Carbon emissions mapping at Unilever Europe: implementing a structural method to map and reduce carbon emissions
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Carbon Emissions Mapping at Unilever Europe

ir. W.J. Stein
Concise summary of this best practice
In 2007, the CEO of Unilever committed to a 25% reduction of CO$_2$ emissions from global manufacturing operations in 2012. Unilever Europe Logistics has aligned to this target. To achieve this objective, the management of European logistics department decided to build a carbon emission estimation methodology to quantify the CO$_2$ emissions, emitted from the sourcing units to the distribution centers.

In cooperation with the Technical University of Eindhoven, a new methodology was developed that allows transport-buying companies to estimate the CO$_2$ emissions in transport (Özsalih, 2009). A major advantage of developing your own carbon tool is that you can ensure that the tool fits with current working procedures, routines, information streams and data availability. This best practice describes how Unilever Europe managed this. The developed methodology supports Unilever Europe in achieving their ambitious sustainability targets.

Key terms
Methodology development, mapping carbon dioxide emissions, sustainability, calculation methods, emission reduction opportunities.

Relevant for
Transport-buying companies, transportation companies (3PL’s and 4PL’s) and shippers.
The impact of business on climate change

Sustainability is receiving lots of attention lately, especially in the transportation business. Freight transport has a large impact on climate change, mostly through the emissions of greenhouse gases. Still, the impact from transport on the climate increases. This is due to a combination of (at least) four causes: Firstly, the transportation sector as a whole is growing due to increasing consumptions. Secondly, the distances that products travel are increasing, due to globalization and home delivery. Thirdly, inventory reduction strategies (such as ‘just in time’ or ‘economic order quantities’) may also increase CO₂ emissions per ton-km. In these methods or calculations, the objectives are optimized delivery times or reduced investments at a certain service level, but the sustainability targets or the efficiency of transportation are not explicitly taken into account. Fourthly, customer demands (such as short time-to-markets and quick response times) are increasing the use of airfreight and fast-response carriers, which also increases the CO₂ emission per ton-km. It can be concluded that, in order to reverse this growth of freight related CO₂ emissions, business-as-usual cannot sustain.

At the same time, the climate has an increasing impact on the supply chain. A recent example is the ash cloud about Iceland (April 2009), shutting down international airfreight and passenger transport for several weeks. Thus, supply chain engineers have to take multiple environmental uncertainties into account: increased risks for disruptions, lawsuit risks, upcoming carbon regulatory compliances, etc. Moreover, customers (and investors) are ever more interested in the well-being of the environment, and increasingly demand their suppliers (and investments) to be eco-friendly. When companies take the lead to mitigate corporate carbon risks, stakeholder value can increase and market share can be gained.
In 2007, the CEO of Unilever committed to a 25% reduction of CO₂ emissions by all sourcing units by 2012. The Unilever's logistics organization in Europe, officially called UltraLogistik, has aligned to this goal and aims a 25% reduction of CO₂ emissions through transports and warehousing. UltraLogistik stated the following objectives concerning CO₂ emissions from transport:

• Absolute visibility of carbon emissions in transport
• Identification and assessment of emission reduction opportunities
• Understanding the impact of regulation alternatives and navigate themselves according to the possible scenarios

However, currently available standards and commercial packages for estimating CO₂ emissions from transport are not directly applicable for most of the transport service buying companies. Most of the available standards lack the necessary level of detail for a thorough analysis of CO₂ emissions in supply chains. On the other hand, the standards with a high level of detail require data that is not available to transport buying companies.

To achieve these objectives, the management of Unilever Europe decided to firstly build a carbon emission estimation methodology in cooperation with the Technical University of Eindhoven. The challenge of building your own carbon tool is caused by the complexity of supply chains and the amount of required knowledge. Nevertheless, the major advantage of developing your own carbon tool is that you can ensure that the tool fits to current working procedures, routines, information streams and data availability. This makes the future usage of the tool less time consuming, and it increases the likelihood that the tool and its results will be accepted by the organization.

In 2009, a team (consisting of employees of Unilever Europe, the researchers of the Technical University of Eindhoven and MSc student Hakki Özsalih) was asked to develop a methodology to estimate the current amount of CO₂ emissions, and to identify ways to achieve the 25% reduction goals. This best practice is based on the key steps by Lash and Wellington (2007) to develop climate strategies, starting with the methodology to quantify the carbon emissions.
Step 1: Mapping corporate carbon emissions in a structural way

Mapping corporate carbon emissions helps companies to identify the quantity of greenhouse gases emitted from different sources across the corporation. Once a company has an overview of its emissions and once the company understands the sources of its emissions, it is better equipped to strategically and cost-effectively address its carbon risks. For example, this allows managers to focus on the major sources of emissions. In many cases, unexpected energy inefficiencies are discovered and consolidated, serving both the environment and the bottom line. Equipped with well-functioning tools, companies are able to track the development of the carbon emissions, frequently and easily. Then, the numbers tell the tale and win-win situations can be found.

To quantify corporate carbon emissions, a company has to execute the following tasks: define the scope, develop the methodology and tool, choose the right emission standard, obtain the required data, and define useful outputs.

Defining the scope
The first challenge in the design of a CO₂ emission tool is the demarcation of the scope. A sound and complete assessment of the product lifecycle is valuable and admirable, but this exercise is accompanied by a staggering amount of complexity (see Figure 1). For Unilever Europe, it was important to develop a proof of concept. It was preferred to show a working solution and to create awareness inside the company. The complete assessment is postponed for the time being. Firstly, an accurate working solution had to be found.

Therefore, Unilever Europe decided to focus on the primary transportation. In this context, primary transport was defined as the international transport of finished goods from the sourcing units to the primary distribution centers via different transportation modals (see Figure 2). The sourcing units, the warehouse activities and the secondary logistics (from main warehouses to customer warehouses) are out-of-scope.

Please note that Unilever took an organizational focus. One can also start with a product or product life-cycle focus, resulting in a complete different approach to quantifying emissions.
The advantages of this choice are:

- The distances of primary transportation are large, thus a large fraction of the CO$_2$ emissions of Unilever Europe's transport are captured in the model.
- The complexity of primary transportation is smaller than the secondary transportation. In most cases, primary transportation comprises full-truck loads, whereas secondary transportation consists a mixture of all kinds of products for different customers.
- The situation of primary transportation is relatively static, so future data maintenance is little time-consuming.

Choosing the right emission estimation standard

The next challenge in mapping CO$_2$ emissions is the choice for the right standard set of norms to calculate the emissions. These standards provide the calculation methods and relevant environmental parameters, such as emission factors of different transportation modes. Unfortunately, there is no universally excepted
standard (yet), upon which companies can build\(^2\). Instead, the choice is numerous and confusing. The differences between these standards are stunning, and one of the major complains about CO\(_2\) emissions calculation standards is that two accepted standards will calculate different amounts of emissions.

To overcome this challenge, the TU/e developed a comprehensive carbon calculation tool together with Cargill, Bausch & Lomb, Unilever Europe and DOW (see also the text box on the eSCF project Carbon Regulated Supply Chains). Basically, the TU/e project built a variant of the NTM calculation method and included additional parameters, assumptions and information from different sources (see Table 1). The NTM\(^3\) was used as the primary source of information for three reasons. Firstly, NTM is primarily developed for buyers and sellers of transport services that seek to quantify emissions from transport activities. Moreover, NTM is known for its high level of detail, which enables a reliable estimation of CO\(_2\) emissions. Furthermore, NTM (being a non-profit, governmental organization) is committed to use both the most credible and publicly available sources of data, which makes it likely that NTM will remain a valid source in the future, when CO\(_2\) estimations have to be legally justified. An extended description of the developed calculation method can be found in the CRSC report (2009).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sources parameters</th>
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<td>Vertical handling</td>
<td>CRSC project</td>
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The parameters and the assumptions of the developed tool come from different sources, selected during the eSCF project Carbon Regulated Supply Chains.

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\(^2\) For the time being, companies have to choose between a large number of standards, including but not limited to: ARTEMIS, EcoTransIT, GHG Protocol, Infras/IWW, Dings and Dijkstra, IFEU 2005 and NTM.

\(^3\) The NTM (Network for Transport and Environment) is a Swedish non-profit organization.
Develop a methodology
The methodology, developed by the TU/e, describes how all the different sources of information are gathered, maintained and used to calculate the CO₂ emissions. The difficulty in developing a methodology lies in deciding on the future level of automation, accuracy and maintainability. Considering the data, the researchers involved aimed to obtain a high level of automation without harming the reliability. What must be included to obtain reliable measures, and what can be assumed without harming the reliability of our results? Which are the most important factors to take into account? What can be assumed, and what needs to be measured? How can we decrease the complexity? The answers to these questions, and more, are gathered in the methodology.

This methodology brings together different sources of information (see Figure 3). The external information is gathered from the different business partners that transport goods for Unilever Europe. The computations itself, mainly consisting of multiplications and summations, are rather straightforward, but the number of equations and parameters can be confusing. There is a large amount of transport options, each requiring their own equations and estimation parameters. The guidelines on the correct usage of the equations are also translated into the methodology. Nowadays, the developed methodology allows a simple, quick and robust estimation, which provides a solid analysis of CO₂ emissions from transport.

The developed methodology describes how all the different sources of information are gathered, maintained and used to calculate the CO₂ emissions.
Much of the relevant data had already been collected in the form of transport data from Unilever Europe’s Transport Management System. Since Unilever Europe outsources its transportation, detailed and reliable information on the actual shipments is used for transactional purposes. Internal information can be integrated with very little effort (since this is taken into account in the development of the methodology).

As opposed to the information on pure road-lanes, the available information concerning intermodal transportation was limited. Therefore, a questionnaire was developed and sent out to all carriers running intermodal lanes. Carriers were asked to specify used transport routes of each individual lane, including the exact road and non-road distances, and the types of transport and equipment. The obtained information on the intermodal transport was combined with the internal data. Hereafter, all required information was available.

The CO₂ awareness of large Western European logistics service providers is generally rather high, and 94% of the required information was gathered. For the larger logistics providers, providing these kinds of information is becoming part of their business. Most of their clients are aware that CO₂ regulations will impact their business, so the larger providers are helping their customers and are able to deliver the information in other occasions. Logistics providers with a smaller fleet may have more difficulty in obtaining and providing the required information, and in most cases they do not have the information at hand.

Nowadays, the carriers are expected to keep Unilever informed on any changes in the transport modes, which is essential to keep the data up-to-date. So for the carriers, providing the relevant information has now become a standard procedure.

**Defining the output**

After the tool was completed, tested and packed with data, the actual carbon emissions were calculated. Finally, to monitor, track and report the CO₂ emissions over time, two performance metrics are developed by Unilever:

- **KPI 1:** Absolute amount of carbon emitted due to transport, in kilograms of CO₂.
- **KPI 2:** Efficiency of carbon emissions, in kilograms of CO₂ per ton-km.

Nowadays, the tool provides Unilever Europe with a dedicated monthly report, allowing Unilever Europe to quickly assess the development of their carbon emissions.
**Step 2: Assessment of carbon-related risks and opportunities**

With the tool, Unilever Europe and the Technical University of Eindhoven executed different experiments to assess carbon-related risks and opportunities to reduce emissions. Below, the most important and surprising lessons, found during the master thesis project of Özsalih, are portrayed:

**1st Lesson: Water and rail are not always cleaner**
Both in industry and in literature, it is very common to characterize water and rail as cleaner ways to ship goods, and consequently these transportation modals are associated with CO$_2$ reductions. However, both theoretical analyses and analyses based on Unilever Europe transportation data showed that it is not possible to conclude that these options always lead to greenhouse gas emission reductions! As a matter of fact, changing from road to rail or water without a thorough consideration may lead to increased CO$_2$ emissions. Clear-cut door-to-door assessments (on lane-level) are required, and generalizations are very difficult to underpin.

**2nd Lesson: Sensitivity of parameters is very low**
Because CO$_2$ calculations consist of a large amount of multiplications with many variables and parameters, it is important to assess the sensitivity of the parameters and variables. Some variables (such as the number of loads, condition of transport and type of truck) are internally available data that is crucial for operational purposes. Here, no uncertainty is expected. Other variables (such as load factors, type of train or engine, and emission factors) are more likely to obtain errors or deviations. Unilever Europe assessed the sources of uncertainty to understand them, and to find ways to improve the reliability and accuracy of the estimations. It was found that the data deviations on lane level might be huge, so one has to be careful with conclusions on lane level. However, the overall impact of deviations is very low to negligible, due to the small share of one deviation in the complete estimation. Large deviations on lane level are cleared out by their individual effect on the complete estimation.
3rd Lesson: Dealing with (European) regulation uncertainty

Previous research of the TU/e identifies four different EU regulation scenarios, with the expected increased costs for different transportation options (see the text box *Upcoming regulations concerning carbon emissions*). The impacts of these different regulation scenarios are tested upon Unilever Europe’s primary transport with the developed carbon tool.

The key learning for Unilever Europe was that although the costs are likely to increase in a CO₂ constrained economy, the business opportunities are likely to increase as well. Companies that are able to adapt quickly to the regulations can achieve significant emission reductions and cost savings, and thereby potentially increase market shares. The impact of carbon regulations will be significant: it can lead to win-win situations wherein 6 to 11% of the CO₂ emissions are saved without increasing the cost base; it can also lead to major cost increases, depending on how tough the regulations (and the CO₂ trading prices) will be. This indicates how important it is for companies to navigate themselves according to the new regulations.

**Upcoming regulations concerning carbon emissions**

Back in 1999, the European Union agreed on the Kyoto Protocol, with an objective to decrease the green house gases by 5.2% in 2012 compared to 1990 values. The EU desires to reach these objectives (amongst others) by introducing a regulation mechanism including carbon-trading allowances, which should be introduced on the market in the next 5 to 10 years. Currently, one can only speculate about these upcoming carbon regulations, and their impact on supply chain management.

Previous research on the Technical University of Eindhoven has shown that companies are likely to face a new decision variable, namely cost of emissions, whilst deciding on supply chain management challenges. This research also suggests that “these emission regulations may require a new understanding of emissions: rather than begin a tax-like cost or a simple transaction entry in the balance sheet, it might be wiser to treat them as inventory items to be managed just like tangible goods”. Finally, this white paper also suggests that a proactive attitude towards upcoming regulations would outperform reactive attitude. Unilever embraced these suggestions and identified the different potential regulation scenarios and tested the impact of upcoming regulations with the developed carbon tool (Source: ESCF white paper EU Emissions regulations, 2008).

4th Lesson: Reduction opportunities for Unilever Europe

Last but not least, Unilever Europe was able to accurately test different reduction opportunities. Unilever Europe found several win-win situations wherein both costs and emissions were reduced, and majority of the promised 25% reduction would be achieved.

The following four initiatives seem to have a great potential for success.
• **Increase load factors (equipment utilization)**

The load factor of the freight capacity is the percentage of freight capacity that is utilized. It is likely that full-truck loads are less polluting than two semi-filled trucks. But, what is the precise relation between the load factor variations and CO$_2$ emissions? Since, changing loads, emissions and number of shipments are related, these relationships are investigated. The investigated relation is shown in Figure 4. Currently, the average load factor of Unilever Europe is 60% (the figure is standardized towards 100 on the Y-axis). So, for example, when the average load factor is increased from 60% to 70%, the total amount of CO$_2$ emissions will decrease by 10%. If Unilever Europe would be able to load the trucks to 80%, 18% less carbon would be emitted compared to the current load factor. Obviously, on an aggregate scale this might be rather difficult, but it can be a rather strong argument to convince your customers to help filling your truck.

![Figure 4](source.jpg)

The relation between the load factor and CO$_2$ emissions.

• **Network optimization to decrease the amount of kilometers traveled**

Optimization of the supply networks can lead to a reduction of (empty) kilometers to be driven. In this research, several consolidation and network design analyses in different European countries were performed. Firstly, it is analyzed whether dedicated warehouses should be combined into larger warehouses, or vice-versa. Secondly, it is analyzed whether a redesign of the current supply chain structure would lead to improvement.

In each scenario, the number of kilometers traveled was reduced significantly. For example, in Poland 10.6% kilometers were reduced due to network design. The average reduction of kilometers traveled in this research was 5.7%, based on eight scenarios. Through careful analyses, it was concluded that network optimizations also lead to significant improvements for the environment.
• **Use different transportation modes**

A straightforward but promising option is the use of double-deckers. Double-deckers are capable of stacking palettes, doubling the amount of freight in a single truck. In theory, the number of rides may be split in two. However, since the increased weight per truck leads to increased emissions, the amount of emission reduction needs to be calculated carefully. It turned out that the reduction (on lane level) might be up to 43%.

Obviously, the company needs to be able to fill the additional space with extra loads for the destination. However, the impact of double-deckers is much larger than increasing the single load factors. Not surprisingly, Unilever Europe is currently experimenting with this sustainable transportation mode.

• **Redesign the supply chain with modal shift opportunities**

To investigate the modal shift opportunities, 75 intermodal carriers were invited by Unilever Europe to quote on 550 existing lanes. The quotation lanes were both long (> 500 kilometer) and heavy (> 50 loads p.a.) and account for a major part of Unilever Europe’s emission in the scope of this research. In total 937 useful bids for 239 lanes were received from 52 carriers. On 208 of the 239 lanes CO₂ emission reductions were found within these bids. (Note that both costs and lead-times were not considered in this part of the research, yet) This equals a 37% reduction of the annual emissions on these specific lanes. After careful extrapolation, it was concluded that potentially 19% of the annual emissions of Unilever Europe (in the scope of this research) could be reduced by modal shifts! Thus, 19% reduction can maximally be obtained via modal shift changes. In the next assessment, the variable cost was also included. The figure below depicts this trade-off between costs and CO₂ savings, showing that win-win situations can

![CO₂ vs Cost Savings](image)

*In 72% of the cases, CO₂ savings go hand in hand with costs savings. Further decreasing the CO₂ emissions via modal change will lead to an explosion of costs.*
be found in 72% of the potentially improved lanes (19% of all lanes of Unilever Europe). The crucial conclusion is that by changing the transportation modal 14% reduction of CO₂ emissions can be achieved without increasing the cost level! Furthermore, it can also be concluded that in 33% of the cases, the CO₂ reductions go hand-in-hand with cost reductions.

In the next and final assessment, the variable service will also be taken into account. Alternative transportation modes are interesting options, as long as customer requirements (such as a certain lead-time) are satisfied. The responsible transport manager of Unilever Europe has asked to analyze all 937 bids. Based on the usual costs and service evaluations, only 187 bids were accepted. Out of these 187 bids, approximately two-third of these bids had a positive effect on the emissions. In total, these options lead to 8% reductions of CO₂ emissions, instead of expected 14%. This difference is due to the service terms agreed with the customers, so it can be concluded that 40% of the potential reductions cannot be achieved due to service restrictions!

This leads us to the next challenge: how do we have to deal with these new opportunities and restrictions?

The Carbon Regulated Supply Chains project

This project at Unilever was part of the Carbon Regulated Supply Chains (CRSC) project of the European Supply Chain Forum (eSCF). In 2007, the participants of the eSCF concluded that there was limited knowledge on carbon dioxide emission in supply chains. Limited academic research had been conducted and there was uncertainty on how new regulations would influence the supply chains of companies. Because of this lack of academic research and because of their expertise on the subject of supply chains, the European Supply Chain Forum (eSCF) decided to start the Carbon Regulated Supply Chains project (CRSC project).

The first phase of the project, literature research was done to determine a method for calculating emissions from transport. In this period, the objectives of the project were formulated as follows:

• To understand the impact of the various regulation alternatives on the design and operation of supply chains;
• To assist decision makers in industry by preparing strategies for coping with the upcoming regulations;
• To impact policy makers and the public opinion on the effectiveness and problems of new regulations.

In the second phase of the project, four simultaneous master thesis projects were executed at four members of the eSCF:

• Bausch & Lomb; an eye-health company
• Cargill; a food manufacturing company
• Dow; a chemical company
• Unilever; a food manufacturing company

During these four projects, the students of the Technical University of Eindhoven worked closely together. Their bundled findings can be found in Akker et al. (2009).
Step 3: Adopt your business in response to risks and opportunities

It can be concluded that the research has found plenty of opportunities to decrease the carbon emissions. Fortunately, sustainability initiatives go often hand-in-hand with cost savings, but some initiatives jeopardize customer service. Companies might need to reconsider their service terms (especially required transport times) in order to achieve significant reductions in CO₂ emissions. It may be cheaper and better for the environment to carry a product by boat, however, when the products need to be delivered in (i.e.) two days, that does not fit the equation.

The next step is to adopt the business to properly balance these three opposing goals. Customer demands, transportation costs and emissions have to be carefully balanced, and the complexity of the interrelations between these objectives cannot be underestimated. There is always the risk that the pursuit of one objective will have an offsetting effect on another objective.

Unilever Europe therefore has identified the three C’s as main focus areas: Customers, Costs and Carbon, and nowadays rates the quotations on any logistical tender based on these three variables. Basically, every future logistical tender will be analyzed on emissions, and Unilever Europe is now looking new working methods, to improve the transparency and objectivity of these decisions. A new decision variable, namely cost of emissions, whilst deciding on supply chain management challenges, might be a solution.

In transportation decisions will now be based on i) customer requirements, ii) transportation costs and iii) carbon emissions.
With the current methodology in place, Unilever Europe has taken a great leap and Unilever Europe is now able to analyze the sustainability of the supply chain quickly and reliably. The future steps of Unilever Europe are to include the secondary logistics into the tool. The secondary logistics have a more complex and dynamic character with smaller packages and more customers and lanes. These future extensions also may include cross docking and warehousing.

European consumers are getting more and more environmentally aware. Major retailers (Unilever Europe's customers) are willing to pay more to be carbon neutral. To be environmental friendly is getting increasingly important with increasingly complex chains. So continuous improvement is crucial, and this methodology is a prominent step forward. Companies with the vision and technology to provide products and services that address climate issues will enjoy a competitive advantage.

**The organization of UltraLogistik**

Unilever is one of the world’s largest consumer goods companies with a turnover of ?40.5 billion. Unilever employs 174,000 people in 100 countries worldwide. In January 2006, the Unilever Supply Chain Company AG (USCC) has been established as part of the new European supply chain organization, co-locating the supply chain key decision-makers in Schaffhausen. USCC is now responsible for all key decisions in the European Supply Chain including buying, planning, manufacturing network and logistics (primary transport) & warehousing operations.

Within USCC, Unilever has made a major investment to in-source and centralize its transport management capability and UltraLogistik is founded as the brand name of the Unilever Transport & Logistics Organization.

- UltraLogistik delivers service for 68 Unilever factories and 200 Contract Packers.
- UltraLogistik organizes approximately 500 trucks per day.
- UltraLogistik operates on more than 3,000 transport lanes.
- UltraLogistik uses 180 transport service providers.
- UltraLogistik employs around 220 employees in both Switzerland and Poland.
Conclusions

The simplicity of the developed methodology allows the company to regularly track and monitor the CO₂ emissions, due to the clear visibility that the methodology offers. Nowadays, Unilever Europe makes monthly reports. Moreover, the methodology also allows comparing different sub-contractors in terms of carbon efficiency, so Unilever Europe can continuously decrease their emissions. In conclusion, this research at Ultralogistik has shown that by switching transport modes, raising load factors and improving fuel efficiency the goal of 25% emission reductions can be obtained (see also table 2). This research and subsequent actions by management enables decoupling of CO₂ emissions from the growth of freight transport. That makes this applied research an intriguing ESCF best practice.

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<th>Potential reduction</th>
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<tr>
<td>Increase average load factor from 60% to 70%</td>
<td>Up to 10% less emissions</td>
</tr>
<tr>
<td>Network redesign</td>
<td>Up to 5.7% less emissions</td>
</tr>
<tr>
<td>Using double-deckers</td>
<td>Up to 43% less emissions (on lane level)</td>
</tr>
<tr>
<td>Redesign using modal shift opportunities</td>
<td>Up to 19% less emissions</td>
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*An overview of the reduction opportunities for Unilever, found during this project of Özsalih (2009).*
References

- NTM's website

Colophon

The eSCF (European Supply Chain Forum) Operations Practices: Insights from Science are published to inform members of the eSCF about the best practices, key managerial insights and scientific principles of Operations Management and Supply Chain Execution.

Editorial

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