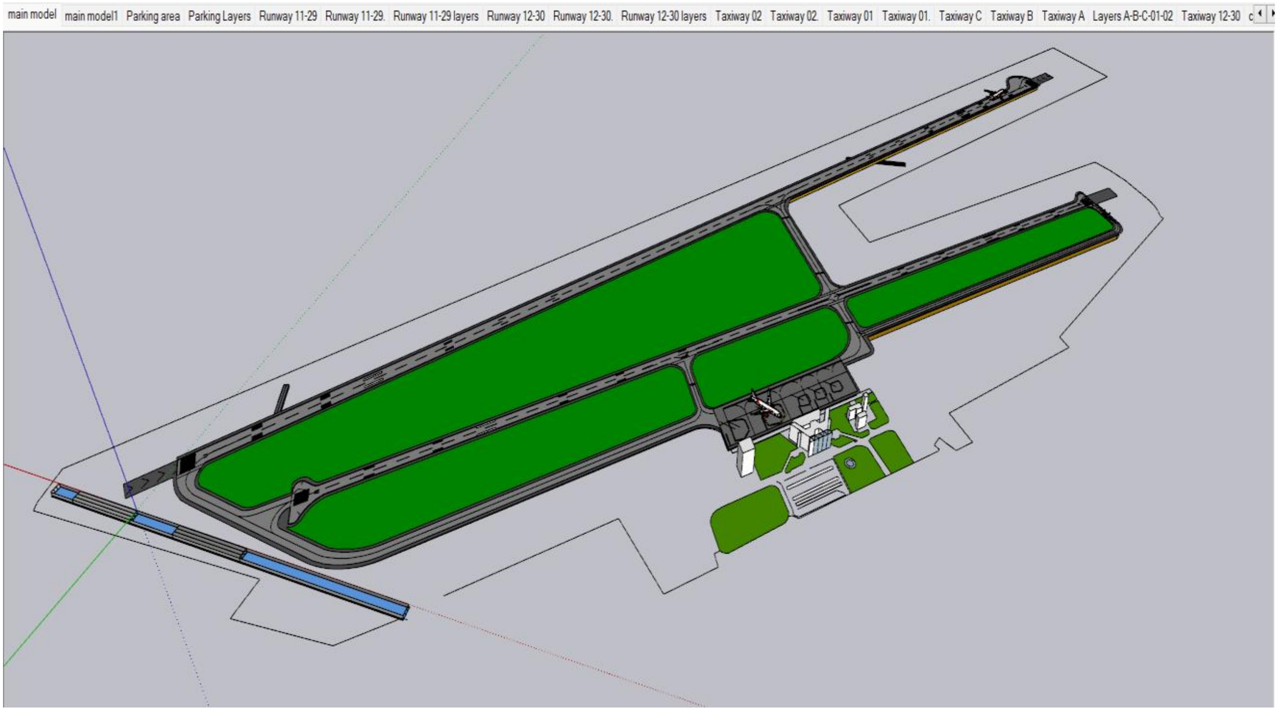


Fig 5.3 Main model from Sketchup.

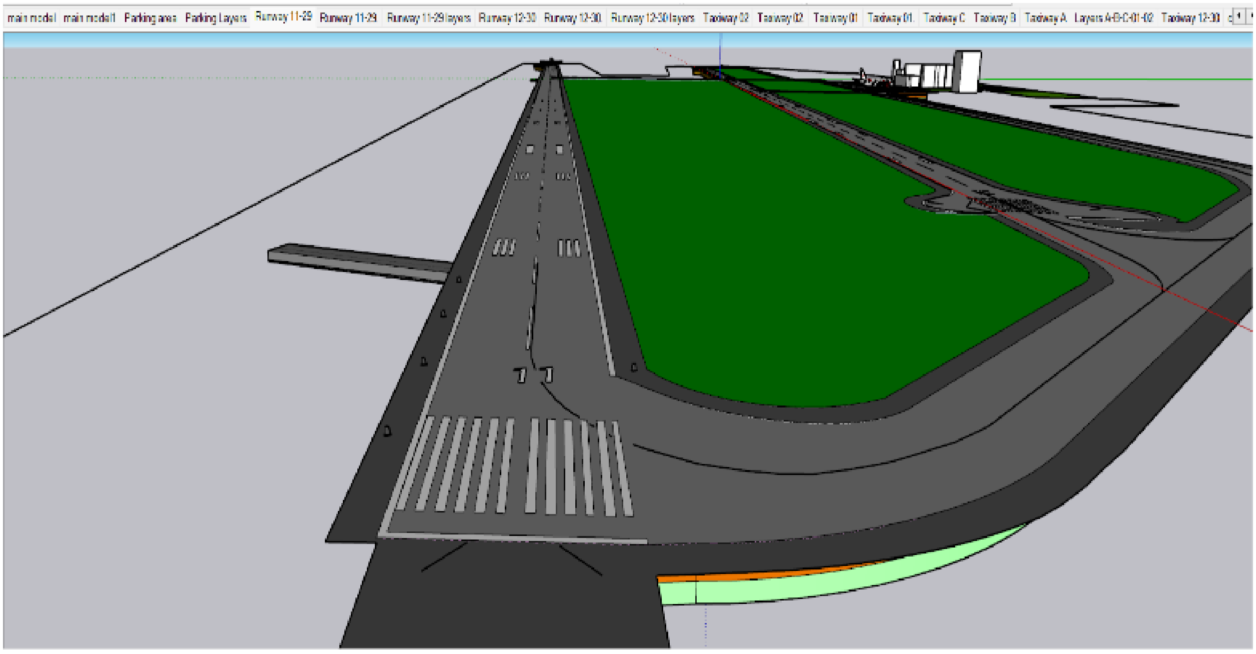


Fig 5.4 The threshold 11 of runway 11-29.

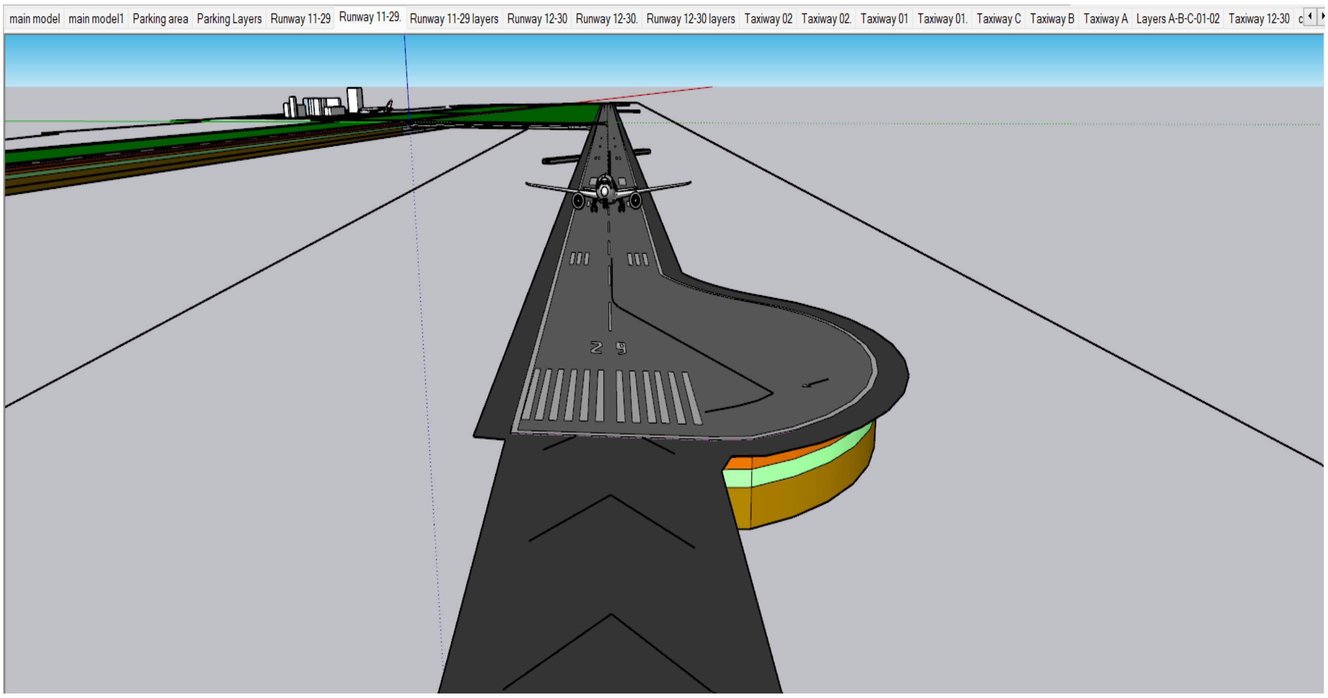


Fig 5.5 The threshold 11 of runway 11-29.

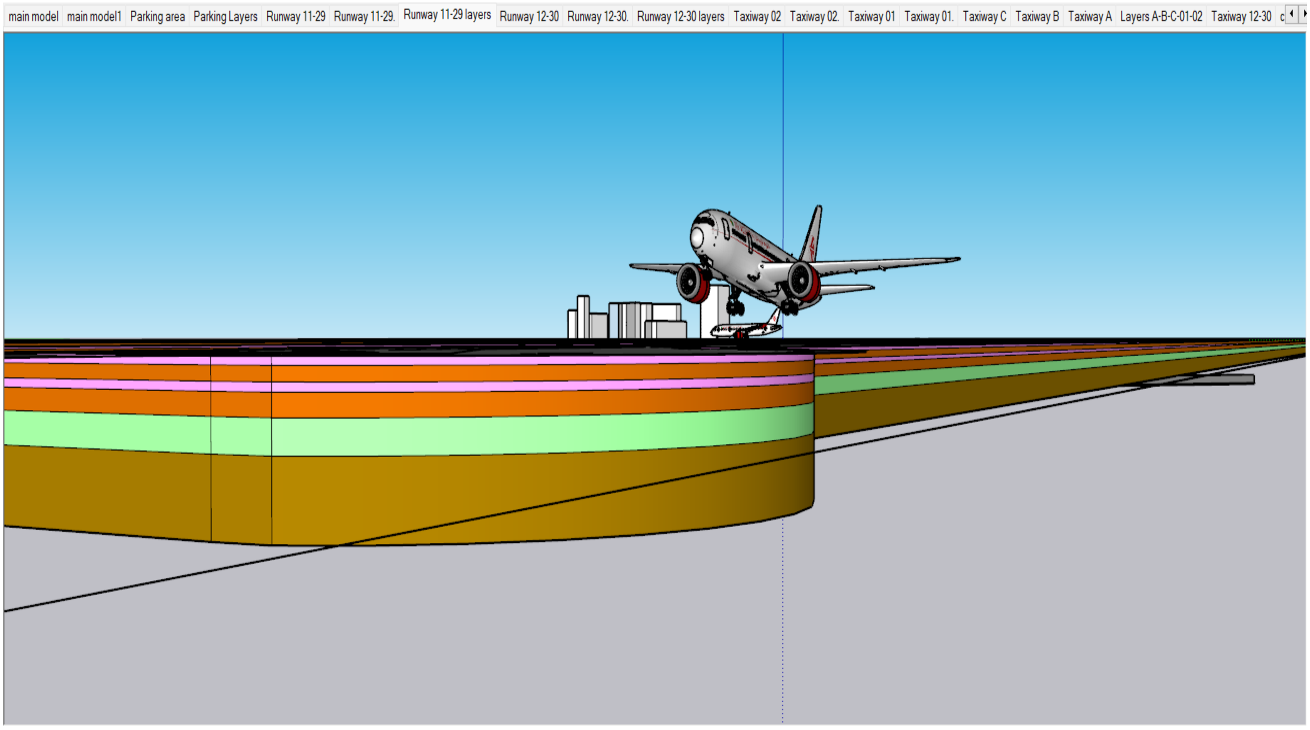


Fig 5.6 Runway 11-29 layers.

Fig 5.7 The threshold 12 of runway 12-30.

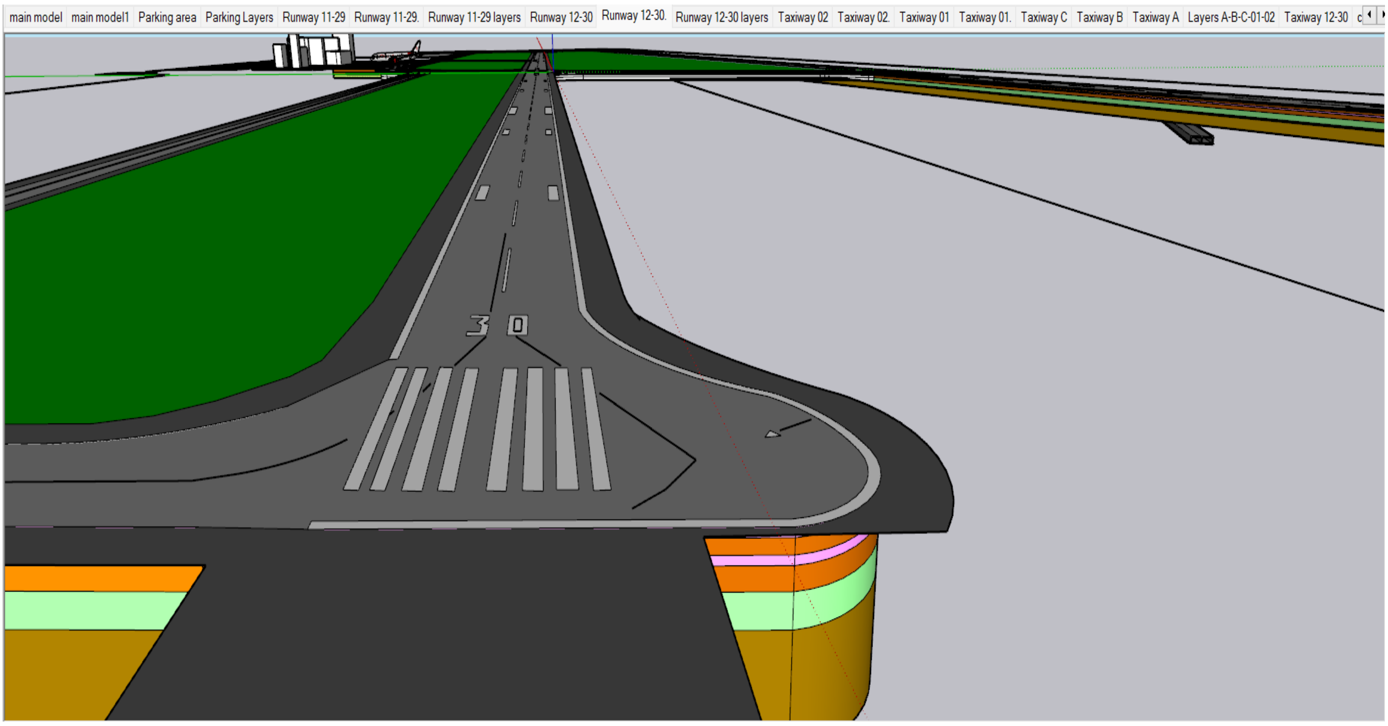


Fig 5.8 The threshold 30 of runway 12-30.

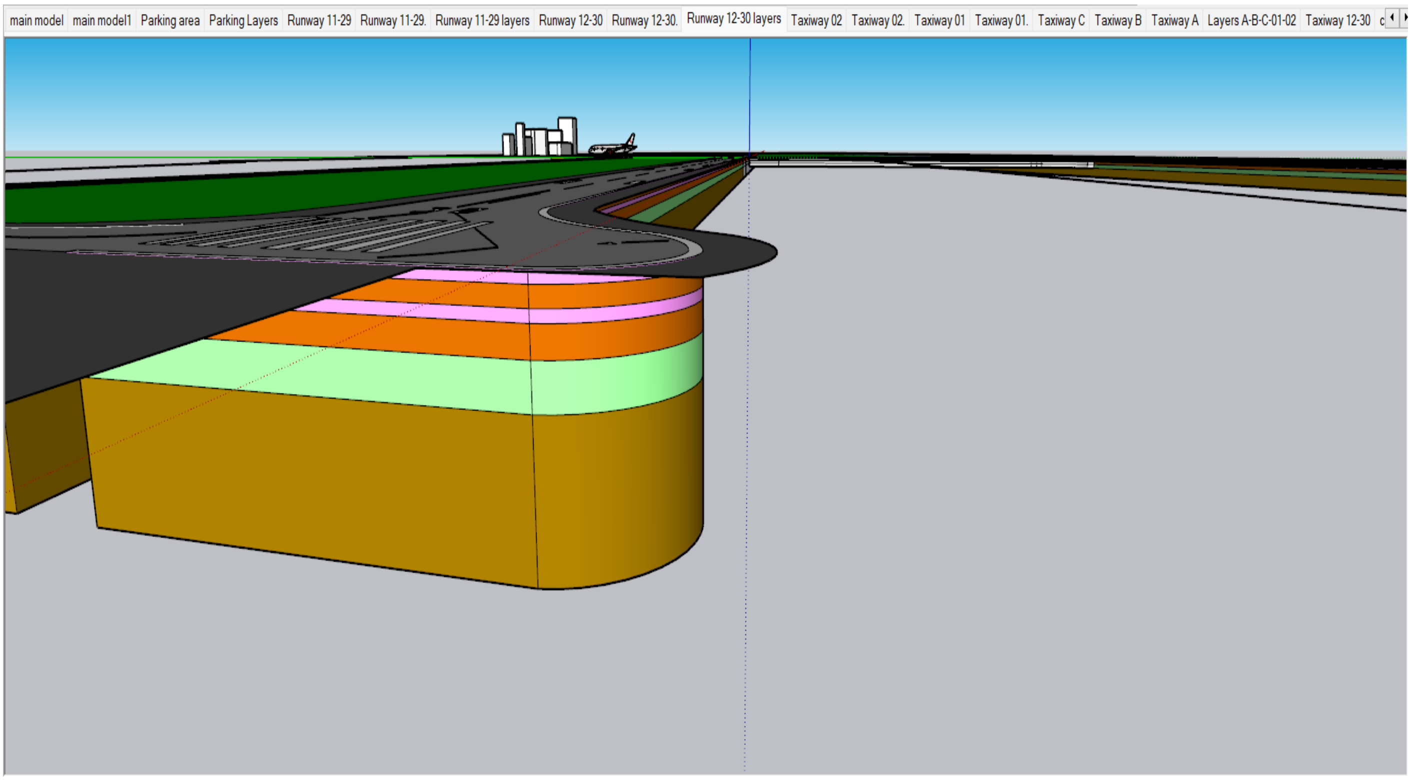


Fig 5.9 Runway 12-30 layers.

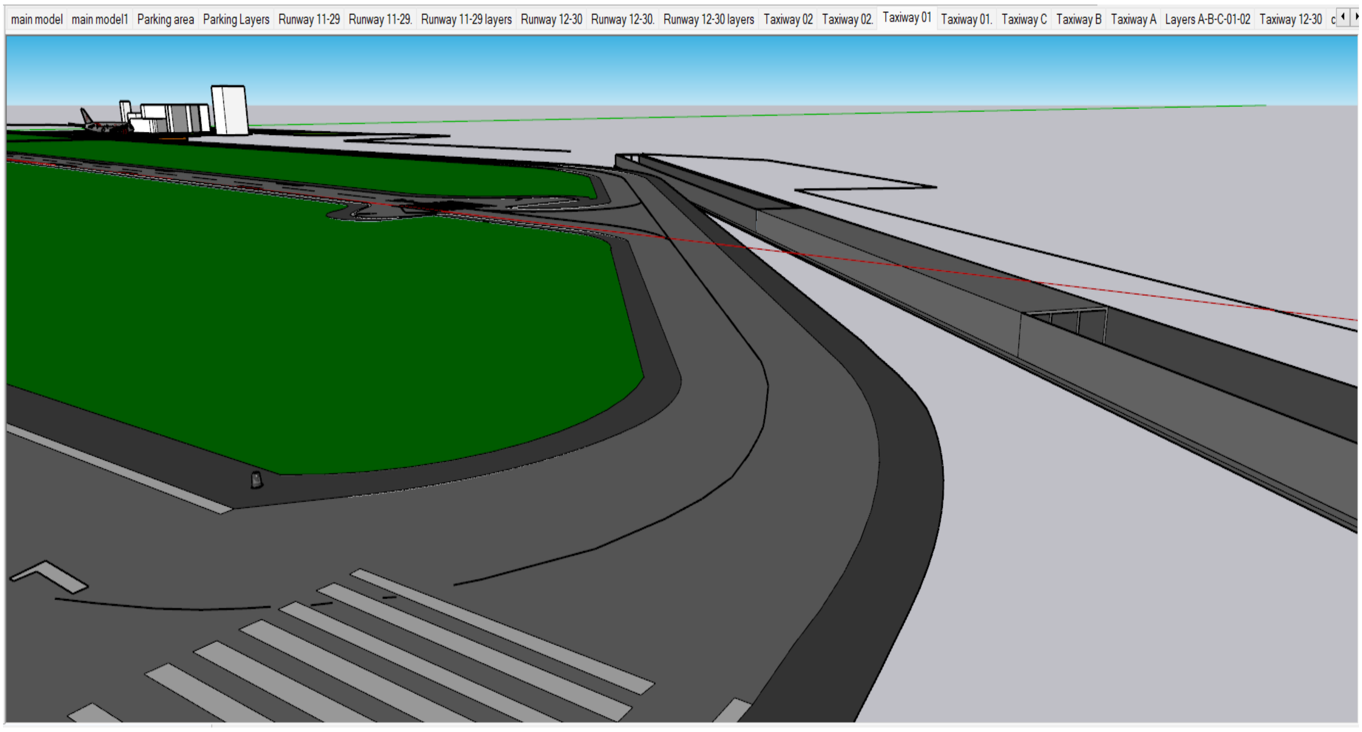


Fig 5.10 Taxiway N1.

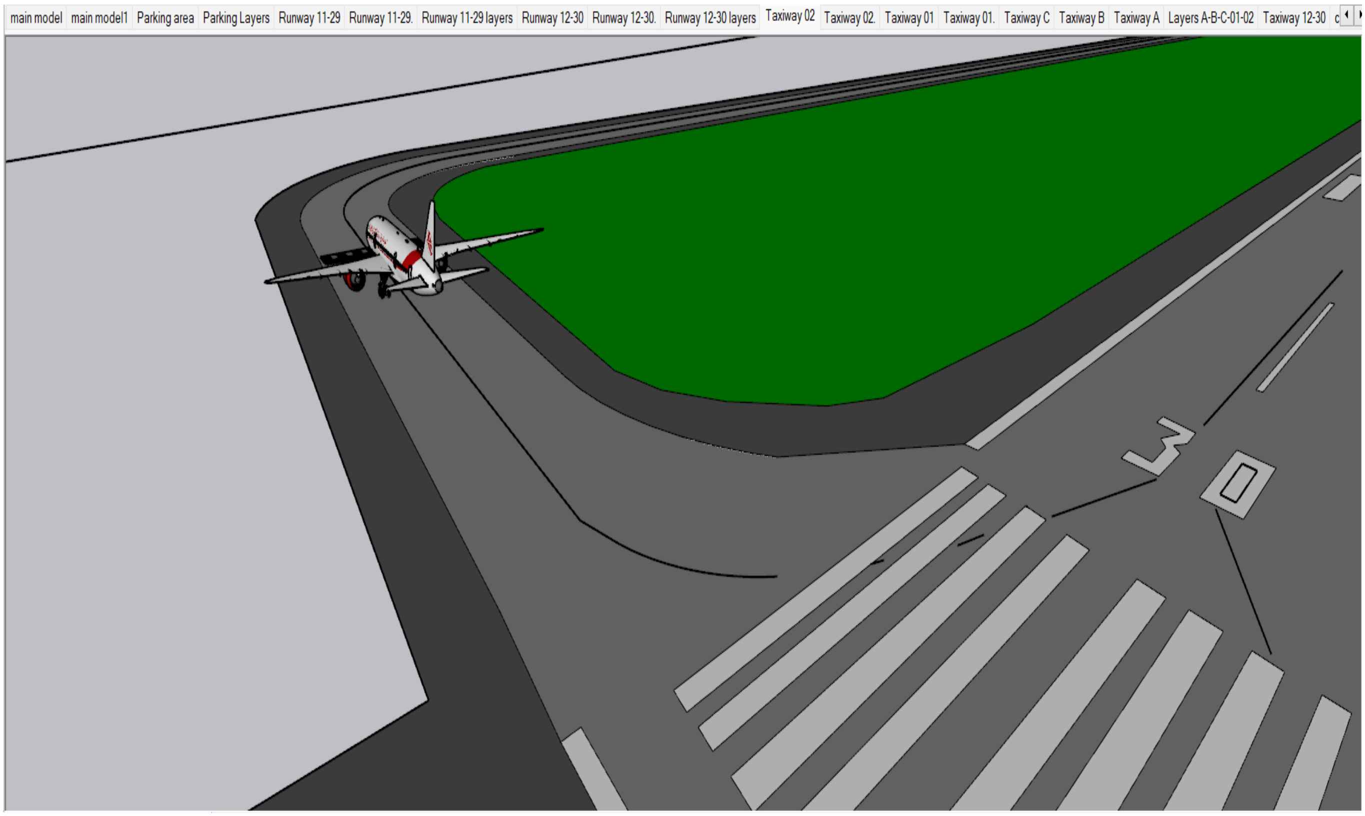


Fig 5.11 Taxiway N2.

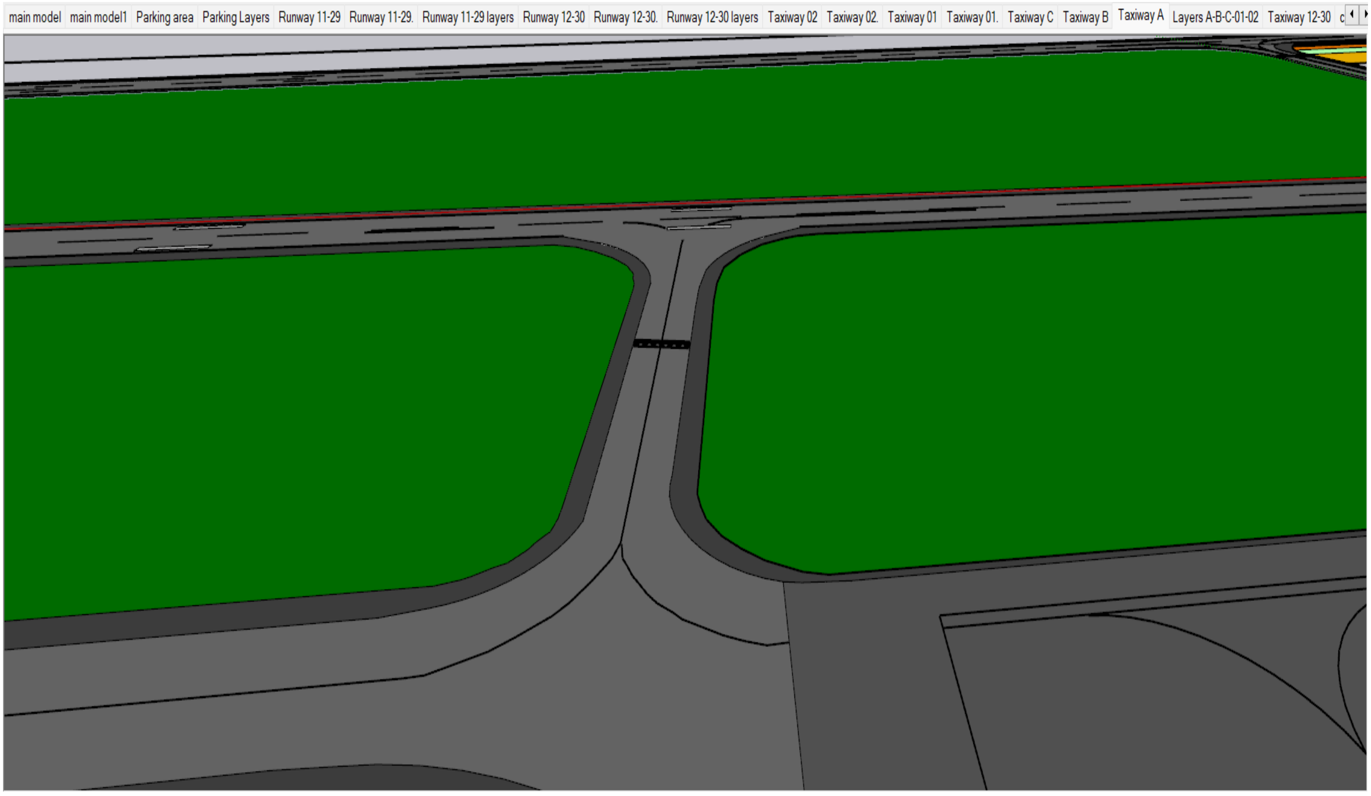


Fig 5.12 Taxiway A.

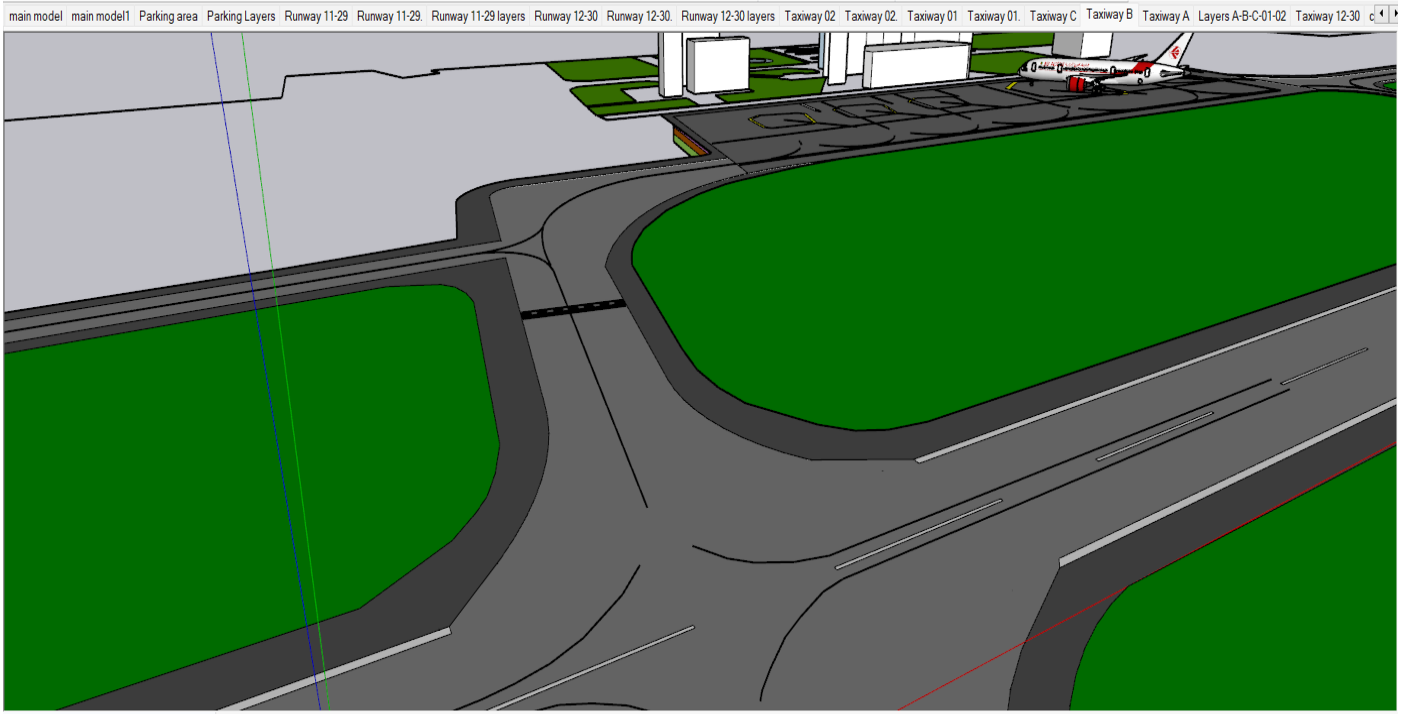


Fig 5.13 Taxiway B.

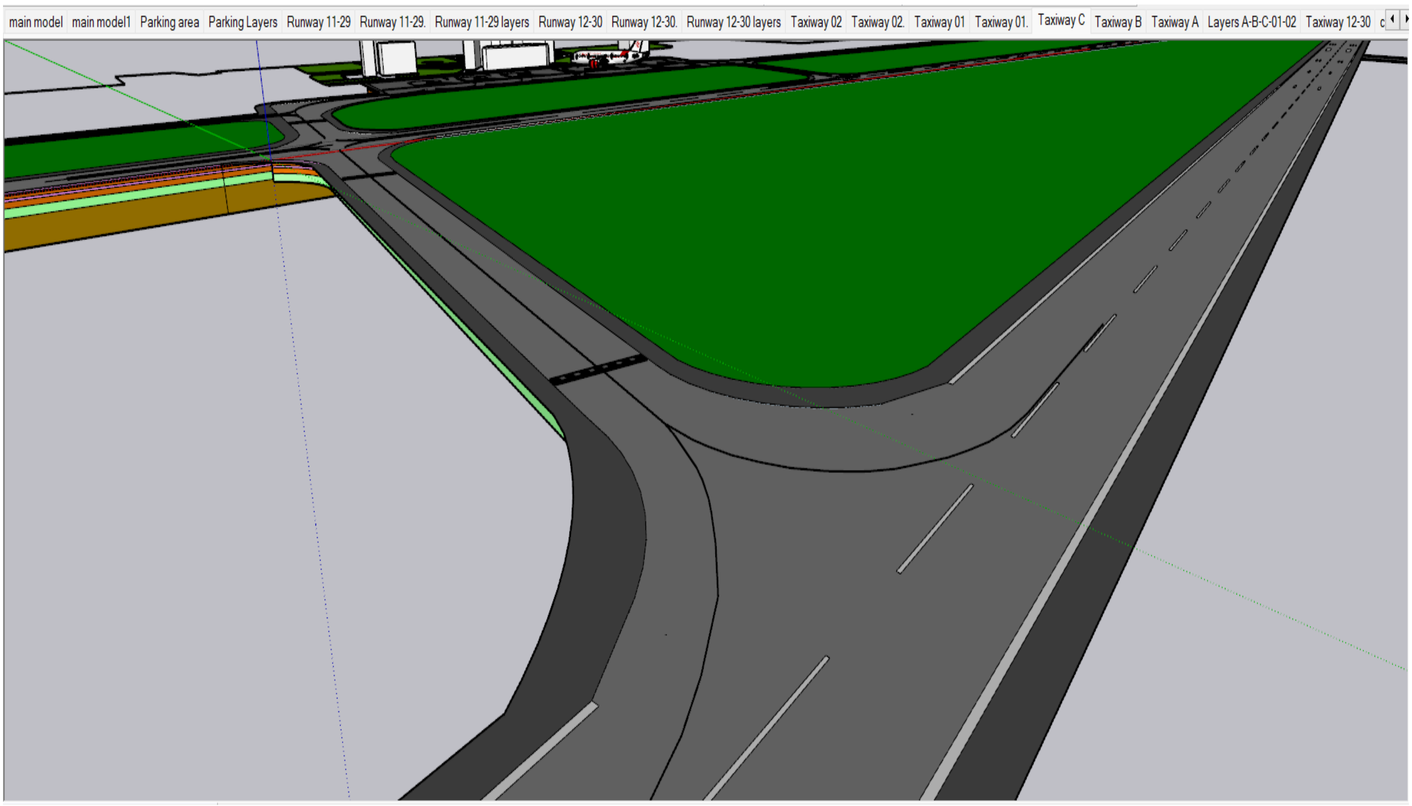


Fig 5.14 Taxiway C.

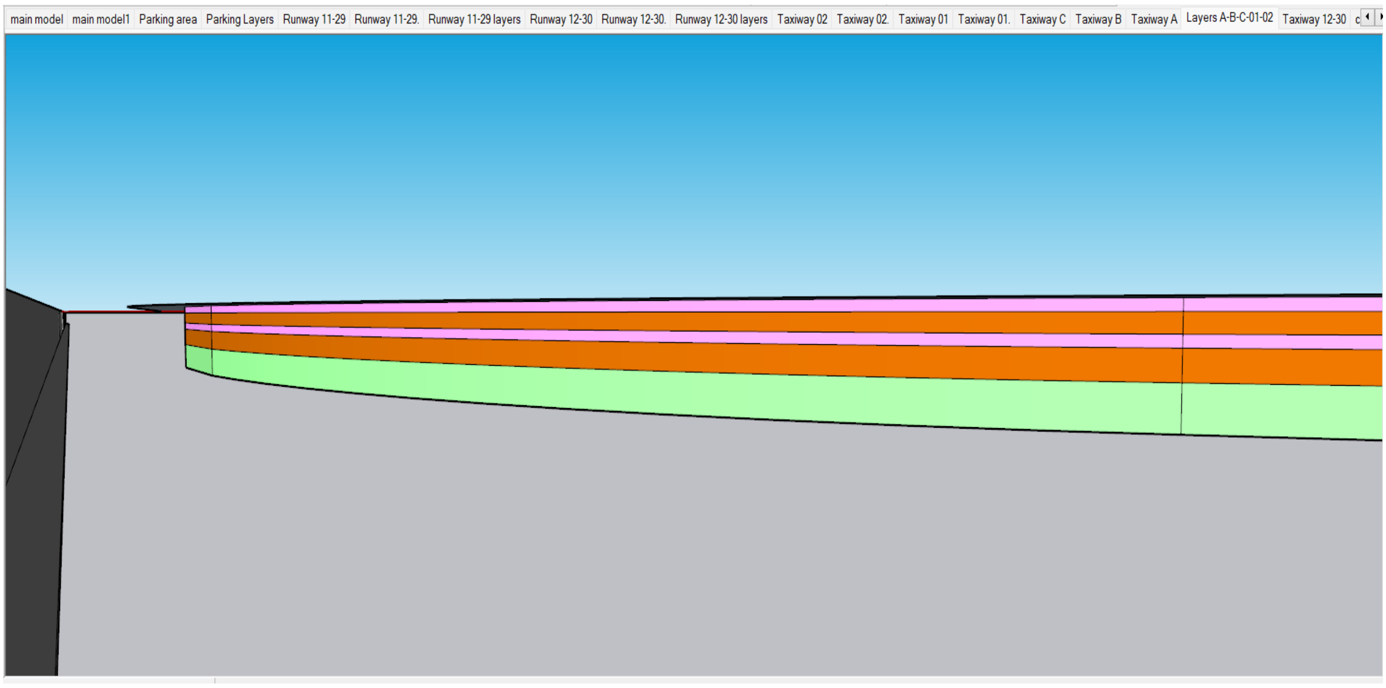


Fig 5.15 Taxiways layers.

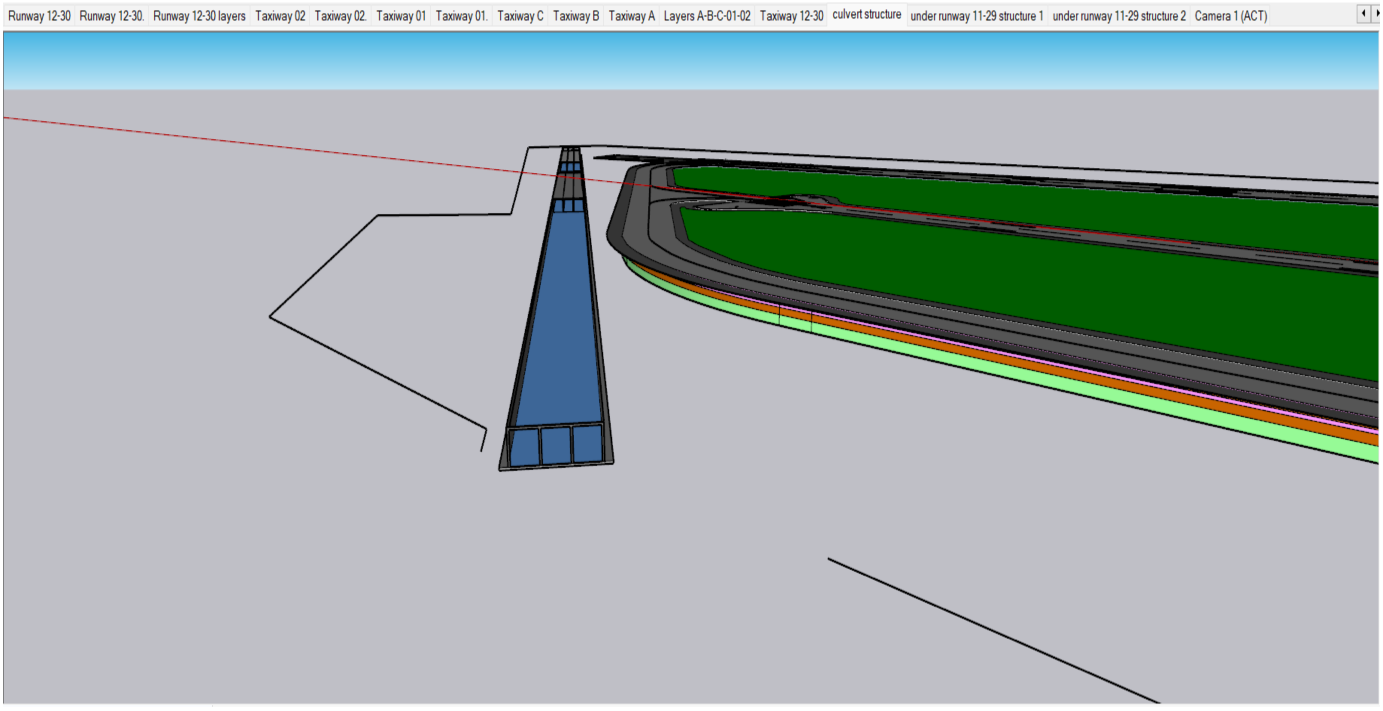


Fig 5.16 Culvert structure.

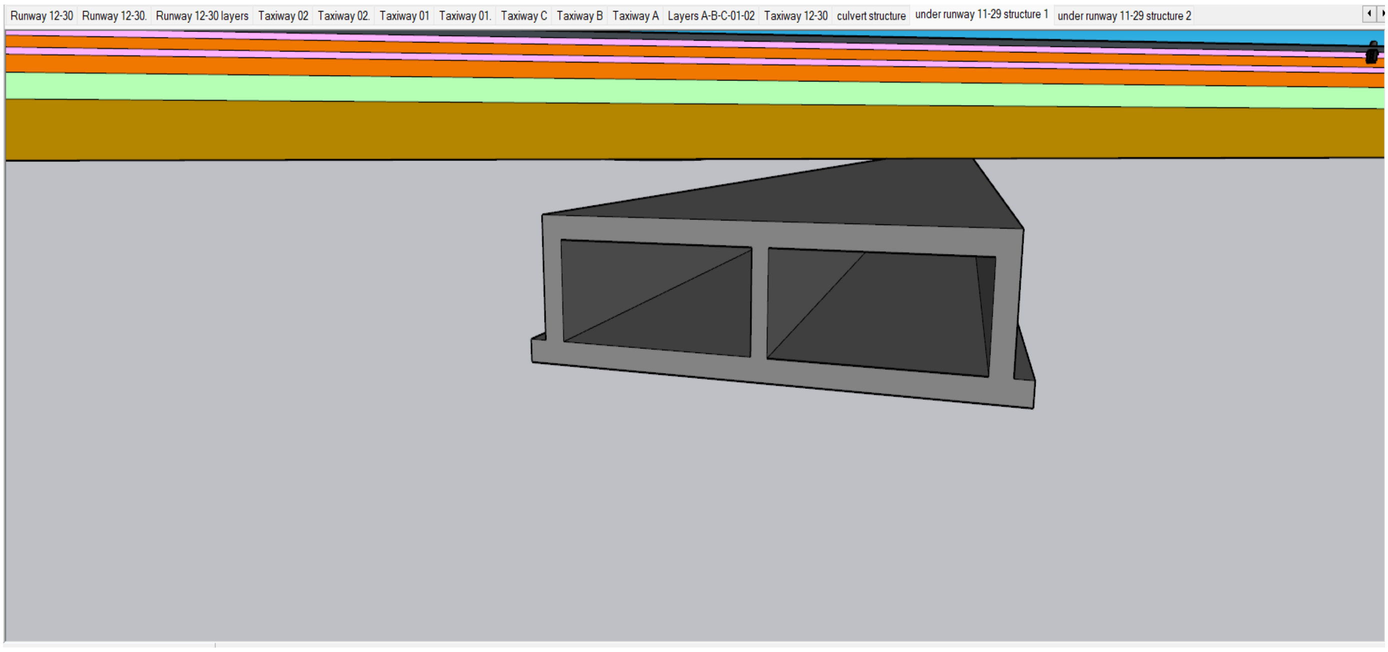


Fig 5.17 Under runway 11-29 structure1.

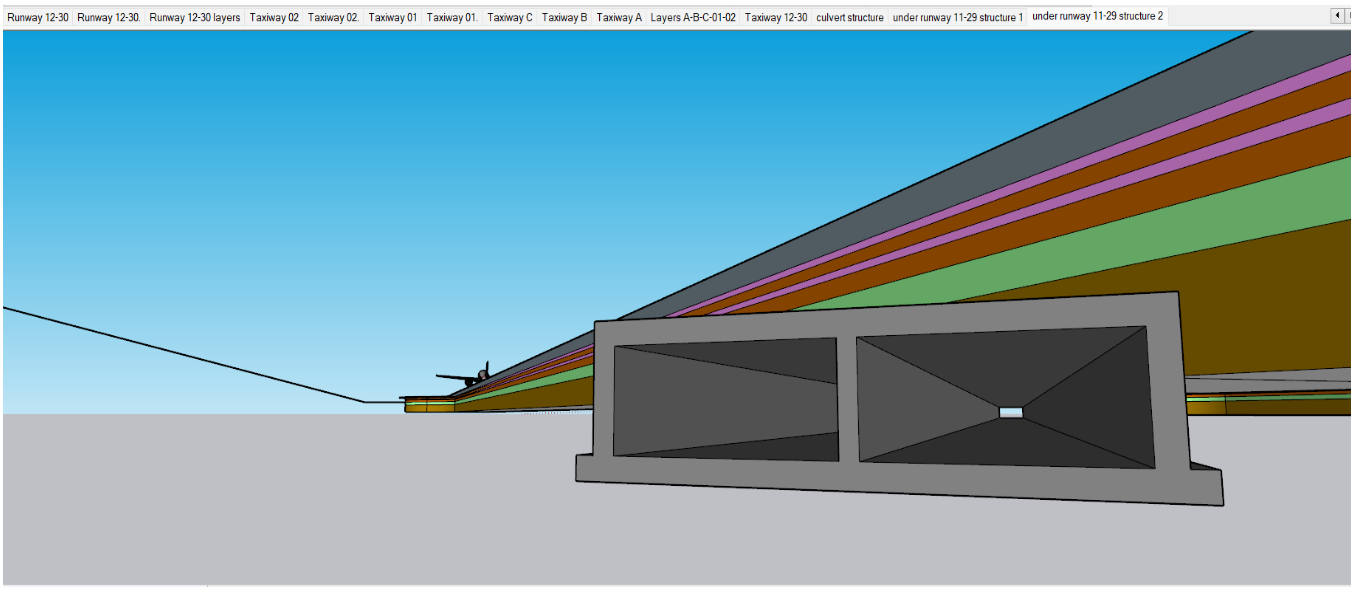


Fig 5.18 Under runway 11-29 structure2.

5.3. BIM Model Deliverable

A BIM model deliverable is the final version of the BIM model that is provided to the client or owner at the end of the project. The deliverable includes all the necessary information and data needed for the operation and maintenance of the asset. This includes information about the materials, systems, and equipment.

The BIM model deliverable is typically provided in a digital format, such as a 3D model, and can be used by the owner or operator to manage the asset throughout its lifecycle. The BIM model can be updated and modified as needed to reflect changes to the asset, such as renovations or upgrades.

Creating a desktop application with a mediator to connect a SketchUp digital model and BIM technology for generating a deliverable BIM model offers significant advantages in the realm of design and construction. By harnessing the capabilities of SketchUp's intuitive 3D modeling environment and leveraging BIM technology's robust data-driven approach, this application enables seamless integration between the two platforms. The mediator acts as a bridge, facilitating communication, data exchange, and synchronization between SketchUp and BIM tools, ensuring a smooth workflow. Through this mediator, the SketchUp model can be enriched with BIM data, such as parametric attributes, material information, and spatial relationships, enhancing its level of detail and accuracy. Additionally, the mediator enables the conversion of the SketchUp model into a deliverable BIM model, compatible with industry-standard formats like IFC (Industry Foundation Classes) or Revit files. This transformation ensures that the digital model retains its geometric and semantic information, facilitating interoperability and collaboration across the BIM ecosystem. Ultimately, this desktop application with a mediator brings together the best of both worlds, combining the simplicity and flexibility of SketchUp's modeling environment with the analytical and information-rich capabilities of BIM technology, resulting in an efficient and comprehensive solution for generating deliverable BIM models in projects.

The interface of the desktop application is equipped with numerous buttons, each representing a specific pavement within the Aerodrome of Tébessa. Upon clicking a button, users are presented with an image displaying the corresponding digital model, which has been created using SketchUp. Moreover, the application offers extensive information regarding the pavements and their structures, encompassing details such as materials, dimensions, and layers.

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Ministry of Higher Education and Scientific Research
Larbi Tebessi University – Tébessa
Faculty of Science and Technology
Department of Civil Engineering

Fig 5.19 Interface of the desktop application of Tébessa Aerodrome.

Conclusion

Conclusion

Building Information Modeling (BIM) is an emerging technology, literature review shows that it is only recently being implemented in Airports over the world, especially in North America. In Europe, most countries are making big progress toward that goal. Implementation of BIM in an Airport facility remains a difficult task, as each Airport is unique, with its own strategic plan and lifecycle development.

Airports are strategic infrastructure for any country, their design, construction, and management are strictly bounded by the NRPR (Norms, Rules, Practices, and Recommendations) of the International Civil Aviation Organization (ICAO). Decision-making is mostly delayed by practical difficulties in accessing technical information, which remains a complicated duty, as it is linked to complicated administrative permissions and restraints.

The objectives of this study were to understand the BIM technology process, to synthesize information about its recent history, the current state of the art, and practice related to BIM in general, and to apply the concept to the modeling of an airport facility i.e., Study case: Tebessa Airport. Technical data were collected through authorized site visits, accessible archives, technical files, drawings, and plans.

A BIM model was successfully developed for the facility considered. The creation of a deliverable BIM model that offers significant benefits in the field of architecture, engineering, and construction. This first experience of integrated digital representation of the Airport's 'civil engineering' physical and functional characteristics would serve as a valuable tool for resource retrieval and decision-making throughout its lifecycle.

The developed BIM model could be considered a first step in gaining experience on how to implement the BIM process in an airport facility in Algeria. Although all efforts were deployed by the author to present the most complete digital model that represents faithfully the Airport infrastructure, the BIM model shall be routinely updated or revised to keep it current with any new development activities and operations, and revised following any changes introduced to the Airport's facilities.

Additionally, the deliverable BIM model proposed for the Tebessa Airport's facility serves as a valuable reference for future expansions, renovations, or retrofitting projects. It supports ongoing facility management by providing accurate and updated information.

In conclusion: by embracing deliverable BIM models, and digital tools, the Airport's design (following the NRPR of the ICAO) would realize cost savings, improved efficiency, and better outcomes. This digital approach would inevitably enhance future decision-making, project coordination, and lifecycle management, benefiting stakeholders involved in facility design, construction, and operation.

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