Six Sigma Project-Story-Book

for the project: *Quality Improvement in Rural Healthcare*

Green-Belt Candidate:
Tony V Raju

Dr Neeta Paul Alice

Content

Introduction

My introduction as a Green-Belt candidate and my Project Sponsor

Green Belt:

Tony V Raju

Education-B-TECH Mechanical Engineering (June 2019)

Projects 1. Ultra-sonic based Imaging of fractured bones
2. Chalk Recycling Device
3. Optimised Transportation model for Kelchandra Pipe Industry

Sponsor:

Dr. Neetha Alice Paul

Education-MBBS,MS

Position-Medical Officer,CHC Sachivothamapuram

Company:

- CHC sachivathomapuram is a rural hospital in Kerala state, India.
- The hospital provide medical service mostly in Non Communicable Disease (NCD) catagory.
- The hospital has 4 doctors and around 370-430 patient visit daily in this hospital.

Scan of the signed confirmation eMail of my sponsor

CONFIRMATION MAIL

My name is Dr Neetha Alice Paul from the Hospital CHC SACHIVOTHAMAPURAM. I am responsible for the medical services offered in this hospital and treatment of patients. I confirm, that Tony V Raju (tonyoct97@gmail.com) will implement the Six Sigma project in my area of responsibility and will support Tony V Raju in the DMAIC phases (DEFINE, MEASURE, ANALYSE, IMPROVE, CONTROL), in the role of a Sponsor.

For the Lean Six Sigma Green Belt certificate he/ she will measurable solve:

- a Quality-Problem of the output,

- an Availability-Problem (reduce cycle time or increase volume) and

- a Consumption-Problem (better utilization of inputs and/or resources and/or elimination of waste in the process).

I allow Tony V Raju to conduct interviews with internal customer of (intermediate) outputs, to involve experts of the topic and to conduct at least one workshop a) in the MEASURE phase to analyze the inputs and the process and b) in the transition of the ANALYSIS to the IMPROVE phase to determine the root causes of the problems and to develop solution ideas to eliminate the root causes.

At the end of each DMAIC phase, Tony V Raju will present the most important results of this phase in his/ her Project-Story-Book. Based on these results, I will decide on the success of the project so far, either to require adjustments in the current phase or to recommend the transition to the next DMAIC phase.

The decision about the implementation of solutions in the IMPROVE-Phase is up to me. I note, however, that a project in which no solutions are implemented and which does not lead to measurable improvements cannot be certified. Therefore, I will check the financial and other benefits for plausibility after the approved solutions are implemented.

I accept that the application and registration at the TUM School of Management begins with the sending of this e-mail, and that the course fee has to be transferred if the Project-Topic and Project-Definition have passed the suitability check.

Scan of my TUM Lean Six Sigma Yellow Belt Certificate

Certificate

Executive Education Program

We hereby confirm that

TONY V RAJU

has successfully completed the certification requirements for the

TUM Lean Six Sigma Yellow Belt

through the successful completion of the 22-week Professional Series of courses on the edX platform, including 30 hours of lecture, weekly quizzes, and guided on-line case studies and projects,

Six Sigma and Lean: Quantitative Tools for Quality and Productivity

Covering the topics

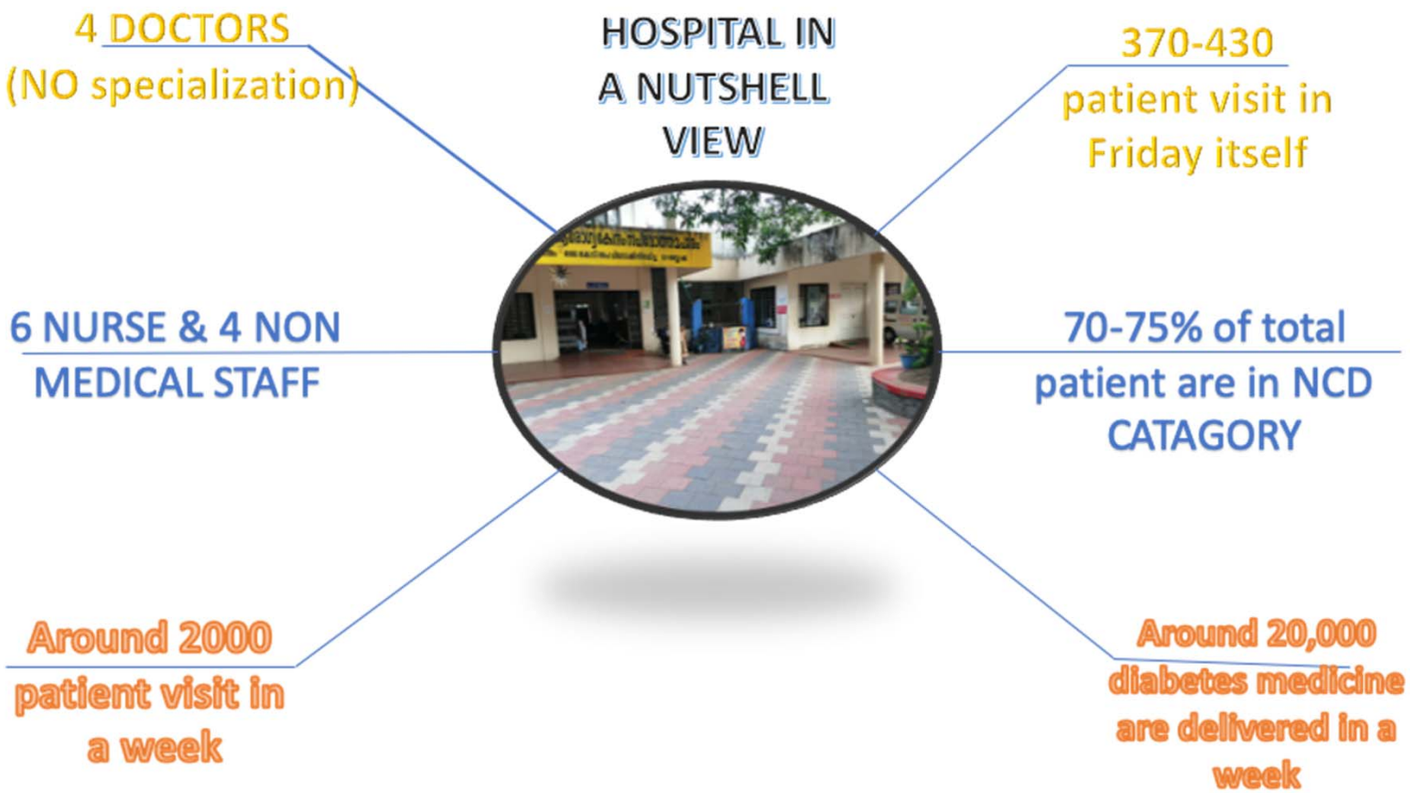
Lean

- History of Lean
- Continuous Improvement (Kaizen)
- 8D Problem Solving
- Value Stream Mapping
- Fishbone, 5 Whys, Cause & Effect
- 3Ms: Mura, Muri, Muda

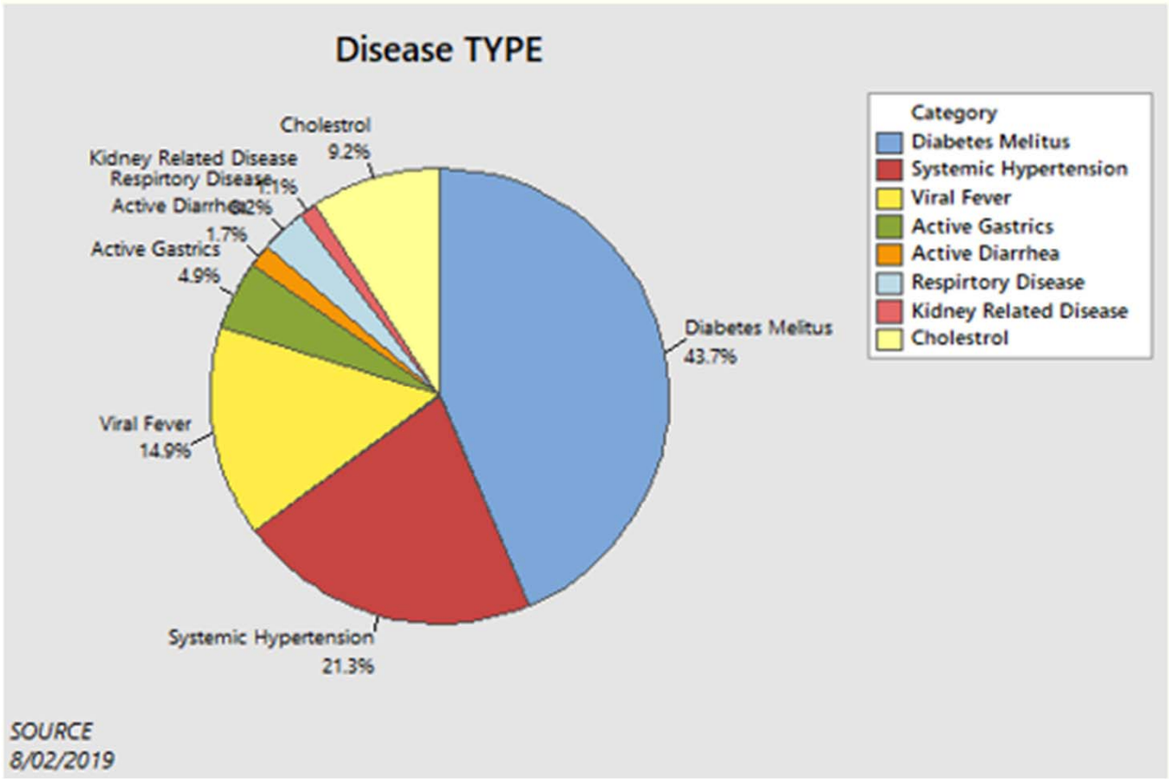
Six Sigma

- Project Identification and Definition
- SIPOC
- Customer Expectations, VOC, Kano
- Critical-to-Quality Parameters
- Process Mapping/ Flow Diagram
- MSA, Gage R&R,

Key Figures to our Hospital



Key Figures to our Hospital



1. Based on a survey (figure left) about type of disease patient have we found that there are two type. One communicable diseases and second non communicable diseases.

2. Communicable disease are disease which spread by air, water, human contact etc. In case of our hospital they include viral fever(14.9%) ,active diarrhea (2%) and active gastric (4.9%).They form around 20% of total patients.

3. Non communicable disease are life-style disease means they won't spread by contact. Diabetes, cholesterol, hypertension are some of its type. They form roughly 80% of total patient.

4. In case of communicable disease patient will go directly to pharmacy after consultation but in case of non communicable disease patient will go to lab and based on lab result they will go to pharmacy.

5. Since non communicable disease (NCD) form 80% of patients we can focus on that group and it will be beneficial in long run.

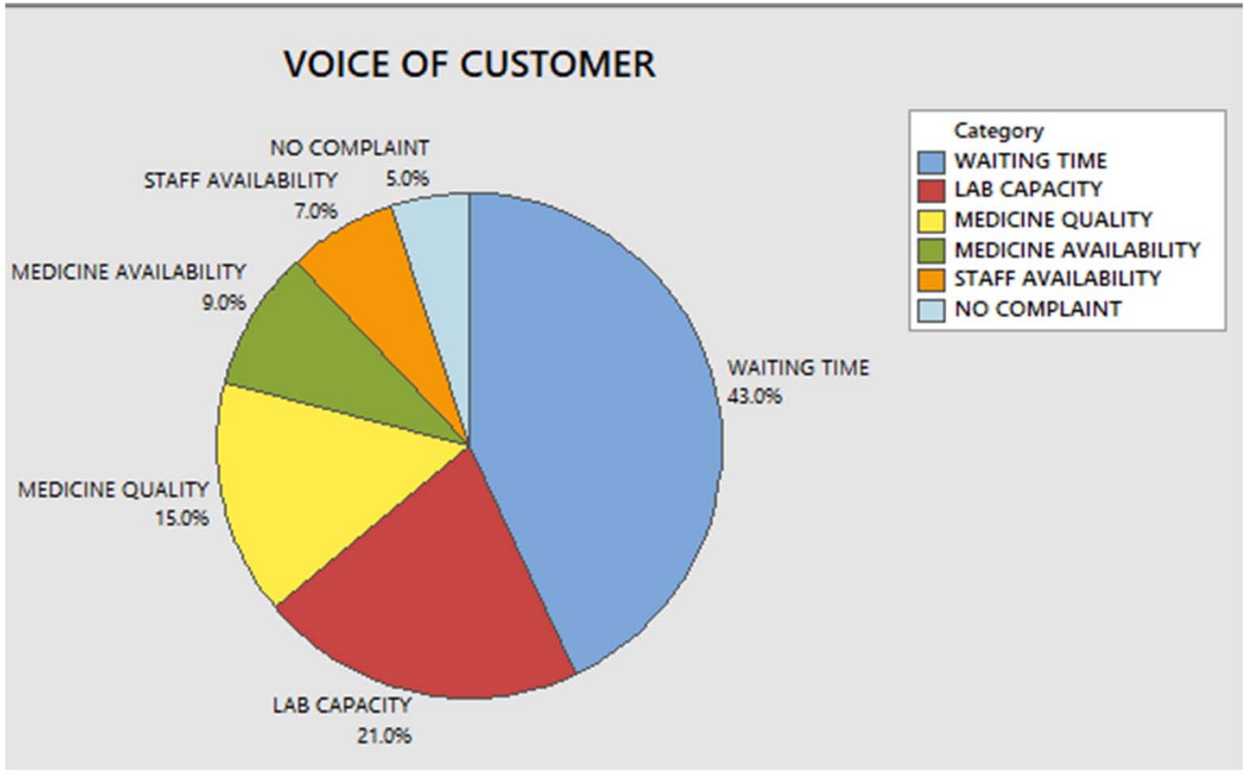
Medical Service in our Hospital

Queue at consultation Room

Queue at Pharmacy

The average Length of stay of patient in hospital is around 1.75-2.5 hours a particular day as doctors have to handle a large population and it cause poor medical service. The workload on lab is very high and also frequent unavailability of medicine occurs.

Survey among patients



Results

1. Based on the survey conducted among patient it is found that
2. Waiting time is the major problem they suffer the most.
3. Lab capacity which in turn affect the waiting time also contribute a major part.
4. Medicine quality a problem which we cannot address as it is out of control becomes third most raised problem.

Interpretation and implication

From the survey we can conclude that solving waiting time and lab capacity can improve the quality of medical service offered to a higher level.

DEFINE

Identification and Definition of a Six Sigma Project

Project-Topic

Project-Definition

The hospital has to handle large patient size and thus the length of stay of patient in government hospital is very high as 2.5 hrs compared to 30 minute length of stay in private hospital.The longer length of stay not only affect the patient health condition but it also create medical error and affect the quality of medical service.The poor capability of diagnosis labortary also affect the length of stay.The frequent unavailaility of some medicine also make situation worser.

MEDICAL SERVICE - i.e. products/ services, that we create - take a long time / are available too late. The loss of time/ delay occurs very often and has a strong impact on the internal/ external customer. The problem can be solved with a very big contribution by the own department.

Relevance of the topic:	**35%**
Suitability for method:	**Six Sigma**
Solvable by own department up to:	**80%**

Section 1: Process and Output

Summary:

The Service MEDICAL SERVICE is an intangible final Output for external Customers and is in the Creation Process TREATING PATIENT within a year 53 - 365 times generated. Important Input of the Process to generate the Product MEDICAL SERVICE is: TICKET,MEDICINE,LAB FACILITIES,DIAGNOSIS DEVICES.

Project-Definition (1/2)

Section 2: Problem

Summary:

1. Problem: MEDICAL SERVICE THE PATIENTS DOES NOT GET ENOUGH TIME FOR TREATMENT.. MEDICAL SERVICE fulfills the requirement on Quality (is error-free) in 30%.

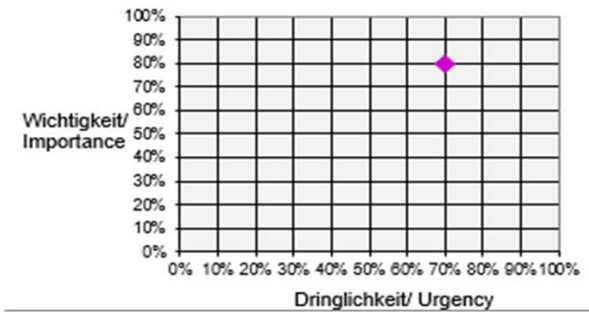
2. Problem: MEDICAL SERVICE NCD LABORTARY TAKE TOO MUCH TIME. MEDICAL SERVICE fulfills the requirement on efficient utilisation of means (no waste of Input, Resources) in 30%.

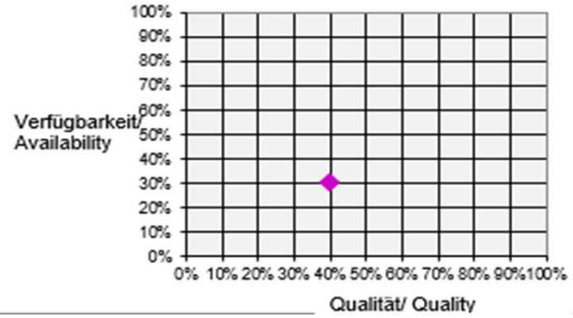
3. Problem: MEDICAL SERVICE FREQUENT UNAVAILABILITY OF MEDICINE IN PHARMACY. MEDICAL SERVICE fulfills the requirement on Availability (right quantity) in 40%.

Section 3: Effect

Summary: Voice of Business

The satisfaction of the process-owners with the Consumption in the Creation Process of the MEDICAL SERVICE is: 50%.
The total costs of the specified 3 problems are estimated by 2500€ / year.
They are primarily the result of quality costs due to scrap and additional expenditure.
The solution of the problems is rated as:
- medium URGENT (70%-Level)
- major IMPORTANT (80%-Level)





Project-Definition (2/2)

Summary: Voice of Customer

The satisfaction of the external customers with the:
- Quality of MEDICAL SERVICE is: 40%.
- Availability of MEDICAL SERVICE is: 30%.

Section 4: Solution

Solution Idea to 1. Problem

An effective study on which area cause bottle neck in the patient flow from ticket counter to pharmacy is need to be identified and improving that stage for example pharmacy or labortarycan reduce the problem.

Solution Idea to 2. Problem

The efficency of the device and operator are need to be analysed and the inabilities are need to be rectified.

Solution Idea to 3. Problem

The critical medicines are need to be identified and provide provision for stocking them

additional Information

Your additional comments, advices, feedback ... are very appreciated.

DEFINE

SIPOC, Voice to Criticals, Project-Charter, Stakeholder Communication

SIPOC with the core process steps included in the project

Supplier	Input (xI)	Process (xMR)	Output (Y)	Customer
1. Ticket Counter	Patient (Information)	Record Patient Details	Patient (General Ticket)	Ticket Counter
2. Patient	Patient (General Ticket)	Consult Patient	Patient (OP Report)	
3. Lab Technician	Patient (Lab Sample)	Test sample	**Patient (Lab Report)**	Doctor
4. Doctor	Patient (Lab Report)	**Assign medical treatment**	Patient (medical treatment)	Patient
5. Hospital (Pharmacy Dept)	Medicine (order)	Produce medicine	Medicine (Delivery)	Hospital

Results

1. First process steps represent ticket counter operation
2. The process steps 2-4 represent consultation,testing &pharmacy activity respectively
3. The process step 5 represents procurement of equipment and medicine respectively.

Interpretation and implication

Since the process is a service system, actual process may not work in systematic fashion. The laboratory testing are only for NCD category patients and others have to go to pharmacy directly.

Voice of Customer & Business, Customer & Management Requirements and Problems

Summary: Voice of Customer (VoC), Voice of Business (VoB), Critical Requirements (CCR/ CBR), Problems, Severity, KANO and CtQ-Rank							
Y	Voice	of ...	Critical Business Requirement (CBR) or Critical Customer Requirement (CCR)	Problem	Kano-Category	Severity	Critical to Quality (CtQ) Rank
Y_01	Patient (medical treatment) long waiting time	Customer	CCR: Patient (medical treatment) Length of stay short	Patient (medical treatment) Length of stay too long	Must-Be	90%	1
Y_02	Patient (Lab Report) Limited Capacity of labortary	Customer	CCR: Patient (Lab Report) Facility usage efficient	Patient (Lab Report) Facility usage inefficient	Must-Be	83%	2
Y_03	Medicine (Delivery) unexpected shortage of medicine	Management	CBR: Medicine (Delivery) Availability stock level >= demand	Medicine (Delivery) Availability stock level < demand	lore/Less-Is-Bette	45%	3
Y_04							

Results

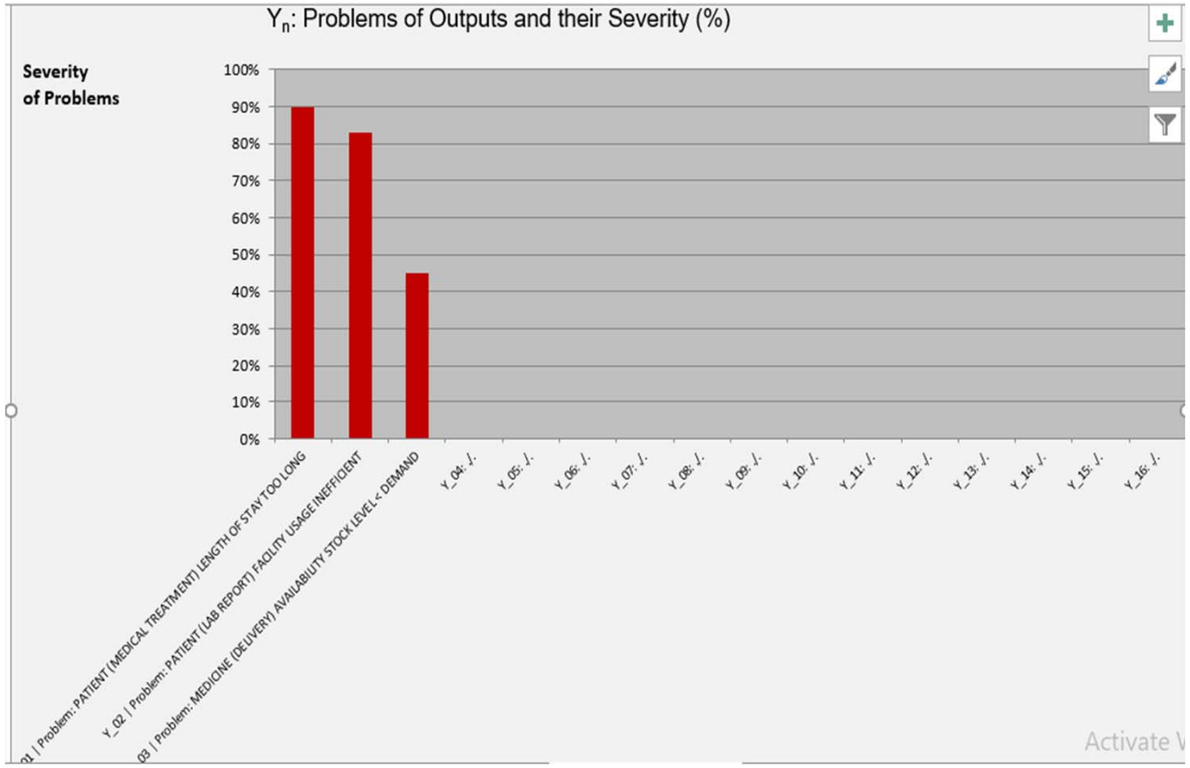
1. Three critical problems are identified under three domain.
2. Two problem are based on customer and one based on management.

Interpretation and implication

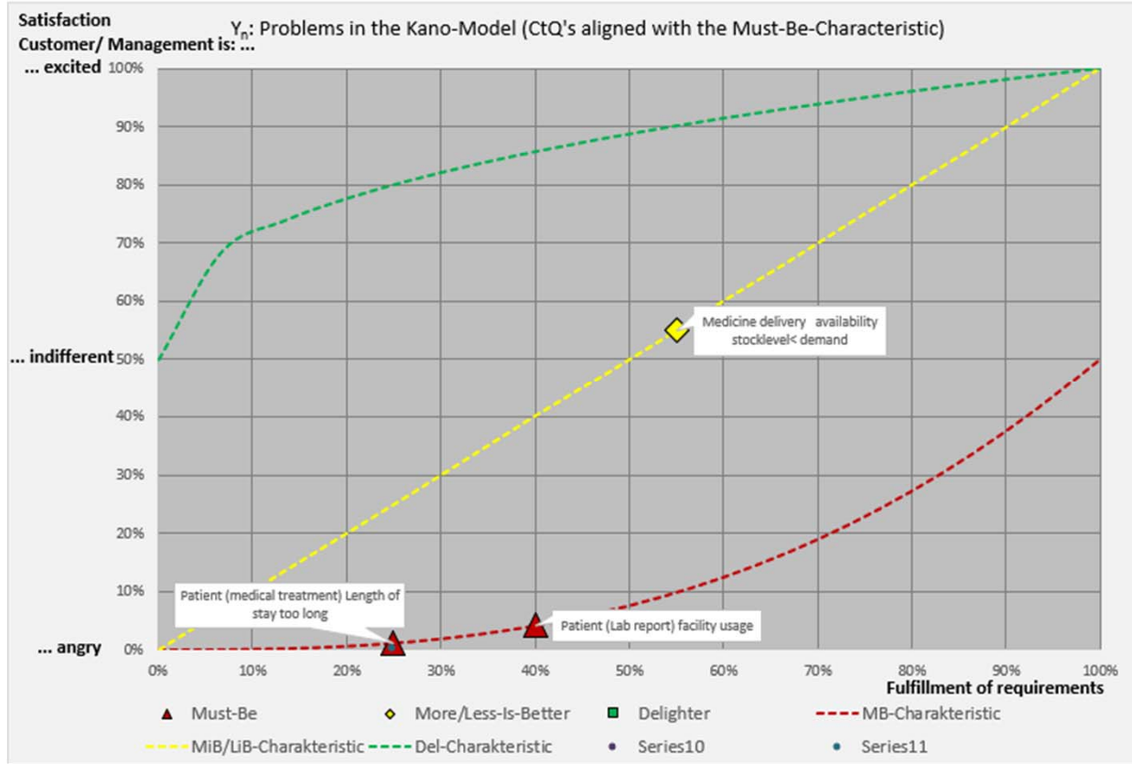
The quality and consumption problem are critical and are need to be effectively addressed and the availability problem can improve patient situation a lot.

The most important problems are: Patients length of stay & Facility usage inefficient

CTQ Bar Chart for the Problems and their evaluation by the KANO Model



Y CTQ Bar Chart



KANO MODEL

Interpretation and implication

The focus of my project is on the Must-Be problems (CtQ's): Length of stay and Facility usage

PROJECT CHARTER

Project-Charter	Project-Name
	Quality Improvement in Rural Healthcare

Business-Case

The Service MEDICAL SERVICE is an intangible final Output for external Customers and is in the Creation Process TREATING PATIENT within a year 53 - 365 times generated. Important Input of the Process to generate the Product MEDICAL SERVICE is: TICKET,MEDICINE,LAB FACILITIES,DIAGNOSIS DEVICES.

Process & Output

Product/ Service:	**Medical Service**
Process:	**Treating Patient**

Voice of Customer (VoC)

The satisfaction of the external customers with the:

- Quality of MEDICAL SERVICE is: 40%.

- Availability of MEDICAL SERVICE is: 30%.

Problems

Y_01 | Patient (medical treatment) Length of stay too long

Y_02 | Patient (Lab Report) Facility usage inefficient

Y_03 | Medicine (Delivery) Availability stock level < demand

Voice of Business (VoB)

The satisfaction of the process-owners with the Consumption in the Creation Process of the MEDICAL SERVICE is: 50%.

The total costs of the specified 3 problems are estimated by 2500€ / year.

The solution of the problems is rated as:

- medium URGENT (70%-Level) / - major IMPORTANT (80%-Level)

Solution-Ideas

An effective study on which area cause bottle neck in the patient flow from ticket counter to pharmacy is need to be identified and improving that stage for example pharmacy or labortarycan reduce the problem.

The efficency of the device and operator are need to be analysed and the inabilities are need to be rectified.

The critical medicines are need to be identified and provide provision for stocking them

Comment

Comment

In Scope		Out of Scope	
in:	Non communicable disease	out:	Communicable disease
in:	Medicine	out:	Labortary equipments
in:	Labortary sample.	out:	
in:		out:	

Management

Sponsor	Dr Neetha Alice Paul	**Supplier**	Pharmaceutical company
A_ccountable	Dr Latha Yohanan	**Customer**	
A_ccountable		**...?**	Nilok Amrth
Controlling		**...?**	

Targets		Timeline
Y_01	Reduce length of stay (minimum 45 min & max 1 hour)	1.11.2019
Y_02	Improve lab utilisation (Process atleast 15 samples in 1 hour)	1.11.2019
Y_03	Determine an EOQ for desirable medicine	1.11.2019

Experts

Black-Belt		**Master-Black-Belt**	Dr Reiner Hutwelker
Green-Belt		**...?**	
Green-Belt		**...?**	
Expert		**...?**	

Timeline	Define	Measure	Analyse	Improve	Control*	Control	End
Target-Date:	1 August 2019	30 August 2019	25 September 2019	28 October 2019	05 November 2019	17 November 2019	01 December 2019
Completion-Date:							
Evaluation:	days expired: 54	days expired: 25	days remaining : 1	days remaining : 34	days remaining : 42	days remaining : 54	days remaining : 68

Results

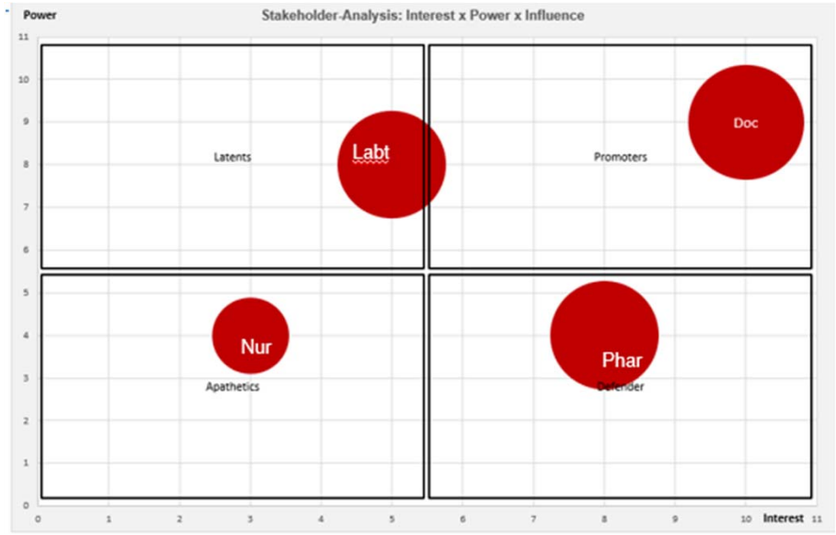
1. The business case is clear
2. The three main problems are identified
3. The Voice of customer is quantified
4. Scope, targets (upside down problems) and team defined

Interpretation and implication

The length of stay and laboratory efficiency are related while availability of medicine is related to an external supplier.

Stakeholder-Analysis and communication plan

Stakeholder-Analysis and Communication-Plan			Interested in ...	Power to support the ...	How do you want to win the support of this Person?						Degree of your Influence on this Person	Rank (Power x Interest x Influence)
Select one of your targets	Who in the company is positively/ negatively affected by the achievement of this target? (Name)	Pseudonym	_ target-achievement		Type of communication	Frequency	Type of communication	Frequency	Type of communication	Frequency		
Y_01	Reduce length of stay (minimum 45 min - maximum 1 hr)	Doctors	Doc	10	9	personal talk	weekly	team discussion	monthly	final presentation	at fixed dates	9	1
Y_02	Improve Lab utilisation (process atleast 15 samples in 1 hour)	Lab Technician	LabT	5	8	workshop	weekly	team discussion	weekly	phase steering	as needed	8	2
Y_03	Determine an EOQ for desirable medicines	Pharmacist	Phar	8	4	team discussion	weekly	personal talk	biweekly	phase steering	monthly	8	3
Y_01	Reduce length of stay (minimum 45 min - maximum 1 hr)	Nurse	Nur	3	4	personal talk	monthly	team discussion	biweekly	workshop	monthly	4	4
...?			...?	...?	...?	...?	...?	...?	...?	...?	...?		



Interpretation and implication

1. The principal stakeholders are Doctors, Lab technician, Pharmacist and Nurse
2. The Doctors forms the promoter group as they have power and interest
3. The lab technician has power but not so aware about the project
4. Nurse show the least power and less influence

Results

1. The effective ranking of each person are assigned
2. The strategy which is needed to be adopted for each catagory are identified
3. The unawareness among nurse and lab technician is need to be addressed

Results of the DEFINE-Steering

Define-Steering				
Master-Black-Belt	**Proceed to next-Phase**	**Remarks**	**Date**	**Contact/ Verification-ID**
Dr. Reiner Hutwelker	**yes**	Dear Tony, You give a transparent representation of the process weaknesses, already enriched by your own analyses and have successfully applied the tools to hospital operations. That is not self-evident - beautiful performance. Therefore a clear GO to MEASURE from me. Please let your Sponsor now also decide on this phase. - Reiner	30.7.2019	reiner.hutwelker@softlogik.de
Sponsor	**Proceed to next-Phase**	**Remarks**	**Date**	**Contact**
Dr Neetha Alice Paul	**yes**	Statistical analysis are verified and found to be valid but the unawareness about this program may create confusion among different people working in this hospital so I recommend necessary communication. I am okay to go with further processing.	03.08.2019	neethapaul95@gmail.com

Only proceed to the next phase after a positive decision of MBB and Sponsor

MEASURE

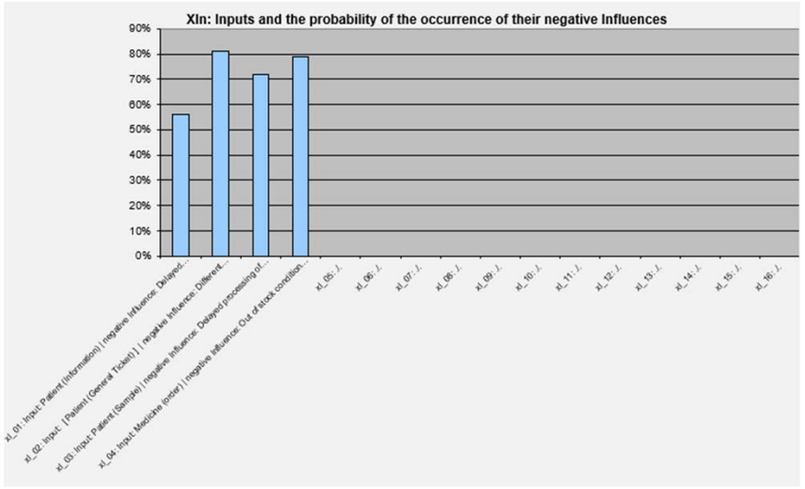
Input-Analysis, Process-Mapping/ -Analysis, C&E-Matrix, Data-Collection-Plan, Hypothesis

Input Analysis

xl_01		
Which Input is necessary for the Process TREATING PATIENT?	Patient (Information)	Input
	Please select an answer.	
What do you require from PATIENT (INFORMATION)?	Quick processing of general ticket	Requirement
	Please enter your answer.	
To which category does the Requirement QUICK PROCESSING OF GENERAL TICKET belong?	Quality (Faultlessness/ Fulfilment of Purpose)	Requirement-Category
	Please select an answer.	
Which deviation of PATIENT (INFORMATION) from the Requirement is problematic for the Process?	Delayed processing of general ticket	negative Influence
	Please enter your answer.	
How often does the negative Influence PATIENT (INFORMATION) DELAYED PROCESSING OF GENERAL TICKET occur?	56%	Probability of Occurrence
	Please enter a value between: 0% - 100%.	

Results

1. Overall 4 different negative influences of the inputs on our defined problems were identified
2. The estimated frequencies of these negative influences range between 55-80%

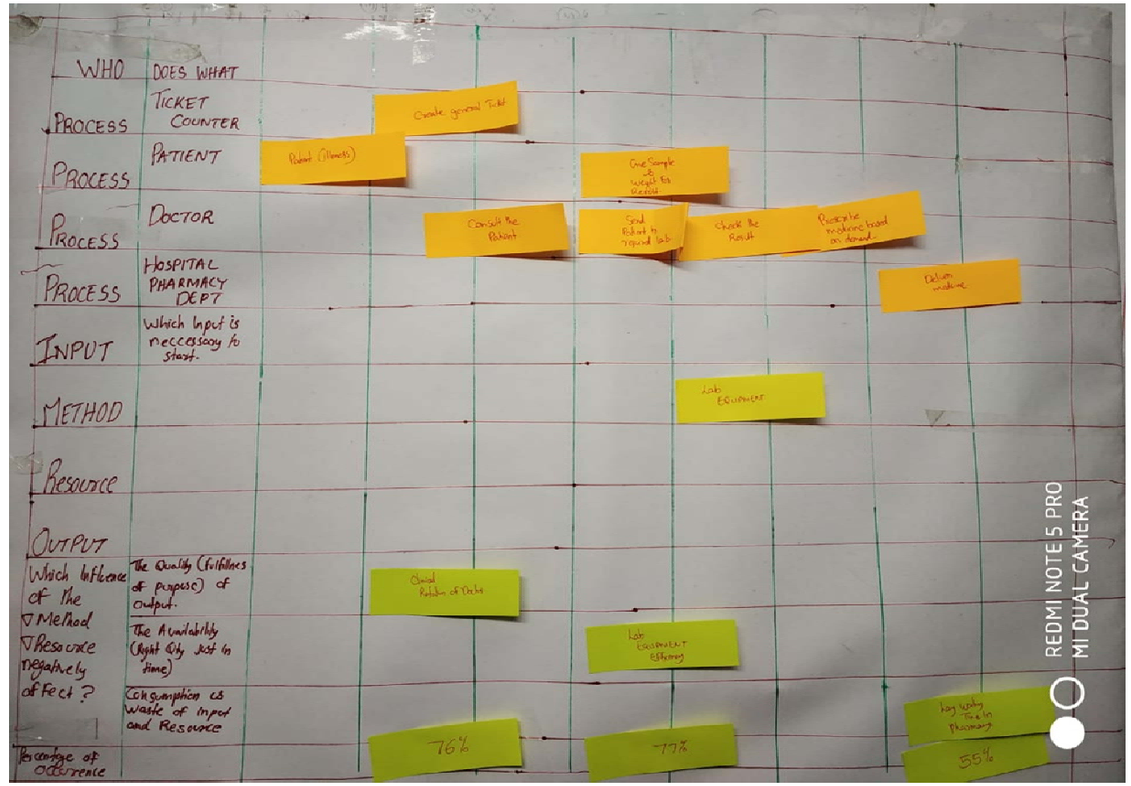


Interpretation and implication

1. The input patient illness show deviation in two operation that is in laboratory as well as in ticket counter.
2. Sampling indirectly affect the length of stay of patients
3. The ordering of medicine play a key role in the out of stock problem of medicine like metformin.

Four negative influences of the inputs on our defined problems were identified, with a frequency between 55-80%

Workshop flipchart with the process-mapping analysis



Process mapping analysis was executed with our subject matter experts

Process-Mapping and Process-Analysis for the focussed process in the hospital

Process-Mapping-Analysis of the Process: Treating Patient

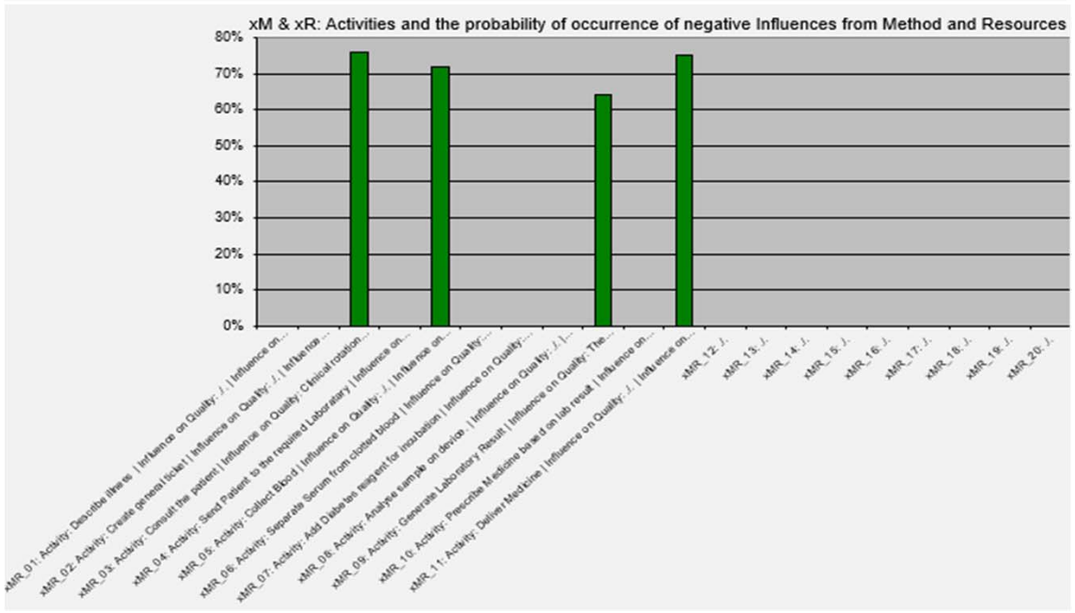
Who ...	... does what?	Please specify the Process-Steps in detailed Activities the format: Verb + Noun (e.g.: weigh Ingredients)										
		1. Activity	2. Activity	3. Activity	4. Activity	5. Activity	6. Activity	7. Activity	8. Activity	9. Activity	10. Activity	11. Activity
1. Process-Step	Ticket Counter		Create general ticket									
2. Process-Step	Patient	Describe illness										
3. Process-Step	Doctor			Consult the patient	Send Patient to the required Laboratary						Prescribe Medicine based on lab result	
4. Process-Step	Lab Technician					Collect Blood	Separate Serum from clotted blood	Add Diabetes reagent for incubation	Analyse sample on device.	Generate Laboratory Result		
5. Process-Step	Hospital (Pharmacy Dept)											Deliver Medicine
6. Process-Step	...?											
7. Process-Step	...?											
8. Process-Step	...?											
9. Process-Step	...?											
10. Process-Step	...?											
11. Process-Step	...?											
12. Process-Step	...?											
Input:	Which Inputs are necessary to start the Activity?	Patient (Information)	./.	Patient (General Ticket)	./.	Patient (Lab Sample)	./.	...?	./.	Patient (Lab Sample)	...?	Medicine (order)
Methods:	Which Instructions/ Rules direct how to perform the Activity?			Clinical rotation		Queuing Rules				Arrival Time of patients		Pharmacy Que as per token.
Resources:	Which Equipment/ Machines/ Tools operate or support the Activity?					Laboratory Devices						
Output:	Which Output results from the Activity?	Patient (General Ticket)	./.	Patient (OP Report)		Patient (Lab Report)	./.	...?	./.	Patient (Lab Report)	...?	Medicine (Delivery)
Which Influences of the: - Methods and - Resources negatively affect:	... the Quality (Faultlessness/ Fulfilment of Purpose) of the Output?			Clinical rotation of doctors to ward increase length of stay at consultation						The patients who came after first serum seperation take longer time for result		
	... the Availability (right Quantity just in Time) of the Output?					variable patient volume						Long waiting time in pharmacy
	... the Consumption and Waste of Input and/ or Resources?											
How often are the Activities affected by these negative Influences?				76%		72%				64%		75%

Interpretation & implication

1. The reduction in number of doctors at consultation room due to clinical rotation will affect the length of stay of patients at consultation.
2. The patients who came late in an hour will take more time for getting lab result because of processing of initial lab sample they received.
3. The long waiting time of patient at pharmacy also affect the availability of critical medicine availability.
4. The variable patient volume is considered under availability category.

Clinical rotation of doctors, queue rules in the laboratory and the variable patient volume are the most important influences ✓

Bar Chart: Influences of methods and resources on the activities



Results

1. The influences of methods and resources on the activities of the process show an estimated frequency between 65-75%

Interpretation and implication

1. The negative influences on the activities in the occur with a similarly high frequency

2. The Length of stay is the area where it is affected by both the clinical rotation as well as the long processing of lab sample

Process mapping analysis was executed and the negative influences are identified

Cause & Effect Matrix (1/2)

C&E Matrix	Output (Y)	Severity	90%	83%	45%	Results for: Impact of Influences (xI & xP) on the Outputs (Y)		
		Kano-Category	Must-Be	Must-Be	More/Less-Is-Better			
		Problems (= Effects)	Y_01 | Problem: PATIENT (MEDICAL TREATMENT) LENGTH OF STAY TOO LONG	Y_02 | Problem: PATIENT (LAB REPORT) FACILITY USAGE INEFFICIENT	Y_03 | Problem: MEDICINE (DELIVERY) AVAILABILITY STOCK LEVEL < DEMAND	Product Sum of the Impact of each Influence (xI & xP) on all Outputs (Y)	Percentual Impact of each Influence (xI & xP) on all Outputs (Y)	Ranking of the Impact of each Influence (xI & xP) on all Outputs (Y)
Influences from Input (xI) (= Causes)	**Probability**	**Rank**						
xI_01: Input: Patient (Information) | Requirement: Quick processing of general ticket | Requirement-Category: Quality (Faultlessness/ Fulfilment of Purpose) | negative Influence: Delayed processing of general ticket	**56%**	**4**	66%			**0,33**	**11%**	**5**
xI_02: Input: [Patient (General Ticket)] | Requirement: Availability of medical service | Requirement-Category: Quality (Faultlessness/ Fulfilment of Purpose) | negative Influence: Different Disease take different time for medical service.	**81%**	**1**	84%			**0,61**	**20%**	**1**
xI_03: Input: Patient (Sample) | Requirement: Clean and on time sample | Requirement-Category: Consumption (Material/ Machine/ Personnel/ Time/ Energy) | negative Influence: Delayed processing of Laboratary sample.	**72%**	**3**		77%		**0,46**	**15%**	**3**
xI_04: Input: Medicine (order) | Requirement: Optimum stock with regular filling | Requirement-Category: Availability (right Quantity just in Time) | negative Influence: Out of stock condition of medicine and higher inventory	**79%**	**2**			82%	**0,29**	**9%**	**6**
Influences from Process-Step (xMR) (= Causes)	**Probability**	**Rank**						
xMR_01: Activity: Describe illness | Input: Patient (Information) | Methods: ./. | Resources: ./. | Output: Patient (General Ticket) | Influence on Quality: ./. | Influence on Availability: ./. | Influence on Consumption: ./.								
xMR_02: Activity: Create general ticket | Input: ./. | Methods: ./. | Resources: ./. | Output: ./. | Influence on Quality: ./. | Influence on Availability: ./. | Influence on Consumption: ./.								
xMR_03: Activity: Consult the patient | Input: Patient (General Ticket) | Methods: Clinical rotation | Resources: ./. | Output: Patient (OP Report) | Influence on Quality: Clinical rotation of doctors to ward increase length of stay at consultation | Influence on Availability: ./. | Influence on Consumption: ./.	**76%**	**1**	71%			**0,49**	**16%**	**2**
xMR_04: Activity: Send Patient to the required Laboratary | Input: ./. | Methods: ./. | Resources: ./. | Output: ./. | Influence on Quality: ./. | Influence on Availability: ./. | Influence on Consumption: ./.								
xMR_05: Activity: Collect Blood | Input: Patient (Lab Sample) | Methods: Queuing Rules | Resources: Laboratory Devices | Output: Patient (Lab Report) | Influence on Quality: ./. | Influence on Availability: variable patient volume | Influence on Consumption: ./.	**72%**	**3**		70%		**0,42**	**14%**	**4**
xMR_09: Activity: Generate Laboratory Result | Input: Patient (Lab Sample) | Methods: Arrival Time of patients | Resources: ./. | Output: Patient (Lab Report) | Influence on Quality: The patients who came after first serum seperation take longer time for result | Influence on Availability: ./. | Influence on Consumption: ./.	**64%**	**4**	44%			**0,25**	**8%**	**7**
xMR_10: Activity: Prescribe Medicine based on lab result | Input: ./. | Methods: ./. | Resources: ./. | Output: ./. | Influence on Quality: ./. | Influence on Availability: ./. | Influence on Consumption: ./.								
xMR_11: Activity: Deliver Medicine | Input: Medicine (order) | Methods: Pharmacy Que as per token. | Resources: | Output: Medicine (Delivery) | Influence on Quality: ./. | Influence on Availability: Long waiting time in pharmacy | Influence on Consumption: ./.	**75%**	**2**			69%	**0,23**	**8%**	**8**
Results for: Determination of Outputs (Y) by Influences (x)	**Product Sum of the Determination of each Output (Y) by the Influences (xI & xP)**		**2,3839**	**0,8771**	**0,5244**			
	Percentual Determination of each Output (Y) by the Influences (xI & xP)		**63%**	**23%**	**14%**			
	Ranking of the Determination of each Output (Y) by the Influences (xI & xP)		**1**	**2**	**3**			

Cause & Effect Matrix (2/2)

Interpretation and implication

1. The cause & effect are analyzed and classified into suitable category.
2. The length of stay of patient is affected by ticket processing, different type of disease, arrival of patients as well as the clinical rotation of doctors.
3. The lab test result is affected mostly by the time spend by lab technician for processing result.
4. The availability of medicine is affected by both the number of patient as well as time spend at pharmacy.

Cause & Effect Heat Map (1/2)

Chart: C&E Heatmap The cells indicate the strength of each relationship between influences (xI and xP) and the related Outputs (Y) as Risks (Probability x Severity). The Risks are the basis for prioritizing of the corresponding Hypothesis between x and Y. (Nothing needs to be entered here)		**Severity**	**90%**	**83%**	**45%**	**Results for: Impact of Influences (xI & xP) on the Outputs (Y)**		
		Output (Y) Problems (= Effects)	Y_01 | Problem: PATIENT (MEDICAL TREATMENT) LENGTH OF STAY TOO LONG	Y_02 | Problem: PATIENT (LAB REPORT) FACILITY USAGE INEFFICIENT	Y_03 | Problem: MEDICINE (DELIVERY) AVAILABILITY STOCK LEVEL < DEMAND	**risk-weighted Product Sum of the Impact of each Influence (xI & xP) on all Outputs (Y)**	**risk-weighted Percentual Impact of each Influence (xI & xP) on all Outputs (Y)**	**Ranking of the risk-weighted Impact of each Influence (xI & xP) on all Outputs (Y)**
Influences from Input (xI) (= Causes)		**Probability**	**D**	**E**	**F**			
xI_01: Input: Patient (Information) | Requirement: Quick processing of general ticket | Requirement-Category: Quality (Faultlessness/ Fulfilment of Purpose) | negative Influence: Delayed processing of general ticket		**56%**	**39,99%**			**0,3999**	**15%**	**4**
xI_02: Input: [Patient (General Ticket)] | Requirement: Availability of medical service | Requirement-Category: Quality (Faultlessness/ Fulfilment of Purpose) | negative Influence: Different Disease take different time for medical service.		**81%**	**58,30%**			**0,5830**	**22%**	**1**
xI_03: Input: Patient (Sample) | Requirement: Clean and on time sample | Requirement-Category: Consumption (Material/ Machine/ Personnel/ Time/ Energy) | negative Influence: Delayed processing of Laboratary sample.		**72%**		**40,94%**		**0,4094**	**15%**	**3**
xI_04: Input: Medicine (order) | Requirement: Optimum stock with regular filling | Requirement-Category: Availability (right Quantity just in Time) | negative Influence: Out of stock condition of medicine and higher inventory		**79%**			**8,58%**	**0,0858**	**3%**	**7**
Influences from Process-Step (xMR) (= Causes)		**Probability**						
xMR_01: Activity: Describe illness | Input: Patient (Information) | Methods: ./. | Resources: ./. | Output: Patient (General Ticket) | Influence on Quality: ./. | Influence on Availability: ./. | Influence on Consumption: ./.						**0,0000**		
xMR_02: Activity: Create general ticket | Input: ./. | Methods: ./. | Resources: ./. | Output: ./. | Influence on Quality: ./. | Influence on Availability: ./. | Influence on Consumption: ./.						**0,0000**		
xMR_03: Activity: Consult the patient | Input: Patient (General Ticket) | Methods: Clinical rotation | Resources: ./. | Output: Patient (OP Report) | Influence on Quality: Clinical rotation of doctors to ward increase length of stay at consultation | Influence on Availability: ./. | Influence on Consumption: ./.		**76%**	**48,14%**			**0,4814**	**18%**	**2**
xMR_04: Activity: Send Patient to the required Laboratary | Input: ./. | Methods: ./. | Resources: ./. | Output: ./. | Influence on Quality: ./. | Influence on Availability: ./. | Influence on Consumption: ./.						**0,0000**		
xMR_05: Activity: Collect Blood | Input: Patient (Lab Sample) | Methods: Queuing Rules | Resources: Laboratory Devices | Output: Patient (Lab Report) | Influence on Quality: ./. | Influence on Availability: variable patient volume | Influence on Consumption: ./.		**72%**		**37,22%**		**0,3722**	**14%**	**5**
xMR_09: Activity: Generate Laboratory Result | Input: Patient (Lab Sample) | Methods: Arrival Time of patients | Resources: ./. | Output: Patient (Lab Report) | Influence on Quality: The patients who came after first serum seperation take longer time for result | Influence on Availability: ./. | Influence on Consumption: ./.		**64%**	**28,00%**			**0,2800**	**10%**	**6**
xMR_10: Activity: Prescribe Medicine based on lab result | Input: ./. | Methods: ./. | Resources: ./. | Output: ./. | Influence on Quality: ./. | Influence on Availability: ./. | Influence on Consumption: ./.						**0,0000**		
xMR_11: Activity: Deliver Medicine | Input: Medicine (order) | Methods: Pharmacy Que as per token. | Resources: | Output: Medicine (Delivery) | Influence on Quality: ./. | Influence on Availability: Long waiting time in pharmacy | Influence on Consumption: ./.		**75%**			**7,08%**	**0,0708**	**3%**	**8**
Results for: Determination of Outputs (Y) by Influences (x)	**risk-weighted Product Sum of the Determination of each Output (Y) by the Influences (xI & xP)**		**1,7443**	**0,7816**	**0,1566**			
	risk-weighted Percentual Determination of each Output (Y) by the Influences (xI & xP)		**65%**	**29%**	**6%**			
	Ranking of the risk-weighted Determination of each Output (Y) by the Influences (xI & xP)		**1**	**2**	**3**			

Cause & Effect Heat Map (2/2)

Results

1. According to the C&E Matrix and Heatmap the two Must-Be problems (CtQ‘s) are triggered by negative influences of the input and activities, resulting in comparable high risks for the corresponding x-Y-pairs

3. The risk is highest for the influence of different type of disease on length of stay of patient at hospital

4. The length of stay of patient at pharmacy has the lowest x-Y-risks

Interpretation and implication

1. The most important risks in influence-problem pairs (x-Y-pairs) will serve as a basis for the hypotheses

Summary of important influence (x) problem (Y) relationships and …

Influences of Inputs, Methods and Resources and their strength on the …

… Problems of the Output	X_01 Delayed Processing of ticket	X_02 Different medical service time	X_03 Delayed processing of lab sample	X_04 Medicine demand	Xmr_01_Clinical Rotation of doctors	Xmr_02_Arrival Nature of patient at lab	XMR_03 Pharmacy waiting time	XMR_04 Variable Patient volume	…
Y_01 Patient length of stay	◑	◕	○	○	◑	◑	○	○	
Y_02 Patient Lab Report	○	○	◑	○	○	○	○	◔	○
Y_03 Medicine Order	○	○	○	◔	○	○	◔	○	○

Legend

○	(nearly) no risk
◔	small risk
◑	moderate risk
◕	strong risk
●	higk risk

Interpretation and implication:

Y01: Different medical service times is a strong risk while clinical rotation, arrival nature & ticket processing are moderate risks

Y02: Delayed processing of lab sample is moderate risk while variable patient sample is small risk

Y03: Medicine demand & Pharmacy waiting time are of low risk on the medicine order

Results

1. The delayed processing of ticket as well as different medical service affect length of stay.
2. The time at which patient arrive influence lab result.
3. The weekly demand is affected by number of patients

… the risks, that the influences trigger or increase the problems

Data Collection Plan

Data Collection Plan | ons and plan the graphical display as well as initial analyses based on the proposals (right ->)

Ranking of Influences (xI & xMR) and Outputs (Y)	Influences (xI & xMR) and Outputs (Y)	Please specify the measurand (e.g. Time)	Please specify the units of the measurand (e.g. days)	Please specify the Target and its Specification Limits - if known - in the format: Target: USL: LSL:	Which different values can the Measurand take? (Scale of Data)	How should the Data be collected?	Is a Measurement-System-Analysis (MSA) necessary?
Output (Y)							
1	Y_01	Problem: PATIENT (MEDICAL TREATMENT) LENGTH OF STAY TOO LONG	Time	Minutes	USL:65 min LSL:45 min	Data discrete or continuous (Cardinal-Scale)	collect existing data	no
2	Y_02	Problem: PATIENT (LAB REPORT) FACILITY USAGE INEFFICIENT	Lab result number	Units	USL:50 unit LSL:25 unit	Data discrete or continuous (Cardinal-Scale)	collect new data	no
3	Y_03	Problem: MEDICINE (DELIVERY) AVAILABILITY STOCK LEVEL < DEMAND	Weekly demand of medicine	Number of Tablet strips	USL:23000 LSL:19500	Data discrete or continuous (Cardinal-Scale)	collect existing data	no

Which Data about the circumstances should additionally be collected? (Blocking-/ Condition-Variables)	How large should the Sample Size be?	Where should the Data be collected? (Location/ Source)	For which Time Interval should the Data be collected? (Start/ End)	Which Variable-Name will you assign to the Measurand?	In which File will the Data be stored?	Who is responsible for the collection of the data?
Type of day (Monday,Tuesday etc)	60	Hospital (Over all)	4 month	Y_01_(Patient)	Leansixsigmahospital_rh_05	Myself
Hour (10 o clock,11 o clock etc)	60	Laboratory	4 month	Y_02_(Lab Report)	Leansixsigmahospital_rh_05	Myself
Type of medicine (Metformin)	60	Pharmacy	4 month	Y_03_(Medicine Delivery)	Leansixsigmahospital_rh_05	Myself

Graphical Representation				Parameter of Central Tendency			Dispersion Parameter		Process-Capability			Control-Charts				
Histogram	Error Bar-Chart/ Interval-Diagram	Box-Plot	Time-Series-Chart/ Run-Chart/ Line-Chart	Modus	Median	Mean	Quartile	Standard Deviation/ Variance	Error Rate (DPU ppm/ z-Value (Sigma-Level)	(DPO/ DPMO/ z-Value (Sigma-Level)	Ppi/ Ppk/ Cpi/ Cpk/ Z-Value (Sigma-Level)	I-MR-Chart (if N <= 100)	xbar-R-Chart (if N > 100 and if subgroup size <= 8)	xbar-S-Chart (if N > 100 and if subgroup size > 8)	p-Chart (if ok vs. ko is discriminated)	u-Chart (if ok vs. different defect opportunities are discriminated)
												100.00%	100.00%	100.00%		200.00%
												100.00%	100.00%	100.00%		200.00%
												100.00%	100.00%	100.00%		200.00%

Results

1. Data collection plan is formulated effectively
2. The circumstances are also evaluated
3. The USL and LSL are also specified, as well as the time period of collection plan mentioned.
4. The sample sizes are specified

Interpretation and implication

1. The parameter, charts and one-sample tests are suggested for the collected data
2. The output are all cardinal scale and has required specific limits.
3. The input and its method are of nominal as well as cardinal scale.

Hypotheses (1/2)

Risk	Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)]
39.99%	There is a/ no Difference in the degree of: Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)] between the Levels of: xL_01: Input: Patient (Information) [Levels of: Ticket nature (New ticket/Old Ticket)].
Difference Hypothesis	t-Test

Risk	Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)]
58.30%	There is a/ no Difference in the degree of: Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)] between the Levels of: xL_02: Input: [Patient (General Ticket)] [Levels of: Disease Type (Diabetes,Cholestrol,hypertension etc.)].
Difference Hypothesis	ANOVA

Risk	Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)]
28.00%	There is a/ no Difference in the degree of: Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)] between the Levels of: xMR_09: Activity: Generate Laboratory Result [Levels of: Type of patient (Intial patient / Final patient)].
Difference Hypothesis	t-Test

Risk	Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)]
48.14%	There is a/ no Difference in the degree of: Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)] between the Levels of: xMR_03: Activity: Consult the patient [Levels of: Doctor number (Doctor present / Doctor absent)].
Difference Hypothesis	t-Test

Results

1. The variaation in time among New ticket/Old ticket are need to be analysed using the t-test.
2. The different disease take different time which is also need to be analysed using ANOVA.
3. The Intial and final patient meant to determine the impact on early sample arrival and can be determined by t-test.

Interpretation and implication

1. The categorical nature of input need ANOVA and T test to determine the results and for further analysis
2. The Length of stay of patient under different disease category has the most risk factor

Hypotheses (2/2)

Risk	Y_02: Output: Patient (Lab Report) [Degree of: Lab result number in an hour (Units/hr)]
40.94%	There is a/ no Relationship between: xI_03: Input: Patient (Sample) [Degree of: Time (Minutes)] and: Y_02: Output: Patient (Lab Report) [Degree of: Lab result number in an hour (Units/hr)] according to the Principle: The larger the value of x, the larger (resp. smaller) is the value of Y.
Relationship Hypothesis	Product-Moment-Correlation (Pearson)/ General Regression

Risk	Y_03: Output: Medicine (Delivery) [Degree of: Weekly demand of medicine (Number of Tablet strips)]
8.58%	There is a/ no Relationship between: xI_04: Input: Medicine (order) [Degree of: Patient Number (Number of patient)] and: Y_03: Output: Medicine (Delivery) [Degree of: Weekly demand of medicine (Number of Tablet strips)] according to the Principle: The larger the value of x, the larger (resp. smaller) is the value of Y.
Relationship Hypothesis	Product-Moment-Correlation (Pearson)/ General Regression

Risk	Y_03: Output: Medicine (Delivery) [Degree of: Weekly demand of medicine (Number of Tablet strips)]
7.08%	There is a/ no Relationship between: xMR_11: Activity: Deliver Medicine [Degree of: time (Minutes)] and: Y_03: Output: Medicine (Delivery) [Degree of: Weekly demand of medicine (Number of Tablet strips)] according to the Principle: The larger the value of x, the larger (resp. smaller) is the value of Y.
Relationship Hypothesis	Product-Moment-Correlation (Pearson)/ General Regression

Risk	Y_02: Output: Patient (Lab Report) [Degree of: Lab result number in an hour (Units/hr)]
37.22%	There is a/ no Relationship between: xMR_05: Activity: Collect Blood [Degree of: Number of patient (Patient per hour)] and: Y_02: Output: Patient (Lab Report) [Degree of: Lab result number in an hour (Units/hr)] according to the Principle: The larger the value of x, the larger (resp. smaller) is the value of Y.
Relationship Hypothesis	Product-Moment-Correlation (Pearson)/ General Regression

Results

1. The clinical rotation of doctor effect can be determined using T test.
2. The performance of lab technician is also determined ny regression method.
3. The influence of variable number of population on the lab result can also be determined by regression analysis.

Interpretation and implication

1. The regression will help to determine relation between medicine demand and patient number.
2. The time at pharmacy can also be a decisional factor.

Example data-sheet of collected data

Serial no	Y_01 Patient length of stay	Y_02 Patient Lab Report	Y_03 Medicine Order	X_01 Delayed Processing of ticket	X_02 Different medical service time	X_03 Delayed processing of lab sample	X_04 Medicine demand	Xmr_01_Clinical Rotation of doctors	Xmr_02_Arrival Nature of patient at lab	Xmr_03 Pharmacy waiting time	Xmr_04 variable patient volume
1	65	12	19160	New Patient	Diabetes	34	864	Doctor Present	Intial Patient	21	17
2	71	9	24410	Old patient	Cholestrol	43	920	Doctor Absent	Final patient	31	12
3	82	11	26500	New Patient	Diabetes	25	1024	Doctor Absent	Intial Patient	27	18
4	43	8	22610	Old patient	Hypertension	31	915	Doctor Present	Intial Patient	19	8
5	119	12	18510	Old patient	Hypertension	27	870	Doctor Present	Final patient	52	12
6	140	11	20280	New Patient	Diabetes	22	906	Doctor Absent	Final patient	62	11
7	110	13	22780	Old patient	Creatin	29	916	Doctor Absent	Intial Patient	48	14
8	36	9	20550	Old patient	Diabetes	34	890	Doctor Present	Final patient	16	13
9	57	10	20450	New Patient	Diabetes	33	906	Doctor Absent	Final patient	24	17
10	76	11	19880	New Patient	cholestrol	32	874	Doctor Present	Intial Patient	41	12

Results

1. The time spend by patients of different token are recorded.
2. The similar data records across different days and weeks are also collected

Interpretation and implication

Results of the MEASURE-Steering

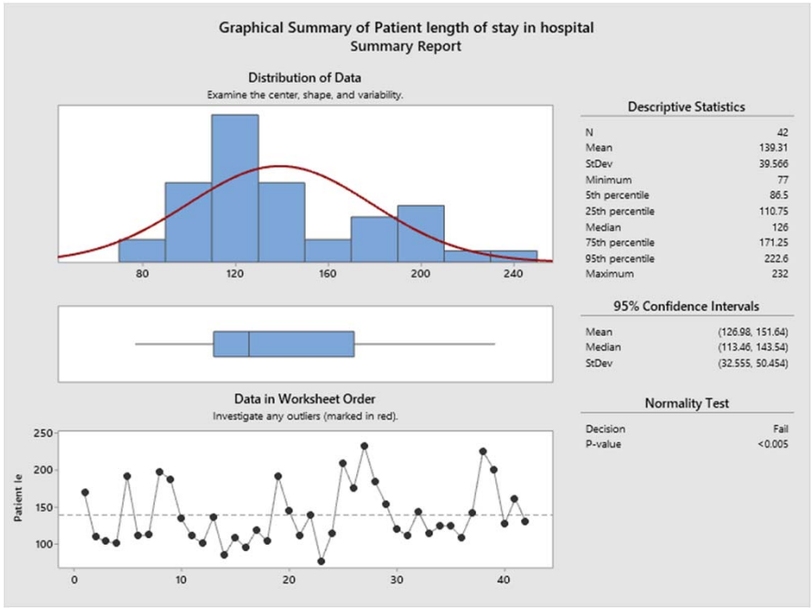
Measure-Steering				
Master-Black-Belt	**Proceed to next-Phase**	**Remarks**	**Date**	**Contact/ Verification-ID**
Dr. Reiner Hutwelker	**yes**	Hello Tony, A clear GO to ANALYSE. Please collect as much as data as possible, suggested in the Data-Collection-Plan. This can be laborious, but it is necessary for a successful continuation of your project.	27.9.2019	reiner.hutwelker@softlogik.de
Sponsor	**Proceed to next-Phase**	**Remarks**	**Date**	**Contact**
Dr Neetha Alice Paul	**yes**	The data collection plan are found to be feasible and satisfied with the current plan for data collection. The concept of initial patient and final patient needs some amount of clarity. So suggesting for more data collection in that area.	2.10.2019	
	no			

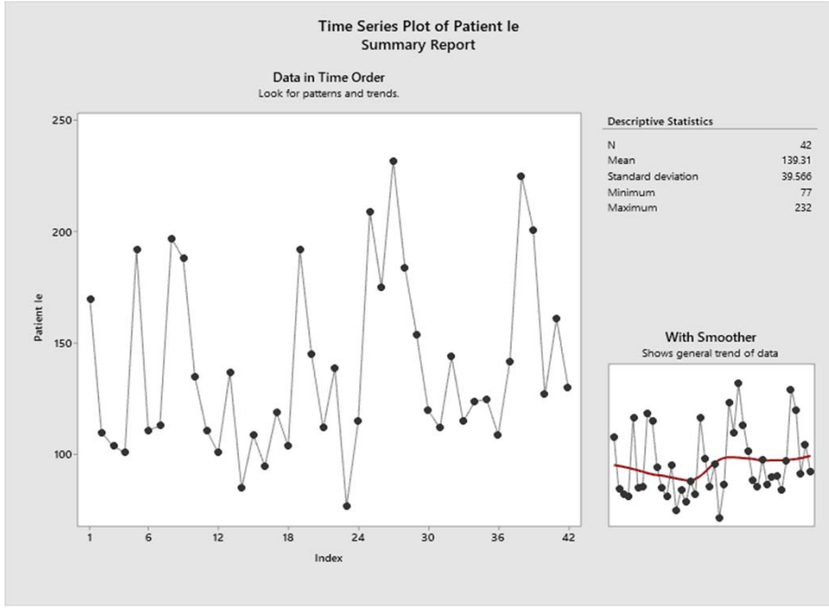
Only proceed to the next phase after a positive decision of MBB and Sponsor

Analyse

Data Evaluation, Process Performance, Test of Hypotheses, Root Cause Analysis

The graphical summary of Y_01 patient length of stay





Results

The graphical summary indicates that

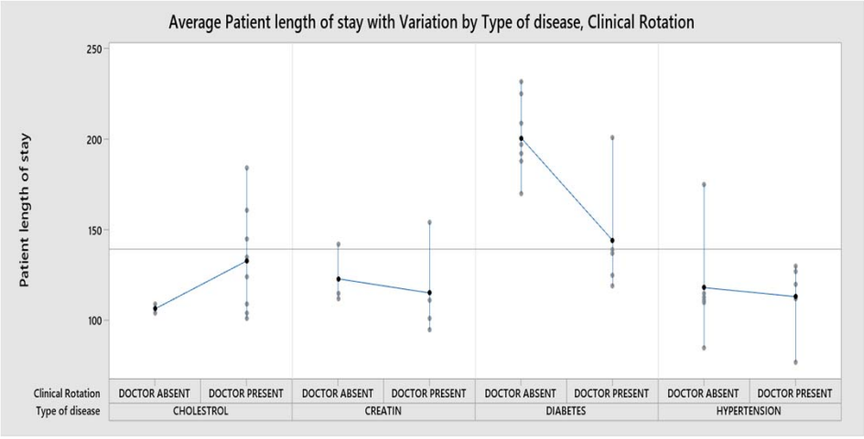
1. The histogram shows the distribution of data and it follows a bimodal pattern – one reason that the normality test indicate a significant deviation.
2. The test gives 95% confidence interval range for mean, median and mode.
3. The time series plot shows the variation of length of stay across the mean and shows a high deviation.
4. The box plot displays the distribution of data based on minimum,median and maximum value of patient‘s length of stay.

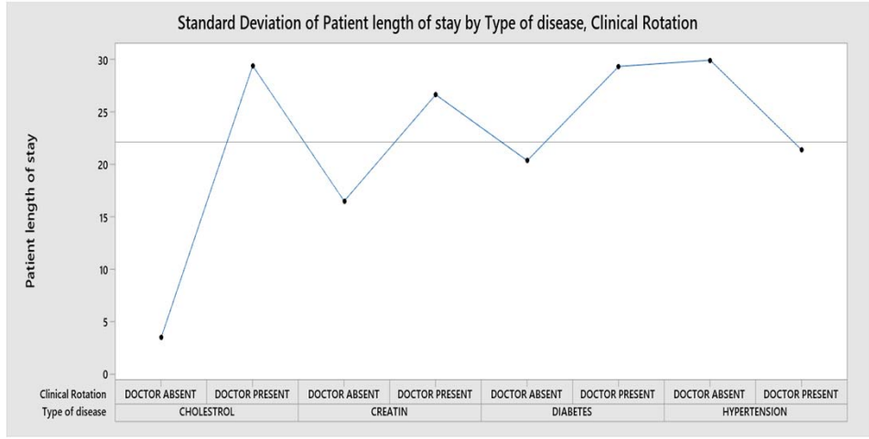
Interpretation and implication

1. The A square value equals 1.43 and p value less than 0.05. Thus, by rejecting the null hypothesis and concluded that data does not follow normal distribution.
2. The non zero skewness value indicate the *non symmetric* nature of distribution.
3. The skewness is increased by the bi-modal distribution, probably due to a special cause
4. The 75% of the data is less than or equal to 171.25 and hence larger value above 200 occurs less frequently.

The graphical summary of the patient‘s length of stay in the hospital shows that it does not follow a normal distribution and the general trend in data is evident from the time series plot.

Mean and standard deviation Multivariate Chart of patient‘s length of stay based on disease & clinical rotation





Results

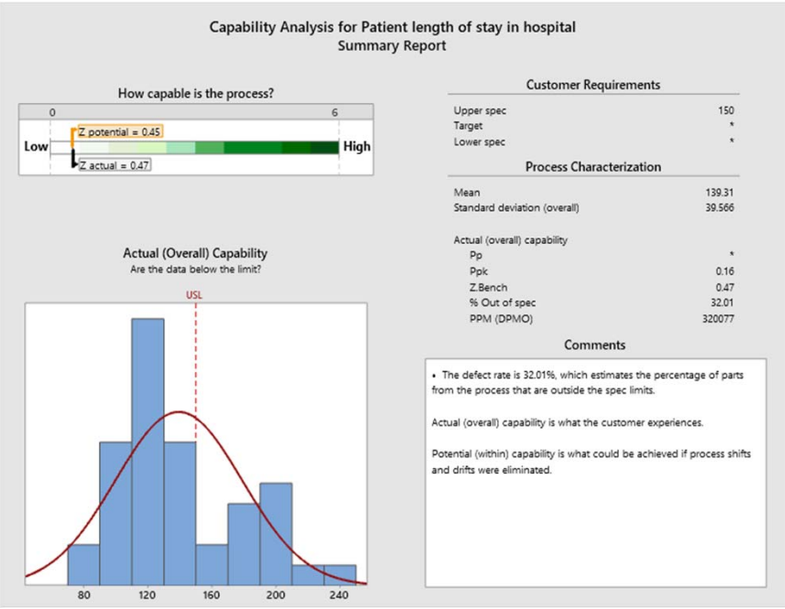
1. The Multi-Vari Chart shows the variation of the:
   - Y Patient length of Stay related to the different levels of the variables:
   - x1-The type of patient‘s disease.
   - x2-The clinical rotation of doctor.
2. The length of stay for diabetic patients is under both doctor rotation conditions (x2) higher than for all other conditions.
3. The cholesterol patients show an appreciable variation in standard deviation in length of stay when considering the effect of clinical rotation.

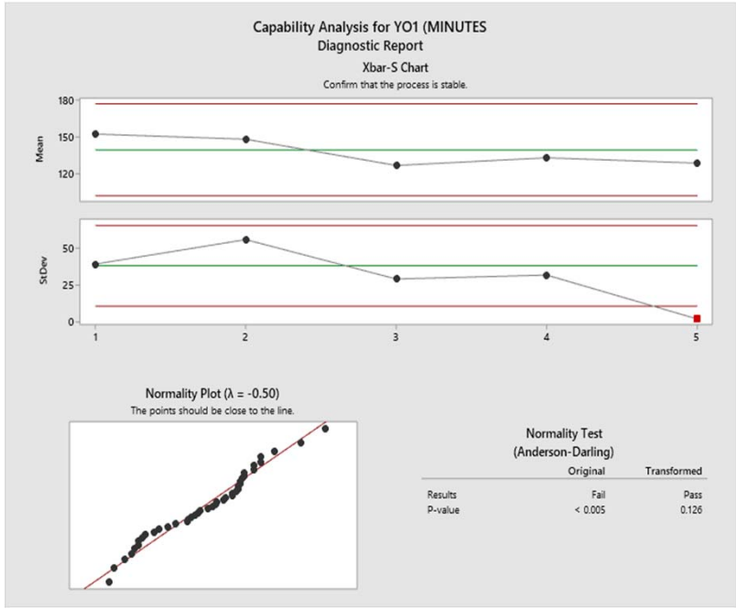
Interpretation and implication

1. The Multivariate chart shows how the clinical rotation of the doctor and the type of the disease affect the length of stay of patients in the hospital.
2. The condition of absence of doctors at consultation increases the length of stay of patients in the hospital and is higher in diabetic patients.
3. The length of stay is highest for diabetic patient and lower for hypertension patients.

The multivariate chart shows that clinical rotation of doctor has the highest impact on diabetic patient‘s length of stay, but the variation in standard deviation due to clinical rotation is highest for cholesterol patients.

Normal Distribution process capability & I-MR chart analysis





Results

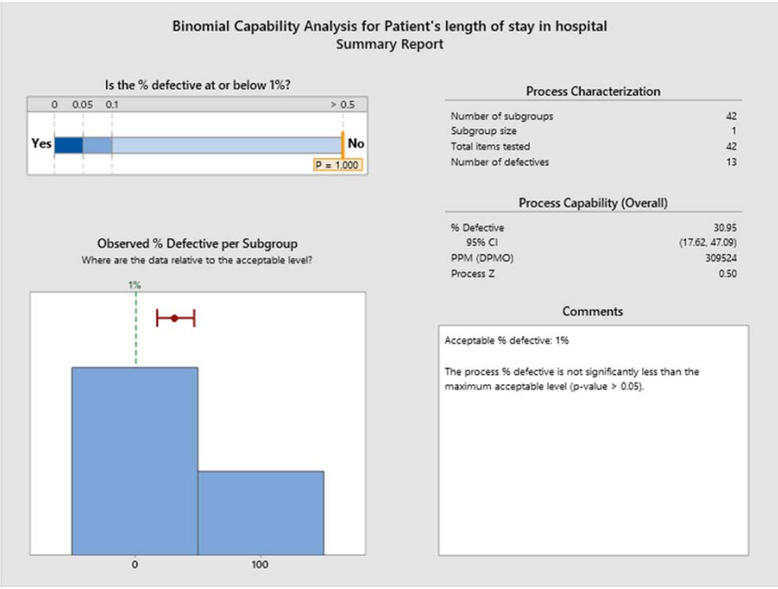
1. The Ppk, % Out of spec and DPMO indicate the process performance.
2. Ppk= 0.16, corresponding to a Z.Bench= 0.47 (Sigma-Level).
3. These indicators are equivalent to 32.01% of the data falling outside the specific limits
4. However, the normality test failed (data on length of stay of patient in the hospital is not normally distributed) and thus the interpretation of the results are under reservation.

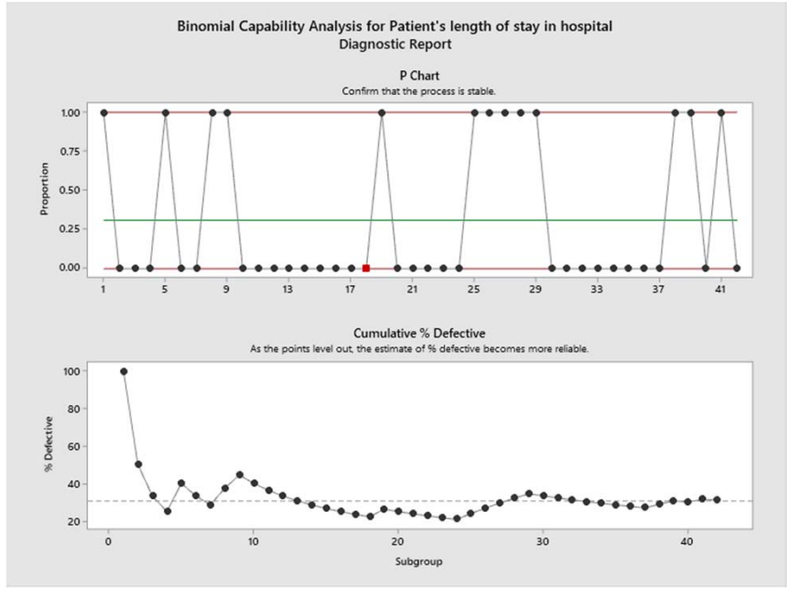
Interpretation and implication

1. The Ppk value shows how well the process is centred about the upper specification limit of 150 minutes.
2. The process performance here shows that hospital current operations are not satisfactory.
3. Because the data is not normally distributed, also the Binomial Capability Analysis is calculated. For this, the cardinal scaled data need to recoded to nominal scaled data.

The process capability shows that almost 32% of patient's length of stay in hospital exceeds the upper specific limit of 150 minutes and since it is not normally distributed, the binomial capability analysis is needed to be done.

Binomial process capability analysis of patient‘s length of stay in hospital





Results

1. The binomial capability analysis of the given data set is carried out with a sub group size of 1 and the P chart shows the proportion of non conforming units for each sub group.
2. The process capability measures 30.95% defects with a confidence interval from 17.62 to 47.09%
3. This corresponds to 309524 parts per million defects.
4. The process z is found to be 0.5 indicating a low Sigma Level.

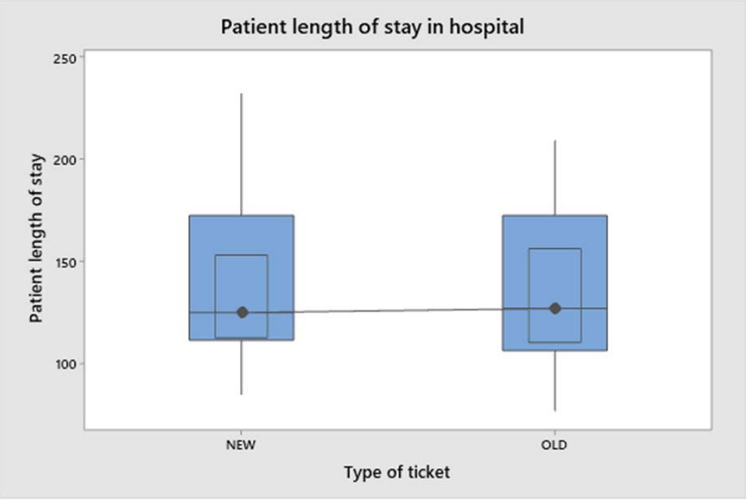
Interpretation and implication

1. The binomial capability analysis is carried out because the data does not follow a normal distribution. Thus we recode the length of stay data with: 0 data lies within the limit of 150 minutes and 1 when data lies outside the specific limit of 150.
2. The current performance level is that 69% of patient’s length of stay is below or equal to 150 minutes and that means a poor performance compared to our target of 99% population to be within that limit.

Binomial capability analysis shows, that 31% of the patient‘s length of stay in the hospital falls above the specification limit of 150 minutes

Mood's median test on type of patient ticket's impact on length of stay patients in hospital

Risk	Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)]
39.99%	There is a/ no Difference in the degree of: Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)] between the Levels of: xL_01: Input: Patient (Information) [Levels of: Ticket nature (New ticket/Old Ticket)].
Difference Hypothesis	t-Test



Descriptive Statistics

Type of ticket	Median	N <= Overall Median	N > Overall Median	Q3 – Q1	95% Median CI
NEW	125	11	10	61	(112.674, 153.162)
OLD	127	10	11	66	(110.347, 156.285)
Overall	126				

95.0% CI for median(NEW) - median(OLD): (-30.4202,26.0652)

Test

Null hypothesis H_0: The population medians are all equal

Alternative hypothesis H_1: The population medians are not all equal

DF	Chi-Square	P-Value
1	0.10	0.758

Interpretation and implication

1. The difference in length of stay of new ticket patients and old ticket patients are neither statistically significant nor practically relevant (2-3 minutes difference)
2. It can be concluded that the type of ticket plays a negligible role in the overall length of stay of patients in the hospital.

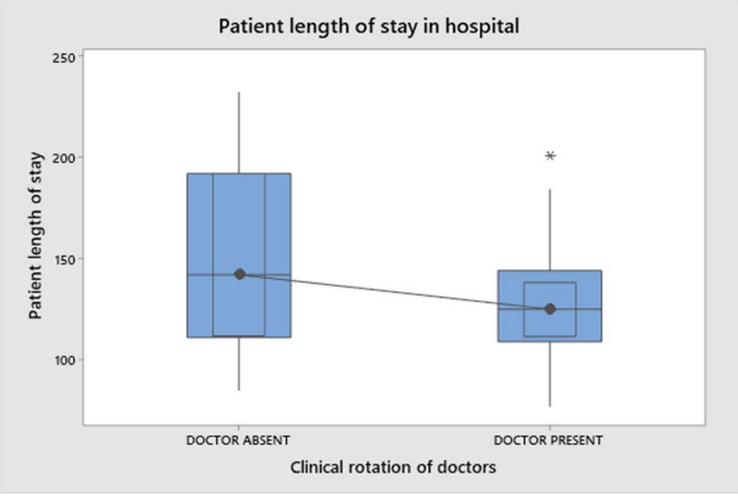
Results

1. The Mood's median test is a nonparametric test that is used to test the equality of medians from two or more populations.
2. The p= 0.758 and it is greater than the specified alpha criterion of 0.05, which confirms the null hypothesis.
3. The 95% confidence intervals (CI) of the Median indicate the same range for both patient types.
4. The Medians for the length of stay differ by 2 minutes between new and old patients
5. The boxplot diagram shows this small difference and the similar variation of the length of stay based on median.

The type of patient (old vs. new) has no impact on the length of stay

Mood's median test on clinical rotation's impact on length of stay of patient in hospital

Risk	Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)]
48.14%	There is a/ no Difference in the degree of: Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)] between the Levels of: xMR_03: Activity: Consult the patient [Levels of: Doctor number (Doctor present / Doctor absent)] .
Difference Hypothesis	t-Test



Descriptive Statistics

Clinical Rotation	Median	N <= Overall Median	N > Overall Median	Q3 – Q1	95% Median CI
DOCTOR ABSENT	142	9	10	81	(111.864, 192)
DOCTOR PRESENT	125	12	11	35	(111.448, 138.104)
Overall	126				

51)

Test

Null hypothesis H_0: The population medians are all equal

Alternative hypothesis H_1: The population medians are not all equal

DF	Chi-Square	P-Value
1	0.10	0.757

Interpretation and implication

1. The difference in length of stay of patient based on clinical rotation of doctor is not statistically significant. Although the median under the condition: Doctor absent is 17 minutes longer, the high variability in the length of stay and the small sample size probably camouflages this difference.
2. Especially for the condition: Doctor absent, we should investigate its causes, to reduce the variability

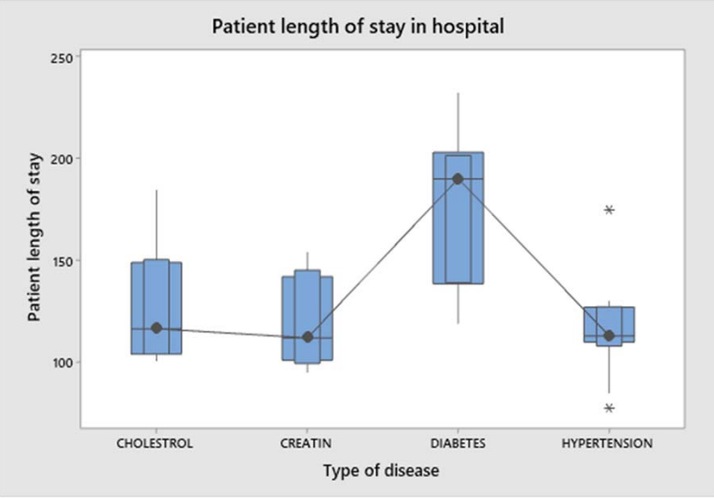
Results

1. The Medians for length of stay differ by 17 minutes when one doctor go for clinical rotation or attending the emergency case.
2. This difference is statistically not significant (p= 0.757), thus confirming the Null Hypothesis.

Although the result is not significant, we should investigate the root causes for the increased and variable length of stay, if the Doctor is absent

Mood's median test on type of patient's disease

Risk	Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)]
58.30%	There is a/ no Difference in the degree of: Y_01: Output: Patient (medical treatment) [Degree of: Time (Minutes)] between the Levels of: xL_02: Input: [Patient (General Ticket)] [Levels of: Disease Type (Diabetes,Cholestrol,hypertension etc.)] .
Difference Hypothesis	ANOVA



Descriptive Statistics

Type of disease	Median	N <= Overall Median	N > Overall Median	Q3 – Q1	95% Median CI
CHOLESTROL	116.5	6	4	45.0	(104, 150.477)
CREATIN	112.0	5	2	41.0	(99.4, 145.2)
DIABETES	190.0	2	12	64.5	(138.897, 201.412)
HYPERTENSION	113.0	8	3	17.0	(107.945, 127.247)
Overall	126.0				

Test

Null hypothesis H_0: The population medians are all equal

Alternative hypothesis H_1: The population medians are not all equal

DF	Chi-Square	P-Value
3	11.10	0.011

Interpretation and implication

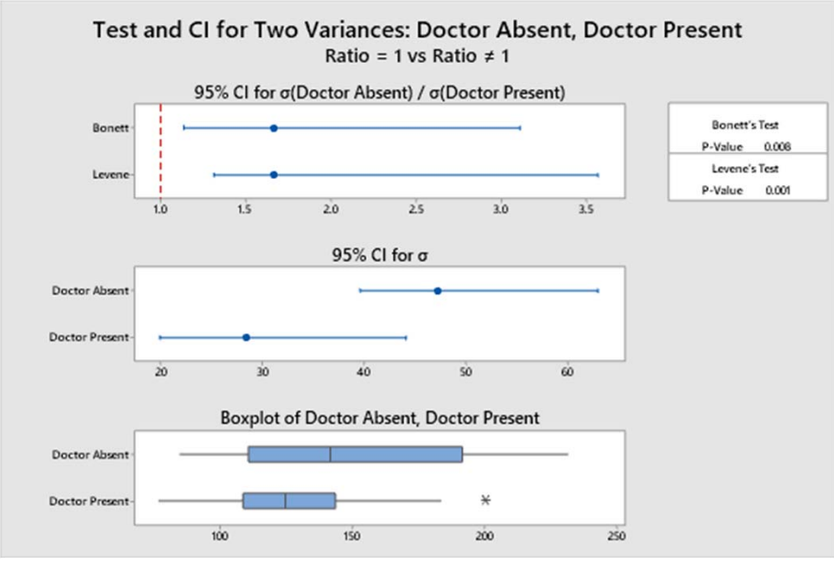
1. The difference in length of stay based on type of disease is statistically significant as well as practically relevant. A diabetic patient spend one hour or more to get a treatment comparing to a creatine patient.
2. The type of disease thus seriously influence the length of stay of patients in hospital.

Results

1. The Medians for length of stay differ by 78 minute between creatin patient (lowest LOS) and diabetic patient(highest LOS)
2. This result is statistically significant (p= 0.011)
3. The 95% confidence intervals (CI) of the Median indicate different ranges for the four type of disease, with the highest variability for Diabetes and the lowest variability for Hypertension.
4. The boxplot diagram indicates these contrast in length of stay between Diabetes and the three other diseases, concerning the length of stay in the hospital.

The causes for this difference in the length of stay will be investigated in the root cause analysis

Hypothesis: There is a difference in: the variability of the length of stay (Y) between the states of clinical rotation (x)



Test

Null hypothesis	$H_0: \sigma_1 / \sigma_2 = 1$
Alternative hypothesis	$H_1: \sigma_1 / \sigma_2 \neq 1$
Significance level	$\alpha = 0.05$

Test

Method	Statistic	DF1	DF2	P-Value
Bonett	*			0.008
Levene	11.75	1	40	0.001

Descriptive Statistics

Variable	N	StDev	Variance	95% CI for σ
Doctor Absent	19	47.372	2244.146	(39.697, 63.034)
Doctor Present	23	28.465	810.261	(20.033, 44.214)

Results

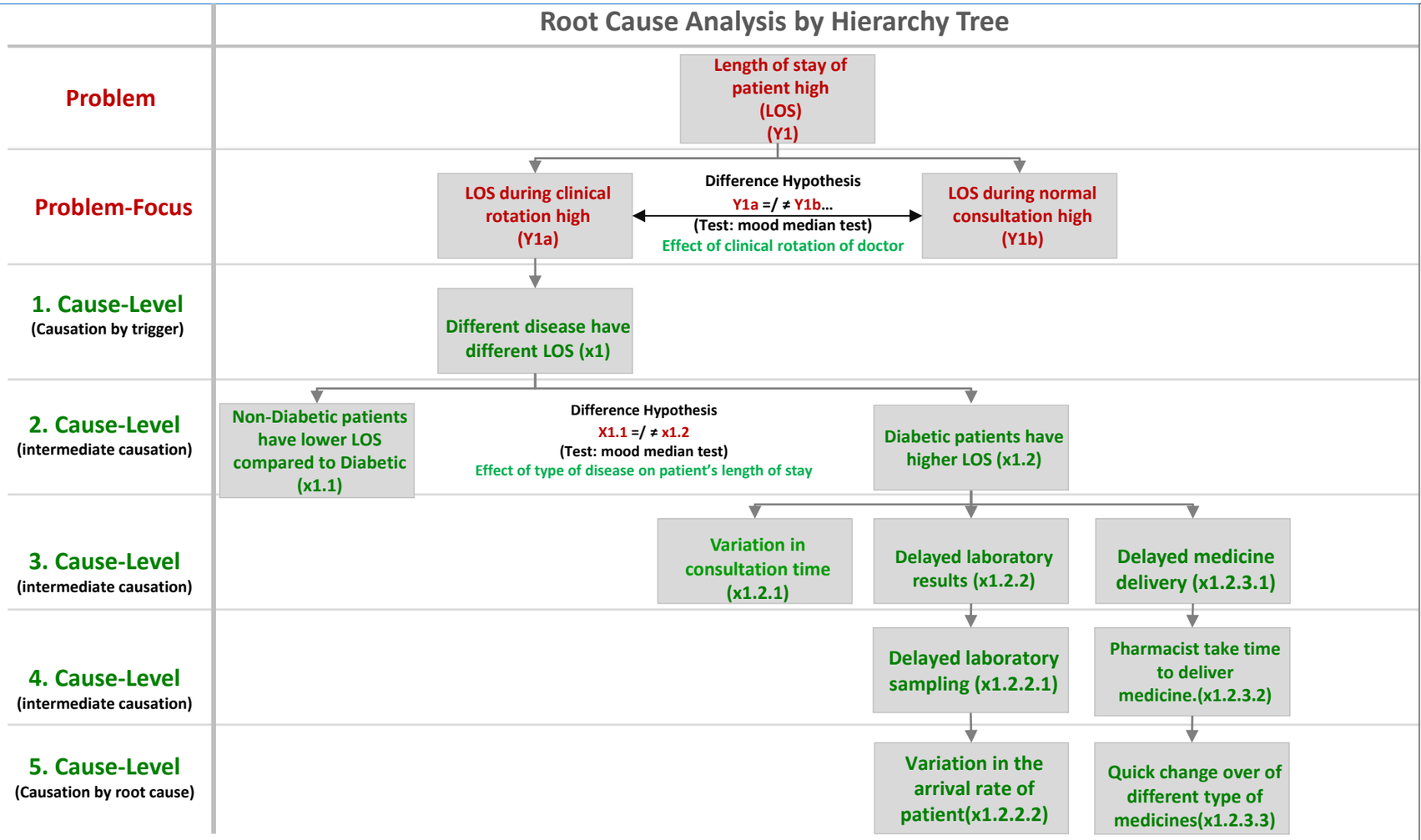
1. The F-test (p= 0.006 and p= 0.001) indicates a significant result, meaning, that there is a difference in the length of stay (Y) between the states of clinical rotation.
2. The Variance of the length of stay is
   - Doctor absent: 2244
   - Doctor present: 810
   and thus differs by a factor of approx. 3. This is presumably practically relevant for our patients.

Interpretation and implication

1. The p value equals 0.008 and is less than the alpha criterion of 0.05 and hence we can reject the hypothesis that variance are equal and can be concluded that clinical rotation of doctor results in a higher variance on length of stay of patients in hospital.
2. When 4 doctors are present in the consultation room the standard deviation is found to be 28.46 but when one doctor goes for clinical rotation it increases the standard deviation of patient's length of stay to 47.372.
3. This variation in the length of stay, depending on clinical rotation, will be included in the root-cause-analysis, to adjust this effect on our patients.

The variance of the length of stay of patients in hospital is affected by the clinical rotation of doctors in hospital.

Analysis strategy: Combined Disease type and Clinical rotation



Results

1. The root cause analysis is carried out to find the cause behind the higher length of stay of patients in the hospital through statistical results and expert reasoning.
2. Due to the practical relevance of clinical rotation, it is better to focus on patients who were consulted when one doctor out of four went for clinical rotation.
3. The type of disease patient has also played an important role in the patient's length of stay. The higher length of stay for diabetic patients is evident from the mood median test and is practically relevant.
4. The reason for the higher length of stay for diabetic patients was found through analysing each process like consultation, laboratory test, and the pharmacy operations.

The main causes, that will serve as interfaces for solutions are: delayed laboratory operation and variation in arrival rate of patients.

Analysis strategy: Combined Disease type and Clinical rotation

Interpretation and implication

1. From the root cause analysis, it is evident that it is better to focus on the diabetic patients and the impact of clinical rotation on length of stay of patients in the hospital in the improvement phase.

2. In diabetic patient's process flow, it can be observed that consultation, laboratory test, and pharmacy play the most critical role and improvement is need to be done on this process.

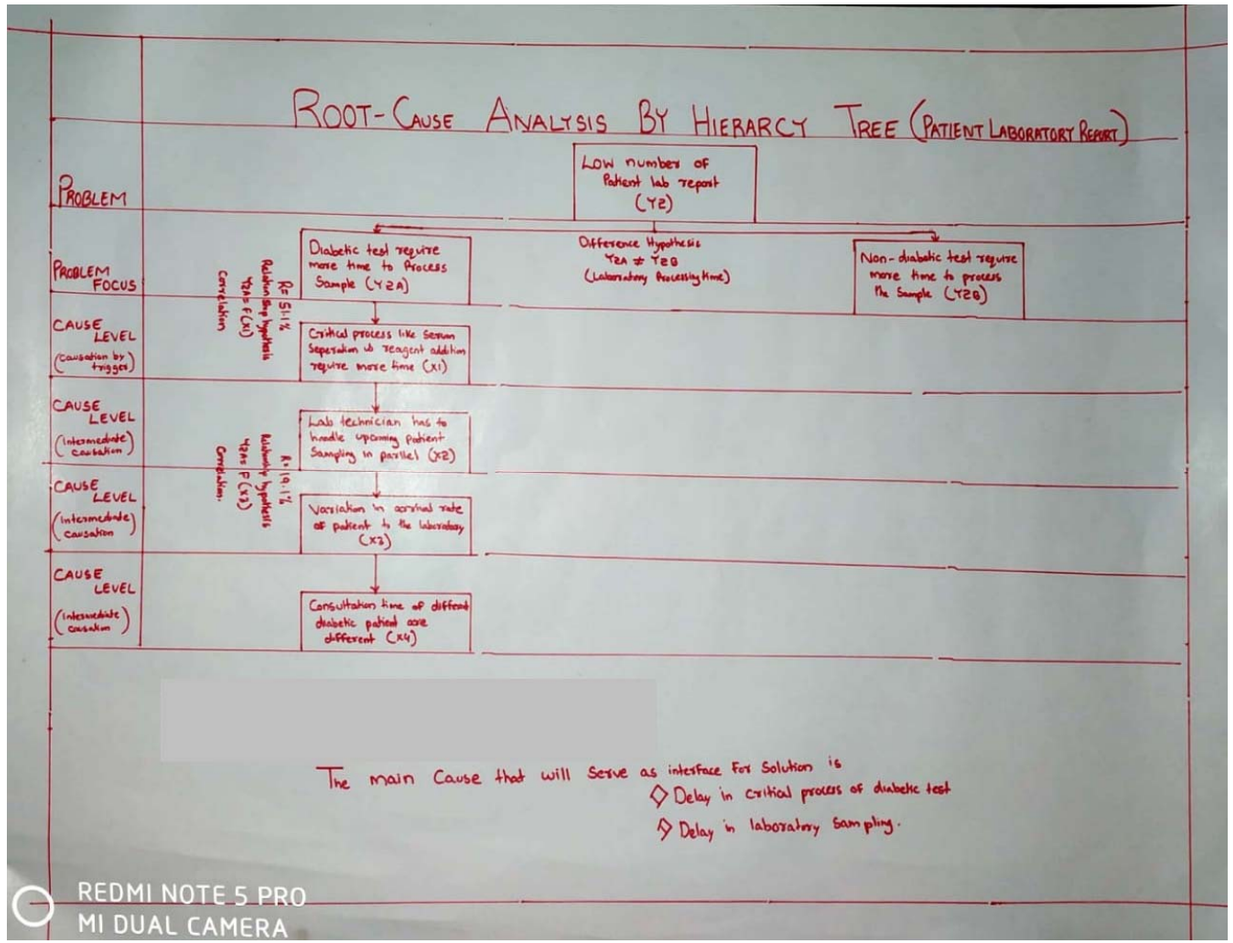
3. In consultation, the time taken by the doctor depends on his treatment method, type of disease, situation, etc. which can't be controlled.

4. In laboratory operation, delayed results are a result of delayed processing of patient samples. The delayed processing of patient samples is because of variation in the arrival rate of patient to laboratory and thus it becomes difficult for lab technicians to handle multiple different operations at the same time. However, the schedule and timing of the laboratory could be adapted to reduce the effect of the variation in arrival rate.

5. In Pharmacy, medicine delivery took a long time and is because pharmacists can't handle the changeover in medicine requirements. To deliver a medicine pharmacist has to check the inventory level, take the medicine from the store and then update the inventory level in software. The pharmacy offers two queues for males and female and it is found that pharmacists take less time to process the medicine requirement of similar disease patient than different patients.

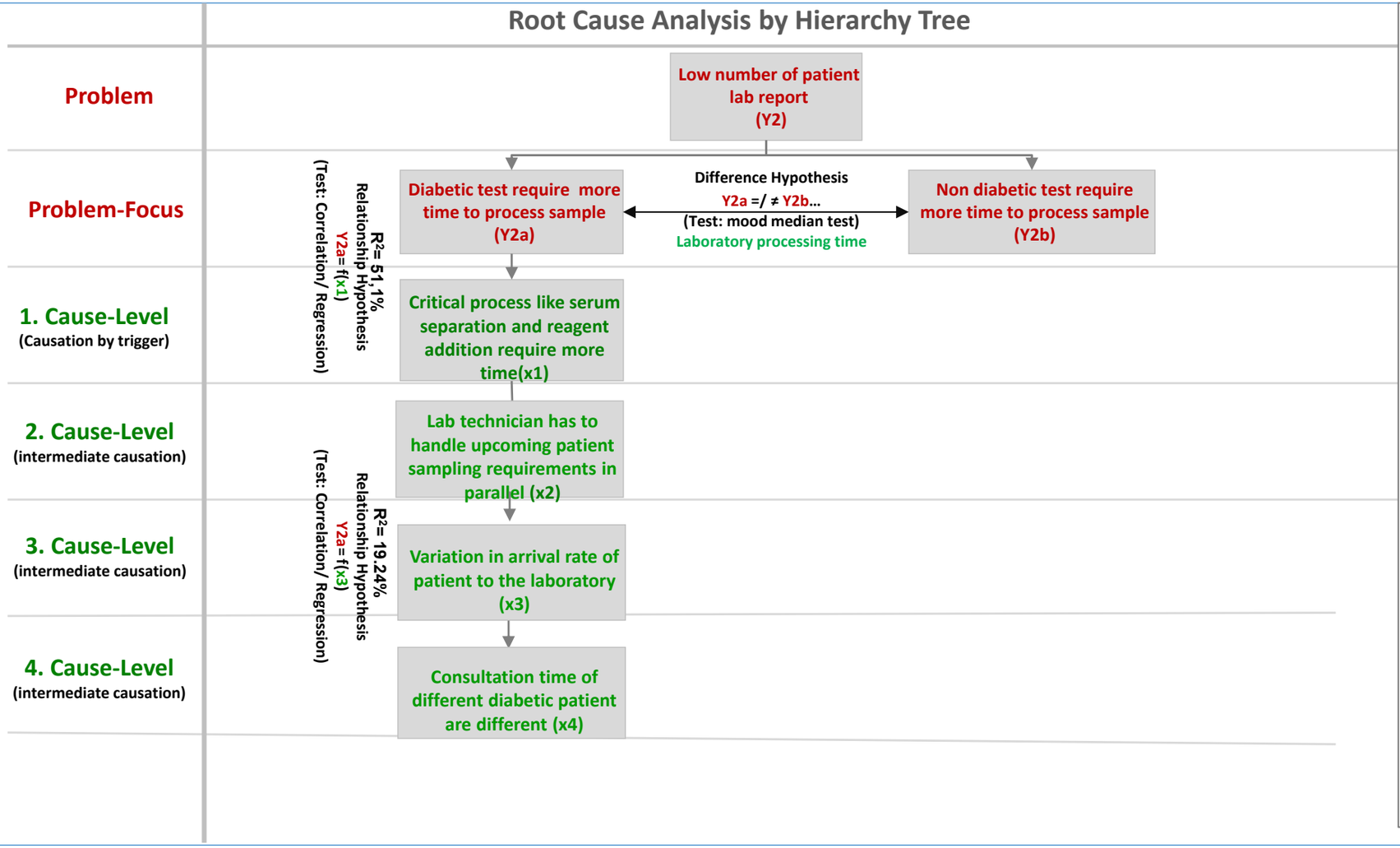
The main causes, that will serve as interfaces for solutions are: delayed medicine delivery and change over in type of medicine

Root cause analysis of low number of patient's lab report



Root cause analysis of low number of patient's lab report was done based on statistical results & expert reasoning

Analysis strategy: Low number of patient laboratory report



Results

1. The root cause analysis is carried out to find the cause behind lower number of patient lab report in the hospital through statistical results and expert reasoning.
2. From the mood median test, the laboratory sampling time is highest for diabetic patient and it is better to focus on diabetic laboratory operations.
3. In the sample processing, serum separation and reagent addition require more time and found that these critical process can explain 51% (R-square value of regression analysis)of the no of lab report produced.
4. These critical process are delayed because of variation in arrival time of patient and statistically speaking their R-square value equals 19% but still, they play a critical role in delaying the process (based on opinion from the technician).

The main causes, that will serve as interfaces for solutions is: delay in critical process of diabetes test.

Analysis strategy: Combined Disease type and Clinical rotation

Interpretation and implication

1. From the root cause analysis, it is evident that it is better to focus on the diabetic patient's lab sample processing, but the same improvement can be applied for cholesterol patients too as they follow a common methodology but vary in type of reagent and time for processing.

2. In diabetic patient's sample processing the most critical areas are serum separation and reagent addition and focus is need to be on reducing error and improving its cycle time.

3. When a lab technician handles one sample, he needs to focus on it but because of the different arrival times of the patient, she/he has to handle other patient requests also and thus delay the process.

4. The different arrival time of the patient is because of diabetic patients are consulted by the doctor in different time as he has to handle other patient along with it.

The main causes, that will serve as interfaces for solutions is: delay in laboratory sampling.

Results of the ANALYSE-Steering

Analyse-Steering				
Master-Black-Belt	**Proceed to next-Phase**	**Remarks**	**Date**	**Contact/ Verification-ID**
Dr. Reiner Hutwelker	**yes**	Hello Tony, Also your results on the ANALYSE phase fulfill all our requirements. Here is my clear GO to IMPROVE. Please again present these results to your Sponsor to get the GO from your hospital.	26.11.2019	reiner.hutwelker@softlogik.de
Sponsor	**Proceed to next-Phase**	**Remarks**	**Date**	**Contact**
Dr Neetha Alice Paul	**yes**	The progress are satisfactory and root cause analysis found reasonable. The improvement areas are effectively found.	27.11.2019	

Only proceed to the next phase after a positive decision of MBB and Sponsor

IMPROVE

Development and selection of Solutions, Measures and risk prevention, Implementation

The improvement solutions based on root causes & effort-benefit analysis

Solutions

Rank	Kano-Category	Costs of the Problem/ Year:	Problem	Root-Causes	Cause determines the Problem to:	Sum of Determination	Solutions	Benefit	Effort	Rank (Effort/ Benefit)	Reduction of Problem-Costs
1	Must-Be	1,000.00 €	Y_01 | Problem: PATIENT (MEDICAL TREATMENT) LENGTH OF STAY TOO LONG	x1.2.2.1 Delayed laboratory sampling. x1.2.2.2 Variation in the arrival rate of patients.	35%	80%	Disease-specific priority should be implemented to reduce the time interval between diabetic patients to the laboratory. Reduce the variation in length of stay of patients in different department by employing standardized practices.	8	5	1	350 €
				x1.2.3.2 Pharmacist take time to deliver medicine. x1.2.3.3 Quick changeover of different type of medicine.	45%		Implementing a specific department for non-communicable diseases within the pharmacy can reduce the medicine delivery delay during change over. An effective arrangement of medicine will also aid the pharmacist to deliver medicine quickly.	7	6	2	450 €
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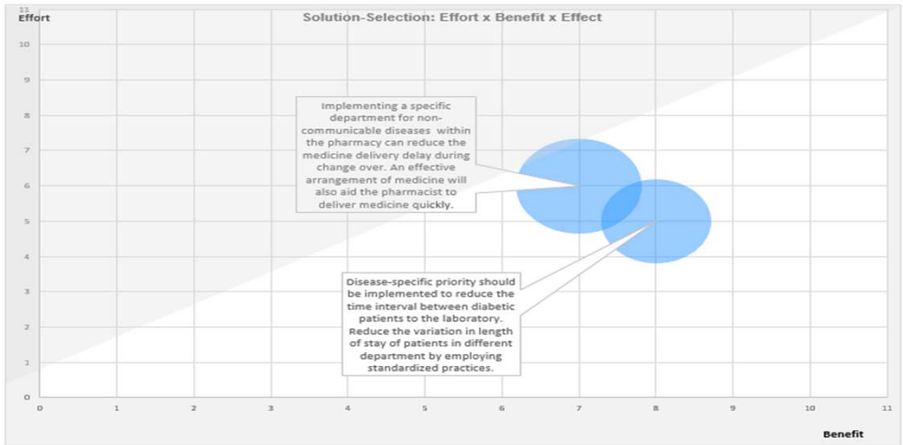


Results

1. The main root cause behind the higher length of stay in laboratory and pharmacy are the variation in arrival rate of patients and higher processing time for pharmacist to deliver medicines respectively.
2. The disease-specific priority can reduce the time interval between diabetic patients.
3. The NCD department within pharmacy can reduce the length of stay in pharmacy.

Interpretation and implication

1. The Effort X Benefit diagram is plotted based on financial and feasibility analysis.
2. The disease specific priority requires less effort and more benefit than implementing NCD department in the pharmacy, but both are equally possible and feasible.

Based on root cause analysis disease specific priority and NCD department can reduce the overall length of stay

Improve phase action plan based on FMEA & financial analysis

Action-Plan												
Rank (Effect/ Benefit)	Reduction of Problem-Costs	Solutions	Measure-No.	Measure (What has to be done?)	Result (What will be achieved?)	Risk-Reduction-Measure (from FMEA)	Costs of Implementation	Cost center	Deadline	Responsibility	Decision on implementation	Implementation-Status in %
1	350 €	Disease-specific priority should be implemented to reduce the time interval between diabetic patients to the laboratory. Reduce the variation in length of stay of patients in different department by employing standardized practices.	1	1. Laboratory operation should start only when the number of diabetic patients in the laboratory reach a particular number say 10. 2. The Consultation department can reduce the time interval between diabetic patients by employing a specialized doctor in the department. 3. 1 out of 4 doctor should be exclusively for diabetic patients. 4. Employ new NCD specific ticket for better communication and quick services.	Continuous and smooth operation of laboratory and improved communication for NCD category patients.	**The specialised doctor can be implemented on a rotational basis. The sign boards and live project trial can convince the people.**	100.00 €	SiSi123456	31.12.2019	Medical officer	yes	60%
2	400 €	Implementing a specific department for non-communicable diseases within the pharmacy can reduce the medicine delivery delay during change over. An effective arrangement of medicine will also aid the pharmacist to deliver medicine quickly.	2	1. The pharmacy medicines should be systematically arranged into communicable disease medicines, non- communicable disease medicines, high valued medicines, low valued medicines and expired medicines. 2. Employ a pharmacist particularly for diabetic medicine delivery. 3. Reduce the number of patients for diabetic medicines like metformin in a day by delivering medicine on all day instead of delivering it on 3 days in a week. 4. Use diabetic card to control the next date of consultation for NCD category patients.	Quick processing of pharmacy operations and effective visual inventory management.	**If the pharmacist number is constrained then the disease based queue can be implemented only for peak time say 11:00 am to 12:00 noon.**	50.00 €	SiSi123456	31.12.2019	Pharmacist	yes	50%

Results

1. The disease specific priority can be implemented by introducing a specialised doctor in consultation and using NCD specific ticket.
2. The implementation of NCD can be achieved by an effective 5S implementation in pharmacy and by employing a particular pharmacist for NCD.
3. Based on FMEA analysis, the practical modification for the solutions are effectively identified.
4. The proposed result is a continuous smooth operation of laboratory and quick processing of pharmacy.

The action plan for specialised doctor and NCD ticket counter were developed by considering all the constrain.

The interpretation of the proposed improve action plan

Interpretation and implication

1. The concept of specialised doctor will help in reducing the time interval between the diabetic patients and thus it will reduce the variation in arrival time of patient to laboratory.
2. NCD specific ticket can improve communication and also reduce the consultation time without compromising quality.
3. Specific department for NCD in pharmacy will reduce the processing time for pharmacist and long waiting time for NCD patient after laboratory.
4. 5S practice can improve the visual management of pharmacy as a whole.

The proposed solution and its possible impact on hospital operations identified.

FMEA analysis of the proposed solutions

FMEA		Risk-Analysis							Improvement	new Risk-Analysis			
Measure-No.	Measure (What has to be done?)	potential Failures/ Problems	actual controls to detect the Failures/ Problems	Detection of the Problem	potential Effects of the Failures/ Problems	Severity of the Effect	potential Causes of the Failure/ Problem	Probability of Cause	RPN	Countermeasures (integrated in Action-Plan)	Severity of the Effect	Probability of Cause	Detection of the Problem	RPN
		Which Failures/ Problems can result from the Measures?	By which existing Controls can the Failure/ Problem be detected, before it occurs?	Rating: 1= each time	Which Effect results from the Failure/ Problem?	Rating: 1= minimal - 10=	Which influence triggers the Failure/ Problem?	Rating: 1= never - 10= always	Risk-Priority-Number	How could the trigger of the Failure/ Problem, i.e. their Root-Causes be eliminated?	Rating: 1= minimal - 10=	Rating: 1= never - 10= always	Rating: 1= each time	Risk-Priority-Number
1	1. Laboratory operation should start only when the number of diabetic patients in the laboratory reach a particular number say 10. 2. The Consultation department can reduce the time interval between diabetic patients by employing a specialized doctor in the department. 3. 1 out of 4 doctor should be exclusively for diabetic patients. 4. Employ new NCD specific ticket for better communication and quick services.	1.The resistance of patients for giving preference to diabetic patients. 2.Doctor's resistance to consult only one type of disease.	1.The response of patients after doing a trial analysis. 2.The personal opinion of doctors	2	The whole operation can be stopped when patients or doctor resist the concept	8	Ineffective implementation and failure to convince the benefit.	7	112	The specialised doctor can be implemented on a rotational basis. The sign boards and live project trial can convince the people.	8	3	2	48
2	1. The pharmacy medicines should be systematically arranged into communicable disease medicines, non-communicable disease medicines, high valued medicines, low valued medicines and expired medicines. 2. Employ a pharmacist particularly for diabetic medicine delivery. 3. Reduce the number of patients for diabetic medicines like metformin in a day by delivering medicine on all day instead of delivering it on 3 days in a week. 4. Use diabetic card to control the next date of consultation for NCD category patients.	The physical difficulty in arranging medicines based on a systematic pattern and difficulty in arranging a special queue for diabetic patients.	The pharmacist opinion in arranging medicine and difficulty in providing special department for diabetic patients.	2	The poor medicine arrangement can increase the processing time and lack of pharmacist will increase more job pressure on current pharmacist.	9	Lack of hospital staff and legal difficulty in implementing improvement on pharmacy.	7	126	If the pharmacist number is constrained then the disease based queue can be implemented only for peak time say 11:00 am to 12:00 noon.	9	4	2	72

Results

1. The RPN refers to risk priority number and is estimated based on detection of the problem, severity of the effect and probability of the cause. The RPN value is high for both improvement solutions in laboratory and pharmacy. The risk factor can be reduced by considering the following.
2. The resistance of patient for giving a preference to diabetic patient should be considered seriously. The specialised doctor should be implemented in a fair manner. The difficulty in implementing 5S & shortage of pharmacist also should be taken care.

Based on FMEA the "Risk Priority Number" of the current solutions are computed and then modified the solutions

The interpretation of the proposed improve action plan

Interpretation and implication

1. The project trial and implementation on only some particular days can convince the people.
2. The specialised doctor can be implemented on a rotational basis. Thus the NCD specialised doctor should change day by day.
3. The disease specific queue in pharmacy can be implemented on peak time if pharmacist shortage exists.

The proposed solution modified based on constrains and stakeholder's opinion

The financial and other benefits of the proposed solutions

Summary and Benefits				
Problems	**Root Causes**	**Implemented Measures**	**Financial Benefits**	**Other Benefits**
Y_01 | Patient (medical treatment) long waiting time	x1.2.2.1 Delayed laboratory sampling. x1.2.2.2 Variation in the arrival rate of patients. x1.2.3.2 Pharmacist take time to deliver medicine. x1.2.3.3 Quick changeover of different type of medicine.	x1.2.2.2 Reducing time interval between patient by employing specialised doctor and NCD specific ticket. x1.2.3.2 Implementing a 5S model in pharmacy and regulate the date of consultation based on diabetic card. x1.2.3.3 Implementing specific department for NCD medicines within pharmacy.	800€ (estimated)	The project will indirectly benefit senior citizen in getting a preference and reduce the handling pressure of lab technician.
Y_02 | Patient (Lab Report) Limited Capacity of labortary				
Y_03 | Medicine (Delivery) unexpected shortage of medicine				
Y_04 |				

Results

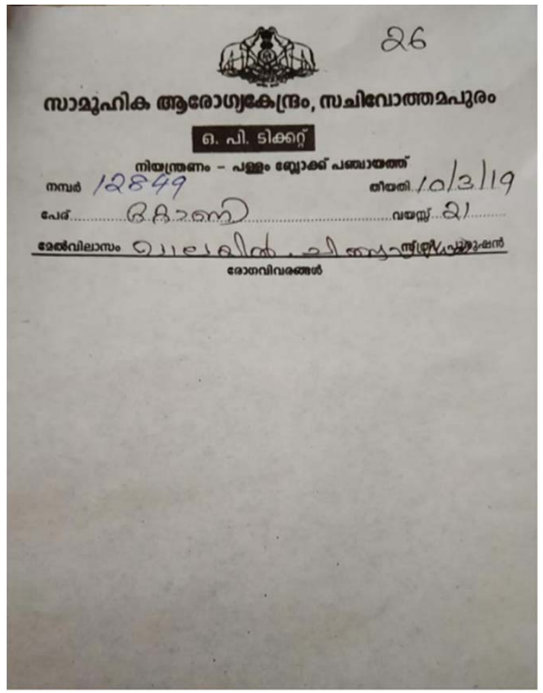
1. The cost is estimated based on average money spend by hospital to improve the physical infrastructure and service cost of different stakeholders involved in it.
2. The lower length of stay is the main benefit but at the same time it can reduce the work stress of the pharmacist, technician as well as doctors.

Interpretation and implication

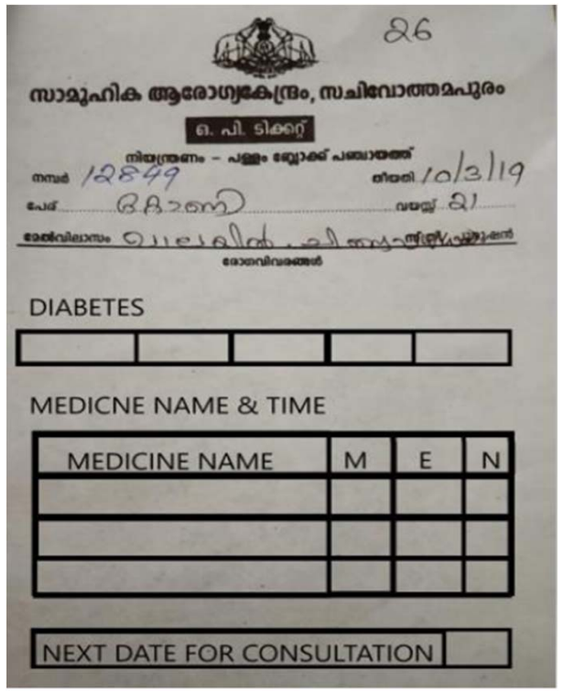
1. Most of the benefits can't be quantified into financial terms but still in long term it helps to improve the overall service offered by the hospital.
2. The key performance index should be mostly evaluated based on the reduction in waiting time, processing time as well as adaptation of people to improved ecosystem.

***The project benefits hospital around 800€* yearly savings and helps laboratory technician and pharmacist to reduce work stress** ✓

NCD-specific ticket design



Old ticket layout



New ticket layout.

Results

1. The present ticket does not differentiate between communicable diseases and non-communicable diseases so it can reduce the quality of information.
2. The NCD specific ticket can provide better communication as well as it can reduce missing data.
3. NCD specific ticket has information regarding history of consultation, separate table for medicine consumption time and next date of consultation.

New NCD specific ticket layout designed

Diabetic specific doctor

A graphical illustration on the idea that 1 out of 4 should be assigned for diabetic patients.

Results

1. Specialised doctor is the concept in which 1 out of 4 doctors should consult only diabetic patients in a particular day and it should be implemented on a rotational basis.
2. It can reduce the variation in arrival time of diabetic patient to laboratory.
3. It can reduce the higher waiting time during clinical rotation and in emergency case.

In consultation one doctor should be made exclusively for diabetic patients and it should be on a rotational basis.

NCD specific ticket counter in pharmacy

Male vs Female ticket counter

NCD vs Communicable disease ticket counter

Results

1. The male vs female queue in pharmacy counter experience almost same waiting time and pharmacist experience no difference in time for delivering medicine.

2. The concept of special queue for diabetic patient can reduce the changeover time for different diseases.

3. It also helps to reduce the waiting time for the patient who came after long queue in laboratory.

The proposed ticket counter helps to reduce the pharmacist processing time

5S model in hospital pharmacy

Sorting of medicine based on patient category

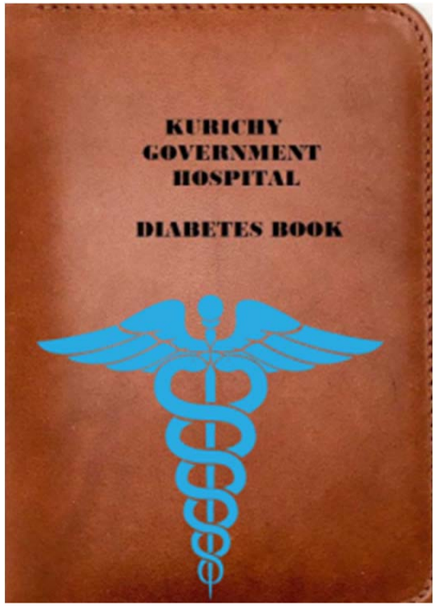
Medicine tray with label for NCD medicines

Results

1. Separate medicine boxes for different diseases.
2. Effective storage of outdated and cancelled medicine.
3. Special NCD counter within pharmacy .
4. Special label for critical medicine.
5. Visual inventory check for medicine.
6. Closeness of related medicines.
7. Ergonomic consideration for pharmacist

5S based medicine arrangement can improve the processing speed of pharmacist

Diabetic card for long term patients



MEDICINE NAME	LAST DATE OF CONSULTATION	PRESENT DATE	QUANTITY	STATUS OF DISEASE	NEXT DATE & TIME OF CONSULTATION
METFORMIN	11-10-2019	01-11-2019	20 STRIPS	TYPE 1	23-11-2019
Oseni	11-10-2019	01-11-2019	10 STRIPS	TYPE 1	23-11-2019

Results

1. The diabetic patients maintain minimum 3 month to more than 1 year relationship with hospital so employing a permanent diabetic card can help to control the next date and time for consultation.
2. The diabetic card contain information regarding last and next date of consultation and about the quantity of medicine they purchased last time.
3. The card also give a quick overview about the history and type of diabetic patient has.

Diabetic card helps to control the number of diabetic patients to hospital in a day as well as in an hour

Results of the IMPROVE-Steering

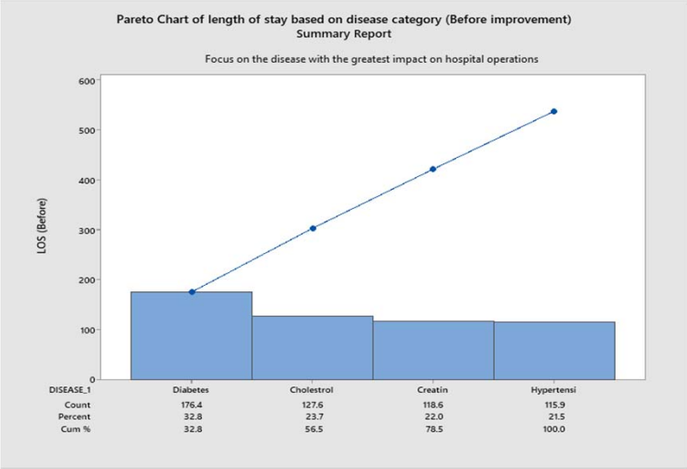
Improve-Steering				
Master-Black-Belt	**Proceed to next-Phase**	**Remarks**	**Date**	**Contact/ Verification-ID**
Dr. Reiner Hutwelker	**yes**	Hello Tony, your results, interpretations and implications look plausible. The impulse to start an additional 5S initiative is convincing. I hope, that you will be able and allowed to implement the solutions.	6.1.2020	reiner.hutwelker@softlogik.de
Sponsor	**Proceed to next-Phase**	**Remarks**	**Date**	**Contact**
Dr Neetha Paul	**yes**	The improvement results are impressive and most of them are implemented on a trial basis.5S implementation require time but separate diabetic counter implemented	10.01.2020	

Only proceed to the next phase after a positive decision of MBB and Sponsor

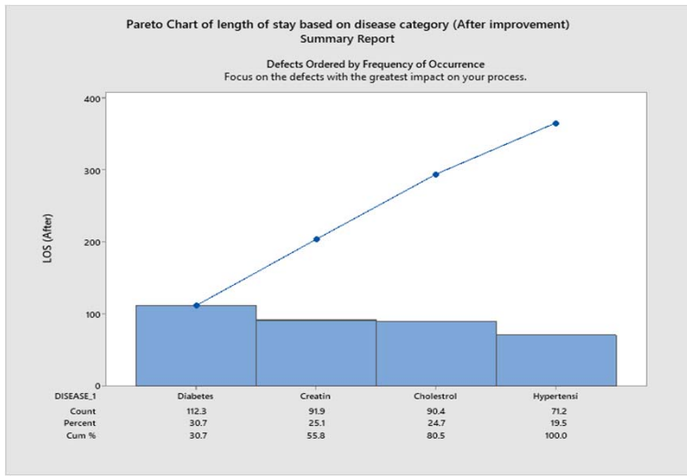
CONTROL

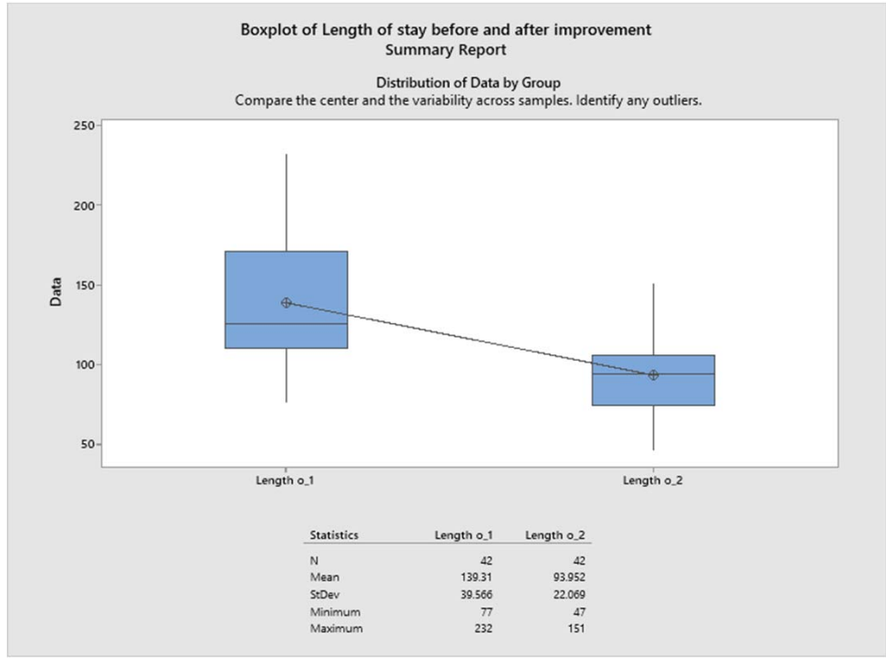
Data-Evaluation, Process-Performance, Improvements & Benefits, Process-Management-Plan & Finalisation

Disease wise pareto-analysis of patient's length of stay before & after improvement



Before/After comparison of length of stay





Boxplot of overall reduction in length of stay.

Interpretation and Implication

1. Diabetic patient's length of stay reduced by almost 36%, which is primarily due to improvement in pharmacy and laboratory.
2. After improvement second-highest length of stay changed from cholesterol to creatin patients.

Results

1.Pareto chart shows the disease wise average length of stay and boxplot shows the overall reduction in length of stay of patients in the hospital.

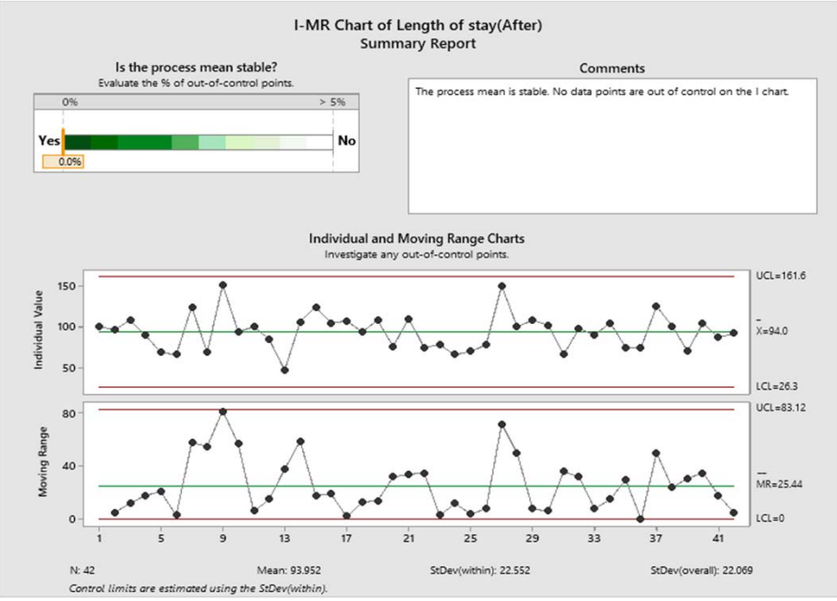
2.The overall length of stay decreased from 139.31 minutes to 93.95 minutes.

3.The overall deviation in length of stay also decreased from 39.5 minutes to 22 minutes.

4.The highest length of stay also reduced from 232 minutes to 151 minutes, showing an improvement in diabetic patient's length of stay, to be tested statistically.

After improvement the overall length of stay of patient in hospital decreased by 32%

The I-MR chart analysis of patient's length of stay in hospital



Results

1. Individual value chart shows the course of all recorded length of stay values with horizontal lines representing the average and the upper (UCL) and the lower (LCL) control limits.

2. The highest recorded length of stay after improvement is 151 minutes which is less than the upper limit of 161.6 minutes. There are no signals in this chart, e.g. outliers.

3. In the moving range chart, the difference of adjacent values is mapped. The data point here refers to difference between successive length of stay values.

4. The MR chart can't be interpreted in this case as it compares length of stay between different disease which is not practically logical.

Interpretation and implication

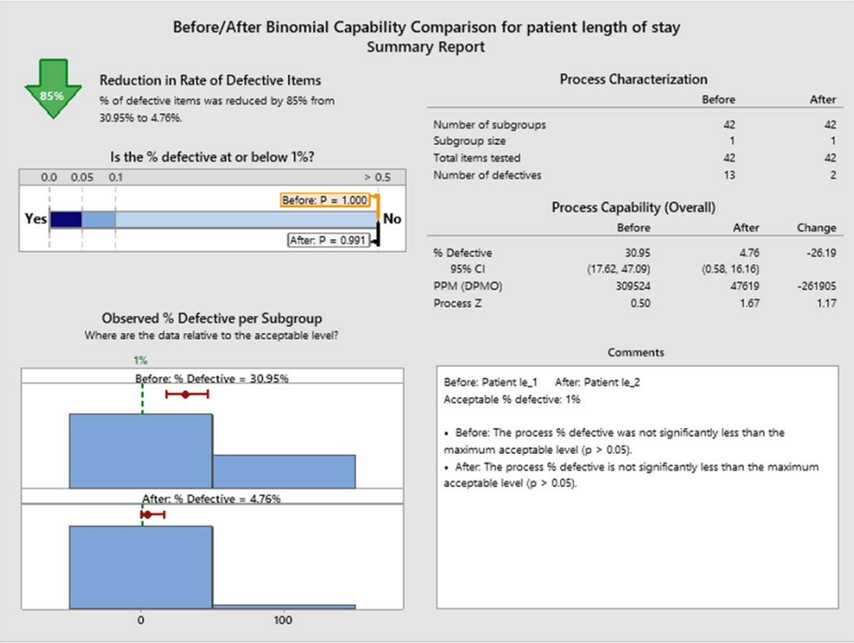
1. The I chart clearly shows the higher length of stay in diabetic patients and corresponding lower length of stay for other diseases.

2. The higher values in MR chart is because of the assumption that all length of stay are the same.

3. In MR chart difference of adjacent values is considered, meaning in our data to compare the length of stay of diabetic patient with hypertension patient. This information is useless to us.

All data point are within the control limit of I chart. The difference in disease diagnosis causes the higher value in the MR chart

Before/After binomial capability comparison for patient's length of stay



Results

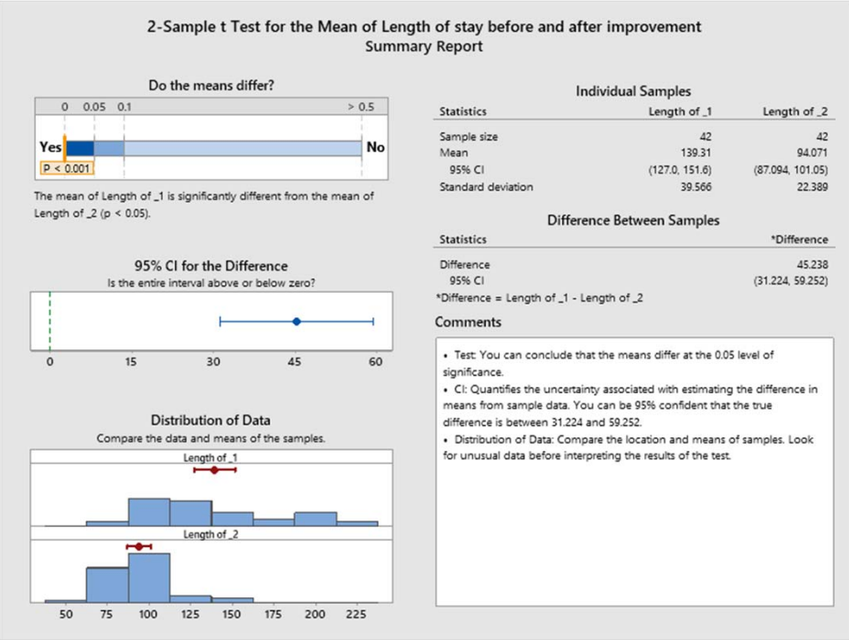
1. The length of stay data (Before/After improvement) fails the Anderson-darling test so the data deviate from the normal distribution.
2. The cardinal data is converted into binomial form based on the concept that patients whose length of stay is more than 150 minutes will be treated as a deviation.
3. The percentage defect reduced from 30.95 to 4.76 %.
4. The process Z (= Z.bench) increased from 0.5 to 1.67.
5. The deviation after improvement is only reported for diabetic patients and for other disease the length of stay is within the specification. This was expected, because lab processing time of diabetics take time to get reduced and 5S practice is not completely intiated in pharmacy.

Interpretation and implication

1. The improvement causes a total reduction in length of stay from 139.31 to 93.95 minutes.
2. Out of 42 sample only 2 patient's length of stay reached above 150 minutes.
3. The standard deviation also reduced from 39.56 to 22 minutes. This difference will be tested statistically with the F-Test (see below).

Improvement resulted in 85% reduction in length of stay deviation

2-sample t test for the patient's length of stay before and after improvement



Results

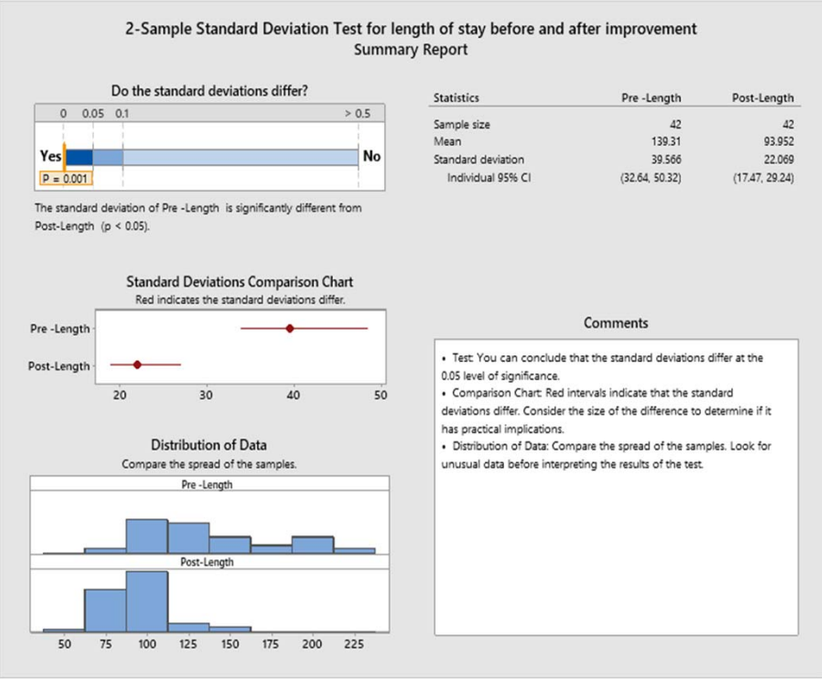
1. Statistical parameters for analysing patient's length of stay before and after improvement are
   I. Before improvement: mean=139.31, SD= 39.5
   II. After improvement: mean=93.93, SD=22
2. Difference between the average length of stay before and after improvement is 45.38 minutes which is statistically significant and practically relevant.
3. The interval diagram plots the difference between the mean and its confidence interval as well as the difference =0 for the H0
4. The two histograms show the distribution of the length of stay before and after improvement with their mean and the related confidence interval of the mean.

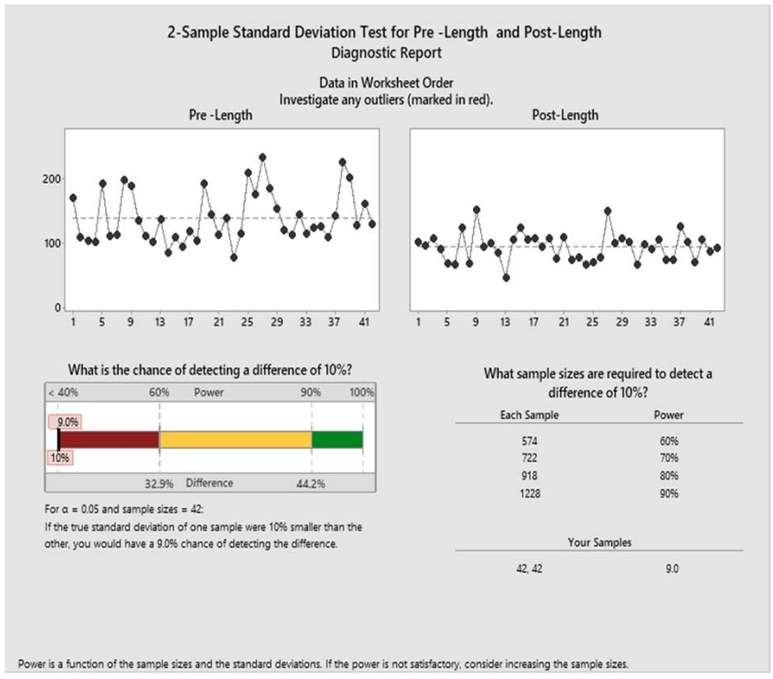
Interpretation and implication

1. After improvement 95% of the patient's length of stay lies between 87 minutes to 101.5 minutes.
2. The distribution of length of stay also reduced considerably leading to a uniform length of stay for non-diabetic patients.
3. The reduction in standard deviation is primarily because of disease specific priority in pharmacy.

The improvement resulted in reducing the length of stay of patient in hospital by almost 45 minutes

2-sample standard deviation test for the patient's length of stay before and after improvement





Results

1. The 2 sample standard deviation test clearly shows that standard deviation of patient's length of stay before and after improvement differ significantly.

2. From the confidence interval the maximum expected deviation reduced from 50 minute to 29 minutes. The average deviation also reduced by 44%.

3. The reduction in length of stay above 200 minute for diabetic patient is the primary reason behind low deviation.

Interpretation and implication

1. The reduction in length of stay for diabetic patient from 176 minutes to 112 minutes resulted in making their length of stay comparable to others. The disease specific priority in consultation and pharmacy resulted in reducing variation by 19 minutes.

2. If we can improve the uniformity of lab processing time, it can produce more reduction in variation of results. This can be achieved by training, implementing poke yoka and designing lab ecosystem based on ergonomics etc.

2 sample standard deviation test shows that standard deviation differ significantly after improvement

Process-Management-Plan

Process-Management-Plan	Define measures to sustainably maintain the process-improvements													
Ranking of Outputs (Y)	Outputs (Y)	Measurand	Unit	Target and specification limits (USL; LSL)	Scale-Level	In which time intervals will the control chart be actualized?	How large will the sample size be in each time interval?	How many data points should the control chart represent?	I-MR Chart (if N <= 100)	u-Chart (if ok vs. different defect opportunities are discriminated)	Which control limits should be used? (LCL; Center-Line; UCL)	Who is responsible for creating the control charts?	In which document is the reaction plan specified?	Who is responsible for maintaining the reaction plan?
Output (Y)		Data from Data-Collection-Plan												
1	Y_01 | Problem: PATIENT (MEDICAL TREATMENT) LENGTH OF STAY TOO LONG	Time	Minutes	USL:150min LSL:na	Data discrete or continuous (Cardinal-Scale)	weekly	42	42	42 data points; no subgrouping	42 data points; (for discrete values: treated as number of defects per output)	I chart UCL:161.6 Centre line:94 LCL:26.3 MR chart UCL:83.12 Centre line:25.44 LCL:0	Junior Doctor	Reaction-plan.xlsx	Junior Doctor
2	Y_02 | Problem: PATIENT (LAB REPORT) FACILITY USAGE INEFFICIENT	Lab result number in an hour	Units/hr	USL:20 unit LSL:na	Data discrete or continuous (Cardinal-Scale)	weekly	32	32	32 data points; no subgrouping	32 data points; (for discrete values: treated as number of defects per output)	I chart UCL:17.66 Centre line:10.74 LCL:3.83 MR chart UCL:8.49 Centre line:2.6 LCL:0	Lab technician	Reaction-plan.xlsx	Lab technician
3	Y_03 | Problem: MEDICINE (DELIVERY) AVAILABILITY STOCK LEVEL < DEMAND	Weekly demand of medicine	Number of Tablet strips	USL:5000 LSL:na	Data discrete or continuous (Cardinal-Scale)	biweekly	42	42	42 data points; no subgrouping	42 data points; (for discrete values: treated as number of defects per output)	I chart UCL:7399 Centre line:3564 LCL:2710 MR chart UCL:4712 Centre line:1442 LCL:0	Pharmacist	Reaction plan.xlsx	Pharmacist

Results

1. The process management plan is a document for the process owner to monitor the process in future, identify new problem find their cause and solve them.

Interpretation and implication

1. Process management plan ensure the sustainability of the implemented measure by
   I. Monitor future performance with control chart
   II. Response to performance drop determined in reaction plan.
2. Control charts and maintenance of the plan are effectively implemented.

Process management plan with control chart and reaction plan developed

Reaction plan for the treatment of deviation

SERIAL NUMBER	HOSPITAL DEPARTMEN	DEPARTMENT OBJECTIVE	OK/NOK	REMARK	PROCESS DEVIATION	OK/NOK	REMARK	INSPECTION METHOD	FREQUENCY OF INSPECTION	RESPONSIBLE PERSON	CORRECTIVE ACTION	OK/NOK	REMARK	VERIFICATION OF IMPROVEMENT
1	Ticket counter	1.Reduce ticket processing speed	✓		More time for ticket processing	✓		Check processing time randomly	Bi weekly	Nurse	Give training	✓		Medical officer
		2.Ensure proper deliver of customised ticket.	✓		Assigning wrong ticket	✓		Check if any such case report	Only if reported	Everyone	Introduce poka yoka	✓		Medical officer
2	Consultancy	1.Disease specific consultation	✓		No such special department	X	Lack of doctors	Create time table on specialised doctor and check the usability	Weekly	Doctors	Create flexible plan	✓		Doctor in charge
		2.Optimum clinical rotation time	✓		Less number of doctors in consultation	✓		Random checking	Randomly	Medical officer	Team work in case of emergency	✓		Doctor in charge
3	Laboratory	1.Reduce sample processing time	✓		Low number of laboratory results	✓		Daily Record	Weekly	Lab technician	Find root cause behind it	✓		Labortary in charge
4	Pharmacy	1.Specialised department for NCD	✓		No such department	✓		Monthly inspection	Monthly	Pharmacist	Strict checking	✓		Pharmacist
		2.Reduce medicine delivery time	✓		More bottle neck at pharmacy	✓		Check processing time randomly	Randomly	Pharmacist	Ensure 5S is followed	X	New stock	Pharmacist

Results

1. Reaction plan was developed by considering feedback from stakeholders,feasibility and by analysing hospital operations.

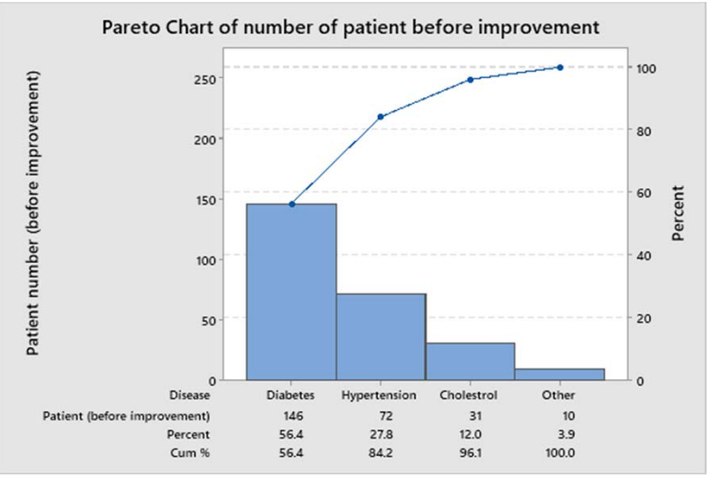
Interpretation and implication

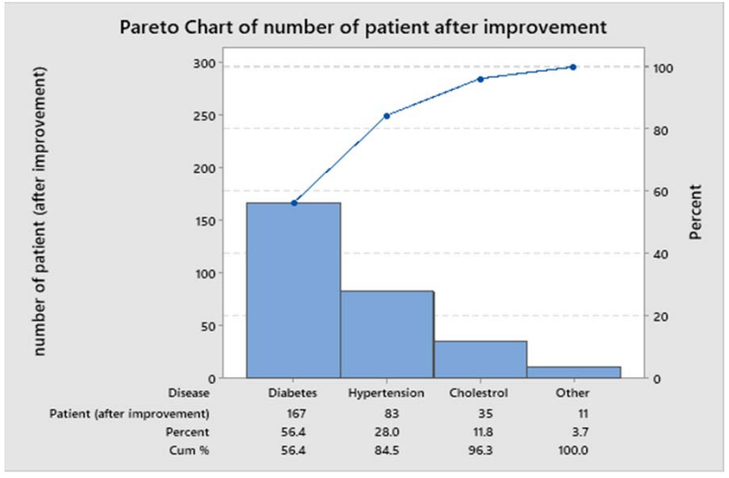
1. The deviations in the proposed plan are need to be identified correctly. Hospital stakeholders as well as patients have same role in it.
2. Deviation in laboratory and pharmacy should be given priority and feedback from pharmacist and lab technician should be taken seriously.
3. 5S checklist should be implemented in both laboratory and pharmacy.
4. Patient feedback form should be implemented and need to follow up.

Reaction plan developed based on feasibility and feedback from stakeholders

Financial & other benefit summary

Summary and Benefits				
Problems	**Root Causes**	**Implemented Measures**	**Financial Benefits**	**Other Benefits**
Y_01 | Patient (medical treatment) long waiting time	x1.2.2.1 Delayed laboratory sampling. x1.2.2.2 Variation in the arrival rate of patients. x1.2.3.2 Pharmacist take time to deliver medicine. x1.2.3.3 Quick changeover of different type of medicine.	x1.2.2.2 Reducing time interval between patient by employing specialised doctor and NCD specific ticket. x1.2.3.2 Implementing a 5S model in pharmacy and regulate the date of consultation based on diabetic card. x1.2.3.3 Implementing specific department for NCD medicines within pharmacy.	800€ (estimated);1000€ (confirmed)	The project will indirectly benefit senior citizen in getting a preference and reduce the handling pressure of lab technician.
Y_02 | Patient (Lab Report) Limited Capacity of labortary				
Y_03 | Medicine (Delivery) unexpected shortage of medicine				
Y_04 |				





Interpretation and Implication

1. The financial benefit is calculated based on increase in number of patients after improvement. Pareto chart shows the disease wise increase in number of patients after improvement.

2. If the patients start utilising public healthcare instead of private hospital they can save ₹500 per visit. On an average it could deliver service worth ₹80000 monthly.

	BEFORE IMPROVEMENT	AFTER IMPROVEMENT
Number of patients	360	390
Average per patient expenditure	500	500
	Worst saving	5000
	Expected saving	10000
	Best saving	15000

The benefits are estimated based on reliable sources with assumptions

Lessons learned in the course of the project

What I learned in the course of the project, concerning:
1. Subject matter/ Product:
Hospital operations with principal focus on optimisation of cycle time in consultation,pharmacy and laboratory.
2. Process:
Process sequence of laboratory test for diabetics,cholestrol and then about inventory management of medicines in pharmacy.
3. Methods/ Tools:
Statistic methods like ANOVA,t-test,regression,pareto analysis,FMEA and softwares like minitab,anylogic etc
4. People/ Teams:
Doctors,Pharmacist,lab technician, nurse and patients
5. Management:
KMCH (kerala medical community health) ,its organisation and medicine distribution cycle etc.
6. Finance:
Financial estimation of public funded hospital ,Stock value of medicine estimation.
7. Company:
CHC Sachivothampuram

Potentials/ topics for further improvements:
1.The current upperlimit of length of stay of patient in hospital (150 minutes) can be reduced to 100 minutes in future with effective planning
2.5S can be implemented in laboratory for increasing the processing speed of laboratary technician
3.Diabetic card can be computer generated which will produce more precise planning for arrival rate of NCD patients
4.MRP can be implemented in pharmacy to autogenerate order when medicine level go below safety stock.

Interpretation and implication

1. The project gave a good insight about the opportunities and challenges in implementing six sigma in a service-oriented industry.
2. The Project is expected to deliver **additional medical service worth 1000 €** per month and thus it could indirectly benefit **more than 160 patients a month**.
3. The effective training of medical staff can reduce cycle time but adopting to that culture take time. MRP for medicine inventory and auto generate diabetic card can further improve the result significantly.

The project successfully implemented, and its future potential identified

Results of the CONTROL-Steering

Control-Steering				
Master-Black-Belt	**Project completed**	**Remarks**	**Date**	**Contact/ Verification-ID**
Dr. Reiner Hutwelker	**yes**	Dear Tony, you have completed your project with excellent results. You have shown mastery of all tools, can interpret the results and draw conclusions. You have also shown relationships to other management techniques that were not part of the course and thus integrated the new knowledge very well. Thus the requirements for your certification from our side are fulfilled. Congratulations, Reiner Hutwelker	4.3.2020	reiner.hutwelker@softlogik.de
Sponsor	**Project completed**	**Remarks**	**Date**	**Contact**
	yes	to be filled in by the Sponsor (if you like then use the Sponsor-Checklist in sigmaGuide)	x.x.xxxx	
	no			

Only proceed to the next phase after a positive decision of MBB and Sponsor

End of this Project-Story-Book

Six Sigma process improvement methods and tools