Improving measuring and target setting for processes impacting customer service in a Fast Moving Consumer Goods company

Master thesis – Industrial Engineering & Management

UNIVERSITY OF TWENTE.

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Management summary

In front of you is the master thesis leading to the graduation of Lucas Koster for his study Industrial Engineering and Management at the University of Twente. The performed research gives an answer on "How to improve service level and increase visibility and accuracy of tracking service losses per supply chain process to enable continuous improvement" in the Procter & Gamble company. For answering this question we have applied the DMAIC (Define, Measure, Analyse, Improve and Control) framework adopted from the six sigma methodology.

To continuously improve the different supply chain processes that exist in the company we propose to measure the performance at the second root cause level which corresponds to all the processes that occur in delivering the service to the customer. This immediately is the result for the Define stage of the framework.

In the Measure stage we developed a dynamical report using the strengths of the Excel PowerPivot plugin where the service at each different touchpoint in the supply chain can be analysed. Zooming into separated areas of low performance becomes an easy task with this report. Our tool is now being used by the complete HairCare category in the EIMEA region.

The real breakthrough has been achieved in the Analyse step. We proposed to use an adjusted control charting algorithm for calculating stable state behaviour of each supply chain process. In the algorithm we use the Laney P' control chart for attributes as basis for the calculation where we remove days that are out of control using the 3-sigma control rule. After this initial iteration we introduce a new variable α to calculate the percentage of days that are out of control after recalculating the control limits. This α now gives us a solid and robust rule where we can rely on for when to re-iterate and remove out of control days for a second time. The algorithm has been built into an analysis tool which can be run each month to automatically calculate targets for each supply chain process service losses impact.

The final steps in the framework are the Improve and Control steps where we incorporated the newly created analysis in the drumbeat process. We give a powerful new background check for all the service losses to identify possible action plans to improve the processes. Finally we adjust the review drumbeat to track all the action plans together via the weekly meeting.

All these steps together lead to improved service tracking and generated a method for target calculation. All together this enables the company to continuously improve their customer service which is one of the main KPIs.

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List of abbreviations and meanings

Cut: a customer order that is not fulfilled completely.

DMAIC: Define, Measure, Analyse, Improve and Control.

EIMEA: Europe India Middle East Africa region

MTD: Month to date

FYTD: Fiscal year to date

CuFR: Case Unfilled Rate

CFR: Case Fill Rate

CFR-KU: CFR Key User

SU: Statistical Units

MSU: Thousand Statistical Units

Chapter 0: Problem Statement

In the framework of completing my master studies Industrial Engineering and Management with a specialization in Production and Logistics Management at the University of Twenty, I have performed research at Procter and Gamble into customer service optimization.

Procter and Gamble, established in 1837 in Cincinnati, Ohio is one of the largest consumer product companies in the world. In 2014 it posted $83 billion revenue and over $11.5 billion of income1. It owns over 200 brands, 23 of them being $1 billion brands, including Pantene, Head&Shoulders, Pampers, Gillette and Ariel. The company has been the largest advertiser in the world for over 100 years. Procter and Gamble products are available in over 180 countries around the world (Sanderson, June 2015).

Inventory management in a company of such scale is a key focus. On June 30, 2014 the company reported holding $6.8 billion of inventory, $4.3 billion of this being finished products. This, amounting to over half of the annual income, is a substantial amount of money frozen in the supply chain. It is understandable that the company is making an effort to sustainably reduce this level, ensuring that the balance between inventory and service levels is under control (Sanderson, June 2015).

The relationship between safety stock and service level delivered by the supply chain is illustrated in Figure 1. We can see that increasing target service level leads to increasing inventory in the supply chain, and the higher the target, the greater the inventory holding cost when increasing the service target by a fixed value. The unrealized service that is allowed by the set target service level (5% in Figure 1) can be caused by a range of different problems that occur. We can think of for example unforeseen demand volatility, production problems but also less obvious problems like wrong master data or transportation problems cause missed service sometimes.

Knowing there are a range of different causes for missed service it would be good to know which part of the allowed misses can be caused by different problems. Is the supply chain performing normally when for example 4% of service is missed by transportation problems or when 5% is missed by wrong set up of the system? To be able to answer these questions we need a solid method of setting targets for specific supply chain processes that are not readily available so we can track the performance and take action when a certain process is not performing well.

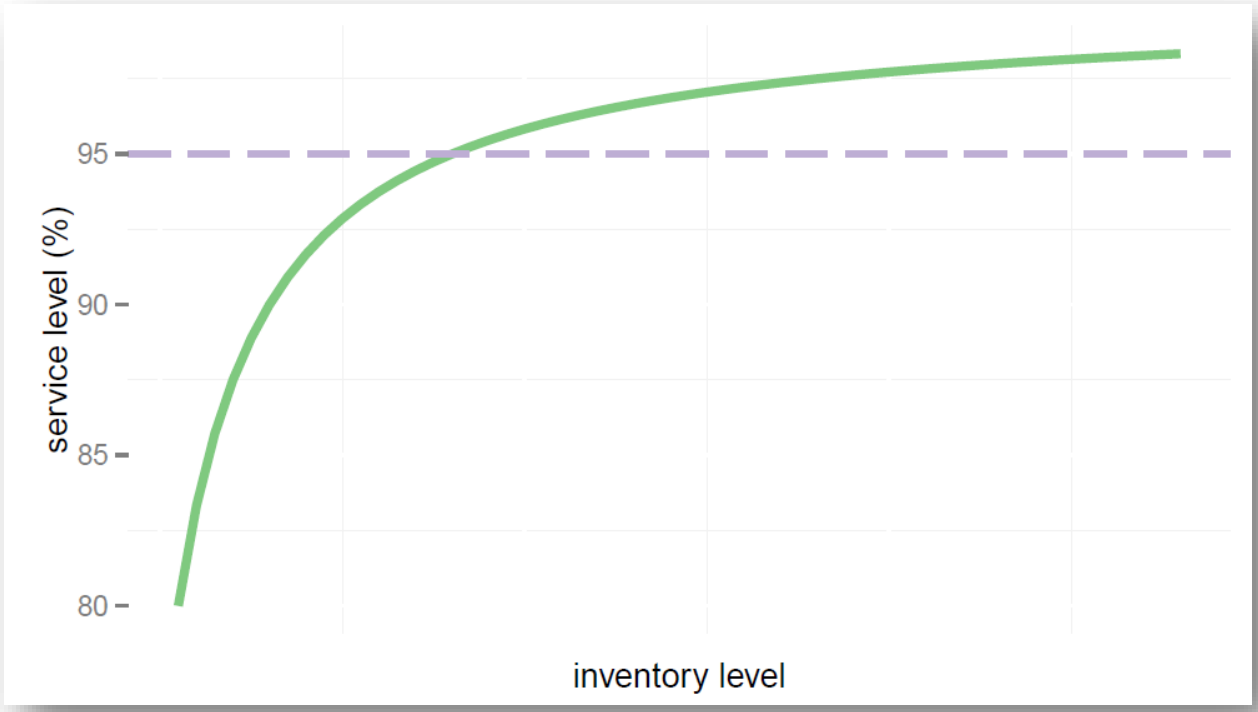


Figure 1 - Service level vs. inventory

Research Questions

To answer the problem that is stated in the previous part we have developed a main research question that when answered will give better insights and improve the service level of the company without raising the safety stock.

- How to improve service level and increase visibility and accuracy of tracking service losses per supply chain process to enable continuous improvement?

To answer this main question we have stated a number of sub questions which will help give a proper answer.

1. At what level of process detail do we need to improve tracking?
2. How can we increase the visibility of achieved service level throughout the supply chain?
3. How can we improve the accuracy in measuring performance of the processes?
4. How can we identify actions to improve measured low performance?
5. Which process should be implemented to enable continuous improvement on service level using the new tracking method?

Methodology

To tackle the problem described in the problem statement we make use of the Six sigma DMAIC approach which stands for Define, Measure, Analyse, Improve, and Control. This approach is proven to enable continuous improvement and is the red line for building the process improvement tool in customer service for Procter & Gamble (Rever).

The DMAIC methodology is very well suited for process improvement because it looks at a process in three main parts, an input to the process, the process itself with multiple linked steps and the output that the process generates (Figure 2). And it states that to improve the output of a process we simply have to look at the input and the process itself and identify where to improve. If we translate this view to the supply chain of Procter & Gamble we can see the connection between the orders or demand as input to the process, the process under study would then be all the steps that need to be done by the company to fulfil the orders and the output is simply the customer service level, Figure 3.

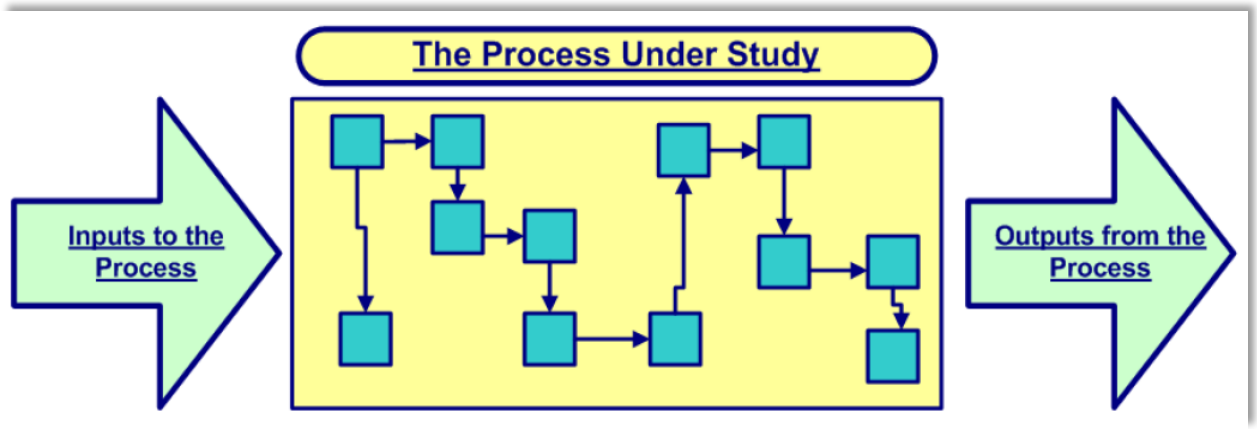


Figure 2 - Process view DMAIC

Figure 3 - Process of P&G

The roadmap for improving processes and key measures of a business is a straightforward, easy to understand set of five steps (Figure 4). DMAIC is an iterative process that gives structure and guidance to improving processes and productivity. The DMAIC steps work because they are understandable and make sense. These steps can be applied to any process, any industry, any company to help guide a process improvement team. The five steps of the DMAIC methodology are explained deeper below.

Figure 4 - DMAIC cycle

Define

In the Define phase it is important to set clear goals for the project. What is the end result that needs to be achieved and which processes are we going to look at?

Measure

The Measure step is often a step which, unfortunately, is skimmed over by most teams. One of the biggest mistakes made when trying to improve results is to make decisions based on "gut" feeling, intuition or anecdotal information. Instead, what is imperative is to base decisions on facts and data and that is the main goal of the measure step. In the Measure step, the team should:

- Identify and operationally define key metrics

- Develop a data collection plan
- Conduct a measurement system analysis to verify that the data is accurate
- Stratify the data
- Establish baseline charts
- Make charts and graphs to help the team better understand what the process is currently delivering in terms of processing times, errors or defects

Analyse

The Analyse step is all about getting to the root cause of the problem. Too often when trying to solve a problem, people or teams tend to focus on a symptom as opposed to the true root cause of the problem. In this step we need to gather clues for improvement and ascertain what the root cause, or causes, are that are the most important drivers.

Improve

Once a team moves through the Define, Measure and Analyse steps, they are now ready to use what they've learned about the process to be innovative when solving the problem at hand. Improve is the step where creative solutions to existing problems can be developed and tested, using various experiment or piloting techniques. The key deliverable in the Improve step is verifiable improvement through measurement.

Control

The real strength of the DMAIC steps is the Control step. Too often, teams do a lot of hard work, actually improve the process and results, and then implementation of the improved process doesn't go smoothly. There is pressure to move on; time isn't spent on having a smooth transition and the buy-in for full implementation just isn't quite there. The result is that sustaining the improvement realized in the Improve step becomes difficult. The purpose of the Control step is to ensure a successful implementation of the team's recommendation so that long-term success is attained.

Chapter 1: Define

The main purpose of this chapter is to define what we want to improve using the DMAIC framework. This is then used as input for the next chapters.

The supply chain of Procter & Gamble HairCare Europe Blois is setup in a complex way and therefor it is challenging for analysis and improvements because of the many touchpoints. Productions in the plant are pushed to a number of first level distribution centrums (DC) from where several second level DCs are supplied via a pull mechanism. Next to this there are also express shuttles available to quickly transport stock between DCs if they are at risk of running out of stock. The full supply chain including transportation times and replenishment methods can be seen in Figure 3.

To understand the setup of the supply chain is important because the DCs is where the impact on the service is generated. Orders come in on DC level and when there is not enough stock available this order will be 'cut', leading in a fully or partially unfulfilled order. To counter against these cut orders the company keeps a level of safety stock of different products in the DCs to be able to counter the effect of demand volatility (forecasted demand is always wrong) and supply issues.

Root causing

Every order that is cut at the DC is root caused by the distribution requirements planners of the different regions. Root causing means that the core trigger of why the order could not be fulfilled is being investigated, this could be because a variety of causes which are predefined by Procter & Gamble. A cause for a cut is build up of three different levels, a first top level that in which part of the supply chain the issue occurred (demand or supply), a second level that describes which process of the top level went wrong and finally a third level that gives insight in what went wrong in the process. This build up is visualized in Figure 2 and the full tree of members for the different levels with description can be found in Appendix A: Root cause tree.

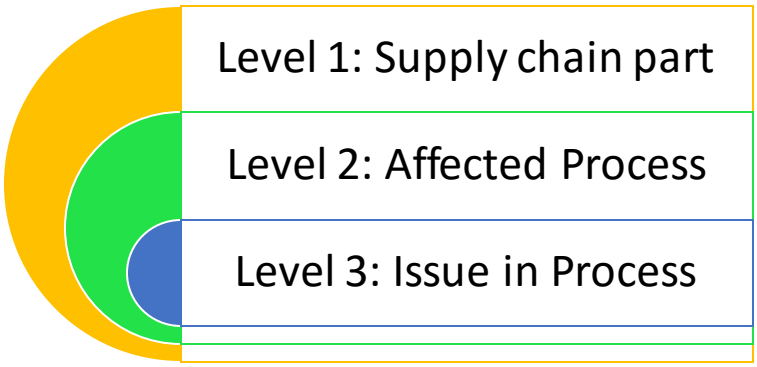


Figure 5 – Root cause levels

Level of analysis

As described in the problem statement it is unclear at this moment if the sub processes making up the supply chain perform as they should. There are no targets defined for the amount of cuts and their impact on the service level that can be caused by these processes and therefore it is impossible at the moment to identify which processes should be improved. The goal of the new improvement tool is to be able to set theoretically backed targets that we can measure the performance of the supply chain processes with and identify areas where the biggest gain in service can be gained. This corresponds with an analysis at the second root cause level where the impact of these processes are measured.

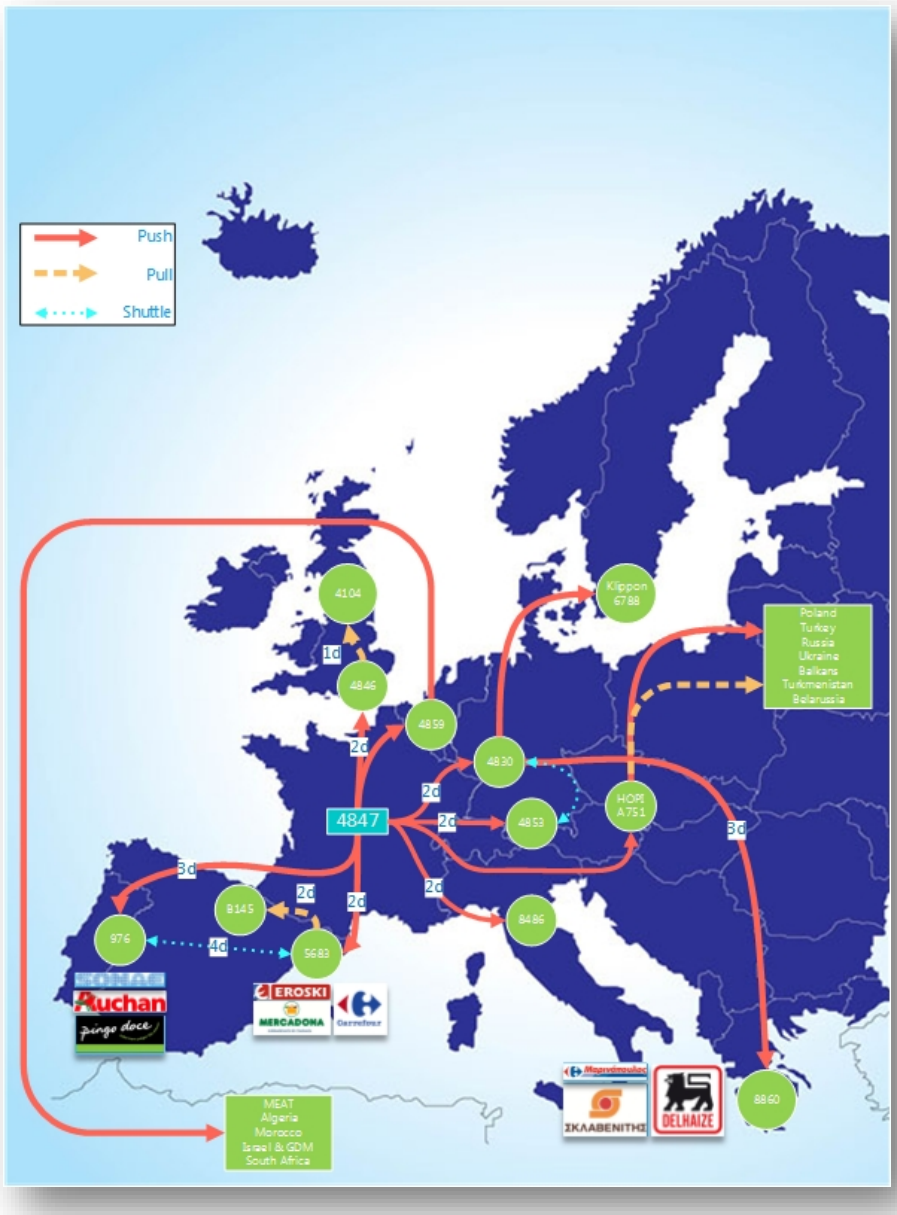


Figure 6 – Blois HairCare distribution chain.

Chapter 2: Measure

After we have defined the level of service we want to improve the CFR on in the first chapter we now build a model that helps us deliver visibility in measuring the actual achieved service level in this chapter. There is no scientific research performed for this chapter but instead explains the process of generating a new tool depending on a vast amount of constraints.

The company Procter and Gamble saves all the data for their achieved service and occurred cuts in their databases giving us a vast amount of data to analyse. At the moment there is no simple system though that could give the insight you want at a specific level on the go. For the next steps in our DMAIC framework this is an important prerequisite and helps building the overall process of continuous improvement.

Service at different touchpoints

As said before there are a lot of different touchpoints and aggregation levels in the supply chain of Procter and Gamble. First of all there is the performance of the complete region, in our case EIMEA, which is measured over all the orders received in the whole continent. Another aggregation that service is measured is at cluster level, a cluster is a collection of countries that use the same FPC (finished product code, synonym for SKU). Because different countries have different languages and different needs for their inhabitants there are a lot of the same products but with another packaging to be aligned with the country it is sold in. And as we measure the service per cluster we also measure the service per country separately.

The above measures are based on regional parameters but there are a number of different plants that supply the DCs for this country which brings us immediately to the next levels of aggregation, per distribution centre and per production plant. Next to these levels of aggregations there also is a need from the MT to be able to track the performance of the main customers independently.

Besides the regional, production and distribution sites we also need to have sight on the performance of different brands or even specific FPCs to be able to identify isolated areas of low performance that otherwise would be unnoticed.

All these different levels of detail and aggregation and the fact that there is not an easy way of immediately seeing the performance on the level we want to see led to the need of developing a tool that gives us this ability.

Service level calculation and unit of measure

Throughout all category and business units of Procter and Gamble the service level is calculated with the same method, the total fulfilled orders divided by the total incoming orders which is known as the Case Fill Rate (CFR).

$$CFR = \frac{Total\ orders\ fullfilled}{Total\ orders} * 100\%$$

This can also be calculated with the formula:

$$CFR = \left(1 - \frac{Total\ orders\ unfilled}{Total\ orders}\right) * 100\%$$

To be able to compare the performance of different categories with each other Procter and Gamble measures all orders in Statistical Units (SU). This measure is defined as the average use of a product per person per year and the conversion is calculated by the company itself. For example shampoo has been set to an average use of 4 litres per person per year, then 1 SU shampoo can be 5 items of 800 ML or 10 items of 400 ML.

Throughout the rest of the thesis all measures for orders and cuts are shown in MSU (thousand statistical units) unless mentioned otherwise. All measures for CFR are shown in percentage (%) and calculated with SU as base for orders and unfilled orders (or MSU which yields the same result).

Data model development

As can be understand a huge amount of data is being generated on all these different levels of aggregation and as the standard Excel application that would be able to fulfil the needs if there was only a small amount of data we had to look into other options. We have come up with a solution to store data in an Access database that allows us to connect to with the Excel Business Intelligence solution 'PowerPivot'.

The data that is stored in the Access database is extracted from the P&G database on a daily basis at the lowest aggregation levels there are, the FPC, production plant, distribution centre, country and customer. With this information we can make custom aggregations for all the higher levels of analysis by connecting to reference matrixes. The full data model is shown in Figure 4 where the two red lined tables represents the data that is downloaded daily and the others tables represent the reference matrixes that have been stored to aggregate on any level of detail. The full developed code can be found in Appendix B VBA Codes for background information.

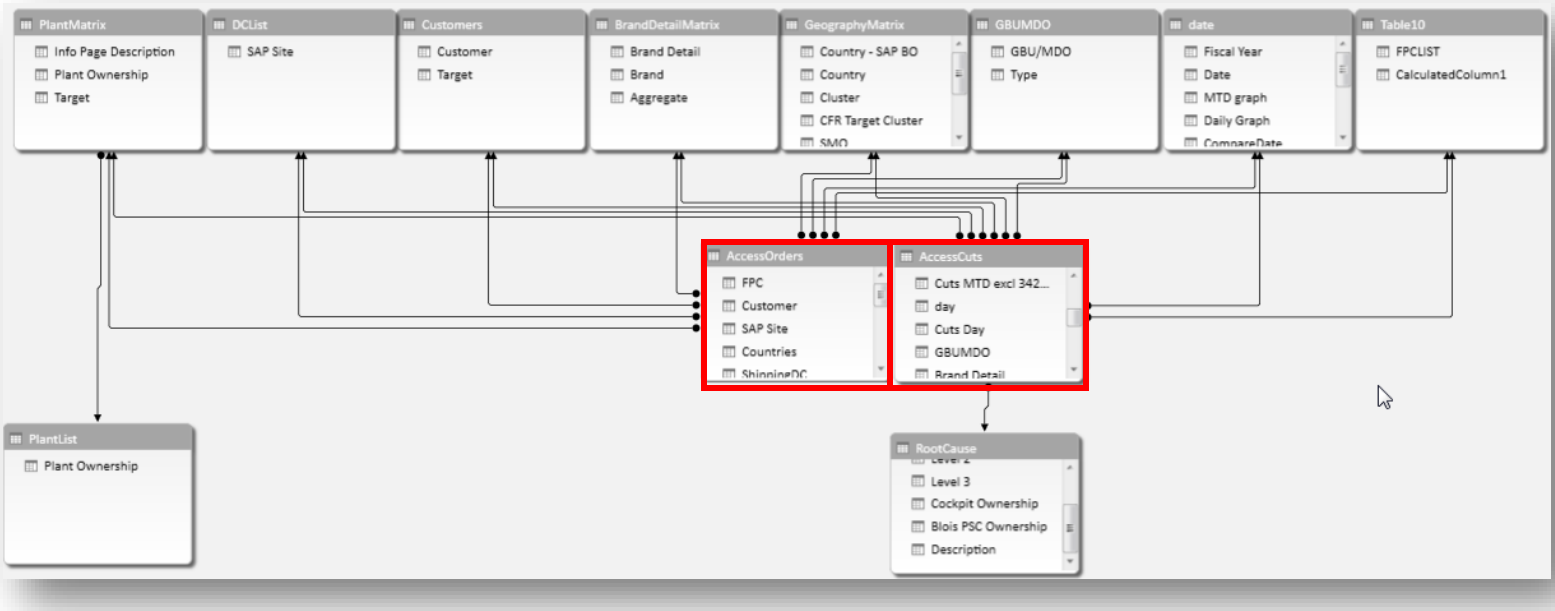


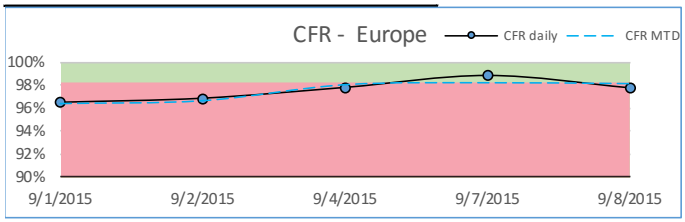
Figure 7 - Developed data model for aggregation

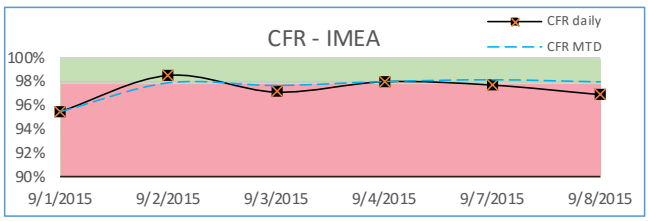
Visualizing performance

With the data stored in the Access database we now can develop a report showing the actual achieved performance on the aggregation levels we want to see. For this we make use of the Excel Business Intelligence solution PowerPivot. The PowerPivot gives us the opportunity to analyse Access data with the use of fast SQL statements, allowing an update performance of under 10 minutes. If we compare this to the previous report that did not had an analysis on all the different levels of detail and took more than 40 minutes to update daily this is a huge gain in time spend every day. The PowerPivot solution retrieves the data from the Access database and stores it locally in the internal memory of the computer allowing this increase in speed.

The report consist of two parts. The daily report part which is updated every day and shows the results for all aggregation levels in a fix layout allowing a quick overview of the results and a deep dive analysis part that gives the users the opportunity to analyse the data in a dynamically interactive manner. This is where the biggest innovation has been gained giving each user the possibility to really dive into the data and with several selection methods find the areas of low service performance.

The report that we have developed is shared with all the full EIMEA Haircare employees involved with service, giving us a distribution list of over 300 employees. A preview of part of the report that is shared daily is shown in Figure 5. The full report can be seen in Appendix B and is attached as Excel document.





Category results - MTD

	Hair Care MTD			Hair Colour MTD			Hair Styling MTD			Total Hair MTD			
Cluster / Category *	**Cuts**	**Orders**	**CFR**	**Cuts**	**Orders**	**CFR**	**Cuts**	**Orders**	**CFR**	**Cuts**	**Orders**	**CFR**	**CFR Target**
Europe *	**12.0**	**1017**	**98.82 %**	**13.1**	**301**	**95.65 %**	**4.4**	**253**	**98.27 %**	**29.5**	**1570**	**98.12 %**	**98.20%**
Northern Europe	4.7	363	98.72 %	7.5	116	93.56 %	1.2	62	98.09 %	13.3	541	97.54 %	98.50%
Southern Europe	3.7	252	98.53 %	.0	4	98.96 %	.0	31	99.88 %	3.8	287	98.68 %	98.90%
DACH	1.5	174	99.16 %			100.00 %	1.3	82	98.37 %	2.8	255	98.91 %	99.00%
FBNL GROUP	.8	123	99.36 %		1	100.00 %	.2	12	98.52 %	1.0	137	99.29 %	99.00%
EE+CAR	.3	18	98.54 %	2.7	76	96.38 %	1.1	36	97.04 %	4.1	130	96.86 %	97.90%
Southeast Europe	.2	63	99.69 %	1.8	25	92.51 %	.1	10	98.67 %	2.2	98	97.77 %	98.70%
CE	.6	21	97.21 %	.9	44	97.86 %	.4	19	97.82 %	1.9	83	97.68 %	98.00%
Turkey & Caucasus	.4	3	86.29 %	.1	36	99.84 %	.0	1	99.75 %	.4	39	98.87 %	96.30%
IMEA *	**12.6**	**707**	**98.21 %**	**.9**	**23**	**96.16 %**	**.0**	**1**	**98.99 %**	**13.5**	**731**	**98.15 %**	97.80%
Arabian Peninsula	2.6	254	98.99 %			100.00 %			100.00 %	2.6	254	98.99 %	98.50%
Near East Group	5.9	139	95.72 %	.5	8	93.87 %			100.00 %	6.4	147	95.62 %	98.50%
Pakistan Group	1.1	124	99.10 %	.1		76.56 %			100.00 %	1.2	124	99.05 %	96.00%
India	2.5	84	96.98 %			100.00 %			100.00 %	2.5	84	96.98 %	97.00%
Israel Cluster		52	100.00 %	.1	5	98.54 %		1	100.00 %	.1	58	99.87 %	98.20%
North West Africa	.3	37	99.29 %	.0	5	99.35 %			100.00 %	.3	42	99.30 %	98.50%
SA & SSA Group	.2	18	98.65 %	.2	3	94.30 %			100.00 %	.4	21	98.06 %	97.50%
GDM			100.00 %			100.00 %	.0		94.06 %	.0		97.83 %	98.50%
Grand Total *	**24.7**	**1724**	**98.57 %**	**13.9**	**323**	**95.69 %**	**4.4**	**253**	**98.28 %**	**43.0**	**2301**	**98.13 %**	98.20%

	Day: 9/8/2015			MTD			FYTD				Cuts Left to target**		Orders trend MTD**			
Plant Ownership	**Cuts**	**Orders**	**CFR**	**Cuts**	**Orders**	**CFR**	**Cuts**	**Orders**	**CFR**	**CFR Target**	**Month**	**Daily**	**EUR %**	**EUR Msu**	**IMEA %**	**IMEA Msu**
Blois	1.69	117.3	98.56 %	8.6	802	98.93 %	86	8186	98.95 %	98.50%	63.11	3.71	72%	3131	74%	300
Urlati	.00	.0	100.00 %	.7	8	91.31 %	28	1765	98.43 %	97.30%	51.49	3.03	1%	16	17%	12
Dammam	2.95	77.6	96.19 %	7.2	440	98.37 %	63	4330	98.54 %	98.20%	24.09	1.42			93%	1615
Capella	.52	16.1	96.74 %	2.0	78	97.42 %	14	822	98.32 %	98.00%	11.62	.68	42%	286		
Huenfeld	.35	40.0	99.13 %	3.1	221	98.59 %	20	2062	99.01 %	98.60%	11.68	.69	78%	802	32%	9
Rothenkirchen	1.02	27.9	96.35 %	3.7	138	97.35 %	35	1495	97.64 %	97.90%	12.69	.75	88%	464	17%	42
Sarreguemines	.06	5.3	98.92 %	.6	27	97.86 %	14	304	95.43 %	98.20%	1.98	.12	75%	98	13%	2
Seaton	.84	9.1	90.68 %	7.2	107	93.24 %	18	743	97.53 %	98.40%	-1.68	-.10	118%	383	46%	11
ESS	.06	1.1	94.40 %	.2	8	97.04 %	6	86	92.51 %	98.20%	.17	.01	130%	29	40%	
Xiqing		6.4	100.00 %		31	100.00 %	3	227	98.48 %	98.20%	2.56	.15			79%	113
Local Customization	.49	24.0	97.97 %	2.3	134	98.25 %	20	880	97.71 %	98.20%			Included in Blois			
Others	1.56	52.9	97.05 %	8.6	322	97.33 %	96	4232	97.73 %	98.20%						
Grand Total	**9.55**	**377.5**	**97.47 %**	**44.2**	**2316**	**98.09 %**	**405**	**25132**	**98.39 %**	**98.20%**	**187.84**	**11.05**	**64%**	**5778**	**70%**	**2715**

Figure 8 – Daily report part of CFR report

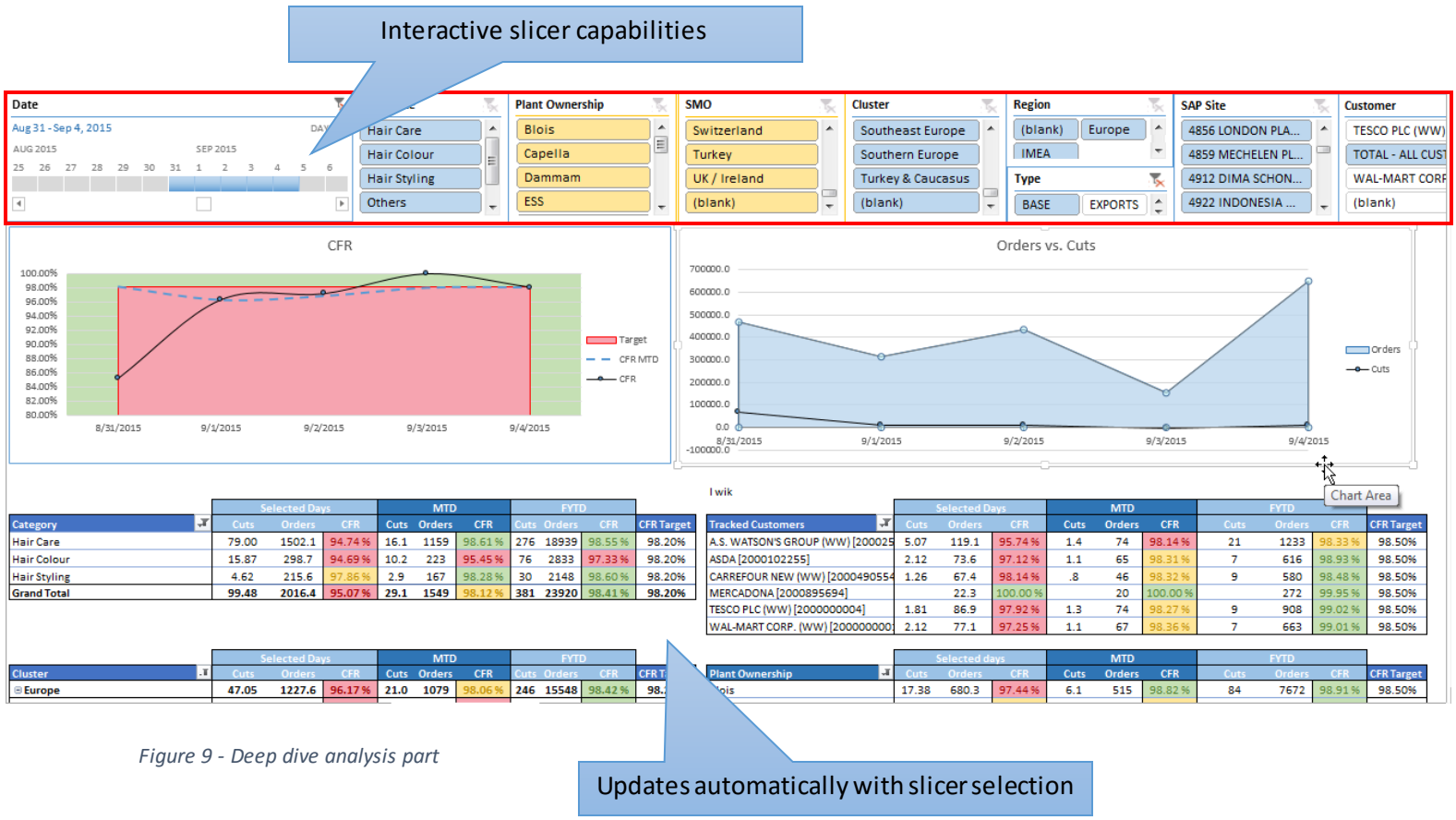


Figure 9 - Deep dive analysis part

Now that we know on which level of detail in the service process (2nd level – Process) we want to improve the service and having the ability to quickly see the actual performance per aggregation level we can continue to the most challenging phase where we analyse the data to automatically propose improvement areas of interest.

Chapter 3: Analyse

From the previous chapters we know that we need to have the ability to say for each second root cause level if they are performing normally or if they are showing performance issues but to be able to do so there must be a target for each of them to compare to. This chapter focuses on developing an approach to set calculated targets for each second root cause level for each region specific.

First we explain the difficulty of this with a toy problem, then we propose a new approach for setting calculating the targets backed with academic research. After this we apply the approach on the toy problem to show that this is working in an easy to understand way and as last we apply the approach to the actual supply chain of Procter & Gamble.

Toy problem

Assume we have to ship 10.000 bottles of shampoo from the production plant in Blois to the DC in London every day. In this shipping process now and then some issues occur and a few bottles are lost or broken. Some sample data is shown in Table 1. In the first column the dates of two weeks are shown, the second columns shows that every day 10.000 bottles are send from the production plant to the receiving DC whereas the third columns shows how many useable bottles are actual received in the DC in London. The performance of this transportation process is shown in the fourth column which is simply calculated by dividing the useable received bottles by the send bottles. The last column shows the chance a bottle does not survive the transport and is broken or lost.

Table 1 - Sample data supply chain process

Day	Send	Received	Performance	P(failure)
Day 1	10,000	9,900	99.00%	0.01
Day 2	10,000	9,800	98.00%	0.02
Day 3	10,000	9,900	99.00%	0.01
Day 4	10,000	9,700	97.00%	0.03
Day 5	10,000	9,950	99.50%	0.015
Day 6	10,000	10,000	100%	0.0
Day 7	10,000	9,800	98.00%	0.02
Day 8	10,000	9,400	96.00%	0.06
Day 9	10,000	9,900	99.00%	0.01
Day 10	10,000	9,850	98.50%	0.015
Day 11	10,000	9,800	98.00%	0.02
Day 12	10,000	9,900	99.00%	0.01
Day 13	10,000	9,000	90.00%	0.1
Day 14	10,000	10,000	100%	0.0

From the data we can see that the performance of the transportation process fluctuates over time (see Figure 1). But how can we say which day is performing as it should and which are out of control if we do not know what is normal behaviour? We could easily say that day 13 is out of control because it is higher than the rest but it would not be backed by any evidence and is just a hunch. To give an answer to this question we introduce a new concept with which we can calculate what the targets values would be if the process is performing normally.

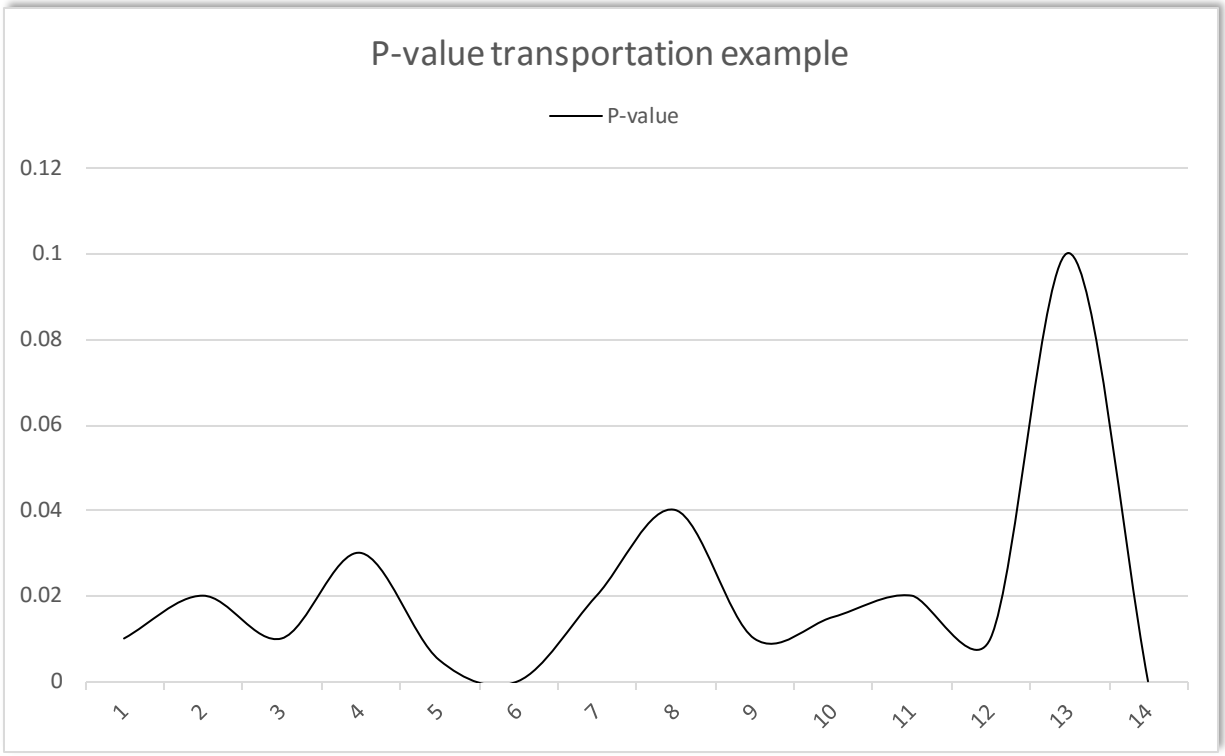


Figure 10 - P-value transportation example

Control charting – calculating normal behaviour targets

Why is control charting feasible

As we explained in the toy problem the problem is that we do not have an idea what is normal behaviour for the process and therefore cannot tell if the process is performing accordingly or not. The six sigma methodology suggest using a control chart to check if the performance of a process is in line with expectation or not and this is exactly what we want to do (Howar).

The control charting in the six sigma methodology is being used for measuring performance in production and manufacturing processes, for example a shampoo filling machine does not fill every bottle with exactly the same amount of shampoo but experiences some variation in doing so. By calculating the

variance over all the bottles that are filled a control chart calculates an upper limit for the maximum deviation of the mean in which the deviation can still be explained by normal process variation. Every filling that falls outside this limit can be said to be caused by special cause variation or an outside influence (Laney, 2002).

We suggest in our research extending this method of calculating limits for root causes as they experience in process variation the same way a manufacturing machine would do and we want to eliminate all the special cause variation as much as possible to create a stable operating supply chain.

Different types of control charts

Over the years a lot of different types of control charts have been developed all suitable for specific types of data, continuous, discrete, and grouped or not, there are to say a number of factors to keep in mind when selecting the control chart to apply all depending on the way your data is represented.

So how does our data look like exactly? We know that we are measuring a proportion of the total amount that is defective so this tells us we are dealing with attributes data. Further our data is not continuous as we are not measuring every bottle on their own but rather can say after a certain time period which amount of bottles has a defective from the total amount we shipped that day. With this type of data a p-chart is being proposed by literature.

Control rules

In developing control charts there are a large different numbers of control rules that can be applied to check if a process is in control or not. These rules are applicable for different types of situations and we have to make a selection of the rules that we apply for the processes we want to measure.

The standard control rule developed at first by Shewhart is the 3-sigma rule (Nelson, 1984). Any point falling outside the mean plus or minus three times the sigma is marked as out of control. Using this rule will on average lead to a “false alarm” every 371 points.

Next to the original three sigma rule the WECO and NELSON control chart rules have been developed (NIST/SEMATECH, 2015). These add additional checks for consecutive points where for example 2 out of 3 points are outside the mean plus or minus two sigma or where 4 out of 5 points are outside one sigma. Adding these control rules will lead to more “false alarms” (every 92 points) but gives more insight in the process state. We have chosen to only apply the standard three sigma rule as a start, in a later stage the company can incorporate additional control rules when it feels the need.

P-chart applied on toy problem

The p-chart is a control chart that calculates the behaviour of a process that generates attributes with a binominal distribution. The control chart then calculates standard deviation of each measure and sets the control limits to the mean plus or minus 3 standard deviations resulting in a confidence interval of at least 99%, this is because the 3-sigma rule states that in any distribution the chance that a point falls within the mean plus or minus 3 standard deviations is 99%.

The formulas used for generating the normal p chart are as follows:

$$n_i = Sample\ size\ subgroup\ i\ (i = 1, \ldots., k)$$

$$x_i = Number\ of\ occurences\ attribute\ of\ interest\ in\ subgroup\ i$$

$$p_i = \frac{x_i}{n_i}$$

$$\bar{p} = \frac{\sum x_i}{\sum n_i}$$

$$\sigma_{p_i} = \sqrt{\frac{\bar{p}(1-\bar{p})}{n_i}}$$

$$CL = Center\ Line = \bar{p}$$

$$UCL, LCL = \bar{p} \pm 3\sigma_{p_i}$$

Applying this simple control chart to the data from the toy problem yields the data shown in Table 2 where the attribute of interest is the number of shampoo bottles that are lost (unfilled rate). We have calculated the upper and lower control limit based on the standard deviation of the complete sample group (all 14 days) because the subgroup is the same size all the days this results in the same standard deviation for all days. The results are also visualized in Figure 8 where we immediately can see a problem with this type of chart. Because of the very big sample size (10,000) the control limits become very tight around the mean resulting in almost every day being flagged as out of control where in reality this is not true.

This problem is caused by the fact that the standard p-chart calculates the standard deviation over the whole sample size and does not take into account within subgroup variation. To overcome this problem with the standard the literature have proposed to use a X-chart where instead of calculating intra-subgroup variation the inter-subgroup variation is calculated and used to define the control limits. But by leaving out the intra-subgroup variation again the control limits are not reflecting the real situation as

there obviously is intra-subgroup variation present and this should also be accounted for. A new approach developed by Laney in 2013 to solve that solves this problem measures both inter and intra subgroup variation and adjusts the control limits for this. This approach has been worked out in the next section.

Table 2 - p chart toy problem data

Day	ni	xi	pi	pmean	sigma pi	LCL	CL	UCL	In control?
Day 1	10,000	9,900	0.010	0.010	0.00142	0.005727	0.010	0.014273	TRUE
Day 2	10,000	9,800	0.020	0.015	0.00142	0.010727	0.015	0.019273	FALSE
Day 3	10,000	9,900	0.010	0.013	0.00142	0.009061	0.013	0.017606	TRUE
Day 4	10,000	9,700	0.030	0.018	0.00142	0.013227	0.018	0.021773	FALSE
Day 5	10,000	9,950	0.005	0.015	0.00142	0.010727	0.015	0.019273	FALSE
Day 6	10,000	10,000	0.000	0.013	0.00142	0.008227	0.013	0.016773	FALSE
Day 7	10,000	9,800	0.020	0.014	0.00142	0.009299	0.014	0.017844	FALSE
Day 8	10,000	9,600	0.040	0.017	0.00142	0.012602	0.017	0.021148	FALSE
Day 9	10,000	9,900	0.010	0.016	0.00142	0.011838	0.016	0.020384	FALSE
Day 10	10,000	9,850	0.015	0.016	0.00142	0.011727	0.016	0.020273	TRUE
Day 11	10,000	9,800	0.020	0.016	0.00142	0.012091	0.016	0.020636	TRUE
Day 12	10,000	9,900	0.010	0.016	0.00142	0.011561	0.016	0.020106	FALSE
Day 13	10,000	9,000	0.100	0.022	0.00142	0.018035	0.022	0.02658	FALSE
Day 14	10,000	10,000	0.000	0.021	0.00142	0.016442	0.021	0.024987	FALSE

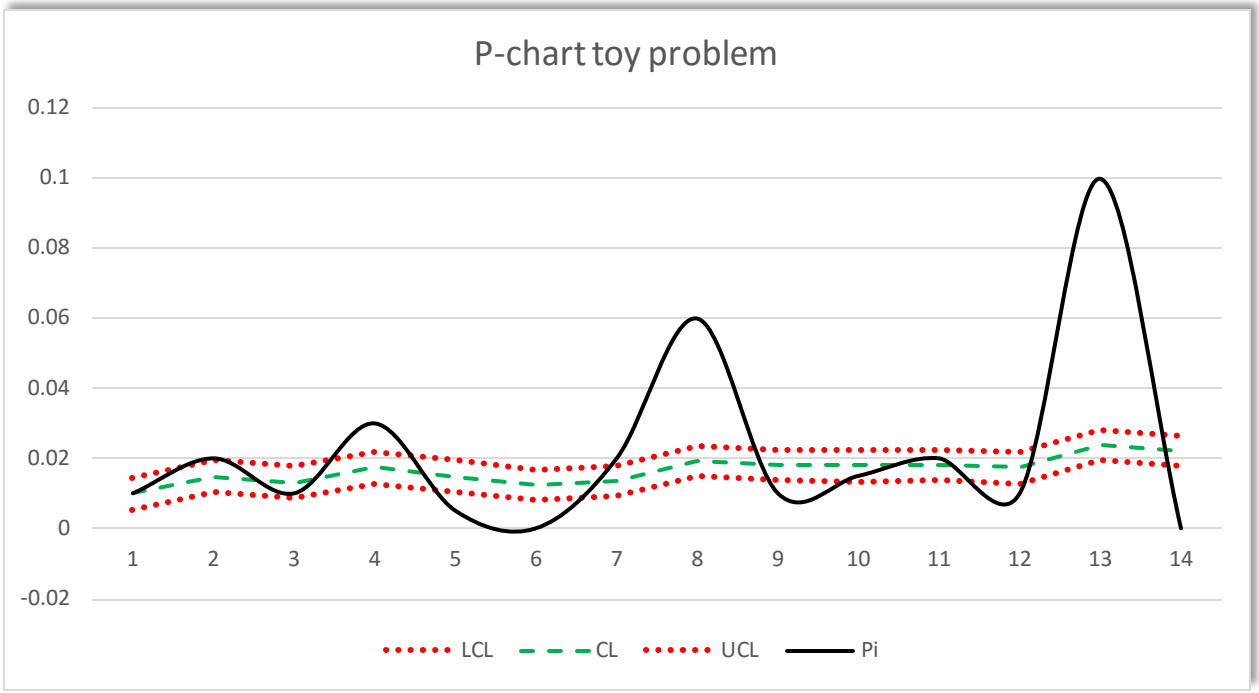


Figure 11 - p chart toy problem

Laney p' control chart

The problem the p'-chart was developed to fix was that conventional control charts assumptions of data distribution where to tight and the restrictions where to hard. As can be read in the quote from the paper where Laney proposed the new control chart for the first time below (Laney, 2002):

> *The classic control charts for attribute data (p-charts, u-charts, etc.,), are based on assumptions about the underlying distribution of their data (binomial or Poisson). Inherent in those assumptions is the further assumption that the "parameter" (mean) of the distribution is constant over time. In real applications, this is not always true (some days it rains and some days it does not). This is especially noticeable when the subgroup sizes are very large. Until now, the solution has been to treat the observations as variables in an individual's chart. Unfortunately, this produces flat control limits even if the subgroup sizes vary. This article presents a new tool, the p'-chart, which solves that problem. In fact, it is a universal technique that is applicable whether the parameter is stable or not.*

Because the number of bottles we ship every day varies widely and also the mean of our processes are not fixed because there are a lot of factors influencing the performance of the process this control chart is the most suitable for the calculations we want to perform and respects all the constraints for our data.

The traditional p-chart calculates the standard deviation on the overall mean assuming that the underlying distribution of the data is fixed over time, but in reality this is not always true. For example in our transportation problem not every truck is the same and this could have impact on the actual performance changing the underlying distribution. Or when it rains on a day the truck could have more delays due to traffic jams and therefore a lower performance, the old traditional p-chart would say this is due to special cause variation because it assumes the distribution would be the same for every day where in fact it is not because this is normal behaviour of the weather and this should be adjusted for (Laney, 2002).

Next to the assumption of a fixed distribution that is not true another problem that the Laney p' chart fixes is the variation in sample size. When a sample size is small the uncertainty in sampling error covers the uncertainty due to other influences like the weather, but because our sampling size tends to be over 300.000 every day this is not covered anymore by the sampling error and therefore Laney suggest recalculating the sampling error for every day individually.

The way Laney solves the issues in the old traditional attributes control charts is by first converting the data to a z-score which means converting every data point to the number of sample standard deviations deviation from the overall mean using the formula shown below.

$$z_i = \frac{p_i - \bar{p}}{\sigma_{p_i}}$$

With these Z scores we can then calculate the intra subgroup variation by looking at the differences between two consecutive measures and taking the average of all the individual differences. The variation within the Z scores is then simply this mean divided by 1.128 (because of sample size of two for comparing Z scores).

$$R_i = |z_i - z_{i-1}|$$

$$\bar{R}' = \frac{1}{k-1}\sum R_i$$

$$\sigma_z = \frac{\bar{R}'}{1.128}$$

Now we know what the actual real present variation is we can transform our Z-scores back to meaningful P-values again so these can be plotted in the normal plane. This transformation is easily done using the following formulas.

$$p_i = \bar{p} + \sigma_{p_i} z_i$$

$$sd(p_i) = \sigma_{p_i}\sigma_z$$

$$CL = \bar{p}$$

$$UCL, LCL = \bar{p} \pm 3\sigma_{p_i}\sigma_z$$

If we now compare the formula for the control limits from the standard p-chart with that from the Laney p'-chart we can see what transformation has been done. The inter subgroup variation has been calculated and is being accounted for now (Laney, 2002).

Standard p-chart: $UCL, LCL = \bar{p} \pm 3\sigma_{p_i}$

Laney p'-chart: $UCL, LCL = \bar{p} \pm 3\sigma_{p_i}\sigma_z$

Applying this new approach to our toy problem from before yields the results that can be seen in Table 3 and Figure 9. The difference with the standard approach that is immediately visible is that the control

limits are much wider and only day 13 is being marked as out of control due to the fact that intra subgroup variation now also is being taken into account.

Table 3 - Laney p'-chart data

Day	ni	xi	Pi	Pmean	Spi	Zi	Ri	R'Mean	Sz	Zi	sd(Pi)	CL	UCL	LCL	Control
Day 1	10,000	9,900	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.08	-0.06	TRUE
Day 2	10,000	9,800	0.02	0.02	0.00	3.51	3.51	3.51	3.11	3.51	0.02	0.02	0.08	-0.05	TRUE
Day 3	10,000	9,900	0.01	0.01	0.00	-2.34	5.85	4.68	4.15	-2.34	0.02	0.01	0.08	-0.05	TRUE
Day 4	10,000	9,700	0.03	0.02	0.00	8.78	11.12	6.83	6.05	8.78	0.02	0.02	0.08	-0.05	TRUE
Day 5	10,000	9,950	0.01	0.02	0.00	-7.02	15.80	9.07	8.04	-7.02	0.02	0.02	0.08	-0.05	TRUE
Day 6	10,000	10,000	0.00	0.01	0.00	-8.78	1.76	7.61	6.74	-8.78	0.02	0.01	0.08	-0.05	TRUE
Day 7	10,000	9,800	0.02	0.01	0.00	4.51	13.29	8.55	7.58	4.51	0.02	0.01	0.08	-0.05	TRUE
Day 8	10,000	9,600	0.04	0.02	0.00	16.24	11.72	9.01	7.98	16.24	0.02	0.02	0.08	-0.05	TRUE
Day 9	10,000	9,900	0.01	0.02	0.00	-4.29	20.53	10.45	9.26	-4.29	0.02	0.02	0.08	-0.05	TRUE
Day 10	10,000	9,850	0.02	0.02	0.00	-0.70	3.59	9.68	8.59	-0.70	0.02	0.02	0.08	-0.05	TRUE
Day 11	10,000	9,800	0.02	0.02	0.00	2.55	3.26	9.04	8.02	2.55	0.02	0.02	0.08	-0.05	TRUE
Day 12	10,000	9,900	0.01	0.02	0.00	-4.10	6.65	8.82	7.82	-4.10	0.02	0.02	0.08	-0.05	TRUE
Day 13	10,000	9,000	0.10	0.02	0.00	54.55	58.64	12.98	11.50	54.55	0.02	0.02	0.09	-0.04	FALSE
Day 14	10,000	10,000	0.00	0.02	0.00	-14.54	69.09	17.29	15.33	-14.54	0.02	0.02	0.09	-0.04	TRUE

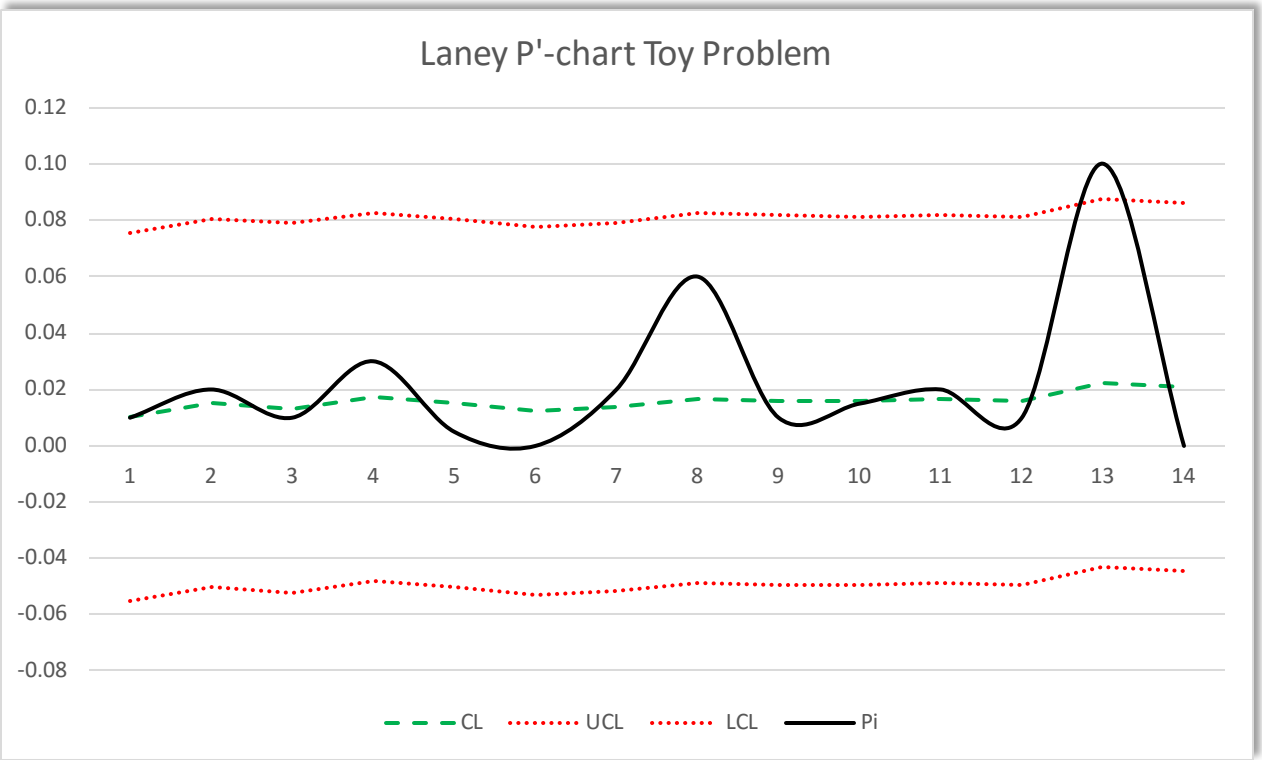


Figure 12 - Laney p'-chart toy problem

Control charting algorithm for benchmarking

With the ability to identify which days are performing normally and which days are out of control we now develop a new benchmarking approach that enables us to set targets for each second root cause level as described in chapter 2.

For the algorithm that we developed there are a number of underlying assumptions which validate the proposed approach:

1. *Root causing is done properly by the Distribution Requirements Planning team.*
2. *Removing days that are out of control leaves a set of data which are in control and these represent the stable state of the supply chain process.*

The first step of the algorithm that we developed consists of calculating the control limits for a certain period of time, the benchmark timespan. These control limits are calculated with the inter and intra variance of the complete data set, this means the first data points is also adjusted for the variance that occur in the latest day. After having the control limits ready we can then check each day that is present in this against these limits and remove them from the set if they violate the limit.

After having done these steps a new problem rises. Because the parameters on which the control limits can be inflated massively by the days that are out of control and therefor giving us too loose limits we need to develop an approach to define if we want to repeat the steps of removing out of control days for a second time. In the academic literature there is no solution present for this problem and therefore we have developed our own practical solution to have a solid algorithm with a clear rule of when to repeat the steps.

Stop algorithm

As described above we have developed a rule of when to rerun the algorithm of removing out of control days for a second time.

We propose introducing a new variable **α** that represents an allowance for the percentage of data points that are out of control with the newly calculated control limits. If the number of data points that are out of control after the removing them for the first time and recalculating control limits is **lower** than **α** we iterate over the data set one more time to remove out of control days again.

The underlying idea behind this approach is that when there are a lot of points again out of control the impact of the intra subgroup variance of the removed data points was relatively lower than when there are only a few new data points out of control. And what we want to achieve is to remove the influence of the first removed data points to obtain correct limits.

α = Allowance of data points out of control after first iteration

If after first iteration % of data points out control < α then remove days one more time.

The full algorithm applied on the toy problem looks as in the following tables and figures:

Step 1: Calculate performance of complete data set. Day 13 is being marked as out of control and the mean performance of the complete set is 0.022 (2.2%)

Table 4 - step 1 algorithm toy problem

days	cuts	orders	Pi	Pmean	Spi	Zi	Ri	R'mean	Sz	Zi	sd(Pi)	UCL	LCL	CL	Control?
Day 1	9,900	10,000	.010	.010	.001	.000	.000	.000	.000	.000	.024	.095	-.051	.022	TRUE
Day 2	9,800	10,000	.020	.015	.001	3.398	3.398	3.398	3.012	3.398	.024	.095	-.051	.022	TRUE
Day 3	9,900	10,000	.010	.013	.001	-2.265	5.663	4.531	4.016	-2.265	.024	.095	-.051	.022	TRUE
Day 4	9,700	10,000	.030	.018	.001	8.495	10.760	6.607	5.857	8.495	.024	.095	-.051	.022	TRUE
Day 5	9,950	10,000	.005	.015	.001	-6.796	15.291	8.778	7.782	-6.796	.024	.095	-.051	.022	TRUE
Day 6	10,000	10,000	.000	.013	.001	-8.495	1.699	7.362	6.527	-8.495	.024	.095	-.051	.022	TRUE
Day 7	9,800	10,000	.020	.014	.001	4.369	12.864	8.279	7.340	4.369	.024	.095	-.051	.022	TRUE
Day 8	9,400	10,000	.060	.019	.001	27.608	23.239	10.416	9.234	27.608	.024	.095	-.051	.022	TRUE
Day 9	9,900	10,000	.010	.018	.001	-5.663	33.271	13.273	11.767	-5.663	.024	.095	-.051	.022	TRUE
Day 10	9,850	10,000	.015	.018	.001	-2.039	3.624	12.201	10.817	-2.039	.024	.095	-.051	.022	TRUE
Day 11	9,800	10,000	.020	.018	.001	1.236	3.274	11.308	10.025	1.236	.024	.095	-.051	.022	TRUE
Day 12	9,900	10,000	.010	.018	.001	-5.097	6.333	10.856	9.624	-5.097	.024	.095	-.051	.022	TRUE
Day 13	9,000	10,000	.100	.024	.001	51.753	56.850	14.689	13.022	51.753	.024	.095	-.051	.022	FALSE
Day 14	10,000	10,000	.000	.022	.001	-15.048	66.801	18.698	16.576	-15.048	.024	.095	-.051	.022	TRUE

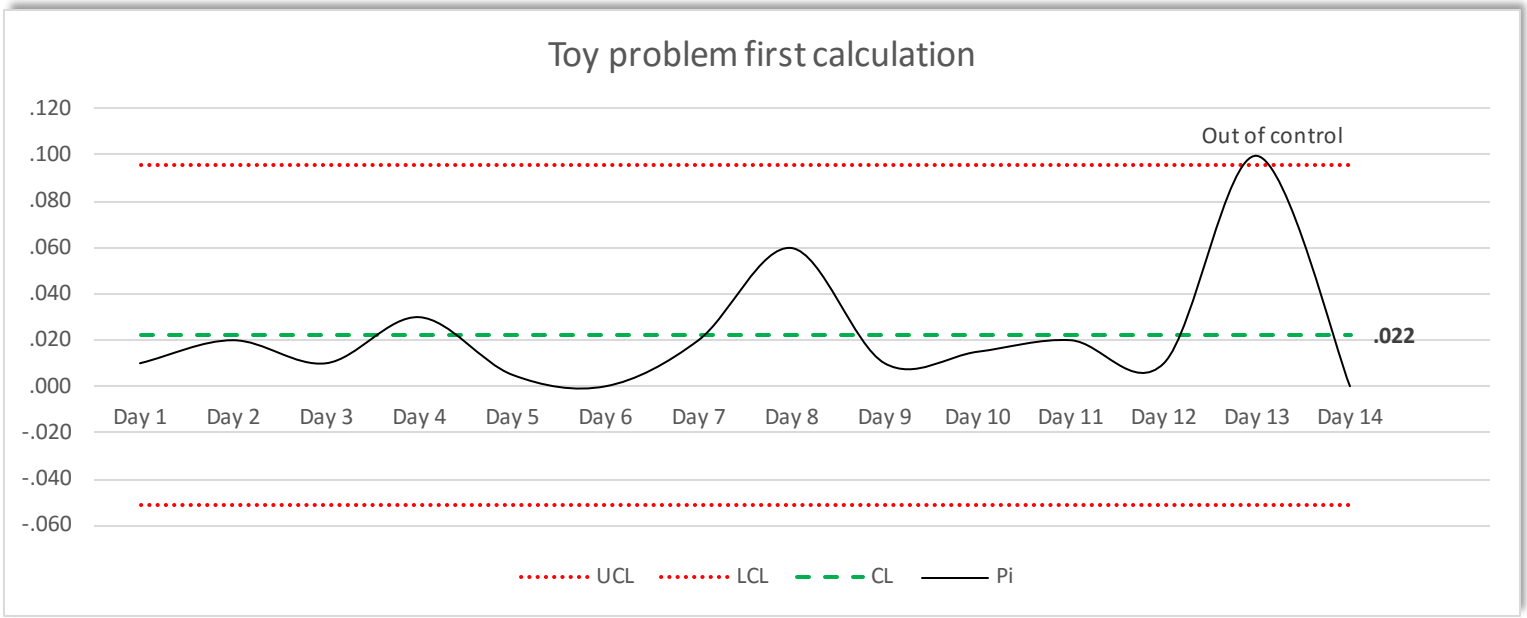


Figure 13 - graph first step algorithm toy problem

Step 2: Remove the out of control point (day 13) and recalculate limits and the percentage of points that are out of control. New mean performance of the set is 0.016 (1.6%).

The percentage of data points that are out of control is **7.69%.**

Table 5- first iteration algorithm toy problem

days	cuts	orders	Pi	Pmean	Spi	Zi	Ri	R'mean	Sz	Zi	sd(Pi)	UCL	LCL	CL	Control?
Day 1	9,900	10,000	.010	.010	.001	.000	.000	.000	.000	.000	.014	.057	-.025	.016	TRUE
Day 2	9,800	10,000	.020	.015	.001	3.966	3.966	3.966	3.516	3.966	.014	.057	-.025	.016	TRUE
Day 3	9,900	10,000	.010	.013	.001	-2.644	6.610	5.288	4.688	-2.644	.014	.057	-.025	.016	TRUE
Day 4	9,700	10,000	.030	.018	.001	9.915	12.559	7.712	6.837	9.915	.014	.057	-.025	.016	TRUE
Day 5	9,950	10,000	.005	.015	.001	-7.932	17.848	10.246	9.083	-7.932	.014	.057	-.025	.016	TRUE
Day 6	10,000	10,000	.000	.013	.001	-9.915	1.983	8.593	7.618	-9.915	.014	.057	-.025	.016	TRUE
Day 7	9,800	10,000	.020	.014	.001	5.099	15.015	9.664	8.567	5.099	.014	.057	-.025	.016	TRUE
Day 8	9,400	10,000	.060	.019	.001	32.225	27.126	12.158	10.778	32.225	.014	.057	-.025	.016	FALSE
Day 9	9,900	10,000	.010	.018	.001	-6.610	38.835	15.493	13.735	-6.610	.014	.057	-.025	.016	TRUE
Day 10	9,850	10,000	.015	.018	.001	-2.380	4.231	14.241	12.625	-2.380	.014	.057	-.025	.016	TRUE
Day 11	9,800	10,000	.020	.018	.001	1.442	3.822	13.199	11.702	1.442	.014	.057	-.025	.016	TRUE
Day 12	9,900	10,000	.010	.018	.001	-5.949	7.391	12.671	11.234	-5.949	.014	.057	-.025	.016	TRUE
Day 14	10,000	10,000	.000	.016	.001	-12.814	6.864	12.188	10.805	-12.814	.014	.057	-.025	.016	TRUE

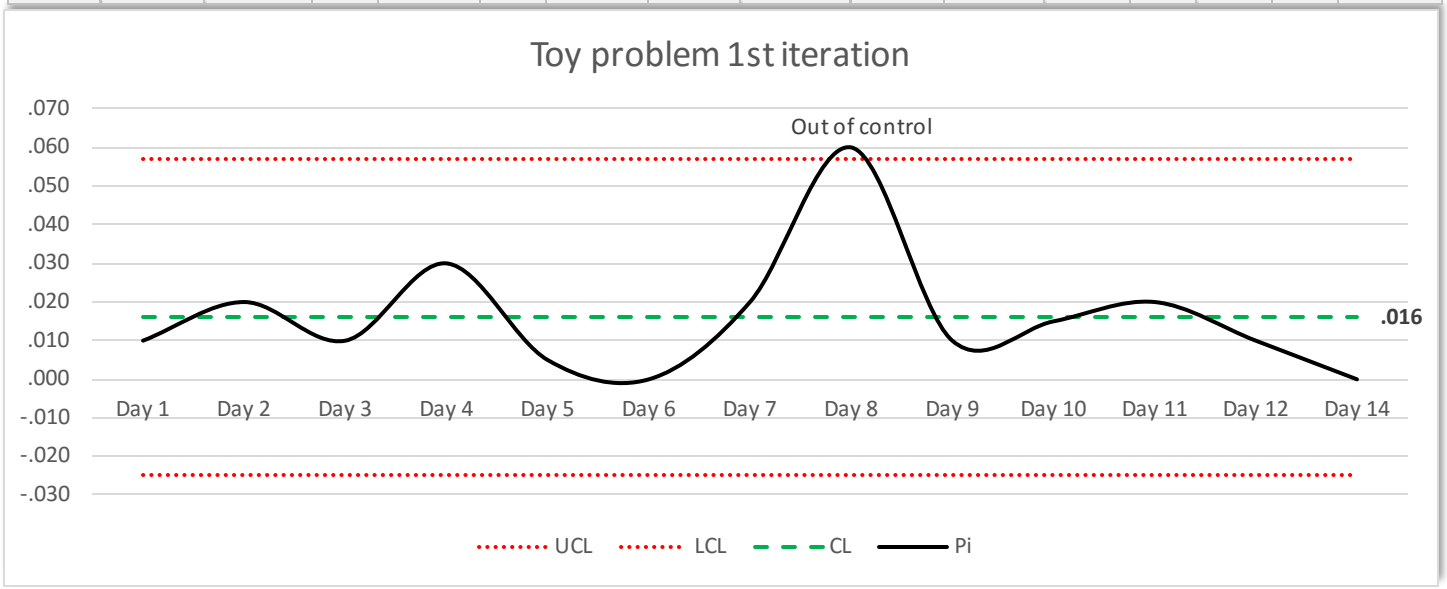


Figure 14- first iteration algorithm toy problem graph

Step 3: Compare the percentage of out of control data points to the set allowance **α.** If this is lower than **α** then we iterate once more over the set removing new out of control days. If **α** in our toy problem would be > 7.69% then we would iterate once more. If **α** < 7.69% the algorithm stops and we have the targeted mean performance of the stable state as centre line.

For the purpose of showing the full algorithm we set **α = 10.00%** for our example and this gives us the final results as follows.

The final target for the transportation process in the toy problem therefore is **maximum 1.3%.**

Table 6 - last iteration algorithm toy problem

days	cuts	orders	Pi	Pmean	Spi	Zi	Ri	R'mean	Sz	Zi	sd(Pi)	UCL	LCL	CL	Control?
Day 1	9,900	10,000	.010	.010	.001	.000	.000	.000	.000	.000	.009	.039	-.014	.013	TRUE
Day 2	9,800	10,000	.020	.015	.001	4.500	4.500	4.500	3.990	4.500	.009	.039	-.014	.013	TRUE
Day 3	9,900	10,000	.010	.013	.001	-3.000	7.501	6.000	5.320	-3.000	.009	.039	-.014	.013	TRUE
Day 4	9,700	10,000	.030	.018	.001	11.251	14.251	8.751	7.758	11.251	.009	.039	-.014	.013	TRUE
Day 5	9,950	10,000	.005	.015	.001	-9.001	20.252	11.626	10.307	-9.001	.009	.039	-.014	.013	TRUE
Day 6	10,000	10,000	.000	.013	.001	-11.251	2.250	9.751	8.644	-11.251	.009	.039	-.014	.013	TRUE
Day 7	9,800	10,000	.020	.014	.001	5.786	17.037	10.965	9.721	5.786	.009	.039	-.014	.013	TRUE
Day 9	9,900	10,000	.010	.013	.001	-2.813	8.599	10.627	9.421	-2.813	.009	.039	-.014	.013	TRUE
Day 10	9,850	10,000	.015	.013	.001	1.500	4.313	9.838	8.721	1.500	.009	.039	-.014	.013	TRUE
Day 11	9,800	10,000	.020	.014	.001	5.400	3.900	9.178	8.137	5.400	.009	.039	-.014	.013	TRUE
Day 12	9,900	10,000	.010	.014	.001	-3.273	8.673	9.128	8.092	-3.273	.009	.039	-.014	.013	TRUE
Day 14	10,000	10,000	.000	.013	.001	-11.251	7.978	9.023	7.999	-11.251	.009	.039	-.014	.013	TRUE

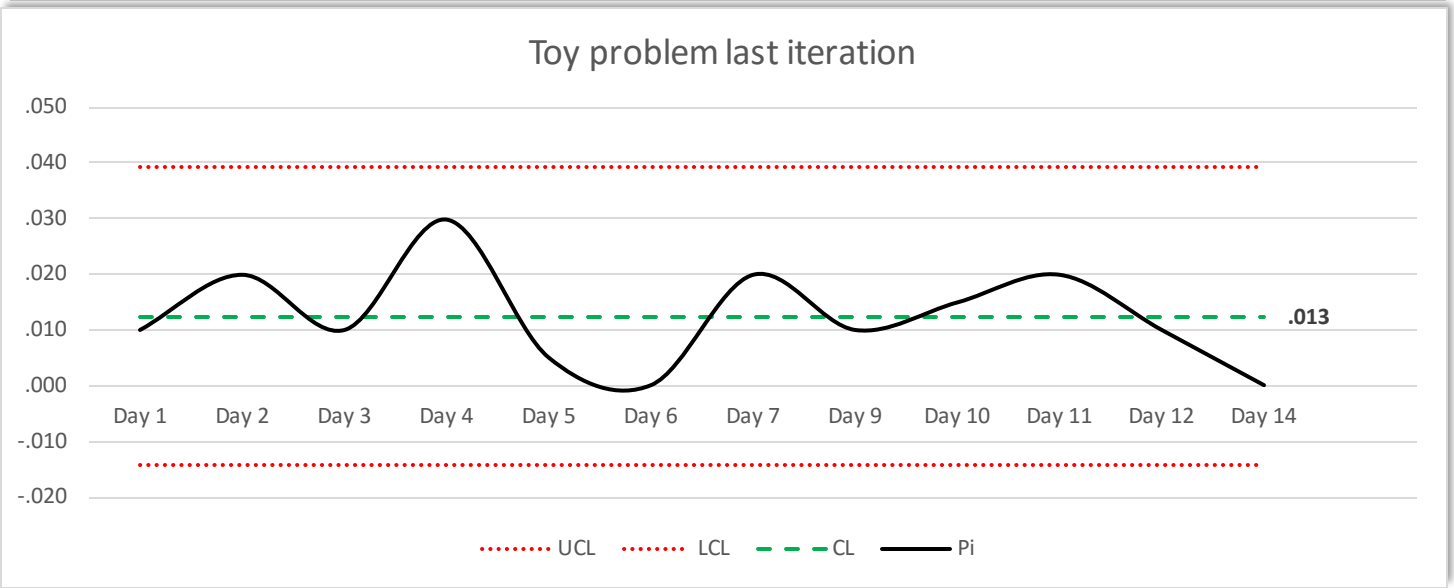


Figure 15 - Toy problem algorithm last iteration

Benchmark approach extended to Procter & Gamble case

Using the algorithm described in the section above we now have the ability to calculate a robust target for each 2nd level root cause in the Procter & Gamble supply chain. With the data present we develope a program that calculates the performance of each process over a timespan of the last X months, removing all the days that are out of control. The average CuFR that is left is then the maximum allowed target for the next month.

The underlying assumption in this approach is that when the company is able to perform on a certain level for a number of months then the performance of the next month should be better or at least as good.

The created tool is run at the beginning of each month and automatically calculates the targets for each process. In the creation of this process there are a number of parameters and settings that needs to be set in the best possible way and is explained in the next part.

Developed program

For the new approach to be adopted as quick as possible we have developed an excel program that automatically calculated the targets and performance for each process with one click. The owner of the tool is the CFR-KU which runs the program on a monthly basis.

The program uses VBA and PowerPivot plugin (see Appendix B VBA Codes for full codes) to analyse the data in an iterative way and outputs the results for each Supply Chain in a separate file. In this file the Cluster leader for the specific supply chain then also has the ability to analyse area's where the performance is not sufficient using a deep dive analysis showing all the background information for the cuts happened in a specific process.

In Figure 13, Figure 14 and Figure 15 we show for the transportation process of the months June, July and August what the output of the algorithm is. We see that at the beginning the average CuFR is 0,162% and after we applied the algorithm this is reduced to a stable state of 0.053%. From the graphs we can also see that there is a huge volatility in the first graph Figure 13 that has been reduced significantly in Figure 14 and Figure 15 showing the cuts nicely moving around the mean and thus showing a stable state.

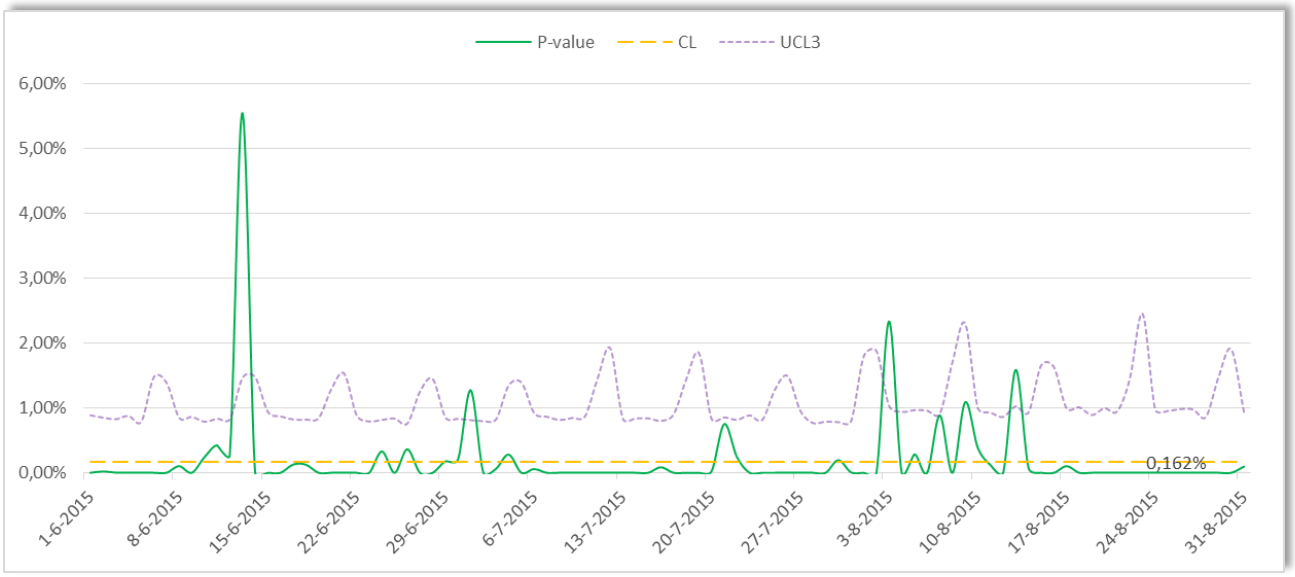


Figure 17 - Transportation process start (P = 0.162%)

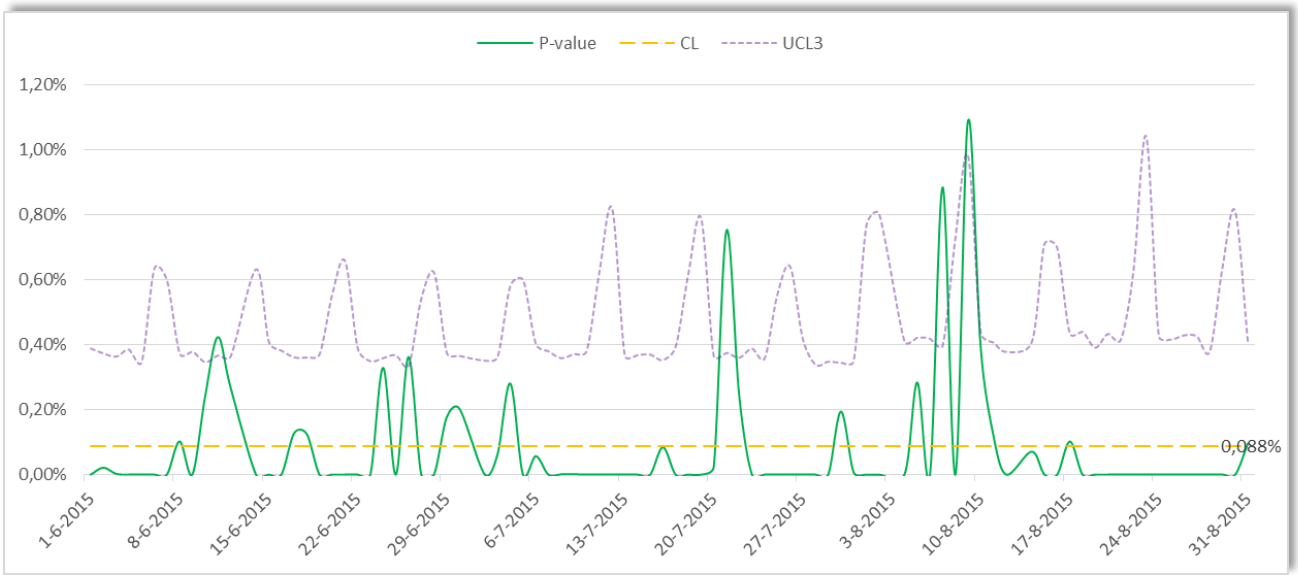


Figure 16 - Transportation process first removal (P = 0.088%)

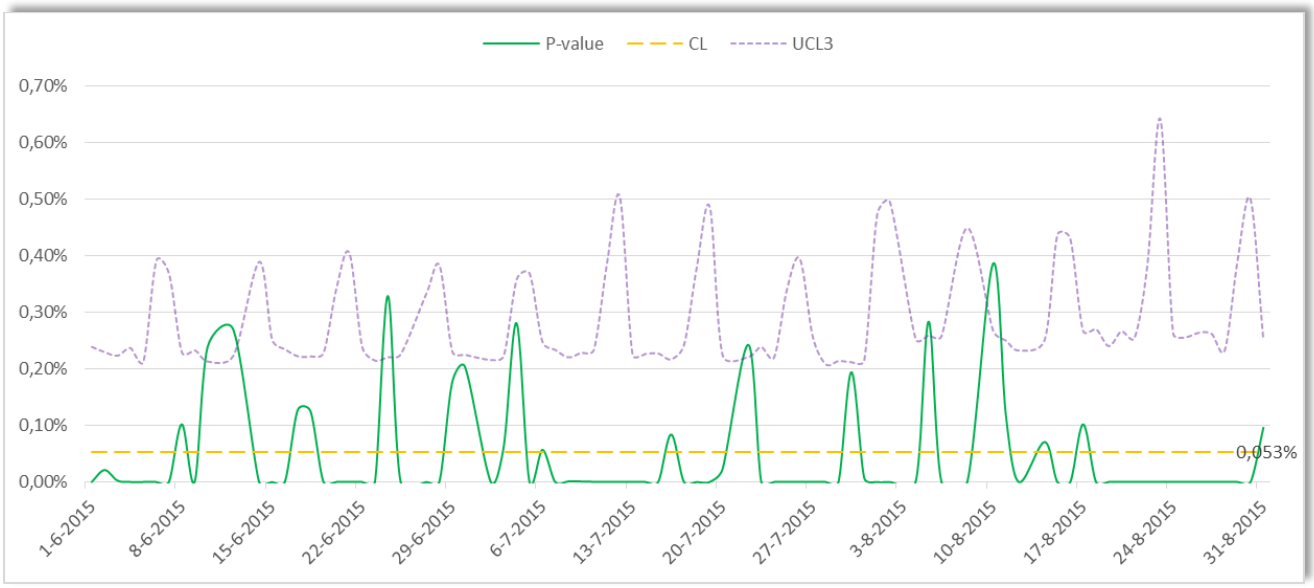


Figure 18 - Transportation process final results (P = 0.053%)

Parameter selection

The parameters and settings in the benchmark program that needed to be set are the following:

α = Allowance of number of data points out of control

X = Number of months to aggregate for benchmarking

Aggregating Western Europe supply chains versus calculating each supply chain individual

To be able to determine which settings should be used we developed a number of criteria which will help is determine what settings are the most suitable for the needs of Procter & Gamble. These criteria are developed in a number of work sessions with the supply chain leaders of Western Europe.

Table 7 - Criteria parameter selection

Criteria	Importance
Run time	++
% of unexplained cuts target	+
Data validity	+++

With these criteria available for selecting the right parameters we have run number of different calculations with all different settings in the tool.

First we see what the optimal timespan for which the data is used to benchmark the data against. We have come up with 3 different options, using one, three or six months of data to calculate the targets. These are scored against the three criteria that are showed in Table 7 - Criteria parameter selection. After running with only one month of data we immediately saw that because there were too little data points for the algorithm we dropped this option. The options for 3 and 6 months have been run afterwards and yields the results shown in Table 9. What we can see from these results is that the 6 months run is performing slightly better on "% of unexplained cuts target" (0.5237% versus 0.4334%). On data validity we can deduct that because we have used a larger dataset with more data points the validity also is slightly higher. On the other side the runtime of the 6 months variant versus the 3 months run was more than 3 times as high (20 minutes versus 60+ minutes). Putting these results in a cross table we can see that using 3 months of data is the most suitable for the criteria set by Procter & Gamble.

Table 8 - Scoring results vs criteria

	Run time	**% of unexplained cuts target**	**Data validity**	Total score
3 months	1	2	2	**4**
6 months	3	1	1	**5**

Table 9 - Results 3 versus 6 months

Root cause	P-mean (3 months)	P-mean (6 months)
1.1 Master Data	0.0021%	0.0041%
1.10 Information/Tech Tools		
1.2 Supply Planning Execution	0.0941%	0.0915%
1.3 Quality/Regulatory	0.0094%	0.0000%
1.4 Material Supply	0.0010%	0.0001%
1.5 Manufacturing Execution	0.0003%	
1.6 Transport & Warehousing	0.0455%	0.0358%
1.7 Order Management	0.0001%	0.0001%
1.8 Other	0.0107%	0.0005%
1.9 Suppressed Demand-Sup Iss		
2.1 Demand Planning	0.1640%	0.1678%
2.2 Initiatives Readiness	0.0750%	0.0068%
2.3 Capacity to Demand Strateg	0.0278%	0.0014%
2.4 Unplanned or Off-strategy		
2.5 Other	0.0384%	0.0050%
2.6 Automated Availability Management (or shorted abbreviation)		
2.9 Suppressed Demand-Bus Pln		
3.1 Customer Operations	0.0012%	0.0005%
3.2 Mkt/customer forecast input	0.1007%	0.0837%
3.3 Communication to customer		
3.4 Cust order out of policy		
3.5 Other	0.0001%	
3.9 Suppressed Demand-Comm Ex		
7.1 Not Analysed	0.5237%	0.4334%

The next setting selection was to choose whether to aggregate the results of all Western Europe versus to calculate each supply chain individually. Again we run both setups and compare the results against the set criteria. We run the results for Northern Europe separately and for all Europe aggregated, the results are shown in Table 11. Scoring the results on the criteria as before we find the results in Table 10. On all criteria's it is better to aggregate the data of the different supply chain to calculate targets. This is in line with what we expected because there is significantly more data available due to the aggregation and the run time is shorter because the analysis only has to be run once instead of for each supply chain separately.

Table 10 - Scoring results versus criteria (2)

	Run time	**% of unexplained cuts target**	**Data validity**	Total score
Separate	3	2	2	**5**
Aggregated	1	1	1	**3**

Table 11 - Results Northern Europe versus Europe

Root cause	**P-mean NE**	**P-mean EUR**
1.1 Master Data		
1.10 Information/Tech Tools		
1.2 Supply Planning Execution		0.0154%
1.3 Quality/Regulatory		0.0016%
1.4 Material Supply		0.0070%
1.5 Manufacturing Execution		
1.6 Transport & Warehousing	0.0215%	0.0467%
1.7 Order Management		
1.8 Other		
1.9 Suppressed Demand-Sup Iss		
2.1 Demand Planning		0.0308%
2.2 Initiatives Readiness		0.0090%
2.3 Capacity to Demand Strateg		
2.4 Unplanned or Off-strategy		
2.5 Other		0.0130%
2.6 Automated Availability Management (or shorted abbreviation)		
2.9 Suppressed Demand-Bus Pln		
3.1 Customer Operations		
3.2 Mkt/customer forecast input	0.0065%	0.0153%
3.3 Communication to customer		
3.4 Cust order out of policy		
3.5 Other		
3.9 Suppressed Demand-Comm Ex		
7.1 Not Analysed	0.4088%	0.5624%

For the last parameter (**α)** that needs to be set it is harder to define this with an experiment, as the parameter does not significantly affects the run time or data validity. Next to this it not always have influence on the % of unexplained cuts as it might differ per month if a second last iteration will be applied based on the **α.** The results of running with an **= 50% versus α = 20%** can be seen in Table 12 and here we

can see that raising the value of alfa will give an extra iteration in more instances (1.2, 1.3 and 2.2 got an extra iteration in the 50% run but not in the 20% run). After consulting with the supply chain leaders we have decided to set the value of alpha to 20%.

Table 12 - Results 50% versus 20% alpha.

Root cause	P-mean (50%)	P-mean (20%)
1.1 Master Data	0.0025%	0.0025%
1.10 Information/Tech Tools		
1.2 Supply Planning Execution	0.0065%	0.0159%
1.3 Quality/Regulatory	0.0208%	0.0352%
1.4 Material Supply	0.0262%	0.0262%
1.5 Manufacturing Execution	0.0117%	0.0117%
1.6 Transport & Warehousing	0.0534%	0.0534%
1.7 Order Management	0.0007%	0.0007%
1.8 Other	0.0017%	0.0017%
1.9 Suppressed Demand-Sup Iss		
2.1 Demand Planning	0.0690%	0.0690%
2.2 Initiatives Readiness	0.0124%	0.0261%
2.3 Capacity to Demand Strateg		
2.4 Unplanned or Off-strategy		
2.5 Other	0.0004%	0.0004%
2.6 Automated Availability Management (or shorted abbreviation)		
2.9 Suppressed Demand-Bus Pln		
3.1 Customer Operations	0.0004%	0.0004%
3.2 Mkt/customer forecast input	0.0690%	0.0690%
3.3 Communication to customer	0.0010%	0.0010%
3.4 Cust order out of policy		
3.5 Other		
3.9 Suppressed Demand-Comm Ex		
7.1 Does not require Analysis	0.5497%	0.5497%
7.1 Waiting to be analysed	0.0342%	0.0342%

Conclusion

In this chapter we have developed a new approach to calculate stable state behaviour of processes. We have shown that the standard P control chart is not feasible to use with the large sample data that is present at Procter & Gamble because of underestimating inter subgroup variance. To overcome this issue we have adopted the Laney P' control chart that measures this variance and then adjust the control limits for it.

With this approach we then have built a software program that automatically benchmarks the last month performance against the previous 3 months and is able to identify which process is performing poorly and should be improved in a robust and scalable way. The next step that needs to be taken is incorporate this data in a drumbeat that ensures good control and improvement of non performing areas.

Chapter 4: Improve & Control

The final steps in the DMAIC framework are the Improve and Control steps. As said this is where the real strength of the methodology comes from and incorporates a review process that allows continuous improvement and tracking of action plan performance. As input for this chapter we use the output from the developed program which is shown in Figure 19 and Figure 20*. In the last figure you can see that we not only measure the MTD performance versus its target but we also calculate the amount of days that the process was out of control, this is useful as second measure to see how big the problems are.*

Actuals per Ownership	UK Ireland	Iberia	DACH	Italy Group	FBNL	Nordic	Grand Total
CFR Actual	98,72%	98,86%	98,76%	97,55%	99,38%	98,67%	98,68%
CFR Target	98,50%	98,90%	99,00%	98,90%	99,00%	98,50%	98,20%
Commercial Execution	,45%	,08%		,58%		,34%	,26%
Customer Operations		,11%					,02%
Demand Planning PSC	,16%	,03%	,37%	,28%	,08%		,17%
Doesn't require analysis.	,29%	,22%	,35%	,13%	,11%	,16%	,24%
Manufacturing Execution			,24%		,03%		,05%
Order Management			,04%				,01%
Others	,01%		,01%	,18%			,03%
QA Plant Driven	,04%	,02%		,94%			,13%
Supply Planning PSC		,20%		,20%	,31%	,50%	,12%
Transport & Warehousing	,34%	,31%	,23%	,00%	,04%		,23%
Waiting to be analyzed		,18%		,13%	,05%	,33%	,07%

Target per Ownership							
Commercial Execution	,07%	,05%	,05%	,05%	,05%	,07%	,08%
Customer Operations							
Demand Planning PSC	,14%	,10%	,09%	,10%	,09%	,14%	,16%
Doesn't require analysis.	,96%	,70%	,64%	,70%	,64%	,96%	1,15%
Manufacturing Execution	,00%	,00%	,00%	,00%	,00%	,00%	,01%
Order Management	,00%	,00%	,00%	,00%	,00%	,00%	,00%
Others	,03%	,02%	,02%	,02%	,02%	,03%	,04%
QA Plant Driven	,03%	,02%	,02%	,02%	,02%	,03%	,04%
Supply Planning PSC	,16%	,12%	,11%	,12%	,11%	,16%	,19%
Transport & Warehousing	,07%	,05%	,05%	,05%	,05%	,07%	,08%
Waiting to be analyzed	,05%	,03%	,03%	,03%	,03%	,05%	,05%

Actuals vs. Target per rootcause lvl 2	UK Ireland	Iberia	DACH	Italy Group	FBNL	Nordic	Grand Total
CFR Actual	98,72%	98,86%	98,76%	97,55%	99,38%	98,67%	98,68%
CFR Target	98,50%	98,90%	99,00%	98,90%	99,00%	98,50%	98,20%
1.1 Master Data	,00%	,00%	,00%	,00%	,19%	,00%	,01%
1.10 Information/Tech Tools							
1.2 Supply Planning Execution	-,06%	,04%	-,04%	-,02%	,01%	-,06%	-,05%
1.3 Quality/Regulatory	,01%	,00%	-,02%	,92%	-,02%	-,03%	,09%
1.4 Material Supply	-,04%	,09%	-,03%	-,03%	,03%	,46%	,00%
1.5 Manufacturing Execution	,00%	,00%	,24%	,00%	,03%	,00%	,04%
1.6 Transport & Warehousing	,28%	,26%	,18%	-,05%	-,01%	-,07%	,15%
1.7 Order Management	,00%	,00%	,04%	,00%	,00%	,00%	,01%
1.8 Other	,01%	,00%	,01%	,00%	,00%	,00%	,00%
1.9 Suppressed Demand-Sup Iss							
2.1 Demand Planning	,02%	-,07%	,28%	,18%	-,01%	-,14%	,01%
2.2 Initiatives Readiness	-,05%	-,04%	-,03%	,14%	-,03%	-,05%	-,04%
2.3 Capacity to Demand Strateg							
2.4 Unplanned or Off-strategy	,00%	,00%	,00%	,00%	,00%	,00%	,00%
2.5 Other	-,03%	-,02%	-,02%	,01%	-,02%	-,03%	-,03%
2.6 Automated Availailability Management (or shorted							
2.9 Suppressd Demand-Bus Pln							
3.1 Customer Operations		,11%					,02%
3.2 Mkt/customer forcast input	,38%	-,02%	-,05%	,53%	-,05%	,27%	,17%
3.3 Communication to customer		,04%					,01%
3.4 Cust order out of policy							
3.5 Other				,15%			,02%
3.9 Suppressd Demand-Comm Ex							
7.1 Does not require Analysis	-,67%	-,48%	-,29%	-,57%	-,53%	-,79%	-,90%
7.1 Waiting to be analyzed	-,05%	,14%	-,03%	,10%	,02%	,28%	,02%
Individual SUM	-,22%	,04%	,24%	1,35%	-,38%	-,17%	-,48%

Figure 19 - Output from control chart benchmark tool (1)

# of days OOC (UCL3)	UK Ireland	Iberia	DACH	Italy Group	FBNL	Nordic	Grant Total
1.1 Master Data					2		2
1.10 Information/Tech Tools							
1.2 Supply Planning Execution		1		1	1		3
1.3 Quality/Regulatory	2	1		6			9
1.4 Material Supply		3			1	4	8
1.5 Manufacturing Execution			5		2		7
1.6 Transport & Warehousing	3	4	3		1		11
1.7 Order Management			2				2
1.8 Other	1		1				2
1.9 Suppressed Demand-Sup Iss							
2.1 Demand Planning	4		4	2	1		11
2.2 Initiatives Readiness				1			1
2.3 Capacity to Demand Strateg							
2.4 Unplanned or Off-strategy							
2.5 Other				2			2
2.6 Automated Availailability Management (o							
2.9 Suppressd Demand-Bus Pln							
3.1 Customer Operations		7					7
3.2 Mkt/customer forcast input	13	1		8		3	25
3.3 Communication to customer		5					5
3.4 Cust order out of policy							
3.5 Other				2			2
3.9 Suppressd Demand-Comm Ex							
7.1 Does not require Analysis							
7.1 Waiting to be analyzed		4		2	1	3	10
Individual Sum	23	26	15	24	9	10	107

CFR Targets	Target (base)	UK Ireland	Iberia	DACH	Italy Group	FBNL	Nordic	Grand Total
CFR Actual		98,72%	98,86%	98,76%	97,55%	99,38%	98,67%	98,68%
CFR Target		98,50%	98,90%	99,00%	98,90%	99,00%	98,50%	98,20%
1.1 Master Data	,00%	,00%	,00%	,00%	,00%	,00%	,00%	,01%
1.10 Information/Tech Tools								
1.2 Supply Planning Execution	,04%	,06%	,05%	,04%	,05%	,04%	,06%	,07%
1.3 Quality/Regulatory	,02%	,03%	,02%	,02%	,02%	,02%	,03%	,04%
1.4 Material Supply	,03%	,04%	,03%	,03%	,03%	,03%	,04%	,05%
1.5 Manufacturing Execution	,00%	,00%	,00%	,00%	,00%	,00%	,00%	,01%
1.6 Transport & Warehousing	,05%	,07%	,05%	,05%	,05%	,05%	,07%	,08%
1.7 Order Management	,00%	,00%	,00%	,00%	,00%	,00%	,00%	,00%
1.8 Other	,00%	,00%	,00%	,00%	,00%	,00%	,00%	,00%
1.9 Suppressed Demand-Sup Iss								
2.1 Demand Planning	,09%	,14%	,10%	,09%	,10%	,09%	,14%	,16%
2.2 Initiatives Readiness	,04%	,05%	,04%	,03%	,04%	,03%	,05%	,06%
2.3 Capacity to Demand Strateg								
2.4 Unplanned or Off-strategy	,00%	,00%	,00%	,00%	,00%	,00%	,00%	,00%
2.5 Other	,02%	,03%	,02%	,02%	,02%	,02%	,03%	,03%
2.6 Automated Availailability Management (o								
2.9 Suppressd Demand-Bus Pln								
3.1 Customer Operations								
3.2 Mkt/customer forcast input	,05%	,07%	,05%	,05%	,05%	,05%	,07%	,08%
3.3 Communication to customer								
3.4 Cust order out of policy								
3.5 Other								
3.9 Suppressd Demand-Comm Ex								
7.1 Does not require Analysis	,67%	,96%	,70%	,64%	,70%	,64%	,96%	1,15%
7.1 Waiting to be analyzed	,03%	,05%	,03%	,03%	,03%	,03%	,05%	,05%
Individual SUM	1,05%	1,50%	1,10%	1,00%	1,10%	1,00%	1,50%	1,80%

Figure 20 - Output from control chart benchmark tool (2)

For improvement concerns one of the main requests was to present the data such that there was a clear "accountability". This means that from the results it must be immediately clear which team or department is under performing and should take actions to get back on track. For the results from the second level root causes to be accountable we assigned every 2nd level root cause to a specific owner, this allocation can be seen in Table 13. The target and actual performance per ownership is then simply the sum of the targets and actuals and is calculated in the benchmark tool automatically as well.

Table 13 - Level 2 root cause with ownership

Lvl2	Owner
1.1 Master Data	Supply Planning PSC
1.10 Information/Tech Tools	Others
1.2 Supply Planning Execution	Supply Planning PSC
1.3 Quality/Regulatory	QA Plant Driven
1.4 Material Supply	Supply Planning PSC
1.5 Manufacturing Execution	Manufacturing Execution
1.6 Transport & Warehousing	Transport & Warehousing
1.7 Order Management	Order Management
1.8 Other	Others
1.9 Suppressed Demand-Sup Iss	Others
2.1 Demand Planning	Demand Planning PSC
2.2 Initiatives Readiness	Supply Planning PSC
2.3 Capacity to Demand Strateg	Supply Planning PSC
2.4 Unplanned or Off-strategy	Supply Planning PSC
2.5 Other	Others
2.6 Automated Availability Management (or shorted abbreviation)	Others
3.1 Customer Operations	Customer Operations
3.2 Mkt/customer forecast input	Commercial Execution
3.3 Communication to customer	Commercial Execution
3.4 Cust order out of policy	Customer Operations
3.5 Other	Others
3.9 Suppressed Demand-Comm Ex	Others
7.1 Not Analysed	Doesn't require analysis.
7.1 Not Analysed	Waiting to be analysed

With the data present which team is not performing as it should be and specifically which supply chain process they should improve we now have to incorporate this in a drumbeat process to make sure correct action plans are generated to improve and just as important make this process so that we can control if the action plans actually have the impact we expect. If the impact is not enough we then have the opportunity to adjust the action plan and get the process and team back on track.

The results per cluster are copied automatically to cluster specific files which are owned by the cluster leaders and where they can analyse their performance. An example for a part of Northern Europe is given in Figure 21. Visible are the different 2nd level root causes, their performance against the target, and the number of days that are out of control and the history of the root cause. With this the cluster leader can

identify which actions should be taken to increase each part that is underperforming. This file is updated every month and a history of the action plan is being kept to see the impact of the actions taken.

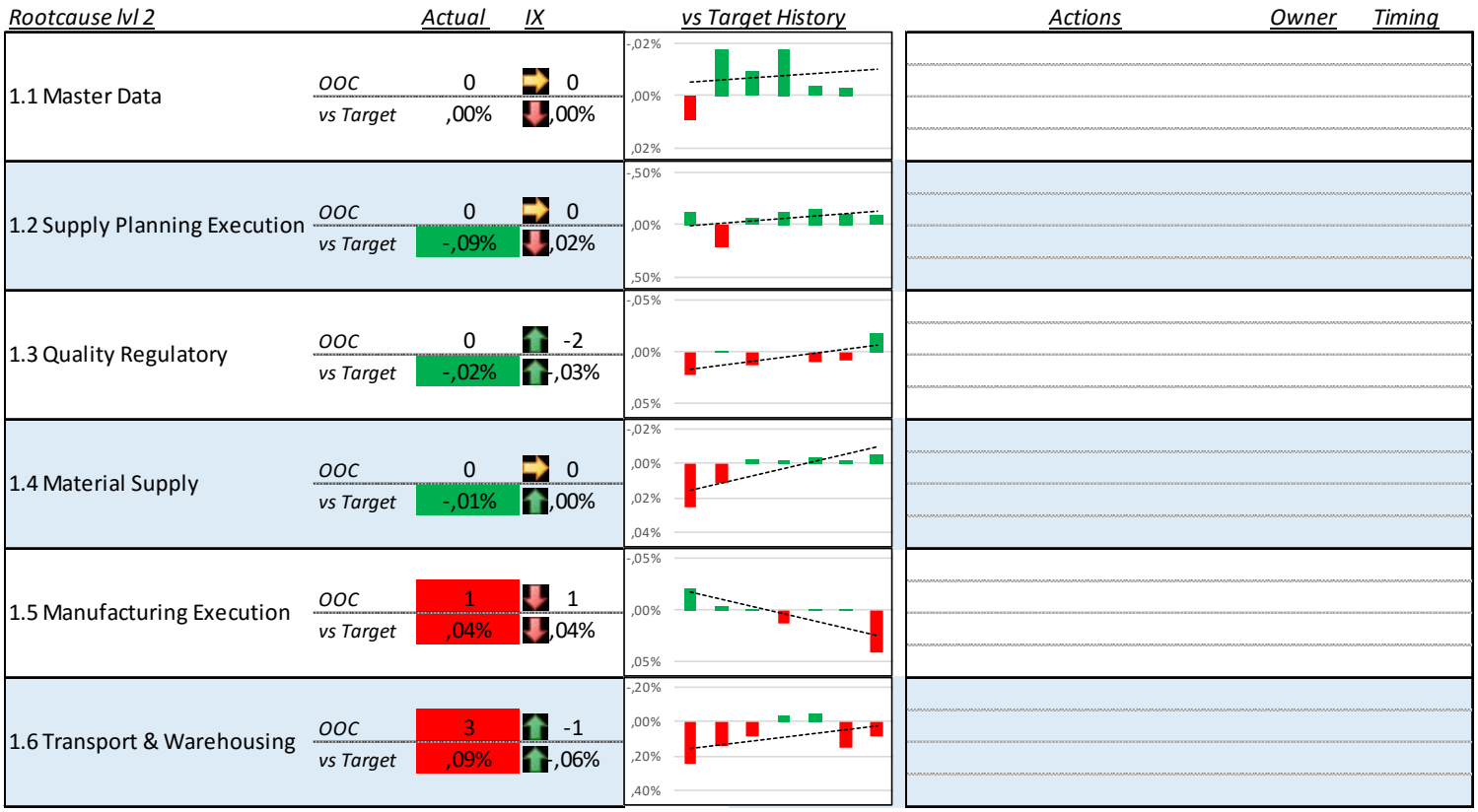


Figure 21 - Northern Europe cluster results example

To come to a reliable and feasible action plan the cluster leader dives into the processes that are out of control (red) manually. We have added a page where the deep dive analysis can be done quickly by giving an overview of the cuts and their background information, Figure 22, the data in this tool is presented in SU rather than MSU for more accurate reporting. With this information at hand the cluster leader is able to determine if there is already an action plan in place to improve the problems or if there is a need to define new actions. In both cases the cluster leader have to make sure there is a final action present to improve the process, either by copying the in place action or by escalating the problem to the accountable team.

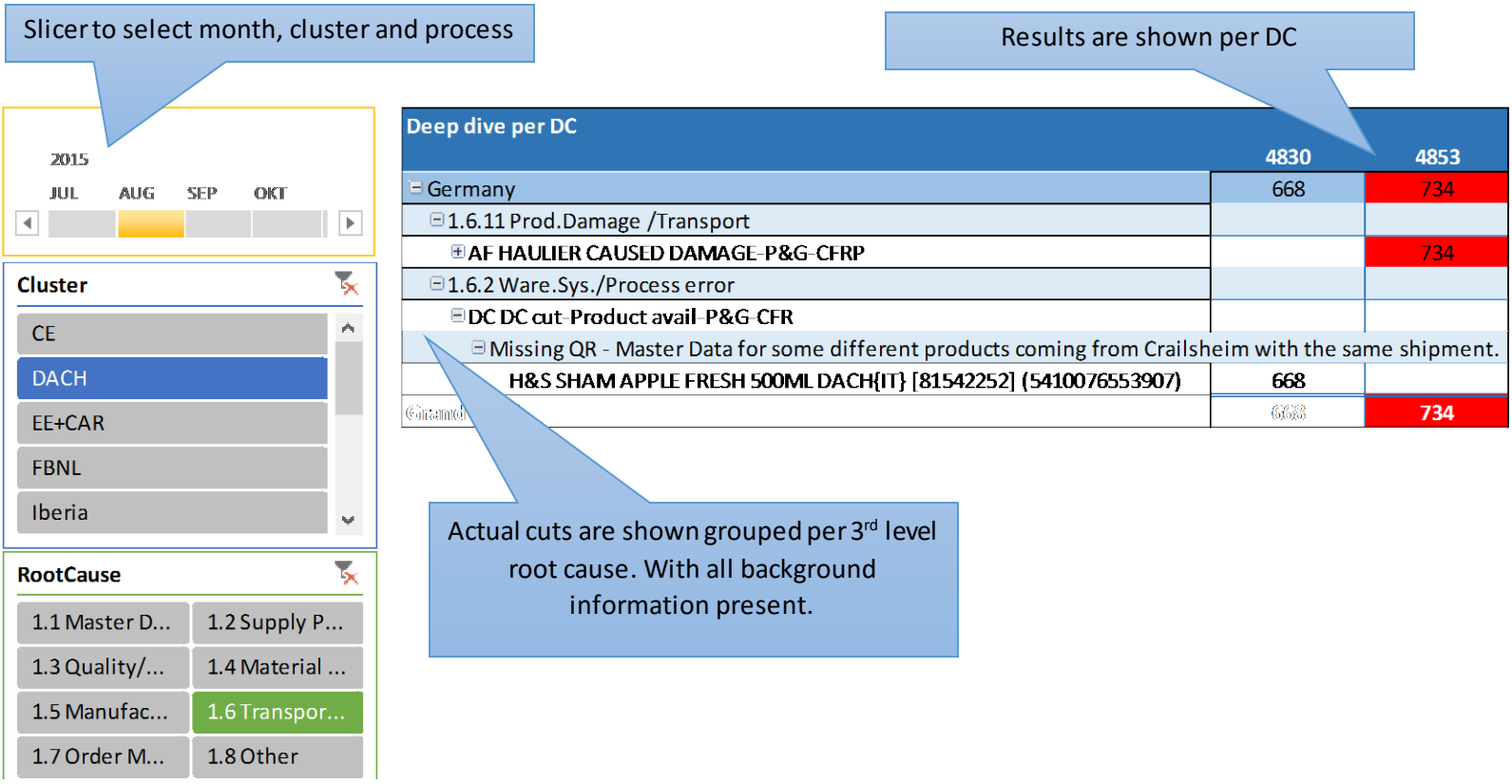


Figure 22 - Cuts deep dive analysis

Control

To make sure the defined actions are executed properly and the impact is as projected we need to build in a proper control structure. The drumbeat with reviews that is present at the moment is shown in Figure 23. As you can see there are a large number of periodical reviews that all focus on different part of performance. We focus on the quarterly – monthly – weekly – daily reviews.

At the moment each periodic review has its own action plan that is being tracked separately. Due to this setup the actions that are being developed in the monthly and quarterly meetings are not being tracked on a regular basis and may lose impact. To overcome this problem in the new situation all actions that are developed are put in a central action plan. This action plan is then reviewed during each weekly meeting and this should improve the impact and success of the actions, Figure 24.

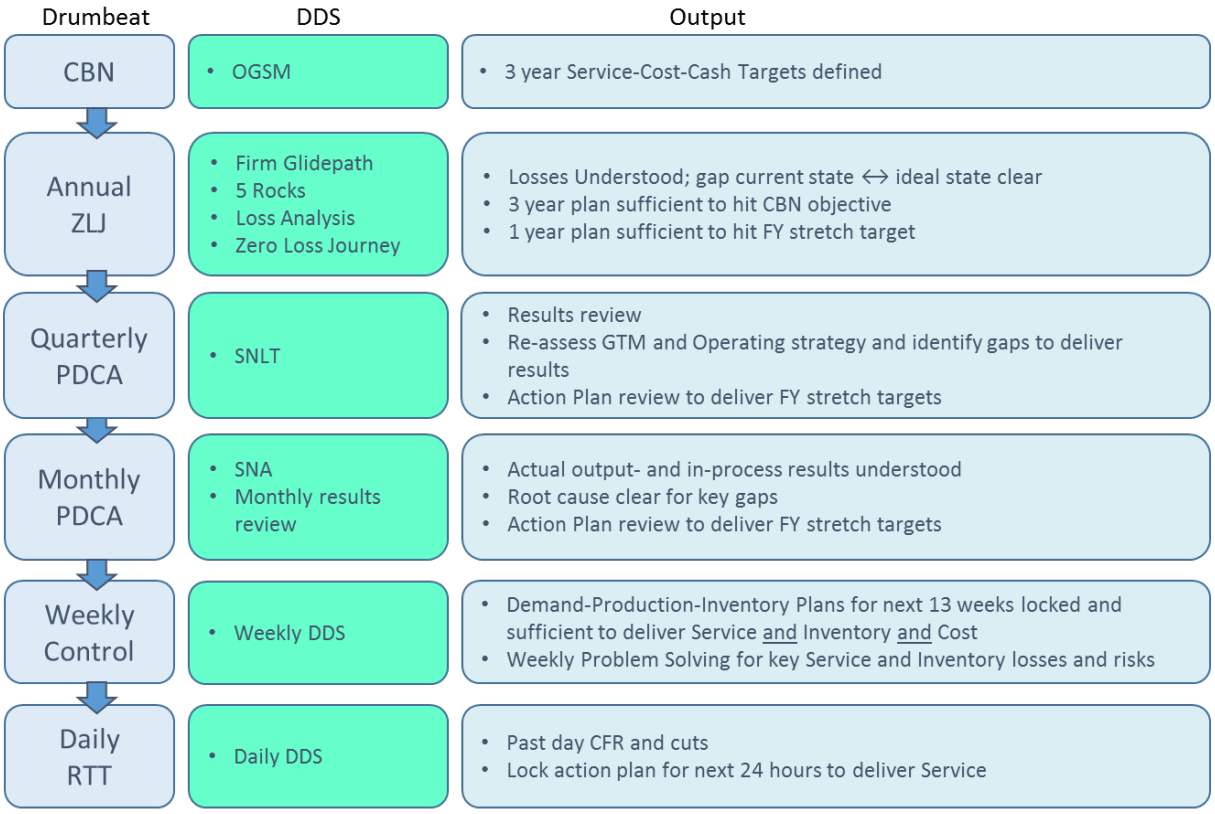


Figure 23 - Performance review drumbeat

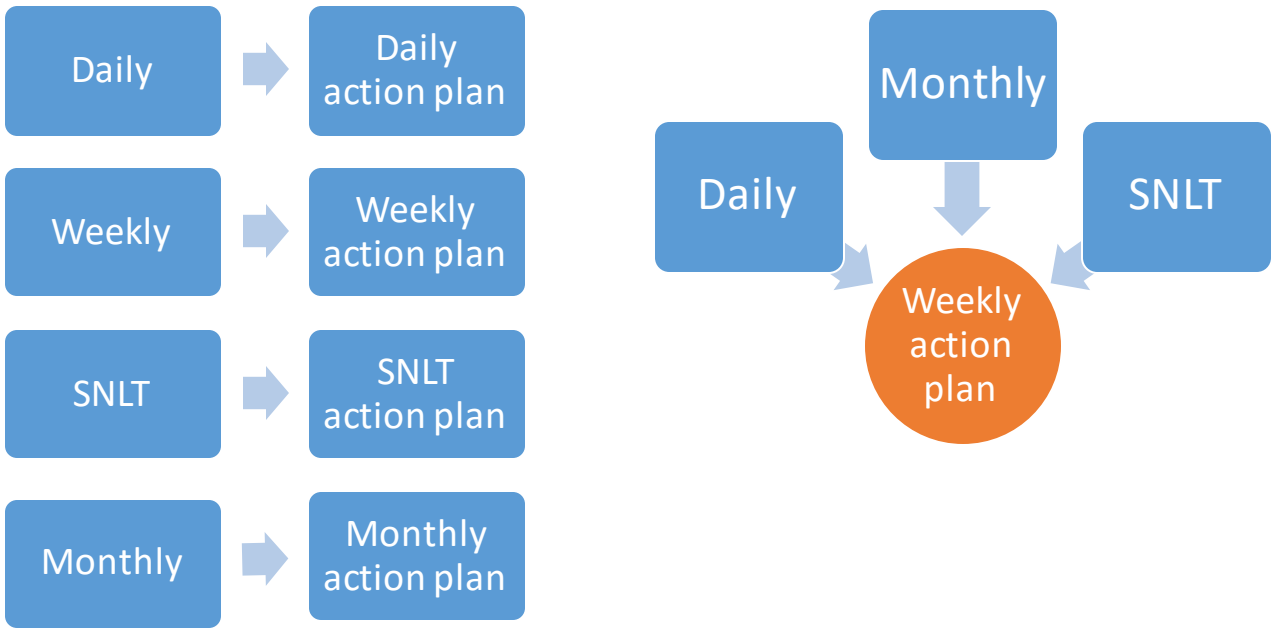


Figure 24 - Old situation versus new situation

Results

All the process adjustments that we developed are being implemented at Procter & Gamble at the moment. Due to a transition of the Planning and Service Centre from Blois to Warsaw the first operational month is in October after the internship and research has been finished and therefore we cannot give actual results as of now.

The leadership team in the European Headquarter in Geneva received the proposed adjustments after we presented the impact positively and therefore we are confident that this will help Procter and Gamble to continuously improve the customer service with success.

The full recommendation and conclusions are summed up in the next chapter.

Conclusion and recommendations

To answer the main research question that was stated in the problem statement we have developed five sub questions that combined gives an answer on the main goal:

"How to improve service level and increase visibility and accuracy of tracking service losses per supply chain process to enable continuous improvement."

1. *At what level of process detail do we need to improve tracking?*

   Measuring the performance at the process level is the most suited for the main goal, this means to focus the tracking and analysis at the 2nd root cause level where the performance of each process is aggregated. The 3rd root cause level is useful to understand what went wrong in the process.

2. *How can we increase the visibility of achieved service level throughout the supply chain?*

   We developed a new reporting tool that gives deep dive capabilities to analyse each part of the supply chain and zoom in or out of specific parts of interest.

3. *How can we improve the accuracy in measuring performance of the processes?*

   By using control charting technique we are able to determine the stable state of each supply chain process. Each month the process should perform just as good as or better than the stable performance of the last 3 months. For this calculation we have developed a breakthrough algorithm that automatically calculates the stable state performance using an adjusted Laney p control chart.

4. *How can we identify actions to improve measured low performance?*

   We developed a tool in which each cluster leader can dive into the problems that occurred in his supply chain and that are flagged by our algorithm as improvement area. By using all the background information from multiple sources we are able to identify core problems in a fast way and developing action plans with this information becomes an easy task.

5. *Which process should be implemented to enable continuous improvement on service level using the new tracking method?*

   By using a centralized action plan that is fed by the daily, weekly, monthly and quarterly reviews each action that is defined is tracked properly. Any deviation from the planning or impact of implementation can be coped with immediately.

Recommendations

We recommend the company to use the developed approach and processes in the HairCare category in Europe for a first year and fine-tune the settings during this period. After this when the results are positive the company can then easily extend the created tools to other categories because they are built to be scalable and robust for any change, the only thing that needs to be adjusted is the report which exports the results from the database to be able to deploy it in other businesses.

During this testing period I also recommend the company to do further research in the control rules to use. At the moment we have only implemented the 3-sigma rule and even better results could possibly be achieved by incorporating the full NELSON or WECO control rules. This needs to be investigated during the actual usage by the owner of the tool (DRP leader).

One of the weaknesses that came up during the testing phase with the tools and have been identified is that the use of Excel 2013 is a prerequisite of the tool. Because Microsoft does not support backward compatibility between the Excel 2013 PowerPivot Plugin with any older version of Excel we are bound by using this specific software package. As Microsoft is launching a new Excel version (2016) later this year it is advisable to tale caution in using this as no information is present about compatibility between these versions. My advice is to only open the tool in Excel 2013 to make sure nothing breaks.

All together this will result in improved measuring and tracking of service losses and together with detailed action plans this results in a higher customer service level for the company.

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Appendix A: Root cause tree

Level 1	Level 2	Level 3	Description
1.0 Supply Issues	1.1 Master Data	1.1.1 SIP Master Data	SIP Master data requirements not communicated correctly or not maintained correctly
1.0 Supply Issues	1.1 Master Data	1.1.2 Category Master Data	Category Master Data requirements not communicated correctly or not maintianed correctly (i.e., Plants not triggered, trigger data base errors - trigger did not create material master views.)
1.0 Supply Issues	1.1 Master Data	1.1.3 MDO Master Data-2nd LvlD	MDO Master data requirements not communicated correctly or not maintained correctly for 2nd Level DC.
1.0 Supply Issues	1.1 Master Data	1.1.4 Order Mngmnt Master Data	OM Master data requirements not communicated correctly or not maintained correctly
1.0 Supply Issues	1.1 Master Data	1.1.5 DRP Master Data	DRP master data requirements not communicated correctly or not maintained correctly
1.0 Supply Issues	1.1 Master Data	1.1.6 Dmnd Pln Sys Master Data	Global Demand Forecast Conversions
1.0 Supply Issues	1.10 Information/Tech Tools	1.10.1 gATP Functionality	A system error resulting in a cut. For example: BOP job / filter variant failure due to masterdata not synched, MAD date inconsistency or other anomaly.
1.0 Supply Issues	1.10 Information/Tech Tools	1.10.2 gATP Cuts with Inv	gATP cut at delivery creation when inventory is confirmed to be available. For example: Substitution did not invoke due to inaccuracy of supply elements.
1.0 Supply Issues	1.2 Supply Planning Execution	1.2.1 Excpt.Mess.not actioned	Exception messages were not actioned by the Planner.
1.0 Supply Issues	1.2 Supply Planning Execution	1.2.2 Excpt.Mess.not reviewed	Exception messages were not reviewed by the Planner in a timely manner.
1.0 Supply Issues	1.2 Supply Planning Execution	1.2.3 SIP SWP	Planner did not follow the existing Standard Work Process (SWP), or in doing so was not consistent with the Plant Operating Strategy System (POSS). This could be due to training or other reasons such as: not taking appropriate actions on exception messages, Planner did not plan production to meet a SAFT requirement before a planned shutdown, Planner did not order material for a CM where planning is owned by P&G, Planner scheduled production on the wrong line (line not qualified for the SKU.)
1.0 Supply Issues	1.2 Supply Planning Execution	1.2.4 Capacity Planning Error	Capacity planning error that doesn't protect current forecast (incl. promotions). This could be due to the Planner not performing capacity planning, not maintaining the C:D agreed in the POSS, or the capacity issue was not escalated for action by BOP.
1.0 Supply Issues	1.2 Supply Planning Execution	1.2.5 Safety Settng incorrect	Safety stock settings were not maintained correctly or in a timely manner. This could be due to: 1) IP reviews not completed in the past 3 months 2) Incorrect assumptions were provided in support of the Inventory Target Setting process 3) Approved safety stock settings not maintained correctly in SAP
1.0 Supply Issues	1.2 Supply Planning Execution	1.2.6 Phase In/Phs Out IOL SWP	Documented PIPO process not in-place, not sufficient or not followed by IOL.
1.0 Supply Issues	1.2 Supply Planning Execution	1.2.7 DRP SWP	DRP Systems Issues and Work Process Failures which resulted in cut cases. 1) Inventory out of balance 2) planner execution 3) system failure 4) system does not meet business need (LEO visibility)

1.0 Supply Issues	1.2 Supply Planning Execution	1.2.8 Site Based DRP prcs fail	Not following the SWP, master data and systems performance is fine
1.0 Supply Issues	1.2 Supply Planning Execution	1.2.9 Glbl Plann SWP not fllwd	Planner from another region did not follow the existing Standard Work Process (SWP) (i.e. cut occurred in sourcing or import region) or in doing so was not consistent with the sourcing regions Operating Strategy. This could be due to training or other reasons. (i.e. another region ordered too much)
1.0 Supply Issues	1.3 Quality/Regulatory	1.3.1 Supplier Quality Manage	Cases not available to ship due to out of specification material, regulatory compliance and/or material quality issues associated with change or going production.
1.0 Supply Issues	1.3 Quality/Regulatory	1.3.10 Artwork Quality	
1.0 Supply Issues	1.3 Quality/Regulatory	1.3.2 Manuf Quality - Micro	
1.0 Supply Issues	1.3 Quality/Regulatory	1.3.3 Manuf Quality/Regulatory	Cases not available to ship due to regulatory requirements and/or (in-process or finished product) was put on hold for inspection or rejected.
1.0 Supply Issues	1.3 Quality/Regulatory	1.3.4 Manipulation Quality	Manipulated Cases/displays/special packs etc not available to ship due to regulatory requirements and/or (in-process or finished product) was put on hold for inspection or rejected.
1.0 Supply Issues	1.3 Quality/Regulatory	1.3.5 Expired Product	Cases not available due to inability to meet ship window date compliance.
1.0 Supply Issues	1.3 Quality/Regulatory	1.3.6 Quality Release Exec	Late release at DC or Plant due to warehouse quality execution.
1.0 Supply Issues	1.3 Quality/Regulatory	1.3.7 Product damage quality issue(not due to Trans or pick)	
1.0 Supply Issues	1.4 Material Supply	1.4.1 Insuf Supplier Capacity	Insufficient supplier capacity planned to protect current forecast plus C:D agreed in the SLEA (MSM/MSMAs)
1.0 Supply Issues	1.4 Material Supply	1.4.3 MSM SWP not Followed	SLEA didn't meet business needs
1.0 Supply Issues	1.4 Material Supply	1.4.4 SLEAs not followed	Vendor Site Level Execution Agreement expectations not followed
1.0 Supply Issues	1.4 Material Supply	1.4.6 Supplier Execution Mnfg	Supplier under-delivered or delivered late due to supplier planning or manufacturing failures
1.0 Supply Issues	1.4 Material Supply	1.4.7 Natural Disaster-Supply	No supply due to natural disaster at the supplier or natural disaster impacted supplier's supplier - and the supplier was unable to produce P&G requirements.
1.0 Supply Issues	1.5 Manufacturing Execution	1.5.1 Manufact. Execut. MPSA	Under production or late production due to manufacturing execution. i.e. schedule was issued but product was not available on-time
1.0 Supply Issues	1.5 Manufacturing Execution	1.5.2 Mnfg Exct Data Integrity	Product was not produced because there was less bulk or packaging inventory than what was stated in the system and as a result there was insufficient bulk or packaging for production.
1.0 Supply Issues	1.5 Manufacturing Execution	1.5.3 Manip.Execut. - MPSA	Under production or late production due to manipulation execution.
1.0 Supply Issues	1.5 Manufacturing Execution	1.5.4 Natural Disaster–No Manf	A natural disaster at the P&G production site has prevented or significantly disrupted the production output.
1.0 Supply Issues	1.5 Manufacturing Execution	1.5.5 Technical Readiness	CPS supported Technical Readiness but manufacturing execution did not deliver.
1.0 Supply Issues	1.5 Manufacturing Execution	1.5.6 Logist/Supp. Readiness	Under or late production/shipment of new initiatives due to supply chain start-up issues
1.0 Supply Issues	1.5 Manufacturing Execution	1.5.7 Product Comp. not avail	Component Materials are not available.
1.0 Supply Issues	1.5 Manufacturing Execution	1.5.8 Late issue of document.	Approval documentation was not issued on time resulting in availability issues.(LAZ/AED)
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.1 IRA discrepancy	Inventory Record Accuracy Issues resulting in less stock than expected.

1.0 Supply Issues	1.6 Transport & Warehousing	1.6.10 Stolen Product	Full Truck stolen or individual product stolen from truck.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.11 Prod.Damage /Transport	Product returned due to damage during the transportation process.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.12 Prod.Damaged - Picking	Product damaged during the picking process.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.13 Wrong Product Picked	Wrong product shipped by DC. Does not match the product ordered.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.14 Paperwork Incomplete	Customer rejected product due to insufficient supporting documentation, such as shipping paperwork or QI documentation.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.15 Late Delivery	Product delivered to customer too late and customer refuses to accept.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.16 Cust.Pickup-Truck Size	Customer Vehicle/Truck is the wrong size for the ordered quantity.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.17 Shipment Loading Error	Includes load building work process, overweight, master data, or physical load process. Where product is cut from a load at the DC prior to shipment known as 'Truck Sizing Corrections'
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.18 Product cut by carrier	Product originally shipped by P&G is cut by the carrier due to downstream manipulation such as re-palletizing.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.2 Ware.Sys./Process error	Warehouse systems or Process Errors.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.3 Outside storage failure	Failure in the outside storage location resulted in cuts to the shipment.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.4 Com.iss. -MP/Plant / DC	Communication issues between Market Planning, Plant and DC
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.5. DC breakdown	Product not available for shipping due to a failure of warehouse equipment.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.6 Inbound haulier Issue	Constraint in interplant shipping impacting our ability to get sufficient product to the DC to meet demand, for example weather disruption on the inbound journey.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.7 Customs Clearance Delay	Product not available for shipping due to customs clearance issues inbound to the ship-site or outbound to the customer.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.8 In-transit LT Incorrect	Product shipped, but not received properly at the DC. The DC is unaware that the product was shipped.
1.0 Supply Issues	1.6 Transport & Warehousing	1.6.9 Delay in transit-issue	Delay of the in-transit product. For example : • Product shipped on time, but delayed in transit. • Product shipped on time, but DC was delayed in processing the receipt. • Delay during shipment to and from contract manufacturers for manipulation.
1.0 Supply Issues	1.7 Order Management	1.7.1 Manual Entry Error	Manual Entry Error
1.0 Supply Issues	1.7 Order Management	1.7.2 Insufficient Leadtime	Order cut due to items with insufficient lead time to produce and/or ship.
1.0 Supply Issues	1.7 Order Management	1.7.3 Systems Error/Interface	A system error resulting in a cut. For example : Line item dropped from customer's order during acquisition of the order from the customer.
1.0 Supply Issues	1.7 Order Management	1.7.4 Delay-New Code or Sub	Incomplete or late setup of new code or substitution
1.0 Supply Issues	1.8 Other	1.8.1 Not covered in 1.0	This root cause code is provided to avoid excessive time loss trying to force fit the issue into one of the root causes above.
1.0 Supply Issues	1.9 Suppressed Demand-Sup Iss	1.9.1 Suppressd Demand-Sup Iss	Production capacity or supply of raw and packing materials insufficient to meet demand.
2.0 Business Planning Issues	2.1 Demand Planning	2.1.1 Demand Planning SWP	Demand Planner did not escalate when demand inputs were insufficient

2.0 Business Planning Issues	2.1 Demand Planning	2.1.2 Communication: Demand Er	Planner received forecast input but failed to enter into the system
2.0 Business Planning Issues	2.1 Demand Planning	2.1.3 Wkly demnd mgmnt/cntrl	Cuts caused by Weekly Demand (Near-term) Maintenance, DFU level overshipments and/or control not performed/performed poorly (i.e. bias not managed through DDS process)
2.0 Business Planning Issues	2.1 Demand Planning	2.1.4 Sys maint/interface fail	Data System failure either into DP system or from DP system
2.0 Business Planning Issues	2.2 Initiatives Readiness	2.2.1 CPS Management	CPS did not allow sufficient time to complete tasks or delayys were not highlighted early enough to prevent impact on end date due to scope change, incorrect specs, etc.
2.0 Business Planning Issues	2.2 Initiatives Readiness	2.2.2 CMK underestimated Cnsmr	Underestimation of the consumer's response to the new initiative.
2.0 Business Planning Issues	2.2 Initiatives Readiness	2.2.3 Market Plan chng not com	Marketing plan changes not communicated or communicated too late to demand planning that resulted in cuts.
2.0 Business Planning Issues	2.2 Initiatives Readiness	2.2.4 Initiative fore not in	Demand planning did not get the initiative forecast into the forecast tool.
2.0 Business Planning Issues	2.2 Initiatives Readiness	2.2.5 Planner human error	Planner did not follow standard work process.
2.0 Business Planning Issues	2.2 Initiatives Readiness	2.2.6 Artwork Planning	Artwork process issues for new initiatives or promotions
2.0 Business Planning Issues	2.2 Initiatives Readiness	2.2.7 Project team Execution	Insufficient base plan, gtm plan, infeasible off quality Ie. 'incorrect demand process inputs'
2.0 Business Planning Issues	2.3 Capacity to Demand Strateg	2.3.1 Capty to Demand Strategy	C:D strategy insufficient due to 1) Aligned C:D targets set incorrectly (too low), 2) C:D targets not defined & documented in the Category Operating Strategy, 3) Plant Operating Strategy not aligned to Category C:D Strategy, 4) operating/inventory strategy not built off of demonstrated performance 5) Need for change in capacity or strategy not addressed
2.0 Business Planning Issues	2.3 Capacity to Demand Strateg	2.3.2 Planned Capacity Not Realized	RCCP issues addressed in BOP but plan not executed as expected.
2.0 Business Planning Issues	2.4 Unplanned or Off-strategy	2.4.1 P&G Mngmnt Decision chg	P&G Management decision making/influence caused cuts. Issue identified and BU proceeds with risk (ex: reduce safety stock for FYE inventory)
2.0 Business Planning Issues	2.4 Unplanned or Off-strategy	2.4.2.Unplan demand-price chng	Unplanned demand from short-notice price changes
2.0 Business Planning Issues	2.4 Unplanned or Off-strategy	2.4.3Unplan demand-tax/legal	Unplanned demand from short-notice tax, legal or customs changes
2.0 Business Planning Issues	2.4 Unplanned or Off-strategy	2.4.5 Glbl BP Prcss not fllwd	Global Supply Chain Planning Processes and Strategies (e.g., Import/Export assumptions not communicated or executed properly, export demand communication misses, capacity planning gaps across regions, overshipment of one country impacting the availability in another country, etc.)
2.0 Business Planning Issues	2.4 Unplanned or Off-strategy	2.4.6 Legal chngs, artwork inv	Due to a short-notice local government legal change, artwork no longer meets regulatory requirements, stock is placed on hold and unavailable to ship.
2.0 Business Planning Issues	2.5 Other	2.5.1 Not covered in 2.0	This root cause code is provided to avoid excessive time loss trying to force fit the issue into one of the root causes above.
2.0 Business Planning Issues	2.6 Automated Availailability Management (or shorted abbreviation)	2.6.1 Cut without Adv notice	Availability Management master data is missing or incorrectly configured causing cuts to occur where the planning teams have no advance visibility of the requirement via the Availability Managent cycle
2.0 Business Planning Issues	2.9 Suppressd Demand-Bus Pln	2.9.1 Suppressd Demand-Bus Pln	Demand forecast was significantly lower than the actual demand. • Constraint in interplant shipping impacting our ability to get sufficient product to the DC to meet demand.

3.0 Commercial Execution Issue	3.1 Customer Operations	3.1.1 Cst ordr out of guidelin	Order submitted with errors due to customer's maintenance of their ordering tables (e.g., combining products that should not be combined, incorrect unit of measure, obsolete product, exceeding truckload limit.)
3.0 Commercial Execution Issue	3.1 Customer Operations	3.1.2 Cust order incorrect pro	Customer submitted an order to P&G for the wrong product.
3.0 Commercial Execution Issue	3.1 Customer Operations	3.1.3 Cst order incorrect pric	Customer inadvertently placed the order with the wrong price.
3.0 Commercial Execution Issue	3.1 Customer Operations	3.1.4 Cst ordr outside of date	Customer submitted the order to ship before the agreed/published new item or promotion first ship date.
3.0 Commercial Execution Issue	3.1 Customer Operations	3.1.5 Space/condition at rcvng	Customer's warehouse not able to receive the product due to insufficient space or inadequate conditions.
3.0 Commercial Execution Issue	3.1 Customer Operations	3.1.6 Sys malfunction at rcvng	Customer's receiving information system not able to receive the product due to incorrect system setup or inaccurate bar code reading.
3.0 Commercial Execution Issue	3.1 Customer Operations	3.1.7. Cust financial status	Order cut due to a credit risk based upon customer's financial/payment status.
3.0 Commercial Execution Issue	3.2 Mkt/customer forcast input	3.2.1 CBD input-Demand/Mkt Pln	CBD input provided to Demand/Market Planning was incorrect or missing (e.g. dates, products, pricing, quantity, etc.) - Incremental Business Assessment (IBA) process not followed (quantity or timing) - Unforecasted, customer-generated demand increase without sufficient lead time. - Significantly overshipped event vs. the forecast provided to Demand/Market Planning.
3.0 Commercial Execution Issue	3.2 Mkt/customer forcast input	3.2.2 Cust chng qty post-windo	Customer or Customer Team increased/ changed the date of product demand quantity (beyond safety & buffer & strategy) or sku split without proper notice. May be due to Event/Feature execution (e.g., feature/event announced on the wrong SKU.) ie. Customer communicated requirement though shipped later than what was communicated
3.0 Commercial Execution Issue	3.2 Mkt/customer forcast input	3.2.3 Cust Didnt Comm Event	Customer failed to provide appropriate information on event causing cuts (i.e Distribution changes, events, inventory adjustments, etc.)
3.0 Commercial Execution Issue	3.2 Mkt/customer forcast input	3.2.4 Unplan demand-cust/compe	Unplanned demand from short-notice of customer changes (e.g., response to competitive opportunities such as a failure of a competitor to fulfill the volume needed for a display event, so at the last minute the customer asks us to ship them our product displays to fill the event.
3.0 Commercial Execution Issue	3.3 Communication to customer	3.3.1 Incorrect prd ordr-PG er	P&G had not communicated correct product information - incorrect product code ordered
3.0 Commercial Execution Issue	3.3 Communication to customer	3.3.2 Prd over allocatn-PG err	P&G had not communicated correct allocation information - product ordered above allocation
3.0 Commercial Execution Issue	3.3 Communication to customer	3.3.3 Prod ord out of ship win	P&G had not communicated correct dates - product ordered out of shipping window
3.0 Commercial Execution Issue	3.4 Cust order out of policy	3.4.1 Cust. not execute alloc	Customer ordered more than the communicated available stock.
3.0 Commercial Execution Issue	3.4 Cust order out of policy	3.4.2 Order exceed promo allot	Orders cut due to customers not respecting the P&G communicated promotion allotment quantities (e.g., we have a planned, limited amount of a special product that we are producing or in NA - Orders made outside of SPS submitted forecast.) BU stated they couldn't support and customer ordered anyway.
3.0 Commercial Execution Issue	3.4 Cust order out of policy	3.4.3 Order exceed price allot	Orders cut due to customers not respecting the allocated order quantitiies during a price change period.
3.0 Commercial Execution Issue	3.4 Cust order out of policy	3.4.4 Commercial Issue-Price	Customer used an old price even though they have the new price. A commercial issue needs to be addressed with the customer.
3.0 Commercial Execution Issue	3.5 Other	3.5.1. Not covered in 3.0	This root cause code is provided to avoid excessive time loss trying to force fit the issue into one of the root causes above.

3.0 Commercial Execution Issue	3.9 Suppressd Demand-Comm Ex	3.9.1 Suppressed Demand-Comm E	Suppressed Demand due to erroneous Commercial Execution
7.0 Not Analyzed	7.1 Not Analyzed	7.1.1. Waiting to be analyzed	Cuts that are still to be analysed.
7.0 Not Analyzed	7.1 Not Analyzed	7.1.2. Does not Require Anal.	Cuts that are automatically closed based on filter rules set up in the root causing tool. Typically very small volume cuts.

Appendix B VBA Codes

Code for Report updates

```
Public newupdatedate As Date
Public lastupdatedate As Date
Public databaselocation As String
Public AllowedToContinue As Boolean
Public updatebrandmatrix As Boolean
Public optimus As String
```

```
Sub RefreshALL()
'refresh the complete datamodel
'please run when geography or other support matrixes have been updated

starttime = Timer

Application.ScreenUpdating = False
Application.EnableEvents = False

            ActiveWorkbook.Model.refresh

Application.ScreenUpdating = True
Application.EnableEvents = True


endtime = Timer
Msgbox "The data has been refreshed: " & (endtime - starttime) / 60 & "
minutes"

End Sub
```

```
Sub CopyDatabaseLocal()

Dim DirFile As String
    DirFile = "c:\OptimusPrime Database\OptimusPrime-DB.accdb"

'if the database is non existing download
If Len(Dir(DirFile)) = 0 Then
    On Error Resume Next
    MkDir "C:\OptimusPrime Database"
    FileCopy databaselocation, "c:\OptimusPrime Database\OptimusPrime-
DB.accdb"

'if the database is older than the one on the server replace it
ElseIf FileDateTime(databaselocation) > FileDateTime("c:\OptimusPrime
Database\OptimusPrime-DB.accdb") Then
    Dim fso As Object
        Set fso = VBA.CreateObject("Scripting.FileSystemObject")
        Call fso.CopyFile(databaselocation, "c:\OptimusPrime
Database\OptimusPrime-DB.accdb", True)
End If

End Sub
```

```
Sub progress(pctCompl As Single)
'updates the progressbar
UserForm1.Text.Caption = pctCompl & "% Completed"
UserForm1.Bar.Width = pctCompl * 2
```

```
DoEvents

End Sub
```

```
Sub start()
'opens the progressbar and starts the importdata macro (in the userform code)
    optimus = ActiveWindow.Caption
    UserForm1.Show
End Sub
Sub MonthClosing()

If Msgbox("This will aggregate the data from daily to monthly for " &
monthname(month(Date) - 2, mmm) & " and send the month closing report for " &
monthname(month(Date) - 1, mmm) & ". Are you sure?", vbYesNo) = vbNo Then
Exit Sub

optimus = ActiveWindow.Caption

'archive the data
archivedate

'Delete the data at daily level for Month-2
AggregateMonths

'Upload the database
uploadDB

'Send month closing email
sendcomplexemailattachmentmonthclosing

End Sub
```

```
Sub ImportData()

Dim pctCompl As Single
Dim maxk, k As Integer

starttime = Timer

'progress BAR
 maxk = 6
 k = 0
 pctCompl = Round((100 / maxk) * k, 0)
 progress pctCompl


'if both downloaded workbooks are open and the name is correct and it is not
monday
If (Check_If_Workbook_Open("CFR-Daily-Cuts.xlsx")) And
(Check_If_Workbook_Open("CFR-Daily-Orders.xlsx")) Then

    Msgbox "The update process is starting now. Please wait for the message
that it is finished"


    Application.EnableEvents = False
    Application.ScreenUpdating = False
```

```
databaselocation = Worksheets("Update").Range("C30").Value
updatebrandmatrix = False

'Copy the database locally
CopyDatabaseLocal


    ''''''''''''''
    'progress BAR'
    ''''''''''''''
     pctCompl = Round((100 / maxk) * k, 0)
     k = k + 1
     progress pctCompl


'unprotect the sheets
If Worksheets("Daily Report").ProtectContents = True Then
    Worksheets("Daily Report").Unprotect
End If
If Worksheets("Deepdive Analysis").ProtectContents = True Then
    Worksheets("Deepdive Analysis").Unprotect
End If

'set the last updatedate to compare with
Worksheets("Daily Report").Activate
lastupdatedate = Worksheets("Daily Report").Range("C1").Value

'Step 1: update the Cuts data
AddCutsToAccess
ImportCutsTime = Timer

'Step 2: update the Orders data
AddOrdersToAccess
ImportShipmentsTime = Timer

    ''''''''''''''
    'progress BAR'
    ''''''''''''''
     pctCompl = Round((100 / maxk) * k, 0)
     k = k + 1
     progress pctCompl


'Step 3: Refresh the PowerPivot
        Windows("OptimusPrime - CFR Report.xlsm").Activate

        'refresh Dates
        Windows("OptimusPrime - CFR Report.xlsm").Activate
        ActiveWorkbook.Model.ModelTables("date").refresh
        DoEvents

        If updatebrandmatrix = True Then
            Windows("OptimusPrime - CFR Report.xlsm").Activate
            ActiveWorkbook.Model.ModelTables("BrandDetailMatrix").refresh
        End If

        'refresh Cuts
        Windows("OptimusPrime - CFR Report.xlsm").Activate
```

```
        ActiveWorkbook.Model.ModelTables("AccessCuts").refresh
        DoEvents

    ''''''''''''''
    'progress BAR'
    ''''''''''''''
     pctCompl = Round((100 / maxk) * k, 0)
     k = k + 1
     progress pctCompl


        'refresh Orders
        Windows("OptimusPrime - CFR Report.xlsm").Activate
        ActiveWorkbook.Model.ModelTables("AccessOrders").refresh
        DoEvents

        'refresh FPC list
        Windows("OptimusPrime - CFR Report.xlsm").Activate
        Sheets("Products - Customers").Activate
        ActiveSheet.PivotTables("PivotTable1").PivotCache.refresh
        ActiveWorkbook.Model.ModelTables("Table10").refresh


        refreshtables = Timer

    ''''''''''''''
    'progress BAR'
    ''''''''''''''
     pctCompl = Round((100 / maxk) * k, 0)
     k = k + 1
     progress pctCompl


'update the last update date with todays update
Worksheets("Daily Report").Activate
Worksheets("Daily Report").Range("C1") = newupdatedate

'Step 4: refresh the filters to get the latest day
updateDateFilters
UpdateFilterTime = Timer

'Save the workbook
ActiveWorkbook.Save

    ''''''''''''''
    'progress BAR'
    ''''''''''''''
     pctCompl = Round((100 / maxk) * k, 0)
     k = k + 1
     progress pctCompl


'Upload DB to the L drive
uploadDB
uploadDBTime = Timer

    ''''''''''''''
    'progress BAR'
```

```
        ''''''''''''''
         pctCompl = Round((100 / maxk) * k, 0)
         k = k + 1
         progress pctCompl


    'Copy the file to the sharepoint
    savecopy
    UploadSP = Timer

        ''''''''''''''
        'progress BAR'
        ''''''''''''''
         pctCompl = Round((100 / maxk) * k, 0)
         k = k + 1
         progress pctCompl


    'Send email
    sendcomplexemailattachment

    'Show the information about the update proces
    endtime = Timer
    Msgbox "Everything went okay! The time the steps took: " & Round((endtime
- starttime) / 60, 2) & " minutes" _
        & vbNewLine & _
        "Import Cuts: " & Round((ImportCutsTime - starttime) / 60, 2) & "
minutes" & vbNewLine & _
        "Import Shipments: " & Round((ImportShipmentsTime - ImportCutsTime) /
60, 2) & " minutes" & vbNewLine & _
        "RefreshTables: " & Round((refreshtables - ImportShipmentsTime) / 60,
2) & " minutes" & vbNewLine & _
        "Update Filter: " & Round((UpdateFilterTime - refreshtables) / 60, 2)
& " minutes" & vbNewLine & _
        "Upload DB: " & Round((uploadDBTime - UpdateFilterTime) / 60, 2) & "
minutes" & vbNewLine & _
        "Upload Sharepoint: " & Round((UploadSP - uploadDBTime) / 60, 2) & "
minutes"



    Application.EnableEvents = True
    Application.ScreenUpdating = True


'if only the cuts are open
ElseIf (Check_If_Workbook_Open("CFR-Daily-Cuts.xlsx")) Then
    Msgbox "The workbook [CFR-Tool-Orders.xlsx] is not open or is not named
correctly."
    End

' if only the orders are open
ElseIf (Check_If_Workbook_Open("CFR-Daily-Orders.xlsx")) Then
    Msgbox "The workbook [CFR-Tool-Cuts.xlsx] is not open or is not named
correctly."
    End

'if non of them are open
```

```
Else
    Msgbox "Both workbooks [CFR-Tool-Cuts.xlsx] and [CFR-Tool-Orders.xlsx]
are not open or are not named correctly."
    End
End If

End Sub
```

```
Sub uploadDB()
'save the newly updated database to the location where this is stored
Dim fso As Object
Windows(optimus).Activate
databaselocation = Worksheets("Update").Range("C30").Value
Set fso = VBA.CreateObject("Scripting.FileSystemObject")
    Call fso.CopyFile("c:\OptimusPrime Database\OptimusPrime-DB.accdb",
databaselocation, True)
End Sub
Sub savecopy()
'save a copy of the report to the sharepoint
    databaselocation = Worksheets("Update").Range("C30").Value
    Application.DisplayAlerts = False
    Worksheets("Daily Report").Activate
    ActiveWorkbook.SaveAs
"http://dcsp.pg.com/bu/PSCGlobal/PSC_Europe_TC/Document%20Library/EU%20Categories/Hair%20Care/Category-CFR/1.%20CFR%20report/OptimusPrime%20-%20CFR%20REPORT " & Format(Now, "DD-MMM") & ".xlsm"
    Application.DisplayAlerts = True
End Sub
```

```
Sub AddCutsToAccess()
'Macro to import the data from the fresh data extract into the dashboard
'For the macro to run it is required that the CFR-Data-Cuts.xlsx file is open

Dim strMyPath As String
Dim strDelete As String


Windows("CFR-Daily-Cuts.xlsx").Activate

strMyPath = Application.ActiveWorkbook.path
strDelete = strMyPath & "\" & "CFR-Daily-Cuts.xlsx"

    'format new data as table
     ActiveSheet.ListObjects.Add(xlSrcRange, Range(Cells(1, 1),
Cells(xlLastRow, 12)), , xlYes).Name _
        = "Table1"


    'add calculated date in new column, weekend will be allocated to friday
    Range("K2").Select
    ActiveCell = _

"=IF(EOMONTH(DATEVALUE([@Time]),0)<TODAY(),EOMONTH(DATEVALUE([@Time]),0),IF(IF(WEEKDAY((TODAY()-1),3)=6,TODAY()-3,IF(WEEKDAY((TODAY()-1),3)=5,TODAY()-2,TODAY()-1))<DATEVALUE([@Time]),DATEVALUE([@time]),IF(WEEKDAY((TODAY()-1),3)=6,TODAY()-3,IF(WEEKDAY((TODAY()-1),3)=5,TODAY()-2,TODAY()-1))))"

    'set the new update date to store when everything went okay
```

```
    newupdatedate = Application.WorksheetFunction.max(Range(Cells(2, 11),
Cells(xlLastRow, 11)))


    'blank check
    Range("L2").Select
    ActiveCell = _
        "=IF([@[Brand Detail]]=" & Chr(34) & Chr(34) & ",,VLOOKUP([@[Brand
Detail]],'[OptimusPrime - CFR REPORT.xlsm]Products - Customers'!$A:$A,1,0))"

    'if blank then pause macro to allow user interaction
    If Application.WorksheetFunction.CountIf(Range("L:L"), "#N/A") > 0 Then
        ActiveSheet.ListObjects("Table1").Range.AutoFilter Field:=12,
Criteria1:="=#N/A"

        Application.ScreenUpdating = True
        Msgbox ("Please follow the instructions on the update tab for
BLANKS")
        Pause
        updatebrandmatrix = True
        Application.ScreenUpdating = False
    End If

    'clear filter again
    Windows("CFR-Daily-Cuts.xlsx").Activate
    ActiveSheet.ListObjects("Table1").Range.AutoFilter Field:=12

    'set the new update date to store when everything went okay
    newupdatedate = Application.WorksheetFunction.max(Range(Cells(2, 11),
Cells(xlLastRow, 11)))

    MoveDataToAccess ("AccessCuts")

    'close and delete
    Windows("CFR-Daily-Cuts.xlsx").Close False
    Kill strDelete

End Sub
```

```
Sub AddOrdersToAccess()
'Macro to import the data from the fresh data extract into the dashboard
'For the macro to run it is required that the CFR-Data-Cuts.xlsx file is open

Dim strMyPath As String
Dim strDelete As String
Dim str As String
Dim count As Integer

Application.ScreenUpdating = False


Windows("CFR-Daily-Orders.xlsx").Activate

strMyPath = Application.ActiveWorkbook.path
strDelete = strMyPath & "\" & "CFR-Daily-Orders.xlsx"

    'format new data as table
```

```
    ActiveSheet.ListObjects.Add(xlSrcRange, Range(Cells(1, 1),
Cells(xlLastRow, 11)), , xlYes).Name _
        = "Table1"

        'add calculated date to new column, weekend will be allocated to
friday
    Range("J2").Select
    ActiveCell = _

"=IF(EOMONTH(DATEVALUE([@Time]),0)<TODAY(),EOMONTH(DATEVALUE([@Time]),0),IF(I
F(WEEKDAY((TODAY()-1),3)=6,TODAY()-3,IF(WEEKDAY((TODAY()-1),3)=5,TODAY()-
2,TODAY()-1))<DATEVALUE([@Time]),DATEVALUE([@Time]),IF(WEEKDAY((TODAY()-
1),3)=6,TODAY()-3,IF(WEEKDAY((TODAY()-1),3)=5,TODAY()-2,TODAY()-1))))"

    'blank check vlookup
    Range("K2").Select
    ActiveCell = _
        "=IF([@[Brand Detail]]=" & Chr(34) & Chr(34) & ",,VLOOKUP([@[Brand
Detail]],'[OptimusPrime - CFR REPORT.xlsm]Products - Customers'!$A:$A,1,0))"

    'if there are blanks pause the macro
    If Application.WorksheetFunction.CountIf(Range("K:K"), "#N/A") > 0 Then
        ActiveSheet.ListObjects("Table1").Range.AutoFilter Field:=11,
Criteria1:="=#N/A"
        Application.ScreenUpdating = True
        Msgbox ("Please follow the instructions on the update tab for
BLANKS")
        Pause
        updatebrandmatrix = True
        Application.ScreenUpdating = False
    End If

    'clear filter again
    Windows("CFR-Daily-Orders.xlsx").Activate
    ActiveSheet.ListObjects("Table1").Range.AutoFilter Field:=11


    'Copy the Cuts data into Access
    MoveDataToAccess ("AccessOrders")

    'close and delete
    Windows("CFR-Daily-Orders.xlsx").Close False
    Kill strDelete

End Sub
```

```
Sub Pause()
'pause the macro to allow user interaction on the sheets (to fill in the
blanks)
    AllowedToContinue = False
    Do Until AllowedToContinue
        DoEvents
    Loop
    Msgbox "Continuing"
End Sub
Sub Continue()
'continue the macro if it got paused by the macro
    AllowedToContinue = True
```

```
End Sub
Function Check_If_Workbook_Open(Name As String) As Boolean
Dim wbk As Workbook

Check_If_Workbook_Open = False

For Each wbk In Workbooks
    If wbk.Name = Name Then
        Check_If_Workbook_Open = True
    End If
Next

End Function
```

```
Sub updateDateFilters()
'Update date filter for Daily Report Pivots

Dim LatestDate As String
Dim Day As Date

'Create the correct string for the filters
LatestDay = "[date].[Date].&[" & WorksheetFunction.Text(Worksheets("Daily
Report").Range("C1").Value, "yyyy-mm-dd") & "T00:00:00]"

'set the filter
ActiveWorkbook.SlicerCaches("Slicer_Date").VisibleSlicerItemsList =
Array(LatestDay)

End Sub
```

```
Sub sendmonthclosing()
Dim LatestDate As String
Dim Day As Date
Dim pvt As PivotTable
Dim pf As PivotField

'set date to last month end
LatestDay = "[date].[Date].&[" &
WorksheetFunction.Text(DateSerial(Year(Date), month(Date), 0), "yyyy-mm-dd")
& "T00:00:00]"

'set the filter
ActiveWorkbook.SlicerCaches("Slicer_Date").VisibleSlicerItemsList =
Array(LatestDay)

'send email for closing month
sendcomplexemailattachmentmonthclosing

'reset datefilters
'Create the correct string for the filters
LatestDay = "[date].[Date].&[" & WorksheetFunction.Text(Worksheets("Daily
Report").Range("C1").Value, "yyyy-mm-dd") & "T00:00:00]"

'reset filter to correct date
ActiveWorkbook.SlicerCaches("Slicer_Date").VisibleSlicerItemsList =
Array(LatestDay)

End Sub
```

```
Sub archivedate()
```

```
Dim pathstr As String
Dim monthnm As String
Dim optimus As String
Dim mnth As String

pathstr = ActiveWorkbook.path
monthnm = monthname(month(Date) - 2)
optimus = ActiveWorkbook.Name
mnth = "[date].[Month].&[" & month(Date) - 2 & "]"

    Sheets("CutsTable").Select
    ActiveWorkbook.SlicerCaches("Slicer_Month").VisibleSlicerItemsList =
Array( _
        mnth)
    ActiveWorkbook.SlicerCaches("Slicer_Fiscal_Year").VisibleSlicerItemsList
= _
        Array( _
        "[date].[Fiscal Year].&[1516]")

'copy the cuts
Workbooks(optimus).Worksheets("CutsTable").Cells.Copy

'Create a new Excel workbook
Dim NewCaseFile As Workbook
Dim strFileName As String

Set NewCaseFile = Workbooks.Add
With NewCaseFile
    Sheets(1).Select
    Cells(1, 1).Select
End With

Selection.PasteSpecial xlPasteValues

'copy the orders
Workbooks(optimus).Worksheets("OrdersTable").Cells.Copy

NewCaseFile.Worksheets.Add
NewCaseFile.Sheets(1).Cells(1, 1).Select

Selection.PasteSpecial xlPasteValues

NewCaseFile.SaveAs pathstr & "\Archive\" & monthnm & ".xlsx"

End Sub
```

```
Sub MoveDataToAccess(table As String)
'Using ADO to Export data from Excel worksheet (your host application) to an
Access Database Table.

'To use ADO in your VBA project, you must add a reference to the ADO Object
Library in Excel (your host application) by clicking Tools-References in VBE,
and then choose an appropriate version of Microsoft ActiveX Data Objects x.x
Library from the list.

'--------------
'DIM STATEMENTS
```

```
Dim strMyPath As String, strDBName As String, strDB As String, strSQL As
String
Dim i As Long, n As Long, lastRow As Long, lFieldCount As Long
Dim maxdate, deleteday As Date
Dim n0, n1, n2, n3, n4, n5, n6, n7, n8, n9 As Variant

'instantiate an ADO object using Dim with the New keyword:
Dim adoRecSet As New ADODB.Recordset
Dim connDB As New ADODB.Connection

'--------------
'THE CONNECTION OBJECT

strDB = "c:\OptimusPrime Database\OptimusPrime-DB.accdb"

'Connect to a data source:
'For pre - MS Access 2007, .mdb files (viz. MS Access 97 up to MS Access
2003), use the Jet provider: "Microsoft.Jet.OLEDB.4.0". For Access 2007
(.accdb database) use the ACE Provider: "Microsoft.ACE.OLEDB.12.0". The ACE
Provider can be used for both the Access .mdb & .accdb files.
connDB.Open ConnectionString:="Provider = Microsoft.ACE.OLEDB.12.0; data
source=" & strDB

If Day(Date) = 1 Then
    deleteday = DateSerial(Year(Date - 1), month(Date - 1), 0)
Else
    deleteday = DateSerial(Year(Date), month(Date), 0)
End If

'delete records in the SalesManager Table:
strSQL = "DELETE FROM " & table & " WHERE day = #" & deleteday & "#"
connDB.Execute CommandText:=strSQL


'--------------
'OPEN RECORDSET, ACCESS RECORDS AND FIELDS

Dim ws As Worksheet
'set the worksheet:
Set ws = ActiveWorkbook.Sheets("Sheet1")

'Set the ADO Recordset object:
Set adoRecSet = New ADODB.Recordset

'Opening the table
strTable = table
adoRecSet.Open Source:=strTable, ActiveConnection:=connDB,
CursorType:=adOpenStatic, LockType:=adLockOptimistic

'--------------
'COPY RECORDS FROM THE EXCEL WORKSHEET:
'Note: Columns and their order should be the same in both Excel worksheet and
in Access database table


lFieldCount = adoRecSet.Fields.count
'determine last data row in the worksheet:
lastRow = ws.Cells(Rows.count, "A").End(xlUp).Row
```

```
'If the date is before the latest update date exit the sub(check only once to
save time)
'strSQL = "SELECT COUNT(day) AS count FROM " & table & " WHERE day = #" &
mylookvalue & "#"



    If table = "AccessCuts" Then

        'start copying from second row of worksheet, first row contains field
names:
        For i = 2 To lastRow


            adoRecSet.AddNew
                For n = 0 To lFieldCount - 1

                    If ws.Cells(i, n + 1).Value = "" Then
                        Select Case n
                            Case 0
                                adoRecSet.Fields(n).Value = n0
                            Case 1
                                adoRecSet.Fields(n).Value = n1
                            Case 2
                                adoRecSet.Fields(n).Value = n2
                            Case 3
                                adoRecSet.Fields(n).Value = n3
                            Case 4
                                adoRecSet.Fields(n).Value = n4
                            Case 5
                                adoRecSet.Fields(n).Value = n5
                            Case 6
                                adoRecSet.Fields(n).Value = n6
                            Case 7
                                adoRecSet.Fields(n).Value = n7
                            Case 8
                                adoRecSet.Fields(n).Value = n8
                        End Select
                    Else

                        adoRecSet.Fields(n).Value = ws.Cells(i, n + 1).Value
                        Select Case n
                            Case 0
                               n0 = ws.Cells(i, n + 1).Value
                            Case 1
                               n1 = ws.Cells(i, n + 1).Value
                            Case 2
                               n2 = ws.Cells(i, n + 1).Value
                            Case 3
                               n3 = ws.Cells(i, n + 1).Value
                            Case 4
                               n4 = ws.Cells(i, n + 1).Value
                            Case 5
                               n5 = ws.Cells(i, n + 1).Value
                            Case 6
                               n6 = ws.Cells(i, n + 1).Value
                            Case 7
```

```
                                n7 = ws.Cells(i, n + 1).Value
                            Case 8
                                n8 = ws.Cells(i, n + 1).Value
                        End Select
                    End If
                Next n
            adoRecSet.Update
        Next i

    ElseIf table = "AccessOrders" Then

        'start copying from second row of worksheet, first row contains field
names:
        For i = 2 To lastRow


            adoRecSet.AddNew
                For n = 0 To lFieldCount - 1

                    If ws.Cells(i, n + 1).Value = "" Then
                        Select Case n
                            Case 0
                                adoRecSet.Fields(n).Value = n0
                            Case 1
                                adoRecSet.Fields(n).Value = n1
                            Case 2
                                adoRecSet.Fields(n).Value = n2
                            Case 3
                                adoRecSet.Fields(n).Value = n3
                            Case 4
                                adoRecSet.Fields(n).Value = n4
                            Case 5
                                adoRecSet.Fields(n).Value = n5
                            Case 6
                                adoRecSet.Fields(n).Value = n6
                            Case 7
                                adoRecSet.Fields(n).Value = n7
                        End Select
                    Else

                        adoRecSet.Fields(n).Value = ws.Cells(i, n + 1).Value
                        Select Case n
                            Case 0
                                n0 = ws.Cells(i, n + 1).Value
                            Case 1
                                n1 = ws.Cells(i, n + 1).Value
                            Case 2
                                n2 = ws.Cells(i, n + 1).Value
                            Case 3
                                n3 = ws.Cells(i, n + 1).Value
                            Case 4
                                n4 = ws.Cells(i, n + 1).Value
                            Case 5
                                n5 = ws.Cells(i, n + 1).Value
                            Case 6
                                n6 = ws.Cells(i, n + 1).Value
                            Case 7
                                n7 = ws.Cells(i, n + 1).Value
```

```
                    End Select
                End If
            Next n
        adoRecSet.Update
    Next i
End If



'--------------

'close the objects
adoRecSet.Close
connDB.Close

'destroy the variables
Set adoRecSet = Nothing
Set connDB = Nothing

End Sub
```

```
Sub AggregateMonths()
'Using ADO to Export data from Excel worksheet (your host application) to an
Access Database Table.

'To use ADO in your VBA project, you must add a reference to the ADO Object
Library in Excel (your host application) by clicking Tools-References in VBE,
and then choose an appropriate version of Microsoft ActiveX Data Objects x.x
Library from the list.

'--------------
'DIM STATEMENTS

Dim strMyPath As String, strDBName As String, strDB As String, strSQL As
String
Dim i As Long, n As Long, lastRow As Long, lFieldCount As Long
Dim maxdate, deletedaystart, deletedayend As Date
Dim n0, n1, n2, n3, n4, n5, n6, n7, n8, n9 As Variant

'instantiate an ADO object using Dim with the New keyword:
Dim adoRecSet As New ADODB.Recordset
Dim connDB As New ADODB.Connection

'--------------
'THE CONNECTION OBJECT

strDB = "c:\OptimusPrime Database\OptimusPrime-DB.accdb"

'Connect to a data source:
'For pre - MS Access 2007, .mdb files (viz. MS Access 97 up to MS Access
2003), use the Jet provider: "Microsoft.Jet.OLEDB.4.0". For Access 2007
(.accdb database) use the ACE Provider: "Microsoft.ACE.OLEDB.12.0". The ACE
Provider can be used for both the Access .mdb & .accdb files.
connDB.Open ConnectionString:="Provider = Microsoft.ACE.OLEDB.12.0; data
source=" & strDB
```

```
deletedayend = DateSerial(Year(Date), month(Date) - 1, -1)
deletedaystart = DateSerial(Year(Date), month(Date) - 2, 1)

'delete records in the cuts Table:
strSQL = "DELETE FROM AccessCuts WHERE day >= #" & deletedaystart & "# AND
day <= #" & deletedayend & "#"
connDB.Execute CommandText:=strSQL

'delete records in the orders Table:
strSQL = "DELETE FROM AccessOrders WHERE day >= #" & deletedaystart & "# AND
day <= #" & deletedayend & "#"
connDB.Execute CommandText:=strSQL


connDB.Close

'destroy the variables
Set adoRecSet = Nothing
Set connDB = Nothing

End Sub
```

```
Sub sendcomplexemailattachment()
'macro to create the mail
Dim MyText As String

Windows("OptimusPrime - CFR REPORT " & Format(Now, "DD-MMM") &
".xlsm").Activate
Sheets("Daily Report").Activate


     Dim olApp As Object 'Outlook.Application
     Dim olEmail As Object 'Outlook.MailItem
     Dim olInsp As Object 'Outlook.Inspector
     Dim olAttachments As Object 'Outlook.Attachments
     Dim wddoc As Object 'Word.Document
     Dim wdRng As Object 'Word.Range
     Dim strAddressees As String
     Dim r As Range

     On Error Resume Next
     Set olApp = GetObject(, "outlook.application")
     If Err <> 0 Then Set olApp = CreateObject("outlook.application")
     On Error GoTo 0
     Set olEmail = olApp.CreateItem(0)
     Set olAttachments = olEmail.Attachments

     For Each r In Sheets("Distribution List").Range("c2:C1000")
        If Len(strAddressees) = 0 Then
         strAddressees = r
        Else
         strAddressees = strAddressees & "; " & r
      End If
     Next

     With olEmail
         .BodyFormat = 3
         Set olInsp = .GetInspector
```

```
        Set wddoc = olInsp.WordEditor
        .display

        .To = strAddressees
        .Subject = "EUROPE/IMEA CFR DAILY REPORT" & " - " & Format(Date, "
dd.mm.yy")

        'Insert the sections
        Set wdRng = wddoc.Sections(1).Range
        wddoc.Sections.Add Range:=wdRng
        wddoc.Sections.Add Range:=wdRng
        wddoc.Sections.Add Range:=wdRng
        wddoc.Sections.Add Range:=wdRng
        wddoc.Sections.Add Range:=wdRng
        wddoc.Sections.Add Range:=wdRng
        wddoc.Sections.Add Range:=wdRng
        wddoc.Sections.Add Range:=wdRng
        wddoc.Sections.Add Range:=wdRng
        wddoc.Sections.Add Range:=wdRng
        wddoc.Sections.Add Range:=wdRng

        'first section
        wddoc.Sections(1).Range.Text = "Good Morning All," & vbNewLine &
vbNewLine & "Please see below latest CFR results." & vbNewLine & vbNewLine

        'second section
        Windows("OptimusPrime - CFR REPORT " & Format(Now, "DD-MMM") &
".xlsm").Activate
        Sheets("Daily Report").Range("B2:O10").Copy
        wddoc.Sections(2).Range.Paste

        'Third Section
        Windows("OptimusPrime - CFR REPORT " & Format(Now, "DD-MMM") &
".xlsm").Activate
        Sheets("Daily Report").Range("B12:T88").Copy
        wddoc.Sections(3).Range.Paste

        'Fourth Section
        Windows("OptimusPrime - CFR REPORT " & Format(Now, "DD-MMM") &
".xlsm").Activate
        Sheets("Daily Report").Range("B11:O11").Copy
        wddoc.Sections(4).Range.Paste

        'Fifth section
        wddoc.Sections(5).Range.Text = "The full report including a deepdive
analysis (Excel 2013 required) can be found following the hyperlink."

        wddoc.Hyperlinks.Add Anchor:=wddoc.Sections(6).Range,
Address:="http://dcsp.pg.com/bu/PSCGlobal/PSC_Europe_TC/Document%20Library/EU
%20Categories/Hair%20Care/Category-CFR/1.%20CFR%20report/OptimusPrime%20-
%20CFR%20REPORT " & Format(Now, "DD-MMM") & ".xlsm",
TextToDisplay:="http://dcsp.pg.com/bu/PSCGlobal/PSC_Europe_TC/Document%20Libr
ary/EU%20Categories/Hair%20Care/Category-
CFR/1.%20CFR%20report/OptimusPrime%20-%20CFR%20REPORT " & Format(Now, "DD-
MMM") & ".xlsm"

        .display
    End With
```

```
 End Sub
```

```
 Sub sendcomplexemailattachmentmonthclosing()
'macro to create the mail
Dim MyText As String
Dim optimus As String

optimus = ActiveWindow.Caption

Windows(optimus).Activate
Sheets("Daily Report").Activate

     Dim olApp As Object 'Outlook.Application
     Dim olEmail As Object 'Outlook.MailItem
     Dim olInsp As Object 'Outlook.Inspector
     Dim olAttachments As Object 'Outlook.Attachments
     Dim wddoc As Object 'Word.Document
     Dim wdRng As Object 'Word.Range
     Dim strAddressees As String
     Dim r As Range

     On Error Resume Next
     Set olApp = GetObject(, "outlook.application")
     If Err <> 0 Then Set olApp = CreateObject("outlook.application")
     On Error GoTo 0
     Set olEmail = olApp.CreateItem(0)
     Set olAttachments = olEmail.Attachments

     For Each r In Sheets("Distribution List").Range("c2:C1000")
        If Len(strAddressees) = 0 Then
         strAddressees = r
        Else
         strAddressees = strAddressees & "; " & r
      End If
     Next

     With olEmail
         .BodyFormat = 3
         Set olInsp = .GetInspector
         Set wddoc = olInsp.WordEditor
         .display

         .To = strAddressees
         .Subject = "EUROPE/IMEA - " & Format(DateSerial(Year(Date),
month(Date), 0), " mmm'yy") & " Month closing results"

         'Insert the sections
         Set wdRng = wddoc.Sections(1).Range
         wddoc.Sections.Add Range:=wdRng
         wddoc.Sections.Add Range:=wdRng
         wddoc.Sections.Add Range:=wdRng
         wddoc.Sections.Add Range:=wdRng
         wddoc.Sections.Add Range:=wdRng
         wddoc.Sections.Add Range:=wdRng
         wddoc.Sections.Add Range:=wdRng
         wddoc.Sections.Add Range:=wdRng
         wddoc.Sections.Add Range:=wdRng
         wddoc.Sections.Add Range:=wdRng
```

```
        wddoc.Sections.Add Range:=wdRng

        'first section
        wddoc.Sections(1).Range.Text = "Good Morning All," & vbNewLine &
vbNewLine & "Please see below latest CFR results." & vbNewLine & vbNewLine

        'second section
        Windows(optimus).Activate
        Sheets("Daily Report").Range("B12:O39").Copy
        wddoc.Sections(2).Range.Paste

        ' hide columns daily FYTD
        columns("C:E").EntireColumn.Hidden = True
        columns("I:K").EntireColumn.Hidden = True

        'Third Section
        Windows(optimus).Activate
        Sheets("Daily Report").Range("B71:L85").Copy
        wddoc.Sections(3).Range.Paste

        'Fourth Section
        Windows(optimus).Activate
        Sheets("Daily Report").Range("B105:L112").Copy
        wddoc.Sections(4).Range.Paste

        ' unhide columns daily FYTD
        columns("C:E").EntireColumn.Hidden = False
        columns("I:K").EntireColumn.Hidden = False

        ' hide columns daily FYTD
        columns("C:D").EntireColumn.Hidden = True
        columns("G:H").EntireColumn.Hidden = True

        'Fifth Section
        Windows(optimus).Activate
        Sheets("Daily Report").Range("B148:I157").Copy
        wddoc.Sections(5).Range.Paste

        ' unhide columns daily FYTD
        columns("C:D").EntireColumn.Hidden = False
        columns("G:H").EntireColumn.Hidden = False



        'Sixth section
        wddoc.Hyperlinks.Add Anchor:=wddoc.Sections(6).Range,
Address:="http://dcsp.pg.com/bu/PSCGlobal/PSC_Europe_TC/Document%20Library/EU
%20Categories/Hair%20Care/Category-CFR/1.%20CFR%20report/OptimusPrime%20-
%20CFR%20REPORT " & Format(Now, "DD-MMM") & ".xlsm",
TextToDisplay:="http://dcsp.pg.com/bu/PSCGlobal/PSC_Europe_TC/Document%20Libr
ary/EU%20Categories/Hair%20Care/Category-
CFR/1.%20CFR%20report/OptimusPrime%20-%20CFR%20REPORT " & Format(Now, "DD-
MMM") & ".xlsm"
        wddoc.Sections(7).Range.Text = vbNewLine & "Please feel free to use
file above to run any deep dive analysis  for your supply chain. The file is
self-explanatory for help just use 'How to use' tab." & vbNewLine & vbNewLine
& _
```

```
        "Thank you very much for your help in advance and continuous
feedback on how our CFR reports can be improved." & vbNewLine & vbNewLine & _
        "Have a nice day."


        .display
    End With
End Sub
```

```
 Sub sendDDS()
     ' Send Email '
     Dim olApp As Object 'Outlook.Application
     Dim olEmail As Object 'Outlook.MailItem
     Dim olInsp As Object 'Outlook.Inspector
     Dim olAttachments As Object 'Outlook.Attachments
     Dim wddoc As Object 'Word.Document
     Dim wdRng As Object 'Word.Range

     On Error Resume Next
     Set olApp = GetObject(, "outlook.application")
     If Err <> 0 Then Set olApp = CreateObject("outlook.application")
     On Error GoTo 0
     Set olEmail = olApp.CreateItem(0)
     Set olAttachments = olEmail.Attachments

     With olEmail
         .BodyFormat = 3
         Set olInsp = .GetInspector
         Set wddoc = olInsp.WordEditor

         .To = "ddsinsights.im@pg.com"
         .Subject = "DDS Data Upload"

            Application.DisplayAlerts = False

            olAttachments.Add "C:\OptimusPrime Database\Digital DDS Upload "
& Day(Date) & " " & month(Date) & " " & Year(Date) & ".xlsx"

            Application.DisplayAlerts = True

          .send

    End With

    ApplicationScreen = True

End Sub
```

Code for control chart calculation

```
Function Reset() As Boolean

Reset = False

    ActiveWorkbook.SlicerCaches("Slicer_Control_P").ClearManualFilter
    If Application.WorksheetFunction.Sum(Worksheets("Analysis").Range("B:B"))
> 0 Then
        Reset = True
        'resets analysis calculation
        Worksheets("Analysis").Calculate
        Worksheets("(Re)set Target").Calculate
        DoEvents
        'updates the days table
        Worksheets("dates").Calculate
        DoEvents
        ActiveWorkbook.Model.ModelTables("cfr").Refresh
        'refresh slicer cache

ActiveWorkbook.SlicerCaches("Slicer_Control_P").WorkbookConnection.Refresh
        DoEvents
    End If

End Function
```

```
Sub start()
UserForm1.Show
End Sub
```

```
Sub RunEurope()
Dim i, j, maxk, k As Integer
Dim sC1, sC2 As SlicerCache
Dim SL1, SL2 As SlicerCacheLevel
Dim sI1, sI2 As SlicerItem
Dim pctCompl As Single


If MsgBox("This will erase current targets and recalculate everything, Are
you sure?", vbYesNo) = vbNo Then Exit Sub

starttime = Timer
Application.ScreenUpdating = False
Application.EnableEvents = False

'Set sC2 = ActiveWorkbook.SlicerCaches("Slicer_Cluster")
'Set SL2 = sC2.SlicerCacheLevels(1)

i = 3
''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''
'ITERATE OVER ROOT CAUSES INCLUDING "ALL RC"
''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''''


    Set sC1 = ActiveWorkbook.SlicerCaches("Slicer_Level_2")
    Set SL1 = sC1.SlicerCacheLevels(1)

    'progress bar
    maxk = SL1.SlicerItems.Count
    k = 1
```

```
    'for each root cause
    For Each sI1 In SL1.SlicerItems

        sC1.VisibleSlicerItemsList = Array(sI1.Name)

        ' One iteration will always be done to remove OOC data
         If Reset = True Then

            'remove the OOC first time
            On Error Resume Next
            Worksheets("Analysis").PivotTables("PivotTable1").PivotFields( _
              "[cfr].[Control P].[Control P]").VisibleItemsList = Array( _
              "[cfr].[Control P].&[True]")

                'calculate new control limits
                    Worksheets("Analysis").Calculate
                    Worksheets("(Re)set Target").Calculate
                    DoEvents


            'After the first iteration we check what percentage of the tops
is OOC, if < X then iterate
            If (Worksheets("Analysis").Range("K1").Value <
Worksheets("(Re)set Target").Range("O1").Value) And _
                (Worksheets("Analysis").Range("K1").Value > 0) Then

                'updates the days that are OOC
                    Worksheets("dates").Calculate
                'removes the new OOC
                    ActiveWorkbook.Model.ModelTables("cfr").Refresh
                'calculate new parameters
                    Worksheets("Analysis").Calculate
                    Worksheets("(Re)set Target").Calculate
            End If

            'set results EUR
            Worksheets("results EUR").Cells(i, 2).Value = "Europe"
            Worksheets("results EUR").Cells(i, 3).Value = sI1.Value
            'RmeanPrime
            Worksheets("results EUR").Cells(i, 4).Value =
Worksheets("Analysis").Range("F1").Value
            'SigmaZ
            Worksheets("results EUR").Cells(i, 5).Value =
            Worksheets("Analysis").Range("F2").Value
            'Pmean
            Worksheets("results EUR").Cells(i, 6).Value =
            Worksheets("Analysis").Range("F3").Value
         Else
            'set results EUR to zero
            Worksheets("results EUR").Cells(i, 2).Value = "Europe"
            Worksheets("results EUR").Cells(i, 3).Value = sI1.Value
            'UCL3
            Worksheets("results EUR").Cells(i, 4).Value = 0
            'UCL2
            Worksheets("results EUR").Cells(i, 5).Value = 0
            'CL
            Worksheets("results EUR").Cells(i, 6).Value = 0
```

```
            End If
         i = i + 1

        'progress bar
        pctCompl = Round((100 / maxk) * k, 0)
        k = k + 1
        progress pctCompl

      Next 'next root cause


  'set info
  setdate

Worksheets("results EUR").PivotTables("PivotTable2").PivotCache.Refresh
Calculate

Application.EnableEvents = True
Application.ScreenUpdating = True
Application.DisplayAlerts = False
ActiveWorkbook.Save
Application.DisplayAlerts = True
endtime = Timer
MsgBox "total time:" & Round((endtime - starttime) / 60, 1) & " minutes"


End Sub
```

Code for results export to update monthly process

```
Sub openworkbook(cluster As String)
Dim folder, filestring As String

If Check_If_Workbook_Open("Root cause Benchmark - " & cluster & ".xlsm") Then
Else
    folder = ActiveWorkbook.Path
    Workbooks.Open (folder & "\results\Root cause Benchmark - " & cluster &
".xlsm")
End If

Workbooks("Root cause Benchmark - " & cluster & ".xlsm").Activate
Worksheets("Data").Visible = True

End Sub
```

```
Function Check_If_Workbook_Open(Name As String) As Boolean
Dim wbk As Workbook

Check_If_Workbook_Open = False

For Each wbk In Workbooks

    If wbk.Name = Name Then
        Check_If_Workbook_Open = True
    End If
Next

End Function
```

```
Sub closeworkbook(cluster As String)
Dim folder, filestring As String


    folder = ActiveWorkbook.Path
    Workbooks(cluster).Activate
    Worksheets("Performance").Calculate
    Worksheets("Data").Visible = False
    ActiveWorkbook.Save
    ActiveWorkbook.Close


End Sub
```

```
Sub exportclusterresults()
Dim rng As Range
Dim i, SaveCol As Integer
Dim cluster As String
Dim month As String
Dim pth As String

Application.ScreenUpdating = False

Windows("European Benchmark Standards - CFR-lvl2.xlsm").Activate
pth = ActiveWorkbook.FullName


Set rng = Worksheets("Europe Benchmark").Range("C27:I55")
```

```
month = Application.WorksheetFunction.Max(Worksheets("OOC check
EUR").Range("1:1"))

'loop over all clusters
For i = 0 To rng.Columns.Count - 1


    'set current cluster to copy
    Windows("European Benchmark Standards - CFR-lvl2.xlsm").Activate
    cluster = Worksheets("Europe Benchmark").Range("C27").Offset(0, i).Value

    openworkbook (cluster)
    Debug.Print cluster
    cluster = "Root cause Benchmark - " & cluster & ".xlsm"

    'ownership impact
    Windows("European Benchmark Standards - CFR-lvl2.xlsm").Activate
    Worksheets("Europe Benchmark").Activate
    Range(Cells(27, 3 + i), Cells(55, 3 + i)).Select
    Selection.Copy
        Workbooks(cluster).Activate
        Worksheets("Data").Activate
            SaveCol = Cells(4, Columns.Count).End(xlToLeft).Column + 1

    Cells(1, SaveCol).Select
    Selection.PasteSpecial Paste:=xlPasteAllUsingSourceTheme,
Operation:=xlNone _
        , SkipBlanks:=False, Transpose:=False
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False
    Cells(1, SaveCol) = month
    Cells(1, SaveCol).NumberFormat = "YYY-MM"

    'impact on smo cfr
    Windows("European Benchmark Standards - CFR-lvl2.xlsm").Activate
    Worksheets("Europe Benchmark").Activate
    Range(Cells(27, 13 + i), Cells(55, 13 + i)).Select
    Application.CutCopyMode = False
    Selection.Copy
        Workbooks(cluster).Activate
        Worksheets("Data").Activate
    Cells(30, SaveCol).Select
    Selection.PasteSpecial Paste:=xlPasteAllUsingSourceTheme,
Operation:=xlNone _
        , SkipBlanks:=False, Transpose:=False
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False
    Cells(30, SaveCol) = month
    Cells(30, SaveCol).NumberFormat = "YYY-MM"

    'days OOC
    Windows("European Benchmark Standards - CFR-lvl2.xlsm").Activate
    Worksheets("Europe Benchmark").Activate
        Range(Cells(57, 3 + i), Cells(83, 3 + i)).Select
    Application.CutCopyMode = False
    Selection.Copy
```

```
        Workbooks(cluster).Activate
        Worksheets("Data").Activate
    Cells(59, SaveCol).Select
    Selection.PasteSpecial Paste:=xlPasteAllUsingSourceTheme,
Operation:=xlNone _
        , SkipBlanks:=False, Transpose:=False
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False
    Cells(59, SaveCol) = month
    Cells(59, SaveCol).NumberFormat = "YYY-MM"

    'cfr target
    Windows("European Benchmark Standards - CFR-lvl2.xlsm").Activate
    Worksheets("Europe Benchmark").Activate
    Range(Cells(57, 13 + i), Cells(85, 13 + i)).Select
    Application.CutCopyMode = False
    Selection.Copy
        Workbooks(cluster).Activate
        Worksheets("Data").Activate
    Cells(86, SaveCol).Select
    Selection.PasteSpecial Paste:=xlPasteAllUsingSourceTheme,
Operation:=xlNone _
        , SkipBlanks:=False, Transpose:=False
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone,
SkipBlanks _
        :=False, Transpose:=False
    Cells(86, SaveCol) = month
    Cells(86, SaveCol).NumberFormat = "YYY-MM"

    ''''''''''''''''''''''''''''''''''''''''
    '       Insert cuts overview           '
    ''''''''''''''''''''''''''''''''''''''''

    Windows(cluster).Activate

    'delete old model in sheet
    On Error Resume Next
    Application.DisplayAlerts = False
    Sheets("Cuts Overview").Delete
    Application.DisplayAlerts = True
    removeconnections
    On Error GoTo 0

    'add new datamodel
    Windows("European Benchmark Standards - CFR-lvl2.xlsm").Activate
    Sheets("Cuts Overview").Select
    Workbooks(cluster).Connections.Add2 "LinkedTable_matrix3", "", _
        "WORKSHEET;" & pth _
        , "European Benchmark Standards - CFR-lvl2.xlsm!matrix", 7, True,
False
    Workbooks(cluster).Connections.Add2 "LinkedTable_Cuts3", "", _
        "WORKSHEET;" & pth _
        , "European Benchmark Standards - CFR-lvl2.xlsm!Cuts", 7, True, False
    Workbooks(cluster).Connections.Add2 "LinkedTable_Table33", "", _
        "WORKSHEET;" & pth _
        , "European Benchmark Standards - CFR-lvl2.xlsm!Table3", 7, True,
False
```

```
    Workbooks(cluster).Connections.Add2 _
        "LinkedTable_GeographyMatrix3", "", _
        "WORKSHEET;" & pth _
        , "European Benchmark Standards - CFR-lvl2.xlsm!GeographyMatrix", 7,
True, False
    Workbooks(cluster).Connections.Add2 "LinkedTable_DateCFR3", "", _
        "WORKSHEET;" & pth _
        , "European Benchmark Standards - CFR-lvl2.xlsm!DateCFR", 7, True,
False
    Sheets("Cuts Overview").Copy After:=Workbooks(cluster).Sheets( _
        3)

    'refresh cluster datamodel
    Workbooks(cluster).Activate
    ActiveWorkbook.Model.Refresh
    'reconnect slicers
    Dim oSlicer As Slicer
    Dim oSlicercache As SlicerCache

    For Each oSlicercache In ActiveWorkbook.SlicerCaches
        For Each oSlicer In oSlicercache.Slicers
            oSlicer.SlicerCache.PivotTables.AddPivotTable (Sheets("Cuts
Overview").PivotTables("PivotTable1"))
        Next
    Next

    closeworkbook (cluster)

Next

Application.ScreenUpdating = True

End Sub
```

```
Sub removeconnections()
Dim xConnect As Object

For Each xConnect In ActiveWorkbook.Connections
    If xConnect.Name <> "ThisWorkbookDataModel" Then xConnect.Delete
Next xConnect

End Sub
```

```
Sub setdate()
 Dim firstday As Date
 Dim lastday As Date
 ActiveWorkbook.SlicerCaches("Slicer_Level_2").ClearManualFilter
 ActiveWorkbook.SlicerCaches("Slicer_Control_P").ClearManualFilter

 firstday =
Application.WorksheetFunction.Min(Worksheets("Analysis").Range("A:A"))
 lastday =
Application.WorksheetFunction.Max(Worksheets("Analysis").Range("A:A"))

 Worksheets("Europe Benchmark").Range("K1") = "Targets are calculated based
on data from: " & vbNewLine & firstday & " Till " & lastday

End Sub
```

```
Sub progress(pctCompl As Single)

UserForm1.Text.Caption = pctCompl & "% Completed"
UserForm1.Bar.Width = pctCompl * 2

DoEvents

End Sub
```