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DELIVERY OF CUSTOMIZED PRODUCT

– Case of Microsoft phone SKU

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DELIVERY OF CUSTOMIZED PRODUCT – case of Microsoft phone SKU

This thesis discusses a previously unstudied timeline between two very well known processes: creating the customized product SKU and delivering the goods for the first time. Understanding and analyzing this timeline is an important step in Microsoft Mobile vision for fast delivery of the customized product in premium service level. Utilizing qualitative case study and Six Sigma methodologies, the process is mapped and the key points of interest are identified. The starting point for measurements is identified as well as the logical finishing point to create a lead time that can be then analyzed further.

Analyzing is done by comparing how the lead time varies e.g. between different products, customers and production situations. Original hypotheses for the measureable part are confirmed or dismissed. The customer requested delivery date is also added as a measureable and compareable information.

By cross referencing the process performance lead time and the customer requested lead time, large similarities were found. This led to analyzing further the internal guidelines on order entry by the method of group interview.

The study did not lead to a new key measurement to be included in the scorecards but it shed light into an unknown timeline that is an important part for delivering the premium service level vision. It points out that internal guidelines on order entry should be the focus area when driving the lead time down towards the needs of the premium service level vision.

KEYWORDS:

SKU, GID, Six Sigma, Order, Delivery, Supply Chain, Variant, Product Management, Customization.

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Kustomoidun tuotteen toimitus – Tapaustutkimus Microsoft-puhelimien tuotevarianteista

Tässä opinnäytetyössä tutkitaan kahden hyvin tunnetun prosessin, kustomoidun tuotevariantin luonti- sekä variantin tehdastoimitusprosessin, aikaväliä ensimmäistä kertaa. Aikavälin tutkiminen on tärkeä askel kohti Microsoft Mobilen visiota toimittaa premium-palvelutasolla kustomoitu tuotevariantti aiempaa nopeammin asiakkaalle. Kvalitatiivisen tapaustutkimuksen- ja Six Sigman metodologioita hyväksikäyttäen prosessi kartoitetaan ja siitä nostetaan esiin tärkeimmät aktiviteetit. Luodun aikavälin alku- sekä loppuhetki määritellään ja niitä hyväksikäyttäen tehdään aineistolle läpimenoajan mittaristo, jota analysoidaan tarkemmin.

Analysointosuudessa saatuja läpimenoaikoja vertaillaan eri tuotteiden, asiakkaiden ja tuotannollisten tilanteiden kesken. Mitattujen tulosten hypoteesit vahvistetaan tai hylätään. Tutkimuksen edistyessä asiakkaan vaatima toimituspäivä nousee avaintiedoksi tuotevariantin valmistumisen, sekä toimituksen lähettämispäivämäärän lisäksi.

Luodun läpimenoaikamittariston prosessin kyvykkyyden ja asiakkaan vaatiman toimituspäivän vertaaminen osoitti suuria samankaltaisuuksia. Tämä johti MMO:n sisäisten toimintatapojen ja säännöstöjen tarkempaan analysointiin ryhmähaastattelun avulla.

Tutkimus ei lopulta johtanut uuden avainmittarin luomiseen MMO:lle, mutta se toi lisää tietoa ja ymmärrystä aiemmin tutkimattomasta aikavälistä, joka on tärkeä osa hallita osana premium-palvelutason vision toteuttamisesta. Yhdistämällä faktoja mitatusta aineistosta ja ryhmähaastatteluista, tutkimuksen avulla voidaan osoittaa alueet joita kehittämällä parannus läpimenoaikoihin on mahdollista.

HAKUSANAT:

SKU, GID, Six Sigma, Tilaus, Toimitus, Supply Chain, Variantti, tuotekehitys, kustomointi.

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LIST OF ABBREVIATIONS AND TERMINOLOGY

07/MDC 07 = State in Mobile Device Configurator indicating that an SKU is orderable.

Allocation = supply constraint situation in production.

Box plot = Standardized diagram displaying the distribution of the data, including measures for example for mean.

DMAIC = Define, measure, analyze, improve, control. The Six Sigma order of steps to take to proceed with the project.

FVT = Factory variant team. The team at the factory that takes the new customized product SKU in use and handles factory orders.

GI/GID = Goods issue date. When the goods leave the factory.

KPI = Key performance indicator.

LT = lead time for certain process or activity.

MDC = Mobile Device Configurator, a tool tracking customized product variants stock keeping unit creation statuses with numbers from 0 to 7.

Minitab = Statistical analysis tool used in the study.

MMO = Microsoft Mobile Ltd.

NOL = Front end ordering tool for customers.

POD = Proof of delivery. The date the goods are received at the customers end.

SAP = Software company. In this thesis SAP refers to production management tool

SIPOC = Suppliers, Inputs, Processes, Outputs, Customers. Six Sigma tool

SKU = Stock keeping unit. Identificator for the customized product and also identification that is used to take in orders

SU, LSU = Sales Unit consists of several local sales units, which include few local sales units, that in turn have several countries and customers in their responsibility area

SW = Software version running inside the customized product.

1 INTRODUCTION

Microsoft Mobile Ltd had a vision that for premium service level, the lead time promise for the customers would be X days to create the customized product stock keeping unit (SKU) and Y days to deliver it from the factory. So total of X+Y days from the moment the customer has indicated the need for the first order by submitting request for the customized product SKU, until the actual time the goods are received by the customer. This study was conducted for MMO Ltd to understand better what happens between these two processes: SKU creation process and goods delivery process. These two processes have been documented, studied and continuously improved but the company hasn't before had data and analyzes on the time period between these two processes. Before any concrete actions to push down the lead time towards the vision of X+Y days for the premium service level are possible, MMO needed to first understand all previously hidden lead time elements and this study was the first step.

There were 3 goals for the study:

- For the first time to see measurements of the timeline between a customized SKU being orderable and when it actually leaves the factory floor with the first delivery. Later in this thesis, this measurement is referred as 07-GID. 07 refers to company internal indicator for the date that an SKU to be orderable and Goods Issue Date is the term for the date the goods are leaving the factory.
- Confirming or rejecting companies hypotheses about the biggest reasons for variation and long lead times
- Understanding the factors in the variation and reasons for the longest lead times.

First part of this study combines shortly the history of Six Sigma and MMO and points out the long relationship between Six Sigma methodologies and MMO and it's predecessor, Nokia devices group. The part is followed by an introduction to the known MMO processes, that are in timeline before and after the studied unknown process gap, with the help of Six Sigma tools.

Third chapter of the thesis defines and maps what are the process steps, inputs and outputs, that have an influence on this measured phase between customized product SKU being orderable and the first delivery of that SKU. It also explains some of the terms

used and combines Mircosoft Mobile Oy processes with what has been written in literature about Product Management and Supply Chain.

The fourth part focuses on the measuring and analyzing the results by Sig Sixma tools. It shows concrete data on what happens between customized product SKU readiness and the first production date and gives the verdict on the companies hypotheses about the reasons for high variation and long lead times for the measurement. After all the originally planned analyzes, there is an additional look into customer behaviour and internal guidelines coming from the factories to understand better some of the long lead times.

In conclusions, the study is wrapped up, improvement and control actions are suggested.

The thesis was done by using tools from the Six Sigma methodology and toolset. It was also the authors certified Six Sigma Green Belt work.

2 CUSTOMER SATISFACTION AND SIX SIGMA

2.1 Microsoft Mobile's goal for premium service level with the help of Six Sigma

Microsoft Mobile was known worldwide for a long time as Nokia devices unit. From that history comes a lot of learnings and knowledge starting from the birth of the mobile phone industry all the way until today. Six Sigma is roughly as old as first Nokia NMT technology car phones in the 1980s, so it is suitable that Nokia was one of the first large companies to embrace Six Sigma and it's learnings. This relationship has carried on all the way from mid 90s to this day. (Barone, Lo Franco 2012, 7-9; Nokia 2015. [Retrieved 28.11.2015]))

The MMO vision towards premium service level is focusing on greater customer satisfaction with the help of speed on delivering the customized product to the customer. That is achieved directly by shorter lead-times but also indirectly with the help of on-time delivery of the product, when the customer has indicated the need to receive it, low variation in the delivery lead-times and quality of the processes. Six Sigma part of the study offers tools to break down the process to find out the elements that are critical to customer, suggests ways to analyze the source data and find reasons for high variation, that causes long lead-times.

Reducing the lead-time and performing with low variance is one clear and concrete action to increase customer satisfaction. To reduce the lead-time, MMO must first study, analyze and optimize each part of the measured process. This was also seen as the first and most important goal for the study. It's also very logical – how to improve a process that you don't fully know or understand? (Shtub 1999, 51-52).

Carreira & Trudell (2006, 13-15) write about the basic needs of the customer: "on-time delivery, the best quality, and the lowest price". They also highlight measurability, especially from customers point of view. It's not enough for the customer that parts of the organization selling the goods/service have done their job on-time, if the last pieces are late. Customer sees only one lead-time and does not appreciate that even 90% of the delivery would be on time internally, if the final goods arrives late. This highlights the need to understand every piece of the process, as well as the whole big picture.

2.2 Six Sigmas first steps and use in MMO

While using Six Sigma methods and toolset for this kind of study might not be the obvious choice, the origins of Six Sigma are actually from a company that has history from the mobile phone industry, Motorola. In the mid 1980s the term Six Sigma was used by Motorola to to describe their problem solving methods to reduce failures and improve the manufacturing process. In the first years being developed further at Motorola, by Michael Harry and Bill Smith under the direction of Robert W. Galvin, Six Sigma approach was named after the measure, analyze, improve and control actions as MAIC.

First adoptions of Six Sigma were focused on manufacturing cost savings and productivity. Excited by Motorola's reported successes (13 billion dollars between 1987-1997) more large companies adopted Six Sigma. IBM and Texas Instruments launched their own Six Sigma programs and General Electric, with the lead of CEO Jack Welch embraced the idea so deeply that he made it mandatory for all the managers to be trained in Six Sigma at least on Green Belt –level, which is the level before Black Belt and Master Black Belt in certified Six Sigma hierarchy. At GE, the MAIC approach grew to DMAIC, with define part added to the standard Six Sigma approach. In this study, the DMAIC approach was also utilized.

Among the first wave of the big companies, also Nokia Mobile Phones and Microsoft adopted Six Sigma training and approach in the companies ways of working in the mid 90s. In Nokia and other companies, the Six Sigma methodology was combined with Lean Production to create Lean Six Sigma, that is still today used, of course constantly evolving and being developed further also in MMO. It's roots are also from manufacturing side but it has spread to several different organisations and industries. (Barone, Lo Franco 2012, 7-9)

Even though this study will dig into the middle ground between customized product creation and the manufacturing and order fulfillment processes, it's not exactly a typical Six Sigma manufacturing study, nor is it only about research and development nor sales. Pestorius, (2006, 5-9) in his book about Six Sigma for Sales and Marketing, writes well about "the myth that Six Sigma is only for operations". This myth is probably already in the year 2015 broken several times by producing results of what Six Sigma can do in other areas. Six Sigma DMAIC is a problem solving toolset that requires data to be analyzed and a customer. But it is suitable for various situations and needs.

2.3 Six Sigma use in other companies

On top of Motorola's huge cost saving in ten years, there are mentions and case studies written about successes in different types of companies with Six Sigma. Along with Motorola, the other company that has early on brough Six Sigma forward is General Electric. According to Desai (2010, 113-114) GE recorded 750 million savings in 98 that got double in 99 to 1,5 billion dollars and the expectations are set for further savings and improvements quartely in the operating margins. GE has also been a good example in showing that Six Sigma has brought positive results inside the company in areas that are not directly related to manufacturing, such as their GE Capital Mortgage and the Medical Systems businesses.

Nokia Networks as well as the mobile phone side has been active on using Lean Six Sigma in improving quality. Nokia Networks has worked together with the Finnish operator Elisa to hunt down problems networks caused by so called sleeping cells, that can cause even network failures. With Lean Six Sigma project the team led by Nokia Networks managed to identify the root cause for the issue, cut down significantly the amount of sleeping cell issues and improved the time to fix any potential issues that do come up. Nokia Networks estimated a 20 million euro direct savings within 2 years with the help of their Six Sigma projects. (Nokia 2014. [Retrieved 29.10.2015])

On top of the mentioned companies, that are mostly from technology background, there are Six Sigma success stories also from other industries. Soft drink company Dr. Pepper Snapple Group started their Six Sigma journey on 2006 with the help The University of Texas' training. What started with training for 6 people, was by July 2012 already reached impressive numbers. Just from April 2010 to July 2012 Dr. Pepper Snapple had recorded over 200 Six Sigma projects completed with combined over 100 million dollars financial impact. Their story had a simularity with Motorola: also at DPS a senior leader, in this case the Chief Financial Officer, was a key to push the excitement and commitment on Six Sigma through in the company through a dedicated program. (Texas Lean Six Sigma 2015. [Retrieved 28.11.2015])

3 MMO SKU VARIANT CREATION AND DELIVERY

3.1 Customized product SKU Variant Creation process

Stock keeping unit is a common term in supply chain literature and well explained by Shamin (2009, 173) as “a unique combination of all the components that are assembled into the purchaseable item”. That is true also for Microsoft Mobile Ltd. The company uses all the information linked to SKU to identify countries and customer requirements of the delivered hardware and software specifications. After the SKU is customized based on the requirements, the same ID is used to place orders to the factory and receive delivery information. Thus in this study the SKU is the key identifier used to combine the customized product creation to the actual delivery to the customers.

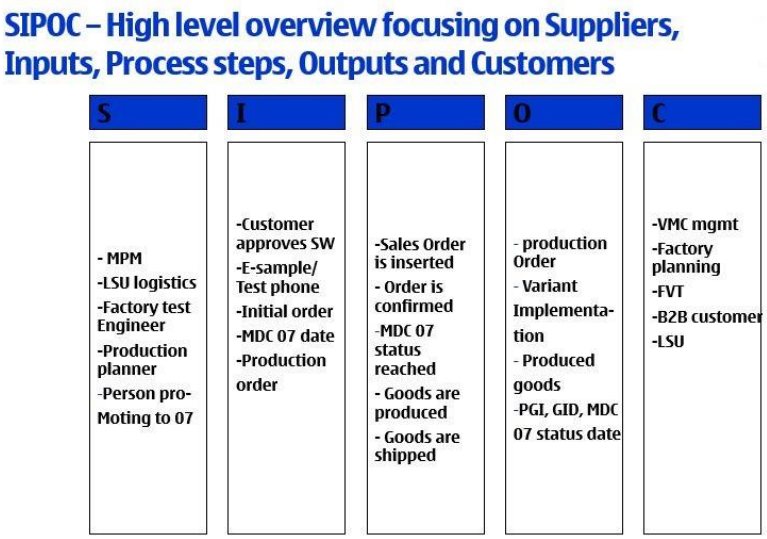

Figure 1. Six Sigma process description of Variant Creation- and Order fulfillment processes suppliers, inputs, processes, outputs and customers by using SIPOC tool.

Six Sigma SIPOC tool, that is used to describe suppliers, inputs, processes, outputs and customers, was used to give a fresh and different view to the known SKU Creation process. It helped to lead discussion with MMO team on which parts of the known process were to be added to this study’s measurements. From the inputs shown in figure 1, the possibilities were the dates of the customized products software approval by customer, the date of factory confirming that it has tested the new product and are able to start to produce it and also the final Mobile Device Configurator (MDC) status 07 that indicates that all actions for the customized product are done. Since the customized

product SKU processes substeps are already measured and have been studied, the MMO team decided that only the MDC status 07 should be part of the study's measurements as it is the single date to confirm that the customized product is finalized.

3.2 Customer order process

Once the customized product SKU variant code is orderable, the order fulfillment process can start. Using the same mindset than for the other known process, the SKU creation process, the steps for the order process were mapped. Along with the SIPOC method shown in figure 1, also a Process Variables Map was created to lead the discussion and bring structure on decision-making on which process steps to capture and include in the measurements. Figure 2 Process Variables Map shows several key dates related to these two process areas. By using the same logic and than for the MDC 07 date, MMO wanted to focus the study as much as possible on the unknown but relevant timeline. At this point the customer order entry was not seen as the key data to be measured but instead the day when the first order for the customized product SKU leaves the factory, Goods issue date, key outputs from the manufacturing process, was selected. Proof of Delivery, POD, date when customer receives the goods was not selected since the transportation time is also known and measured. (Shtub 1999, 2-3)

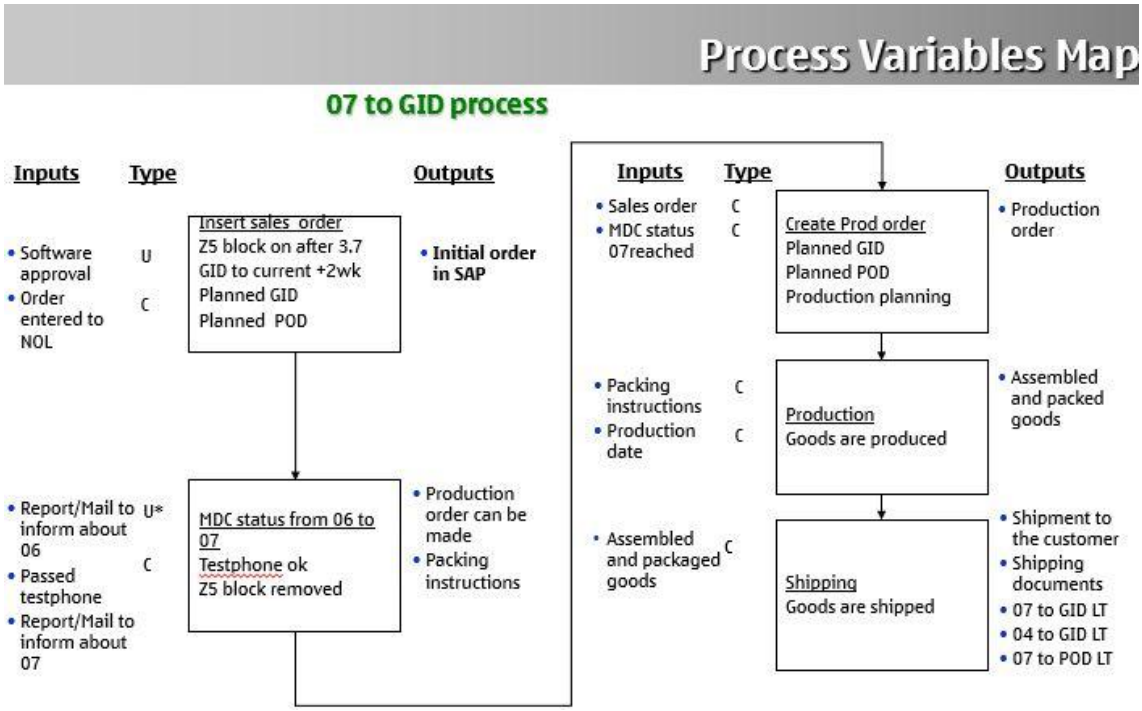

Figure 2. Six Sigma Process Variables Map describing the inputs and outputs of Variant Creation- and Order fulfillment processes.

In MMO processes the customer enters orders either direcly in the order interface or through customer representatives working for Microsoft Mobile. Tools used in this process are called NOL (customer interface) and manufacturing system SAP

In customized product SKU process for MMO, there is a step to confirm manually that there is a real customer demand for the customized product, before finalizing it. Also the customer representative gives the software approval. Due to this nature of customer driven SKU variant creation, the study assumes that once the customized product is ready to be ordered, there is also an order placed soonest. The general assumption of the customer behavior is that customer wants the finished SKU first delivery as soon as possible.

3.3 Manufacturing and delivery process

Parts of the customer order process and manufacturing process are overlapping, since the requested delivery date and initial promise of the shipping date come through the customer order process, but the actual goods issue date and eventual proof of delivery dates are outputs from the manufacturing and delivery process. Since the GID and POD are already gone through in previous chaper and the other manufacturing processes are already known and measured, there is no special focus in the manufacturing part on this study.

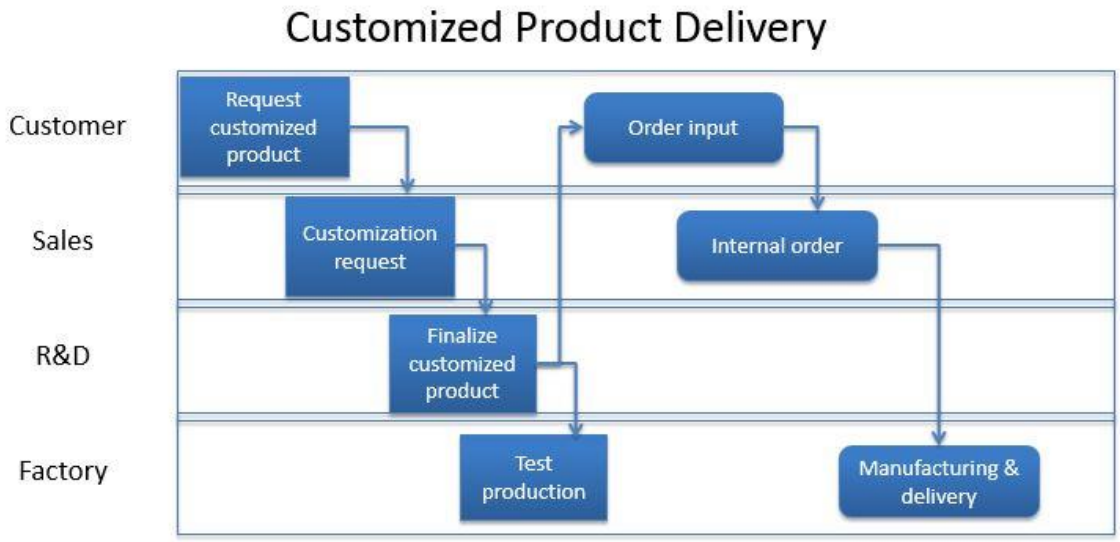

Figure 3. SKU code is the identification number for finalized customized product and the unit the customer orders

Figure 3 describes the linkage between the customized product creation process and order fulfillment process. In MMO standard processes, a finalized stock keeping unit code is the output of the customized product creation process. That same SKU code is used as identificator to insert the order and handle the manufacturing. At the beginning of this study, it was unclear how factory controls the customer requested date and what kind of internal guidelines there are for entering this date. The analyzing phase brough light to the situation.

4 ANALYZING THE DATA

To conduct the study and especially the process definition and measurements part, Six Sigma methodologies and features were used. Six Sigma stands for efforts to achieve stable and predictable processes with minimal variation, characteristics and data points that can be measured, analyzed and continuously improved. Six Sigma was originally developed to help improve manufacturing processes but it has been adopted into use in other types of business process improvement programs as well. From Six Sigma's process improvement toolset, DMAIC tools, the define, measure and analyze tools are in scope of the study. The improve and control parts were outscoped. (Desai 2010, 2)

In the define phase, out of the tested tools, SIPOC, Process Variables map and Cause and Effect matrix were useful as described in chapter 3. Although the importance of Cause and Effect matrix was found out only later in the analyze phase 4.5. They helped to clarify what should be the starting point of the measurement and what would be the logical end point for the measurement. Define tools help to identify for example what really is the problem, who is the customer and what does the customer want. (Taghizadegan 2006, 44-47)

Following the defined process scope to be studied is the measurement phase. Critical MMO measurement metrics for SKU, customer requested date and GID all came from IT systems and the data is both reliable and valid. In six sigma terms, the measurement system analysis (MSA) is in order. Linkage between the variant creation process, customer order process and the manufacturing process is the common unique ID of SKU. All the data was originally added to excels from the sources and imported to Minitab statistical analysis tool used in Six Sigma studies to create the measurements and analysis of means and variances. MMO did not have any baseline for 07-GID data, since this was the first time it was combined. (Desai 2010, 50)

In figure 4 the data, that was collected and combined in excels from NOL, MDC and SAP tools, was imported to Minitab statistical analysis tool. The lead time between the two processes was measured and the mean was 22 days.

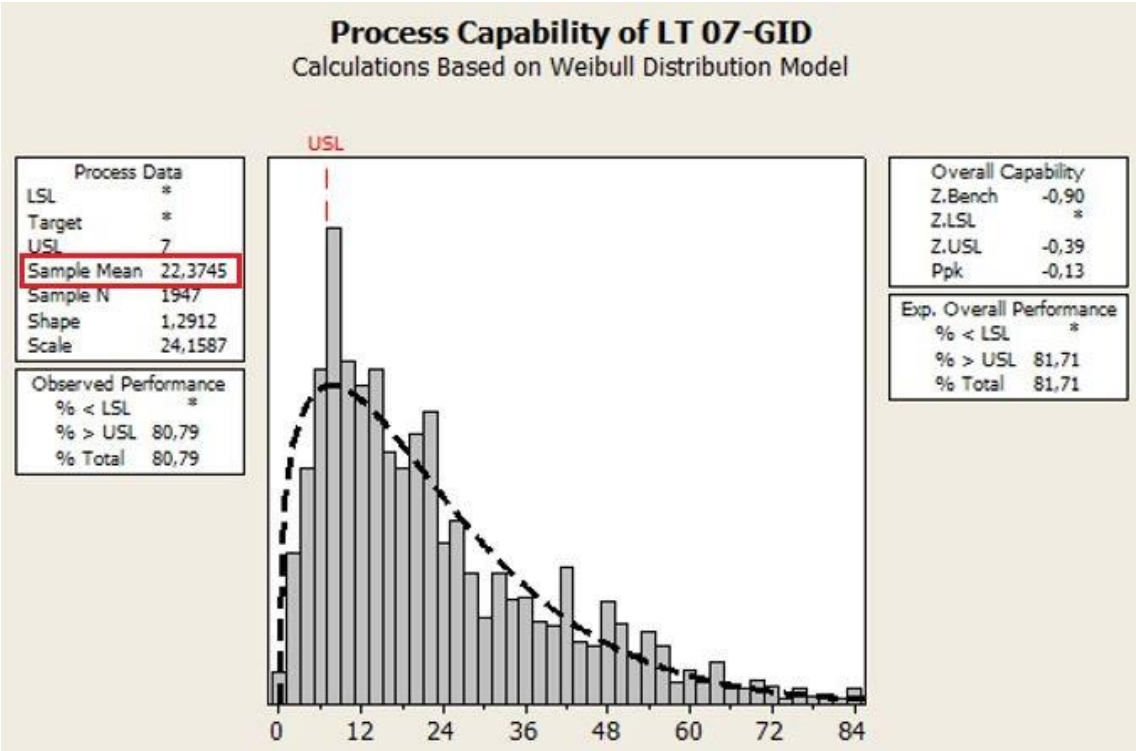

Figure 4. 07-GID measurement population distribution with mean of 22.

In this study the 07-GID refers to lead time in days. Instead of doing a typical customer view and measuring the time only from order to delivery, the goal is to find out information about a different, more complex lead time revealing new hidden lead time between the processes. Minimizing the actual lead time that is visible and important for the customer, requires MMO to understand every part of the hidden lead time internally. Figure 4 was the first time MMO had concrete data on the process capability on the time between a finalized customized product and the first delivery of that product. Next steps were to find out how much variance different factors had in this lead time and to understand this average lead time of 22 days better. (Christopher 1998, 157)

4.1 Defining scope and hypotheses

The amount of data for the analysis was very large. NOL delivery data for time period between March and September already included 221 00 rows, so it was decided to have only European customers and factories in scope of analyzing the data. This decision was backed up by the fact that 70% of SKU variants were created for European customers. Also only the first orders for a new SKU variant was measured, because the interest was on the capability of this process and later orders than the first one would disrupt the data of the measurement.

Even though MMO had not studied this lead time before, there was so much experience, studies and measurements on the processes of variant creation, order fulfillment and production, that there were some hypotheses set before data was analyzed. Hypotheses are traditionally used in quantitative studies, but even though this is a case study, the hypotheses that MMO had, are related to the quantitative measurements made from the source material. MMO hypothesis were that:

- highest variance for the data would be found by comparing the customers and products.
- allocation situations would not only bring the highest variance, but to also to explain large part of the measured lead time. (Hirsjärvi, Remes, Sajavaara 2004, 149)

The original plan of having only SAP good issue date and MDC 07 data points to be measured was later in the study modified to include also the critical NOL data of the initial customer requested delivery date. This enabled getting more reliable customer requested delivery date. In the initial SAP data, the customer requested delivery data provided several invalid results of extremely early customer requested delivery dates, often even before customer had approved the software for sales. SAP data was used to capture the good issue dates reliably.

MDC	NOL	SAP
• Tool where customized product creation is tracked • MDC 07 date • Date when customized product SKU is finalized	• Tool where customer enters orders • Customer requested delivery date • Date when customer requests the delivery	• Tool that guides and tracks manufacturing • GID - Good Issue date • Date when goods leave the factory

Figure 5. Data sources for the study listed and explained. MDC, NOL, SAP.

As a summary, the key data sources for the studies are combined in figure 5. Mobile Device Configurator tools tracks the creation of the customized product. NOL is the tool where the customer enters the order for the finalized customized product with the SKU code being the identificator for the orderable unit. When the manufacturing is completed, SAP captures the actual dates when the goods are shipped.

4.2 Variation per customer

Figure 6 shows comparison of the means between several interest points of the study. This high level overview confirmed that variance was large between different countries, customers and products. It also confirmed the plan that the study could focus on European factories and European customers scope, as neither plant nor Sales Unit (SU) information were one of the key attributes having high variance.

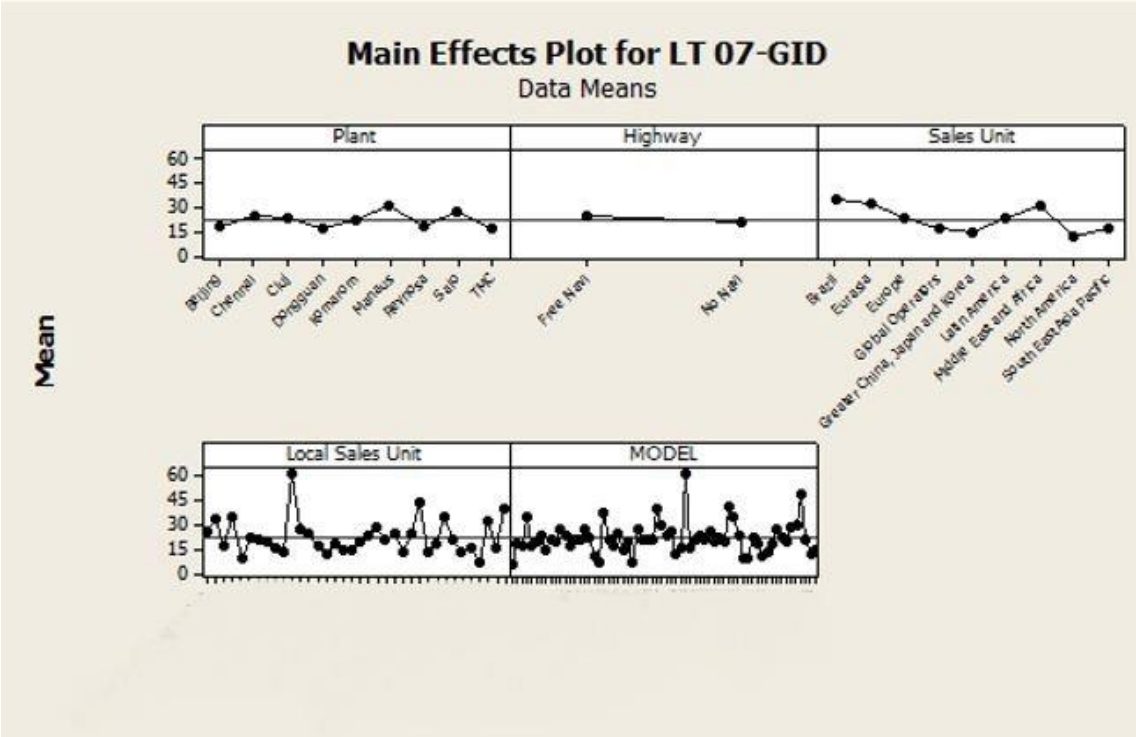

Figure 6. 07-GID lead time means classified by plant, highway project, SU, LSU and product model.

The high variation in the means when classifying the source material per local sales unit (LSU) in figure 4 meant that, according to original hypothesis, the customer data was confirmed to be worth looking into. Customer in MMO are grouped in local sales units and those are in turn grouped into sales units based on geography and internal agreements.

A local sales unit including Spanish and Portuguese customers had new product launches for several interesting customers, so their 07-GID measurement means were looked into. The lead time averages for 07-GID measurement for these customers (names of the customers are masked) in the LSU is shown on the figure 7. The large difference in measured means between two simular kind of customers, named here SPD and SPC, was surprising. However, after checking each individual SKU lead time, it was clear that the difference came from 1 variant having extremely long lead time and since sample size for one customer is under 10, one high lead time can mislead when focusing on mean as the measurement.

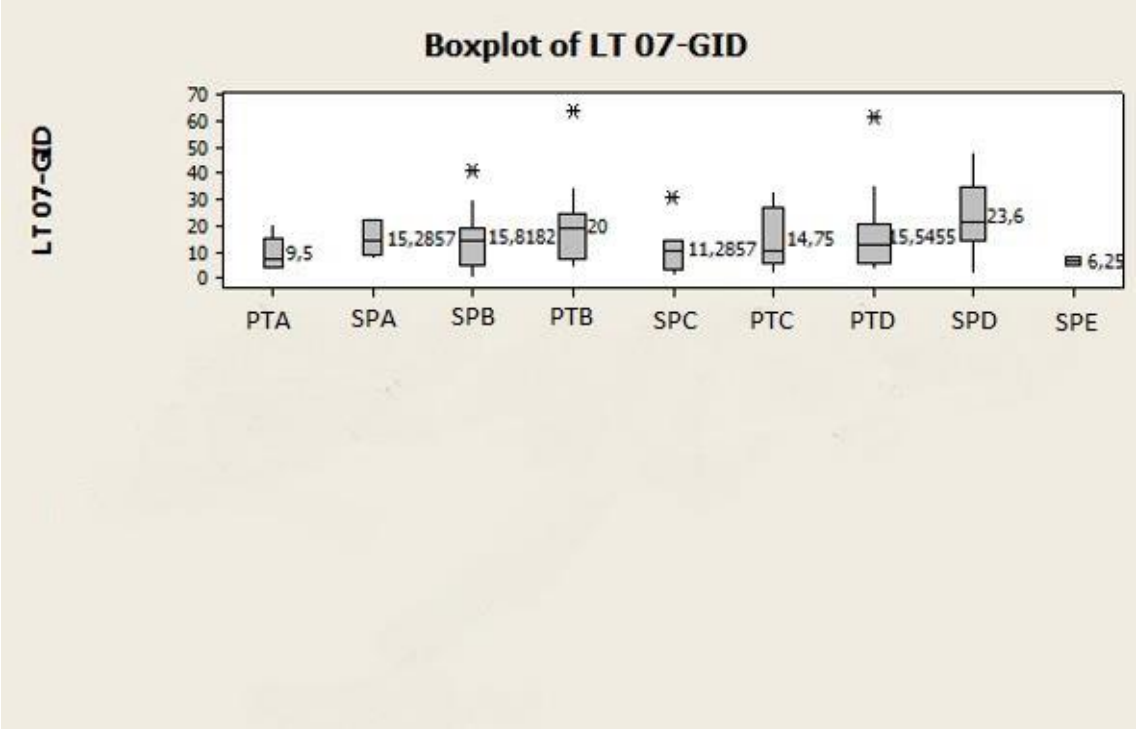

Figure 7. Box plot lead time mean for customers in Spain and Portugal.

As a conclusion, there was high variance among the customers lead time scores but the sample sizes, after looking into only the first deliveries of the customized product SKU, were small and a single SKU variant could be the reason for high variance.

4.3. Variation per product

Figure 8 shows selected products (names are masked) with sample size over 10 SKU variants during the investigated time period. Product specific data confirmed one of the hypotheses that there would be high variance among different products. Most surprising detail on the figure is that two of the same category products, 220A and 230A, had such large difference in the mean value, 13 days.

ByVar2	Mean2	Median2	Range2	Count2
500A	21,3733	18,0	75	163
650A	23,5674	22,0	81	144
400A	19,5900	16,0	55	104
700A	19,5316	12,0	81	84
630A	20,5263	16,0	78	81
750A	21,7812	18,0	81	71
220A	17,2069	14,5	51	59
620A	24,2909	23,0	66	57
550A	25,8235	20,0	63	56
230A	30,7778	30,0	82	33
510A	16,8400	11,0	74	25
660A	15,5217	14,0	65	23
200A	29,6818	29,0	62	22
300A	19,5000	9,0	62	18
270A	14,8333	15,0	19	13

Figure 8. 07-GID lead time mean and median measures classified per product.

The two prodcts first customized product deliveries were shipped from the same factory, focus customer groups were similar and the sample size of the measurement was over 50 for both products. The only difference that could be found was the 230A product was more popular in terms of the amout of customized SKU variants. Difference couldn't be analyzed further.

4.4 Variation due to factory issues and allocations

Even though companies that manufacture physical goods would do great demand planning and forecasting, supply constraint situations do happen for many reasons. For example long lead times combined with challenging availability of components and variations in demand are causes for supply constrant situations. Another way to explain those situations is that demand is greater than supply. In this study and in MMO, supply constraint situations are called allocations. Before the study started, MMO had several hypothesis and one of the strongest ones was that if an SKU is finished at a moment when the product is in allocation, the lead time would be very long and variance between SKUs affected by allocation and not affected would be large. In addition, it was thought that allocation would explain large part of the lead time. (Hugos 2011, 42-46)

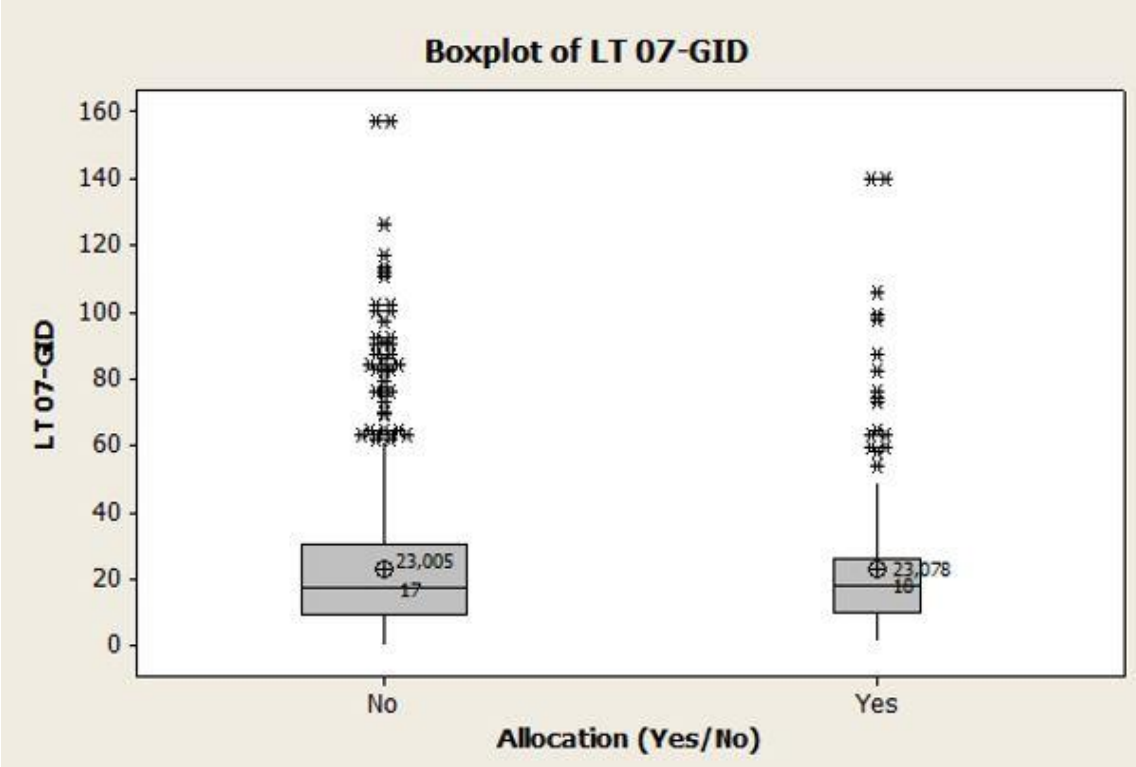

Figure 9. Box plot comparing the 07-GID lead time means by product SKUs that were in allocation during the time of first delivery and of those that were not in allocation.

Allocation data (Yes/No) was added to each first order row as well as description of the possible allocation reason. This was managed to be done with the help of logs on which products were and are in allocation on which weeks and factories.

In figure 9, the analyze showed that allocation had no effect on the lead time. The figure compares means of the population which were under allocation, marked as yes in the figure and of those that were not in allocation that are marked with the box plot named no. The means were 23,0 and 23,1. This was a big and a surprising piece of information as it was dismissing one hypothesis.

4.5 Customer requested delivery date

After the analysis on the customer, product and allocation brought less results than what was expected, some of the earlier material of the study were revisited. The six sigma tools method called Cause and Effect Matrix was used already at define phase but only the revisit after part of the study was done, gave the study a fresh approach. With the help from MMO experts, all the process inputs were rated based on the experts view of their importance to the customer. This created the Cause and Effect Matrix, shown in figure 10. It pointed clearly that from the customer point of view, key part of the process is the order input.

Cause and Effect Matrix

		Rating of Importance to Customer	10	10														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
			07 to GID LT	04 to POD LT	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Requirement	Total
	Process Step	Process Input																
1	Inser sales order	SW approval	0	1														10
2	Inser sales order	Order to NOL	9	3														120
3	MDC 06-07	Info about 06	0	1														
3	MDC 06-07	Testphone pass	0	3														30
4	MDC 06-07	Info about 07	3	1														40
5	Create prod ord.	Sales order	3	1														40
6	Create prod ord.	MDC 07	0	1														10
7	Production	Packing instr.	3	1														40
8	Production	Prod date	1	1														20
9	Shipping	Packed goods	0	3														30

Figure 10. Cause and Effect matrix on 07-GID process steps.

The NOL tool was used to add data to the study from the customer initial request for the shipping day of the first order of the customized product SKU. That led to having still the same start date, 07 for SKU being ready, but two dates to compare it against to, both the actual day the goods have left the factory, but also the day when the customer has originally requested the goods to be shipped.

The comparison of the two lead times measures, 07-GID and 07-Customer requested shipping date showed that these two lead time measurements were very close to each other. In figure 11 box plot the means between the two lead times were 28,2 and 28,7 which were surprisingly close to eachother. It raised a question – is MMO really always delivering the first delivery of the customized product almost exactly when customers require it?

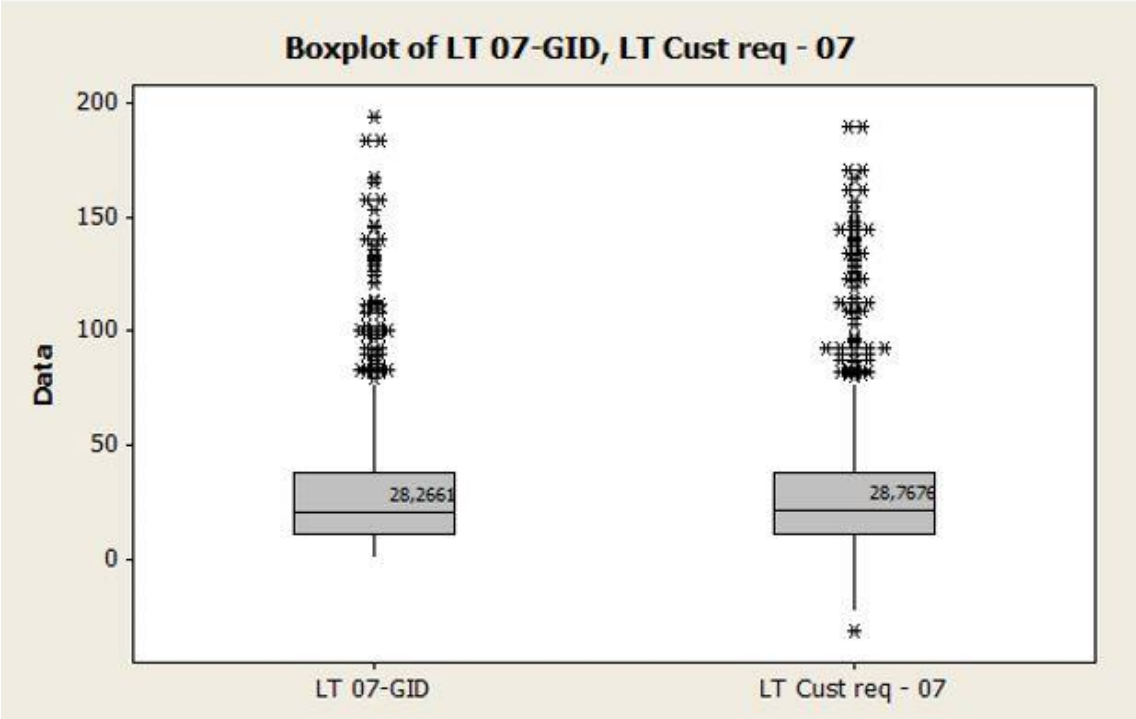

Figure 11. 07-GID measurement mean compared to 07-customer requested GID measurement mean.

To answer the question, the individual customized product SKUs first shipping dates were compared to the same SKUs requested shipping date. This result would show how often individual shipping dates meet the customers requests.

In figure 12, the results can be seen. The comparison showed that 46% of the first deliveries of SKUs were later than the customer had requested. It means that customer requested delivery dates on average are as far from the completed variant creation process as the actual shipping of the product but actual customer experience is that almost half of the time first deliveries come a bit later than requested.

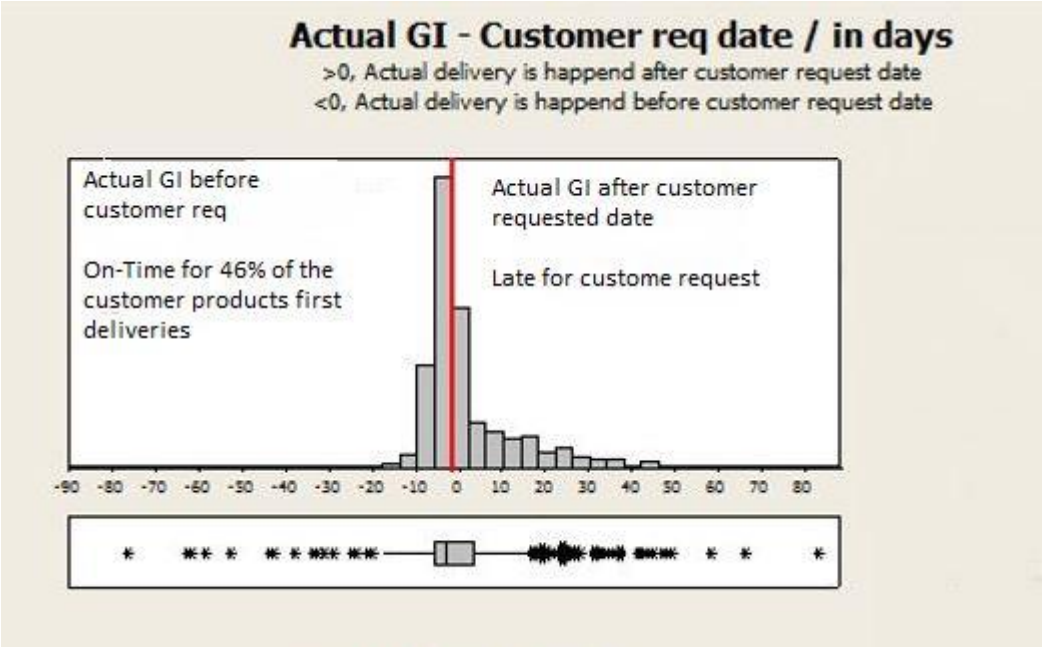

Figure 12. Comparing the first shipment date of a customized product SKU to the customer requested shipping date.

This result was not a surprse, since there are many known factors related to the two known processes, creating a customized product SKU variant and manufacturing, that can lead to first delivery date being hard to estimate. Nevertheless, the simular lead time measurements on average gave reason to look further into customer behavior as well as doing one more mathematical analysis comparing these two lead times.

5 CONCLUSIONS

5.1 Regression test on 07 - GID measurement vs 07 – customer requested delivery date

Data from the regression test, shown in figure 13, that compared the measured individual SKU 07 - GID lead time to those individual SKUs 07 - customer requested shipping date showed that 71% of MMO total 07 – GID can be explained with customers requested delivery date. This was a surprising result. When this result was shared with MMO business owners initially, we decided that there is a need to hear the customer representatives. As a result, group interview times with European customers logistics and factory representatives were held. The focus on the interviews was to find out about decisions and actions in the internal order entry frontend tools to enter the order and the date. Group interviews was selected to be the method to gather information from different functions at the same time and hear several views for the same topic. (Hirsjärvi, Remes, Sajavaara 2004, 199-200)

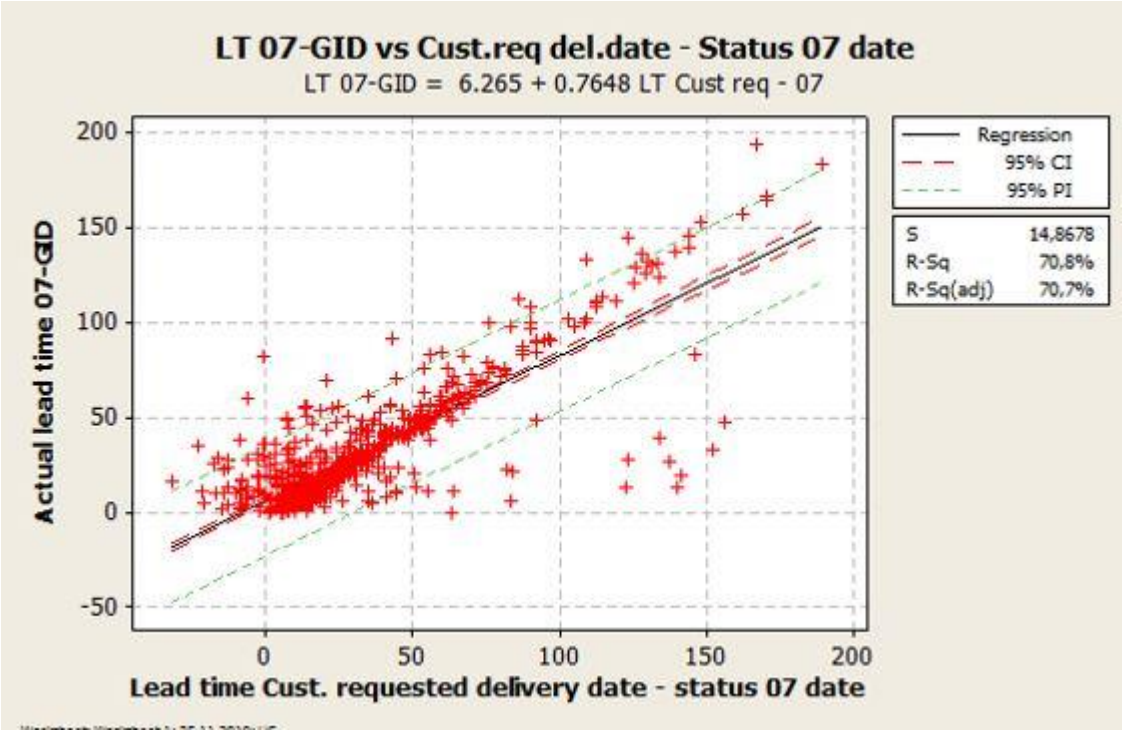

Figure 13. Minitab regression test comparing populations of 07-GID and 07-customer requested date.

The key finding on the interviews was that there is a possibility in the customer order entry tool for the LSU to set rules for first possible order entry date per customer. This possibility was largely used and the normal first possible entry date was generally 20 days from the current day. And the day the order times would be confirmed was often the time that the SKU would be ready, so our measuring start point of 07 status. The reasoning for these rules had been factories push for freezing orders for current week + 2 weeks. Also it was mentioned that since the deliveries came sometimes from factories in Asia, the longer lead times were needed.

5.2 MMO guidance and actions

07 – GID lead time was established and followed for some months. However, since about 20 days was already built by default in the lead time, this lead time was not considered as a key performance indicator (KPI) in MMO scorecard for the future. Parmenter (2010, 2, 4) has analyzed differencies between key result indicators and key performance indicators. As there are other factors contributing so heavily to this measurement, it was clear that only following this measurement is not going to bring MMO closer to the vision of the premium service level. 07-GID was not a KPI that would guide MMO to what to do to increase performance, rather it was an result indicator showing the symptoms inside other internal processes – the order entry process in this case.

Since the date of entering the order and the date of where the proposed delivery is requested were so critical, another project was held to change the logic on when the order could be entered. In this project the initial order entry was done already earlier than the 07 date, as soon as the customer had approved the software. This was done with the help of SAP block usage that allowed the preliminary order but made sure that no production could happen before the 07 status and completed SKU was reached. This was seen as the best possible action to gain speed and efficiency on getting freshly completed customized products to our customers.

5.3 Evaluating the study and personal learning during the process and on the job

Author's background before doing the study included working in MMO and former Nokia for about 10 years. The work in there had always been close to this area: either by taking in customers orders, creating the customized products SKUs or then by managing development projects on the process areas. The study was done using Six Sigma methodology that was trained on the job. The Six Sigma learning combined with the thesis' analytical and theory based mindset gave a possibility to look into the study with a fresh view. It was great to read about industry standard ways of doing similar businesses and to be guided by a clear toolset for problem solving, rather than companies internal hypotheses.

One of the major learnings while doing this study and writing about it, was regarding to setting the scope. This study, as defined, sheds light to an unknown timeline between two very large process areas and utilizes the methods of Six Sigma to proceed forward. It felt necessary to include parts of the customized product creation process, customer order fulfillment process and also Six Sigma to this study. This led to touching only the surface of the theories of three areas, rather than really deep diving on one clear area of interest. It was a learning experience and highlighted the importance of setting a clear scope and also what are the consequences when the scope is very wide.

Conclusion of the study was not to create a new metric for 07 – GID for understandable reasons but it was worth exploring and not only for personal learnings sake. Based on the Six Sigma learnings and this study, the author has adopted fact based analytical approach in the daily work with projects.

SOURCES

Barone, S; Franco, E. 2012. Statistical and Managerial Techniques for Six Sigma Methodology. UK: Joh Wiley & Sons, Ltd.

Carreira, B; Trubell, B. 2006. Lean Six Sigma that Works: A Powerful Action Plan for Dramatically Improving Quality, Increasing Speed, and Reducing Waste. USA: AMACOM Books.

Christopher, M. 1998. Logistics and Supply Chain Management. Second edition.Great Britain: Financial Times Professional Limited.

Desai, D K. 2010. Six Sigma. First edition. Mumbai: Himalaya Publishing House Pvt. Ltd.

Hirsjärvi, S.; Remes, P. & Sajavaara, P. 2004. Tutki ja kirjoita. 10th edition. Jyväskylä: Gummerus.

Hugos, M. 2011. Essentials of Supply Chain Management.Third edition. Hoboken, New Jersey: John Wiley & Sons, Inc.

Nokia 2014. Time to wake up. Nokia Networks' Lean Six Sigma program helps Elisa identify and reset sleeping cells. Retrieved October 29, 2015 from http://networks.nokia.com/de/news-events/insight-newsletter/articles/time-to-wake-up-nsn-s-lean-six-sigma-program-helps-elisa-identify-and-reset-sleeping-cel

Nokia 2015. Our story. Retrieved November 28, 2015 from http://company.nokia.com/en/about-us/our-company/our-story

Parmenter, D. 2010. Key Performance Indicators (KPI): Developing, Implementing, and Using Winning KPIs. New Jersey: John Wiley & Sons, Inc.

Pestorius, M. 2006. Applying the Science of Six Sigma to the Art of Sales and Marketing. USA: American Society for Quality.

Shamin, M. 2009. Encyclopaedia of Logistics Management. Vol.I. Mumbai: Himalaya Publishing House.

Shtub, A. 1999. Enterprise resource planning (ERP): The dynamics of operations management. Dordrecht: Kluwer Academic Publishers.

Taghizadegan, S. 2006. Essentials of Lean Six Sigma. USA: Elsevier Inc.

Texas Lean Six Sigma 2015. Success Stories: Dr. Pepper. Retrieved November 28, 2015 from http://www.texasleansixsigma.com/success-stories/dr_pepper