SINTEF

«Green and Sustainable
Summer Internships 2019»

KPIs for Sustainable Procurement

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02.09.2019

Abstract

In this study we have looked at the topic of sustainable procurement, and how this could be monitored and visualized with the use of key performance indicators. It was proposed to divide procurement into the categories ”orders”, ”transportation”, ”reception of wares”, ”utilities”, ”wares” and ”suppliers”. A proposition for what could be key performance indicators for each category was also created. Since the suppliers of a company are a big factor of the sustainability of it's procurement, a way of monitoring and comparing the sustainability of suppliers was suggested. It was discussed how different key performance indicators would be expedient to use for different businesses, and the importance of choosing the right ones in order for them to be effective. An example of a selection of key performance indicators was presented in a table where data was fabricated in order to give values to the key performance indicators. An example of a supplier form was also made. A good visualization of key performance indicators and their development over time was deemed critical for the effectiveness of their use. Because of this, a dashboard was created in Python with Dash by Plotly, to illustrate with an example how visualization of key performance indicators could be done. The data for the dashboard came from the example table made with fabricated data. In the dashboard, a supplier table with traffic light rating was included. The data for the suppliers in this table was also fabricated. In the end, some suggestions for further work and business opportunities related to this topic was given.

Contents

1 Introduction

1.1 Project Background

The desire to prevent further climate change from global warming, along with the UN's sustainability goals has increased the focus on sustainability in companies all over the world. Sustainability is often divided into three perspectives: economical, social and environmental. The topic of circular economy is also considered a closely related subject to sustainability. Many companies have made an effort to become more sustainable by monitoring and taking action to improve internal sustainable factors such as emissions, handling of waste and hazardous work environments. In this report, the objective will be to describe and exemplify how companies can further increase their sustainability by developing key performance indicators (KPIs) for sustainable procurement.

1.1.1 Grønne Bærekraftige Sommerjobber 2019

Sintef Helgeland's "Grønne bærekraftige sommerjobber 2019" is a summer project that challenge students to solve real-life problems for the local industry. The tasks are to be approached on the basis of the principle of circular economy. The five students were given three problems to be solved over the course of eighth weeks, including Digitalization and Automation, Energy System Optimization and KPI's for Sustainable Procurement. In this report, the result of the KPI project will be presented. Contributing partners for this project are Sintef Helgeland, Mo Industripark AS, Elkem Rana AS, Arctic Circle Data Center AS, Celsa Armeringsstål AS, Sintef Molab AS, Storvik AS, Arctic Cluster Team, Nord University and Nordland Fylkeskommune.

1.1.2 UN's sustainability goals

The UN has defined 17 sustainability goals (SDGs), see Figure 1, agreed upon by all the members states; each goal having corresponding targets that need to be met in order to achieve that goal [1]. The focus was placed on the following selected targets from SDG 6, 7 and 12 because they were most specific, quantifiable and considered relevant to the participating companies and their core business:

Figure 1: UN Sustainability Goals

- 12.2: By 2030, achieve the sustainable management and efficient use of natural resources
- 12.4: By 2030, achieve environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.
- 12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.
- 12.6: Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle
- 12.8: By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.

- 6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
- 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
- 7.2: By 2030, increase substantially the share of renewable energy in the global energy mix

1.1.3 Sustainability in procurement

Sustainable procurement means to meet the needs for goods, services, works and utilities in a way that achieves value for money in terms of benefits to the organisation, society and the economy, whilst minimising damage to the environment. In order to do this one must understand the economical, social and environmental consequences related to the purchases that are made. This requires information on the production and transportation of the goods, and insight of the social and environmental conditions of the manufacturer. By applying the principles of circular economy in procurement, one could achieve the practice of circular procurement. An approach to this is to follow the principle of the three Rs: Reduce, reuse, recycle. These are steps in the waste hierarchy [2] that can be followed in regards of both materials and energy in order to reduce the amount of waste going to landfill and the carbon footprint.

- Reduce: First, one considers if the purchase is really necessary. If it is, then the possibility of purchasing a smaller amount, or a variant with a longer lifetime must be explored. This would prevent emissions related to producing and transporting goods, waste in the form of packaging on the goods as well as the waste the goods would end up as at the end of their lifetime.
- Reuse: Secondly, efforts are made to reuse equipment as an alternative to purchasing new ones. This can be done by purchasing used appliances, having broken our outdated articles repaired or upgraded and dismantling equipment that is out of use so that parts can be used other places.

- Recycle: Lastly, one could utilize recycled materials where this is possible, further minimizing the amount of waste going to landfill.

The benefits of sustainable procurement could include increased economic value as well as positive social and environmental effects. Documenting the sustainability of the company could also provide an advantage in the marked by being considered sustainable, which could be used when marketing the company.

1.1.4 Visualization of KPIs

In order for the KPIs to be used effectively, it will be important to summarize them and visualize them in a way that makes them quick and easy to understand for members in all parts of the organization. This understanding of what the KPIs represent and how they are built up will be essential when making procurement decisions for better sustainability. If the KPIs are not easily understandable one may risk that they are not used, simply because they are not considered useful by the organization members who are supposed to use them. A proper visual representation is key to making the progress and trends of the KPIs over time more clear. Diagrams showing the KPI values from year to year or month to month and comparing them to target values for the KPIs could be a way of doing so.

2 Developing KPI's for Sustainable Procurement

In this section, different categories proposed for monitoring sustainability in procurement are explained along with their associated KPIs, as well as thoughts around what would be considered sustainable practice for each category. In order to come up with this, research was done of existing categories, KPIs, visualizations and systems for procurement used elsewhere. Some useful information was found from Datapine [3], The Linde Group[4], Walmart [5] and others [6] [7]. With this as an inspiration, a new set-up was made with the purpose of specifically monitoring sustainability in procurement. The particular categories and KPIs presented in this section were chosen because they were considered the main parts of a procurement process, and would be applicable for most of the companies participating in the project.

2.1 Orders

The category concerns the actual placing of orders done by the organization. The KPIs created for this category are shown in Table 1 below. Sustainable practice of orders involves rapidly handling of the needs reported to the procurement department by the other departments, placing the orders ahead of the needs so that they arrive in time and making orders of expedient size and frequency.

Table 1: KPIs in the ”orders” category with metrics and explanation

KPI	**Metric**	**Explanation**
Number of orders	num.	Shows the total number of orders made in the time period. Provides a reference point to see other KPI values in relation to the total number of order
Number of just-in-time orders	num.	Shows how many just-in-time orders that have been made in the time period
Number of orders made after inventory is empty	num.	Shows how many orders that were placed after the stock of the needed product is already empty.
Average time from input of need to order placed	hours	The average time it took from a member of the organization reported a need to an order was either planned or placed. Shows the effectiveness of the procurement department and the communication into the department

2.2 Transportation

This category contains information on the transportation of deliveries for the organization, as well as the travels made by employees in the organization. The KPIs created for the transportation category are shown in table 2.2. Sustainable practice in the transportation category involves procuring locally when possible to lower emissions from transport and choosing green means of transportation both for transport of deliveries and for employee travels.

Table 2: KPIs in the ”Transportation” category with metrics and explanation

KPI	Metric	Explanation
Total freight distance	km	Shows the total distance that goods and wares have been carried in order to reach the organization
Average freight distance per shipment	km/shipment	The average hauling distance of goods and wares in the time period
Share of freight distance carried out with green transportation	%	Shows how much green transport that has been used. Which means of transport that are considered ”green” and not has to be defined, or one could have shares of the freight distance carried out with different means of transport directly
Total CO_2 equiv. emissions from shipments	kg	Shows the carbon footprint created as a result of transporting wares and goods to the organization. As this would be complicated to calculate precisely, a simplified formula using a certain emission per kilometer for different means of transportation could be a way to put the value for this KPI together more easily
Average CO_2 equiv. emissions per shipment	kg/shipment	The average carbon footprint per delivery
Work travel emissions per employee	kg/employee	The emissions related to all travels made in a work context in the time period, calculated with a standardised formula with a certain emission set per kilometer traveled with different means of transportation

Share of flights where carbon offset was paid for	%	As there are situations where employees are dependent on traveling by aeroplane, buying carbon offsets for the flights could be a way of making up for the emissions from the air travels. This KPI shows the portion of business flights where the organization has paid for carbon offset

2.3 Reception of wares

This category deals with the handling of deliveries upon their arrival at the company. The KPIs created for this category are shown in table 2.3 below. Sustainable practise of reception would include making the right preparations in order to make the reception as effective as possible, as well as performing quality controls to make sure that the received goods are both correct and in good shape, or to discover needs of improvements in the transportation to prevent damage.

Table 3: KPIs in the ”Reception of wares” category with metrics and explanation

KPI	Metric	Explanation
Number of received deliveries	num.	The total number of deliveries received by the organization in the time period.
Number of deliveries arriving later than scheduled time	num.	Shows how many deliveries that arrived later than the time promised by the supplier or transport company. A limit value for what is considered late should be set in order to clearly define what should be put down as late or not.
Number of deliveries arriving later than the goods is needed	num.	This KPI shows the number of times that a delivery has arrived later than the need for the contents of the delivery.

Average time handling deliveries	hours	Shows the average time from a delivery arrives until the goods have been taken care of and put in its place. This gives an indication on the organizations effectiveness in logistics, and of the man-hours that goes into handling deliveries.
Number of wrong deliveries	num.	Shows how many times the organization has received deliveries that did not meet the specifications needed. This could be due to the organization ordering the wrong product, defects on the product or the supplier not delivering what was agreed upon.
Share of wrong deliveries with no problem/ adaptation needed/ can't use as consequence	%	Receiving a wrong delivery can have different consequences, and here three such consequences are suggested. The share of wrong deliveries received in the time period having the different consequences are presented.
Number of damaged deliveries	num.	Shows how many deliveries that arrived with damages.
Share of damaged deliveries with no problem/ reparation needed/ can't use as consequence	%	Receiving a damaged delivery can have different consequences, and here three such consequences are suggested. The share of damaged deliveries received in the time period having the different consequences are presented.

2.4 Utilities

This category contains information on the procurement of utilities, more specifically water and energy. The KPIs created for this category are listed in table 2.4 below. For

sustainable practice when it comes to procuring utilities, one should procure renewable energy and move away from fossil energy sources, use recycled energy/water if possible and procure water in a way that does not contribute to the depletion of scarce drinking water sources.

Table 4: KPIs in the ”Utilities” category with metrics and explanation

KPI	Metric	Explanation
Water consumption	m^3	The total consumption of water in the time period
Water consumption per unit of product produced	$m^3/unit$	The consumption of water used to make one unit of product. For companies producing many products, it should be considered if the water consumption for all products should be monitored or if only some products should be focused on
Share of recycled water used	%	This KPI shows the portion of reused water in the water consumption. This could be reuse of water from own production or from other sources where the water would otherwise be released
Share of water consumption form scarce source	%	Shows the portion of the water consumption obtained from drinking water sources considered scarce. In areas with limited access to drinking water, consuming large amounts of drinking water for production could affect the local residents negatively as their source of drinking water could get depleted
Energy consumption	GWh	The total energy consumption from all energy sources in the time period

Energy consumption per unit produced	MWh/unit	Shows how much energy that was used to produce one unit of product in the time period
Electricity consumption	GWh	The total consumption of electricity in the time period
Share of renewable energy	%	Shows the portion of renewable energy in the total energy consumption
Share of fossil fuels	%	Shows how much of the total energy consumption has been provided by different fossil fuels in the time period.
Share of recycled energy	%	Shows how much of the energy consumption that comes from recycling energy from own or other's production

2.5 Wares

This category deals with the different goods and wares procured, The KPIs created for this category are shown in table 2.5 below. Sustainable practice for this category would involve procuring the wares from green sources, procuring recycled materials and reducing unnecessary plastic packaging on the wares.

Table 5: KPIs in the "Wares" category with metrics and explanation

KPI	Metric	Explanation
Amount of product X procured	depends	Shows the amount of certain products procured in the time period, given as a number or a mass depending on the product in question.

Share of product X procured from ”greenest on market”	%	If there are different manufacturers of product X, this KPI shows the share procured from the one considered greenest. It could also be applicable to distinguish between ”green” or ”not green” suppliers of product X in stead of only measuring how much comes from the very greenest
Share of product X procured from recycling	%	If product X can be reused, or is a bi-product from another process, this KPI shows the portion of the procurement form recycling/reuse
Plastic packaging on wares	kg	Shows the amount of plastic waste from the packaging on goods and wares delivered to the organisation in the time period

2.6 Suppliers

The supplier category provides an overview of the suppliers on some points that are independent of factors such as the location and size of the supplier company and what products they deliver. International standards make the main base of these points. The KPI's created for this category are shown in table 2.6 below. For this category it will not be a matter of having a sustainable practice, but rather ensuring that the organization has suppliers that do so.

Table 6: KPIs in the ”Suppliers” category with metrics and explanation

KPI	Metric	Explanation
Number of suppliers	num.	The total number suppliers that are regularly deliver either goods or services to the company

Share of suppliers with ISO14001 certification	%	The portion of the suppliers that have been certified to the ISO14001 standard, which specifies demands to environmental management
Share of suppliers with ISO50001 certification	%	The portion of the suppliers that have been certified to the ISO50001 standard, which specifies demands to energy system management
Share of suppliers with ISO45001 certification	%	The portion of the suppliers that have been certified to the ISO 45001 standard, which specifies demands to HSE management
Total CO_2 equiv. from production of wares procured from suppliers	tons	With access to the emissions related the supplier's production of one unit of product and an overview of how much of each product have been procured, one can have a number for the total carbon footprint from all products procured in the time period
Total number of work injuries on supplier locations	num.	As a way to measure the safety in the supplier facilities, this KPI shows the number of work accidents related to producing the products procured. If possible, one could include only the accidents that occurred in the departments of the suppliers that produce the specific products procured

2.6.1 Tool for rating and comparing suppliers

Since the suppliers and their practices strongly influence the sustainability of the organizations procurement, it was deemed expedient to have a system for rating the sustainability of each supplier. A way of doing this would be selecting KPIs that relate to the sustainability goals in the company, and monitoring regular suppliers on these areas. This would hopefully also contribute to increasing the focus on sustainability

further back in the value chain. In order to rate the suppliers, one could use a table with a traffic light system. This system would be put together by setting intervals for a red/yellow/green rating for the KPI values, where a the supplier would be rated by which interval their KPI value is within. If desirable, a total rating of the suppliers could also be created. By giving each color in each KPI a value weighted out from how they are prioritized, one could give the supplier a total score by summing them together. By setting value intervals for a red/yellow/green for the total score the suppliers could get be rated in total as red, yellow or green. How much money the company pays each company should also be included, for example by including in the table the share of supplier costs going into each supplier. An example of such a supplier table is presented in figure 7 and figure 8 in section 3.3. In the same way that KPIs could be selected for a supplier table to monitor the sustainability of regular suppliers, it could also be used when selecting a supplier. By creating a supplier form that would be filled out by the bidders in a tender, the company can take take the sustainability of the possible suppliers into account before choosing. An example of such a supplier form is presented in table 8 in section 3.2.

3 Expedient Selection and Visualization of KPIs

3.1 Expedient Selection of KPIs

Which of these proposed KPIs that should be used by a company depends on the company's business model and its objectives for sustainability. The selection of KPIs will also be dependent on the availability of the relevant data, and KPIs that leads to an inconvenient amount of registration and work load may not be expedient to use. This is also the case for choosing the range for which to measure the indicators, i.e. months vs. years. In table 3.1, we have chosen KPIs we believe are quite universal for all relevant companies. The data presented for each indicator are made up, with the purpose of illustrating how the indicators can be used in daily operation. This example data is also used when creating an example dashboard presented in section 3.3.

Table 7: Example data for selection of KPIs

	Jan	Feb	Mar	Apr	May	Jun	Jul	Avg/Tot	Target for 2019
Orders									
Number placed [num]	22	19	29	16	18	24	20	148 [tot]	

Made after out stock [num]	1	0	2	0	1	0	2	0.85 [avg]	1
Avg. time from need to order [h]	2,6	3,9	1,8	2,2	2,7	3,4	2	2,66 [avg]	3
Transportation									
Avg. distance of shipments [km]	1890	2678	2345	2217	3014	2516	3140	2542,86 [avg]	
Share of green transport [%]	5,2	12,0	9,1	10,4	13,5	6,7	9,5	9,49 [avg]	10
Reception of Wares									
Number of received deliveries [num]	18	24	26	17	18	22	19	144 [tot]	
Share of delayed deliveries [%]	0,0	4,1	0,0	5,8	0,0	0,0	0,0	1,41 [avg]	2
Number of wrong deliveries [num]	0	2	1	0	0	1	0	4 [tot]	5
"No problem" as consequence [%]	-	50	100	-	-	0	-	50 [avg]	
"Need of adaption" as consequence [%]	-	50	0	-	-	0	-	25 [avg]	
"Can't use" as consequence [%]	-	0	0	-	-	100	-	25 [avg]	
Number of damaged deliveries [num]	0	1	0	1	1	0	0	3 [tot]	5
"No problem" as consequence [%]	-	100	-	0	100	-	-	66 [avg]	
"Need of adaption" as consequence [%]	-	0	-	100	0	-	-	33 [avg]	
"Can't use" as consequence [%]	-	0	-	0	0	-	-	0 [avg]	
Utilities and Wares									
Water cons. per ton prod. [m^3]	0,18	0,24	0,21	0,18	0,20	0,19	0,22	0,20 [avg]	0,20
Water cons. from recycled source [%]	15,1	21,0	23,2	16,9	22,5	18,6	19,2	19,50 [avg]	20
Energy cons. per ton prod. [MWh]	12,2	11,0	9,6	8,9	10,6	10,2	9,1	10,23 [avg]	10
Energy cons. from renewables [%]	71	72	68	73	69	70	71	70,57 [avg]	70
Energy cons. from fossils [%]	14	13	17	13	16	15	14	14,47 [avg]	15
Energy cons. recycled from self [%]	9	10	11	10	9	8	10	9,57 [avg]	10
Energy cons. recycled from others [%]	6	5	4	5	6	7	5	5,43 [avg]	5
Amount of raw mat. 1 procured [num]	2600	3000	2900	3200	2500	2700	3000	19900 [tot]	
Greenest available raw mat. 1 [%]	55	60	59	62	57	66	53	58,86 [avg]	60
Amount of raw mat. 2 procured [num]	1100	1200	1000	900	1150	1060	1300	7710 [tot]	
Greenest available raw mat. 2 [%]	27	24	26	21	28	22	25	24,71 [avg]	25

3.2 Supplier Form

In order to rate and compare suppliers, as discussed in Subsection 2.6.1, one need to collect the same type of data from each. This can be done by i.e. sending a standardized form to every potential supplier. An example of this form is presented below in Table 3.2.

Table 8: Example supplier form

KPIs	Metric	Supplier answer

HSE		
ISO45001 certified	YES/NO	
Number of work injuries last 12 months	num	
Serious/fatal injuries	num	
Energy		
ISO50001 certified	YES/NO	
Yearly energy consumption	GWh	
Yearly consumption of electricity	GWh	
Share of electricity being renewable	%	
Yearly consumption of fossil fuel energy	GWh	
Yearly consumption of other energy types	GWh	
Energy consumption per product produced	MWh	
Recycled energy used	%	
Share of consumed energy (chemically bound energy not included) being recycled	%	
Water		
Yearly water consumption	m^3	
Water consumption per product produced	m^3	
Share of water consumption coming from scarce water source	%	
Share of water consumption coming from recycled water	%	
Share of water consumption being recycled after use	%	
Environment		
ISO1400 certified	YES/NO	
Compliant with REACH directive	YES/NO	
Compliant with ROHS directive	YES/NO	
Yearly CO2 emissions	tons	
Emission of CO2 eq. Per product produced	tons	
Funds spent on R&D on environmental improvements last 3 years	€Mill.	
Share of water with toxic waste or chemicals released into rivers/ocean	%	
Share of biproducts/waste sent to landfill last 12 months	%	
Transport		
Distance for shipping from company	km	
Share of the shipping distance carried out by ship	%	
Share of shipping distance carried out by aeroplane	%	
Share of shipping distance carried out by train	%	
Share of shipping distance carried out by truck	%	
Other		
Share of total supplier costs going to this supplier	%	

Share of wrong deliveries from this company last 12 months	%	

Every category's importance differ between companies. The company should therefore define their own weighting system for each indicator. By doing so, one can eventually categorize the suppliers into a "Traffic-light-rating" system, as shown in the dashboard example in Figure 6. I.e. could the indicator "Share of electricity being renewable" be rated like this; Green for 90-100 %, yellow for 50-89 % and red for $<$ 50 %. In addition, each color could have its own weighting score, i.e. 1 point for green, 0.5 point for yellow and 0 for red. At the end, all these scores can be summarized into a total score for the supplier. This way, one can easily compare the potential suppliers based on what's most important for the company in terms of sustainability.

3.3 Dashboard

When approaching the project partners with this issue, it became clear that most of them struggled with KPIs that were poorly visualized and often spread around in many different Excel sheets and other programs, making them less accessible. Several had the impression of KPIs being just numbers that was difficult to relate to. This led to a slightly negative attitude towards the indicators among the employees, and the KPIs not being used in the way they were intended. A more graphical and holistic visualization of the evolution of the indicators and their influence on other parts of the business' performance could be a motivation as they can see the direct effect of their actions more clearly.

As our project dealt with KPIs for sustainable procurement, we chose to focus on visualizing these. However, we wanted to create a setup that could easily be implemented for the rest of the company's KPIs later. The solution should also be able to include all indicators in the same dashboard instead of having different platforms for each category. This way, each division can see the others' performance and motivate and inspire each other. This could also lead to more cooperation between the divisions inside the company. The dashboard could be used in i.e. monthly meetings with representatives from all divisions to evaluate the company's joint progress. For further accessibility, the dashboard with key visualizations could be displayed on a monitor in i.e. the company's cafeteria.

Excel is the KPI visualization tool most commonly used by companies today. This is a tool that is easy to use, but often turns disorganized when both detailed input data and graphics are displayed together. It could also be bothersome to share with a larger number of employees. We therefore recommend creating a website/app that import data from i.e. Excel and display graphics that are easy to understand, all in the same place. This way one separates the messy raw data from the graphics, and get a more accessible overview of the company's performance. Now, one can also share the dashboard with every employee with only the people intended to able to manipulate the input data.

To illustrate what's possible when creating a dashboard, we have created a simple example in Python with Dash by Plotly. This is an open-source solution with a relatively low user interface and many possibilities for visualization and data processing. However, further study should be done if intended to be implemented as an actual dashboard for a company with a large amount of data and many KPIs.

Below, screen shots of the example dashboard app is presented. For some of the categories, selected key values are displayed at the top part of the tab. This is to give a quick overview over the current situation. We have mainly chosen to use line and bar plots to visualize the KPIs in this example. This way one is able to see the evolution of the KPI and compare the performance of each month. For the KPIs regarding different shares of something, i.e. energy consumption from different sources, stacked bar plots are chosen, also to enable comparison of different months.

Figure 2: Example dashboard, tab for Utilities and Wares

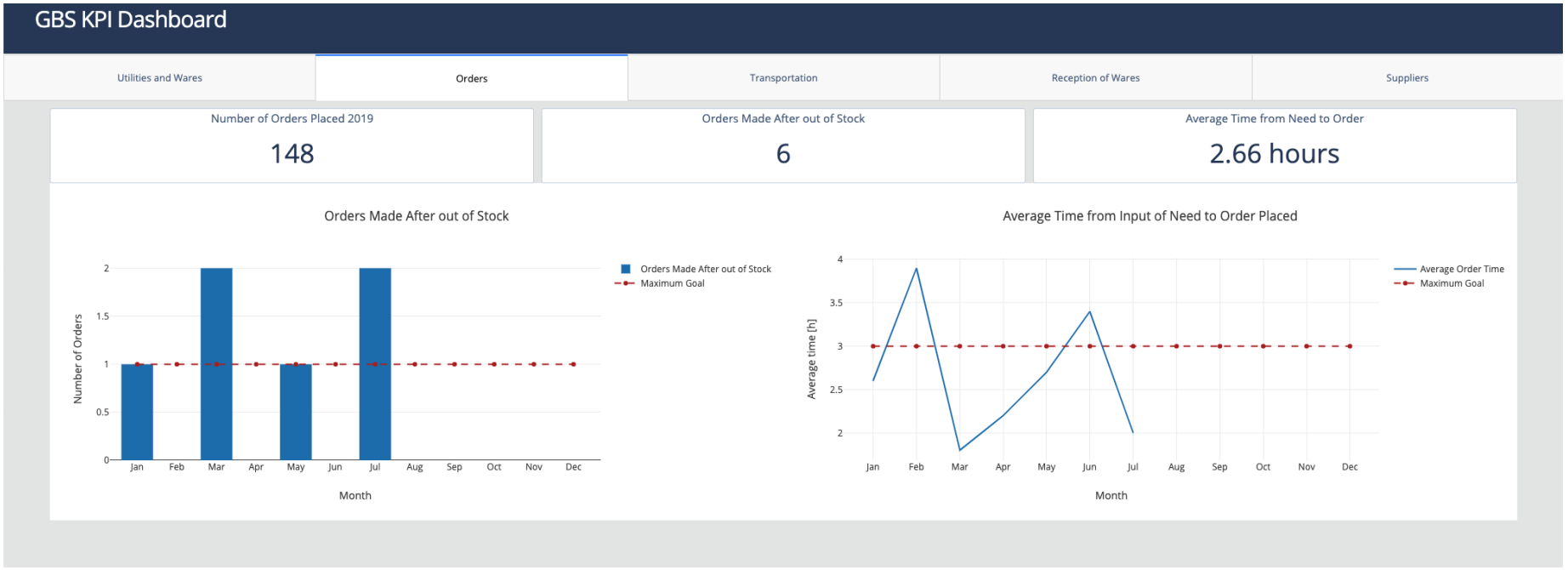


Figure 3: Example dashboard, tab for Orders

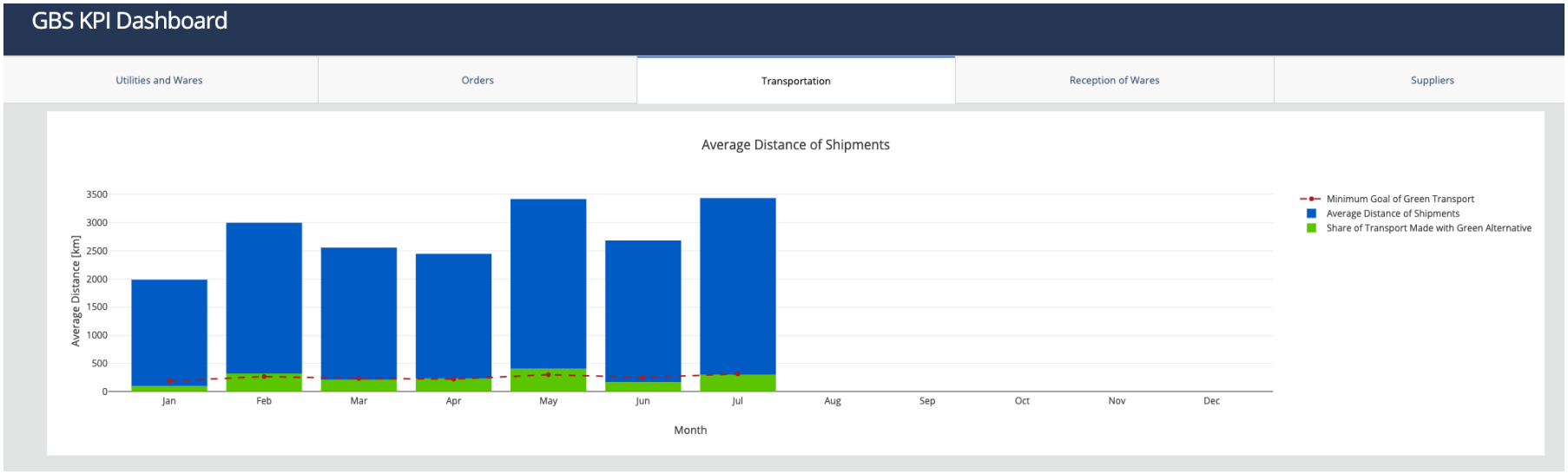


Figure 4: Example dashboard, tab for Transportation

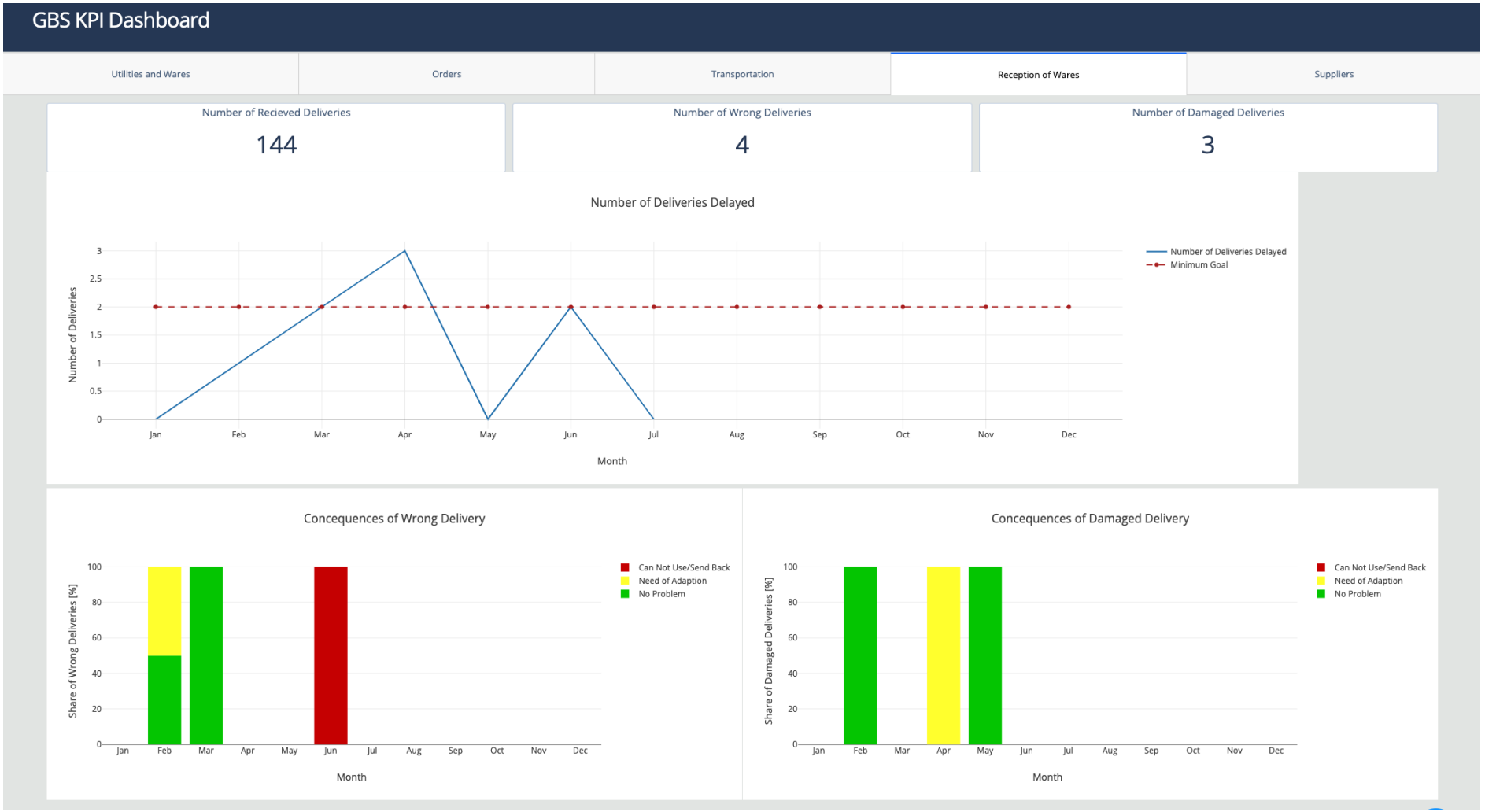
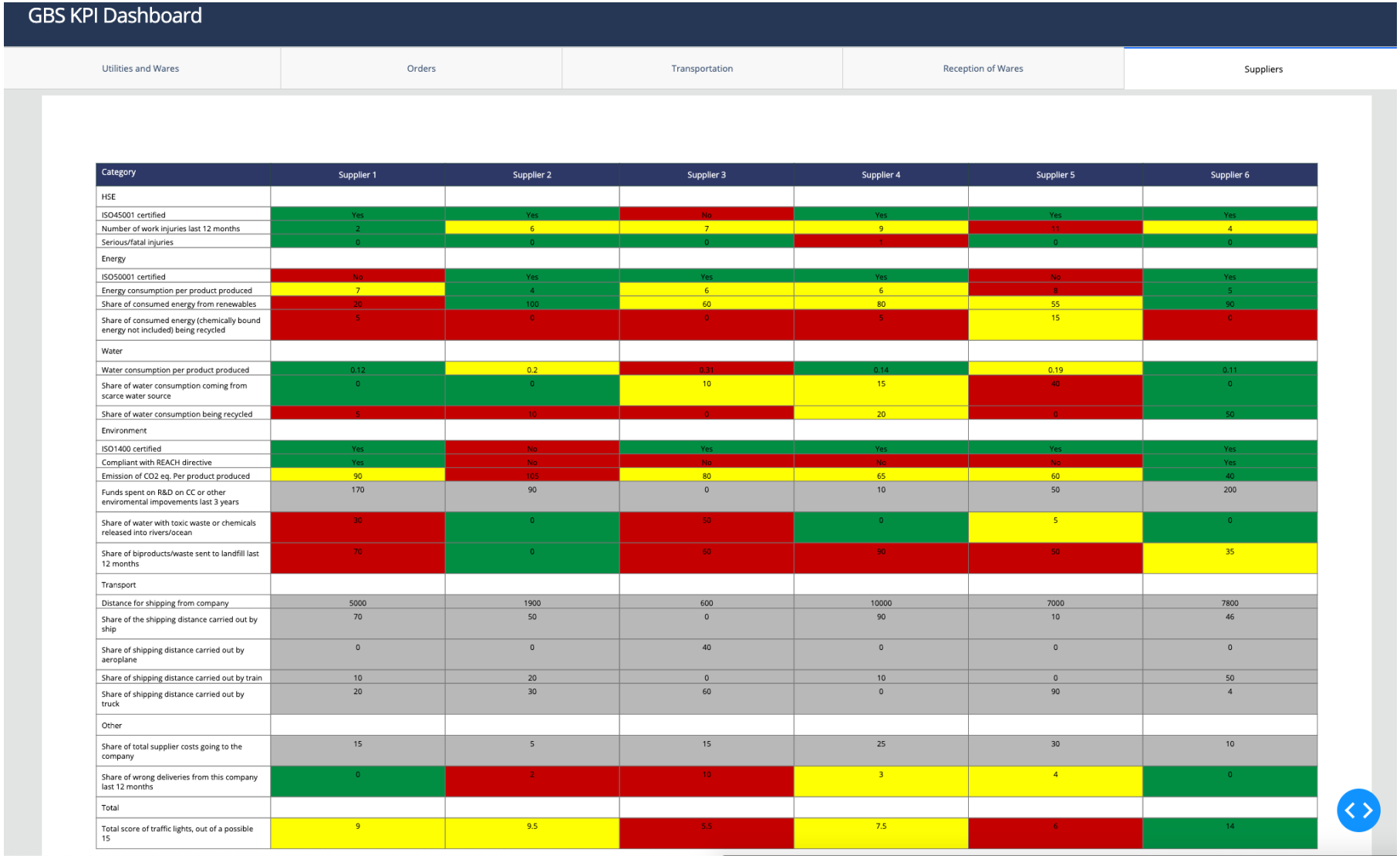


Figure 5: Example dashboard, tab for Reception of Wares



Category	Supplier 1	Supplier 2	Supplier 3	Supplier 4	Supplier 5	Supplier 6
HSE						
ISO45001 certified	Yes	Yes	No	Yes	Yes	Yes
Number of work injuries last 12 months	2	6	7	9	11	4
Serious/fatal injuries	0	0	0	1	0	0
Energy						
ISO50001 certified	No	Yes	Yes	Yes	No	Yes
Energy consumption per product produced	7	4	6	6	8	5
Share of consumed energy from renewables	20	100	60	80	55	90
Share of consumed energy (chemically bound energy not included) being recycled	5	0	0	5	15	0
Water						
Water consumption per product produced	0.12	0.2	0.31	0.14	0.19	0.11
Share of water consumption coming from scarce water source	0	0	10	15	40	0
Share of water consumption being recycled	5	10	0	20	0	50
Environment						
ISO1400 certified	Yes	No	Yes	Yes	Yes	Yes
Compliant with REACH directive	Yes	No	No	No	No	Yes
Emission of CO2 eq. Per product produced	90	105	80	65	60	40
Funds spent on R&D on CC or other enviromental impovements last 3 years	170	90	0	10	50	200
Share of water with toxic waste or chemicals released into rivers/ocean	30	0	50	0	5	0
Share of biproducts/waste sent to landfill last 12 months	70	0	60	90	50	35
Transport						
Distance for shipping from company	5000	1900	600	10000	7000	7800
Share of the shipping distance carried out by ship	70	50	0	90	10	46
Share of shipping distance carried out by aeroplane	0	0	40	0	0	0
Share of shipping distance carried out by train	10	20	0	10	0	50
Share of shipping distance carried out by truck	20	30	60	0	90	4
Other						
Share of total supplier costs going to the company	15	5	15	25	30	10
Share of wrong deliveries from this company last 12 months	0	2	10	3	4	0
Total						
Total score of traffic lights, out of a possible 15	9	9.5	5.5	7.5	6	14

Figure 6: Example dashboard, tab for Suppliers

4 Further work

In this report propositions for KPIs for sustainable procurement and how they can be implemented and visualized has been presented. The next step should be to further customize these indicators to fit each company's procurement system. One should also look further into how to register and collect data used for the KPIs and how these can be integrated into a potential dashboard solution. The final step would be to implement an actual dashboard solution, and to start using it operationally. One possible way of implementing this could be by having one of the partnering companies run a pilot project where they set certain goals for sustainability as part of a procurement strategy. The appropriate KPIs to measure sustainability then needs to be selected. Afterwards, the necessary data should be collected and sorted. Lastly, this should be visualized, and the development over time should be studied. It can then be determined if the new way of focusing on sustainability yielded the desired results. There are also business opportunities around this topic that should be looked further into. Developing good KPIs, organising the data flow and setting up a visualization tool can be a complicated task for each company to perform. Therefore there could be a market for delivering this as a service to companies. Two suggested business models came up during the course of this project. The first one is based on offering a combination of consultation and system setup. The client company would get a procurement strategy including goals for sustainability, KPIs for monitoring the progress against these goals and a dashboard for visualizing, and pay for this. The second business model is based on offering a sustainability database for evaluating suppliers. The suppliers would pay a subscription fee to have their company in the database, and the buyers would do the same to get access to the database in order to evaluate possible suppliers.

References

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[5] Walmart. Sustainable Supply Chain. https://corporate.walmart.com/esgreport/environmental?locale=en-US#sustainable-supply-chain, 2019.

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A Python Code for Example Dashboard

```
1
2  """
3  Created on Jul 22 12:37:04 2019
4
5  This is a modified code for the example dashboard presented in the
       report.
6  Some data that is not considered necessary for the understanding of the
       code
7  is removed. This code consists of 7 seperate files; one for each tab,
       one for
8  the app server and one main file for
9  compilation (index.py).
10 """
11
12 #app.py
13
14 import dash
15 import pandas as pd
16 import flask
17 import dash_core_components as dcc
18 import dash_html_components as html
19
20
21 external_stylesheets = ['https://codepen.io/chriddyp/pen/bWLwgP.css']
22
23 server = flask.Flask(__name__)
24 app = dash.Dash(__name__, server=server,
25                 external_stylesheets=external_stylesheets,
26                 url_base_pathname='/gbs-kpi-dashboard/')
27 app.config.suppress_callback_exceptions = True
28
29 def indicator(color, text, id_value):
30     return html.Div(
31         [
32
33             html.P(
34                 text,
```

```
                    className="twelve columns indicator_text"
                ),
                html.P(
                    id_value,
                    className="indicator_value"
                ),
            ],
            className="four columns indicator",

        )

#index.py

import dash
import dash_core_components as dcc
import dash_html_components as html
from dash.dependencies import Input, Output


from app import app
import orders
import utilities
import transport
import rec_wares
import suppliers

app.layout = html.Div(
            [
                    #Header
                    html.Div([
                            html.Span("GBS KPI Dashboard", className='app-
    title'),
                            ],
                            className="row header"
                            ),
                    #tabs
                    html.Div([
                            dcc.Tabs(
                                    id="tabs",
```

```
                                    style={"height":"20","verticalAlign":"
    middle"},
                                    children=[
                                            dcc.Tab(label="Utilities and
    Wares",
                                                    value="uti_wares_tab"),
                                            dcc.Tab(label="Orders",
                                                    value="orders_tab"),
                                            dcc.Tab(label="Transportation",
                                                    value="transport_tab"),
                                            dcc.Tab(label="Reception of
    Wares",
                                                    value="rec_wares_tab"),
                                            dcc.Tab(label="Suppliers",
                                                    value="suppliers_tab"),
                                            ],
                                        value="leads_tab",
                                        )
                            ],
                            className="row tabs_div"
                            ),

                    # Tab content
            html.Div(id="tab_content", className="row", style={"margin": "
    2% 3%"}),

            html.Link(#layout stylesheets here)
        ],
        className="row",
        style={"margin": "0%"},
    )

@app.callback(Output("tab_content", "children"), [Input("tabs", "value"
    )])
def render_content(tab):
    if tab == "uti_wares_tab":
        return utilities.layout
    elif tab == "orders_tab":
        return orders.layout
```

```
    elif tab == "transport_tab":
        return transport.layout
    elif tab == "rec_wares_tab":
        return rec_wares.layout
    elif tab == "suppliers_tab":
        return suppliers.layout
    else:
        return utilities.layout


if __name__ == '__main__':
    app.run_server(debug=True)

#utilities.py

import dash
import dash_core_components as dcc
import dash_html_components as html
import pandas as pd
import plotly.graph_objs as go
from app import indicator
import numpy as np


#load data

m_3=dcc.Markdown(
    dangerously_allow_html=True,
    children=
       '0.20 m<sup>3</sup>'
)

layout = html.Div([
        html.Div([
        indicator("#119DFF",
                  "Average Water Consumption per Ton Produced",m_3),
        indicator("#119DFF",
                  "Average Energy Consumption per Ton Produced","10,23
   MWh"),
```

```
145         indicator("#119DFF",
146                   "Amount of Raw Materials Procured 2019", "27 610 tons
    ")]),
147         html.Div([
148                 dcc.Graph(id="recywatergraph",
149                  figure={
150                         'data' : [go.Scatter(
151                                         x = month,
152                                         y= waterrec,
153                                         mode='lines',
154                                         name='Share of Monthly Consumption'
155                                 ),
156                                         go.Scatter(
157                                         x= month,
158                                         y=waterrec_goal,
159                                         line=dict(color='firebrick',dash='
    dash'),
160                                         name='Minimum Goal')
161                         ],
162                         'layout': go.Layout(
163             title = 'Share of Water Consumed That Comes from Recycled
    Sources',
164                                 xaxis = {'title': 'Month'},
165                                 yaxis = {'title' : 'Share of Water [%]'}
166             )
167         }
168     )],style={'width': '50%', 'display': 'inline-block'}),
169
170     html.Div([dcc.Graph(id="energyconsumption",
171                 figure={
172                         'data': [go.Bar(x=month,y=renewables,name='
    Renewables',
173                                         marker_color='rgb(0,204,0)'),
174                                 go.Bar(x=month,y=rec_own,
175                                         name='Recycled from Own
    Production'),
176                                 go.Bar(x=month,y=rec_other,
177                                         name='Recycled from Other
    Sources',
```

```
                                        marker_color='rgb(255,255,51)'),
                                    go.Bar(x=month,y=fossils,name='Fossils'
    ,
                                        marker_color='rgb(0,0,0)')],
                            'layout': go.Layout(
                            title = 'Energy Consumption from Different
    Sources',
                                    barmode='stack',
                                    xaxis={'title':'Month'},
                                    yaxis={'title':'Share of Consumption
    [%]'})})],
                                    style={'width': '50%','display':'inline
    -block'}
),

     html.Div([dcc.Graph(id="rawmaterials_procured",
                 figure={
                         'data': [go.Bar(x=month,y=raw_1,name='Raw
    Material 1'),
                                    go.Bar(x=month,y=raw_2,name='Raw
    Material 2')],
                            'layout': go.Layout(
                                    title = 'Amount of Raw Materials
    Procured',
                                    barmode='stack',
                                    xaxis={'title':'Month'},
                                    yaxis={'title':'Amount of Material [ton
    ]'})})],
                                    style={'width': '50%','display':'inline
    -block'}
),
                    html.Div([
                    dcc.Graph(id="rawmaterialgraph",
                     figure={
                            'data' : [go.Scatter(
                                        x = month,
                                        y= raw_1_green,
                                        mode='lines',
                                        name='Share of Raw Material 1'
```

```
                                ),
                                        go.Scatter(
                                        x= month,
                                        y=raw_2_green,
                                        mode='lines',
                                        name='Share of Raw Material 2'),

                                        go.Scatter(
                                        x=month,
                                        y=raw_1_goal,
                                        line=dict(color='firebrick',dash='
    dash'),
                                        name='Goal Raw Material 1'),
                                        go.Scatter(
                                        x=month,
                                        y=raw_2_goal,
                                        line=dict(color='royalblue',dash='
    dash'),
                                        name='Goal Raw Material 2')
                            ],
                            'layout': go.Layout(
                title = 'Share of Raw Materials from Greenest Available
    Source',
                xaxis = {'title': 'Month'},
                yaxis = {'title' : 'Share of Material [%]'}
                )
            }
     )],style={'width': '50%', 'display': 'inline-block'}),

 ])

#orders.py

import dash
import dash_core_components as dcc
import dash_html_components as html
from plotly import graph_objs as go
import numpy as np

```

```
from app import indicator

#load data

layout=html.Div([
        html.Div([
            indicator("#119DFF","Number of Orders Placed 2019","148"),
            indicator("#119DFF","Orders Made After out of Stock","6"),
            indicator("#119DFF","Average Time from Need to Order","2.66 hours")],
            style={'marginTop':'5'}),
        html.Div([
                html.Div([dcc.Graph(id="lateordergraph",
                 figure={
                        'data' : [go.Bar(
                                    x = month,
                                    y= lateorders,
                                    name='Orders Made After out of Stock'
                                ),
                                    go.Scatter(
                                    x= month,
                                    y=lateorders_goal,
                                    line=dict(color='firebrick',dash='dash'),
                                    name='Maximum Goal')
                        ],
                        'layout': go.Layout(
                                title = 'Orders Made After out of Stock',
                                xaxis = {'title': 'Month'},
                                yaxis = {'title' : 'Number of Orders'})
                    }
                ) ],style={'width': '50%','display':'inline-block'}),
                 html.Div([
                  dcc.Graph(id="avg_ordertime",
                    figure={
                        'data' : [go.Scatter(
                                    x = month,
```

```
                                    y= average_ordertime,
                                    mode='lines',
                                    name='Average Order Time'
                                ),
                                    go.Scatter(
                                    x= month,
                                    y=avg_ordertime_goal,
                                    line=dict(color='firebrick',dash='
    dash'),
                                    name='Maximum Goal')
                            ],
                            'layout': go.Layout(
                        title = 'Average Time from Input of Need to Order
    Placed',
                                xaxis = {'title': 'Month'},
                                yaxis = {'title' : 'Average time [h]'}
                )
            })],style={'width': '50%','display':'inline-block'})
        ],style={'marginTop':'5'})
    ])

#transport.py

import dash
import dash_core_components as dcc
import dash_html_components as html
from plotly import graph_objs as go
import numpy as np

#load data

layout=html.Div([
            dcc.Graph(id="green_transport",
                        figure={
                            'data' : [go.Bar(
                                    x=month,
                                    y=green_transport,
                            name='Share of Transport Made with Green
    Alternative',
```

```
                                        marker_color='rgb(102,204,0)'),
                                    go.Bar(
                                    x = month,
                                    y= transport,
                                    name='Average Distance of Shipments',
                                    marker_color='rgb(0,102,204)'
                                ),


                                    go.Scatter(
                                    x= month,
                                    y=green_transport_goal,
                                    line=dict(color='firebrick',dash='dash'),
                                    name='Minimum Goal of Green Transport')
                            ],
                            'layout': go.Layout(
                                    title = 'Average Distance of Shipments',
                                    xaxis = {'title': 'Month'},
                                    yaxis = {'title' : 'Average Distance [km]'},
                                    barmode='stack')
                        }
                    )
                ])

#rec_wares.py

import dash
import dash_core_components as dcc
import dash_html_components as html
from plotly import graph_objs as go
import numpy as np

from app import indicator

```

```
#load data

layout=html.Div([
            html.Div([
                    indicator("#119DFF","Number of Recieved Deliveries",
    "144"),
                     indicator("#119DFF","Number of Wrong Deliveries","4
    "),
                     indicator("#119DFF","Number of Damaged Deliveries",
    "3")]),
             html.Div([
                     dcc.Graph(id='delayed_deliveries',
                               figure={
                                       'data':[go.Scatter(
                                               x=month,
                                               y=delayed,
                                               name='Number of
    Deliveries Delayed',
                                               mode='lines'),
                                           go.Scatter(
                                           x=month,
                                           y=delayed_goal,
                                         line=dict(color='firebrick',
    dash='dash'),
                                           name='Minimum Goal')],
                                        'layout': go.Layout(
                                                title='Number of
    Deliveries Delayed',
                                                xaxis={'title':'Month'
    },
                                                yaxis={'title':'Number
    of Deliveries'})
                                  })],style={'width':'90%','display': '
    inline-block',
                                  'margin':0}),
            html.Div([
                     dcc.Graph(id='consequence_wrong',
                               figure={
                                       'data':[go.Bar(
```

```
                                                x=month,
                                                y=wrong_np,
                                                name='No Problem',
                                                marker_color='rgb
(0,204,0)'),

                                                  go.Bar(
                                                      x=month,
                                                      y=wrong_noa,
                                                      name='Need of
Adaption',
                                                      marker_color='rgb
(255,255,51)'),
                                                  go.Bar(
                                                      x=month,
                                                      y=wrong_cnu,
                                                      name='Can Not Use/
Send Back',
                                                      marker_color='rgb
(204,0,0)')],
                                        'layout': go.Layout(
                                        title='Concequences of Wrong
Delivery',
                                        xaxis={'title':'Month'},
                                        yaxis={'title':'Share of Wrong
Deliveries [%]'},
                                        barmode='stack')})
                ],style={'width': '50%', 'display': 'inline-block'}),
            html.Div([
                    dcc.Graph(id='consequence_damaged',
                              figure={
                                      'data':[go.Bar(
                                                x=month,
                                                y=damaged_np,
                                                name='No Problem',
                                                marker_color='rgb
(0,204,0)'),
                                                  go.Bar(
                                                      x=month,
```

```
                                                    y=damaged_noa,
                                                    name='Need of
    Adaption',
                                                    marker_color='rgb
    (255,255,51)'),
                                                go.Bar(
                                                    x=month,
                                                    y=damaged_cnu,
                                                    name='Can Not Use/
    Send Back',
                                                    marker_color='rgb
    (204,0,0)')],
                                            'layout': go.Layout(
                                            title='Concequences of Damaged
    Delivery',
                                            xaxis={'title':'Month'},
                                            yaxis={'title':'Share of
    Damaged Deliveries [%]'},
                                            barmode='stack')})
                ],style={'width': '50%', 'display': 'inline-block'}),
            ])

#suppliers.py

import dash
import dash_core_components as dcc
import dash_html_components as html
from plotly import graph_objs as go
import numpy as np

green='rgb(0,153,76)'
category_color='white'
red='rgb(204,0,0)'
header='rgb(52,64,114)'
grey='rgb(192,192,192)'

layout = html.Div([
        dcc.Graph(
                figure = {'data' :  [go.Table(
```

```
                        header=dict(
                                values=['Category','<b>Supplier 1</b>',
                                        '<b>Supplier 2</b>',
                                        '<b>Supplier 3</b>','<b>
Supplier 4</b>',
                                        '<b>Supplier 5</b>','<b>
Supplier 6</b>'],
                        line_color='darkslategrey',
                        fill_color=header,
                        align=['left','center'],
                        font=dict(color='white',size=12)),
                                cells=dict(
                        values=[ #data from supplier form
                                ],
                    fill_color=[#traffic light colors],
                                        align=['left','center'],
                                        font = dict(color='black',size
=11)))],
                                'layout': go.Layout(
                                        height=2000)})])
```

B Complete List of KPIs

Kolonne1	Kolonne2
	Metric
Orders	
Number of orders placed	num
Number of "just in time" orders placed	num
Orders made after out of stock	num
Avg. Time from input of need to order placed	hours
Transportation	
Total freight distance	km
Average freight distance	km
Share of freight distance carried out with green means oftransportation	%
Total CO2 eq. emissions from shipments	kg or tons
CO2 emissions per shipment	kg
Number of flights traveled by employees	num
Share of flights where carbon credit was bought	%
Reception of wares	
Number of received deliveries	num
Number of deliveries arriving later than the ware is needed	num
Number of deliveries arriving after schedueled time	num
Average time spent handling wares upon delivery	hours
Number of wrong deliveries	num
Share of wrong deliveries with "no problem" as consequense	%
Share of wrong deliveries with "need of adaptation" as consequense	%
Share of wrong deliveries with "can not use/send back" as consequense	%
Number of damaged deliveries	num
Share of damaged deliveries with "no problem" as consequense	%
Share of damaged deliveries with "need of reparation" as consequense	%
Share of damaged deliveries with "can not use/send back" as consequense	%
Utilities	
Water	
Water consumption	m^3
Water consumption per ton product produced	m^3
Share of recycled water	%
Share of water consumtion taken from scarce source/drinking water	%
Energy	
Total energy consumption	GWh
Total electrisity consumption	GWh
Share of electrisity consumption from renewable source	%
Energy consumption per ton product produced	MWh
Share of energy consumption from fossil fuels	%
Share of energy consumption from other sources	%
Share of energy consumption recycled from self	%
Share of energy consumption recycled from others	%
Wares	
Amount of product 2 procured	ton
Share of product 1 procured from greenest available source	%
Amount of product 2 procured	ton
Share of product 2 procured from greenest available source	%
Total plastic packaging from wares	kg
Average plastic packaging per delivery	kg

Share of procured wares coming from recycling, by share of costs	%
Suppliers	
Number of suppliers	num
Share of suppliers being ISO14001 certified	%
Share of suppliers being ISO50001 certified	%
Share of suppliers being ISO45001 certified	%
Total CO2 emission from goods procured from suppliers?	
total number of work injuries on supplier locations	
Total number of serious/fatal injuries on supplier locations	

C Complete Supplier Form

Supplier Form	Metric
HSE	
ISO45001 certified	yes/no
Number of work injuries last 12 months	num.
Serious/fatal injuries	num.
Energy	
ISO50001 certified	yes/no
Yearly energy consumption	GWh
Yearly consumption of electricity	GWh
Share of electricity being renewable	%
Yearly consumption of fossil fuel energy	GWh
Yearly consumtion of other energies	GWh
Energy consumption per product produced	MWh
Recycled energy used	%
Share of consumed energy (chemically bound energy not included) being recycled	%
Water	
Yearly water consumption	M^3
Water consumption per product produced	M^3
Share of water consumption coming from scarce water source	%
Share of water consumption coming from recycled water	%
Share of water consumption being recycled after use	%
Enviroment	
ISO1400 certified	yes/no
Compliant with REACH directive	yes/no
Compliant with ROHS directive	yes/no
Yearly CO2 emissions	tons
Emission of CO2 eq. Per product produced	tons
Funds spent on R&D on CC or other enviromental impovements last 3 years	Mill €
Share of water with toxic waste or chemicals released into rivers/ocean	%
Share of biproducts/waste sent to landfill last 12 months	%
Transport	
Distance for shipping from company	km
Share of the shipping distance carried out by ship	%
Share of shipping distance carried out by aeroplane	%
Share of shipping distance carried out by train	%
Share of shipping distance carried out by truck	%
Other	
Share of total supplier costs going to this supplier	%
Share of wrong deliveries from this company last 12 months	%
Total	
Total score of traffic lights	