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KareXpert

"Healthcare Software Maintenance in a Medium-sized Healthcare IT organization through Analysis of Tickets Severity"

By

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PG/20/031

Under the guidance of

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Internship in the department of

Product Service Delivery

and has successfully completed her Project on

"Healthcare Software Maintenance in a Medium-sized Healthcare IT organization through Analysis of Tickets Severity"

From

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We wish her all the best for future endeavours.

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We wish her all success in all her future endeavors.

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CERTIFICATE OF APPROVAL

The following dissertation titled **"Healthcare Software Maintenance in a Medium size Healthcare IT organization through Analysis of Tickets Severity**" at **"KareXpert"** is hereby approved as a certified study in management carried out and presented in a manner satisfactorily to warrant its acceptance as a prerequisite for the award of **PGDM (Hospital & Health Management)** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed, or conclusion drawn therein but approve the dissertation only for the purpose it is submitted.

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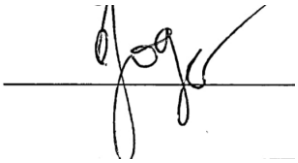
Dr. S.B. Gogia	
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FEEDBACK FORM

Name of the Student: Dr. Mansi

Name of the Organisation in Which Dissertation Has Been Completed: KareXpert

Area of Dissertation: Product Service Delivery & Operations

Attendance: 100%

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Suggestions for Improvement: -

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Full form
ADT	Admission, Discharge and Transfer
AI	Artificial Intelligence
B2B	Business to Business
CDSS	Clinical Decision Support System
CPOE	Computerized Provider Order Entry
CR	Change Request
DICOM	Digital Imaging and Communications in Medicine
DTR	Desired time to Release
EHR	Electronic Health Record
EMR	Electronic Medical Record
ER	Emergency Response
FR	First Response
HIMS	Hospital Information Management System
HIS	Hospital Information System
IP	Inpatient
IS	Information System
IT	Information Technology
LIMS	Laboratory Information Management System
MAR	Medicinal Administration Request
MIS	Management Information System
OP	Outpatient
PACS	Picture Archiving Communication System
QA	Quality Assurance
RIS	Radiology Information System
RPM	Remote patient Monitoring
RT	Resolution Time
SaaS	Software as a Service
SCM	Supply chain Management
TAT	Turn-around Time

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ORGANIZATIONAL PROFILE

KAREXPERT

Headquarters- Gurugram

Founded in 2018

Founder- Nidhi Jain

Key Investors- Reliance Industries

Business model- B2B

Target Market: Hospitals, Clinic Chains, Pharmacy Chains, Diagnostic Chains, Government Hospitals

Client Segment: HealthTech / MedTech / Healthcare, SaaS, Software, Technology

Target Companies: Small Enterprise, Medium Enterprise, Large Enterprise, Start-ups

Target Geography: India, Global, Asia Pacific, Europe

India's public healthcare system is too overburdened due to a lack of resources and inadequate application of modern technology. However, health tech solutions like telemedicine, health record digitisation and AI for predictive analysis/diagnosis may soon improve this scenario.

Observing that legacy solutions led to inefficiencies, a dip in service quality and revenue loss, Gurugram-based KareXpert was launched in 2018 to provide timely tech support for service enhancement and business growth. KareXpert is India's first SaaS-based integrated digital healthcare platform. It is a Jio Platform-funded venture to connect 100,000 hospitals in the next five years. The company offers end-to-end digital empowerment to hospitals and healthcare providers through its comprehensive range of AI-enabled, cloud-based, and mobile-ready solutions that are designed for coordinated patient care, optimizing operational costs, and increasing revenue.

It is a commercial concept in which hospitals pay a monthly fixed cost. The solution includes a Cloud Gateway that allows medical equipment (Lab, Radiology, and so on) and IoT devices to connect directly to the platform. KareXpert platform has its customers ranging from Nursing Homes to Large Corporate chains with 100+ medical facilities which are live or under implementation.

The platform-based approach comes with pre-integrated and ready-to-service full-stack solutions. It offers Advanced HIMS, EMR/EHR, LIMS, RIS/PACS, pharmacy, connected ambulance, e-Claim & insurance, inventory & SCM, queue management, MIS Reports, business intelligence, and hospital branded mobile apps. The KareXpert SaaS platform helps hospitals to streamline patient data flow across geographies and devices. It also helps them achieve a higher degree of collaboration between all stakeholders in the healthcare system.

KareXpert's modern and distinguishably designed services, keeps patient care and efficiency at the centre of its operations. Besides offering a user-friendly interface and 24/7 customer support, its cloud-based solution is often remotely deployed across India compared to on premise/traditional solutions. Moreover, KareXpert showcases online demos of its services with minimal travel the client's locations, due to its SaaS based cloud first/mobile first platform. This comes in handy during the continued COVID 19 situation, where social distancing is that the need of the hour. because the company eliminates the necessity for hospitals to depend on existing IT infrastructure, KareXpert's industry business model has become very idealized, with well-known companies like KPMG, AWS, Google, and Microsoft collaborating and supporting their cause.

Hospital Information Management System

Hospital Information Management System (HIMS) is a piece of software that manages all aspects of a hospital's workflow, including medical, financial, legal, administrative, and healthcare performance. It also scans all paper records and converts them to digital format.

A hospital information management system (HIMS) is a collection of applications for managing healthcare data. It serves as a centralized database that collects and stores all information about patients, doctors, and employees. As a result, healthcare providers can provide a speedy diagnosis by accessing a patient's health information at any time. It also comprises data-handling systems for hospital operational management and healthcare policy decisions.

Contents of HIMS

Practice Management System

The practice management system is intended to assist healthcare staff with the centre's everyday operations. This covers scheduling and billing, as well as inventory management and other services. It can be used by anyone, from small practitioners to multi-centre institutions, to automate numerous administrative processes.

Patient Portal

The patient portal is a platform that allows patients to access their health information.

They can also use the app to schedule appointments with their doctors. It also allows consumers to receive lab results via the portal and maintain active connections with their healthcare providers and pharmacists.

Clinical Decision Support System (CDSS)

CDSS assists with the analysis of data from a variety of clinical and administrative systems. It aids clinicians in making well-informed clinical decisions. These details are used to help in diagnosis and to forecast medical occurrences such as drug interactions.

Remote Patient Monitoring (RPM)

RPM devices collect data from patients and provide it to healthcare specialists who aren't available in that location. It can track blood sugar levels, blood pressure, and medical occurrences like heart attacks. It can be extremely beneficial for patients who are unable to receive face-to-face medical care but are suffering from a chronic illness.

Along with the basic modules KareXpert platform contains the following features:

EMR/EHR

- **Patient Profile** is to Monitor, track and upload patients' medical records, diagnostic reports, prescriptions, etc.
- **E-Prescription** is used to send E-prescriptions to patients and keep a record of the whole treatment process.
- **Diagnostic Reports** for instant access to diagnostic reports along with doctor notes to all the stakeholders.

- **Progress Reports** to get a visual representation of the progress made by the patient throughout the treatment with custom notifications configured for any abnormality.
- **MRD-Medical Record Department** is used to keep trail of your physical files of old records along with new digital medical records of the patient and make sure nothing goes missing.
- **MAR-Medicinal Administration Request** maintains the MAR worklist, medication administration, enable order list for Drug intent and manage frequency & Time mapping.
- **Medicinal Order** is used to prescribe only those medicines which are in stock with an inbuilt intuitive drop-down suggestion. It also sends auto-updates to the pharmacy for quicker turnaround time.
- **Clinical Order** comes with predefined templates to help you quickly set up any procedural orders or testing orders.
- **Specialty Focus** provides customized templates as per specialty empower the hospital staff to quickly process the patient data.

OPD Management

- **Patient Portal-**It is a self-service portal for everything that a patient wants.
- **Alert Manager** is to keep the patients informed about their health status.
- **Queue Management** for managing all online & walk-in appointments, Manage queues, TV displays, and token systems.

IPD Management

- **ADT Admission, Discharge, and Transfer** for IP admissions, transfers, bed management, and discharge management.
- **OT Management** has Interactive dashboards, OT worklist & transfer list, surgery scheduler, and manage approvals.
- **Cath Lab Management to** Manage Cath-lab schedule, worklist, transfers, etc.
- **Clearance Status**-Keeps track of the clearance status of the patient.
- **Diet Management** is used to create, manage, and share the diet plan of the inpatient with the hospital mess department. It also contains Dietician schedules, diet plan creators, and pre-build diet templates

Billing Management

- **IP & ER Billing to** get paid faster and more by managing IP Billing, planned discharge, clearance status, refund, and cashier operations efficiently.
- **OP Billing** to manage orders, diagnostic, PHC, consultations bills, settle dues, refund, and manage the collection.
- **Accounts Receivable (TPA)-** Manage all accounts receivable in one place. Management of pay-outs, settlements, and accounts receivable. Send due alerts.
- **Online Payment** accepts online and offline payments via Credit Cards, Net Banking, Wallets, and EMI cards.
- **Doctor Pay-out** is used to set up doctor profiles, configure services, post bills and manage final payments.

Operations Management

- **Facility Management** -Manages single or multiple hospital facilities, setup billing, manages departments, doctor schedules, etc. in a few clicks.
- **Housekeeping**- Manage day-to-day housekeeping activities at the hospital.
- **CSSD**-Maintain CSSD inventory, indent request/issue/acknowledge, and view stock.

Patient Feedback Management

- Feedback Management to continuously monitor, measure, and improve the service quality with department-wise patient feedback, ticketing board, and dashboards.

Doctor Portal

- Doctor's Profile allows the doctor to register, edit profile page, availability, view patient records manage appointments, search, sort, find the nearest Hospital, make e-prescription, and provide teleconsultations via video, audio, or chat.

LIMS and RIS

- supports all kinds of labs gives full visibility of sample journey from sample collection to acknowledgment to dispatch.
- Sends sample reports to the patients and auto verification alerts to the doctors
- Books patient appointments against different machines. Make patient data available at modality to eliminate dual data entry

- Track lab occupancy with scan in/out of the patient
- Easy DICOM image processing -Lets the patient, doctor, and other stakeholders get access to digital scans on web/mobile apps

Pharmacy

- Gives instant access to e-prescriptions and auto-filling of orders right from the prescriptions
- Manages returns and acknowledges return orders.
- Maintains the requisition order for medicine, supplies, etc.
- Centrally track full or partially issued orders.

Revenue Tracking & Reporting

- With the detailed and integrated billing module, we can track payments & settlements without any errors.
- Gives us the detailed business reports track with real-time reporting and gain insights into business operations

Inventory Management

- Gives the dynamic view of available stock ensures effortless inventory planning
- Real-Time Alerts & Notifications for various inventory and supply chain events

Emergency Response System

Gives full visibility on ambulance operations like:

- Sterilization Process checklists to ensure the proper sterilization of all the vehicles and equipment before and after the ride
- Ambulance Dispatch System to Request, Approve, Assign and centrally manage a fleet of ambulances and have full visibility of available ambulance for dispatch.
- Checklist Management to create and manage the checklist of action items that need to be followed by the paramedic/ER staff. [26]
- Start & Stop a Ride-Manage vehicle availability and track Turn-Around-Time (TAT) from the start-to-stop ride
- Monitor Patient Vital Health using integrated medical IoT devices, ER doctors at the hospital can monitor patient vitals like blood pressure, ECG report, temperature, etc. as soon as the patient is onboarded to an ambulance
- Doctor Tele-consultation enables ER doctor teleconsultation while inpatient is in transit.

PROJECT REPORT

1. INTRODUCTION

The tremendous technological growth has led to the application of software systems in our daily lives. Software Product management is a discipline and a business process that manages the process from product inception to delivery. Its lifecycle consists of two phases- pre-delivery stage and post-delivery stage. [(1)] Software Product is evaluated on its technical and functional aspects.

Software product development is a stage before delivery and is largely based on its technical aspects. Software product life cycle includes several steps: requirements planning, analysis, specifications, design, implementation, testing, delivery and deployment, operations and maintenance. Once development is complete, the software product will be available to the customer and will continue to change over time, regardless of application domain, size or complexity. [(2)]

Post-delivery quality aspects of software include the product standards, in addition to the service standards provided to the customer. To provide high-quality check for products, non-functional requirements along with functional requirements must be considered by service providers. Software maintenance is a crucial post-delivery endeavour which plays a vital part for client gratification. [(1)] It is a part of software product development life cycle and modifies a functional product that was previously delivered to a client, with the aim to amend errors, enhance performance or conform to the environment and thereby increasing the acceptance rate of the system for its users and other people affected by its use.

The healthcare industry is highly dynamic, it integrates technology into processes to improve patient's efficiency and quality of life. In some cases, the healthcare system must meet the required standards as it is subject to regulatory guidelines and other health compliance requirements. Primarily, in healthcare, medication prescribing, and ordering was a paper-based process and was prone to medical inaccuracy and adverse effects. CPOE with CDSS enhances patient safety and are examples of information systems that enable healthcare organizations to enhance clinical processes, control costs, and respond to the need for excellent care. [3]

To provide high quality products and services, service providers need to pay attention to both the technical and functional aspects of their products. Therefore, it is very important to prioritize software services and its related aspects. In the current scenario, IT services are managed by the ticket system. Ticketing is the process accustomed to managing service delivery. Ticket reporting and resolution is also a key aspect of software maintenance in healthcare IT organizations. [1] Tickets help track and coordinate software maintenance efforts. The tickets are raw, unprocessed data that have an enormous amount of information. it's critical to proceed with the research on incident related tickets since analysis of tickets is critical in deriving the patterns related to it.

The current study proposes to understand and identify issues related to software maintenance through ticketing process in XX organization (name anonymized based on organization's request)

2. RATIONALE

Ticket management is an ongoing process as it has the same impact on product quality as it does on customer satisfaction which can further contribute for improving quality of service provided by the organization. It is also important for the long-term profitability of service providers. XX organization has a service level agreement of less than 24 hours for closing the tickets which was not observed. Hence, this study is based on analysing the existing turn-around time for the tickets raised and identify the reasons for deviation from service level agreements.

3. RESEARCH QUESTIONS

The following research questions would be addressed in this study:

Q1- How frequently issues are raised by the customer in various modules of XX Digital Platform?

Q2- What is the severity of the issues raised?

Q3- What is the turn-around time to close the tickets?

Q4- What are the causes for the deviation from the service level agreements?

Based on the above Research questions, the following objectives are proposed for the study.

4. OBJECTIVE

To identify the deviations of the existing turnaround time of the tickets raised in XX Digital Healthcare Platform from standard turnaround time and reasons thereof.

Specific Objectives

(1) To analyse the severity and frequency of the issues (tickets) raised by customer in various modules of XX Digital Platform

(2) To analyse the time taken to close the tickets in the existing software maintenance process in the organization.

(3) To perform root cause analysis of the turnaround time of the tickets.

(4) Based on the above to recommend steps that can be taken for closing the tickets within the standard time mentioned in the organization policy.

5. METHODOLOGY

- Study Design: Observational
- Study Setting- KareXpert Hospital Information System
- Study Duration- 01/02/2022 to 30/04/2022
- Data Type: Primary Data – tickets raised, type, frequency, created date and time, date of closure
- Data collection Tool- Primary Data -Customer Ticketing Tool (containing reports of tickets raised); Interaction with technical team
- Databases Searched: Google Scholar; Scopus; PubMed, etc

- Search strings utilized were combinations of terms: Healthcare, IT, software, tickets, severity, software quality, maintenance, CDSS, CPOE, ticket analytics
- Ethical Consideration: No identification data like name of the facility(client) was collected.

6. REVIEW OF LITERATURE

Software Maintenance modifies the product that was previously provided to the customer for error correction, performance or specific feature improvement or its adoption to the modified environment.

[1] P. Bhatt et.al (2004) in their study Dynamics of software maintenance mentioned the issue of outsourcing IT services as there will be an increased number of software's that will be moved for maintenance in future. They also provided an approach for predicting the effort and time it takes to perform maintenance activities. In addition, dynamic attributes related to maintenance activity are specified. In addition, the importance of early estimation of the cost, effort, and time of maintenance activities can be associated with increased efficiency, improved budgets, and improved staff allocation. (4)

[2] In the book "Software Engineering" by Sommerville (2010), it was emphasized that the operational success of various organizations is directly related to the proper functioning of the system. This can be an activity that consumes, most of the organization's efforts and resources, up to 80% of the total budget, according to their study. (5)

[3] Jingyue Li, Tor Stalhane, Jan M.W. Kristiansen, Reidar Conradi (2010) conducted an empirical study in two companies to find the cost drivers of software corrective

maintenance. In this study, they had analysed activities and effort of correcting 810 software defects in one Norwegian software company and 577 software defects in another. They compared the defect profiles according to the defect correction effort. The study showed that size and complexity of the software to be maintained, maintainers' experience, and tool and process support are the most influential cost drivers of corrective maintenance in one company, while domain knowledge is one of the main cost drivers of corrective maintenance in the other company. (6)

[4] N. Lalband and D. Kavitha (2019) stated that implementing a healthcare system is a complex process. If we do not focus on the systematic software development process, it will increase the error in the implementation and lose quality, cost and trust. In their survey, a brief discussion about different software development lifecycle models used in the software industry was given. Authors stated that during healthcare software development, various issues such as reliability, security, performance, and availability should be considered. From the comparison of various software development cycles, it was evident that agile method is best suited for the development of smart healthcare systems. (7)

[5] Sara H. Foster et. al. (2014) in their study Cost-Effectiveness of a Computerized Provider Order Entry System in Improving Medication Safety Ambulatory Care (8) said that introduction of CPOE in the outpatient setting of medium-sized group practice is cost-effective strategy to provide excellent cost-effectiveness and improve drug safety. They also said that the same results apply to practices with few providers implementing basic electronic prescription systems. The study suggests that the adoption of CPOE in the ambulatory setting provides excellent value for the investment, and is a cost-effective strategy to improve medication safety over a wide range of practice sizes. (8)

[6] From the study done by E. Kathini and J. G. Kiongo (2020) on Utilization Levels of Computerized Physician Order Entry (CPOE) By Health Care Workers in Mbagathi District Hospital Nairobi, Kenya, it was evident that to use the CPOE, one need not to be a medical professional as the study was done on health-care workers, which make up the majority. The objective of this study was to assess Utilization levels of CPOE by health care workers in Mbagathi District Hospital. The study concluded that offering training to the staff, staff trained regularly, staff equipped with adequate and necessary skills are key impetus to service delivery. The majority of physicians believed CPOE would lead to a reduction of medical errors and more efficient patient care. However, physicians were highly concerned with how CPOE would affect their own work efficiency as most of them still use manual system due to lack of knowledge of computer use as 75% of physicians were not trained to use CPOE while 81% were using paper prescription. [(9)]

[7] According to the study done by G. Narayana Samy et. al. (2010) on Security threats categories in healthcare information systems, storage of health information in electronic format can raise concerns about patient's health, safety and privacy. Health management information systems (HMIS) are threatened by both accidental and intentional events which can impact the reliability of healthcare information systems and may influence its future use. Researchers identified two basic approaches to handling human errors as a security threat. First is avoidance, for example, by improving the system interface, providing better security policies and procedures, and providing better training. The second is to build in tolerance. This approach focuses more on the design of systems, so that they are fault tolerant with respect to human errors and minimise the effects of human errors as security threats. Therefore, this study has proven useful in identifying

critical threats to HIS and could be significant for information security officers or policy makers in designing and implementing effective security systems and policies. (10)

[8] A view of 21st century healthcare industry and software quality improvement practices by Tien D. Nguyen*, Hong Guo and Raouf N.G. Naguib (2011) stated that software vendors in the healthcare industry were given highest level of accountability as healthcare information system defects will not only result in financial loss but could also cause serious consequences to human lives. The impact and future development of software within the healthcare field was discussed. At the same time, it identified the current state, challenges and solution of software quality improvement and assurance practices for this domain. Results of the study showed that around half of the respondents indicating that both the technical and management activities, ranging from problem resolution to project management, were regarded as key to help them develop and maintain a high-quality software system. While 'software design' practice received the most votes with 69%, 'process assessment' and 'process establishment' got the least attention with 17% and 21%, respectively. (11)

[9] Lopez and Salmeron in their study Monitoring Software Maintenance Project Risks

stated that software maintenance plays an important role due to the ever-changing requirements and high variability of the software environment. They stated that Software maintenance projects are developed for fixing bugs, improving performance or other attributes or adapting them within a changing environment.

In this line, they bring together several software maintenance classifications. The one most used recognizes three categories:

• Corrective maintenance category. Activities to correct software design failures, software code failures and implementation failure. These corrections are needed because applications would not otherwise perform adequately.

• Adaptive maintenance category. Activities to apply adaptation to the new environment states and user requirements.

• Perfective maintenance category. Activities to enhance performance, cost effectiveness, efficiency and maintainability. The practitioners thereby try to improve the initial application.

These categories do not cover all the activities to maintain software. New categories have been thus added to previous classifications:

• Preventive maintenance category- Activities to anticipate and discover potential problems. With this mind, cyclical inspections are carried out. These tasks reduce the risk of serious bugs and the consequences are minimized.

• User support category- Activities to respond to the users' requests and their continuous training needs. These tasks help the users' community because they reduce the software user's aversion risk and program misuse.

However, they stated that success in software maintenance projects is not guaranteed. Failures in software maintenance have played a role in many high-profile disasters. The author argues that the optimization model proposed to derive the maintenance plan leads to the minimization of the actual maintenance cost while the reliability and risk are within the tolerance. Even if this method is not used in a real project, the numerical example shows that the total maintenance cost is the lowest at when the risk reaches the threshold value. [12]

[10] In the study Mean Average Distance to Resolver: An Evaluation Metric for Ticket Routing in Expert Network by Jianglei Han, Aixin Sun (2017), they stated that customers' problems and change request are processed as tickets. In a large company, each ticket is assigned to a support engineer for processing. Han and Sun focus on large organizations and mainly how the ticket can be routed inside the company. The authors present two metrics: MSTR (Mean Steps to Resolver) and RR (Resolution Rate) and propose another one called MADR (Mean Average Distance to Resolver). This work shows a routing system supported by an expert group. (13)

[11] Customer issues and change requests are treated as tickets as said by Tao Zhang et.al. (2016). Ticket states can be broadly grouped into the following major phases (14): *Ticket understanding* where it is summarised, filtered as duplicate, and assigned value for attributes such as priority and severity. *Ticket assignment*, generally, a developer is responsible for servicing of the ticket. The reassignment degrades the quality of tickets. (15) *Ticket Fix*: Appropriate action to fix the issue is taken. These interactions are usually recorded as comments. Code changes may be required to fix some issues.

[12] Ta-Hsin Li, Rong Liu, Noi Sukaviriya, Ying Li, Jeaha Yang, Michael Sandin, and Juhnyoung Lee (2014) in their study--Incident Ticket Analytics for IT Application Management Services stated that Analysing incident tickets becomes a critical task in managing the operations of the service in order to keep the operations within the agreed upon service level agreement. Ticket analytics is essential to identify anomalies and trends, as well as detect unusual patterns in the operations; such analysis is hard to do manually especially for large accounts with complex organization and scopes. This paper was focused on ticket analytics and some key statistical techniques applied in the analyses.

They also talked about ticket backlogs which are typically calculated as the cumulative sum over time for the number of tickets opened in a period of time minus the number of tickets closed in that period of time. In this case, they should be interpreted as the accumulation over time of tickets to be closed rather than the accumulation of tickets waiting to be resolved. As such, they are affected by the business practice of closing a resolved ticket. Therefore, ticket backlogs should be monitored at a frequency which is compatible with the business practice. For example, if tickets are closed immediately after resolution, the time elapsed between opening and closing tends to be short (e.g., in hours). In this case, backlog. calculation should be done in a short time interval (e.g., daily). On the other hand, if it takes days or weeks to close a ticket for certain type of requests, then a weekly or monthly frequency should be sufficient. Ticket resolution times often contain outliers that can easily obscure the calculated mean resolution time. Therefore, more robust metrics, such as the median, should be considered as a possible alternative to the mean for monitoring the resolution time. The variability of ticket resolution time can vary dramatically across different ticket categories. This complicates the cross-category comparison, because the mean resolution time is no longer as meaningful as it is when the variability remains the same for all categories. In such cases, other metrics, such as the relative effect score, may be considered as possible alternatives. [(16)]

[13] Improving bug triage with bug tossing graphs, a study by Gaeul Jeong et. al. (2009) stated that the assignment of bug reports is still primarily a manual process. Often bugs are assigned incorrectly to a developer or need to be discussed among several developers before the developer responsible for the fix is identified. These situations typically lead to bug tossing, i.e., a bug report being reassigned from one developer to another. In this study, 445,000 bug reports and their detailed activities from the projects were analysed.

Results showed that it takes a long time to assign and toss bugs. In addition, some bugs have a long tossing length, which means they are passed among many developers before the bug is actually fixed. To improve the bug assignment process and reduce unnecessary tossing steps, we proposed a tossing graph model, which captures past tossing history. In their experiments, the model reduces tossing steps by up to 72% and improved the accuracy of automatic bug assignment by up to 23 percentage points. The proposed tossing graph model can be easily integrated into existing bug tracking systems. For example, when bugs are assigned to a developer, the integration can recommend additional developers based on previous tossing history. This is helpful, especially when the first-choice person to fix a bug is not available (e.g., because of vacation or other commitments). Another scenario is to assign bugs not to single developers but rather to a group of developers. Here an initial developer would be identified first and their integration would add the remaining related developers. [(22)]

[14] Erario et. al (2019) stated that customer knowledge management also plays a vital role in producing high quality software. It includes the acquisition, storage, sharing and application of knowledge from customers. The results of this process are business and operational performance, competitive advantage, innovation, and product quality. In this highly competitive business world, putting customer satisfaction first is critical. The sooner the ticket raised by the customer is closed successfully, the higher is their satisfaction, so it is very important to close the ticket with optimal time, effort, and cost. [(17, 18)]

According to the authors [(17)], in all organizations, the development team does the software maintenance themselves. Not all organizations have a dedicated team for maintenance activities, but they do not rule out the possibility of having such a team and under service-level agreements, this possibility may exist.

7. RESULT & DISCUSSION

(I) Analysis of Severity and Frequency of The Issues (Tickets) Raised by Customer in Various Modules of XX Digital Platform

A total of 739 tickets were raised in the period of three months (1 Feb- 30 April) by the customer using the ticketing tool. The tickets can be divided into four severity levels [19]:

Severity Level 1 – Tickets which fall in this category have critical impact and the customer is unable to either use the software or continue work using the software. In such cases, the service provider needs to work on the resolution within one hour of notification. According to the analysis, only 3% of total tickets raised fall into the severity category, out of which 66.7% of the tickets, fall into severity level 1, and were raised in modules namely Appointment, Emergency, EMR/EHR, Feedback Management, MIS reports, OP Billing, OT Management. (Figure 1)

Severity Level 2 – There is a lag in some critical functions of the software and there is no viable alternative. While other areas of the software were not affected, the claimed defect had an adverse effect on customer's performance and the service provider needs to work on the resolution within two hours of notification. Figure 1 shows that around 20% of the tickets were of severity level 2 and belong to EMR/EHR, IP and OP billing.

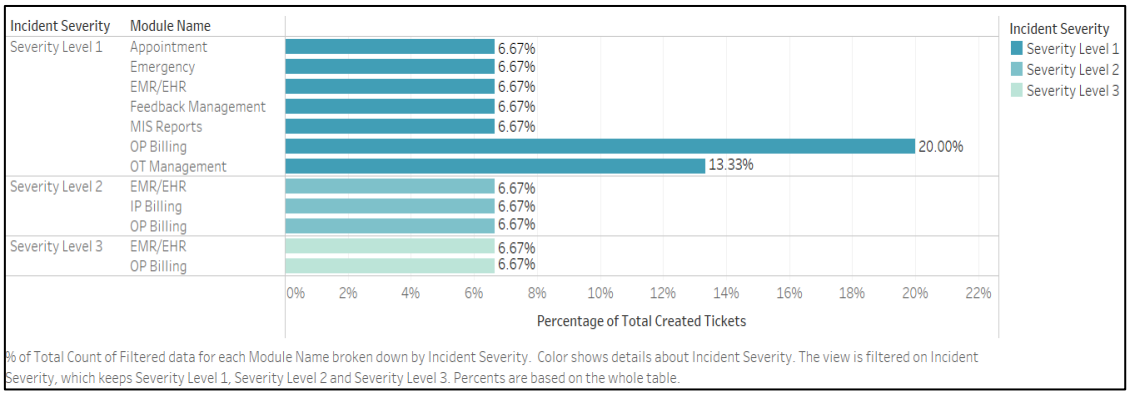

Figure 1- Percentage of total tickets created for each module broken down by severity

Severity Level 3 – Customer may not be able to use critical features of the software but can use non-essential features of the software if an alternative solution is available or not and minimize the loss of operational functions and implementation resources. Then, corrective action is initiated within one working day of notice and provide an acceptable resolution. Around 13% of the tickets which fall in the severity, which are from EHR/EMR and OP Billing module, lie in this category.

Severity Level 4 – Customers submit requests for software information, software enhancements, documentation clarification that do not affect operation. Implementation or use of the software will continue and an initial request for response is provided within 2 business days.

Priority, as the name suggests, prioritizes defects in accordance to their business requirements and the severity of the defects. Priority indicates the urgency of fixing the defect. When an issue reported is opened, it is prioritized by the testers from an end user's perspective. So, there are general levels of priority as described below [20]:

Priority 1 (Urgent) – In this case, the functionality of the software may be blocked, and testing cannot be performed. This has to fixed within 1 day.

Priority 2 (High) – In this, a feature is not available to use as it is required, due to program defect or updated code that has been written or sometimes even because of some environmental problems through the code. This issue must be fixed before the release is made. Severity level 2 defects generally fall in this category.

Priority 3 (Medium) – Functionality issues are dealt with in this case but not in accordance to the expected result. Sometimes even cosmetic errors such as expecting

the right error message during the failure could qualify to be in this category. Defects should be fixed after all major issues are fixed.

Priority 4 (Low) – Under this, mostly defects are reported to suggest some improvements to an existing design or to request a small attribute to improve the end-user experience. These defects may be fixed in future and do not require immediate attention. Priority determines how long; it takes to fix an issue.

We have analysed the created tickets based on their priority (Figure 2), there were 166 (22.5%) tickets for urgent priority, 178 (24.1%) belonging to high, 42 (5.7%) for medium and 353 (47.8%) tickets were for low priority.

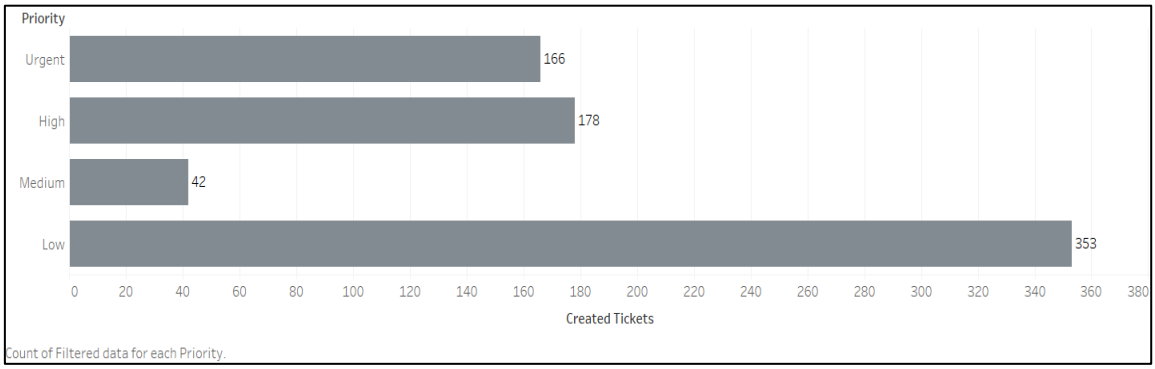

Figure 2 – Number of tickets raised for each priority

In addition to this, it was observed that majority (20.56% of total created tickets) were in the EMR/EHR module and 48.68% of which were of low priority. OP billing and IP Billing module comprised of 9.6% and 6.22% of the total tickets created on the customer ticketing tool respectively. Figure 3 shows the analysis of created tickets for each priority and module name. There were 64(8.66%) of the tickets, which do not belong to any module.

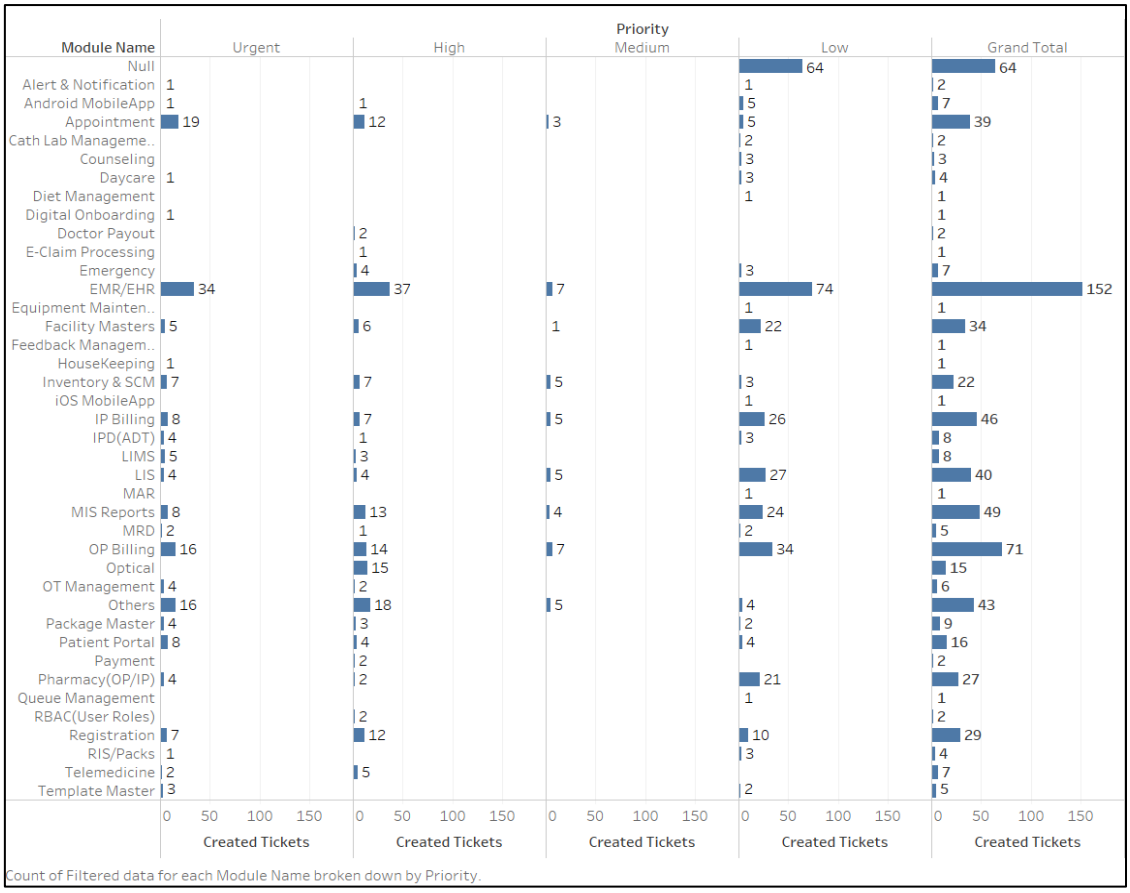

Figure 3 – Created tickets for each module name broken down by priority

A customer when raises a ticket, there is a provision for them to define the type of ticket as change request, when they want any change in the existing workflow or process or as incident, when they encountered any incident while running the software. There were 173 (23.41%) change requests and 185 (25.03%) incidents, which were raised as tickets by customers.

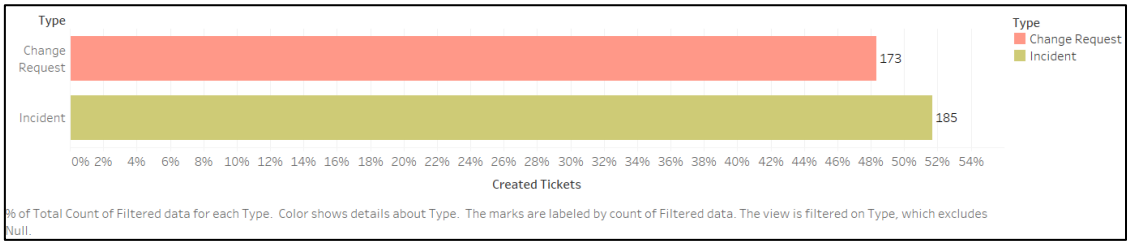

Figure 4 created tickets for each type

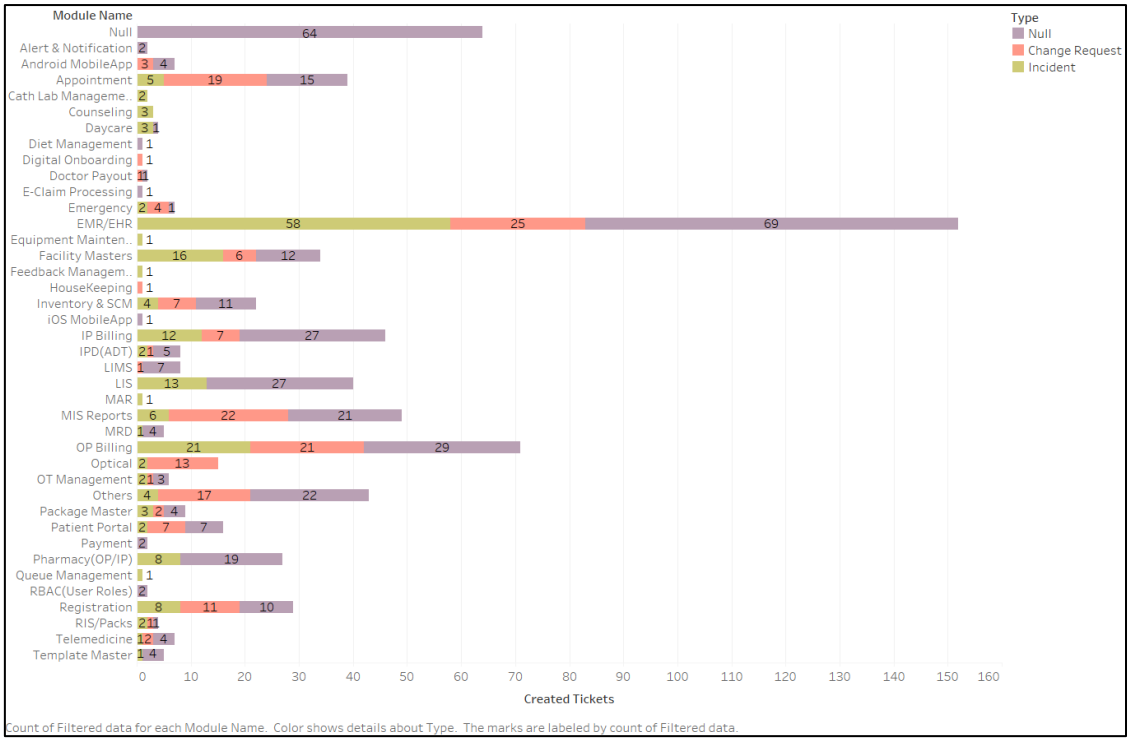

Figure 5 – Created Tickets for each module and detail about type(CR/incident)

As per Figure 5, maximum change requests and incident were reported in EMR/EHR module as 58 (7.8% of total created tickets) and 25 (3.4% of the total created tickets) respectively. OP Billing comprises of 21(2.8%) of CR and incident tickets whereas in IP Billing more incidents(1.6%) were reported than change requests(0.9%). In appointment module, 2.6% of the change requests was there and Management Information system reports consituted 3% of the change requests.

Table 1 - Created Tickets for each module and detail about type(CR/incident)

Module Name	Type (Not defined)	Change Request	Incident	Total
EMR/EHR	69	25 (3.4%)	58(7.8%)	152 (20.6%)
OP Billing	29	21 (2.8%)	21 (2.8%)	71 (9.6%)
MIS Reports	21	22 (3%)	6 (0.8%)	49 (6.6%)
IP Billing	27	7 (0.9%)	12 (1.6%)	46 (6.2%)
Others	22	17 (2.3%)	4(0.5%)	43 (5.8%)
LIS	27	-	13(1.8%)	40 (5.4%)
Appointment	15	19 (2.6%)	5 (0.7%)	39 (5.3%)
Facility Masters	12	6 (0.8%)	16 (2.2%)	34 (4.6%)
Registration	10	11 (1.5%)	8 (1.1%)	29 (3.9%)
Pharmacy (OP/IP)	19	-	8 (1.1%)	27 (3.7%)
Inventory & SCM	11	7 (0.9%)	4(0.5%)	22 (3.0%)

(II) Analyse The Time Taken to Close the Tickets in The Existing Software Maintenance Process

Resolution of tickets is a key task within the software maintenance process of an organization under study.

Resolved tickets correspond to the properties of the tickets resolved during the selected period. The tickets resolved were analysed with respect to the ticket properties like Source, Status, Priority etc. The number of tickets resolved in the selected period were 280. They are raised by customers from various **sources** like via email, phone, or portal. 61.2% of the resolved tickets were from phone, followed by 38.1% which were from the portal itself.

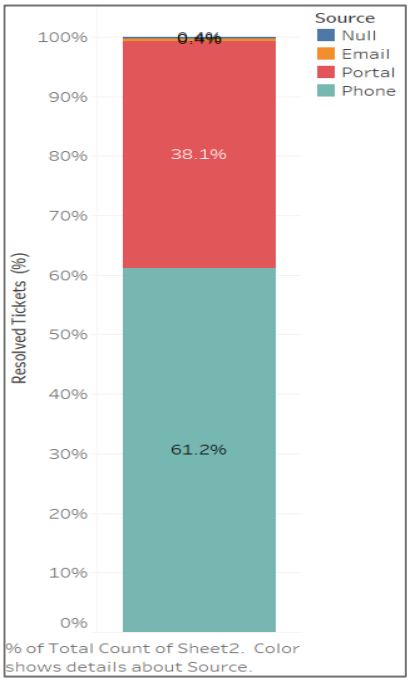

Figure 6- Sources of tickets

Table 2 shows the break-up of tickets resolved based on their current priority and their average resolution time in days. Out of the total 280, 210 (75%) were prioritized as “low”, 30 (10%) as “Urgent”, 24 (9%) as “High” and the remaining 16 (6%) were in "Medium”.

Table 2- Resolution Time and Resolved Tickets broken down by priority

Priority	Resolved Tickets (Count)	Resolution Time(Days) AVG
Urgent	30.0	2.0
High	24.0	1.9
Medium	16.0	4.6
Low	210.0	2.1
Grand Total	280.0	2.2

Resolution Time(Days) AVG and Resolved Tickets (Count) broken down by Priority. The view is filtered on Priority, which excludes Null.

There are four types of environment present for the onboarding process i.e. development, QA, UAT (User Acceptance Testing) and production. Customer can raise the tickets either while doing hands-on testing in the UAT environment before the acceptance of the software or if any problem is encountered in the production environment.

In table 4, the tickets were analysed based on the average first response time(i.e, the time taken for the first response once the ticket is created) and the average resolution time (in days) broken down by Environment vs priority and modules present in the software. Majority i.e., 23.7% of the resolved tickets were of the module EHR/EMR followed by OP Billing (12.7%), IP Billing (10.6%), LIS (11.3%), Facility Masters (9.2%), etc respectively. The table 3 below shows the percentage of resolved tickets split by various modules present in the KareXpert software.

Table 3 - Percentage of resolved tickets in each module

Module Name	Resolved Tickets (%)	Module Name	Resolved Tickets (%)
Not Defined	0.4%	LIS	11.4%
Alert & Notification	0.7%	MIS Reports	6.8%
Android MobileApp	0.7%	MRD	0.7%
Appointment	3.2%	OP Billing	12.5%
Day care	1.4%	Others	0.7%
Diet Management	0.4%	Package Master	0.7%
Digital Onboarding	0.4%	Patient Portal	0.4%
Emergency	1.8%	Pharmacy (OP/IP)	5.3%
EMR/EHR	23.5%	RBAC (User Roles)	0.4%
Facility Masters	9.2%	Registration	2.1%
Inventory & SCM	3.2%	RIS/Packs	0.7%
IP Billing	10.7%	Telemedicine	0.4%
IPD(ADT)	1.4%	Template Master	0.7%
LIMS	0.4%		

Table 4- Average first response time (in minutes) and Average resolution time (in days) broken down by environment vs priority and modules present in the software

Analysis of Resolved Tickets

		Environment			
		Production		UAT	
Priority	Module Name	FR (in minutes)	Resolution Time(Days) AVG	FR (in minutes)	Resolution Time(Days) AVG
Urgent	MRD	394	0		
	LIS	389	0		
	Inventory & SCM	217	4		
	OP Billing	145	4	5	0
	IPD(ADT)	20	0		
	EMR/EHR	10	2	122	7
	LIMS	10	1		
	Android MobileApp	10	3		
	IP Billing	7	1		
	Appointment	5	0	35	2
	Facility Masters			45	4
	Total	93	2	50	3
High	EMR/EHR	113	2		
	Registration	111	6		
	IP Billing	11	1		
	Inventory & SCM	8	0		
	Appointment	5	4		
	OP Billing	2	0		
	Facility Masters	1	0		
	MIS Reports			30	15
	Total	63	2	30	15
Medium	EMR/EHR	255	3		
	Inventory & SCM	228	8		
	IP Billing	185	2		
	LIS	16	2		
	OP Billing	10	0	30	19
	Appointment	10	0	30	13
	Facility Masters	0	0		
	Android MobileApp			30	15
	Total	111	2	30	16
Low	Others	607	10	30	10
	Patient Portal	607	18		
	Facility Masters	124	3	30	11
	Appointment	120	4	30	9
	EMR/EHR	108	1	30	10
	IP Billing	96	1		
	OP Billing	84	1	231	9
	LIS	51	0		
	Registration	32	0		
	MIS Reports	21	1	30	11
	Inventory & SCM	12	0	16	12
	Template Master	10	1	30	8
	Package Master	10	2	30	9
	IPD(ADT)	10	1		
	MRD	7	0		
	Digital Onboarding	5	4		
	RIS/Packs			30	11
	Total	88	1	57	10
Grand Total		88	1	53	10

FR (in minutes) and Resolution Time(Days) AVG broken down by Environment vs. Priority and Module Name. The view is filtered on Module Name and Exclusions (Environment,Module Name,Priority). The Module Name filter excludes 7 members. The Exclusions (Environment,Module Name,Priority) filter keeps 71 members.

Table 5- Average first response time (in hours) and Average resolution time (in days) broken down by environment vs priority and modules present in the software

		Environment			
Priority	Module Name	Production		UAT	
		FR(in hours)	Resolution Time(Days) AVG	FR(in hours)	Resolution Time(Days) AVG
Urgent	LIS	6	0		
	Inventory &SCM	4	4		
	OP Billing	2	4		0
	EMR/EHR	0	2	2	7
High	EMR/EHR	2	2		
	Registration	2	6		
Medium	EMR/EHR	4	3		
	Inventory &SCM	4	8		
	LIS	0	2		
Low	Patient Portal	0	18		
	EMR/EHR	2	1		10
	OP Billing	0	1		9
	Inventory &SCM	0	0		12

When product modification is required , then the request is forwarded. The developers responsible for maintainence are selected and the service ticket is sorted, according to the priority is assigned. In, addition, it is determined that if maintenance will cause problems in the product or other areas of the software product and schedule is finalized in such cases. These processes run sequentially or in parallel. A development environment is set up and appropriate maintainence is performed for providing a solutiion to the customer. [17]

According to the analysis, 54.4% of the total resolved tickets were change requests, 37.4% of the total were incident, which were raised by the customers. The Figure below shows the analysis of the number of resolved tickets by type (change request/incident) in various modules present in the software along with their average resolution time.

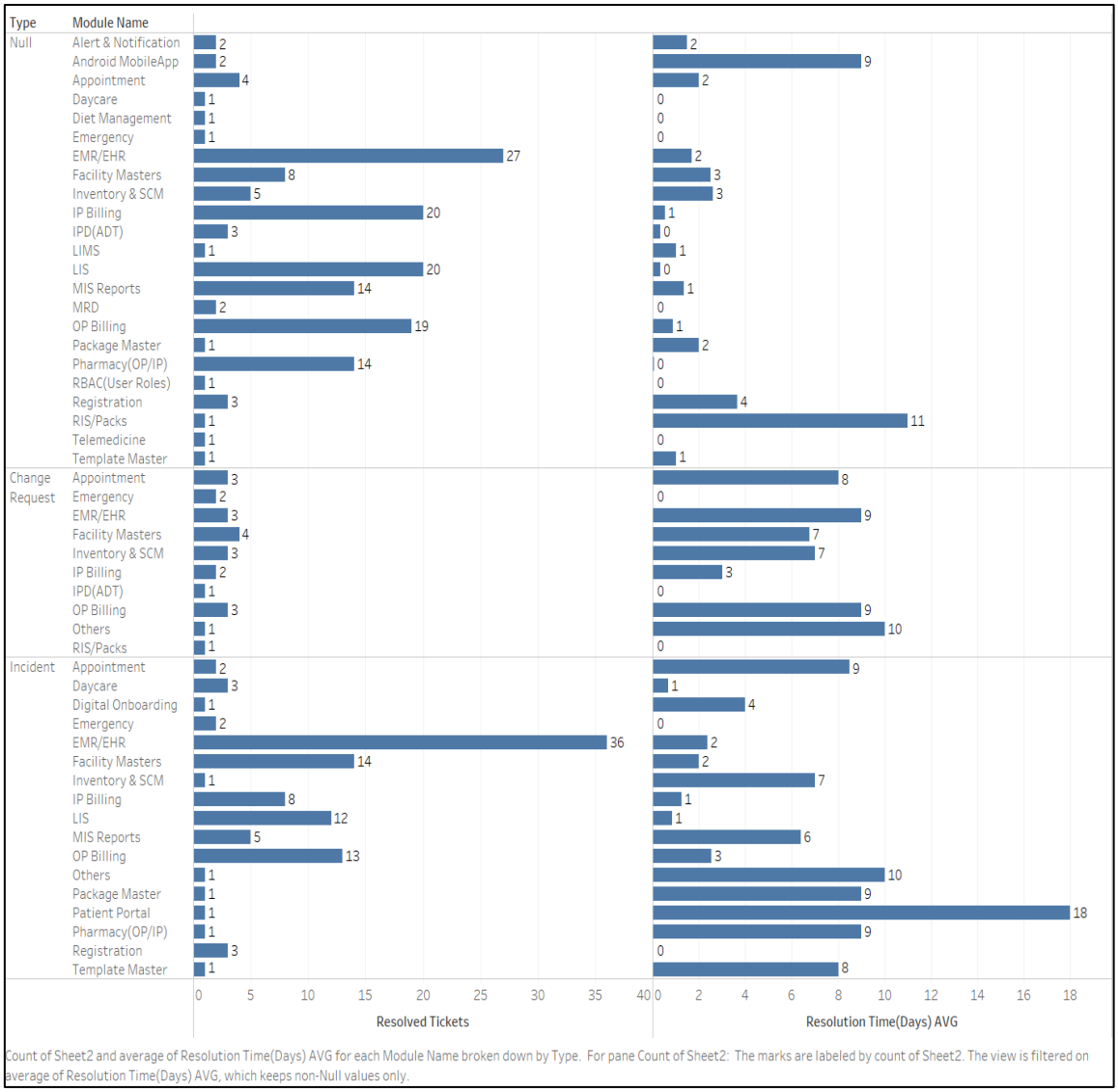

Figure 7- Resolution Time (in Days) for each module name by type (change request/incident)

(III) Root Cause Analysis of the Turnaround Time of the Tickets

In an industrial context, tickets must be resolved within a specific service level resolution time as measured by a service level clock. We have taken three months data of resolved tickets of a medium-sized healthcare IT organization for analysis purpose. M01, M02, M03 stand for month names. Created time be regarded as at what duration tickets have reported by the end user. Resolved Time be regarded as at what time the ticket has marked as resolved. Turn-around time is the resolution time, which is calculated by resolved time minus created time. The mean TAT of the following months is shown below:

- M-01 – Six Days
- M- 02 – Nine Days
- M-03 – Six Days

The table M-01, M-02, M-03 shows month-wise tickets details as mentioned below:

- Created Time (yyyy-mm-dd hh:mm: ss)
- Resolved Time (yyyy-mm-dd hh:mm: ss)
- Turn Around Time (in days)

M-01			
	Created Time	Resolved Time	TAT (in days)
1	2022-02-05 16:54:06	2022-02-16 15:48:26	11
2	2022-02-16 0:37:26	2022-02-24 10:30:55	8
3	2022-02-17 20:07:42	2022-02-22 19:14:16	5
4	2022-02-17 22:28:54	2022-02-23 8:52:48	5
5	2022-02-18 18:32:24	2022-02-19 11:33:47	1
6	2022-02-19 16:23:15	2022-02-22 9:40:21	3
7	2022-02-19 17:02:28	2022-02-21 14:05:08	2
8	2022-02-19 18:09:11	2022-02-21 14:02:07	2
9	2022-02-21 15:10:29	2022-02-22 9:57:05	1
10	2022-02-21 16:27:12	2022-02-28 16:00:54	7
11	2022-02-21 18:49:49	2022-02-22 10:02:20	1
12	2022-02-21 20:34:15	2022-02-22 11:47:23	1
13	2022-02-24 15:36:03	2022-02-24 15:48:05	0
14	2022-02-18 17:30:20	2022-02-19 11:34:01	1

M-02			
	Created Time	Resolved Time	TAT (in days)
1	2022-02-19 13:50:31	2022-03-31 20:10:39	40
2	2022-02-21 10:31:03	2022-03-10 12:28:24	17
3	2022-02-22 11:04:37	2022-03-23 10:44:57	29
4	2022-02-22 11:12:41	2022-03-23 10:44:00	29
5	2022-02-25 20:55:20	2022-03-07 18:42:41	10
6	2022-02-02 11:16:25	2022-03-23 10:42:21	49
7	2022-03-07 16:00:29	2022-03-22 14:19:54	15
8	2022-03-16 15:05:48	2022-03-29 7:46:46	13
9	2022-03-16 15:14:07	2022-03-31 9:24:17	15
10	2022-03-16 15:56:19	2022-03-31 9:27:24	15
11	2022-03-16 16:01:05	2022-03-31 9:29:15	15
12	2022-02-16 16:02:31	2022-03-25 7:39:35	37
13	2022-02-16 16:03:02	2022-03-31 9:30:27	43
14	2022-02-16 16:04:13	2022-03-25 7:39:00	37

15	2022-01-12 12:55:27	2022-02-14 14:10:24	33
16	2022-01-13 18:14:55	2022-02-01 20:50:25	19
17	2022-01-14 19:47:56	2022-02-01 14:38:24	18
18	2022-01-18 14:41:47	2022-02-04 11:04:09	17
19	2022-01-18 14:55:50	2022-02-04 11:01:26	17
20	2022-01-21 12:32:05	2022-02-08 10:06:10	18
21	2022-02-01 14:49:40	2022-02-01 18:09:22	0
22	2022-02-01 23:31:16	2022-02-01 23:39:07	0
23	2022-02-02 19:01:54	2022-02-03 15:30:50	1
24	2022-02-04 14:48:25	2022-02-14 14:07:01	10
25	2022-02-04 15:07:00	2022-02-10 10:42:31	6
26	2022-02-05 21:38:26	2022-02-09 16:44:32	4
27	2022-02-06 19:19:42	2022-02-09 15:16:13	3
28	2022-02-08 16:58:55	2022-02-08 17:35:42	0
29	2022-02-08 17:26:52	2022-02-09 15:25:13	1
30	2022-02-14 17:30:51	2022-02-15 12:09:43	1

Table 6

M-03			
	Created Time	Resolved Time	TAT (in days)
1	2022-03-25 21:37:52	2022-04-05 14:24:56	11
2	2022-03-02 11:14:39	2022-04-15 18:37:17	44
3	2022-03-04 19:39:23	2022-04-05 11:58:35	32
4	2022-03-17 16:56:51	2022-04-12 14:08:18	26
5	2022-03-04 16:06:15	2022-04-13 15:02:16	40
6	2022-03-19 18:29:08	2022-04-02 13:48:08	14
7	2022-03-19 19:54:09	2022-04-02 13:49:33	14
8	2022-03-23 12:01:27	2022-04-14 17:44:10	22
9	2022-03-23 23:37:42	2022-04-12 8:27:30	19
10	2022-03-24 21:39:32	2022-04-02 13:50:54	9
11	2022-03-24 23:00:15	2022-04-02 13:58:43	9
12	2022-03-26 10:44:41	2022-04-02 13:59:44	7
13	2022-03-26 16:54:34	2022-04-02 14:00:48	7
14	2022-03-28 9:35:08	2022-04-16 23:48:16	20
15	2022-03-28 9:43:32	2022-04-26 12:57:29	29
16	2022-03-28 10:06:22	2022-04-13 17:05:37	16
17	2022-03-28 10:13:03	2022-04-01 18:37:09	4
18	2022-03-28 10:14:07	2022-04-01 18:37:29	4
19	2022-03-28 10:16:54	2022-04-06 9:26:02	9
20	2022-03-28 12:06:48	2022-04-01 18:21:25	4
21	2022-03-28 14:32:09	2022-04-06 9:22:36	9
22	2022-03-29 10:37:05	2022-04-12 12:14:59	14
23	2022-03-29 17:32:02	2022-04-16 9:31:19	18
15	2022-02-16 16:05:08	2022-03-25 7:38:13	37
16	2022-02-17 9:38:47	2022-03-31 10:43:34	42
17	2022-02-17 9:39:53	2022-03-25 7:37:22	36
18	2022-02-17 9:41:22	2022-03-31 10:43:58	42
19	2022-02-17 9:42:46	2022-03-31 9:38:06	42
20	2022-02-17 10:06:54	2022-03-25 7:36:14	36
21	2022-02-17 10:07:57	2022-03-31 9:38:43	42
22	2022-02-17 10:09:43	2022-03-25 7:34:58	36
23	2022-02-17 10:11:19	2022-03-25 7:34:23	36
24	2022-02-17 10:17:11	2022-03-19 9:10:23	30
25	2022-02-17 10:18:25	2022-03-19 9:10:21	30
26	2022-02-17 10:24:32	2022-03-19 9:10:18	30
27	2022-02-17 10:25:38	2022-03-25 7:33:24	36
28	2022-02-17 10:28:41	2022-03-25 7:32:24	36
29	2022-02-17 17:07:29	2022-03-07 18:30:09	18
30	2022-02-17 18:02:15	2022-03-19 9:08:45	30
31	2022-02-17 20:29:05	2022-03-01 12:47:03	12
32	2022-02-23 9:59:00	2022-03-02 9:58:05	7
33	2022-02-24 13:39:15	2022-03-25 16:39:41	29
34	2022-02-25 7:09:58	2022-03-25 18:59:31	28
35	2022-02-25 11:25:18	2022-03-25 17:50:15	28
36	2022-02-25 19:57:49	2022-03-30 19:13:23	33
37	2022-03-01 17:22:44	2022-03-27 18:02:17	26
38	2022-03-01 19:58:34	2022-03-02 10:13:08	1
39	2022-03-01 21:03:38	2022-03-02 10:00:11	1
40	2022-03-03 19:47:58	2022-03-07 17:27:20	4
41	2022-03-05 16:29:07	2022-03-20 10:47:18	15
42	2022-03-06 23:15:04	2022-03-07 12:24:56	1
43	2022-03-07 10:50:23	2022-03-07 12:22:51	0
44	2022-03-07 11:13:18	2022-03-17 22:39:16	10
45	2022-03-07 11:32:04	2022-03-07 12:25:38	0
46	2022-03-07 12:32:49	2022-03-21 14:06:02	14
47	2022-03-11 21:56:45	2022-03-31 9:41:50	19
48	2022-03-12 10:55:00	2022-03-12 10:55:00	0
49	2022-03-13 22:03:58	2022-03-22 20:59:19	9
50	2022-03-14 12:59:26	2022-03-31 9:42:17	17
51	2022-03-14 14:11:19	2022-03-23 14:02:10	9
52	2022-03-14 14:19:14	2022-03-29 17:42:48	15
53	2022-03-15 12:45:35	2022-03-19 8:47:13	4
54	2022-03-15 17:08:17	2022-03-19 8:41:21	4
55	2022-03-17 14:55:55	2022-03-31 9:55:08	14
56	2022-03-17 15:08:44	2022-03-31 9:56:25	14
57	2022-03-18 13:34:18	2022-03-31 9:55:48	13
58	2022-03-18 20:10:21	2022-03-21 15:11:28	3
59	2022-03-19 10:45:54	2022-03-31 9:56:42	12

24	2022-03-29 19:38:49	2022-04-01 16:53:52	3
25	2022-03-30 16:55:52	2022-04-12 8:17:26	13
26	2022-03-30 16:59:20	2022-04-12 8:14:02	13
27	2022-03-30 17:41:27	2022-04-01 18:19:51	2
28	2022-03-30 18:02:38	2022-04-06 9:13:49	7
29	2022-03-30 20:27:22	2022-04-06 9:20:54	7
30	2022-03-31 19:19:44	2022-04-09 11:13:06	9
31	2022-04-01 0:53:53	2022-04-01 10:46:05	0
32	2022-04-01 3:43:04	2022-04-01 10:45:16	0
33	2022-04-01 10:43:50	2022-04-01 10:44:44	0
34	2022-04-01 13:37:21	2022-04-01 16:53:09	0
35	2022-04-02 20:29:17	2022-04-05 13:57:43	3
36	2022-04-03 19:59:09	2022-04-07 13:01:55	4
37	2022-04-04 16:38:34	2022-04-05 10:04:26	1
38	2022-04-04 16:39:51	2022-04-05 11:04:44	1
39	2022-04-04 16:42:31	2022-04-16 23:29:25	12
40	2022-04-04 16:44:39	2022-04-05 10:05:35	1
41	2022-04-04 19:05:33	2022-04-27 10:02:34	23
42	2022-04-04 19:07:51	2022-04-27 9:57:49	23
43	2022-04-04 19:12:21	2022-04-06 9:17:15	2
44	2022-04-05 10:09:23	2022-04-08 11:19:50	3
45	2022-04-05 10:11:06	2022-04-08 11:19:40	3
46	2022-04-05 10:16:00	2022-04-07 23:57:12	3
47	2022-04-05 19:54:48	2022-04-06 9:06:07	1
48	2022-04-05 20:01:21	2022-04-05 21:34:44	0
49	2022-04-06 20:39:59	2022-04-06 21:01:13	0
50	2022-04-07 12:33:21	2022-04-14 12:12:55	7
51	2022-04-07 15:25:17	2022-04-14 12:14:19	7
52	2022-04-07 17:17:56	2022-04-07 17:18:16	0
53	2022-04-08 0:05:20	2022-04-08 11:19:20	0
54	2022-04-08 0:08:31	2022-04-18 16:51:59	11
55	2022-04-08 0:10:07	2022-04-08 11:18:10	0
56	2022-04-08 0:11:44	2022-04-08 14:38:25	1
57	2022-04-08 10:19:13	2022-04-08 10:19:35	0
58	2022-04-09 16:44:33	2022-04-16 23:29:10	7
59	2022-04-09 19:11:22	2022-04-14 14:10:47	5
60	2022-04-11 14:21:47	2022-04-11 14:22:05	0
61	2022-04-12 16:58:05	2022-04-12 17:56:39	0
62	2022-04-13 12:09:03	2022-04-14 12:09:22	1
63	2022-04-13 17:12:04	2022-04-21 17:36:39	8
64	2022-04-13 17:41:14	2022-04-14 15:36:12	1
65	2022-04-13 18:23:35	2022-04-13 18:39:33	0
66	2022-04-13 18:43:31	2022-04-13 19:03:13	0
67	2022-04-13 23:11:10	2022-04-14 9:07:30	0
68	2022-04-14 11:57:09	2022-04-18 8:37:40	4
69	2022-04-14 17:43:03	2022-04-14 17:43:29	0

60	2022-03-21 13:01:22	2022-03-25 7:28:14	4
61	2022-03-21 14:39:54	2022-03-25 7:27:38	4
62	2022-03-21 14:43:55	2022-03-25 7:27:11	4
63	2022-03-21 18:17:41	2022-03-22 12:32:27	1
64	2022-03-21 18:41:03	2022-03-22 20:57:38	1
65	2022-03-22 16:51:11	2022-03-22 17:06:19	0
66	2022-03-22 17:00:42	2022-03-22 20:58:33	0
67	2022-03-22 17:03:45	2022-03-22 17:05:06	0
68	2022-03-22 19:45:33	2022-03-22 20:56:30	0
69	2022-03-23 11:49:01	2022-03-23 11:49:27	0
70	2022-03-23 12:11:03	2022-03-23 18:05:42	0
71	2022-03-23 15:37:28	2022-03-24 14:24:01	1
72	2022-03-23 19:04:49	2022-03-27 13:11:14	4
73	2022-03-23 21:39:10	2022-03-24 13:43:27	1
74	2022-03-24 15:10:19	2022-03-25 17:34:34	1
75	2022-03-24 15:44:33	2022-03-27 15:41:26	3
76	2022-03-25 11:13:09	2022-03-25 11:18:49	0
77	2022-03-25 14:50:39	2022-03-25 14:54:30	0
78	2022-03-25 15:56:45	2022-03-25 16:38:23	0
79	2022-03-27 10:50:17	2022-03-27 10:58:08	0
80	2022-03-27 13:09:44	2022-03-27 13:10:14	0
81	2022-03-27 15:29:41	2022-03-27 15:30:01	0
82	2022-03-27 15:30:42	2022-03-27 15:30:56	0
83	2022-03-27 15:32:34	2022-03-27 15:32:59	0
84	2022-03-27 15:34:56	2022-03-29 9:35:24	2
85	2022-03-27 15:37:38	2022-03-27 15:37:53	0
86	2022-03-27 15:38:30	2022-03-27 15:38:46	0
87	2022-03-27 15:40:13	2022-03-27 15:40:25	0
88	2022-03-27 15:42:39	2022-03-27 15:42:58	0
89	2022-03-27 15:44:16	2022-03-27 17:53:56	0
90	2022-03-27 15:46:31	2022-03-27 15:47:03	0
91	2022-03-27 15:47:45	2022-03-27 15:47:59	0
92	2022-03-27 15:49:47	2022-03-27 15:50:11	0
93	2022-03-27 15:59:54	2022-03-27 16:00:46	0
94	2022-03-27 16:03:24	2022-03-27 16:04:01	0
95	2022-03-27 16:04:34	2022-03-27 16:05:17	0
96	2022-03-27 16:07:12	2022-03-27 16:07:25	0
97	2022-03-27 16:08:05	2022-03-27 16:08:18	0
98	2022-03-27 16:10:09	2022-03-27 16:10:23	0
99	2022-03-27 16:11:05	2022-03-27 16:11:19	0
100	2022-03-27 16:15:43	2022-03-27 16:16:12	0
101	2022-03-27 16:16:53	2022-03-27 16:17:20	0
102	2022-03-27 16:17:53	2022-03-27 16:18:26	0
103	2022-03-27 16:19:15	2022-03-27 18:00:03	0
104	2022-03-27 16:25:44	2022-03-27 16:25:59	0
105	2022-03-27 16:26:31	2022-03-27 16:26:42	0

70	2022-04-14 20:09:13	2022-04-16 23:28:58	2
71	2022-04-14 20:23:24	2022-04-16 16:19:01	2
72	2022-04-16 12:44:37	2022-04-16 14:08:09	0
73	2022-04-18 17:29:57	2022-04-18 17:30:09	0
74	2022-04-18 17:34:06	2022-04-18 17:40:20	0
75	2022-04-20 18:43:47	2022-04-21 17:38:15	1
76	2022-04-21 10:10:47	2022-04-21 10:11:43	0
77	2022-04-21 10:23:00	2022-04-21 10:24:18	0
78	2022-04-21 10:27:39	2022-04-21 10:28:18	0
79	2022-04-21 10:29:51	2022-04-21 10:29:51	0
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82	2022-04-21 10:34:19	2022-04-21 10:34:19	0
83	2022-04-21 10:43:57	2022-04-21 10:43:57	0
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85	2022-04-21 10:46:17	2022-04-21 10:46:17	0
86	2022-04-21 17:41:34	2022-04-22 11:03:00	1
87	2022-04-21 18:35:25	2022-04-22 14:07:48	1
88	2022-04-22 16:22:21	2022-04-26 11:58:12	4
89	2022-04-26 11:54:12	2022-04-26 11:54:49	0
90	2022-04-26 20:47:15	2022-04-27 19:04:34	1
91	2022-04-27 13:21:56	2022-04-27 13:34:12	0
92	2022-04-27 13:27:08	2022-04-27 13:34:08	0
93	2022-04-27 13:29:59	2022-04-27 13:34:05	0
94	2022-04-27 13:33:33	2022-04-27 13:34:00	0
95	2022-04-28 13:54:30	2022-04-28 14:07:35	0
96	2022-04-28 16:20:07	2022-04-28 16:48:17	0
97	2022-04-28 16:46:26	2022-04-28 16:46:49	0
98	2022-04-29 13:47:10	2022-04-29 13:47:27	0
99	2022-04-29 13:48:03	2022-04-29 13:48:17	0
100	2022-04-29 13:48:46	2022-04-29 13:49:15	0

Table 8

106	2022-03-27 16:27:16	2022-03-27 16:27:28	0
107	2022-03-27 16:27:59	2022-03-27 16:28:17	0
108	2022-03-27 16:28:49	2022-03-27 16:29:08	0
109	2022-03-27 16:29:39	2022-03-27 16:29:50	0
110	2022-03-27 16:31:02	2022-03-27 16:31:19	0
111	2022-03-27 16:31:54	2022-03-27 16:32:08	0
112	2022-03-27 22:01:50	2022-03-27 22:01:50	0
113	2022-03-27 22:13:05	2022-03-27 22:13:05	0
114	2022-03-27 22:16:23	2022-03-27 22:16:23	0
115	2022-03-27 22:19:59	2022-03-27 22:19:59	0
116	2022-03-27 22:23:35	2022-03-27 22:23:35	0
117	2022-03-27 22:27:42	2022-03-27 22:27:42	0
118	2022-03-27 22:33:00	2022-03-27 22:33:00	0
119	2022-03-27 22:35:34	2022-03-27 22:35:34	0
120	2022-03-27 22:36:16	2022-03-27 22:36:16	0
121	2022-03-27 22:39:05	2022-03-27 22:39:05	0
122	2022-03-28 9:30:54	2022-03-28 9:33:00	0
123	2022-03-28 9:34:19	2022-03-28 9:44:16	0
124	2022-03-28 9:37:33	2022-03-28 9:45:03	0
125	2022-03-28 9:39:06	2022-03-28 9:48:09	0
126	2022-03-28 9:40:01	2022-03-28 9:50:48	0
127	2022-03-28 9:41:12	2022-03-28 9:50:03	0
128	2022-03-28 9:44:21	2022-03-28 9:45:35	0
129	2022-03-28 9:53:02	2022-03-28 11:03:50	0
130	2022-03-28 9:56:46	2022-03-28 10:56:46	0
131	2022-03-28 9:59:42	2022-03-29 18:19:16	1
132	2022-03-28 10:02:19	2022-03-28 10:49:09	0
133	2022-03-28 10:03:38	2022-03-28 10:48:30	0
134	2022-03-28 10:04:35	2022-03-28 10:48:07	0
135	2022-03-28 10:05:27	2022-03-28 10:47:31	0
136	2022-03-28 10:07:57	2022-03-28 10:44:59	0
137	2022-03-28 10:09:39	2022-03-28 10:44:00	0
138	2022-03-28 10:10:33	2022-03-28 10:41:14	0
139	2022-03-28 10:14:54	2022-03-30 18:29:07	2
140	2022-03-28 10:15:49	2022-03-30 18:44:45	2
141	2022-03-28 10:18:12	2022-03-29 17:53:36	1
142	2022-03-28 10:19:24	2022-03-28 10:36:21	0
143	2022-03-28 10:20:24	2022-03-28 10:35:50	0
144	2022-03-28 10:21:19	2022-03-28 10:35:16	0
145	2022-03-28 10:22:31	2022-03-28 10:34:53	0
146	2022-03-28 10:25:38	2022-03-28 10:33:14	0
147	2022-03-28 11:20:11	2022-03-28 11:27:26	0
148	2022-03-28 12:03:31	2022-03-28 12:05:27	0
149	2022-03-28 17:01:49	2022-03-28 17:01:49	0
150	2022-03-29 23:56:26	2022-03-31 11:18:45	1

Table 7

The average/mean of turn-around time of three months is seven days. Based on the feedback received from the development and operations team, root-cause analysis for the delay of turn-around time was carried out.

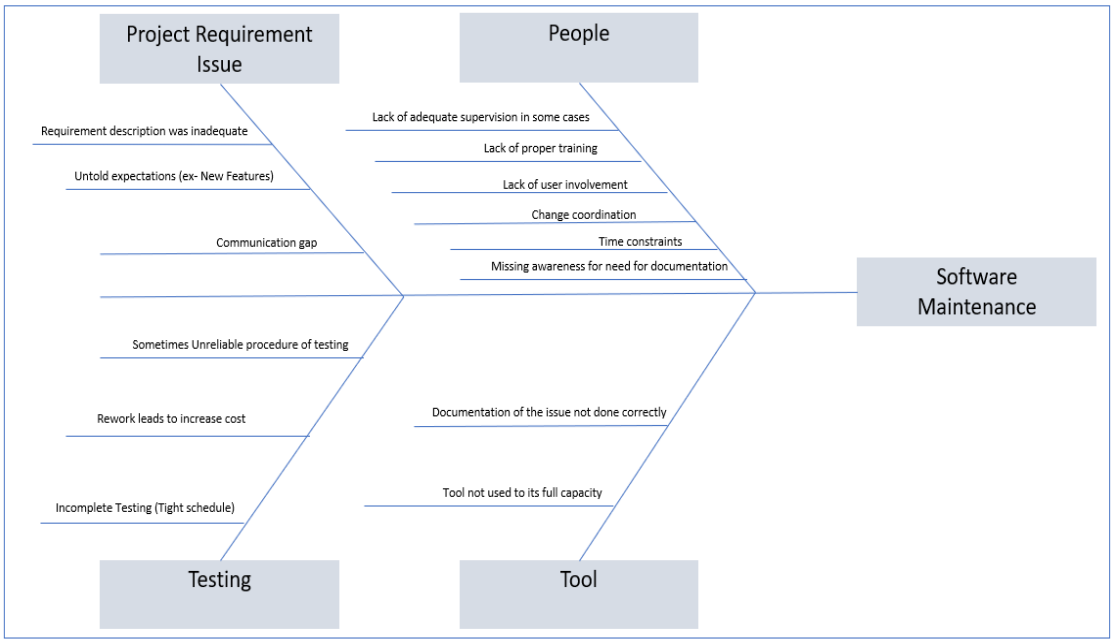

Figure 8- Root cause analysis of software maintenance in the organization

The main causes identified for the delay of turn-around time are related to the following (figure 8):

(1) Project Requirement Issue- Sometimes, client has untold expectations in pre- and post-delivery of the software while raising the change requests. In some cases, the requirement descriptions of requests are inadequate, which leads to communication gap between the parties, thus causing the delay.

(2) People- When a new information system is implemented in an organization, it usually involves changes related to human resources, technology and procedures. Sometimes, employees lack proper training and adequate supervision on the project. They are unable to prioritize work and tend to avoid documentation due to time constraints.

(3) Tool- The most common issue faced by development and application team during the maintenance phase is description related to the issue. The issues raised in the system are not properly documented, which causes further delay in the process.

(4) Testing- There is a need for proper re-testing of the software before the handover of the system or even after the handover, once the desired modifications requested by the client is done. In such cases, the test cases are sometimes handed over to new employees due to time constraints of other experienced team members, which is sometimes unreliable.

In addition to the above causes for the delay in turn-around time, in EMR module, delay in implementation and integration of EMR with other systems, can also be taken into consideration. When a patient comes into a facility for treatment, the hospital needs records from other facilities, this patient has visited previously to get a complete picture of their health. In addition to this, it is also influenced by the new features and development in the system. However, EMRs sometimes lack ease of use due to some complex features in the software.

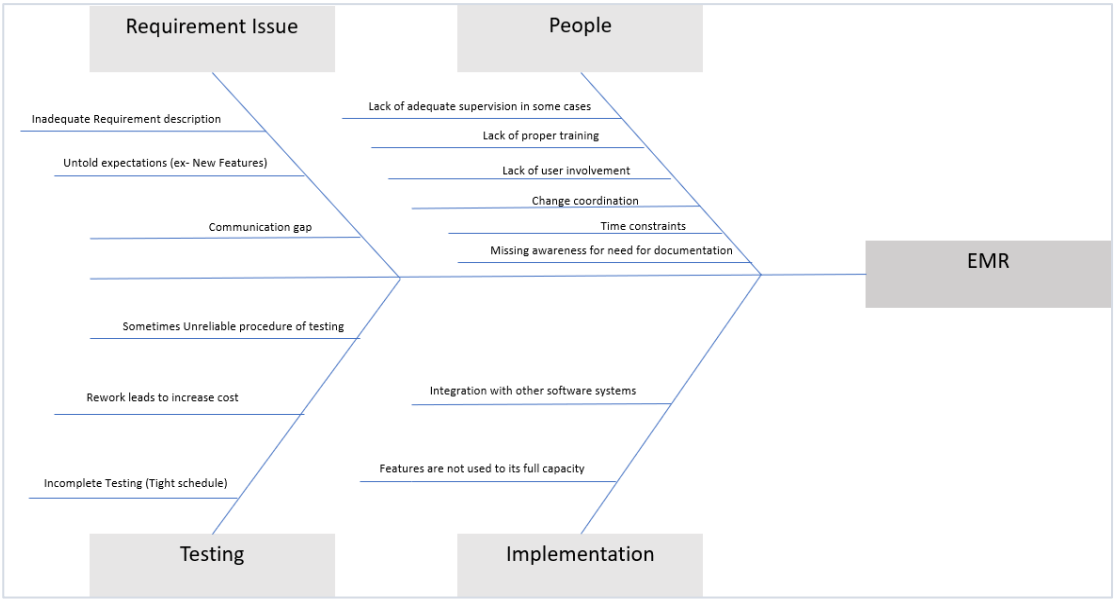

Figure 8- Root cause analysis of EMR module in the software

However, it was noted by the team that for some tickets, the first response time was delayed, but the resolution was provided within two days, this delay in the first response was the major factor that resulted in the overall increase in the turn-around time. Some tickets were raised as queries of the customers, for which they had to wait for the weekly release of the software, these were the additional factors which lead to the increase. An analyst (responsible for providing the ticket) when assigned a ticket, can request input from the user to resolve those tickets. When user input is requested, the service level clock is stopped to prevent penalties of the service provider. However, this latency adds to the user's perceived resolution time and degrades the user experience. **In our study, we found that majority of tickets contained queries entered by users during their lifecycle.** User input requests resulted in resolution times, nearly double the service resolution times measured by users. We see that there are two types of user input requests. Actual request, requesting information from the user for ticket processing; It is tactical when no information is requested but a user input request is triggered simply to pause the service level clock. [21]

8. RECOMMENDATIONS

Comparative analysis of tickets should be performed on a timely basis with parameters such as component, owner (analyst), reporter, etc. a final resolution such as duplicate, rejected and resolved, and turnaround time for tickets can be considered to derive useful insights for improvement.

While testing and gathering project requirements, early detection and defect prevention should be done and if potential defects are identified then it should be fixed, so that fixing them at later stages is avoided. Ensure that all re-work is kept to minimum. In such cases, a project manager can retrieve the logs from ticket tracking tools and can analyse the problem and provide the statistics, if it is recurrent and provide his/her recommendations on the root cause and best solution or prevention.

Weekly trainings can be conducted for new employees under the supervision of senior and experienced professionals.

Adequate prioritization of activities should be done to understand the best options from different options with the right balance of resources and outcomes involved. Identify time-consuming unnecessary activities or processes, etc. Some activities are performed as part of a process that contribute little to the overall outcome.

While raising the issue in the customer ticketing tool, users should make sure that the information related to the issue raised is properly documented and assigned to the correct person in-charge.

As per the interaction with the technical and delivery team, it was seen there are multiple issues reported as bugs, but they continue to be deprecated because the developers say they are not bugs or related to other components. Then, efforts go in vain. So, some

processes can be improved to reduce these cases. Avoiding unnecessary lags, when an issue is reported, taking ownership, and avoiding tossing can result in early resolution of the tickets.

Today's software systems use numerous checks and balances to sample data and detect anomalies in the process. Ignoring a process in the initiation of the project will eventually lead to more risks and lead to project constraints deviations in later phases. Risk management is necessary in these cases.

9. CONCLUSION

Tickets analytics was performed to obtain an analysis report on the severity of the ticket, volume of the ticket and the time it was resolved. [(1)] Implementation of an effective maintenance strategy at the point of service reflects the high profitability and high level of customer satisfaction of the business. A thorough analysis of tickets and related details has proven to be beneficial in long run. However, trend analysis can be done in future to develop strategies to maintain quality [(1)]. Enhancement activities can be done in the saved time and with proper management which can lead to improving service level agreements with customers and thereby can help in getting new projects from the customer. This will help project managers to plan and allocate team members to different project activities depending on the estimation and prediction of the turn-around time in subsequent periods. [(1)]

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