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Mercury is a European contractor that builds and manages complex engineering projects that reimagine how people work and live in the built environment. Mercury believe that real innovation happens if you are willing to be brave. Its determination and sharp focus enable Mercury to deliver leading-edge construction solutions across a range of key sectors, taking our clients to new territories they never thought possible.

Mercury's purpose is to deliver its clients' vision through leading-edge construction solutions, going beyond their duty which turns clients into partners and builds relationships that thrive across the following sectors: Enterprise Data Centres; Hyperscale Data Centres; Life Sciences & Technology; Building Services; Healthcare; Fire Protection; and TSS.

Author

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Overview & Background to Lean Initiative

Over a 48-year period, Mercury has built a reputation for delivering complex engineering projects across a range of key sectors. This case study focuses on historical initiatives undertaken for a large-scale semi-conductor client where Mercury has been at the forefront of new and retrofit project build activities since it was a green-field site in 1992.

In terms of capital project timescales, clients' needs dominate our focus on how we plan for and execute any project build in the context of safety, cost, quality, and time. Fast-track scheduling, in particular, brings enormous challenges for procurement teams in meeting client expectations due to the risks inherently associated with the unknown. Long lead-time materials procurement on a global scale requires, of course, a clear understanding of the product, but also of the relative weight and fluidity of the tiered conditions in the supply chain. These conditions ultimately determine the extent to which materials can be procured efficiently and to which relative wasteful activities can be reduced or completely eliminated.

When taking into consideration that over 90% (by value) of spend on materials for this sector is bespoke, the challenges grow exponentially as the project footprint and complexities increase and the relative project timelines decrease. During the ten years from 2010 to 2020, we have experienced additional compression of up to 20% on standard project timelines. Along with this, we have encountered increased risk of time-based contractual penalties being imposed. Growing costs associated with expediting materials which have been placed on order either too late to the schedule or not placed at all, begin to impact contractors' ability to meet their own budgets and inevitably have the potential to impact the construction schedule overall.

Lean Initiative Undertaken – Lean Thinking, Tools, Techniques

This case examines Mercury's eight-year Lean initiative to make its procurement systems and processes more effective and more efficient, with the focused aim to return substantially enhanced value-add to its client. During completion of a project in 2011 and commencement of a new project build in late-2012, it was recognised that there were significant process gaps in the end-to-end materials procurement function. Traditionally, construction teams lead the procurement process and this is due to legacy factors like, for example, the traditional view of procurement as an administration function and the lack of professional procurement representation at senior level. Procurement teams typically focused their attention on placing purchase orders (POs) as quickly as they could, and spent much time reacting to the lateness and or inadequate nature of requirements coming downstream. Achieving the "best price" essentially entailed the leveraging of personal

relationships and rarely involved standard industry practice in terms of bid analysis (BAS) methods and objective negotiating techniques.

By now the traditional approach of having one primary "issue for construction" (IFC) design package and a schedule that was based on all systems being completed prior to handover, had been replaced with multiple IFC design releases and systems being completed for handover progressively throughout the project. This led to systems being handover while the majority of the project was still in construction. This necessitated a sea change in how "material take off" (MTO) was being completed and material procured. It is fair to say that this change was still being implemented and consequences understood at the initial stages of the project which led to traditional bulk MTO being completed and which did not necessarily accommodate the early systems material requirements. Obviously the partial IFC design release also necessitated placing orders for long lead material prior to "issue for fabrication" (IFF) being achieved. In summary, large volumes of material were ordered, but to ensure the correct material was ordered in time, a change in the process was needed and quickly.

The initial fix was to create an Excel spreadsheet that would capture all MTOs as they were being completed for each part of each system on the project and in line with design release. The engineering function designed this template for use by the engineering and construction teams. That spreadsheet became known as the "engineering materials report (EMR)". This served as a tracker to ensure MTOs were being done and to also ensure that orders were being placed on time against each MTO. Estimated lead-times were factored in for critical materials, and PO required dates were calculated on field-need-date (FND) less the estimated lead time. This model served us very well, and still does so to this day with many tweaks and small improvements since. Within six months of its introduction, the project team was satisfied that all materials that should have been ordered were ordered. This brought materials ordering up to date and the next challenge was to design, implement, and maintain an ongoing and efficient set of processes that would ensure consistency and standardisation in the long-term.

The procurement "RFx" encompassed the entire formal request process and included "request for quote" (RFQ), "request for information" (RFI), and "request for proposal" (RFP). Into the RFx process itself consisted of numerous methods – none of which were contained in an SOP and all of which were subjective in terms of market engagement. A root cause analysis (RCA) identified that a person with experience would approach the vendor market in a completely different manner to a junior with little or no experience. There was literally no control over who should and should not approach the market place, nor how they should do so. Decision-making was uncontrolled to the extent that vendors could receive verbal instructions to any value. These methods manifested in a lot of wasted time for engineering, construction, procurement, and finance.

Ultimately, procurement people who were tasked with ensuring suppliers received their POs and that materials arrived on time, were faced with a relentless flow of last minute requests. This resulted in large volumes of POs being issued to market on the basis of quotations received by numerous people outside of the procurement department. Analysis found that up to 40 people were involved in the RFx process, including four buyers. Furthermore, due to the late nature of POs, the supply chain itself was formed out of discrete knowledge that vendors had about the project and around specific relationships forged as a result. Ultimately, the procurement function was at the mercy of its supply chain and could only rely to a large extent on those personal relationships to achieve any level of satisfaction that project timelines could be met. There was a very clear need for a strategic, objective, operationally excellent, and consistently applied standard work approach to procurement.

Utilising Pareto analysis on spend, we categorised at a high level not only where the spend was going but how much effort was associated with each category. It was notable that 80% of total PO spend was awarded to 10% of the total vendor base, with one vendor accounting for 17% of spend, and 312 vendors accounting for the remaining 83%.

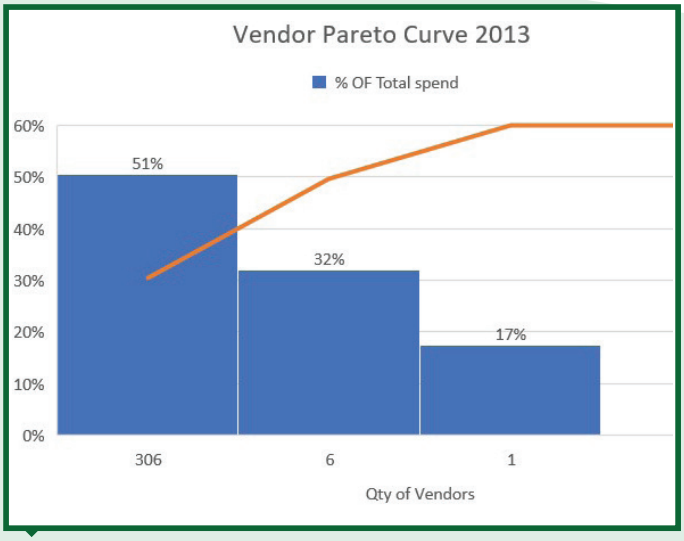

Figure 1. Vendor Pareto Analysis

A further drill-down of the top seven vendors (totalling 49% of spend) to examine why and how spend was allocated, found the following:

- Procurement was not involved in most of the big decisions and were not involved in the initial product submittal and approval phase. Client approval takes time, and Procurement needs to be involved at the earliest stage to provide alternatives for submittal.

- Quotations from suppliers went to people outside of Procurement and were only provided to Procurement when the material was being requisitioned for purchase. This left zero time to adequately go to market for alternative bids.
- Most quotations contained either a sea freight or an air freight adder, and which was approved by someone outside of Procurement. Airfreight alone accounted for 2.25% of total project spend.
- Strong relationships were built with the suppliers and it was hard for people to change from the practices and people that they were used to.
- Some suppliers provided on-site assistance to junior engineers with MTOs, which therefore reduced competition.
- There wasn't enough information available to enable proactive procurement.
- Requisitions mostly contained free text which gave very little detail about the product being requested. POs were processed based on quotations provided by people from outside of Procurement.
- In the case of one supplier, most of the products ordered could have been purchased from official distributors locally.

The most significant finding out of this RCA was that, given the repetitive nature of the equipment, we had no agreed materials list and no agreed pricing structure with vendors. Data capture in our ERP system was not being maximised to enable an efficient and standardised approach to purchasing regularly bought items.

We deployed the DMAIC method to set out our plan in terms of understanding more about the issues and solving them. The objective was to improve the buying process to a point where all repetitive materials could be bought quickly, competitively, and to the correct specification. The focus moved to having the right information, and to having it early and consistently. The need for having robust and standardised information, readily available to key users, formed the basis of thinking over the ensuing years. In fact, it became mostly about how to manage the information and capture the critical data.

Defining the problem

Taking into consideration the findings of our initial review of vendor spend, the extended analysis of high value suppliers found that:

- Where procurement had an opportunity of increased early involvement, data was not being captured in the ERP system that would empower the team to be more proactive in the RFx process. The symptom in this instance was that POs were being placed with the same suppliers based on historical purchases.
- In scenarios where RFQs were being issued to market by procurement, they were being repetitively issued for the same products.
- RFQs were being issued post-requisition approval in all cases, and there was zero long-form RFQ for bulk price leveraging.
- The procurement function was consumed with processing POs, with little or no time available to agree long-term conditions with vendors or to think and act strategically.
- 100% of RFQs issued were in short-form outputted from the ERP. Short-form RFQ from the ERP does not ensure all terms and conditions (T&Cs) are captured in the tender process and only focusses on the price of a material.
- Much wasted time was subsequently spent processing invoices. Lack of accurate information and verbal instruction were the main root causes for misaligned invoices.

Measuring and analysing the issues

Our first task was to examine the data available in the ERP system and understand the reasons why this data was not being used in the initial phases of procurement. The main findings were that:

- Most of the data on the ERP system was either out of date or inaccurate.
- Engineers and construction people spent too much time searching for information on the ERP and they could not rely on it because it was not clear.
- It took too long to get new material data set up on the system.
- The people responsible for raising requisitions were not adequately trained to do so.
- On further analysis it was shown that the procurement team spent up to 50% of their time resolving queries that were raised by vendors due to the inadequate information provided on RFQs.

Each material data record in the ERP is known as a "material master" (MM). In mid-2013, there were approximately 30,000 MM records in the ERP, and findings included:

- Only 2,500 records could be used with a level of accuracy that would enable a piece of equipment or material to be purchased using that data alone.
- Only 45% of POs contained MM.
- Of the 2,500 MM that could be used, for every PO that was raised, a short-form RFQ was also raised.
- Zero agreed prices locked into our ERP system.
- Approximately 50% of RFQs were being issued to the market repetitively for the same material.

Improving the situation

Our objectives started to form organically as we worked through analysing the problems. At a high level, these objectives were to:

- Create time for experienced procurement people to work strategically by removing constraints such as administrative buying.
- Build a data library that was robust enough to encourage engineering and construction to use it in the early phases of planning and material requisition.
- Forge relationships internally that would assist in making things happen.
- Forge relationships with key vendors who would see the benefits of standardising how we interacted with them.
- Create SOPs and train users to be experts in the new processes.

Lean thinking was born in manufacturing out of the need to make things better and to be more efficient. We began looking at ways to leverage learning in how manufacturing procures raw materials. In manufacturing, production planning requires forensic detail on materials availability, cost, and specification. Each material and component is identified with a unique identifier specific to that material or component and specific to each vendor it is procured from. On review of the data in our own ERP, very few of the 2,500 active MMs contained detailed product descriptions to include, for example, client specs, manufacturer part numbers, lead times, units of measure, or pricing. Most of the MMs were generic and required further manipulation/editing, either as part of a requisition or PO. This more or less rendered the MMs in the system useless as the various editing of the same MM would ultimately change the conditions in our ERP and, consequently, automation and meaningful analysis were impossible. We needed to take a common-sense approach given the volume of variables in materials conditions and the bandwidth of the supply chain.

The task was to have manufacturing grade data for all materials and equipment to be procured, and specific to each vendor. Key data required included: item descriptions; client specification; supplier and/or manufacturer part numbers; units of measure; agreed prices; and agreed accurate lead times.

The data build was broken into three key phases, commencing in 2013. At the time of writing, ongoing updating and maintenance of the data is simply "how we do things around here"; however, to suggest in 2013 that this would be the way we would do things for all materials would have been a big and bold statement. Tasks and activities contained in each element were not limited to just those set out in each element as, in some cases, all elements of work for some vendors were achieved in the first two years of the initiative. As client project work ramped down in late-2014/early-2015, the Lean initiative's work also ramped down. Into 2018/2019, and in preparation for the 2020 project build for the same client, this Lean initiative recommenced.

Element I – Commenced 2013

The focus here was primarily on cleansing the existing data in the system and agreeing a process to set up new data that would suit the construction team, the engineering team, plus the vendors. Key activities carried out during this phase included: initial data cleansing of obsolete records in the ERP system; developing an ongoing obsolescence procedure; implementing a process of ongoing communication with vendors for all new data set-up to ensure continuous alignment of supplier and manufacturer part numbers; commencing realignment of supplier quoted units of measure (UOM) against our MTO UOM; and commencing an agreed pricing model for 2,000 individual materials.

Element II – Commenced 2018

The focus here was to agree pricing T&Cs with suppliers. The main challenges with this phase was to agree long-term and medium-term pricing with suppliers. In particular with commodities that are high-value bespoke items, the supplier reluctance to commit became our biggest challenge.

Processes were agreed where products were categorised and expiry dates on prices were integrated into the ERP system. We set up price information records (PIR) with key vendors. We enabled access to commercial teams to view PIRs for budgeting purposes, and we set up an agreed BAS process. We collaborated with the BIM and Engineering teams to ensure that new data set-up was cleansed and approved through the design specifications. Even where long-term pricing could not be agreed, the work associated with the initial phase enabled a much more efficient turnaround of "price on application" (POA) queries.

The extra time saved enabled several outcomes, including: semi-automated PO process; set-up of consignment stock agreements; better competition in the market due to increased time to conduct RFQ and BAS; increased focus on managing stock at hand; increased number of progress meetings with suppliers; increased time for reporting to senior management; better quality reporting to senior management.

The most significant shift in activity with this phase was the reduction in reliance on discrete knowledge. Regularly bought items could be processed by junior team members and work could be seamlessly reassigned to others less experienced. Time was created for more strategic tasks to be executed by the more experienced team members. Point in case was that a new buyer to the company with no experience in the industry did most of the day-to-day buying for a smaller but significant project in 2017 for the same client.

Element III – Continuing in 2018

The focus here was to agree lead times. For project planning to be effective in the context of materials scheduling, it is necessary to know the relevant lead times, the long lead, the local supply, and where risk lies. On any project, experienced people will easily call out some of the historically long lead items, but this is not an exact science in itself. The basis of the EMR referred to earlier, is that POs are placed based on a need date in the future – the FND. Required PO dates are calculated very simply by ordering on or before the FND, less the lead time, and allowing for a buffer time. The logic of the buffer time is to cover where delays might occur and/or to allow for procurement RFQ timing.

FND=**X** – Lead Time=**Y** – Buffer time=**R**
– Required PO Date=**Z**
Z = X-(Y+R)

This formula is the basis for the timing of cutting POs; however, it is laden with risk due to the fluid nature of material availability. Factors such as quantity, required date, budget, client specification, minimum order quantities, delivery methods, and customs considerations, all weigh heavily on the validity of lead times quoted, and accuracy and honesty also play a big part. Suppliers had a huge

part to play in this phase. Some risked overcommitting with aggressive lead times that they could never meet just to look favourable at tender stage. Others did the opposite and quoted extended lead times which put them at risk of losing potential business. Order too late and the schedule is bust – Order too early and you impact cash flow at the very least.

The main tasks carried out during this phase included:

- Analysing all historical data pertaining to actual delivery times.
- Extending data library to include all size ranges, specifically out of gauge outside diameters.
- Categorising materials as "critical" and "non-critical".
- Engaging with key vendors to establish best and worst case scenarios for material lead times.
- Validating vendor data against historical data where possible.
- Validating data for new materials through open discussions with vendors and manufacturers.
- Comparing lead time data between competitors.
- Agreeing and inputting lead times specific to each material and each vendor.

Element IV – December 2018

The focus here was on aligning planning with execution vis-à-vis materials management. In preparation for the next major project with this client, new challenges were presented in terms of materials management. The scale of this project (in construction phase at time of writing) is much greater than anything we had undertaken before. Added to that, the project would be built using the "advanced work packaging" (AWP) methodology which is a structured approach to improving construction projects from design to commissioning, and is accomplished by aligning planning and execution activities throughout the project life cycle. It is such rigourous front-end planning along with the detailed engineering activities that support enhanced execution at the workface, and, in construction, the workface is where trades turn materials into functioning plant. Project set-up and planning establishes the basis for coordinated "construction work packages" (CWPs) which are strategic subdivisions of the "construction work area" (CWA). A CWA is a section of the construction site that has been defined as a logical area of work. CWPs then enable progression of work by the planning, execution and monitoring of more granulated "installation work packages" (IWPs).

The need arose to carry out a full review of our materials management processes to identify areas of risk in terms of how to plan for and execute the end-to-end materials management function. In December 2018, we engaged an external Lean service provider to carry out a full Lean review of our systems and processes, and to make recommendations for improvement. The brief was to evaluate the materials management process (which does not add specific value but supports value creation); conduct a current and future state analysis; and make recommendations on how we could achieve the future state. The primary recommendations made were to improve the functionality of the then Excel-based EMR process, and to give consideration to long-term ERP materials planning and migration from Excel-based planning to fully integrated MRP.

The following were undertaken as part of this element:

- Interviews with all key stakeholders.
- Value stream mapping (VSM) on our Order & Receipt process for stocked materials.
- A Kaizen event to highlight wastes.
- A workshop to identify and prioritise Kaizen tasks.

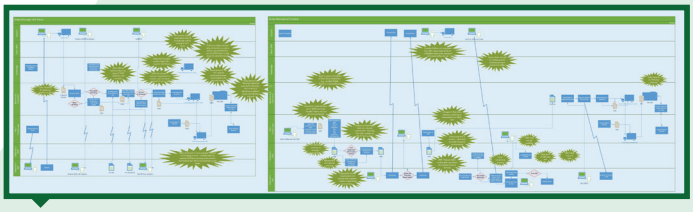

Figure 2. Value Stream Mapping

Lean Initiative Improvements & Impact

We faced many challenges on this Lean initiative. Operationally, we had to get people to help and keep up the effort as well as to create time to work on enormous volumes of data. With the Supply Chain, we had to get suppliers on-boarded, and we had to keep them interested when there was no immediate benefit to them. Culturally, within both the Procurement function as well as across the wider group, we had to enable the changing of long-held practices and attitudes by introducing the Lean mindset and tools to Procurement. The overriding challenge was encapsulated in the statement that "This isn't for us, this is all about manufacturing. What has it got to do with Procurement?"

There have been a number of high-level functional impacts, including:

- During our last major project with this client we had 2,500 partially useful MM in our ERP system. At the time of writing, we have 53,000 PIR agreements (Item, Lead time, and various Pricing T&Cs) across 112 vendors. Improvements to these numbers is now seen as "how we do things around here".
- When we commenced these initiatives, we did not have a long-form RFQ process in place. We currently issue all major packages to market via long-form RFQ. This process ensures we request and capture all pertinent information regarding pricing and T&Cs.
- Increases in efficiency on admin buying has created value-add in terms of enhanced strategic skillsets to the procurement function. Compliance and governance play

a huge role in our daily operations, and, in 2013, we did not know exactly how compliant we were but now we have the systems, data, and people to measure it and to manage it.

- End-to-end supply chain management of key categories, Lean supply chain, and full end-to-end logistics control from manufacturer to site. On previous projects, some of these categories were de-risked through the use of distributors.
- Spend is now apportioned more objectively across the supply chain with key partners, both in terms of consolidation and spread. Risk has been reduced significantly as there are more competitors and alternatives in the market place who are willing and able to meet our requirements.
- We have a full suite of procurement reporting on BI including:
    - Materials expediting
    - Schedule impact mitigation
    - Inventory management
    - Vendor performance
    - Price
    - Lead times
    - Quality
    - Purchase Price Variance (PPV) management
    - Budget management
    - Transport costs
    - Incoming freight
    - Internal transfers
    - AP management
- On-site JIT vendor managed inventory (VMI) agreements with four key vendors. These agreements mean that key consumable type materials, which were traditionally purchased on a daily basis, are now on site and managed by the vendors. Key vendors have invested in and implemented on-site scanning systems that enable Mercury personnel to collect materials on JIT basis. Downtime associated with waiting for materials to arrive to site is essentially eliminated for these categories. Daily POs to these vendors is limited to one PO per month.
- The use of standardised material data has improved from 45% in 2013 to 99% in 2020.

There have been benefits in terms of buying activity, including:

- Continuous flow – Zero lag time from requisition to PO for 53,000 SKUs – Takt time reduced.
- Increased time to focus on critical high value procurement activity – Opportunity time increased.
- Consistent pricing agreements.
- Average PO value in 2020 is five time greater than in 2013.
- 43% decrease in the number of POs per buyer.
- No increase in the number of buyers on a project that is four times larger and more complex than the previous major project undertaken.
- 95% decrease in the number of engineers processing requisitions.

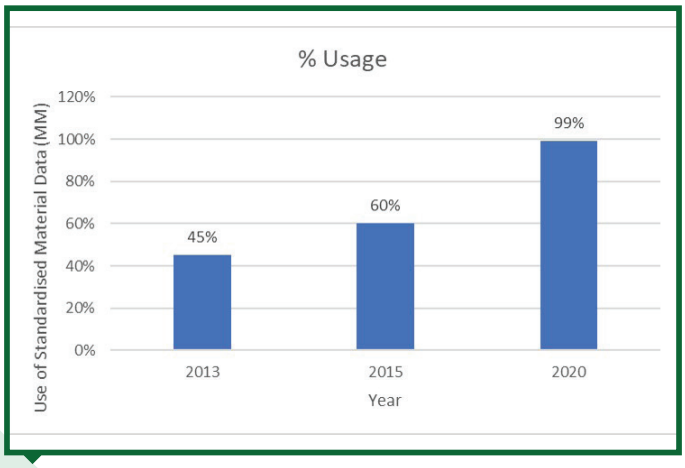

Figure 3. Usage of Standardised Material Data

Supplier agreement improvements include:

- In 2020, there are 112 supplier agreements in place (in 2012 there were zero and 2013 there were four).
- In 2020, there are 53,000 PIRs in place (in 2012 there were 2,500 MMs in place – prices only).
- In 2020, there are four Consignment stock agreements in place (in 2013 there was one Consignment stock agreement).
- In 2020, Procurement is driven by Procurement, with SOPs in place, whereas in 2012 Procurement was driven by construction with a high-risk SCM strategy.

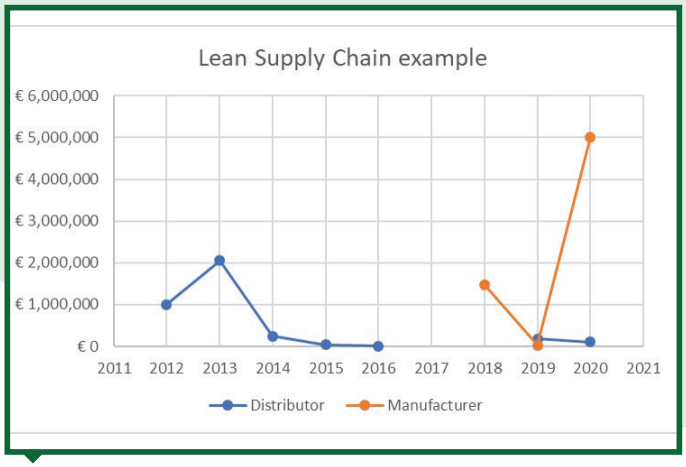

Figure 4. Migration of Spend from Key Distributor to Manufacturer

In terms of alignment of spend, Figure 4 illustrates an example of one key vendor where 2020 spend is limited to sole source equipment only.

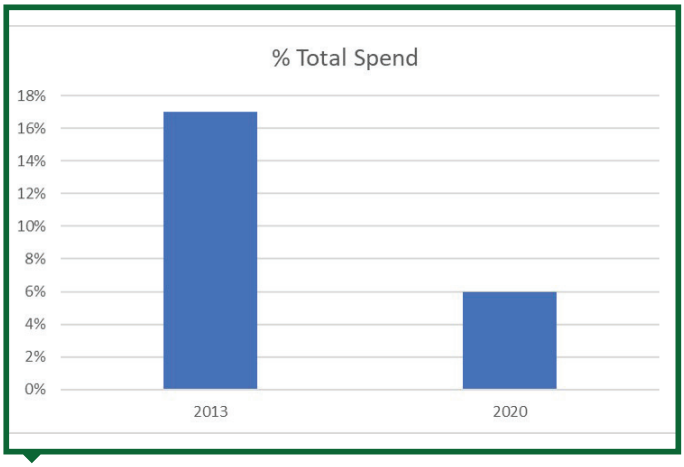

Figure 5. Lean Supply Chain Example

Born out of a need to do things better for our client, this Lean initiative has been an enormous and long-term undertaking to enable full implementation of material master usage on SAP and entailing large-scale information management. Lacking formal training in Lean within the Procurement function until 2015, this project hit many speed bumps throughout its eight-year period; however, two critical factors stand out as being pivotal in achieving the initial objectives set out, namely the team approach and the commitment of Mercury senior leadership in making it happen.

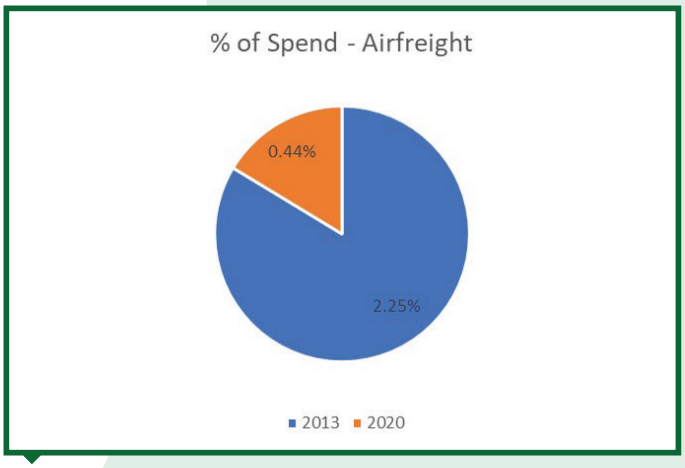

Figure 6. Reduction of Costs Associated with Purchasing Late to the FND

We now have a fully integrated EMR on SAP ERP, coupled with a Materials Requirement Planning (MRP) materials demand planning system going live November 2020. These information management systems would not be possible without the data and the work done on this Lean initiative. The requisitions process will become fully automated, and the demand and supply of materials will be managed similar to how it is done in manufacturing. The Mercury CI journey continues with gusto and Procurement plays its part.

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