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SIX SIGMA IN SERVICE SECTORS

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ABSTRACT:

The main motive of the paper is to answer the queries of what is Six Sigma? Why Six Sigma required in the service sector, Benefits of six sigma in the service sector and Difficulties of Six Sigma in the service sector. Service industries are much more attentive in improving their products and process by diminishing the dissimilarity or variation because dissimilarity or variation is one of the contender or combatant of the quality which it is eliminated and assessed by the customers. In many industries, Six Sigma has successfully implemented like healthcare, airports, financial services, small-scale industries, banking over the last 20 years. The execution of six sigma methodology is dealt with in the literature paper deals with the help of statistical tools in the service sector.

KEYWORDS: *Six Sigma, Variation, Service Sectors.*

1. INTRODUCTION

According to Henderson 2000 [1], the amount of dissimilarity or variation around a process average is represented by Six Sigma. It is data-driven tactics for improving the process, increasing customer satisfaction and for reducing the variation it is described by with focus on financially measurable results Six Sigma was evolved at Motorola by BILL SMITH in the 1980's and it was popularized by General Electric and others in the 1990's (Henderson 2000) [1]. (σ) Sigma is a letter is derived from the alphabets of Greek and it has become a statistical symbol of process variation. Six Sigma is a quality enhancement process. Its motive is to minimize the number of imperfections as 3.4 parts per million. It was successfully implemented in the wide range of manufacturing, and business settings at companies including small scale and large scale (Campbell 2003) [2]. It is one of the brand new ways of thinking about the customer value and work. It is one of the robust ways to make and create a corporate culture. Six Sigma is also a measure/calculates the total quality to let the company be aware of it, abolishing the errors and dissimilarities/variations from its processes, this can be applied not only to the shop floor but also it applies to each and every function in the company (*Jiju* Antony 2007) [3]. Using individuals called extremely trained in the quality principles and tools of six sigma, Master Black belts, Black belts, Greenbelts, organizations can focus on resources which perform less well to attain high purchase outcomes. If we reduce the variation or dissimilarities of the process it directly leads to improving the stability of process performance and its outcome. The team of stakeholders or the participants in the process applies DMAIC using a systematic approach to process improvement. The DMAIC is derived and explained in the following Table 1.

2. LITERATURE REVIEW:

Here we will see literature review of some of the researchers related to their area of work or research have provided their contribution, based on these researchers contribution we will confirm our study i.e. Six Sigma in service sectors. It is quietly different from the manufacturing sector because the service sectors deal mainly with people and it is not like the products stored on a shelf it is very difficult when compared to manufacturing sectors.

- According to Qureshi et al., 2012 [4] the customer satisfaction or the user needs must be considered for the proper implementation of operational strategies and Six Sigma tools that can be differently intensified applicability of Quality Management System tools differently in the service sector.
- The research and development institution is an information or knowledge-based environment, it is a big challenge and very difficult to apply Six Sigma in the service sector in that institution, because already they have skilled and talented people who know the concepts of the quality management system [5] .
- Kucerova M, Vanova authors reported that the application of DMAIC helps the Non-profit organizations, Research and, development setup also (Kucerova M, Vanova 2009) [6]. One of the researchers reported that the implementation of Lean Six Sigma when applied to food product industry the process variability was reduced and identified the major important processes in the R &D that has to be improved urgently.
- The main objective of 6 Sigma is to reduce the variation and decrease the errors in the process by (D. Montgomery) [7].
- Six Sigma is mainly to reduce errors it is a quality program, it lowers the costs of the products, increases the customer satisfaction and lastly builds better leaders. Lean Six Sigma is a tool which increases the customer satisfaction and it is also called as a leadership development tool (Snee, R.D.) [8].
- When we have seen at first step itself SMEs appears to be very much large (Antony, J., Kumar, M & Madu, C, N. 2005) [9].

- According to Andrew J. Thomas the main methodology included in this are define, measure, analyze, improve, control (Thomas, A., Barton, R., 2008)[10].
- The methods like six sigma and lean manufacturing are best suited because there is a need for statistical tools, measurement activities in the laboratory testing activities by (Jeremie M. Gras& Marianne Philippe 2007)[11].
- Sharon said that the lean and Six Sigma both can be used in reducing the errors in the laboratory in many laboratories like pathology, cytology, microbiology and also including molecular biology (Bhim Singh & S.K. Sharma 2009)[12].
- Many of the organizations are using Lean manufacturing, Six Sigma, and total quality management concepts and how they are developing the good practices in the process by (Sehul H. Patel 2018)[16].

Table.1 DMAIC Methodology

	Description
Define	· Define phase includes firstly define the objectives of the project, define the customer requirements related to the project and stated clearly customerrequirements called (CTQ), critical to quality characteristics. · Evaluate and select the best project, create a team and launch the team. · Some of the tools used are VOC to CTQs, PUGH matrix, Project Charter.
Measure	· Identify the reliable data related to th e CTQ's, Map the relevant process wi th the inputs and output, behavior measurement system. · Identify where the errors /defects are occurring or can occur and star t measuring inputs, process, results/outputs. · Document the process. · Check sheets to observe process performance and consumer surveys are the tools used.
Analyse	· Generate the hypothesis about the possible root causes of dissimilarities/variation. Survey the statics using statistical tools to separate the "censorious few" causes of dissimilarities. · In this behavior stage, practical business problems are converted to statistical problems. · Value, and N on-value-added analysis, Pareto charts, histogram, run charts or scatter plots are the tools used.
Improve	· Using the team's expertise, identify the ways to eliminate the causes. · Validate the most condemnatory inputs and optimize the process. · Some of the tools like FMEA, stakeholder analysis, Documentation.
Control	· Validate and ensure the process control that variations should not have occurred often. · Feedback is important to understanding how well the change is working

3. WHY SIX SIGMA REQUIRED IN THE SERVICE SECTORS?

According to *Jiju* Antony [3], if it is shown that the service process like customer order entry, baggage, payroll, invoicing, billing, shipping etc.., these are accomplishing < 3.5 sigma quality level, the defects are above 24000 parts per million opportunities or 97.63% yield. Considering these are service process if we implement six sigma in this we can improve the sigma level to 6 sigma level, the imperfection rate will fall to 3.4 parts per million opportunities and the process yield will be expanded to 99.99, If the companies or organizations are busy in continual development programs such as Six Sigma significantly commercial returns comes to the bottom line, just like manufacturing process similarly the service process create rework, scrap, in the form of cost of poor quality. Most of the developed countries do not have the manufacturing based financial status of the economy mainly for these countries are from logistics, e-commerce, financial services, and healthcare services. In this case, Six Sigma can be executed to minimize the poor quality so that it can be achieved more consistently. One of the important reasons why Six Sigma was introduced in the service sectors that the customers feel "process variability" in the delivery of service the provided and not on the "process means". The main intention or goal of Six Sigma is to minimize the process variation [3].

4. SOME EXAMPLES OF SERVICE SECTORS WHERE WE CAN IMPLEMENT SIX SIGMA:

4.1. Guidelines for Implementing Six Sigma in the Service Sector:

According to Ayon Chakrabarty, 2006 [13] suggested several management guidelines for the execution of Six Sigma in service organizations. They are (CSF), (CTQ), and (KPI).

a) Customer Success Factors (CSF):

These are mandatory for any six sigma initiatives to be a success. Some of the important customer success factors are,

Customer focus, Education and training, top management commitment, financial benefits.

b) Critical to Quality Characteristics (CTQ):

CTQ's are nothing but the expectations of the customers from a

service/product, these are the KPI's of product or service whose specifications limits must be met in order to persuade the customer. Some of the CTQ's are,

Time, cost, employee, behavior, information.

c) Key Performance Indicators (KPI):

The Actual statistics of a particular outcome or accomplishment are provided by the KPI's. Some of the important KPI's are, Efficiency, reduced variation, cost reduction, customer satisfaction, Time to deliver.

With the help of DMAIC methodology, Statistical tools, and considering these (CSF, CTQ, KPI) we can implement Six Sigma in the following service sectors, some of the examples are shown in Table.2

Table. 2 Examples for implementation of Six Sigma

Type of service sector	Potential areas where six sigma can be implemented
Healthcare	Bottlenecks in emergency departments, waiting time to serve at the reception in a hospital, number of medical errors, (Antony *jiju* 2006) [14] improving the patient satisfaction in Accident and Emergency , improving nurse or pharmacy technician recruitment, surgical capacity, reducing inventory levels, reducing the number of wrong diagnoses (Thawani Sunil2004) [15].
Airline industry	Handling of baggage[15], the number of reservation failures and mistakes, waiting time at the check-in counter.
Banking	In reducing the customer complaints, number of flaws in account opening , Excessive internal and external callbacks, payment handling etc, number of ATM breakdowns, number of complaints received per month.
Facility management and maintenance	Postponement in the purchase of materials, occurrence of payroll errors for maintenance employees [2], measuring the activities in maintenance, time postponement in the completion of different types of work orders [2], minimize breakdowns, minimizing the occurrence of unscheduled ma intenance, and maximize equipment effectiveness.
Small and medium enterprise	The small and medium enterprises are the heart of modern economics; these act as suppliers to large organizations so that SMEs appears very large at the first step itself. Here in this, we can apply in minimizing breakdowns, anumber of complaints, the time delay in giving delivery to organizations by(Sehul H. Patel 2018) [16].

5. BENEFITS OF SIX SIGMA IN SERVICE SECTORS:

The Benefits of Six Sigma in both manufacturing and service sectors are shown below:

- Minimized project time, reduced costs, improved data, integrity, and improved results are some of the benefits.
- The advice or guidelines provided by the methodologies of Six Sigma help the workers to carry out the job, and help them to solve the potential problems.
- Process design is enhanced, by minimizing the TACT time of the manufacturing process and product development cycles.
- With the role of Six Sigma in minimizing the errors, the error rate per unit is minimized after implementation in the manufacturing process or service sector process.
- It can use to find out and remove the root causes of the problem; in order to prevent the validity is reduced.
- Six Sigma can build a predictive model based on experience to ensure a continuous enhancement of the process.
- It provides effective management decisions.
- It leads to faster delivery services to customers.
- The systematic reduction of variety and reduced cost of poor quality improves the consistency level of service.
- It has increased awareness of various tools and techniques leading to greater job satisfaction.

6. SOME CHALLENGES, DIFFICULTIES AND IMPLEMENTATION ISSUES ARE:

- The fundamental problem here is with the accuracy of data, the data were not readily available.
- The difficulty level is collecting the data in the service process is higher than in the manufacturing.
- The measurement of the customer's satisfaction is more difficult due to the intersection with a delivery of service.
- Human behavior has a major influence on service process, such as their eagerness, kindness etc.

- The behavior of the service centers determines the quality of service provided to the customers.
- The service sectors need to explain to their involvement of customers in the data collection process.
- Service sectors have more uncontrollable factors when compared to the manufacturing process.

7. CASE STUDY

XYZ Pizza is having its outlet located in Dharampeth, Nagpur & caters to all the areas East-West North-South as well as suburbs up to the radius of 15 km. It offers 20 types & in three sizes of various packaged of pizzas along with Coke & Chocó lava cake. It has 17 delivery boys with 18 vehicles. It receives average 1800 orders per day & most of the orders are to be delivered at lunch (1-2 pm) & supper time (5-6pm). It is having monthly sales of Rs.18 Lakhs through the deliveries & other income through the visitors coming to the shop. In recent times it is facing increased competition in terms of delivery time because of the opening of various competitors like Pizza Hut, Smokin Joes etc. & also there has been increased in fuel prices adding to the cost of delivery. The maintenance problems of vehicles used by the delivery boys have also been increased resulting to minor mishaps & late deliveries. The customer complaints are on the rise & this has become a major worry. Management of XYZ Pizza decides to carry out six sigma study for solving the problem & improving the system. Currently, the mean time of delivery of the parcel after the order is registered is 42 min. With 32% delivery taking more than 90 min. The XYZ Pizza has promised to deliver the order within max. 40 min. From the time of placing the order.

Table.3 Initial survey of the following information has gathered for last month

Reno	Deviated Points	Frequency/Month(30 Days)
1	Late Delivery	576
2	Wrong Billing	90
3	Damaged packaging	144
4	Wrong Deliveries (Delivery of orders to the wrong address)	196
5	No delivery	72
6	Incomplete Delivery (Ex. In combo pack, coke is missing etc.)	243
7	Quality Problems (Not Tasty/ Wrong Size etc.)	51

XYZ Pizza carried out the survey to assess the needs, requirements & viewpoints & survey revealed the following:

- " Takes to a long time to get my order registered"
- "Takes too much time to get my order delivered"
- " Waiting for a delivery boy is irritating"
- " Taste was Great but the size of pizza received is not as per order"
- "Receiving the damage parcels loses my appetite"
- " I don't want to pay the bill if delivery is not as per the order"
- "They always get my order mixed up with the other Barnes family 2"
- "They promised 40-minute delivery and they were late. It was 55 minutes."
- "Our last pizza was cold & elastic ".

The methodology of DMAIC:

1. Define Phase:

VOC TO CTQ's:

From the above needs, requirements and survey we understood that these are the VOC (voice of customers), and our team converted the VOC into technical terms i.e.., (Critical to quality) as shown in Table.4.

Table.4 Voice of customers to Critical to quality

Sr. No	VOC	CTQ
1	Takes too much time to get my order delivered	Late Delivery
2	" I don't want to pay the bill if delivery is not as per the order	Wrong Delivery
3	Receiving the damage parcels loses my appetite	Damage packaging
4	" Takes to a long time to get my order registered"	Quick order register
5	The taste was Great but the size of the pizza received is not as per order	Incomplete order

· **Pugh Matrix:**

Here CTQ's are given a rating by the team members according to (1-10) scale that how much is important to the customer is shown in following PUGH matrix in Table.5 and we have got a higher rating for the Late delivery. So, we select late delivery as our project.

Table. 5 PUGH matrixes

	Importance to customer	Importance to customer	Importance to customer	
CTQ	**MEM 1**	**MEM 2**	**MEM 3**	**TOTAL**
LATE DELIVERY	9	9	9	26
WRONG DELIVERY	8	7	6	21
DAMAGE PACKAGING	6	7	6	19
QUICK ORDER REGISTER	5	5	6	16
INCOMPLETE ORDER	7	6	5	18

Project Charter:

From the Table.3, we have calculated the Present sigma level by using the formulae DPMO (Defects per Million Opportunities). The project charter is the first step of the six sigma define phase it consists of project goals, project start date, and close date etc.., the project charter is shown in the below fig:1

PROJECT CHARTER

PROJECT TITLE : To reduce average delivery time of pizza.

Present sigma level :- 3.95

Team:
Member - 1
Member - 2
Member - 3

BACKGROUND OF PROJECT :The company enjoyed a leading position in market but in recent time it is facing increased in competition in terms of delivery time.

AIM OF THE PROJECT : To reduce Avg. delivery time of pizza of Dhrampeth outlet from 42 min to 36 min and to sustain in the competitive market .

DIRECT BENEFITS : 1.Customer satisfaction. 2.Reduction in delivery time.

Start date : 01/06/18 | **Expected closing date**:02 /09/18

CHARACTERISTICS OF OUTPUT OF PRODUCT & ITS MEASURES :

CTQ	MEASURE	DEFECT DEFINATION
1.late delivery time	1.% no of late delivery.	1.Time more than committed time i.e. 42 min.

MEETING FREQUENCY : On each weekend (4pm to 6 pm) in conference room.

Figure: 1 Project Charter

· **SIPOC chart:**

SIPOC chart is prepared to about the inputs, process and outputs and who is the customer is shown in the below Table 3.

Table.6 SIPOC Chart

Supplier	**XYZ Pizza**
INPUT	Receiving customer order(Tele-phone, email)
PROCESS	communication to the kitchen for processing, Processing the order & assigning to the delivery boy
OUTPUT	Delivery to customers & reporting back & delivery logout including payment
CUSTOMER	Office, House, Shops

2.Measure Phase:

· **Flow process chart:**

The following activities right from the receiving the order are categorized as following flow process chart fig: 2.

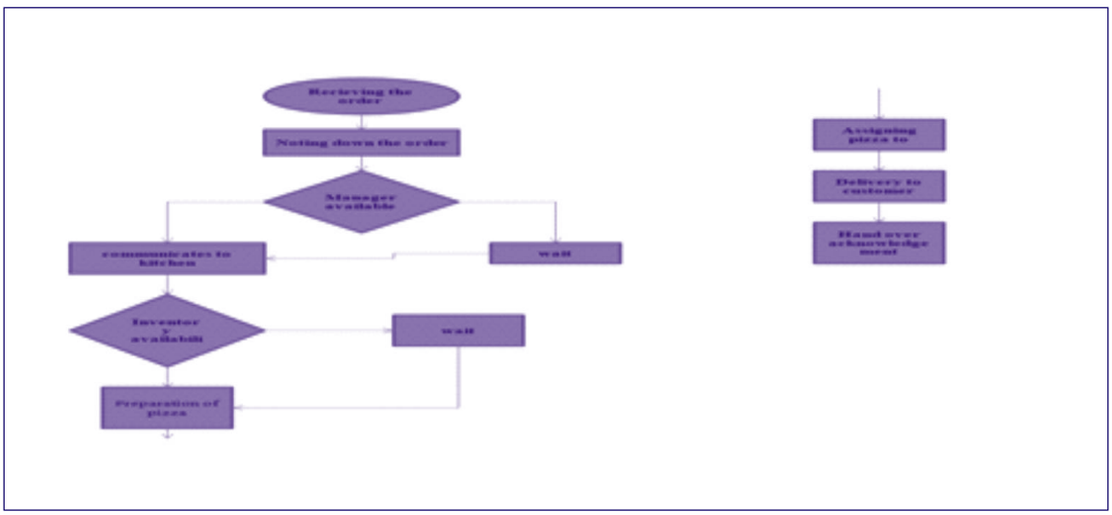


Figure: 2 Flow process chart

· **Non-value-added and Value-added activities:**

The following fig: 3 consists of non-value-added activities and value-added activities.

VALUE ADDED	NON VALUE ADDED
➢ Receiving the order. ➢ Reciept of order. ➢ Communicate to kitchen ➢ Noting the order correctly. ➢ Communication to kitchen for processing the order. ➢ Process of cooking food. ➢ Processing goods to deliver by delivery boy. ➢ Delivery to customer.	➢ Inventory not available ➢ Waiting time for receiving order ➢ Computer telephone not working ➢ Waiting for delivery boy. ➢ Un availability of bike. ➢ Waiting for manager

Figure: 3 Value added and Non value added

During the processes, the following problems were observed:

- The computer system is not working smoothly
- Inadequate inventory for cooking
- Improper order noting
- Wrong picking up the parcel by delivery boy
- Non-availability of vehicle
- Break down of the vehicle in transit
- Client address not found
- Damaged Packages
- Wrong Delivery
- Incomplete order fulfillment
- Client Not Found/Available
- Minor accident
- No clarity of order to be processed in the kitchen
- Improper sequencing of order processing
- Poor knowledge of the delivery boy
- Insufficient information from the customer
- Non-planning of regular maintenance of vehicles
- Wrong Size of pizza
- Non-availability of delivery boy
- Poor Quality of Pizza.

	M 1	M 2	M 3	Total
1. Too Long Distance	9	8	8	25
2. Computer System failure	3	3	4	10
3. Details not noted properly	8	8	8	24
4. Vehicle not available	7	8	8	23
5. Vehicle Failure	3	5	5	13
6. Detail data not logged in properly	4	5	6	15
7. Pizza not prepared on time	9	8	9	26
8. Bad Road conditions	9	8	7	24
9. Address not located	8	8	8	24
10. Addressee not at home	4	4	5	13
11. Too many deliveries to made	5	5	6	16
12. Traffic Conditions Adverse	7	9	9	25
13. Delivery boy not available	9	8	8	25
14. Delivery boy overloaded	3	6	6	15
15. Planning of orders not done properly	8	9	8	25
16. Raw material not available	9	8	8	25
17. Cooking system not available	5	5	5	15
18. Packing material not available	3	5	4	12
19. Mishaps on Road	3	3	3	9
20. Cook overloaded	4	5	5	14

Figure: 4 cause effect matrix

To determine the major causes contributing to late delivery are done by using the cause-effect matrix analysis as shown in above fig: 4.

3. Data Collection:

Table.7 Delivery Boy in current technological support Vs Deliveries

SR. NO	NAME OF DELIVERY Boy	CATEGORY (E/I)	NO. OF DELIVERIES MADE	NO. OF LATE DELIVERY	NO. OF TIMES VEHICLE FAILED	NO. OF TIMES PARCEL DAMAGED
1	DB1	E	6452	690	29	15
2	DB2	E	5596	879	11	12
3	DB3	I	2283	612	7	35
4	DB4	I	3987	979	16	10
5	DB5	E	6487	895	26	7
6	DB6	I	3799	1961	39	23
7	DB7	E	8923	961	16	11
8	DB8	I	6964	1784	9	14
9	DB9	E	7892	456	41	22
10	DB10	E	4811	410	28	18
11	DB11	E	6236	298	24	19
12	DB12	I	2456	1395	7	16
13	DB13	E	6587	269	20	34
14	DB14	I	3259	459	10	20
15	DB15	I	2925	347	25	48
16	DB16	E	7869	1421	27	12
17	DB17	E	9561	563	9	28

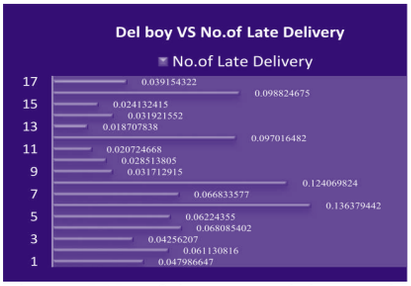


Figure: 5 No of times parcel damaged

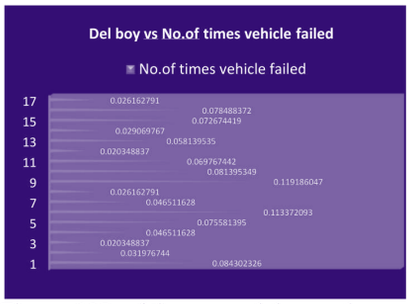


Figure: 6 No of times parcel damaged

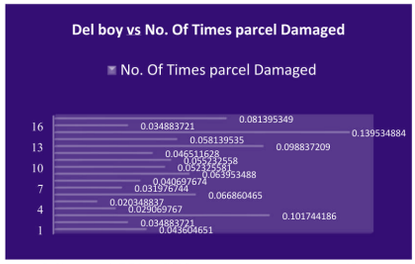


Figure: 7 No of times parcel damaged

From the above Table.7 data we have drawn the bar charts that, from the fig: 5 it shows that DB-6 and DB-8 are the two delivery boys had faced maximum number of late deliveries, from the fig: 6 it shows that DB-9 and DB-6 vehicles failed maximum number of times and from the fig: 7 it shows the maximum damaged parcels are by DB-15.

Table.8 Location Vs Deliveries

Sr.No.	Location (F/M/N)	No.of deliveries	No.of No delivery	No.of Late Delivery	No.of times vehicle failed	No. Of Times parcel Damaged
1	F	45614	213	584	23	14
2	M	32611	124	219	19	21
3	N	19571	57	344	17	32

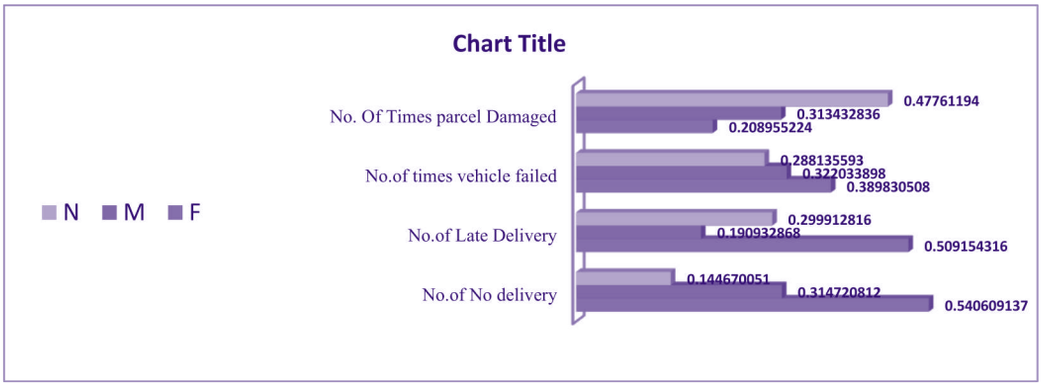


Figure: 8 Location Vs Deliveries

From the Table.8, we have drawn the bar chart for the location vs. deliveries and it tells us that maximum No of parcels damaged, no of times vehicle failed, no of late delivery and know of no delivery are mostly by Far locations as shown in fig: 8.

Table.9 Receptionist Vs Deliveries

Sr. No.	Receptionist	No. of Times wrong Details Login	No. of wrong delivery	No. of Late Delivery	No. Of Times Late Login
1	Juli	7	31	421	8
2	Mona	11	26	739	9
3	Rajesh	6	19	576	8

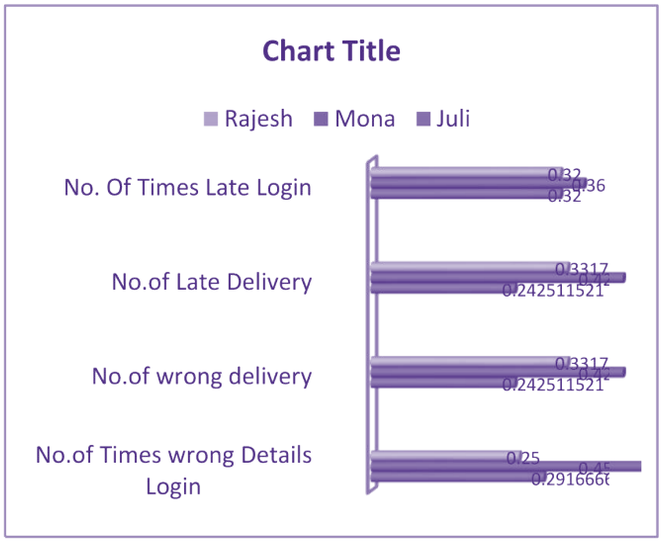


Figure: 9 Receptionist Vs Deliveries

From the data of Table.9 the bar chart is drawn for Receptionists vs. deliveries is shown in fig: 9 it tells us that most of the late login, late deliveries, wrong deliveries, and wrong details login are done by the receptionist MONA.

Table.10 Vehicle Vs Deliveries

S. No	Vehicle No.	Tot. no. of deliveries	Number of times Late Delivery	Number of Times Vehicle Breakdown	No Of times Parcel damaged
1	C-101	4562	512	64	21
2	C-102	3562	112	12	51
3	C-103	2998	215	45	12
4	C-104	8321	621	34	32
5	C-105	4125	153	26	41
6	C-106	3698	61	73	52
7	C-107	2145	114	21	63
8	C-108	3214	38	94	84
9	C-109	3265	92	34	15
10	C-110	4510	76	51	9
11	C-111	7241	280	34	8
12	C-112	5220	161	61	34
13	C-113	4125	95	81	26
14	C-114	789	48	78	17
15	C-115	1023	62	79	19
16	C-116	2178	123	24	40
17	C-117	3691	159	65	6
18	C-118	2897	62	42	17

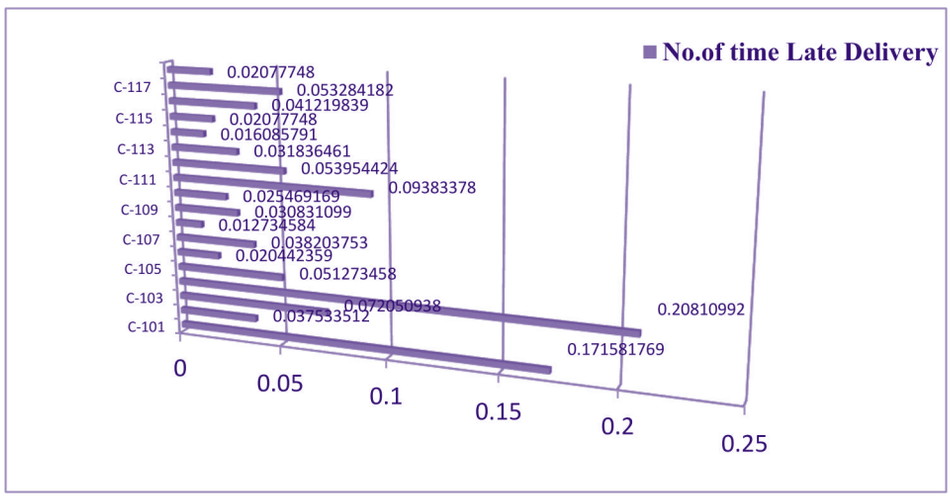


Figure: 10 Vehicle Vs Late Deliveries

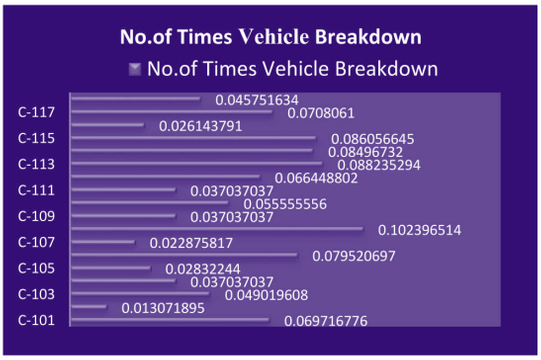


Figure: 11 Vehicle Vs Times Vehicle Breakdown

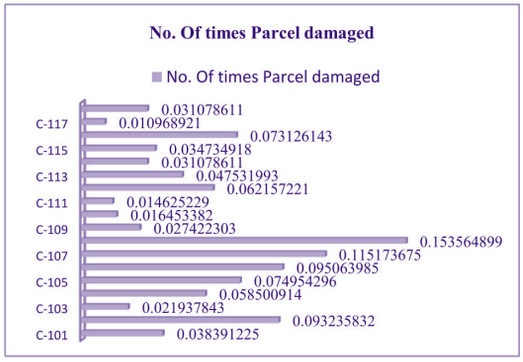


Figure: 12 Vehicle Vs Parcel damaged

Considering the data from the Table.10 (vehicle vs. deliveries) the bar chart is drawn as shown in fig: 10, from the bar chart we know that C 104 vehicle had done maximum number of late deliveries, from fig: 11 C-107 has max number of times vehicle breakdowns, from fig: 12 C-107 maximum number parcels damaged.

Table. 11 Kitchen Inventory Vs Deliveries

Sr. No.	No. of times the late processing	Order Size	No. of wrong delivery	No. of Late Delivery	No. of Times incomplete delivery	No. of Times Size/ Quality Variations
1	62	LO	14	54	24	61
2	38	MO	40	63	12	29
3	95	SO	21	25	19	31

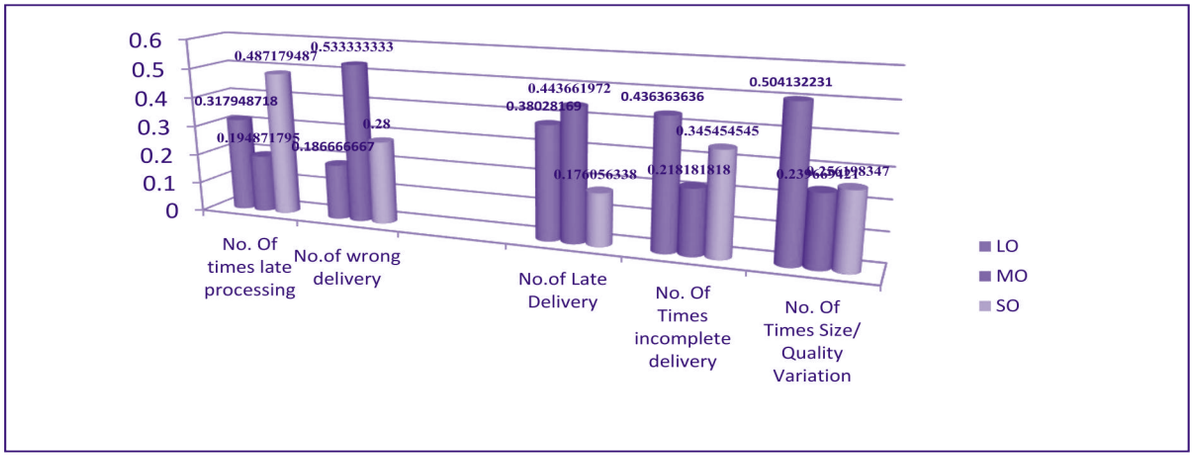


Figure: 13 Kitchen Inventory Vs Deliveries

From the Table.11 (Kitchen vs. deliveries) max number of late processing, wrong delivery, late delivery, incomplete delivery, quality variations are by Large Order size as shown in fig: 13.

Table.12 Busy Day Vs Delivery

Sr. No.	Day (Weekdays/Weekend Days-MN/AN/EN)	No. of Late Delivery	No. of wrong delivery
1	WD-MN	268	24
2	WD-AN	152	15
3	WD-EN	384	9
4	WND-MN	710	22
5	WND-AN	127	15
6	WND-EN	864	31

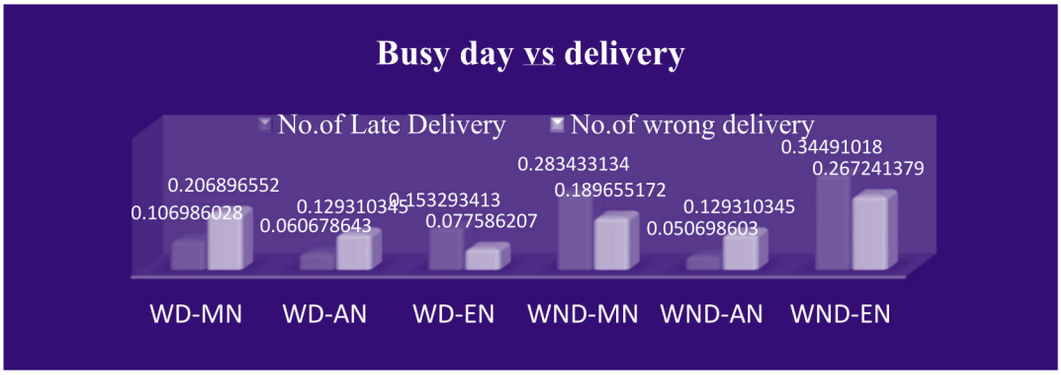


Figure: 14 Busy Day Vs Delivery

From the Table.12 data, we have drawn the bar chart as shown in fig: 14 and from the bar, we know that a maximum number of late deliveries are found on weekend days.

3. Analyse Phase:

Here in the Analyse phase data is collected in the related to various reasons and frequency is also noted as shown in Table.13.

· **Pareto chart**:

Table.13: Defects and frequency

Sr.No	Defects	Frequency
1	Delivery boy not available	29
2	No clarity of order to be processed in a kitchen by a receptionist	78
3	Breakdown of the vehicle during transit	18
4	The receptionist taking your order typed in the wrong/inadequate address, and the driver had to go back to the store to call you and get the correct address	109
5	Cook not available	7
6	Delivered pizza found rubber-bandy	26
7	Receptionist unable to communicate while taking pizza ordered	111
8	Dough consistency problem	24
10	Kitchen manager unable to prioritize the order	3
11	Delivered pizza toppings found sticky	18
12	Delivery boy communication problem	9
13	Payment gateway showing error	11
14	Anyone of the raw material required to prepare pizza found short.	104
15	Computer system hangover	9
16	Oven temperature fluctuations	17
17	Weighing machine giving errors	16
18	Packaging personnel missed the order items during peak timing	84
19	Vehicles found busy	91
20	Receptionist not available	5

The Pareto chart is drawn as per the defects and frequency from the data given in Table.13 and major causes are identified as per the 80-20 rule shown in fig: 15.

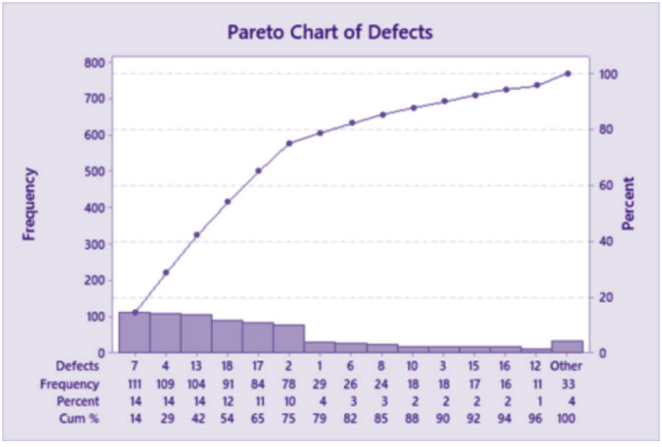


Fig: 15 Pareto chart

The major causes identified from the Pareto chart are,

· Receptionist unable to communicate while taking pizza ordered.

· The receptionist taking your order typed in the wrong/inadequate address.

· Raw material found short for making pizza.

· **Cause Affect Diagram:**

For one of the major cause i.e., (Receptionist unable to communicate while taking pizza ordered) of the causes further carried out Cause-Effect diagram fig: 16 to find out the major causes associated with it

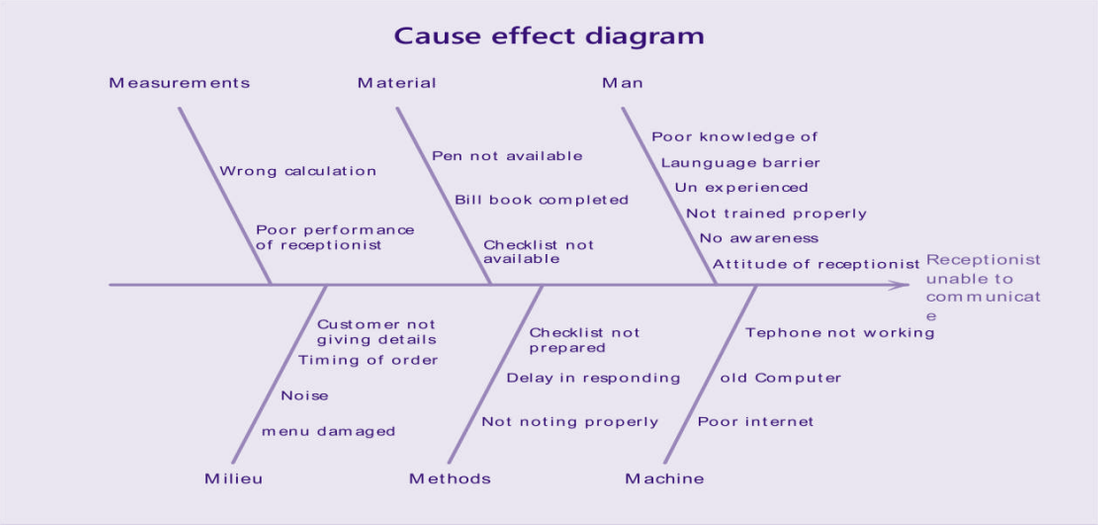


Fig: 16 Cause-effect diagrams

· **Failure Mode Effect Analysis:**

FMEA is an analytical methodology used to ensure that potential problems have been considered and addressed throughout the product and process development cycle.

FMEA helps too, discover the potential failures their potential causal mechanisms and the risks designed into a product or process, Develop actions that reduce the risk of failure, Follow-up and evaluate the results of actions on the risks that were discovered it is shown in fig: 17.

PROCESS	FAILURE MODE	EFFECT	CAUSES	CONTROL AVL.	S	O	D	RPN	SIGNIFICANT OR NOT
Deliver pizza to customer	Late delivery to customer	Customer Dissatisfied. Customer wont pay.	Delivery boy busy Bike breakdown	Availability of del boy Maintenance of bike	9 8	4 2	3 1	108 16	NS S
	Wrong delivery to customer	Customer cheated.	Del boy not trained. Order misplaced	Training required. Proper communication	9 8	5 2	2 5	90 80	NS NS
	Damaged packaging	Customer Dissatisfied.	Minor accident. Negligence of management	Safety rules. Periodic checks	9 10	1 1	1 2	9 20	S S

Fig: 17 Failure mode effect analyses

4. Improve Phase:

Data were analyzed using various tools such as Pareto chart, Ishikawa Diagram etc.

The brainstorming session was held by the team & they listed the various ideas/solutions to problems.

Some of the solutions are as follows-

- Training to receptionist
- Inventory Management
- Use of GPRS system
- Vehicles Maintenance & Balancing.

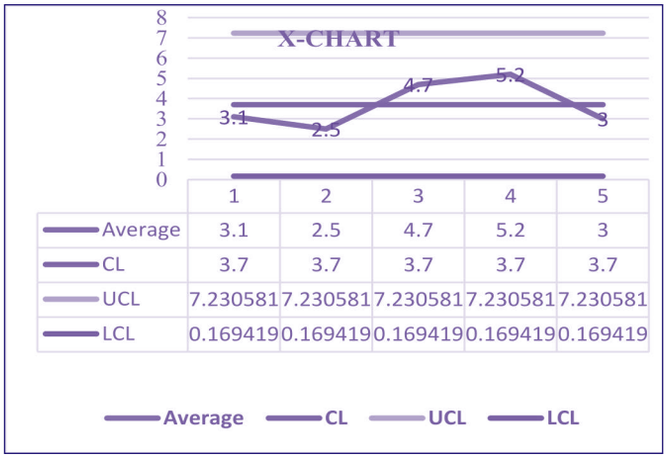
5. Control Phase:

The improvements are carried out on demo basis. To evaluate the effectiveness of improvements taken the data for five days has been gathered. Depending on the distances for home delivery, the time is previously communicated during order taking (Promised time of delivery) if require more than 30mins.

Table. 14 Sample data collection

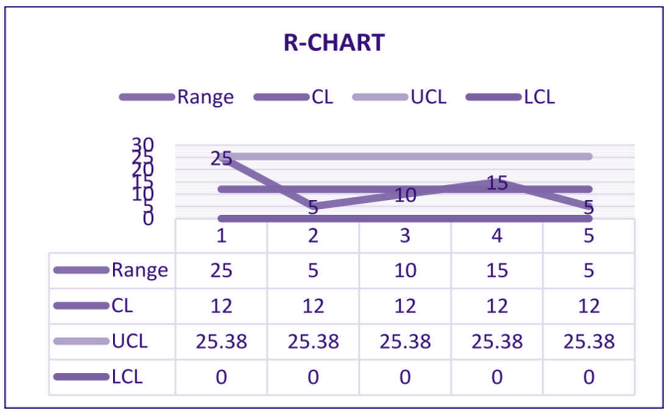
Sr. No.	Date	Time of Order Receipt	Promised Delivery Time	Actual Delivery Time	Delivery Boy	Vehicle NO.	Location (Far/Near)	Right/Wrong Delivery
1	25.11	11.02	11.32	11.25	DB1	101	N	R
2	25.11	11.15	11.45	11.45	DB3	111	N	R
3	25.11	12.00	12.30	12.25	DB4	104	N	R
4	25.11	12.14	12.44	12.40	DB5	102	N	R
5	25.11	12.20	1.10	1.00	DB6	107	F	R
6	25.11	12.40	1.20	1.10	DB2	106	F	R
7	25.11	1.20	1.55	2.10	DB7	105	F	R
8	25.11	5.40	6.15	6.10	DB1	101	F	R
9	25.11	5.50	6.25	6.25	DB8	101	F	R
10	25.11	7.00	7.35	7.30	DB9	105	F	R
11	26.11(S)	12.30	1.05	1.00	DB5	111	F	R
12	26.11	12.40	1.10	1.07	DB4	112	N	R
13	26.11	3.30	4.10	4.05	DB6	102	F	R
14	26.11	4.50	5.20	5.18	DB2	101	N	R
15	26.11	5	5.40	5.40	DB11	103	F	R
16	26.11	5.25	6.05	6.05	DB3	101	F	R
17	26.11	6.15	6.45	6.45	DB4	107	N	R
18	26.11	6.20	7.10	7.05	DB11	108	F	R
19	26.11	6.40	7.25	7.20	DB13	101	F	R
20	26.11	6.55	7.20	7.20	DB15	105	N	R
21	27.11	7	7.30	7.25	DB11	101	N	R
22	27.11	7.15	8.00	7.55	DB15	106	F	R
23	27.11	11.30	12.20	12.10	DB16	105	F	R
24	27.11	11.25	12.10	12.05	DB2	101	F	R
25	27.11	12.05	12.45	12.40	DB5	107	F	R
26	27.11	12.40	1.10	1.05	DB4	101	N	R
27	27.11	1.20	1.50	1.48	DB3	102	N	R
28	27.11	1.50	2.20	2.20	DB1	101	N	R
29	27.11	2.10	2.50	2.45	DB3	102	F	R
30	27.11	2.30	3.10	3.05	DB7	103	F	R
31	28.11	4.20	5.00	5.00	DB5	107	F	R
32	28.11	4.45	5.25	5.20	DB5	105	F	R
33	28.11	5.00	5.40	5.35	DB6	101	F	R
34	28.11	5.15	5.50	5.45	DB1	105	F	R
35	28.11	5.20	5.50	5.50	DB4	102	N	R
36	28.11	5.50	6.30	6.25	DB2	101	F	R
37	28.11	6	6.45	6.30	DB3	103	F	R
38	28.11	6	6.30	6.25	DB14	102	N	R
39	28.11	6.05	6.35	6.30	DB13	105	N	R
40	28.11	6.15	6.45	6.38	DB11	101	N	R
41	29.11	6.18	6.50	6.45	DB2	102	N	R
42	29.11	6.55	7.25	7.20	DB4	108	N	R
43	29.11	7.05	7.25	7.25	DB6	109	N	R
44	29.11	7.05	7.45	7.40	DB4	115	F	W
45	29.11	7.10	7.50	7.45	DB7	115	F	R
46	29.11	7.25	7.55	7.55	DB2	109	N	R
47	29.11	7.30	8.10	8.05	DB1	101	N	R
48	29.11	7.35	7.55	7.55	DB2	101	N	R
49	29.11	7.40	8.20	8.15	DB4	108	F	R
50	29.11	7.45	8.30	8.30	DB1	107	F	R

From the above data as shown in Table: 14 the control charts (X chart and R chart) are drawn shown in fig: 18, 19.



	1	2	3	4	5
Average	3.1	2.5	4.7	5.2	3
CL	3.7	3.7	3.7	3.7	3.7
UCL	7.230581	7.230581	7.230581	7.230581	7.230581
LCL	0.169419	0.169419	0.169419	0.169419	0.169419

Fig: 18 X Chart



	1	2	3	4	5
Range	25	5	10	15	5
CL	12	12	12	12	12
UCL	25.38	25.38	25.38	25.38	25.38
LCL	0	0	0	0	0

Fig: 19 R Chart

8. CONCLUSION:

The paper explains one of the several case studies to implement six sigma in service sector, it can be used in the service sector to reduce processing times, errors, reducing the customer complaints, inventory errors etc.., in this case study we have implemented successfully DMAIC methodology with the help of root cause diagrams, bar charts, Pareto diagram, process chart in the service sector and improved the sigma level. This paper strives to outline the literature review of Six Sigma in the service sectors.

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