# Development of a Custom Technical Incident and Spare Part Management System for Effective Telecom Network Service Delivery

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*Abstract*--**Managing technical incident in telecommunication industry is very important in order to ensure business continuity. However, there is a need to find effective ways of managing spare parts when there is a need for the replacement of such spare parts in order to fix technical incidents. That is why telecom operators require relevant systems for adequate incident and spare part management. With the outsourcing arrangement between some operators and third-party site handlers in Nigeria and most developing countries, there is a need for proper technical incident handling and spare part management. Many of the problems that arise in telecommunication operation come from non-correlation of escalation with the spare part required to restore normal operation of the service after an interruption. This research focuses on designing and developing a web-based system for handling proper management of technical issues and provision of required spare parts promptly as required. This is to ease operations and communications among telecom operators and their technical service providers. The system was built using combination of web development tools such as Jinja Templating Engine, CSS, HTML, JavaScript, JQuery, Python, Flask and SQLite. The developed system has been tested and found useful for the scenarios that it was developed for. The solution allows online management of spares parts, tracking of escalations, provision of fault details and capturing of all faulty equipments due for repairs. It is believed that the custom system can help in achieving effective telecom network service delivery by the company that uses such approach.**

*Keywords*: **Technical Incidents; Spare Part Management System; Telecommunication Service.**

## I. INTRODUCTION

Many telecommunication companies in Nigeria outsourced their site maintenance services to technical companies that provide support for their various technical supports and operations. Most of these companies are under pressure to maintain an ever-growing volume of network traffic, transform business models to stand strong against over-the-top services, and delight customers with excellent support. Since the success of any telecommunications company lies in customer experience, the telecoms and their outsourced companies must jointly plan adequately for technical incident reporting and spare part management systems [1].

Incident management process is a set of procedures and actions that are used to respond to and to resolve critical incidents, how such issues are detected and communicated, who is responsible, what tools are used, and what steps are taken to resolve them. Information Technology (IT) Service Operations is a high priority improvement target for IT service providers because it is very critical for business operations [2]. IT incident report refers to as the type of documentation of an event which disrupted the normal operations [3]. A case management system conveniently handles various types of escalation enquiries, complaints, and notes over multiple channels. On the other hand, a Spare Parts Management System (SPMS) is an organized maintenance solution. It has been reported that availability of SPMS improves materials and spare parts management as this will create more time for maintenance personnel [4]. Spare parts are extra parts that are available and in proximity to a functional item, such as an automobile, boat, engine, for which they might be used for repair [5].

Telecommunication companies that out-sourced their technical support services have to work very closely with such supporting firms so as to achieve effective network service delivery.

The outsourced companies on their part are expected to be able to manage technical incident issues as well as the needed spare parts effectively. Whenever there is a technical incident, there is a need for the provision of the needed spare parts in a timely manner. This work is used to establish the usefulness of custom solution that can handle the spare part replacement and incident handling in the organization used as a case study requirement. Custom software development is the creation and maintenance of tailor-made software systems that contain unique features [6]. The importance of building custom software solutions is for adequately addressing problems in different scenarios with technological solutions [7].

Thus, having a system in place that can handle both the technical incident reporting and needed spare parts inventory as peculiarity demands in telecom sector is a good step. This study focuses on building a custom system that can be used to handle incident and spare part management issues based on the problem identified in the telecom sector of the Nigerian economy. A general incident management workflow is as shown in Fig. 1.



Fig. 1.  Incident management workflow [3]

A web-based system that provides information of faulty equipment at telecom base station was designed and developed [8]. Authors argued that their work allows online request for spare parts to be done, provide details of transmission media (fiber) faults and capture all faulty equipment due for repairs at the warehouse (technical workshop). Qualitative research approach will be adopted in the study and interview will be used to collect data (users' requirements). The automated telecom network spare parts management system will provide efficient access to spare parts, reduce downtime of network services due to equipment failure and boost customer's

satisfaction.

Some measures can be used for adequate spare parts management forward [9]. The study emphasized the need to conduct a thorough risk analysis in order to identify the weak spots in the spare parts supply chain. The paper further mentioned that doing so will subsequently define the most urgent and important contingency measures. Moreover, some models were built to help the process of incident resolution and implementation of IT infrastructure changes to increase the overall support of IT management [10]. The main objective is to build the predictive models using machine learning algorithms and CRISP-DM methodology. Authors used the incident and related changes database obtained from the IT environment of the Rabobank Group Company, which contained information about the processing of the incidents during the incident management process. They used Random Forests and Gradient Boosting Machine classifiers for identifying incident sources as well as in predicting possible impacts of the observed incident. Both types of models were tested on a testing set and evaluated using defined metrics.

A case-study was carried out based on analysis of how to manage spare parts was investigated [11]. The study emphasized the importance of adequate spare part inventory management in the engineering sector. Similarly, an approach for inventory control of service parts in operational environment was also proposed [12]. Various measures that have to be considered to achieve an effective inventory management in relation to spare parts needs are put forward.

## II.  METHOD

The methodology used in this study involves requirement gathering, system design and development using scenarios on technical incident handling and spare parts management in telecommunication industry. The analysis enables the researchers to identify necessary features for design and development of a custom solution that can replace the use of Microsoft excel spreadsheet and the application of the telecom provider for handling technical incident and spare part management issues. The

specifications used for the design and development were sourced through observation and interview methods. The system was then developed as required using a combination of tools. This study used suitable development tools to build the web-based system of this nature [13]. The custom system has the capabilities to discover, track and resolve the telecom escalation tickets. The system was built using combination of web development tools such as Jinja Templating Engine, CSS, HTML, JavaScript, JQuery, Python, Flask and SQLite. The system can equally help to address all types of claims for different types of telecom services such as GSM, PSTN, Data, FTTH and IPTV. Fig. 2 shows the working process of the proposed integrated Technical Incident Reporting System and Spare part Management System.
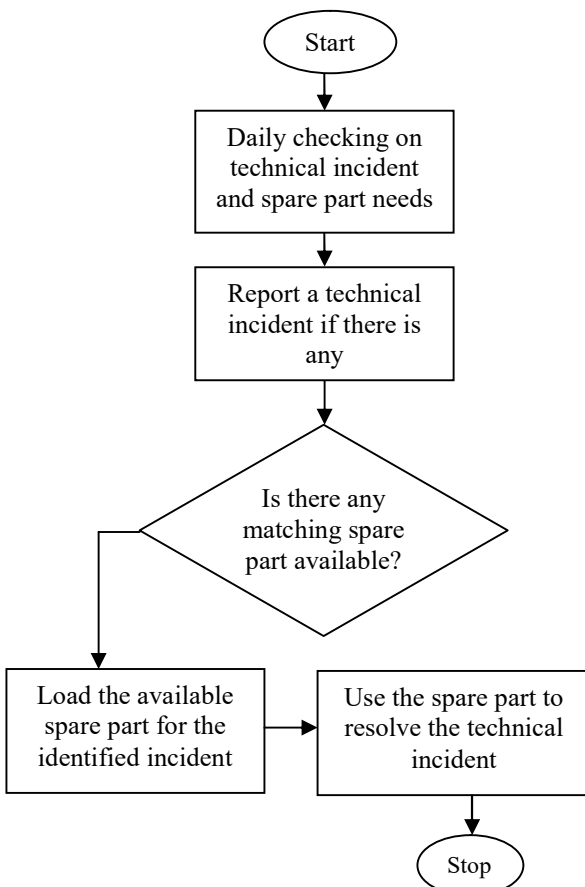


Fig. 2. Flowchart of the proposed system

The modules in the proposed system include: administrator and user logins, interface for opening and responding to cases, spare part handling and technical incident reporting. For the back end, the DBMS tool was used to handle some of the needed tables in the database. These include: cases, conversations, customer faults, fault_requests,item_requests,item_returns,item_types,items, remembers,users and utilities. Each of the tables has different fields and data types. The fields and the data types guide the way the application backend was built. They are as shown in Table I to XI. The tables consist of different fields or values that are handled in the proposed application based on system requirement analysis carried out.

TABLE I Cases

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | ID | Integer |
| 2 | User_id | Integer |
| 3 | Customer_id | Integer |
| 4 | Remark | Text |
| 5 | Ticket_no | VarChar(64) |
| 6 | Title | VarChar(64) |
| 7 | Status | DateTime |
| 8 | Status_change_date | DateTime |
| 9 | mttr | Integer |
| 10 | deadline | DateTime |
| 11 | Posted_on | DateTime |
| 12 | Closed_on | DateTime |

TABLE II Conversation of Users

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | Id | Integer |
| 2 | User_id | VarChar(04) |
| 3 | body | Integer |
| 4 | image | VarChar(255) |
| 5 | Case_id | VarChar(64) |
| 6 | Posted_on | VarChar(64) |

TABLE III Customer

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | Id | Integer |
| 2 | Company_name | VarChar(04) |
| 3 | State | Integer |
| 4 | Location | VarChar(255) |
| 5 | Site_no | VarChar(64) |
| 6 | Contact_name | VarChar(64) |
| 7 | Email | VarChar(64) |
| 8 | Phone | VarChar(64) |
| 9 | Address | Text |
| 10 | Added_by | Integer |
| 11 | Posted_on | DateTime |

TABLE IV Faults

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | Id | Integer |
| 2 | Name | VarChar(64) |
| 3 | Body | Text |
| 4 | User_id | Integer |

TABLE V Fault Request

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | Fault_id | Integer |
| 2 | Request_id | Integer |

TABLE VI Item Request

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | Id | Integer |
| 2 | type_id | Integer |
| 3 | Reply_id | Integer |
| 4 | Qty | Integer |
| 5 | Request_date | DateTime |
| 6 | Eta | Integer |
| 7 | Deadline | DateTime |

TABLE VII Item_returns

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | Id | Integer |
| 2 | Type_id | Integer |
| 3 | Serial_no | VarChar(64) |
| 4 | Waybill_no | VarChar(64) |
| 5 | Out_date | DateTime |
| 6 | Case_id | Integer |
| 7 | User_id | Integer |
| 8 | Receive_date | DateTime |
| 9 | Receiver_id | Integer |

TABLE VIII Item Types

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | Id | Integer |
| 2 | Name | VarChar(64) |
| 3 | Partno | VarChar(64) |
| 4 | Body | Text |
| 5 | Image | Text |
| 6 | Unit | VarChar(64) |
| 7 | threshold | Integer |

TABLE IX Items

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | Id | Integer |
| 2 | Type_id | Integer |
| 3 | Serialno | VarChar(64) |
| 4 | Waybillno | VarChar(64) |
| 5 | Stock_date | DateTime |
| 6 | Case_id | Integer |
| 7 | Request_id | Integer |
| 8 | Out_date | DateTime |

TABLE X Utilities

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | Id | VarChar(64) |
| 2 | Mttr | Integer |
| 3 | Rows_per_page | VarChar(64) |
| 4 | Eta | VarChar(64) |
| 5 | Enduser_id | Integer |
| 6 | Email | VarChar(64) |

TABLE XI Users

| S/N | Data Field | Data Type |
|---|---|---|
| 1 | Id | VarChar(64) |
| 2 | Username | VarChar(64) |
| 3 | Email | VarChar(64) |
| 4 | Name | VarChar(64) |
| 5 | Phone | VarChar(64) |
| 6 | Location | VarChar(255) |
| 7 | Password_hash | VarChar(255) |
| 8 | Role_id | Integer |
| 9 | Activated | Boolean |
| 10 | Activation_hash | VarChar(255) |
| 11 | Activation_sentat | DateTime |
| 12 | Reset_hash | VarChar(255) |
| 13 | Reset_sent_at | DateTime |
| 14 | Registered_at | DateTime |
| 15 | Reset_hash | Integer |
| 16 | image | Text |

## III. RESULT AND DISCUSSION

### A. Results

The design and development of the software system is based on the analysis carried out in the setting used as a case study. Different tables that were used to handle the fields in the system are as shown above. Depending on the type of the data that we want the system to accommodate the data fields allow the user to enter valid inputs into the database. The forms that were created for handling data entry into some of the tables in the database based on the identified fields are used for taking inputs at the testing stage. The graphical results obtained from testing the application are the various screenshots captured as denoted in Fig. 3 to 10.

New case page enables customer to open a new case (Fig. 4). Returned items page shows list and details of returned faulty items (Fig. 5). Case list page itemize with detail all the case logged on the system (Fig. 6). Fault list page contains list and description of possible fault to device or service on the network for escalation (Fig. 7). Administrator can add or delete from the list as required. Fig. 8 contains the list of users and role assigned to their profile (Admin/Staff/Customer). Administrator can add or delete from user as well as assign and change role as it may be required.

Items module contains item (spare) types, list of spares, items requested and list of request made. Administrator can add or delete items from the list. The details are as captured in Fig. 9.

Fig. 3.  Main Menu – Staff



Fig. 4.  New Case



Fig. 5.  Returned Items

Fig. 6. Report of Case List



Fig. 7. Fault List

Fig. 8.  User List



Fig. 9.  Item Types



Fig. 10.  Item List

## B. Discussions

The creative approach used at the design stage is believed to be useful for developing the solution to meet the user specifications based on the scenario at hand. Figures 3 to 10 are the screenshots obtained from the running of the application while Table I to XII are used to capture the structure, fields and basic description of the tables in the database. The conceptualized and developed system is the type that is targeted at handling the report of technical incidents at telecom installations as well as managing the needed spare parts needed for fixing such incidents. The system is expected to have the capability to deal with a huge volume of tickets generated from various channels, such as call centers, web, and email. It also provides a database for the needed spare part per region as well as log spare parts per escalation. It manages tickets through a systematic tracking process for any actions conducted regarding an issue. It will offer an abundance of tools to deal with cases, such as assigning priority, allocating resources, ticket linking, SLA monitoring, service monitoring, and notifications. Now we can ensure a timely resolution of all submitted tickets with SLA monitoring capabilities.

The system was meant to replace the existing system that has been found to combine manual Spare Part Management System and a semi-automated Incident Management System. The new system successfully automated and integrated all the modules together thereby improving on the feature that are not included in the existing system. The modules in the proposed system include: User Registration, Incident Support and Spare Part Management. It can also open case, reply case, close/reopen case, display list of case logged, stock spares, present spares to users, request fulfillment as well as comprehensive report display and generation.

Some of the features included in the system are targeted at having a solution that addresses some of the common problems in relation to the services rendered by the technical contracts as well as the telecom company. This system was designed and built to handle Incident Management and Spare Part Management in a single dashboard compared to scattered Excel sheets previously in use at the organisation used as case study. Thus, the proposed system can aid

the coordination of escalated incident with the specific spare required to clear the issue. It keeps record of the required spare stock level and alert on shortage of stock accordingly. The Web-Based Incident and Spare Part Management (SPM) System is a targeted at addressing scenarios in the telecommunication and IT infrastructure organization. The test summary report shown in Table XII represents a general result from the application as obtained.

TABLE XII Test Summary Report

| Test Case No. | Objective | Test Data | Expected Result | Actual Result | Conclusion |
|---|---|---|---|---|---|
| 1 | Registration of new user | Apply as a new user | Success | Success | Pass |
| 2 | Validation on Login Page | Try to login valid credentials | Success | Success | Pass |
| 3 | Opening of a new case | Open a new case | Open new case | Success | Pass |
| 4 | Add Fault | Add Fault in Fault list | Success | Success | Pass |
| 5 | Add new User | Add User in user list | Success | Success | Pass |
| 6 | Add Item | Add Item in Item list | Success | Success | Pass |
| 7 | Reply case | Reply case | Success | Success | Pass |
| 8 | Requesting for Spare | Log and request for Spare | Success | Success | Pass |
| 9 | Fulfilling SPMS request | Fulfill user SPMS request | Success | Success | Pass |
| 10 | Closing of a case | Close resolved case | Case close | Success | Pass |

## IV. CONCLUSION

This study analysed existing system used for handling technical incidents and spare part replacement in a telecom company operating within Nigeria as a case study. The new system built is a Web-Based Incident and Spare Part Management (SPM) System that is based on the operational mechanisms that exist between a contractor and telecom service operator. The system was meant to replace the existing system that has been found to combine manual Spare Part Management System and a semi-automated Incident management System. The new system successfully automated and integrated all the modules together thereby improving on the

feature that are not included in the existing system. The modules in the proposed system include: User Registration, Incident Support and Spare Part Management. The system can open case, reply case, close/reopen case, display list of case logged, stock spares, present spares to users, request fulfillment as well as comprehensive report display and generation. The system will be able to guarantee Service Level Agreement and improve subscriber's satisfaction as a result of network downtime which is minimized or prevented. Thus, this study was able to establish that the new custom and web-based Incident and SPM System can help in achieving effective telecom network service delivery as it integrate the two different modules better.

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