

Q1:

1	A
2	B
3	C
4	C
5	A
6	A
7	B
8	B
9	A
10	B
11	B
12	B
13	A
14	C
15	C
16	B
17	A
18	B
19	A
20	B
21	C
22	C
23	A
24	B
25	B
26	C
27	B
28	B
29	A
30	B
31	C
32	B
33	A
34	B
35	A
36	C

Q2:

a) Apply a useful method that allows you to find out whether delivery of resin material from local supplier or sourcing from PRC is better for EWF! Which supplier would you prefer and why?

To analyze whether it is preferable for EWF to source from the local supplier (HV) or sourcing from China (PRC) a unit total costs (UTC) analysis will be performed since it allows for a holistic comparison that not only takes the 'hard' cost factors into account but also considers performance factors and policy factors. These will be considered in a price-adder formula and be either debited or credited to the overall price depending on their estimated attractiveness for the firm.

In the UTC analysis, we will both take into account the prices of ABS and PP resin for an extensive analysis. We will make the UTC-based on a comparison per ton. If EWF were to source from China, it is expected that they would order larger quantities, also considering the freight prices are per TEU. It is thus possible that they might have to expand their warehousing capabilities, however, this is not accounted directly for in this UTC analysis.

For **cost factors** we start off with the quoted price per ton as listed in table 2.1. Then, we add the payment options which implies EUR 50 to be paid by SZ as well as a 0.5% transaction fee. Whereas for HZ fees for bank transfers are negligible and thus set to 0.

Regarding freight costs, we assume that TEU's are half full when shipped to EWF, which allows for some flexibility when ordering from China to avoid stockouts. This gives a freight costs per ton that is calculated as: $(\text{Maximum delivery per unit} / \text{price of TEU}) * 2$. We multiply by 2 to take into account they would only be half full, which is a bit conservative. However, this can also make up for the fact that they would likely need more inventory storage when ordering in larger batches which might require an expansion of the warehouse. We use the values listed in the table since it is mentioned that freight forwarded organizes the sea transport in China and the land transport to Tilburg which includes all transport costs, customs duties and fees.

Additionally, for the prices of truck delivery, we can see that there can be 24 tons per truck delivery. We take into account that the cost per tonnes for delivery remains at 250 euros per order, such that they also limit the inventory they would have to hold.

For **performance factors** we subtract 3% for HV since they are assessed as having more attractive payment options that allows for payment 45 days after delivery, which is great for EWF's liquidity and reducing their C2C-cycle.

We add 3% for SZ since they are suing FOB whereas HV is using DAP, and thus the risk transfers earlier if EWF were to choose SZ as a supplier.

We then add 2% per week in lead time to reflect the value in having higher responsiveness, which favors HV over SZ. Additionally, we add 1% per percent that is not delivered on time and we add 5% for each 0.1% when there is occurrence of loss or damage, since this is a significant risk that could limit EWF's production and thus their turnover.

For **Policy factors** we add a country or origin effect for +5% if outside EU, which applies to SZ. Additionally, sustainability is a very important consideration for EWF. The company is dedicated to a mission of saving the planet by fighting piles of trash caused by single-use water bottles.

Thus, it is essential for the firms to also use low-emission suppliers who respect the environment and who focus on lowering their carbon emission. It is assumed that the Chinese producer who operates in a country with less strict environmental regulation compared to the EU, has a less strict environmental policy and might be very polluting, which would cause a major problem for EWF both in their mission and in their brand value. Thus, 30% is added to SZ for this reason.

We thus see when doing the unit total costs analysis, that even though SZ has lower prices and overall lower hard cost factors than HV, that when you take into account the performance factors and policy factors, that HV turns out to be the cheapest option **both for PP and for ABS**, based on our analysis. The total UTC for HV of PP is EUR 3445 compared to EUR 4411.9 for SZ PP by sea and EUR 3891.9 by rail. For ABS, the UTC for HV is EUR 1634.5 whereas for SZ ABS by sea is EUR 2211.9 and 1977.9 by rail. Thus overall, we conclude that HV is the preferred supplier, largely affected by the country-of-origin effect, the environmental considerations and the on-time delivery performance. This is of course based on my estimates related to the importance of performance and policy factors and may differ from EWF's own preferences.

In EUR	SZ PP (sea)	SZ PP (rail)	HV PP	SZ ABS (sea)	SZ ABS (rail)	HV ABS
Cost factors						
Quoted price per ton	2000	2000	3000	900	900	1300
Payment options (0.5% transaction fee for SZ + 50 dollars to be paid)	150	150		95	95	
Freight costs per ton	361.9	361.9	250	361.9	361.9	250
Total hard cost factors	2511.9	2511.9	3250.0	1356.9	1356.9	1550.0
Performance factors						
Payment options (-3% for more favorable payment terms)	0	0	-90	0	0	-39
Incoterms used (+3% for SZ for higher risk)	60	60	0	27	27	0
Lead time (+2% per week)	240	120	60	108	54	26
On-time delivery performance (+1% per percent not on time)	700	400	150	315	180	65
Occurrence of loss or damage (+5% for each 0.1%)	200	100	75	90	45	32.5
Policy factors						
Country of origin (+5% outside EU)	100	100	0	45	45	0
Environmental policy (+30% if no environmental considerations)	600	600	0	270	270	0
Total soft cost factors	1900	1380	195	855	621	84.5
Total UTC	4411.9	3891.9	3445.0	2211.9	1977.9	1634.5

b) Given your decision in a), please suggest a suitable inventory control system and order policy for the company concerning resin materials!

To avoid excess inventory as well as to lower the risk of stockouts, the firm should implement a reorder point inventory control system at which at a defined level of inventory (ROP), EWF orders a fixed amount (EOQ).

We will firstly calculate the reordering point by using the formula:

$$ROP = dL + ss = dL + z \sqrt{L * \sigma_d^2 + d^2 * \sigma_L^2}$$

Where D is demand per time period, L is the average lead time, σ_d^2 is the variance of demand, σ_L^2 is the variance of lead time and z is the service level which will be set to 95% such that $Z=1.65$.

Firstly, we calculate the total demand of ABS resin per day.

The firm uses 30 grams of ABS per bottle and has an annual output of 2 million bottles. Thus, the yearly demand is $30 * 2M = 60M$ grams of ABS which corresponds to 60,000 kilos or 60 tons per year. We calculate the demand per day in kilos by dividing 60,000 with 365 and gets that **$D=164.38$** for ABS.

The lead time is 7 days as mentioned in table 2.2 so $L=7$. It is also stated that lead time variance is 1.05, so $\sigma_L^2 = 1.05$.

It is mentioned that water bottles are a non-seasonal product and as such EWF has smooth sales throughout the year, and no significant demand variance is observable. Thus, we set the variance in demand per day equal to 2% of the total demand per day such that $\sigma_d^2 = 3.29$

We can now calculate the ROP of ABS resin for EWF:

$$ROP = 164.4 * 7 + 1.65\sqrt{7 * 3.29 + 164.4^2 * 1.05} = \mathbf{1428.73 \text{ kilos}}$$

Thus, when the inventory of ABS reaches 1429.18 kilos they should reorder when using HV. This also implies a safety stock level of $1.65\sqrt{7 * 3.29 + 164.4^2 * 1.05} = \mathbf{278.07 \text{ kilos}}$.

Thus, we have now determined the reordering point of ABS, and will now calculate the Economic Order quantity that is optimal for the firm to order per order, to minimize the combination of inventory holding costs and order processing costs.

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Where D is total demand for the year, S is cost to place a single order and H is the cost to hold one unit in inventory for a year.

The total demand for the year was determined above and is equal to 60,000 kilos per year.

S is set equal to 250 which is the cost of delivery via truck when using HV.

And lastly, the annual holding costs of raw materials are estimated to be 2,500 EUR/ton. This means that the holding costs per kilo is $2,500 / 1,000 = 2.5$ euros per kilo.

We can now calculate EOQ for ABS:

$$EOQ = \sqrt{\frac{2 * 60,000 * 250}{2.5}} = 3464.10 \text{ kilos}$$

This thus indicates quite frequent ordering since they have a yearly demand of 60,000 kilos (and also have to account for safety stock), which is affected by the relative low costs to place a single order as well as the limited costs associated with holding raw materials inventory.

Now, we do the same calculation of ROP and EOQ for PP resin, where we use the same formulas.

Firstly, we calculate ROP:

$$ROP = dL + ss = dL + z \sqrt{L * \sigma_d^2 + d^2 * \sigma_L^2}$$

The firm uses 72 grams of ABS per bottle and has an annual output of 2 million bottles. Thus, the yearly demand is $72 * 2M = 144M$ grams of ABS which corresponds to 144,000 kilos or 144 tons per year. We calculate the demand per day in kilos by dividing 144,000 with 365 and gets that $D=394.52$.

The lead time is 7 days as mentioned in table 2.2 so $L=7$. It is also stated that lead time variance is 1.05, so $\sigma_L^2 = 1.05$. We again set the variance in demand per day equal to 2% of the total demand per day to reflect the smooth sales cycle as done under ABS as well, and we get that $\sigma_d^2 = 7.89$.

Calculating the reordering point:

$$ROP = 394.52 * 7 + 1.65 \sqrt{7 * 7.89 + 394.52^2 * 1.05} = 3428.79 \text{ kilos}$$

Thus, when the stock of PP reaches 3428.79 kilos or equal to approx. 3.429 tonnes, the firm should reorder PP.

We can now calculate the **order quantity for PP** that is optimal for the firm to order, to minimize the combination of inventory holding costs and order processing costs.

$$EOQ = \sqrt{\frac{2DS}{H}}$$

D is the total demand for the year and equal to 144,000 kilos as calculated previously.

S is the cost to place a single order and is equal to EUR 250 and H is the cost to hold one unit in inventory for a year which is the same for both PP and ABS and thus equal to EUR 2.5 per kilo.

We can now calculate EOQ for PP:

$$EOQ = \sqrt{\frac{2 * 144,000 * 250}{2.5}} = 5366.56 \text{ kilos}$$

Thus, at the reordering point of 3428.79 kilos of PP, EWF should order 5366.56 kilos to ensure the lowest combination of inventory holding costs and order processing costs.

Additionally, it might be relevant for EWF to see if they can pool the delivery of the raw materials, to lower delivery costs and time spent on managing the inventory, however this would likely to some extent compromise the firms ability to follow its ROP and EOQ.

c) Please raise some indicators to show how well EWF performs as a whole from a supply chain point of view and give some advice EWF could improve in this respect!

To provide some indicators that helps analyze how well EWF performs as a whole from a supply chain point of view a C2C-cycle analysis will be made as well as a calculation of the inventory turnover and the firms gross profit margin.

Firstly, the inventory turnover is calculated as:

$$\text{Inventory turnover} = \frac{COGS}{\text{Average inventory}}$$

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COGS is listed in the text as EUR 8m and the average inventory is calculated by firstly dividing the annual cogs with the annual output: $8M / 2M = EUR 4$.

Then we know that the whole process from raw materials to the bottles are sold takes 45 days, so 45 days worth of inventory is worth:

$$\text{Number of days in inventory} / 365 * \text{COGS} = \text{Average inventory}$$

$$\frac{45}{365} * 8,000,000 = EUR 986,301.37$$

This assumes no fluctuations in inventory over the period, which is a somewhat reasonable assumption (although not a perfect assumption) due to the low variance of demand as mentioned in the text.

Thus, we can now calculate the inventory turnover:

$$\text{Inventory turnover} = \frac{8,000,000}{986,301.37} = \mathbf{8.11 \text{ times}}$$

The firm thus turns over its average inventory approx. 8.11 times in a year which seems within expectations but not overly high, given that the firm also deals with fast-moving goods and the inventory turnover is thus expected to be relatively high.

The gross profit margin of the firm is calculated using COGS (EUR 8M) and annual turnover (EUR 18m) and is equal to:

$$\text{Gross profit margin} = 1 - \frac{\text{COGS}}{\text{Sales}} = 1 - \frac{8,000,000}{18,000,000} = \mathbf{55.56\%}$$

This seems relatively high for a functional product such as water, but it is likely due to the brand value focused on sustainability that allows for this price markup. This likely attracts consumers who are willing to pay a price premium. However, it is important to mention that it is difficult to say much about whether this is high or low without comparison with the market standards.

Lastly, we calculate the cash-to-cash cycle using the formulas as listed below for days inventory held (DIH), days sales outstanding (DSO) and days payable outstanding (DPO). All the numbers necessary for this is given either in the text or have already been used before, and we thus directly apply the formulas:

$$DPO = \frac{\text{Average accounts payable}}{\text{COGS}} * 365$$

$$DPO = \frac{1,000,000}{8,000,000} * 365 = \mathbf{45.6 \text{ days}}$$

This aligns well with the 45 days mentioned in table 2.2 which is HV's current payment terms.

Next, we calculate the days sales outstanding:

$$DSO = \frac{\text{Average accounts receivable}}{\text{COGS}} * 365$$

$$DSO = \frac{1,500,000}{8,000,000} * 365 = \mathbf{68.4 \text{ days}}$$

Again, it is difficult to comment much on this without an ability to compare with competitors. However, it seems to be a bit long time, which can be due to EWF offering flexible payment terms or many days of credit to retailers, wholesale chains and retail chains, since they might have built a long relationship with them and know they are creditworthy. Alternatively, if this is due to liquidity issues, e.g. for the small retailers, than it is a significant risk for EWF.

Lastly, we calculate the days inventory held. Based on the calculation for inventory turnover, we calculated the average inventory to be *EUR* 986,301.37:

$$DIH = \frac{\text{Average inventory}}{COGS} * 365$$

$$DIH = \frac{986,301.37}{8,000,000} * 365 = \mathbf{45 \text{ days}}$$

This should also be 45 days since we used the 45 days as mentioned in the text, to calculate the average inventory turnover.

The Cash-to-cash-cycler is thus:

$$C2C = DSO + DIH - DPO$$

$$C2C = 68.4 + 45 - 45.6 = \mathbf{67.8 \text{ days}}$$

Thus, it takes on average 67.8 days from the firm pays for its raw materials and components used for its products until they receive cash from sales.

It is advised that the firm tries to lower their cash-to-cash cycle to improve efficiency and liquidity. This can be done by lowering the days sales outstanding, by enforcing stricter payment options and following up quickly on clients who are not paying on time. However, it is important that this does not come at the expense of lost sales, for example if they have much stricter terms than competitors. For days payable outstanding, EWF can try to negotiate the credit terms with their supplier (HV) to see if they would be interested in extending it. Over time, as they build a closer relationship with HV, it could be expected that they would build trust and be more flexible on payment terms.

Lastly, both for improving the cash-to-cash cycle, specifically days inventory held, but also for improving the overall supply chain configuration, it is recommended that the firm engages in collaborative planning forecasting and replenishment with its supplier (HV). This fits well with the suggestion in b) where we calculated the reordering point and the preferred order quantity. This can be done by EWF sharing sales data from its warehouse management system and inventory data levels with HV such that they can quickly adjust if the demand starts to become more volatile. Likewise, if EWF has ensured integration downstream with its retailers through POS-data, this could also be shared with HV and make the firm more responsive to changes in demand.

EWF might also decide to rely more on the principles of lean inventory management, which fits well with a functional product with low demand variance. EWF could therefore decide to implement a just-in-time inventory management system for the purpose of increasing efficiency, avoiding wasteful activities and improving the inventory turnover as well as the C2C-cycle (through days inventory held).

Q3:

The global supply chains are currently facing major disruptions as a result of geopolitical uncertainty and protectionist measures such as tariffs. This essay will firstly outline some of the principles and driving factors of supply chains and show how these affect different types of supply chain configurations with concrete examples. Following this, it will be discussed how tariffs could impact concretely impact the structure of these supply chains. *This will be handled in one essay such that a, b, and c will be answered together.*

To characterize and contextualize the principles and drivers for the configuration of supply chains, a few definitions related to logistics, supply chain and supply chain management are needed.

Logistics can be defined as the process of planning, implementing, and controlling procedures for the effective and cost-efficient transportation and storage of goods including services from the point of origin to the point of consumption, for the purpose of conforming to customer requirements.

Supply chain is a much wider and inter-company spanning term that can be defined as the network of organizations that are involved in, through upstream and downstream linkages, the activities that produce value in the form of goods and services in the hands of the ultimate consumer. Supply chain management is thus the management across and within this network of organizations of both relationships, and flows of material, information and resources. To navigate the challenges and disruptions that modern supply chains are facing, it is essential for managers to adopt a holistic approach to SCM, in which the management of these relationships and flows of material, information and resources are done in an integrated and coordinated way across functions and organizations.

Previously, the traditionalist perspective was taken in which supply chain management was seen as part of logistics. However today, and in this essay, a unionist perspective is taken in which logistics is seen as a part of supply chain management, which reflects the broader and boundary-spanning concept of SCM.

A key principle and influencing factor for firms is that their supply chain strategy should fit with their overall competitive strategy in order to align it to the firms strategic and operational objectives.

There is thus no 'one-size-fits-all' supply chain that is undisputably better, but for each firm it is contingent on the firm's competitive strategy, incl. the type of product it sells, as well as the market conditions. According to Fischer, firms with functional products and long product life cycles that are facing predictable demand should focus on having a lean supply chain centered around efficiency to reduce costs, whereas firms with innovative products, short product life cycles and unpredictable

demand should prioritize an agile or response supply chain that is configured such that it is quickly able to adjust and respond to changing demand. These different supply chain structures will be delved more into below.

An example of a firm operating with a lean supply chain is Toyota who through their Toyota Production System (TPS) have a focus on being highly efficient by removing wasteful activities (Muda) to reduce costs. They do so, by implementing a just-in-time inventory management approach which looks to reduce or minimize storage and obsolete inventory, such that the components arrive just-in-time for when they are needed. At the same time, they rely on “Autonomation” or Intelligent Automation, in which Toyota leverages automation in the production for efficiency, but at the same time allow humans to step in and intervene when mistakes happen.

Prior to the geopolitical uncertainty, many firms were focused on cost reductions. This was supported by globalization and principles from Friedmans theory of the flat world, in which advancements in ICT as well as trade agreements lowered the importance of national borders. This was furthermore supported by “Containerization” which facilitated global trade and contributed to lower freight rates. Many firms, especially European and American firms took advantage of this to either outsource or offshore parts of their value chain to lower cost locations with the purpose of decreasing their costs. Specifically, many firms decided to outsource or offshore lower value-add activities, which according to the smile value creation theory are things such as production, assembly and packaging. A great example of this is Apple who outsourced their production and assembly to China, while keeping their most value-adding activities such as R&D, design and marketing in key markets in Europe and the US. However, recently these firms have experienced some problems in the face of tariffs and general geopolitical uncertainty – which will be elaborated later in this essay. Apple have for example decided to expand their production in India and Vietnam to diversify away from being reliant on China, since the US administration has implemented higher tariffs on China, and it thus increases the cost of these goods when shipped to other locations.

Other firms have preferred an agile supply chain focused on speed and flexibility such that they can quickly adjust to the unpredictable demand they are facing. An example of this is Zara who uses a leagile strategy in which they use mass production of grey garment up to the decoupling point at which they make the final product configurations and adjust the products to meet the actual demand. They do so by integrating to POS-data from the retail storers such that the final product configurations are based on actual demand signals. And at the same time, they have invested in flexible manufacturing systems and nearshored more than 50% of their production to countries like Portugal, Spain, Morrocco and Turkey which allows for quick outbound logistics.

Tariffs effect on supply chain configurations

Recently, supply chains all over the world has faced challenges. This has also been due to the effect of wars which has created regional disruptions, but this essay will specifically focus on the impact of tariffs which increases prices for goods that cross borders and thus challenges the global footprint of supply chains. The current US administration has been a driver for implementing them, and several countries have responded with retaliatory tariffs, ultimately resulting in a more protectionist approach that counters Friedman's theory of the flat world.

Applying Hau Lees Typology matrix to analyze these developments, with supply uncertainty on the y-axis and demand uncertainty on the x-axis, it is evident that an increase in supply uncertainty as a result of tariffs moves the preferred supply chain configuration for many firms from an 'efficient supply chain' to a 'risk-hedging supply chain', and from a 'responsive supply chain' to an 'agile supply chain'.

This can affect the structure of firms supply chains in several ways, and we are already seeing firms implement some of these measures to make their supply chain more resilient. Firstly, firms have been focusing more on multiple supplier sourcing to increase supply chain resilience, such that they decrease their dependency on specific suppliers who might become considerably more expensive due to tariffs. This reflects an inherent trade-off since sourcing from multiple suppliers reduces the economies of scale and requires time spent on managing more relationships, but on the other hand it mitigates the risk from tariffs. This shows the trade-off between responsiveness and resilience on one side, and then efficiency and cost reductions on the other side.

Secondly, there has been an increase in nearshoring, backshoring and friendshoring to decrease supply chain risk by ensuring that firm's production is more easily accessible and is less exposed to geopolitical uncertainty, incl. tariffs. An example that aligns with this approach is TSMC (Taiwan Semiconductor Manufacturing Company) which recently invested \$65 billion in a production plant in Arizona to serve the US market. They did so primarily to mitigate the risk related to the US-China-Taiwan Tensions, which risked leading to export and import restrictions. However, after the election of Trump it also served as a risk mitigator against the tariffs, such that TSMC can sell to its US customer base, which reflects a significant percent of its revenue, while worrying less about tariffs. However, it will still likely impact the TSMC production plant in the US given the retaliatory measures that is being implemented by other countries, thus affecting their imports.

The tariffs also affects firms preferred relationships with their suppliers. When applying the Kraljic Matrix, which categorizes items from suppliers based on their impact on profit on the y-axis and

supplier risk on the x-axis, it can be seen that an increase in supplier risk moves many items from non-critical items to bottleneck items and from leverage items to strategic items. This creates a need for closer collaboration with suppliers to reduce the supply risk. One preferred strategy can be to build strong relationships with multi-national suppliers of goods that produce throughout the world (such that they are less exposed to country-specific tariffs) and then enter long-term contract with these suppliers at a fixed price. This can also be implemented together with collaborative planning forecasting and replenishment (CPFR) to ensure demand visibility and information visibility upstream in the supply chain, such that firms and suppliers can quickly adjust to these disruptions.

Furthermore, many firms may choose to not only nearshore or inshore their production, but also inshore their supplier relations, especially of strategic items and bottleneck items such that the firm's reduce dependency on foreign suppliers and mitigates their risk this way. It is thus evident how the increased risk as a result of tariffs and general protectionist measures might lead to many firms prioritizing resilience over efficiency, and limit the extend to which their supply chains are global and focused on cost reductions, by instead focusing more on building relationships with national suppliers and suppliers from countries that are less exposed to tariffs.

To sum up, there is no one-size-fits-all strategy that is undisputably better than others, and it is therefore essential for firms to align their supply chain strategy with their competitive strategy and also consider the external market conditions. Previously, many firms were focused on efficiency and cost reductions throughout their supply chain, helped by globalization and the world becoming flatter, as well as the possibilities of outsourcing and offshoring. However, recently due to the supply chains disruptions as a result of tariffs and general geopolitical uncertainty, we have seen, and expect to continue to see firms making their supply chains more resilient and responsive, for example by (i) sourcing from multiple suppliers with more focus on national suppliers such that items are not exposed to tariffs, (ii) by inshoring or nearshoring production and (iii) by building closer relations with the firm's most important suppliers such as doing CPFR to enhance demand and information visibility and be better prepared to handle disruptions. It is thus plausible that the global footprints of supply chains will be reduced over the coming years and challenge Friedmans theory of the flat world.