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- COMPUTING PROJECT.

TITLE* :*TELECOMMUNICATION TOWER MANAGEMENT SYSTEM, A STUDY ON ZAMTEL, ZAMBIA

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Declarations

I **Hilary Kabinda Kabwe** do declare that this research project submitted for the Masters (MIT) in Information Technology has been carried out entirely by myself and that it has not been submitted in any previous application for a degree. The works of other persons have accordingly been duly acknowledged.

Sign:

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Date: 12/06/2024

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Name: **Hilary Kabinda Kabwe**

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Student ID: MIT202200634

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Dedication

I wish to dedicate this work to God Almighty for the opportunity to obtain this Masters, I also want to dedicate it to my Father Martin Mulenga Kabwe, and to my late Mother Violet Tabbu Mwasha Kabwe for grooming my character in my upbringing to aim higher.

Finally I also like to dedicate this work to my wife Chausiku Lunda Kabwe and My Children Zion Mulenga Kabwe and Malaika Zuri Kabwe for being a constant motivation in my life, to work extra hard, for all their love, support and patience during the entire period of my study, especially the weekends and holidays that were sacrificed, pursuing my studies.

Copyright

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Finally, my acknowledgements to my colleagues and management at Zamtel who were always there whenever I needed their support and the data availed to me during this research.

List of Abbreviations & Acronyms.

DBMS	Database Management System.
DFD	Dataflow Diagram.
DWDM	Dense Wave Division Multiplexing
ERD	Entity Relationship Diagram.
HTML	Hypertext Protocol Language.
FTTH	Fiber To The Home.
ICT	Information & Communications Technology.
PHP	Hypertext Preprocessor.
PWD	Plans, Works & Development.
RAD	Rapid Application Development.
SDD	Software Design Document.
SDLC	System Development Lifecyle.
SMS	Short Message Service.
SQL	Structured Query Language.
SSL	Secure Socket Layer.
TLS	Transport Layer Security
VarChar	Variable Character.
WAMPServer	Windows, Apache2, MySQL & PHP Server.
TMS	Tower Management System
MSC	Mobile service switching centre
MUX	Multiplexer
MW	Mega watts
NSS	The network switching subsystem
ODU	Outdoor unit
PM	Preventive Maintenance
CM	Corrective Maintenance
AI	Artificial Intelligence

Abstract

Telecommunication is one of the most ever evolving fields on the modern day market as it remains an underlining factor in Service provision cutting across Infrastructure as a service, (IaaS), Software as a Service (SaaS) and Platform as a Service (PaaS). Telecom towers form the backbone of our modern communications infrastructure covering a wide and diverse geographical structure and some of these towers were placed in remote areas, it is a difficult and laborious effort for humans to continuously monitor these towers.

Monitoring and Management Solutions remains key to running a Successful Telecom Business, from the passive infrastructure that is typically present in wired and wireless network locations emerge Active Equipment and Data on performance parameters as to be constantly monitored for the business to operate at an optimal level making use of each and every resource involved to maintain Profitability.

The purpose of the solution is to help Manage, Monitor and Maintain Telecom infrastructure, minimize total Operational Cost (OPEX) and Servicing costs, Maximize Energy Savings, Preserve Network Availability, and Stop Revenue Loss. Tower Management System (TMS) via internet-based devices will enable a firm to establish, Monitor, Manage and Maintain tower parameters provide online solutions, through an established virtual connection to the tower. Tower asset monitoring will be made completely online with the help of this project providing a platform that aids decision making and guides investments.

Contents

Chapter 1

1.0 Introduction

Telecom firms, such as Zamtel, extract more steady revenue flows by efficiently using the following wings: Cost of capital savings, efficiencies through expertise in identifying operational efficiencies and reducing operating expenditure (Opex), and it is in the simplicity of their operating structure allows them to capture consolidation and optimization synergies by expanding their footprint or scaling the business to new jurisdictions. Telecommunication companies are often able to obtain financing at a cheaper cost of capital, which is one of the primary factors, but if not well monitored and evaluated, can cause savior damage on the asset portfolio and credit rating which can be quite impacting on future investments as it also reduces elasticity towards future trends characterized in this Business sector.

1.1 Problem statement

Zamtel is Currently wallowing in debt generated from Tower Rentals which currently are standing at an average of K29 000 per Month per tower over 1256 cell sites country wide, creating an overall fixed cost of K36 424 000, the rental price is not reflective of customer base or Tower performance in terms of Uptime Availability Record and Profitability. To cushion the ever rising debt bill Zamtel has embarked on giving away more infrastructure to Infratel in a Debt Swap agreement to cancel some of its debt. The big questions to ask are;

- Is this method of Tower management sustainable?
- What are the remedial measures that Zamtel can implement to operate at Optimal Level?
- What variables can we identify to develop a Model that speak to Profitability of a tower?

1.2 Aim

The Aim of this Study is to develop a Tower Management system providing a sustainable Model that can enable Zamtel and Infratel to operate at an Optimal Level for Business Sustenance and Profitability through increased efficiency.

Once this System is developed, one will not need a lot of experience to Manage Towers, including the management of all resources such as Power equipment as well as Active equipment. It should also help determine whether the Towers should be handed back to Zamtel noting that this Business Transformation was a failed project.

1.3 Objectives

- To Derive the Variables that affect Tower Profitability
- To develop a Model that can make use of identified variables that can be used to make a decision on the type of Managed Solution to employ
- To deduce Tower Rental as a percentage of Tower profitability

1.4 Significance of study

Telecoms is an investment-driven industry, optimizing investment decisions becomes key to sustainable development which help solve a key challenges for companies in the Telecom Business. Part of this decisions is Replacement of Equipment such as Batteries and active Network equipment to avoid plunging into a series of Down times affecting Tower Profitability.

Telecoms is a million Dollar Business and has the capacity to turn to drive the economy if done correctly but it is also Capital intensive due to its nature of being investment driven, if mishandled can cause huge losses that can plunge a company and its Supply Chain into a Disaster.

Once a Management Model is developed, it can save Infrastructure to operate at an Optimal Level Profiting the Companies and its Government Saving Them Millions of Dollar that tentatively be used to foster development.

Newer Models of running away from expenses of Building, Owning, Managing and Maintaining of network infrastructure instead focusing on pushing the demand for innovations and deployment of management models in the wireless environment, was the main feature in the business as opposed to the traditional full ownership of network infrastructure.

Companies in the Mobile Network sector such as Zamtel and IHS which is the leading Tower Infrastructure in country if not Africa has observed and is slowly reverting back to subcontracting to full operations of Owning Managing and Maintaining Service provision. This has proved to be more a more efficient and effective cheaper way of doing business, owing its success to remote the Efficient use of Remote Management tools.

This project will see us develop model that is made to efficiently aid Tower Management through resource Optimization guarantying profit maximization to companies per Resource, per Tower in this Business Sector.

Project Scope.

The scope of this research project will Cover Zamtel Mobile Network Southern Region, and fully understand Components involved in Mobile Service Delivery. Work experience in the Telecom Industry has also given me an extensive understanding of the in the components that make (BTS) Base Transvers Station, this will help develop parameters in which to limit our research Research. The scope will focus on the following deliverables; Power Or Energy including Backup Solutions, Transmission, Recharges in terms of Sales, and Resource Optimization of Technologies taking revenue collections at a base KPI. Once the variables are identified and developed the system is to be completed by the end of June 2024 tried and tested.

1.5 Background

Zamtel is Zambia's own state-owned Telecommunication company, boasting of having the widest set of IT Solution ranging from DWDM links, Metro Fiber Links, Fixed Access Enterprise Solutions via a Country wide Fiber Optics Network to Wireless Solutions Such as Point to Point, Enterprise and Domestic Consumer Products Such as Fiber to the Home Links (FTTH) and FTTH via Point-to-point Radios.

Zamtel was also the sole owner of all its Telecommunication Towers and Data Centers doted across the country. In 2019, The Zambia Telecommunications Company (Zamtel) through its CEO, Sydney Mupeta announced that they will commenced works to modernize and expand their Telecom network in rural areas across the country. This project costed the firm $280 million, via a Loan obtained from Huawei. 100 sites where selected for upgrade in the first phase of the project, out of 1,009 targeted Sties. https://www.ecofinagency.com/telecom/0311-37689-zambia-zamtel-invests-280mlninthe-expansion-of-its-networks-in-rural-areas.

In the same year Zamtel embarked Business model transformation and wanted to down size and concentrate on offering mobile and fixed line services, to enhance reduction operational cost (OPEX), with Shareholder's approval, from Industrial Development Corporation (IDC), Zamtel birthed a new company and was given all Passive equipment such Towers and Data Centers.

Infratel Corporation Limited, a new company was created as part of the IDC Group's business model transformation, was given the mandate to optimize Zamtel's infrastructure and carry out what they termed as government's open access strategy. This meant that with immediate effect Zamtel became a tenant on all tower infrastructure with an obligation to pay rentals on all towers to Infratel.

Due to a failed Telecommunication Tower Management Strategies, Zamtel plunged into an ever-increasing Debt that has seen it lose its Hard Earned Infrastructure through Debt Swap including Its Prestigious Zamtel House.

In this Research, we seek to bring out investigate some of the challenges in Telecommunication Tower Management and tentatively work out a remedy through developing a system that will help in the Following Decision-Making Processes.

- Tower Rental Charge: This can be done via a Variable called Population picking out potential Market.
- Tower Yield: This will speak to available installation space on a tower, to maximize the space through collocating increasing tower Profitability
- Tower Resource Management: Equipment Life Span and health such as Battery Autonomy, which directly translates into uptime which directly speaks to Tower Profitability on the side of Service Provider

Chapter 2

2.0 Literature Review

Mataloto, B., Ferreira, J.C. and Cruz, N., 2019 developed a novel approach that assists local administration entities in identifying savings through personalised data visualisation. These savings activities were executed locally through the creation of personalised heuristics that are applied automatically. This is an interaction method for air conditioning (A/C) or heating systems that was developed using an infrared approach and may be used to a variety of equipment. The acquired data is processed to produce an integrated view in dashboards that can be distributed to mobile devices.

The main findings of this research include a low-cost and fully developed EMS system with an installation cost of roughly $2 per square metre and unique features designed for the user.

An extension of such a research can be applied to Telecommunication towers that should add a significant level of information to guarantee a development of a decision making Aid that and be able to influence decision making enhancing efficiency and effective model of management, to avoid political and an tested decision making.

Khan, A., Kellerer, W., Kozu, K. and Yabusaki, M., 2011 in an Article Network Sharing in the Next Mobile Network: TCO Reduction, Management Flexibility, and Operational Independence proposed a next mobile network architecture, where several entities share the physical network infrastructure, except for administration and control of the physical infrastructure , the deduced that virtual network creation and maintenance, and the usage is segmented from each other to reduce management complexity in each setion.

As previously mentioned, focus on lowering mobile operators' CAPEX and OPEX (infrastructure, deployment, operations, maintenance, and energy expenses). Operators can reduce costs and make greater use of the resources that the network has to offer. Furthermore, by expanding an operator's coverage or boosting its capacity, sharing solutions might result in an improvement in the perceived quality of the network and services. Khan, A., Kellerer, W., Kozu, K. and Yabusaki, M., 2011. Network sharing in the next mobile network: TCO reduction, management flexibility, and operational independence. *IEEE Communications Magazine*, *49*(10), pp.134-142.

Ananda, D.R.D. and Kurniawan, R., 2023. Management Information System For Telecommunication Tower Fee Payment, Discovered Challenges in organizing in Telecommunications tower data in distinct Microsoft Excel files. This was discovered that it slows down data retrieval, hampers data modifications, and raises the likelihood of errors.

To address this issue, the Information Technology Division of DISKOMINFO Mempawah District created a web-based management information system to monitor and accelerate fee calculation and SKRD (Tower Utilisation Permit) issuance. The waterfall development process was chosen to achieve a thorough understanding of the system requirements prior to beginning development, as well as to ensure that each step is completed before proceeding to the next. Ananda and Kurniawan established telecommunications tower fee payment system helped DISKOMINFO ensure timely fee payments, which are critical for the development of Telecommunication Industry.

The above mentioned system speaks to effectiveness and efficiency of deliverables with Regards Telecommunication Towers which is the Cole business of this project, Tower Management System (TMS) seeks to develop a web based model that should look at aiding Tower Management with easy access to data for efficient distribution of resources. With an efficient system of management of Telecom Equipment profitability can be achieved without sacrificing any Company assets but enhancing the productivity of every Tower through resource optimization taking into consideration the Sales KPIs. Recharges at each tower also gives information on the lead business activity or technology on demand, this information helps the sales team to deliver products that are needed on the particular market sector.

Koumadi, K.M., Folley, R., Quist-Aphetsi, K. and Acakpovi, A., 2013. Investigated the Challenges of Multiple Tower Sharing in Multi-Operator Mobile Communication Environments constraints such as, non-optimal GSM antenna height on coverage and signal quality, tower. Tower Sharing limits diversity and yield is hampered, adding Resources such a Second Carrier on the same network might not be achieved due to Tower Stress.

Load limitations on transmission link and space management. Simulation results and on-site measurements confirm these challenges which may increase the operation expenditure of mobile.

Networks. The benefits of passive infrastructure sharing are perceived to only be good, hence more research is needed to determine their economic advantages and disadvantages. Koumadi, K.M., Folley, R., Quist-Aphetsi, K. and Acakpovi, A., 2013. Technical challenges of tower sharing in multi-operator mobile communication environments. *International journal of informatics and communication technology*, *2*(3), pp.124-131.

The other Gaps we are trying to investigate is, creating a perpetual cost of tower rentals and avoiding to run something so Passive that seems to be a walk in the Park, why then would companies opt to sale Network towers, A Passive Metal Equipment with minimum maintenance, but attracts quit significant rental Fees over time can be avoided and Outsourcing in this vain is not a one size fits all, but is a variant of the Nature of company Ownership. One can easily hold rental fees against maintenance and purchase cost to evaluate the optimal level of operation over a period of time by Tower yield which is a product of Tower and height, Location and availability of power solutions.

2.1 Related Works In Telecom Tower Management Systems

Savadi, P.G. and Aravind, H.S., 2012. Web Based Telecom Tower Management Using GSM Technologies. Created a Web based Monitoring tool, designed to gather performance parameters data installed at passive infrastructure such as Telecom Towers sites. This Solution was designed to enable Mobile Network operators or Telecom companies to maintain network availability, optimize tower energy operational costs, to reduce overall servicing costs.

In My Research TMS seeks to leverage on the knowledge gap left by Savadi P.G and Aravind, H.S on their GSM Telecom Tower Management System, in Optimization of Energy parameters as well as Optimization of Technologies to maximize revenue collections. The System we seek to develop, should be accessible hence the design remains web based, but its strength lies in a Continuous learning of its Business environment through Preventive Maintenance and Optimization of technologies present on site e.g 2G, 3G 4G

or 5G taking recharges as key performance indicator on revenue collection to identify their returns in terms of Profitability. Cases of Settlements that are widely spaced may not utilize 4G and 5G well in that there ground coverage is not more that 2km, so for Profitability, Once the system is developed recommendations of were such underutilized resources can be installed will be availed. TMS will serve as an Aid to decision making through Power or Energy Availability and returns on Technology.

2.2 Huawei's Mateline System.

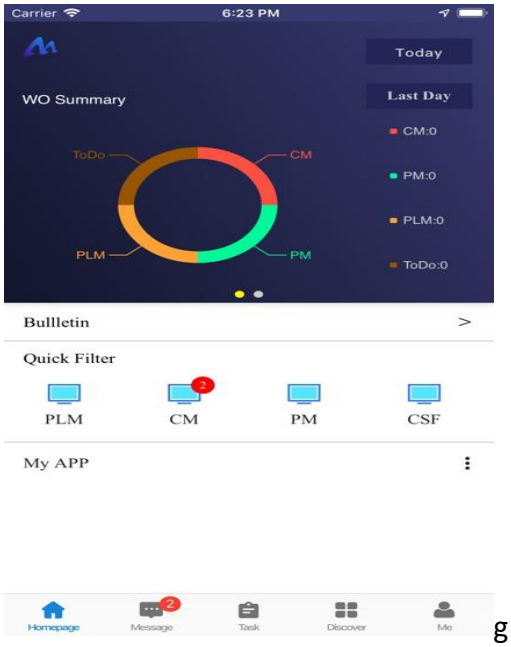
Professional experience with the Mateline Tower Management System at through my employer Zamtel via a paid for tenure, the following information was reviewed.

Huawei's Mateline System is another Tower Management System that addresses the ever-changing telecommunications parameters for business efficiency, the Mateline System stands out as a significant step forward in communication infrastructure. It’s designed to meet the demands of current digital ecosystems, exemplifies Huawei's dedication to network efficiency, dependability, and scalability. It saves as an aid to Technological Parameters operating at a Telecom Tower Infrastructure, such state of Power Supply, Power Backup, Transmission technology present on Site and its state but neglects the faculties relating to tower sales and revenue collections.

2.2.0 Knowledge Gap

TMS creation continues to investigations the financial benefits of Resource Optimization on technologies to maximize revenue collections across technologies. Mateline does not include financial faculties and focuses on technical parameters as seen above. This project addresses that missing component to aid decision making that incorporates sales aspect.

Figure 1. Mateline Mobile Interface



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PLM: Product Life Cycle, this variable speaks to Life span of Products i.e Batteries, Telecom Radios, Product and Service Licences.

CM: Corrective Maintenance, This refers to the day to day Site interventions of faults, for quick resolution.

PM: Preventive Maintenance, Refers to Scheduled visits that encompasses checking of all technical parameters on Site to prevent unsolicited Outages.

CFS: Cybersecurity Framework (CSF) is a voluntary framework that provides critical infrastructure organizations with guidance on managing cybersecurity risk.

CHAPTER 3

3.0 RESEARCH METHODOLOGY

3.1 Introduction.

This chapter describes the many approaches employed in the study project. Data collection tools, procedures, and sample sizes, as well as data analysis, have all been highlighted.

SDLC was employed as the development technique. The Software Development Life Cycle (SDLC) is a process that defines the methods and strategies for developing, designing, and maintaining software projects while ensuring that all project goals, objectives, functional requirements, and user requirements are met (Arora and Arora 2016). The SDLC stages are: planning, analysis, design, development, testing, implementation, and maintenance.

3.5.1 Data Collection.

In order to carry out this study, the developer used interviews which comprised of both closed and open-ended questions. This technique allows the developer to grasp even the hidden sentiments of the failing systems that may not be covered in the questions asked, also used observation as tool to collect data.

3.5.2 Sample Size.

For this study, the sample size was a selected number 90 Telecom Towers in Lusaka Region which extends from Siavonga to Luangwa District in terms of Telecom Infrastructure.

3.5.3 Data Analysis

Site ID	Site Name	Region	Town	Technology	Sales Engineer	Sales	Profit Range	Status
CEP0001	CEP0001-MUMBWA EX	Lusaka South	Mumbwa	4G	Oscar Kaluba	4,415	=>K3300<k5000	Profitable
CEP0002	CEP0002-MUMBWA ZAF	Lusaka South	Mumbwa	3G	Oscar Kaluba	476	<500	Loss making
CEP0015	CEP0015-SAVANNA PARK	Lusaka South	Chibombo	4G	Sunday Kasanga	6,336	Above 5000	V Profitable
CEP0017	CEP0017-KAMAILA	Lusaka South	Chibombo	2G	Sunday Kasanga	228	<500	Loss making
CEP0049	CEP0049-TEN MILES	Lusaka South	Chibombo	4G	Sunday Kasanga	5,130	Above 5000	V Profitable
CEP0087	CEP0087-CHEMBE	Lusaka North	Luano	2G	Emmanuel Chikalipa	153	<500	Loss making
CEP0089	CEP0089-MBOSHA	Lusaka North	Luano	2G	Emmanuel Chikalipa	327	<500	Loss making
CEP0095	CEP0095-SHAKUMBIRA	Lusaka South	Mumbwa	2G	Kelson Kafwakulotwa	133	<500	Loss making
CEP0096	CEP0096-MULENDEMA	Lusaka South	Mumbwa	2G	Oscar Kaluba	65	<500	Loss making
CEP0097	CEP0097-KAINDU	Lusaka South	Mumbwa	2G	Oscar Kaluba	297	<500	Loss making
CEP0119	CEP0119-KALENDE HILL	Lusaka South	Mumbwa	3G	Oscar Kaluba	27	<500	Loss making
CEP0134	CEP0134-MUMBWA GINNERY	Lusaka South	Mumbwa	3G	Oscar Kaluba	338	<500	Loss making
CEP0140	CEP0140-NALUSANGA PRIMARY SCHOOL	Lusaka South	Mumbwa	2G	Oscar Kaluba	124	<500	Loss making
CEP0143	CEP0143-NAMITONDWA	Lusaka South	Shibuyunji	3G	Kelson Kafwakulotwa	751	=>K500<K1000	Loss making
CEP0170	CEP0170-Mulilabanyama	Lusaka South	Itezhi-tezhi	2G	Oscar Kaluba	595	=>K500<K1000	Loss making
CEP0189	CEP0189-MALIMA HILL	Lusaka South	Mumbwa	2G	Kelson Kafwakulotwa	4,524	=>K3300<k5000	Profitable
CEP0190	CEP0190-MPUSU RURAL HEALTH CENTER	Lusaka South	Mumbwa	2G	Oscar Kaluba	1,755	=>K1650<K2475	Medium
CEP0192	CEP0192-NALUBANDA PRIMARY SCHOOL	Lusaka South	Mumbwa	2G	Oscar Kaluba	4,641	=>K3300<k5000	Profitable
EAP0012	EAP0012-Nyakuseka	Lusaka North	Rufunsa	2G	Emmanuel Chikalipa	92	<500	Loss making
EAP0025	EAP0025-Talabuku	Lusaka North	Rufunsa	2G	Emmanuel Chikalipa	137	<500	Loss making
LKP0001	LKP0001-MAKENI	Lusaka South	Lusaka	4G	Lynn Chikwama	1,115	=>K1000<K1650	Loss making
LKP0002	LKP0002-Chilanga	Lusaka South	Chilanga	4G	Isaac Hussen	2,319	=>K1650<K2475	Medium
LKP0003	LKP0003-Chelstone	Lusaka North	Lusaka	4G	Michael Chapota	2,631	=>K2475<K3300	Medium
LKP0004	LKP0004-Airport	Lusaka North	Chongwe	4G	Michael Chapota	1,216	=>K1000<K1650	Loss making
LKP0005	LKP0005-CHINIKA	Lusaka South	Lusaka	4G	Constance Kabulumina	3,093	=>K2475<K3300	Medium
LKP0006	LKP0006-INDEPENDENCE S	Lusaka South	Lusaka	4G	Cynthia Chisanga	4,522	=>K3300<k5000	Profitable
LKP0007	LKP0007-ROMA G.H	Lusaka North	Lusaka	4G	Sharon Zulu	4,098	=>K3300<k5000	Profitable
LKP0008	LKP0008-Road Junction	Lusaka North	Lusaka	4G	Rachael Musonda	1,068	=>K1000<K1650	Loss making
LKP0009	LKP0009-CHAINAMA	Lusaka North	Lusaka	4G	Chikaye Chinonge	4,245	=>K3300<k5000	Profitable
LKP0010	LKP0010-Leopard Hill	Lusaka North	Lusaka	4G	Dominic Chipango	2,808	=>K2475<K3300	Medium
LKP0011	LKP0011-KAFUE RPT	Lusaka South	Kafue	4G	Shantanga Muwo	4,110	=>K3300<k5000	Profitable
LKP0012	LKP0012-LUSAKA HOUSE	Lusaka South	Lusaka	4G	Constance Kabulumina	2,843	=>K2475<K3300	Medium
LKP0013	LKP0013-ZRA	Lusaka South	Lusaka	4G	Constance Kabulumina	3,706	=>K3300<k5000	Profitable
LKP0014	LKP0014-UTH	Lusaka North	Lusaka	4G	Ireen Mwiinga	1,106	=>K1000<K1650	Loss making
LKP0015	LKP0015-TapChilanga	Lusaka South	Lusaka	4G	Isaac Hussen	3,326	=>K3300<k5000	Profitable
LKP0016	LKP0016-KAUNDA SQUARE2	Lusaka North	Lusaka	4G	Michael Chapota	2,427	=>K1650<K2475	Medium
LKP0017	LKP0017-CHONGWE WATER TANK	Lusaka North	Chongwe	4G	Emmanuel Chikalipa	3,834	=>K3300<k5000	Profitable
LKP0018	LKP0018-MULUNGUSHI INTER. CONF CENTER	Lusaka North	Lusaka	4G	Sharon Zulu	209	<500	Loss making
LKP0019	LKP0019-WATER PUMPING	Lusaka South	KITWE	4G	Constance Kabulumina	3,059	=>K2475<K3300	Medium
LKP0020	LKP0020-LOS ANGELES ROAD	Lusaka South	Lusaka	4G	Constance Kabulumina	1,385	=>K1000<K1650	Loss making
LKP0021	LKP0021-KAFUE HOUSE	Lusaka South	Lusaka	4G	Constance Kabulumina	2,605	=>K2475<K3300	Medium
LKP0022	LKP0022-SANJE CRESCENT	Lusaka North	Lusaka	4G	Sharon Zulu	2,575	=>K2475<K3300	Medium
LKP0023	LKP0023-OLYMPIA	Lusaka North	Lusaka	4G	Sharon Zulu	1,359	=>K1000<K1650	Loss making
LKP0024	LKP0024-ZAMTEL HOUSE	Lusaka North	Lusaka	4G	Ireen Mwiinga	2,428	=>K1650<K2475	Medium
LKP0025	LKP0025-KAMWALA HIGH SCH	Lusaka North	Lusaka	4G	Ireen Mwiinga	2,441	=>K1650<K2475	Medium

Figure 2. Recharges Per Site

The above Data was collected to show Site performance that can be used to relate performance of Technical variables against business Variables, with Telecom Infrastructure responsible of delivering the services to the customer, Cellular towers are the foundation of our modern communications infrastructure. Each tower has a power plant that includes batteries, air-conditioning, a diesel generator with a backup tank, and a power conditioning unit. Non-utility sites may rely on hybrid power sources, such as wind and solar plants. Not only does a tower contain Passive infrastructure but it also contains a base transceiver station (BTS) where all active equipment that enables wireless communication between User Equipment (UE) and the Network.

The Figure below illustrates the functionality of active equipment variables involved in service delivery.

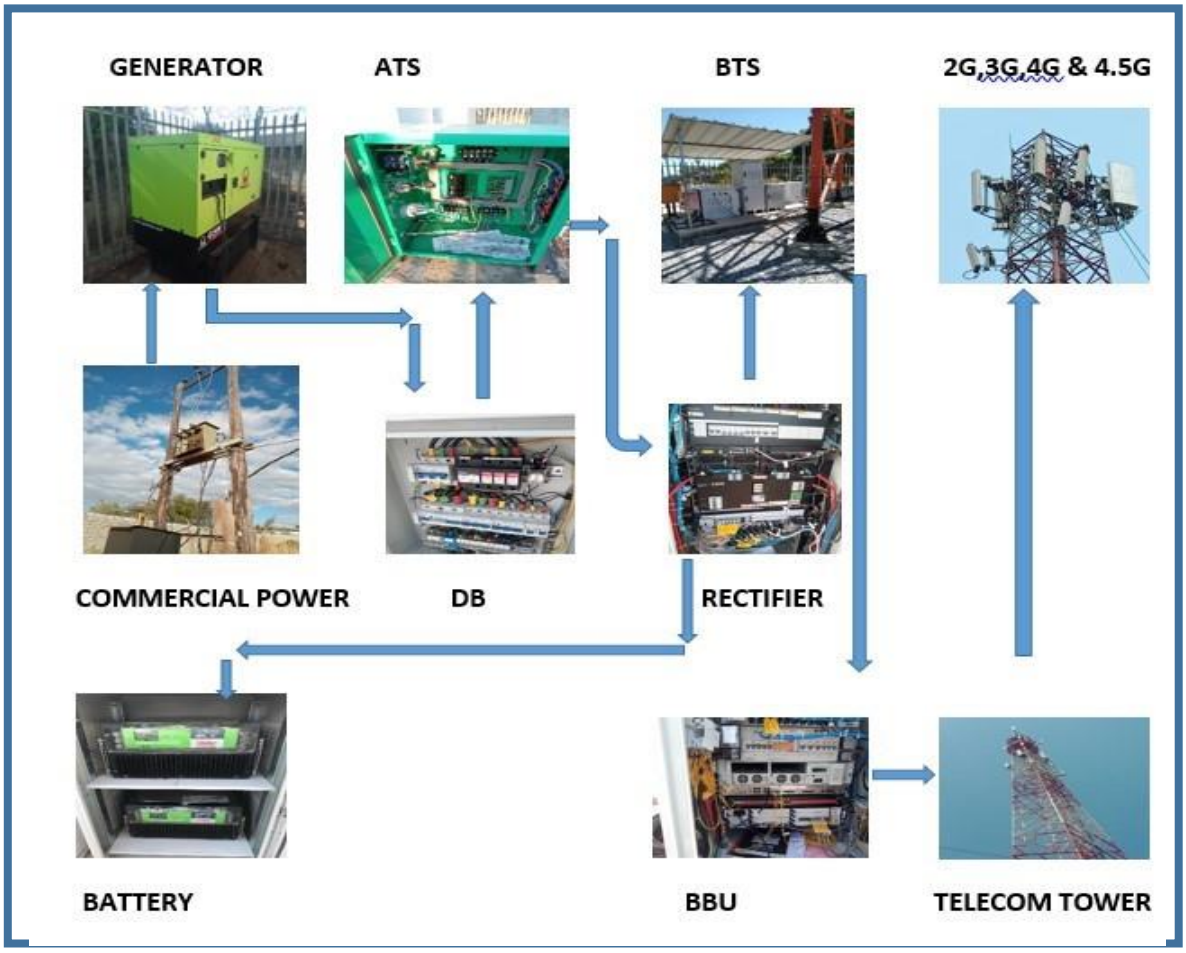

Figure 3 Tower Operation Diagram

Below are the monitoring tools used in Preventive Maintenance (PM) which is a process used in making sure all technical parameters such as in the above diagram are in check to avoid any service interruptions which speaks directly to Financial KPIs through sales variables. In this project we wish to automate Preventive Maintenance (PM) making it a business aid to facilitate a smooth operation resulting in reduced Corrective Maintenance, which then tentatively results in reduced (OPEX) Operational Cost.

3.6 Identification of Variables

The design and implementation of the PHP Model to be used to determine variables with causal effect to be considered for framing price of Rental charge or Dismiss Rental charge, and Network Resource Optimization.

Variable	Details	Cause Effect	KPI Affected
Transmission	Fiber Microwave	Transport used to deliver service, any interruptions affects Uptime	Availability
Power	Main Supply & Backup	Once Grid power is off Backup picks up	Availability
Asset Licenses & Monitoring	License Expiry, as well as Depreciation of Equipment	Loss Stability on equipment, Batteries Loose Autonomy, a basic Loss of efficiency	Availability
Technology Evolution	Innovation and Implementation of new technologies	E.g the Coming of 5G	Demand pull Market turbulence

Table 1 Variable Correlation Table

Chapter 4

4.0 System Building

4.1 Introduction.

This chapter describes the development technique that was utilized to design the system. The chapter also discusses the design methodologies and tools utilized during the system development process. Then system analysis, design, and development were detailed. Finally, the system's testing was discussed after it was built.

4.2 Coding/Development Tools.

The system was developed using open source software and other software development platforms. These were:

(a) HTML is the language used to create web pages.

(b) JavaScript is a client-side programming language.

(c) Cascaded Style Sheets (CSS) enhance the appearance of online pages.

(d) Browser: This program links a client computer to the internet and serves as the user interface for the Tower Manage System.

(e) PHP is a server-side programming language.

(f) MySQL Server: Tables hold all data in this database hosting setting.

(g) WAMPServer consists of Windows, Apache, MySQL, and PHP. It is commonly used for internal testing and web development, but it can also be used to host live websites. The WAMP package's most important component is Apache (also known as "Apache HTTP Server"), which is required to run the web server within Windows. WAMP also includes MySQL and PHP, the two most popular programming languages for creating dynamic websites. PHP is a scripting language that allows you to retrieve data from the MySQL high-speed database.

(f) **The following are some of the designed input features: input before coding.MySQL Server:** The tables are used to store all data in this database

(g) WAMPServer consists of Windows, Apache, MySQL, and PHP. It is commonly used for internal testing and web development, but it can also be used to host live websites. The WAMP package's most important component is Apache (also known as "Apache HTTP Server"), which is required to run the web server within Windows. WAMP also includes MySQL and PHP, the two most popular programming languages for creating

dynamic websites. PHP is a scripting language that allows you to retrieve data from the MySQL high-speed database.

4.3 System Specifications.

To ensure the system runs smoothly, the following hardware and software minimum specifications are recommended:

4.3.1 Hardware Specifications.

(a) Client-side Processor speed: 2.0 GHz

(b) Server-side Processor speed:3.0 GHz

(c) 1.8.0 GB HDD

(d) 1.8 GB of RAM

(e) Video: 800X600, 256 colour.

4.3.2 Software Specifications.

(a) Operating System: Windows 7 or higher.

(b) Client-side: Any updated cross-platform Web Browser (e.g. Chrome, MS Edge, Firefox).

(c) Server-side: WAMPserver.

(d) Internet connection.

4.4 Development Methodology.

SDLC was used as a development technique. The Software Development Life Cycle (SDLC) is a process that outlines the methods and strategies for creating, planning, and sustaining software projects while ensuring that all project goals, objectives, functional requirements, and user requirements are met (Arora and Arora 2016). The SDLC stages include planning, analysis, design, development, testing, implementation, and maintenance.

The following are some of the designed input features: input before coding.

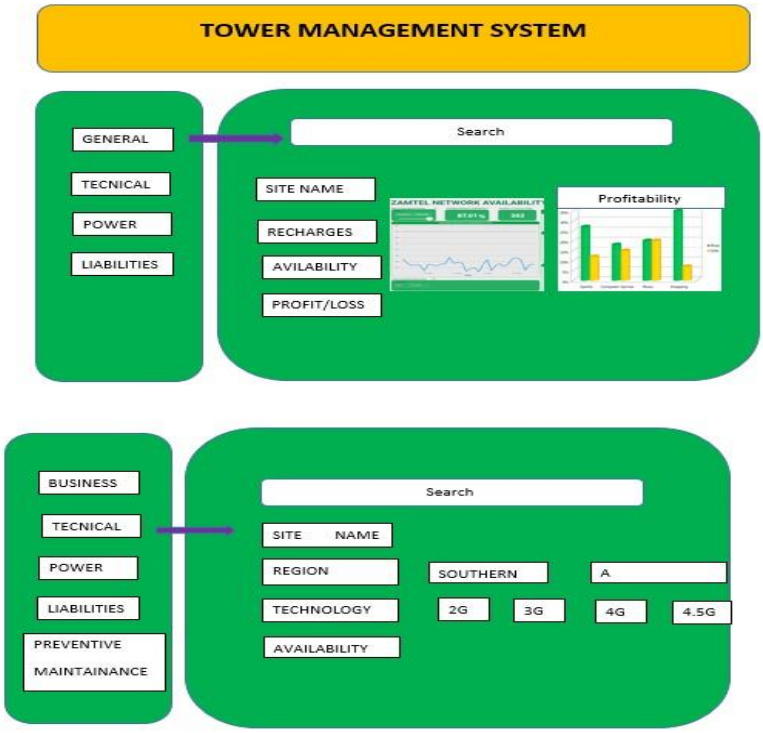

Figure 4 Tower Management System Admin Page Design

The design of the system has been two fold, the Administrative side as well as the user Interface side.

Administrator has the rights to Input data such as Sites, and all the equipment pertaining to the particular site not with holding a sales key performance Indicator of Recharges. The manual forms such as seen in figure 3, will be replaced by a digital reporting system that is able to highlight operating parameters as well as and display visual checks on infrastructure at a tower.

This will help in Service recovery, fault resolution lead time as well as enhance actions of preventive maintenance, which all contribute to profitability of a tower.

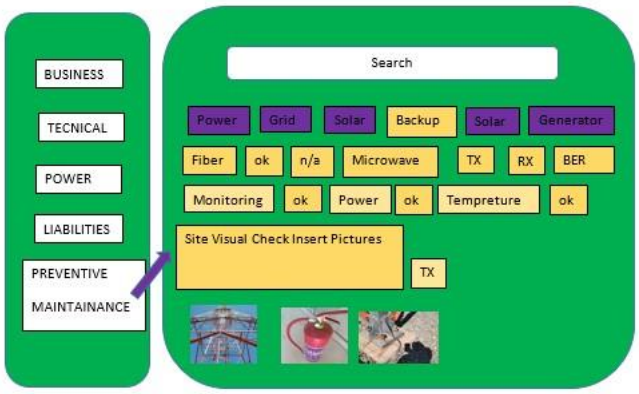

Figure 5 Tower Management System User Inspection Page

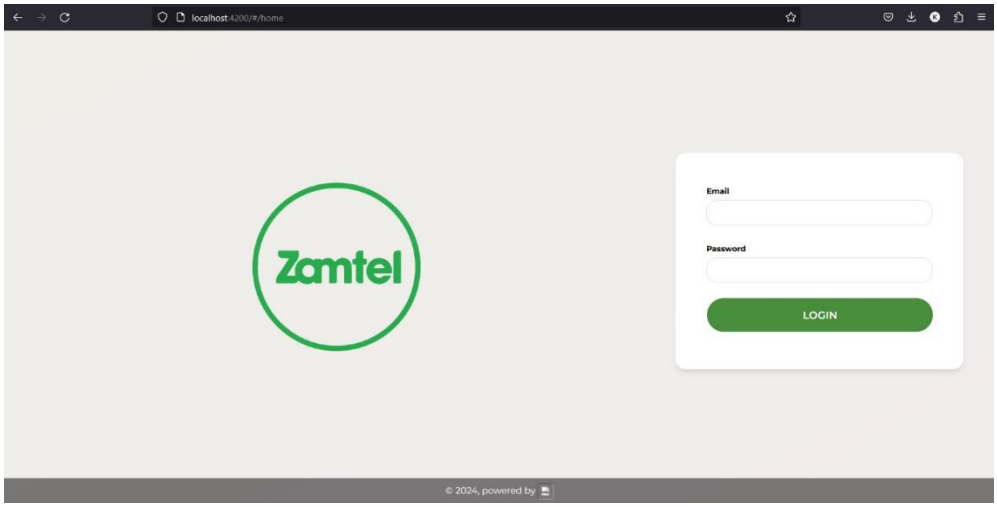

Figure 6 Tower Management System Login Page

The Above Figure 5 displays a login Screen into the TMS designed for Zamtel Case study

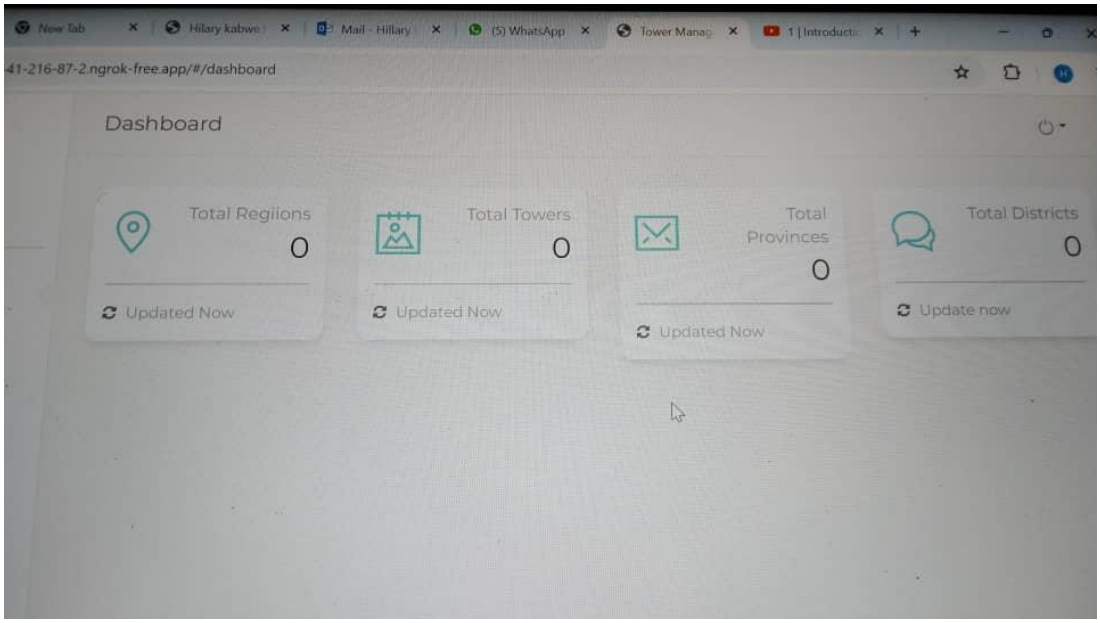

Figure 7 General Interface Page

Figure 6 above illustrates the input data generally displayed in different fragments of the Region

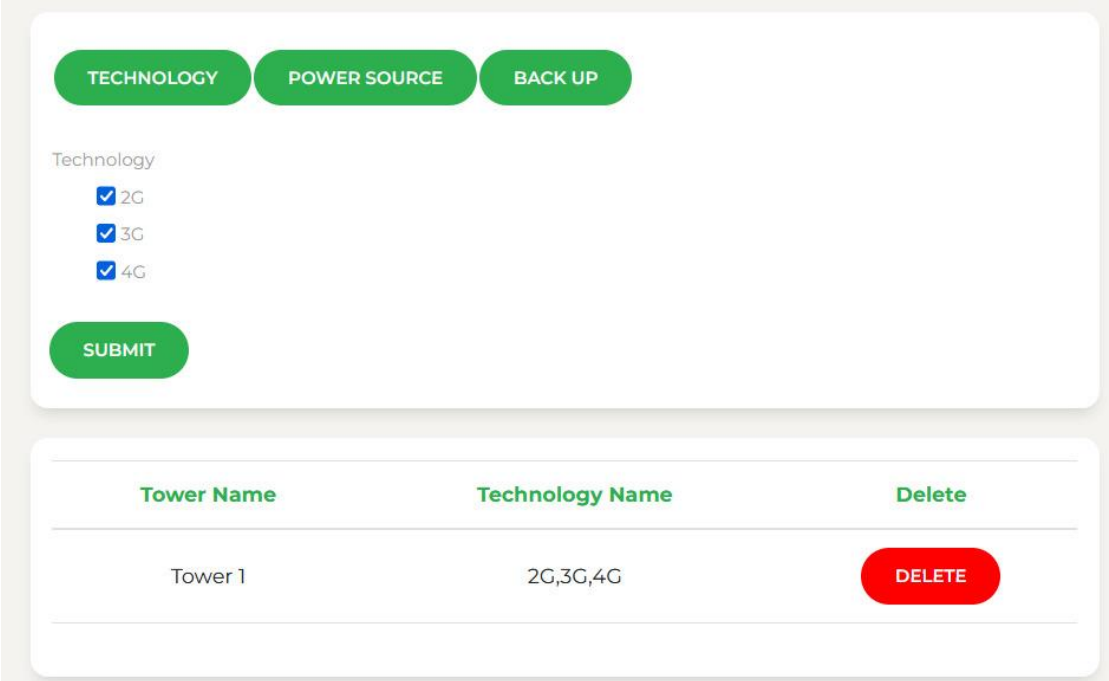

Figure 7 User Technical Interface Page

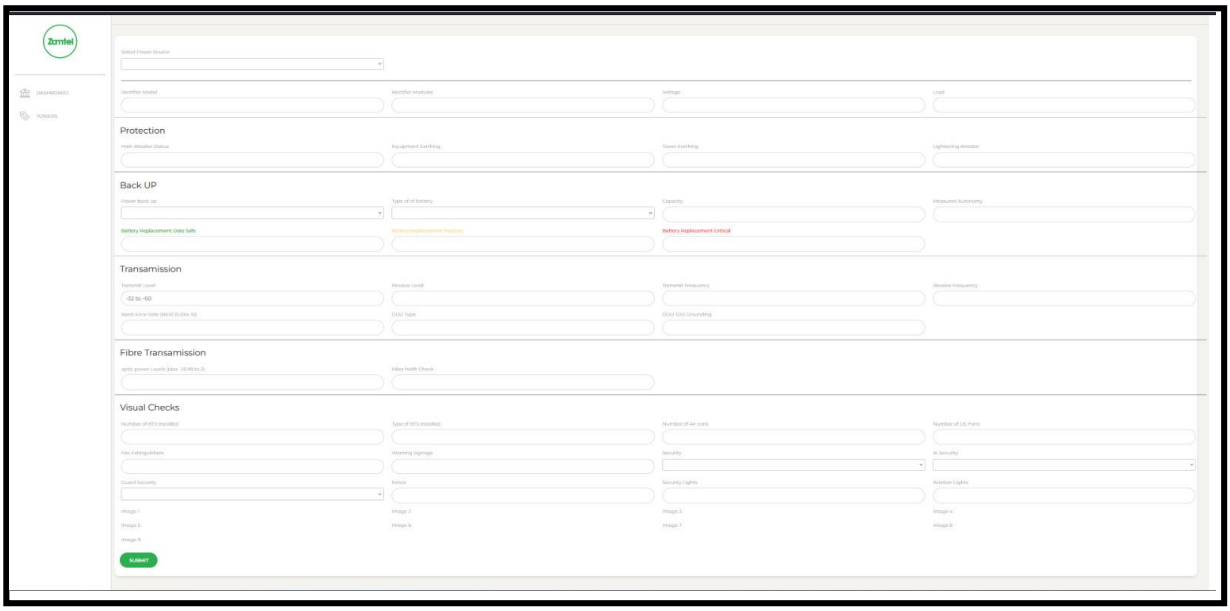

Figure 8 User Interface, Inspectors Page Technical Parameters

The Preventive Maintenance form in Appendix 1 is replaced by the online system as show above in the Figure with this platform Data Integrity is preserved and portable giving it an omnipresent ability and can be accessed online anywhere, above displays Technical Parameters that upon inspection can help an Inspector to check through on confirm. Such as the ZICTA inspections can also make use of these reports so as to Paper work, and enhance efficiency through digital reports generated of the quarter as teams are doing their periodic Preventive maintenance.

Chapter 5

5.1 Results

The Figure 9, below shows an example of an Inspection Report generated by the system.

The report is able to give you information in the following categories:

PLM: Product Life Cycle, this variable speaks to Life span of Products i.e Batteries, Telecom Radios, Product and Service Licenses. TMS provides Critical Alarms through the animation of Days left towards product shelve life.

Green Co-noting an able time before critical Shelve Life.

Orange representing a mild danger towards Shelf life

Red representing Danger towards replacing Product as by then its survival will not be reliable. This provides a guide towards budget lines to replacement of equipment.

CM: Corrective Maintenance, This refers to the day to day Site interventions of faults, for quick resolution. TMS is able to assist in fault localizing through reports such as the one below in figure 11, as it builds up information from case to case.

PM: Preventive Maintenance, Refers to Scheduled visits that encompasses checking of all technical parameters on Site to prevent unsolicited Outages. This remains a very important Report to aid Decision making through the comparison of the performance of each component towards the Availability then towards Revenue generation.

The Report serves two Options:

1) It opens the user up to availability which ties itself to revenue with a positive correlation, from the amounts calculated to be revenues per day and per hour, on the number of hours the site is available, a decision can then be arrived at, weather to Buy or Rent Power Backup system
2) Regulatory Framework: The report serves also as a requirement for the regulating body such as ZICTA. In each absence mobile service operators are fined Millions of dollar. TMS seeks to provide a cost serving measure through provision of this report even from the comfort of a home.

Revenue Tracking: from one technology to another TMS helps optimize telecom Resources at a Tower using financial KPIs as it gives an option to redistribute them on the network were needed for the technologies underperforming among 2G, 3G and 4G.

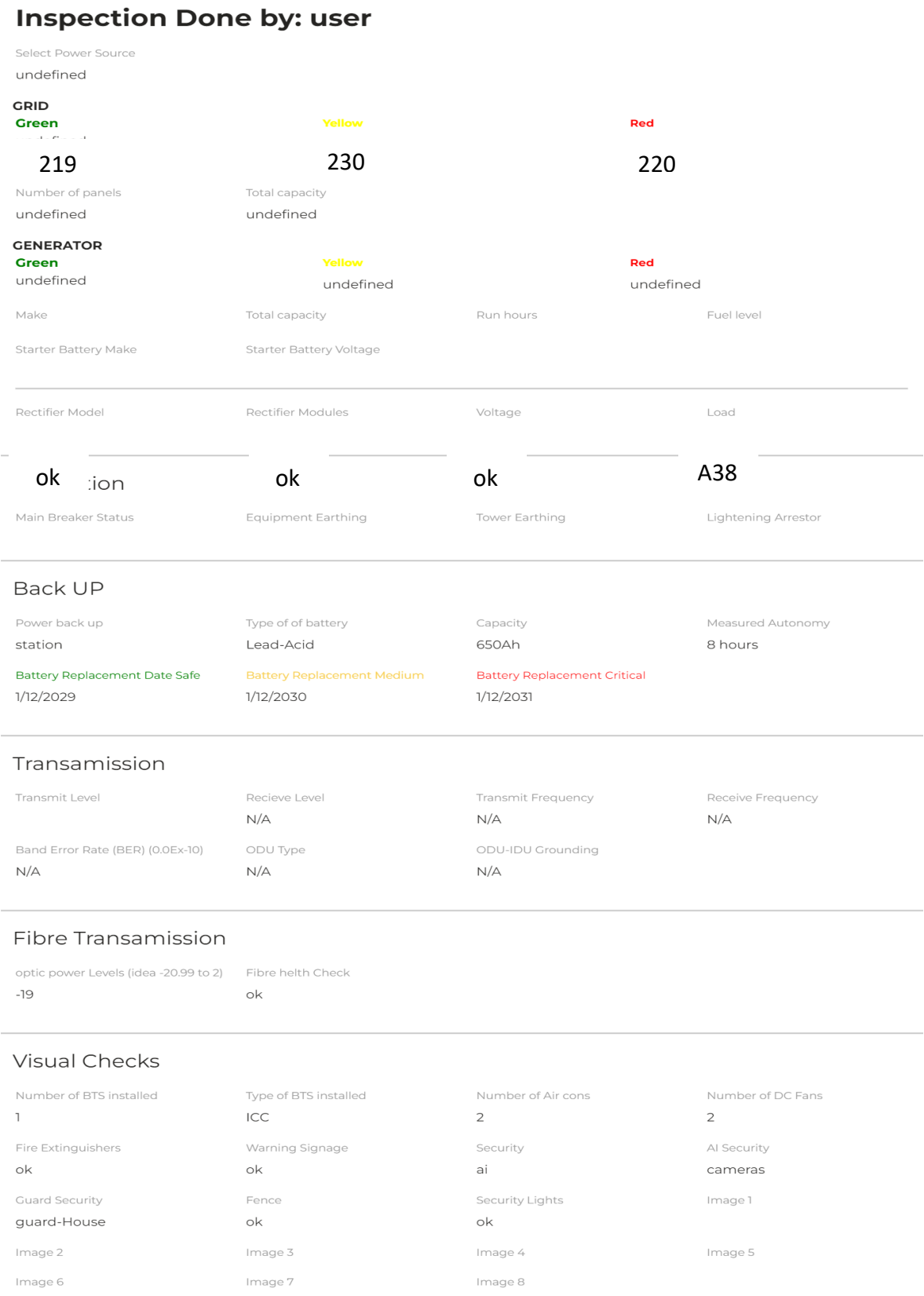

Figure 9. TMS Auto Generated Report

6.0 Conclusion

The Tower Management System presents a solution that helps maintain network uptime, optimize telecom infrastructure through a demand pulled direction while also optimizing energy costs, lower overall servicing costs, and prevent revenue loss. Tower yield is by far determined and decisions remotely made and a monitoring and evaluation phase is engaged. This provides aided decision making solution with actual parameters coupled by tested efficiencies. This project will offer an online method for monitoring Tower retention as an asset so as to enhance service delivery and profitably.

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Appendix

Q1 2024 PREVENTIVE MAINTENANCE CHECKLIST		
SITE ID:		**DATE:**
ENGINEER NAME: Hilary Kabwe		**GN#: 1029**
PHONE#: 0950004474.		**SIGN:**
POWER SYSTEM		
SYSTEM	**THRESHOLD**	**COMMENT**
RECTIFIER		
Type		
Load		
Priority Loading		
Output Voltage		
Number of Modules Installed		
Number of Modules Working		
COMMERCIAL VOLTAGE		
Red	198-260	
Yellow	198-261	
Blue	198-262	
Distribution Board Status		
Main Circuit Breaker		
SOLAR		
Type		
Measured Voltage(Optional)		
Number of Arrays		
Dimensioned Power		
GENSET		
Make		
Rating		
Run Hours		
Fuel Level		

Genset Fuel Log Book		
Genset Engine Oil		
Auto Start/Stop Functionality		
Automatic Transfer Switch		
Genset Maintence Log Book		
Service Due Status		
STARTER BATTERY		
Rated Voltage	12V	
Measured Voltage	(12V-13.5V)	
Battery Status		
Charger Status		
BACKUP BATTERIES		
Hybrid/Station batteries		
Make/Type		
Rating		
Voltage Output	(47V-55V)	
Planned Autonomy		
Measured Autonomy(Optional)		
Remote Power System Monitoring Status (Neteco)status		
EARTHING (Ohms)/=<4		
Equipment		
Tower		
Decollosion Required		
Earth Renew		
Earth Separation		
EQUIPMENT		
MICROWAVE		
Measured Transmit/Ideal Level		
Measured Receive/Ideal Levels		
Planned Transmit Frequency		
Measured Transmit Frequency		

Planned Receive Frequency		
Measured Receive Frequency		
Change Over System		
MUX		
BER(24hrs)	(0.0Ex-10)	
ANTENNA		
IF-ODU Connections		
Antenna Mounting Torqueing		
Waveguide status		
Grounding (IDU/ODU)		
FIBER		
Fan Status		
Optical Power/Ideal Levels	(-20.99--2.99)	
Fiber Health Check		
RADIO		
Base Station Type		
Base Station Visio Checks		
No of BTSs Installed		
Technology (2G/3G/LTE)		
Base Station Alarms (LMT)		
ALARM MONITORING(NOC)		
Power		
Transmission		
Environment		
GENERAL		
EQUIPMENT BLOWING		
Power		
Transmission		
Radio		
CABLES		

Connections		
Cabling		
Labelling		
AIRCONDITIONING		
No of Aircons Installed		
No of Aircons Working		
DC Fans Status		
SECURITY		
Gate/Lock		
Equipment Housing Lockable		
Fire Extingusher Status		
Crushed stone(agrigate) in site perimeter (lightening Protection)		
Site Log Book		
Manned		
Guard House		
Site Fence		
Security Lights		
Aviation Lights		
Access Roads		
Tower Feeder cable status		
Warning Signage		
Site Cleanliness		
Tower Painted		
IDLE EQUIPMENT		
GENERAL COMMENTS		

The cost of deploying, managing and maintaining network infrastructure is driving the need for innovative models of infrastructure deployment and management within the wireless environment from the initial full ownership of network infrastructure model.

, network operators are adopting models of sharing network infrastructure triggered mainly by rapid technological change, fulfillment of regulatory mandates and other constraints