Six sigma applied to warehouse operation

A project Report on “ DMAIC App to improve Warehouse Operation” Undertaken At xxxxxxxxxxxxxx Warehouse In fulfilment of Capstone Project of Post Graduate Diploma in Industrial Engineering (PGDIE) By Rajul Agarwal (103) Puneet Jain (107) PGDIE- 41 Under the guidance of Dr. K. Maddulety Professor NITIE, Mumbai National Institute of Industrial Engineering, Mumbai-400087 Acknowledgement “ Too often we are so preoccupied with the destination, we forget the guiding light” -anonymous

I take this opportunity to extend my sincere thanks to HCCB, India for offering a unique platform to earn exposure and garner knowledge in the field of Warehousing Management. I wish to extend my sincere and heartfelt gratitude to my guide Mr. Sudhakar Nair, Warehouse Manager HCCB who guided, supported and encouraged me during the entire tenure of the project. I sincerely thanks to Dr K. Maddulety, my faculty guide, who has been guiding me throughout the project. 1. Executive Summary

This project illustrates an approach to address the complexities faced by beverage industry by identifying critical supply chain activities which indirectly affect Customer Satisfaction. The solution is based on Six Sigma implementation through DMAIC Approach at these critical nodes. It has been established through various experiments that Customer Loyalty & Retention is very low in such industry; hence the customer satisfaction is directly affected by product unavailability. So the product availability is found to be a major concern here as it directly affects the customers buying decision.

It is observed that in this industry, Product availability is majorly affected by the inconsistencies at the warehouse. This project particularly focuses on

these warehousing processes which include the transportation of goods from plant to warehouse, then storing goods at warehouse and finally dispatching of goods to the customers. Based on this we have attempted to provide a blue print of possible advantages such as improved fill rates and better service levels. An empirical study was conducted at XYZ Beverage Company which produces carbonated soft drinks (CSD) and Non-Carbonated Beverages (NCB).

Subsequently, its complete warehousing operation process was understood and DMAIC approach was used to improve the process dynamics. In the measure phase, using Process Capability Analysis it was found that the warehouse process doesn’t follow six sigma levels owing to the high level of damages/defectives and additionally there was a vast scope of improvement. Henceforth, Root cause analysis was done to identify the various causes of damages/defectives. The major causes identified here were lack of standardized operating procedures (SOP), over stacking & overloading.

In the implementation phase, an action plan divided Phase wise, is proposed here so as to take into account variability caused by the two shifts in which the warehouse operates. A strict control needs to be followed so as to maintain six sigma levels, for which p-chart type should be used in combination with proposed Warehouse Operation check list. Table of Contents: Acknowledgement| …1 | 1. Executive Summary | …2| 2. Literature Review| …4| 3. Introduction| …4| 4. Process Mapping| …5| 5. Define Phase 6. 1 DMAIC project Charter Worksheet 6. 2 CTQ tree 6. Voice of Customer 6. 4 Voice of Business | …5…5…5…6…6| 6. Measure Phase 7. 5 data to be

measured 7. 6 Process sigma calculation 7. 7 Statistical summary of defectives 7. 8 Control chart 7. 9 Process capability analysis| ...6...6...7...7... 8...9| 7. Analysis Phase 8. 10 Root Cause analysis| ...9...9| 8. Implementation Phase 9. 11 Proposed action plan 9. 12. 1 Dividing process 9. 12. 2 Major Changes Identified| ...10...10...10...10| 9. Control Phase 10. 12 identifying the controlling elements 10. 13 FMEA 10. 4 SPC charts| ...11...12...14...15| 10. Conclusion | ...16| 11. References| ...16| 2. LITERATURE REVIEW 1. DMAIC Approach to Improve the Capability of SMT Solder Printing Process This paper implements the Define-Measure-Analyse-Improve-Control (DMAIC) approach to improve the capability of the solder paste printing process by reducing thickness variations from a nominal value. Process mapping and identifying key QCH are carried out in the " Define" phase here, while mean (x) and range R control charts followed by the estimates of process capability indices are adopted in the " Measure" phase.

Then, the Taguchi method including L18 orthogonal array (OA), signal-to-noise (S/N) ratio, and analysis of variance (ANOVA) for S/N ratio is implemented in the " Analyse" phase. Taguchi's two-step optimization is conducted in the " Improve phase. " Finally, the x and R control charts for solder thickness are used in the " Control" phase. This paper was used to understand the DMAIC implementation process methodology followed by any process. The insights obtained were how Process capability analysis was carried out and furthermore how use of control charts be validated. . Applying Six Sigma Techniques in Plastic Injection Moulding Industry This paper presents an approach to implement a six sigma technique to decrease the scrap rate in a plastic injection molding plant. The primary tools used

here are SIPOC, MSA, FMEA, P-Control Charts and Hypothesis Testing. In this case study we compare the average scrap rate for the “ Before” study period with the average scrap rate of the “ After” study period. This paper was used to understand the use of p-charts and how they can be applied in processes were defectives are being looked at.

The insights obtained were effective use of FMEA and p-charts in such processes. 3. Introduction: HCCB operates a warehouse in Sewri. It caters to South and central Mumbai. It has a capacity of around 2000 Pallets or approximately 3-4 Lacs bottles (includes Recyclable Glass Bottles + pet bottles + can). It has around 35 mini trucks which daily carries around 38 thousand of bottles dispatched from the warehouse and deliver it to the different stockist/Retailers. The warehouse operates in two shifts every afternoon consignment comes from plant to the warehouse which is unloaded there and then stacked.

Every morning at a specified place called floor the pallets are arranged inspected and then containers are loaded to the mini trucks which deliver it to the stockists/retailers. 4. Process Mapping: When a truck containing pallets of soft drinks is loaded at the plant it is fully inspected and then move towards the Warehouse * Once it is reached to the Warehouse, forklifts unload the pallets and then arrange it in the warehouse * FIFO is followed for outflow of goods Now the pallets are arranged at a floor where all the pallets are inspected * Simultaneously with inspection carriers (small trucks) keep on arranging inside the warehouse * During inspection if any damage is found then it is replaced by the same fresh item * After inspection the containers are loaded (Manually) to the carriers * While loading some bottles

gets damaged that is also replaced by the fresh one and a count is kept for damaged goods * Once the loading is done the carriers move towards their destiny i. e. either to Stockist/retailers 5. Define Phase: 4. 1 DMAIC project charter worksheet

DMAIC Project Charter Worksheet| Project Title: To reduce the damages& improve the productivity of warehousing process| Project Guide: Prof. Madhu Letty, MrSudhakar Nair| Team Members: Rajul Agrawal, Puneet Jain| Business Case: Reduce the cost of warehousing & last mile delivery| Problem Statement: The task is to identifythe sigma level of warehousing process including last mile delivery as a single processand then analyse the process and find the scope of improvement| Goal Statement: To improve the warehousing process & reduce damages| 4. 2 CTQ Tree: Reduce damages Men Machine Method * Proper Training Learning Curve * Commitment * Proper Maintenance * Proper Stacking * Use of Rodent boxes * Inspection 4. 3 Voice of Customer: Here the customers are stockists/retailers to whom the goods are delivered. The Voice of Customer (VOC) is used to describe customer’s needs and their perceptions of product or service. The customer requirements from process and product are: * No damage/deformed item should reach to customer * If any damage is found then on the spot replacement * Customers don’t want to keep the track of damaged items which needs to be replaced next time when delivery van will come 4. Voice of Business: VOB is something which is critical from the perspective of stakeholders (WHse managers, Operators, All sorts of employees etc.) in the business. * Improve profitability * Reduce cost * Least damages * Improve fill rate * Improve customer satisfaction 6. Measure Phase: 5. 1 Data to be

measured: The following table shows the defective items noted in the month of October- November. From this data we calculated the defective proportion & defects per million opportunities. Defective Items| Total Items loaded| Defective proportion| DPMO| 145| 392732| 0. 000369209| 369. 2087| 55| 392700| 0. 000394703| 394. 7033| 132| 378243| 0. 000348982| 348. 982| 159| 332345| 0. 000478419| 478. 4185| 165| 402389| 0. 000410051| 410. 051| 145| 345673| 0. 000419472| 419. 4716| 123| 326789| 0. 00037639| 376. 3897| 190| 389023| 0. 000488403| 488. 403| 120| 334565| 0. 000358675| 358. 6747| 110| 324123| 0. 000339377| 339. 3773| 121| 306543| 0. 000394724| 394. 7244| 156| 402489| 0. 000387588| 387. 5882| 212| 437698| 0. 000484352| 484. 3522| 138| 290873| 0. 000474434| 474. 4339| 112| 238945| 0. 000468727| 468. 7271| 119| 367545| 0. 00032377| 323. 7699| 129| 263421| 0. 00048971| 489. 7104| 56| 463752| 0. 000336387| 336. 3867| 145| 375643| 0. 000386005| 386. 0048| 123| 342356| 0. 000359275| 359. 2751| 90| 289532| 0. 000310846| 310. 8465| 225| 462163| 0. 000486841| 486. 8412| 121| 284532| 0. 00042526| 425. 2597| 175| 404512| 0. 00043262| 432. 62| 180| 403212| 0. 000446415| 446. 4153| 127| 329261| 0. 000385712| 385. 7122| 212| 431962| 0. 000490784| 490. 7839| 132| 337961| 0. 000390578| 390. 5776| 198| 326781| 0. 00060591| 605. 9104| 109| 392861| 0. 000277452| 277. 4518| 5. 2 Process Sigma Calculation: Average no. of items loaded each day = 360418 Average no. of defective items per day = 148

Average defective proportion = 0. 000411328 Average DPMO = 411 Value of Sigma = 4. 9 Since the process sigma is 4. 9 which is less than 6. Now the next task is to analyse the process to find the scope of improvement. 5. 3

Statistical summary of “ No. of defective items observed at various days” Observations: * Since P-value > 0. 05 so the data passes the normality test * From the histogram it is visible that frequency distribution of defective data can be approximated to normal distribution * Since the data can be approximated as normally distributed we can apply process capability and SPC analysis . 4 Control Chart: Here in this case when the goods are inspected either they will be accepted to be shipped or simply discarded. So here we are not concerned with the no. of defects but concerned with the non-conformances (defectives). So the P-chart has been selected for SPC analysis:- Observations: * The above P-chart shows that all the observations lie inside the natural control limits. * It can be said that the process is under statistical control. * Since the process is under statistical control we can check for its capability. 7. Process Capability Analysis using MINITAB 15: * The desire is to minimise the damages to nil so the target valueis set to be zero. Observations: * Process sigma = 3. 34 * PPM Def = 410 which is lesser than 3. 4 ppm 7. Analysis Phase: 6. 1 Root Cause Analysis: 6 Implementation Phase: 7. 1 Proposed Action Plan: 7. 1. 1 Dividing the whole process of warehousing to deliver goods to the stockist/retailers into 4 stages: The process is divided into 4 stages on the basis of people& machines involved. In stage 1 goods are transported to the warehouse by one set of people (3 PL).

Since warehouse operates in 2 shifts so when the trucks come from plant to warehouse that is unloaded by different set of people & in stage 3 “ stacking at floor+ inspection + loading containers to carriers” are done by different set of people (working in 2nd shift). In stage 4 the goods transported from

warehouse to stockists/retailers by different set of people and different carriers are involved. The purpose of dividing the whole process into 4 stages is to get more specific causes stage by stage and to get more insights.

Since the different people and machines are involved in each stage so some specific plans may be put in place to reduce the damages. The following table shows the different causes and actions: Stage| Causes| Action Plan| 1| * In-Transit Damages * Bad Road Conditions * Mishandling by the operators| * Since in stage 1 the transportation is done by the 3PL so while selecting 3PL service provider company can bring some clauses in the agreement related to minimum breakage acceptable * Operators can be nstructed to follow the best route * Maintenance of carriers periodically after a specified time| 2| * Jerk in forklift * Over stacking * Improper training * Mishandling by the operators| * Establish SOP for the forklifts operation * Periodic maintenance of forklifts * Company currently uses diesel run forklifts that can be replaced by battery operated forkliftswhich require less maintenance * Provide incentives to the operators for achieving a certain level of damage free work * Provide ergonomically fithandles to the containers * Pet bottle packets as shown below gets unwrapped sometimes that needs proper packaging * Above kind of packaging can be either replaced by carton (but that would not be a cost effective solution) or same packaging can be improved | 3| * Improper operation/jerk in forklift * Improper inspection * Mishandling | * Try not to rotate the people involved in inspection so that their learning curve makes them more efficient in that particular task * Provide incentive to the employees * Encourage employees | 4| * Overloading * Improper truck

operation| * Avoid overloading * Proper training to the truck operators * Hire experienced operators * Provide incentives| | Environmental Causes * Rat Bite| * Especially tetra packed drinks are attacked by Rats * Use Rodent boxes to kill the rats * Daily check the rodent boxes & clean it if needed| 7. 1. 2 Major changes which can be brought in future to improve the overall process * SOP for forklift operations * Proper maintenance of forklifts and Trucks * Use of battery operated forklifts * Avoid overloading * Avoid over stacking 7 Control Phase: 8. 1 Identifying the Controlling Elements:

The Critical-To-Quality Elements needs a proper control and inspection and hence the following Steps can be taken for the same: 1. Fork Lift Inspection Check Sheet: 2. Training Check List/ Regular Knowledge Tests 3. Rodent/ Insects Check List 4. Better Stacking Procedures a. Increasing the strength of the pallets from by increasing the cross pieces by 8 from 5 for the same 5cm x 10cm boards. b. In case of need to over stack during peak demand, we can keep the crates at a cross position so that the load gets distributed 8. 2 Failure Mode and Effect Analysis (FMEA): Use of FMEA tool for better analysis of damage reasons will help establishing a better control procedure. FMEA Flow Diagram 8. 3 Use Statistical Process Control (SPC) Charts:

The case here is for graphing defectives for a varying sub group set. Hence use of p-chart should be used for continuous control. It will check when the variation is natural and when it needs correction. The following excel template can be used where directly data can be entered and the resulting p-chart will be generated. Excel template for Formulating p-chart 9. ESTIMATED BENEFITS OF PROJECT The biggest benefit of the project is in terms of reducing the risk of product unavailability downstream. The

probability of defects can be drastically decreased and remain in specification limits. * 4-Stage Implementation phase for reducing defectives * Increased Sigma Levels approaching six sigma standards Increased Customer satisfaction and Product availability * Laid down Standard Operating Procedures (SOPs) for better warehouse operations control 10. CONCLUSION The reasons for the excessive defects are found. Over-stacking, Over-Loading & improper forklift operation were found out to be prime reasons using Cause and Effect Diagram. These were considered the CTQ’s for the warehousing operation. Project benefits were estimated and it is found that this improvement can bring the improvement in fill rate. 11. REFERENCES: * www. dmaictools. com * www. sixsigmatutorial. com * www. sixsigma. in * Six Sigma Way ? Team Field book by Peter S. Pande, Robert P. Neuman and Roland R. Cavanagh * Six Sigma for managers by Greg Brue