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Designing of Information System Framework (ISF) for Digitized Referral Appointment System (DRAS): Case study of Tanzania

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Abstract
The issue of making an appointment to access referral services in Tanzania, you need to have individual relationships to medical staffs as friendship or relatively. In many years ago, existing referral systems did not offer assurance to get specialty hospital services. The number of ICT projects has been adopted and put into applications but referral services remains forgotten. The problems of referral services in Tanzania include shortage of human resources, facilities, equipments, records keeping systems and referral appointment system. Basically, patients have to travel at one hospital to another seeking quality healthcare delivery on faith with assurance of being served. Thus; create long waiting time for patients, doctors' idle time, unnecessary cost to patients and disturbances. The major purpose of this paper is to design detailed Information system framework through application of ICT to solve referral challenges. This solution will provide efficient use of few available health resources like medical specialty doctors, time and equipments. The proposed system designing will allow patient to book an appointment before travelling. Hence; this will provide medical staff awareness, reduction of waiting time, minimizing Doctors' idle time and unnecessary costs to patients.
Keywords: Referral services, Information and Communication Technology (ICT), Information system framework (ISF), Digitized Referral Appointment System (DRAS)

1. INTRODUCTION

1.1 Understanding current situation of referral services

In order to access referral services in Tanzania; patients have to get official documents written by the medical staff who attended the case and then to be signed by the medical officer. This document has brief of patient treatment history, suggested hospital name, specialty services to access without specifying date. After arriving at referral hospital has to submit those documents to reception or registration counter where he has to pay to access health services; this step will enable the patient to be registered and to get file for keeping records for every visiting. The referral documents are inserted into patients' files to be seen by the doctors at consultation room (Thus results complexity to keep those documents). The patient has to wait together with normal patients for initial consultation. At laboratory room; the patient has to be registered, pay for diagnosis services and wait for results and second consultation (This creates long waiting time [1]). Last the doctor will direct a patient to get medical drugs for discharging or admission for advanced services.

The Tanzania referral pyramid starts from the district level, regional level, consultancy referral level and National level (MoH 1990, 1994, 1998, 1999). All referral documents are filled by medical staff who attended

the patient and to be authorized by medical officer.

To arrange patients scheduling are complex in hospital because of dynamic changes and usage of paper system of writing in a file by hand. The pyramid is divided into eight divisions which is family level, village level, dispensary level, health centre level, district level, regional level, referral level (consultancy level) and National level (MoH 1990, 1999). The challenges faced referral services are lack of health resources and equipments to Tanzanians hospitals which results patients to travel from one hospital the other. Existing tradition referral systems doesn't offer to make appointment to access referral services for assurance, thus; creates the problems of long waiting time for patients and doctor's idle time [2].

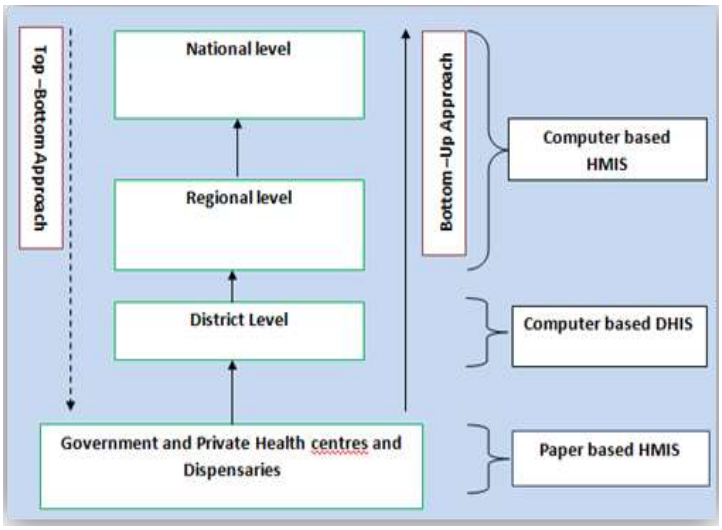


Figure 1: The referral pyramid in Tanzania

The observed existing referral challenges to surveys are as follows: - Long waiting time causing complaining about patients and wastage of resources, unawareness to doctors causing partial preparation to attend the cases and results poor service quality bellows the standards. There is overcrowding of patients coming without making appointment and resulting great burden to medical staff and hence affecting service quality (Figure 2).

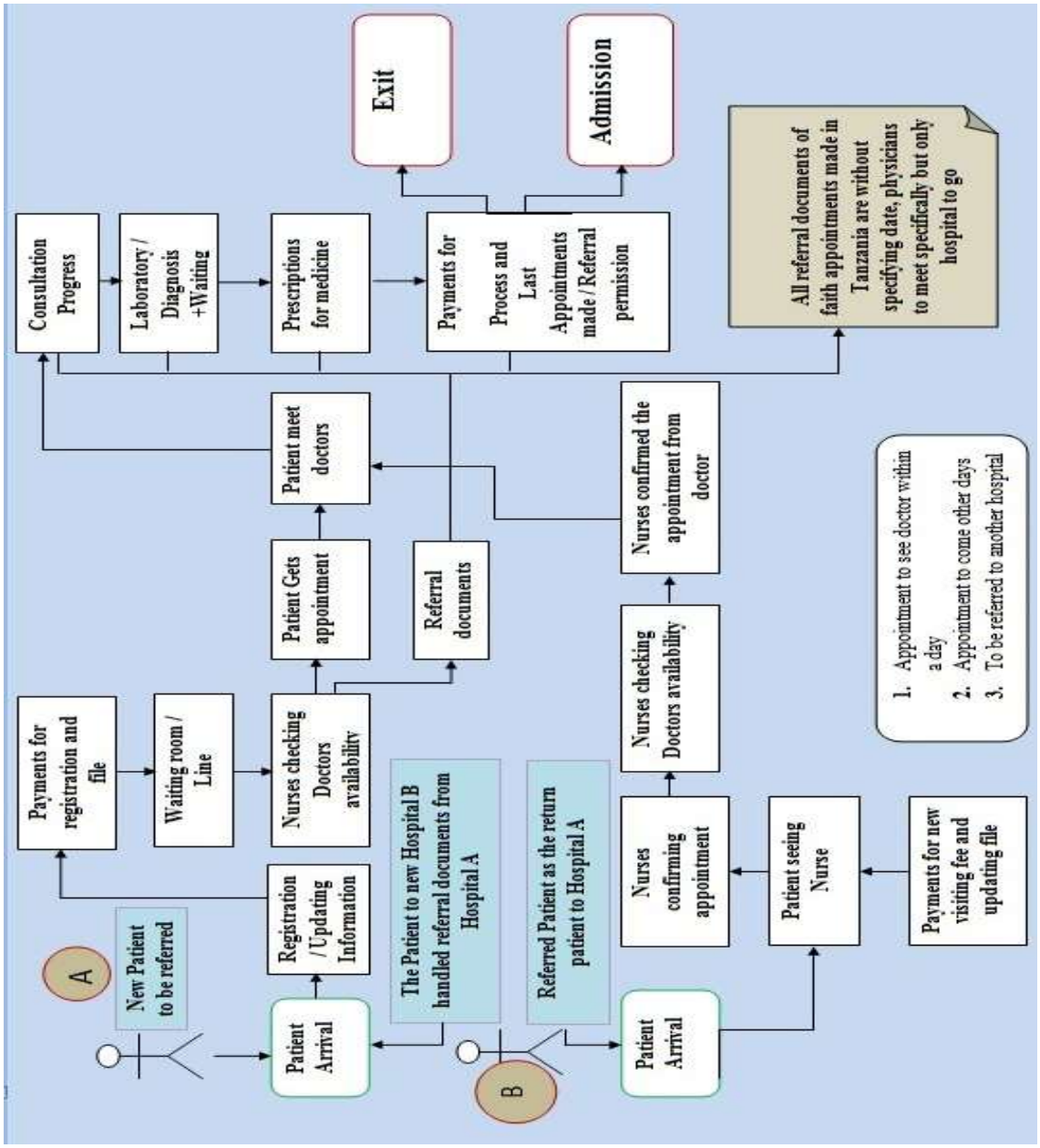


Figure 2: The business processes in accessing health services and the challenges of long waiting time.

From figure 2; the patient who wishes referral services has to go to regional hospital, register and paying for services charges. During consultation a doctor will attend patient's cases and advising to provide referral to visit another hospital. A doctor will fill referral form; patients' treatment history, reasons of referral, expected hospital to go and specialty services needed without specifying date because hospital and hospital has no link to communicate. By the time of reaching the hospital, patient carrying paper documents will be registered again as a new patient, paying for services charges and waiting for doctors' consultations. During first consultation, a doctor will see patients' referral documents inside the file from registration counters. This creates long time process and dissatisfaction with health services provided.

2. Exposure of Patient appointment system Framework and business processes

Patients Appointment System (PAS) in the literature review used paper system long time ago. Most of the system

was using telephone by which central operators they were using simple queuing models just to calculate patient time in consultations and in waiting time to know the medical staff capacity per day [3].

The telephone appointment system (TAS) had the following benefits; is cheaper and quicker than seeing patients face to face but it is risks because how can you understand the case by voice? In the right circumstances, they can increase efficiency, improve access and boost patient satisfaction. The drawbacks of telephone are that; Languages can be a barrier between doctors and patients communications that affect booking processing. Sometimes doctor's phone during accepting appointment bookings becomes busy and patient delayed to get line and Doctors burden becomes great to talk more online.

Early appointment system including in Tanzania was done by considering the time of doctors is more important than patient time which was bad concepts because the life of the patient is very important to be given highest priorities than doctor's time. The researchers Wijewickrama and Takakuwa (2005) came with solution of developing appointment system by valuing time for patients and doctors to minimize waiting time for patients and doctors idle time [4]

Based on this concepts developers designed a system only to minimize doctor idle time but to solve this negative ideas current systems are developed by considering time both for patients and for doctors [4]

Internet appointment system allowing patients to create amend and cancel their appointments online which is convenient for patients than telephone; It quick and easy to use, Patients receive automated booking confirmations via system or email account [5]. It has the following drawbacks; not everyone has access to a computer, some patients may need training to use the system and patients may be concerned about the security and confidentiality of the information online.

On the other hand, researchers focused on the following cases; Management of patient information, medication history, appointment system, Doctor schedule and calendar, health care document and payment systems.

Descriptions of observed from literature review study shows that: The patient went to the hospital seeking for services, does not know too much about his or her health. After arriving at the reception, registered and paying for services charges, then have to wait to see medical staff who will attend and if the cases is not hot after medicine prescriptions may be allowed to back home. If the cases somehow are hot then doctor may give appointment to visit another day by specifying date and services. For appointed day, patient will again report to registration counter for updating information and paying for day services charges, before asking nurses to confirm appointment arranged to see the doctor (Figure 3).

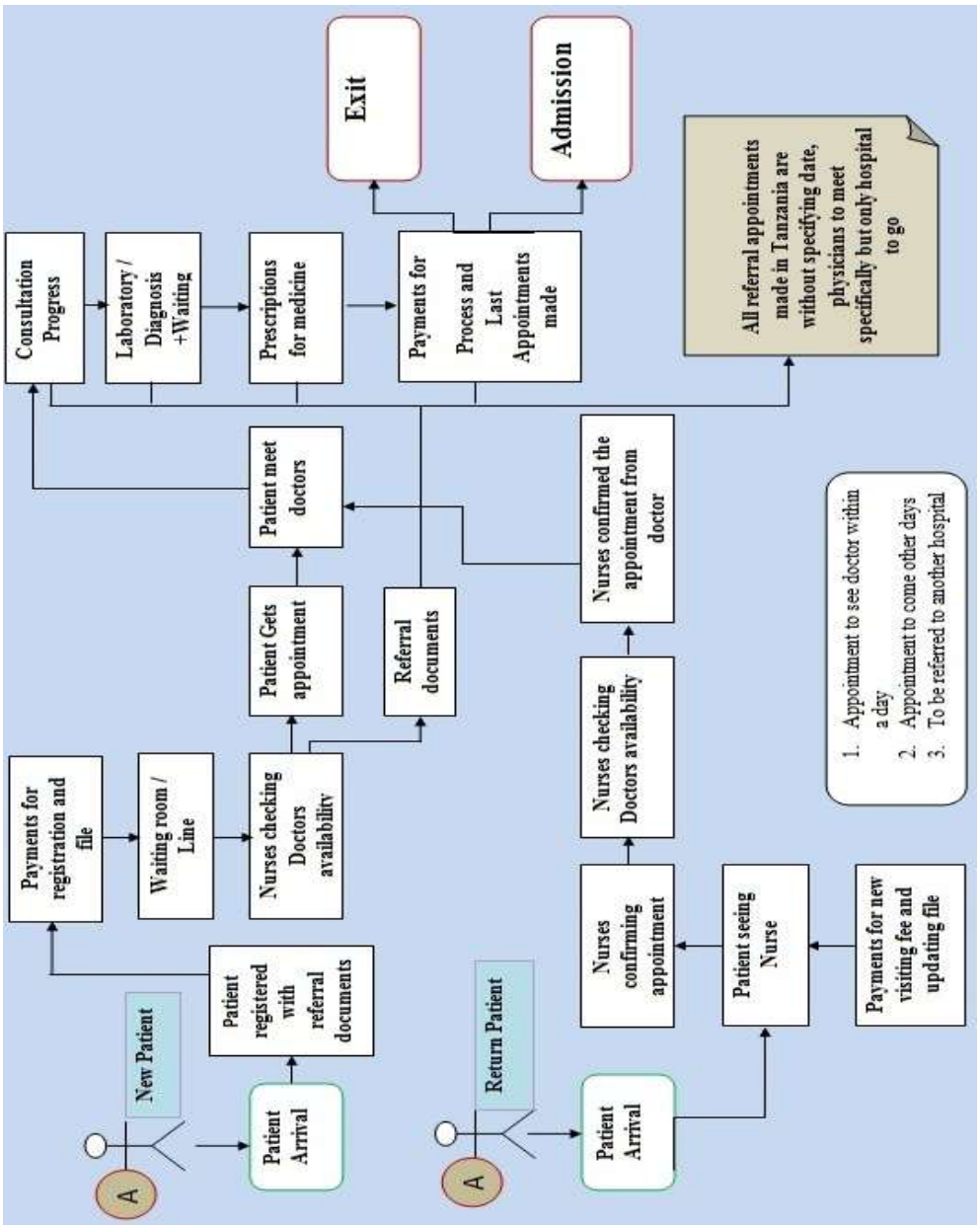


Figure 3: Accessing appointments within one hospital and not referral communication to another hospital.

3. Proposed business processes for DRAS

The proposed business process for DRAS will be working such that a registered patient to the PAS, the information will be available to other hospitals connected (Regional, consultancy and National level), after doctors to help patient to make appointment, the process will result appointment date, time, specialty services and hospital to go after patient to confirm via email, system or cell phone. A patient history will be written to web-based computer such that no need of carrying referral documents (patient ID will be used to view information profile for updating file to reception desk and doctors consultation room). Due to integration technology, the system process will be linked to payments system and reminding services. A patient before travelling will clear registration process and payments. The process remaining will be only to meet nurses for appointment confirmation to see doctors for consultation. By reducing number of processes during making appointment will reduce patient waiting time, improve doctors performance and increasing services satisfactions (refer the different between processes on figure 3 and 4)

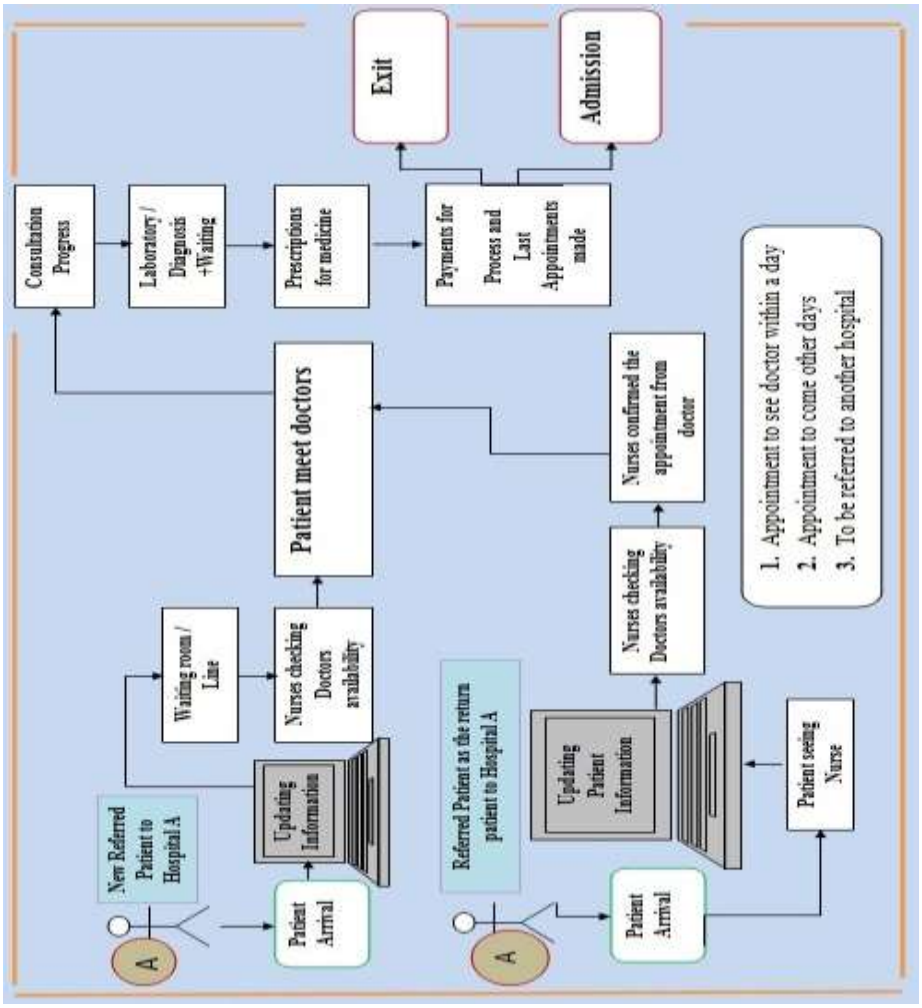


Figure 4: Proposed business process for DRAS

4. The details of IS framework for designing of DRAS

The digitized referral appointment system is a computer based (paperless application) designed with high flexibility and ease of usage to be implemented in hospitals to facilitate referral services. The system serves in controlling and managing booking appointment for different health resources and different hospitals offering specialty services. The resource can be specialty medical staffs CT-Scan services, X-ray services, Time, medical drugs, diagnosis services and accommodations. Each resource has a definite possible schedule that indicates the available time and other required resources for booking appointment.

This system controls doctor's time to attend patients per day, doctor's calendar, facilities and capacity as to other physician's team. The application of DRAS in running referral services it reduces waiting patient time, efficiently usage of few resources to result the best health care delivery. According to Dexter et al. (1999) reported that; patients measures quality of health services in terms of waiting time given for appointment to access health services [6].

However; early appointments with existing referral systems considered the value of doctor time than patient time, but DRAS is designed to minimize the doctor idle time and patient waiting time [4]. DRAS has capabilities to control patient waiting time based on appointment type [3] and better approaches [7] which should have the following major functions:-

- Managing and reducing medical staff idle time,
- Managing and reducing patient waiting time,

- Improving healthcare delivery and referral services,
- Managing accuracy of appointments information and generating reports for decision making.

This system is designed to manage efficiency booking appointments and to manage daily clinic works electronically by using web-base environment.

4.1 Objectives of the system

The appointments system is a means for E-health care that allows quick booking and managing of patients appointments while eliminating the possibility of one time collision of the same time slot for different patients. Only eligible and registered patients with have access to reserve appointments, thereby to provide the best and satisfactory service by improving the following:-

- The establishment of a paperless environment and to link referral hospitals services and regional level,
- Scheduling of the medical activities and services within the healthcare centre,
- Optimizes utilization of medical resources at the referral hospital,
- Increase efficiency of medical care outcome,
- Reduction of burden on staff needing to memorize provider preferences and relying on manual paper based processes,
- Increase patient satisfaction and medical staff morale.
- Makes it easier for scheduling appointments within the hospital by the help of health care provider.

4.2 Functionality

- On-line booking and reservation of Appointments,
- Pop up explanations when putting the mouse on a certain function,
- Access is permitted to authorized staffs of the respective functions,
- Statistical data generation pertaining to invariable parameters,
- Report generating, updating and notifications to customer online or via mobile applications.

4.3 Functions of the System

4.3.1 Patient

DRAS allows patients at regional hospital to browse specialty services schedule, available tools, equipments, expected diagnosis services and time slot. In order to supply direct appointments with internet, this features offer a convenience practice which can avoid time consuming in waiting line of the clinic. The patient will clearly know their occupied time and assurance of getting services according to the booking arranged. For the first time to log into the system, patients have to register to access appointment bookings. The registered username and password will allow booking process in simple steps as follows: - The patients to log in by using User ID and Password then to view the account having profile of medical history, name, address, age, sex, blood group and record of diagnose processes and treatment. If the Patient does not appear in the hospital on the date of booked appointment, the system would automatically cancel the record of the appointment.

4.3.2 Medical Staff (Doctor & nurse) Function

Medical staff will be able to see calendars, to see cases of patients expected and to view appointments stored into the database. The doctor can use patients' names and ID to retrieve personal data and medical history through DRAS integrated to hospital information system. During treatment progress, the doctor can view and update patient information into the database, such as patient diagnosis and medicines. If the patients are needed

injections, the updated records will transfer to the nurse for preparation and finally the system will calculate the total amount of expenses due to services and print out the reports for patient.

4.3.3 Administrator's Function

The system provides different privileges level of access rights. The administrator can control and make changes to user's privileges rights. In addition, the administrator has the right to change any scheduled appointment, medical staff calendar and other resources information.

The system provides many reports for medical staff libraries and administrators to manage and coordinating referral and general hospital operations; such as Medical history report, medicines report and patient reports. DRAS allows administrators to perform backup of information about the system to the external storage tool. If users wants to change username and password or have forgotten will contact administrator simply by sending text. If provided information is matched; administrator will reset password and allows patient to sign new username and password.

4.3.4 Administrative clerk Function

This is one of the actors to the system deals with managing records of the patients and general profile. This is the one who contact the system administrator about changes of patient information happened.

4.4 Functional requirements of the system

4.4.1 Functional requirements

Analysis and design of the IS Framework for Digitized Referral Appointment system (DRAS) has the following Business processes as adopted and modified from Yadav, (2010) as follows:-

- Schedule patients' appointment,
- File insurance claims,
- Send statements to patients accounts,
- Recall patients for repeating of procedures,
- Display various reports, views and mailings.

4.4.2 Non functional requirements

A non-functional requirement describes how the system should be implemented. It specifies criteria that can be used to judge the operation of a system, rather than specific behaviors. Functional requirements supported by non-functional requirements to impose constraints on designing and implementing performance requirements, security, reliability and efficiency. In external requirements the following constraints are considered; legal, economic privacy and integration. In the process requirements we are considering delivery and implementation requirements. Basically non-functional requirements focused on the system to be (System shall be) (Formore details of inputs and descriptions for each process category see table1).

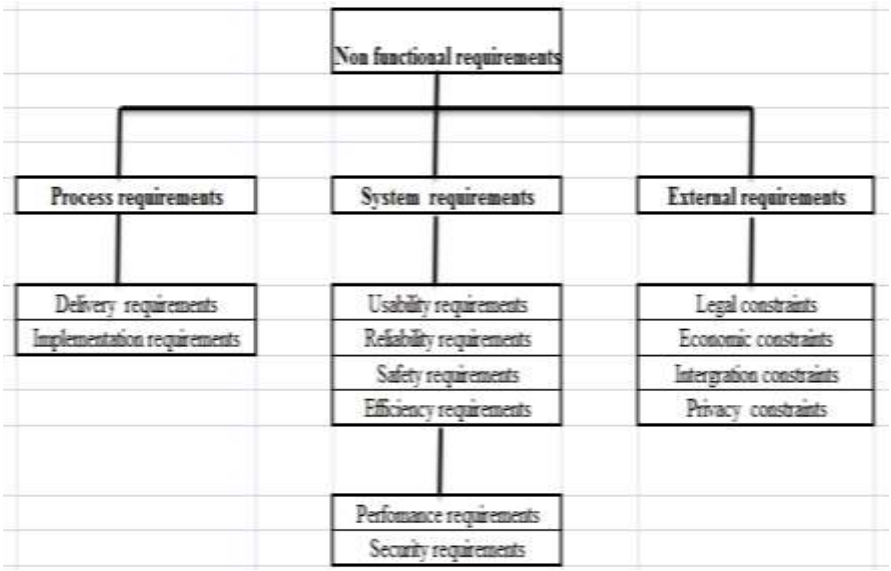


Figure 5: Non functional requirements: **Source:** Yadav, (2010) ''System Analysis and Design''

Table 1: Non functional requirements

Process	Process category	Inputs and descriptions
Delivery requirements	Process requirements	Introduction Section, System Requirements, System Design Section and conclusion
Designing implementation	Process requirements	Use of UML Language for analysis and designing of system framework.
Usability	System requirements	DRAS will be created in a way that it will make it easy for users to operate and learn it. The system will include:- Informative error messages Well-formed consistent graphical user interfaces and page layout Clear and consistent navigation.
Reliability requirements	System requirements	DRAS shall have an availability of 99%. This means that out of every 100 requests for service 99 must be satisfied. When server connection fails, connectivity will be within 1 minute from its detected failure (under normal system load). If connection is not restored, connection will be from a remote backup server.
Safety/Security	System requirements	The access permissions for system will only be changed by the system administrator. Each actor will have usernames and passwords, actor specific roles, and actor specific permissions. The system data will be backed up every 24 hours and the backup copies stored in a remote saver.

Efficiency	System requirements	DRAS will make the operations of the clinic more efficient by computerizing referral services that have been performed manually. Users will have quick access to information. Users will be notified at every step
Performance	System requirements	DRAS should process multiple processes per minimum time and with minimal loss to performance.
Legal constraints	External requirements	DRAS will be Health Insurance Portability and Legal Accountability.
Integration requirement	External requirements	DRAS will interact and exchange information with the payment authorization system.

5. Process analysis (PA)

5.1 Data Flow Diagrams (DFD)

A data flow diagram (DFDs) includes the major data and material flows and transformation processes that occur within the DRAS after being modeled. A DFD provides no information about the timing of processes or whether processes will operate sequential or parallel. The DFD for this deliverable provides a physical model to show the implementation-dependent data and material stores required in the referral appointment system. The context diagram shows how patients by the help of medical staffs will access systems to make appointment of accessing referral specialty services at consultancy hospital level (For more details refer figure 8)

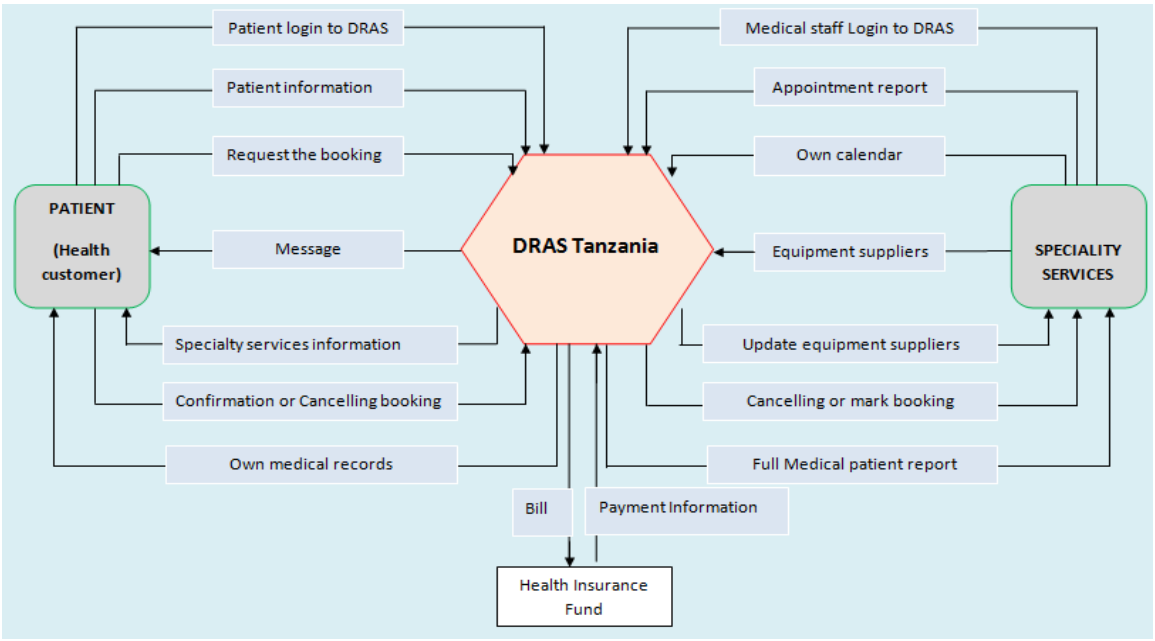


Figure 6: Context DFD

5.2 Level 0 Contexts DFD

The context-level data flow diagram shows the interaction between the system and external agents which act as

data sources and data sinks but on the level 0 context diagram the system's interacts with the outside world and modeled purely in terms of data flows across the system boundary. The context diagram shows the entire system of DRAS as a single process and gives no clues as to its internal organization. Process 1 are the first process of the patient to register on the system; here patient starts to access booking appointment processes (The booking process information stored at D1). Process 2 are about to fill required treatment history from patient profile, because DRAS and HIS are integrated, the information will be retrieved from the D2 by the authority on administrative clerks. Process 3 are for payments handled the help of accounts clerks (the information is stored at D3 (for the patients to pay before, will reduce payment and registration process by the day of arriving at the hospital). Process 4 is for generating reports of all processes like financial, billing, appointment and profile information (For details of Level 0 Contexts DFD see figure 7 and for process explanations see the table 2).

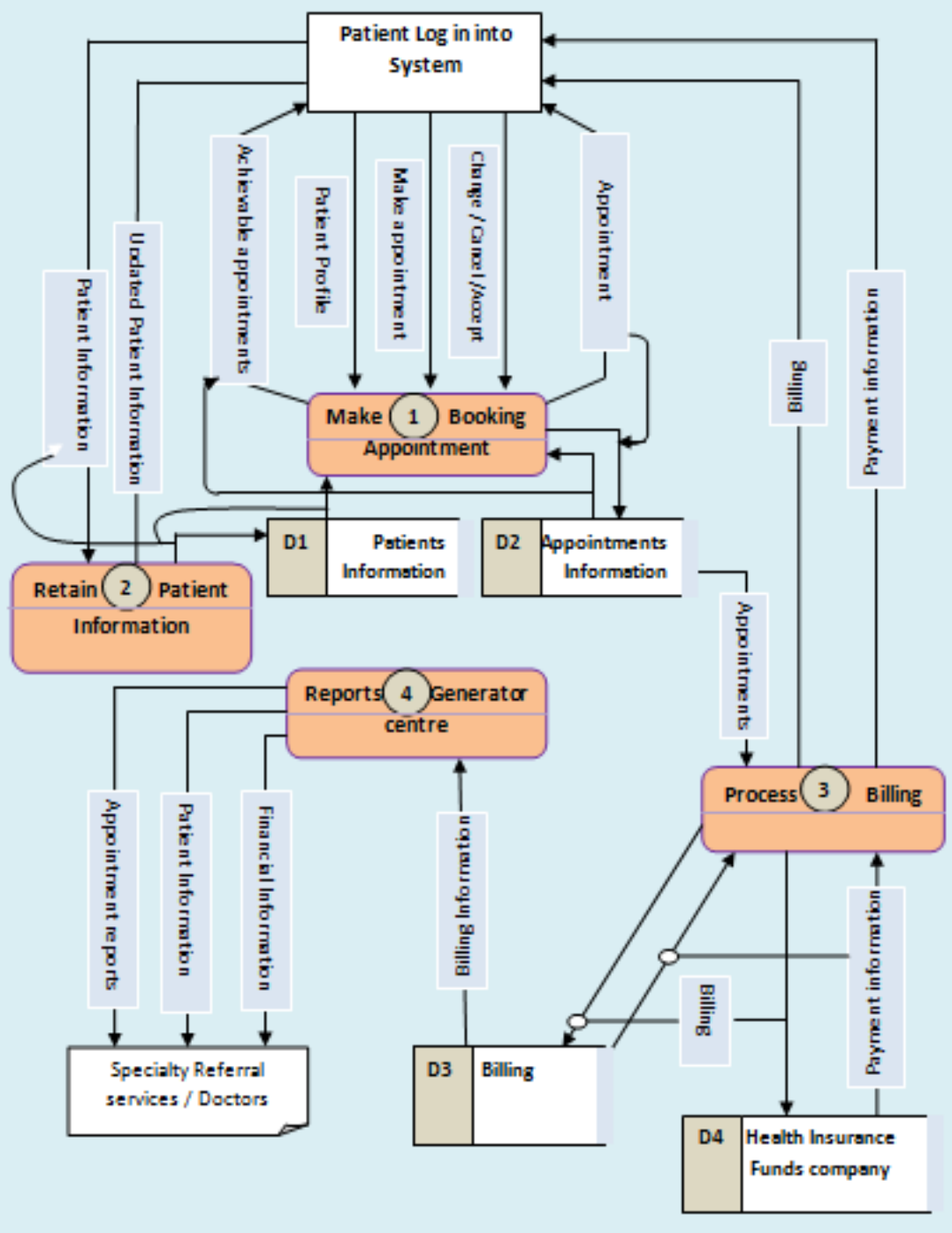


Figure 7**:** Level 0 Context DFD

5.3 Business processes for Level 0 Context DFD

Table 2: Business processes for Level 0 Context DFD

	PROCESS	NAME OF THE PROCESS	EXPLANATIONS
	1	Make Booking Appointment	A patient is able to view page having menu directing booking instructions and conditions
	2	Retain Patient Information	Administrative Clerk is responsible to keep records of patients like history and accounts managing.
	3	Process Billing	This module deals with process payments verifications from Cell phone Financial transaction and Health Insurance companies
	4	Report Generator center	This module deals with generating all reports regarding making appointments from the first step to last step. These reports including Financial information, Patient information and appointments.
	DATABASE	**NAME OF THE PROCESS**	**MAJOR ACTIVITIES**
	D1	Patients Information	It stores all Patients Information
	D2	Appointments Information	It stores all information like matured, pending and succeeded appointments
	D3	Billing	It stores all billing information from all payments and verifications
	D4	Health Insurance Funds company	It stores all payment information from Health insurance companies

5.4 Level 1 Context DFD

At level 1, Main processes of Level 0 are broken into sub processes of process 1. Sub processes involved here are to retrieve patient information about the patient profile, patients gets profile status, gets appointment types ofcentral system of DRAS, patient to choose appointments types or cancel the process and last sub process is to confirm scheduled appointment after receiving notification of choice and calendar where sub processes are represented by 1.1–1.5 while D1 and D2 are databases to store patient and appointments information (For more details about each sub processes explanations see figure 8 and table 2).

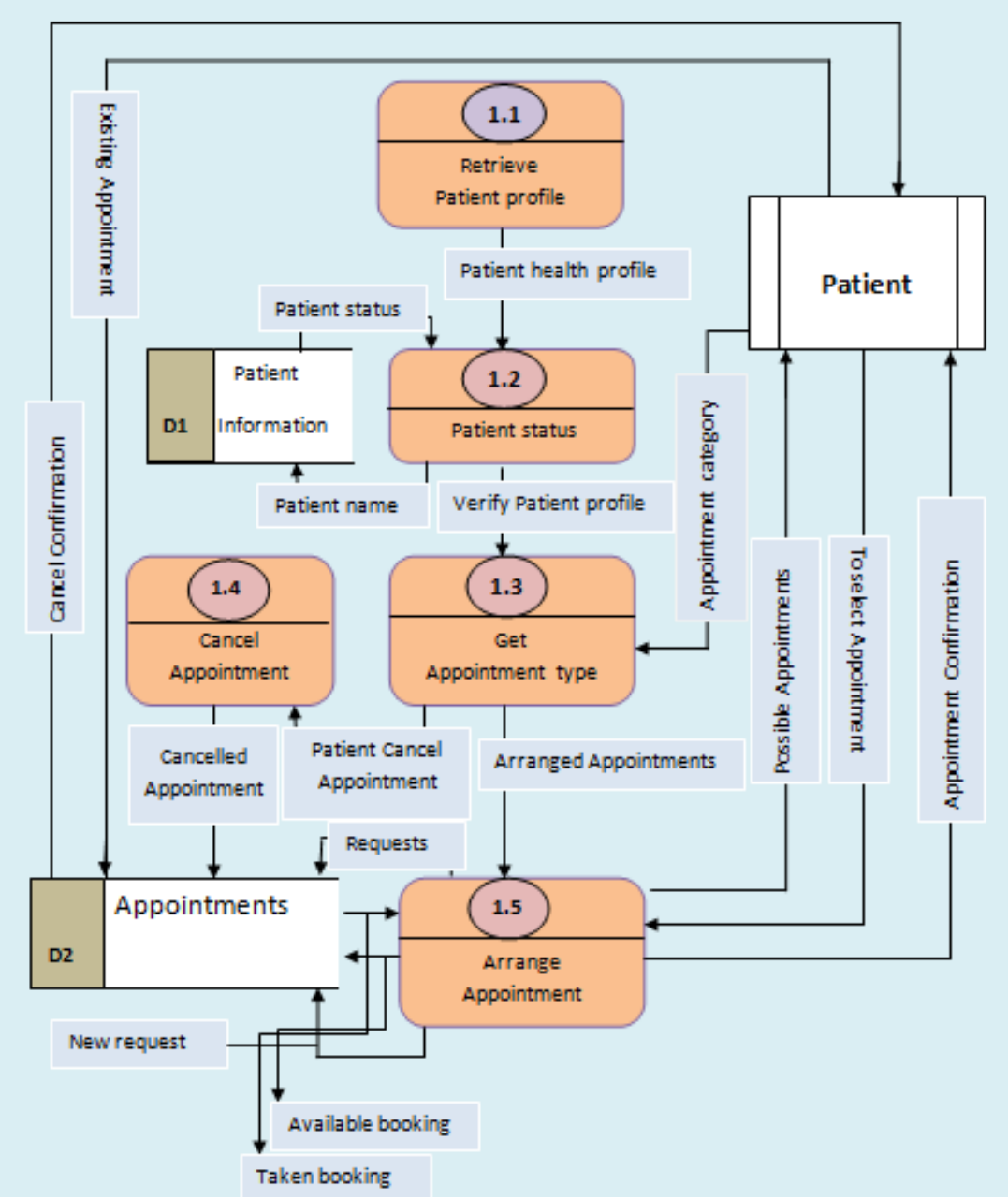


Figure 8: Level 1 Context DFD

5.5 Business processes for Level 1 Context DFD

	PROCESS	NAME OF THE PROCESS	EXPLANATIONS
	1.1	Retrieve Patient profile	A patient is able to view his accounts to log in for accessing making appointment.
	1.2	Patient status	A patient is able to view his current health status and history.
	1.3	Get Appointment type	At this module, Patient can choose appointment type if is single or multiple or consultation of diagnosis services.
	1.4	Cancel Appointment	If the patients has fails to confirm appointment within valid time, the system will cancel and assigns for new applications.
	1.5	Arrange Appointment	This module deals with scheduling appointments as selected by the patient to respected calendar.
	DATABASE	NAME OF THE PROCESS	MAJOR ACTIVITIES
	D1	Patient Information	It stores all Patients Information
	D2	Appointments Information	It stores all information like, pending and succeeded appointments

Table 3: Business processes for Level 1 Context DFD

5.6 Integrating processes from context DFD

This is the step of explaining integrated processes of context DFD

5.6.1 Business Process 1

At process 1, the following functions are done: - patient to register to the system, to make an appointment, to cancel or to change the appointment, to access appointment status and to access patient profile (The updated information is stored to database1.1) (refer the figure 9).

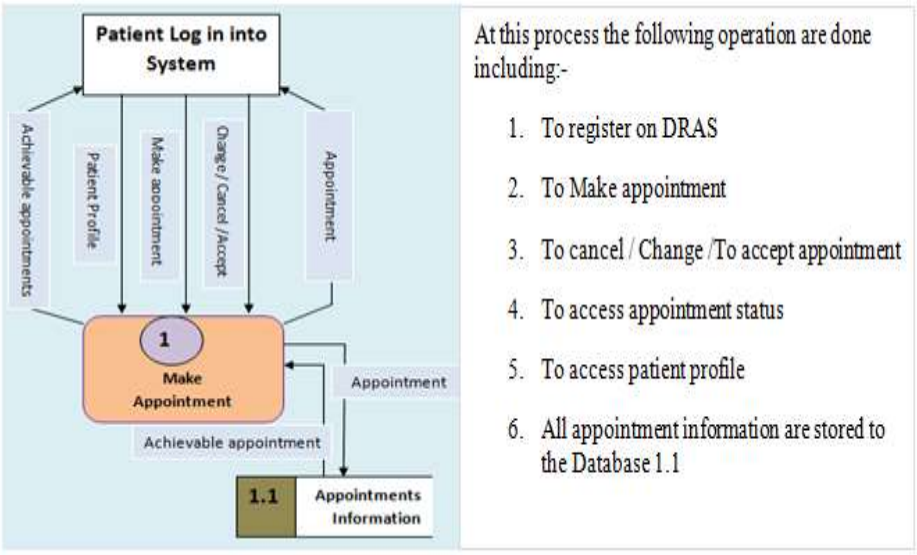


Figure 9: Make Appointment

5.6.2 Business Process 2

At process 2, the following functions are done: - To process patient information, updating patient information and to storing in database 2.1 (refer the figure 10).

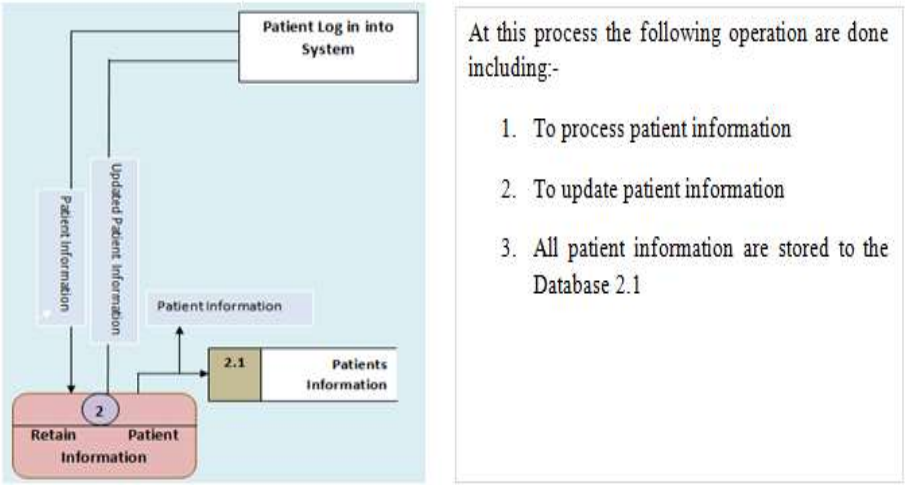
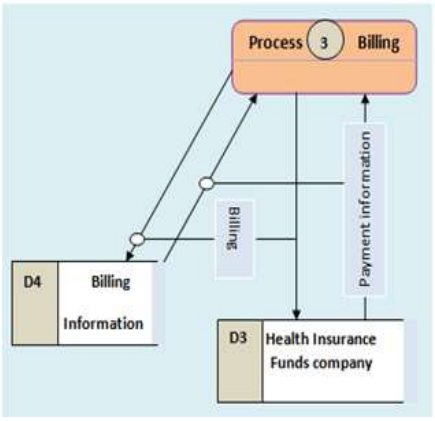


Figure 10: Retain Patient Information

5.6.3 Business Process 3

At process 3, the following functions are done: - to enable the patient to pay cash before travelling and arriving calendar (will be required to pay by M-PESA and transaction ID will be entered to the system for verification of transaction, the same process will be for banking depositing). For a patient who uses NHIF will be required to fill ID; this process is done after patient to confirm scheduled appointment and the updated billing information is stored to database 4 (Refer the figure 11).



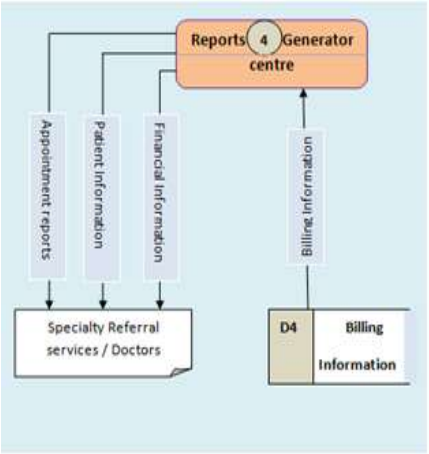
At this process the following operation are done including:-

1. To enable patient to pay making appointment fee electronically simply by entering M-PESA transaction ID to central system. This process is done after a patient to confirm scheduled appointment
2. This model linked to NHIF company database (D3) for the patient who have this service
3. All this information are stored to the Database 4

Figure 11: Process Billing and payments process

5.6.4 Business Process 4

At process 4, the following functions are done: - Generating payment financial reports, patient profile reports and patient appointment reports and to store to database 3 and 4 (refer the figure 12).



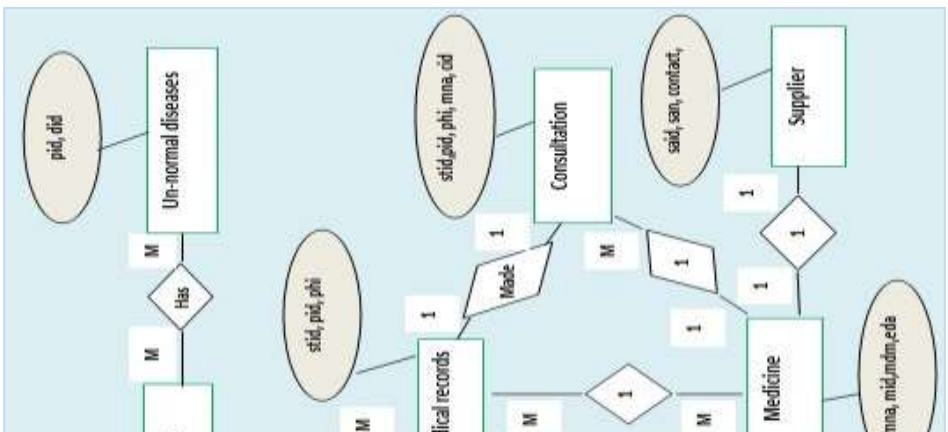
At this process the following operation are done including:-

1. To generate payments financial report
2. To generate patient information report
3. To generate patient appointment reports
4. To generate financial information associated with NHIF or CHF
5. All this information are stored to the Database D4

Figure 12: Report Generator centre

6. E-Relation diagram (ERD)

An entity-relationship diagram is the data modeling technique that creates a graphical representation of the entities and the relationships in a database within a DRAS. ERD often uses symbols to represent three different types of information; boxes are commonly used to represent entities, diamonds are normally used to represent relationships and ovals are used to represent attributes. According to DRAS framework designing; entities include appointments, patient, un-normal diseases, specialty services, medical records, calendar, resources, medicines, consultations and supplier (for more details about entities, attributes and relationships see the figure 13).



ppr = patient profile **did** = disease id **fuln** = full name **Rid** = resources id	**pid**= patient id **sid**= staff id **cal** = calendar **rcat** = resources category	**phi** = patient history **mde** = medicine expiring date **mdm** = medicine manufacturer date **cid** = consultation id	**mid** = medicine id **mname**=medicine name **apid** = Appointment id **sna** = supplier name	**ssid** = speciality services id **hol** = holiday **type** = calendar type **said** = supplier id

Figure 13: ERD Schema

7. Use Case Diagram (UCD)

Class diagrams in the Unified Modeling Language (UML) is a type of static structure diagrams that describes the structure of a system by showing the system's classes, attributes, operations and the relationships among objects. CD simplifying how objects in a DRAS interact with each other, hence Using CD it is easier to describe all the classes, packages, and interfaces that constitutes a system and how these components are interrelated. From context diagrams, patients, doctors, administrative clerk, payment authorizer and system administrator will be able to access the system but in different privileges (figure 14 and 15).

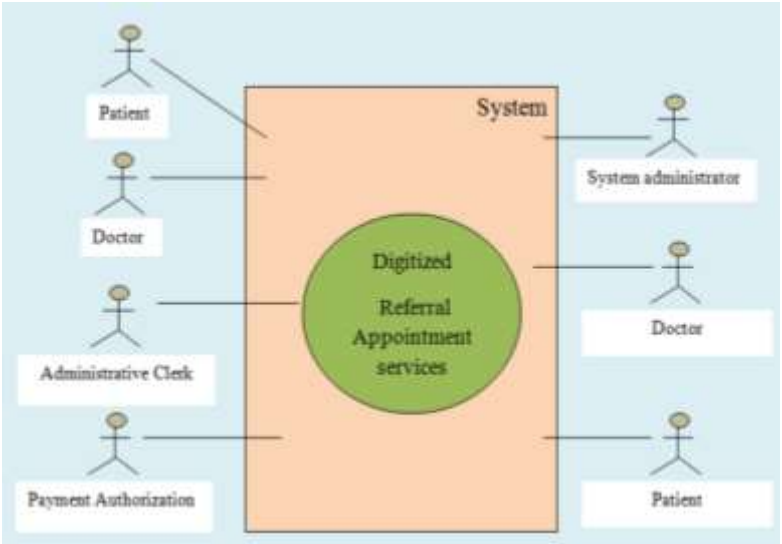


Figure 14: Use case context diagram

7.1 Level 0 Use case diagram

From context diagram level 0 diagram; patients are able to choose appointment types and to view information profile, Insurance company clerk is able to perform billing under NHIF or CHF members, M-PESA coordinator will be able to verify transaction ID, Medical staff (Doctor) is able to view patient information and treatments, administrative clerk is able to manage (patient information, handle insurance claim and bill) while System administrator is able to manage all databases of the system, users privileges and maintaining the system (figure 15).

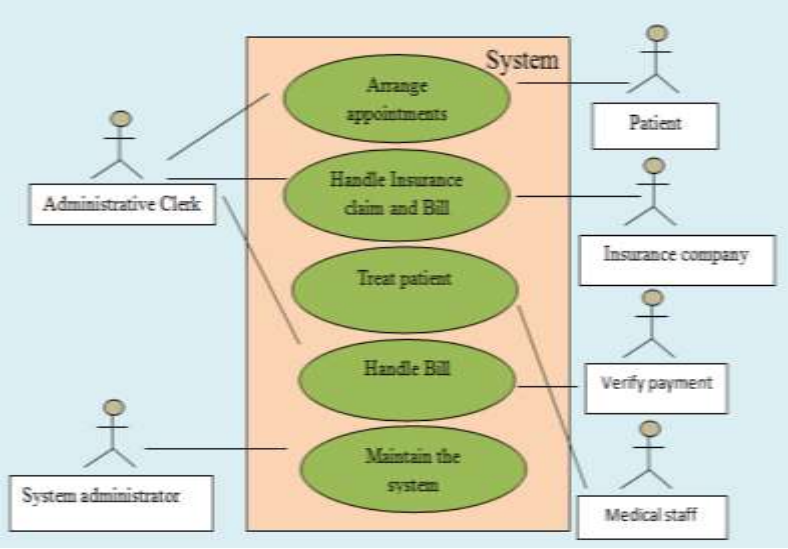


Figure 15: Level 0 Use case diagram

7.2 Level 1 Use case diagram

From context diagram level 1 diagram; patients are able to set new appointment, cancel appointment and re-book appointments while administrative clerks is able to manage patient appointments information on each step (figure 16).

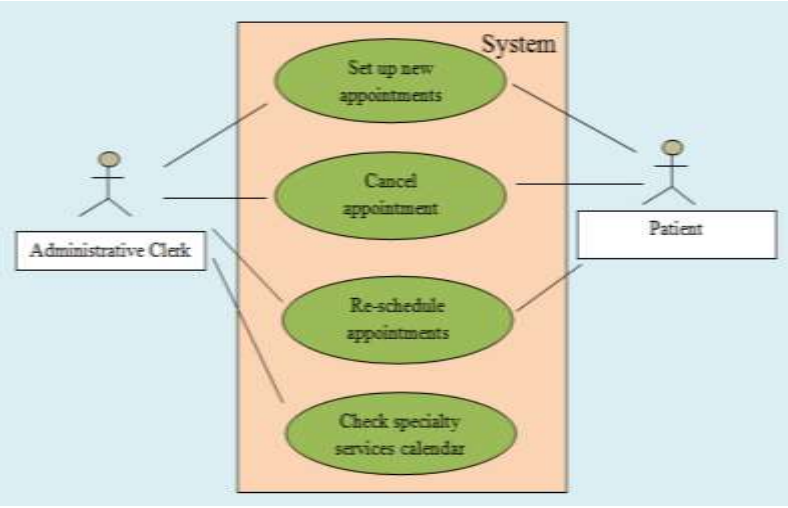


Figure 16: Arrange appointments

7.3 Level 2 Use case diagram

From context diagram level 2 diagram; insurance clerks is able to process NHIF or NHF payments and other payments, hackers has no chance to access payments information while administrative clerks is able to manage file insurance claims, track insurance claims and to process insurance (figure 17).

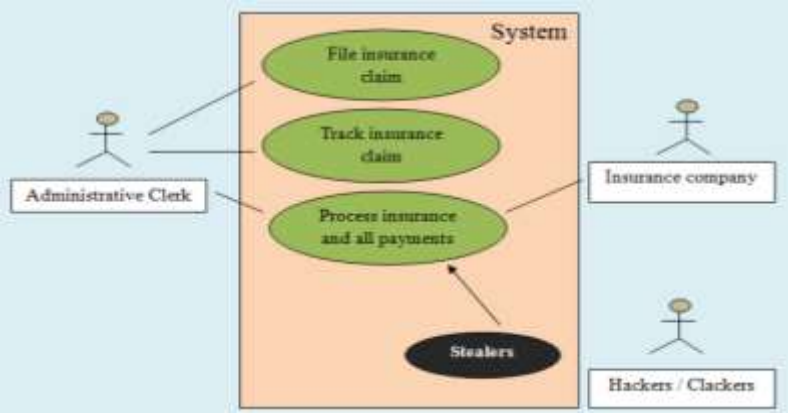


Figure 17: To handle insurance claim

7.4 Level 3: Use case diagram

From context diagram level 3 diagrams; the patient is able to view his or her information profile, system administrator is able to view, to add, to delete updating and to manage all information. Medical staff is able to view patient profile and to add new treatment information while administrative is able to manage all patient information (figure 18).

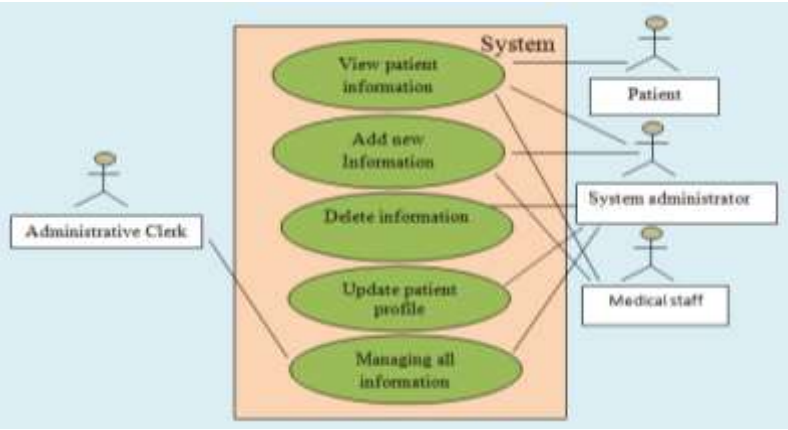


Figure 18: To treat patient

7.5 Level 4: Use case diagram

From context diagram level 4 diagrams; administrative clerks is able to manage to send a bill to patient profile, re-send and tracking bill (figure 19).

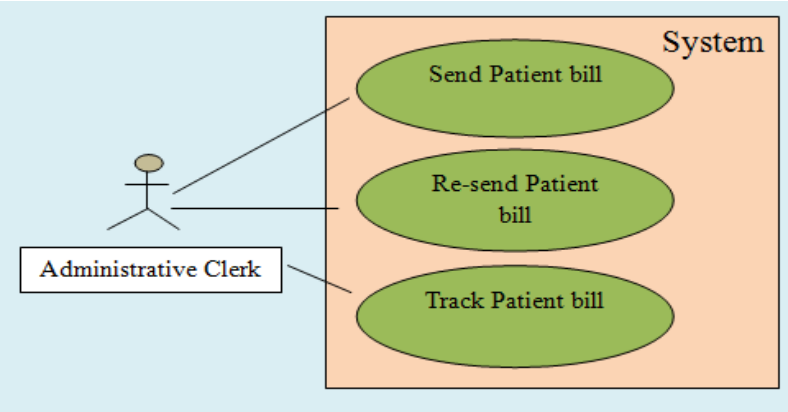


Figure 19: To handle Bill and Payments

7.6 Level 5: Use case diagram

From context diagram level 5 diagrams; System administrator is able to add new function of the system, delete functions, hanging the functions, managing security issues, customizing and maintaining the system (figure 20).

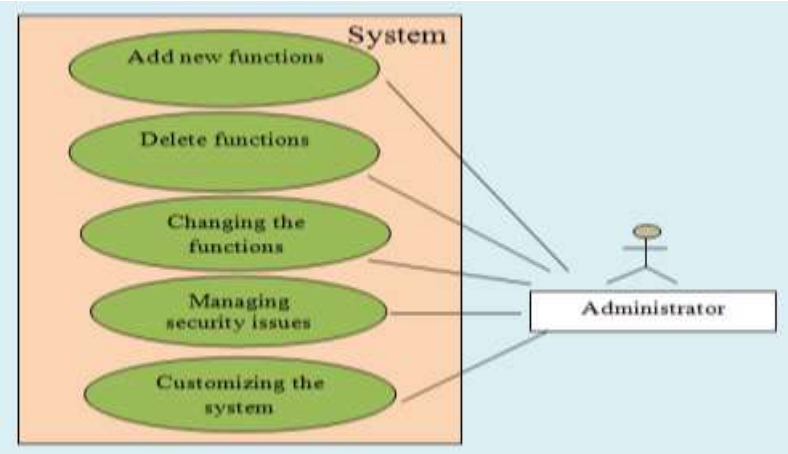


Figure 20: Maintain the system

8. Sequence Diagram (SD)

A Sequence diagram is an interaction shows processes operations arranged by focusing the behaviors within the system (It is arranged in time and in particular scenario of use cases). Proposed DRAS will allow patients to log in into the system and accessing booking applications by sending booking requests (can return to index page to access other functions or to restart the booking process). The system will send notifications of the patients and waits for confirmations via DRAS or Mail or Cell phone, by confirming the system will allocate the patient to the calendar permanently. If happen the patient to cancel the allocated appointment, the system will delete the allocated appointment and wait for new applicant (figure 21).

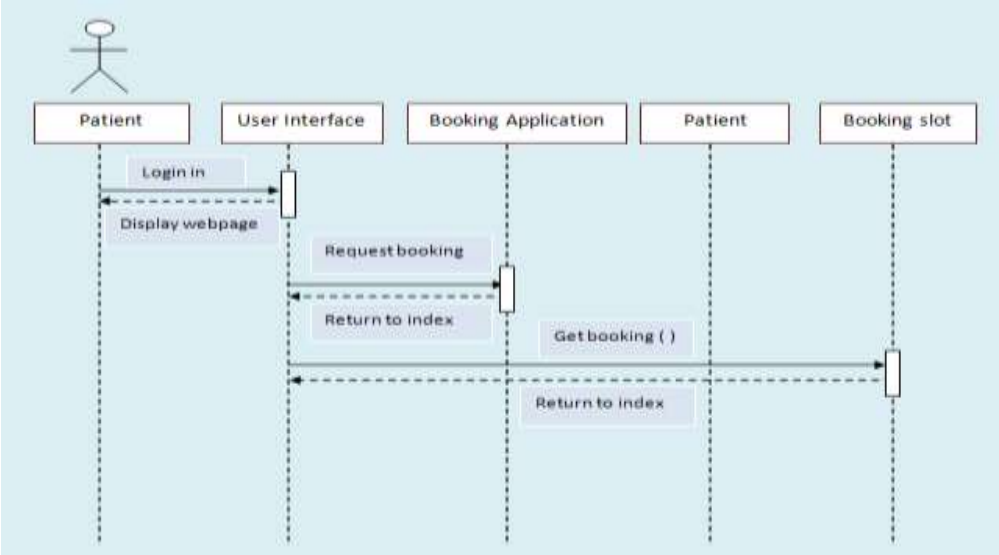


Figure 21: The sequence diagram scenarios

9. Exposure for proposed booking approach of DRAS

Booking approaches' for appointments is the one of the important managerial tasks performed in the hospital. A long time ago, people went to a hospital expecting to wait as long as an hour or more while doctors experienced to see more people in a full waiting room as normal situations. People they were just waiting even without assurance of being consulted. Booking appointment is one phase and managing those patients who came for services due to their appointment is second phase. The whole process to schedule appointment is done manually and automated way. A computer cannot understand current condition of the patients but can be triggered under conditions. The objective of booking appointment is to provide assurance to patients in access services before traveling which is done by so-called appointment scheduling rules (ASRs). Good techniques are that is able to optimize doctors idle time and patient waiting time [8] and hence improving hospital operations and healthcare facilities [9].

9.1 Double booking (DB)

With the DB method two or more patients are given particular appointment time slot [8]. DB has the challenges of causing complain about patients arrived on time [10]. DB utilizes resources better and always there are ready patient to get services but also it has the following weakness; needs more resources, enough examination rooms, small number of patients per day for short waiting time and it creates long waiting time for late patients.

9.2 Open booking (OB)

Takes a certain interval of time like 8:00am – 10:00am; this is free appointment by which are provided by interval of hours. The algorithm to follow here is FCFS for normal patients and if happens seriously patient to come FCRS will be used.

- This results frustration of patients waiting time if more patients arrived within one time.
- It needs small number of patients per day.

9.3 A Pure block systems (PBS)

This technique manages appointments at the start of a clinic session hour for all patients to be seen during the session [11] by allocating date rather than exact appointment time. The algorithm to be used here is FCFS based on patient's arrival order [11]. Although this processes it has the number of challenges if many patients arrived

on time fort the beginning of clinic sessions, patient will have to wait without knowing at what time they are going to get services, although they will have assurance of being treated within a the day [12]

9.4 Singe block system (SBS)

Assign all patients to arrive in a block at the beginning of the clinic session, allocating a date rather than an exact appointment time; this result long waiting times for some late patients and increases unnecessary cost [13] but it shorten idle time for the medical staff [14]. The researcher has identified that the root of referral services problems is improper appointment systems at hospitals [8]

9.5 Wave scheduling (WS)

It is the methods used in hospitals having several and enough examination rooms and medical staff. It takes three – four patients to be seen at every half of the hour and two or three to be seen at the second half by the algorithm of FCFS and if happens all to come on timing the seriously patient will be seen first and the rest will wait less to 20 minutes which is the standard [8]. This method needs people who are coordinating to prioritize patients' condition on waiting room.

9.6 Modified wave scheduling (MWS)

Modified Wave Scheduling (MWS) is methods by which patient appointments overlap so that when one patient is late, the next patient will get advantage to be served [15]. Patient appointments are clustered to create heavier volume of the beginning of the hour and beginning of each clinical session. The clusters are numbers of patients grouped together if having the same problems of easiest way of serving them faster than patients with mixed problems. This algorithm is like double booking but it works such that if the first patient is served few minutes than allocated time then the remaining time will be the starting time of second patients [4]. For this case doctor idle time is removed more numbers of patients are served within appointed days. This approach results medical staff to be bored by attending the similar cases and huge load of patients grouped into clusters.

9.7 Intelligent Agency Rule (IAR)

It is based on centralized intelligent agents for making appointment of negotiating and collaborating with the agents of doctors who process appointment time for the patient under all necessary considerations like patient condition. All the requests are received to central staff desks that prioritizes to request; it causes long waiting chains in approving appointments, delay in notifications to patients on scheduled calendar and also creates great burden to appointment scheduling coordinators [9].

9.8 Modified Open Booking (MOB)

This is adopted from open booking as used at Muhimbili National Hospital (MNH) where electronic HIS is used to manage hospital operation and appointments for the second visit patients. 10 patient's new cases are scheduled to come at 8:00am to be served up to 11:00am and 20 patients of return cases to come from 11:30am up to 16:00pm regardless the condition. The one who will come first will be seen first (FCFS), but if happen seriously patient to arrive will be given highest priority. This scheduling creates complaining among patients assigned to come at one time and creates long waiting time for late patients.

10. Proposed appointment approach for DRAS

As we have seen several types of booking scheduling methods according to circumstances around the world. Tanzania we have several challenges as summarized as follows: - inadequate referral hospitals, specialists' doctors, normal Medical doctors, equipment, communications infrastructure such as roads and improved Information system to facilitate referral appointment services.

Proposed booking method for DRAS is a combination of wave scheduling (WS) and intelligent rule (IR) to get HCH algorithm (H = Hot cases, C= Cold cases and H= Half of an hour) by which Hot cases are seen at the first half of every hour and the rest Cold cases to be seen at the second half of an hour. This is modified from Wave scheduling; the problems of this are not considering the cases of the patients while in IR we are considering cases by involving human central system to manage patient's conditions and decision making. This central system coordinator receives booking requests and channeling them to respected system element by considering the cases triggered. By using HCH algorithm, will balance stress to doctors and other medical staff in attending two or three tough cases first and easily two or three cases at the second half of an hour. If happen each one to arrive separately FCFS queuing algorithm will take place; and if two or three patients arrived on time seriously patient will be taken first and even if all arrived on time waiting time will be less to 20 minutes which is not boring at all.

The proposed DRAS is able to manage accuracy of information, security, reminding, and availability of services, information accessibility and flexibility of data processing (for details refer figure 22).

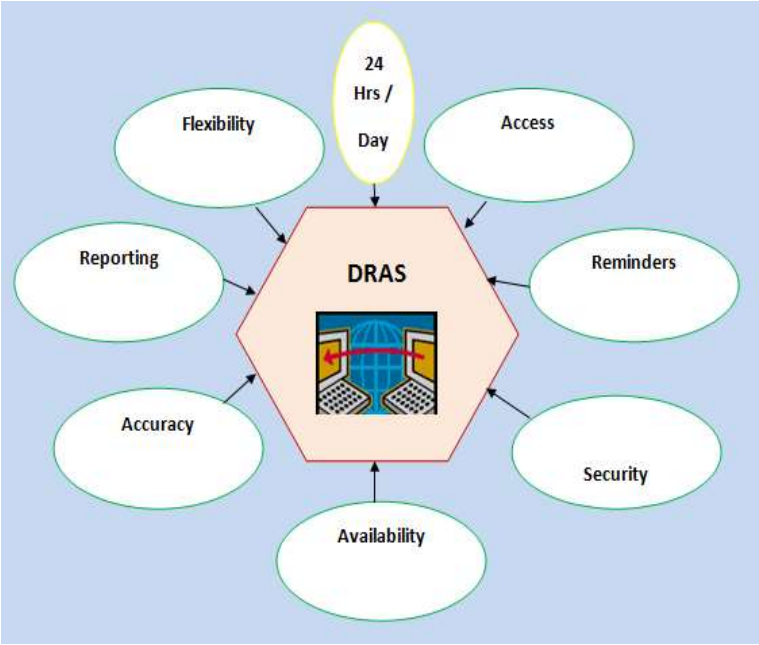


Figure 22: The functions of proposed DRAS

11. Security and integration measures

The Information systems are very important in every community life and development including in health sector [16]. The security of those systems must be taking into consideration during designing and developing. Confidentiality of patients data is very important because may cause problems to patients [16]. The health information is used to different hospitals, different management and different purpose to save life of the people. To disseminate health information on different environments and different functions depends on system integration framework.

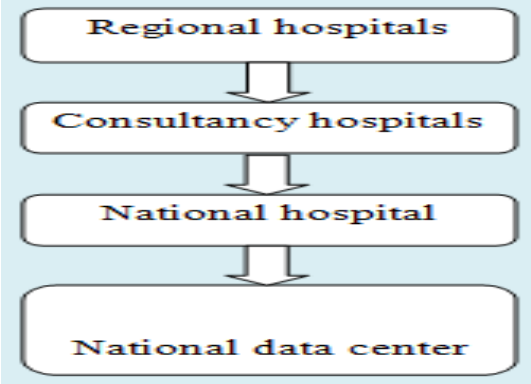


Figure 23: Health Information System and integration framework

The term Health information integration (HII) is the practice of joining or combining the functions of a set of health information subsystem (HIS) which comprising of hardware and software to support the requirement of health industry [17]. The purpose of linking isolated computers environments are to make them easy to use and sharing of health information [18]. When we want to manage referral appointment bookings; we need to disseminate and integrating information to deferent environment including regional level hospitals, consultancy level hospitals and National level hospital. Hence; when we want take security measures, we should consider information levels and environment of health profile in Tanzania. The booking appointment to access referral services might pass into security measures for privacy of information which needs to be integrated. The processes to be taken are as indicated to figure 22 bellow:-

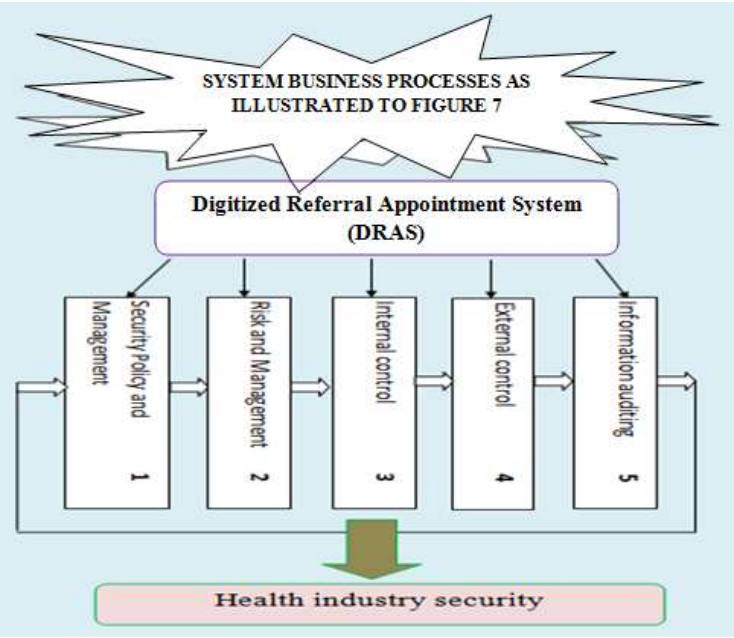


Figure 22: security and integration measures of referral appointment system

Security Policy and Management - 1

In Tanzania the policy to secure information in proposed DRAS should specify the following:-

- To guide users privileges and their functions to use the system,
- Legal power for misusing of appointment Information systems,
- Punishment for the theft of information.

Risk and Management - 2

In information systems risks may occur to the following circumstances; theft of information, misuse of information, system damaging, theft of equipment and infrastructure as a whole. Decisions should be taken farther in risk control using four key principles:-

1. *Accept:* The analyst health information should be aware of possibilities of risk to occur.
2. *Avoid:* After accepting, the next step is finding the way of avoiding those risks.
3. *Transfer:* Is to transfer those risks to the top management for needful decision making.
4. *Reduce:* If the risks are unavoidable then the management should find the way of reducing it.

Internal control - 3

If it is within hospital, the system must be protected from the extent to which there is convergence of such systems which leads to sharing of information. For users of such systems must be protected against laying log-in pages as a barrier to enter into the system except you permitted. Internal controls also are responsible to avoid problems of information flow within hospital department communication.

External control - 4

When there information used within hospital and to other hospitals, protection must be taken so much because you have a huge theft to be a broad field. Website governing systems must be developed well to guard smashes accordingly. The router switch connecting hospitals to facilitate booking appointment must be kept fully prevented from theft and damagers of the system. All security measure will be taken to resist online theft to trace financial matters. Coded security session should be very strong such that unauthorized people cannot break it.

Information auditing - 5

The process of analyzing and evaluating Information system is very important stage by which it helps to detect challenges, leakage of information and blockage rectification. By analyzing performance of information flow will help to improve accuracy, security and decision making.

Conclusion

The health services in Tanzania are very important sectors which are seen as a development mirror for everything. All classes of people in development or status of life depends on health. The quality of services to public referral hospitals is measured by waiting time for registration, consultation, diagnosis services and inconveniences caused by bad time management and improper communication Technology between hospital and hospital to link health information for quality healthcare delivery of referral services. The proposed designing of IS framework for DRAS in this paper present an innovative solution in resolving the challenges for patients to access referral services in Tanzania.

12. Recommendations

The future work for researchers to address is to deal with advanced details of information system integration and security internally and externally. Second issues to be recommended are how Information system policy will be planned and put into implementation to build sustainable referral appointment system in Tanzania.

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