# iPodia – Innovation Team Project

**Part B**

Group 12

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December 5th 2017

## Agenda

1. Configuration of the ideal production network
2. Profitability of the product variants
3. BCG-Matrix
4. Outlook and Management Summary

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1. Configuration of the ideal production network
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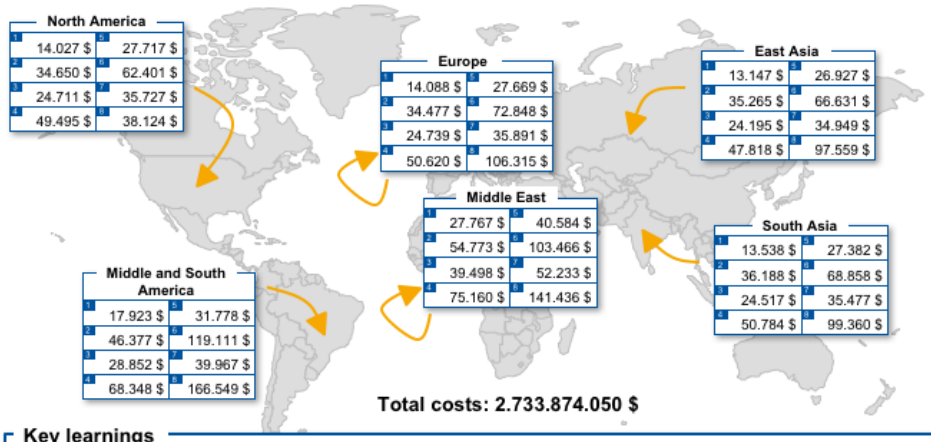
# With the Local for Local production concept, every country's demand is served by local production sites

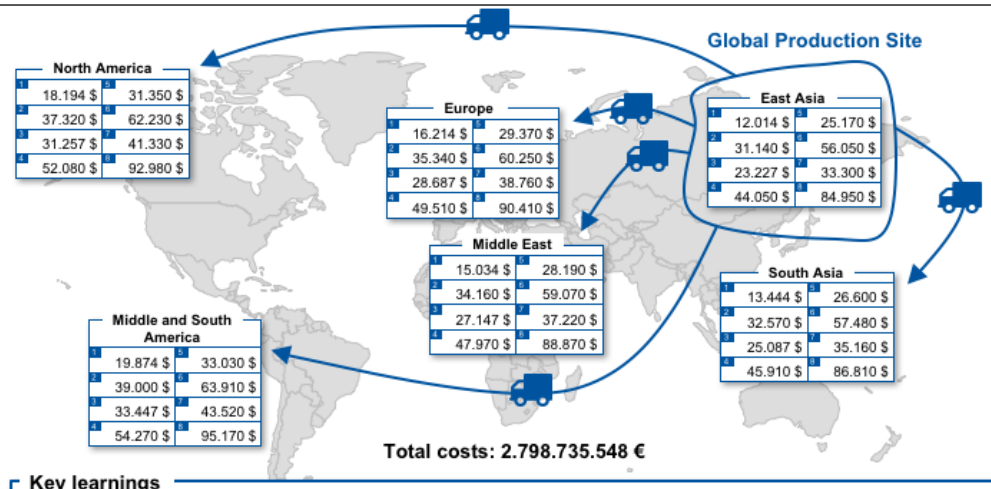



**Total costs: 2.733.874.050 $**

**Key learnings**

- Unit prices are low where demand is high (fixed costs spread over more units)
- Not every variant should be produced in every country

# With one global production site, production costs are lowered through economies of scale, but shipping comes as an expense




**Total costs: 2.798.735.548 €**

**Key learnings**

- Where demand is low, global production and shipping is less expensive than that of the Local for Local production.
- Concentrating production of low demand models is more important than the actual plant location



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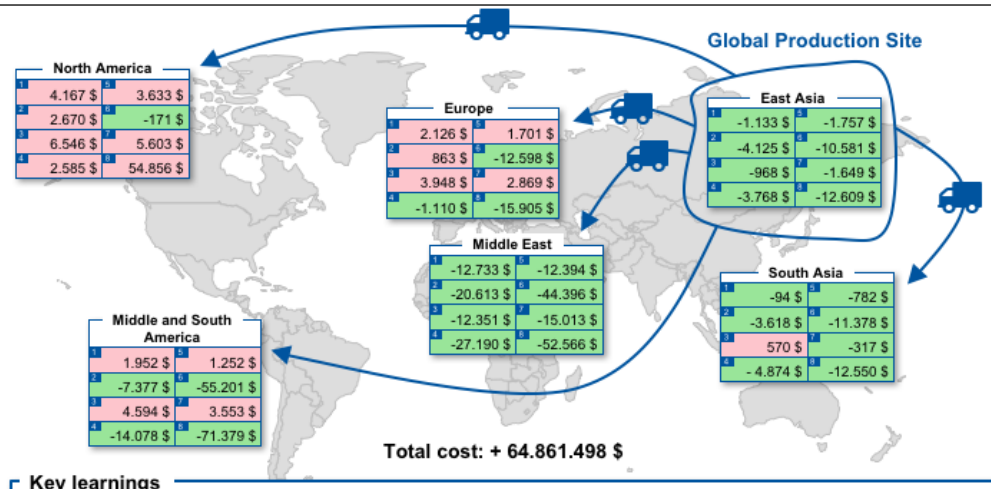
# A global production site enables savings where demand is low or the shipping costs are low




**Total cost: + 64.861.498 $**

**Key learnings**

- A global production site enables savings where demand is low (Middle East) or shipping costs are low (close to production).
- For countries with large domestic markets, like Europe and the US, local production is more profitable.



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## Optimization Model (1/2)

**Target Function**

- The following is the target function needed to be minimized in order to find the ideal production network.

$$\sum_j f_j y_j + \sum_i \sum_j z_{ij} \left( \sum_k c_{ijk} x_{ijk} + v_{ij} \right)$$

$i - variant$
$j - warehouse$
$k - customer$

**Relevant costs**

- $f_j$ = Fixed operating cost for warehouse $j$, if opened (overall site costs)
- $c_{ijk}$ = Per-unit manufacturing cost of variant $i$ at warehouse $j$ plus the transportation cost for shipping from warehouse $j$ to customer $k$
- $v_{ij}$ = overhead cost if variant $i$ is produced at warehouse $j$

**Variables**

$x_{ijk}$ = Amount of variant $i$ to be sent from warehouse $j$ to customer $k$

$y_j = \begin{cases} 1, & \text{if warehouse } j \text{ is opened} \\ 0, & \text{otherwise} \end{cases}$ $z_{ij} = \begin{cases} 1, & \text{if variant } i \text{ is produced at warehouse } j \\ 0, & \text{otherwise} \end{cases}$



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The variant and transportation operating cost per unit takes into consideration the different transportation costs for the variant models (2 seater and 4 seater).

## Optimization Model (2/2)

**Constraints**

There are 3 types of constraints for the model:

(1) The demand for some variant , $d_{ik}$, of each customer must be filled from the warehouses (Eq. 2)

(2) Goods can be shipped from a warehouse only if it is opened. (Eq. 3)

(3) Goods of certain variant can be shipped from a warehouse only if the variant is produced at a warehouse that is opened. (Eq. 4)

subject to

$$\sum_j x_{ijk} = d_{ik}, \qquad i \in \mathbb{N} \cap [1,m], k \in \mathbb{N} \cap [1,n] \tag{2}$$

$$\sum_i \sum_k x_{ijk} - y_j \left( \sum_i \sum_k d_{ik} \right) \leq 0, \qquad j \in \mathbb{N} \cap [1,n] \tag{3}$$

$$\sum_k x_{ijk} - y_j z_{ij} \left( \sum_k d_{ik} \right) \leq 0, \qquad i \in \mathbb{N} \cap [1,m], j \in \mathbb{N} \cap [1,n] \tag{4}$$

$$x_{ijk} \geq 0, \qquad i \in \mathbb{N} \cap [1,m], \quad j,k \in \mathbb{N} \cap [1,n]$$

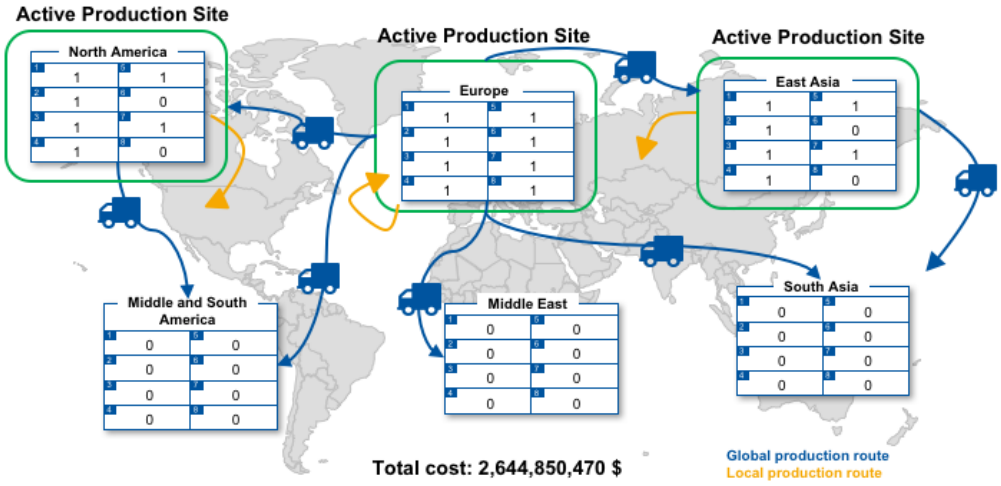
$$y_i = 0 \text{ or } 1, \qquad i \in \mathbb{N} \cap [1,n]$$

$$z_{ij} = 0 \text{ or } 1, \qquad i \in \mathbb{N} \cap [1,m], j \in \mathbb{N} \cap [1,n]$$

$i - variant$
$j - warehouse$
$k - customer$

In our case, m = 8 and n = 6.

## Ideal Production Network




- The solution for the ideal production network was calculated implementing the optimization model in python using the Gurobi Solver

1, if variant $i$ is produced at warehouse $j$
0, otherwise

# Ideal Production Network

**Production site: North America**

| Transport to | NA | M/SA | EU | ME | SAsia | EAsia |
|---|---|---|---|---|---|---|
| Variant 1 | 4455 | 1504 | 0 | 0 | 0 | 0 |
| Variant 2 | 1973 | 384 | 0 | 0 | 0 | 0 |
| Variant 3 | 4681 | 1468 | 0 | 0 | 0 | 0 |
| Variant 4 | 1260 | 226 | 0 | 0 | 0 | 0 |
| Variant 5 | 3568 | 1356 | 0 | 0 | 0 | 0 |
| Variant 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Variant 7 | 4015 | 1380 | 0 | 0 | 0 | 0 |
| Variant 8 | 0 | 0 | 0 | 0 | 0 | 0 |

**Total production at the site: 26270 units**

**Production site: Europe**

| Transport to | NA | M/SA | EU | ME | SAsia | EAsia |
|---|---|---|---|---|---|---|
| Variant 1 | 0 | 0 | 4353 | 627 | 0 | 0 |
| Variant 2 | 0 | 0 | 1989 | 327 | 0 | 0 |
| Variant 3 | 0 | 0 | 4691 | 573 | 0 | 0 |
| Variant 4 | 0 | 0 | 981 | 227 | 0 | 0 |
| Variant 5 | 0 | 0 | 3510 | 691 | 0 | 0 |
| Variant 6 | 1053 | 81 | 365 | 134 | 333 | 426 |
| Variant 7 | 0 | 0 | 3678 | 480 | 0 | 0 |
| Variant 8 | 928 | 62 | 279 | 112 | 299 | 354 |

**Total production at the site: 26553 units**

**Production site: East Asia**

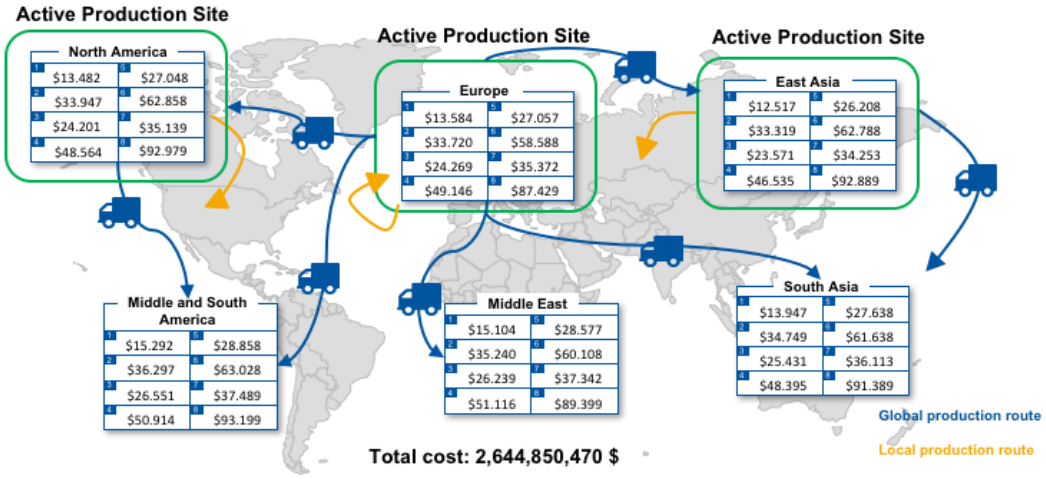
| Transport to | NA | M/SA | EU | ME | SAsia | EAsia |
|---|---|---|---|---|---|---|
| Variant 1 | 0 | 0 | 0 | 0 | 3974 | 5365 |
| Variant 2 | 0 | 0 | 0 | 0 | 878 | 1120 |
| Variant 3 | 0 | 0 | 0 | 0 | 3864 | 5382 |
| Variant 4 | 0 | 0 | 0 | 0 | 672 | 1389 |
| Variant 5 | 0 | 0 | 0 | 0 | 2963 | 4147 |
| Variant 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Variant 7 | 0 | 0 | 0 | 0 | 3651 | 4643 |
| Variant 8 | 0 | 0 | 0 | 0 | 0 | 0 |

**Total production at the site: 38048 units**

**Key Findings**

- Production sites in the following countries are **not** suitable: ***Middle and South America, Middle East, South Asia***
- Three production sites in North America, Europe and East Asia
- Each production site supplies the closest biggest market (e.g. NA -> M/S. America, EU -> Middle East, EA -> SA)
- Europe supplies globally variant 6 and 8

# Cost per Unit of Ideal Production Network




**Total cost: 2,644,850,470 $**

$$\textit{Cost per Unit} = (Production\ Cost + Transportation\ cost) + \frac{Overall\ Site\ Costs}{Units\ produced\ at\ the\ site} + \frac{Overhead\ Production\ costs\ for\ the\ variant}{Units\ of\ the\ variant\ produced\ at\ the\ site}$$



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## Reflection on the Ideal Production Network

**Reflection 1**

- For countries with large domestic markets, like Europe and the US, local production is more profitable.

| Country | Demand |
|---|---|
| **North America** | **21936** |
| Middle /South America | 6464 |
| **Europe** | **19848** |
| Middle East | 3174 |
| South Asia | 16636 |
| **East Asia** | **22829** |

Largest domestic Markets

- Those three largest domestic markets are also where our operating production sites are located.
- The production sites NA, EU and EA can supply their neighboring markets because the transportation costs are lower than the costs that would occur from a seperate production site.

# Reflection on the Ideal Production Network

## Reflection 2

- Why should the variants 6 and 8 to be produced globally in Europe?
- A global production site enables savings where demand is low (e.g. Middle East) or production and shipping costs are low

| Variant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Global Demand | 20280 | 6673 | 20661 | 4758 | 16237 | **2394** | 17849 | **2036** |

Two variants with lowest global demand

| Costs | Producing in | Manufacturing costs | Overhead cost for variant | Transportation costs | Total |
|---|---|---|---|---|---|
| Variant 6 | N. America | $132.610.980,00 | $6.100.000,00 | **$7.421.263,00** | $146.132.243,00 |
| | Europe | **$131.892.870,00** | $6.000.000,00 | $7.869.973,00 | **$145.762.843,00** |
| | East Asia | $134.166.885,00 | **$4.200.000,00** | $9.559.993,00 | $147.926.878,00 |
| Variant 8 | N. America | $171.422.780,00 | $6.100.000,00 | **$8.068.065,00** | $185.590.845,00 |
| | Europe | **$169.997.650,00** | $6.000.000,00 | $8.853.594,00 | **$184.851.244,00** |
| | East Asia | $172.949.705,00 | **$4.200.000,00** | $10.617.306,00 | $187.767.011,00 |

- Europe is the most economic production site for producing the Variants 6 and 8 globally

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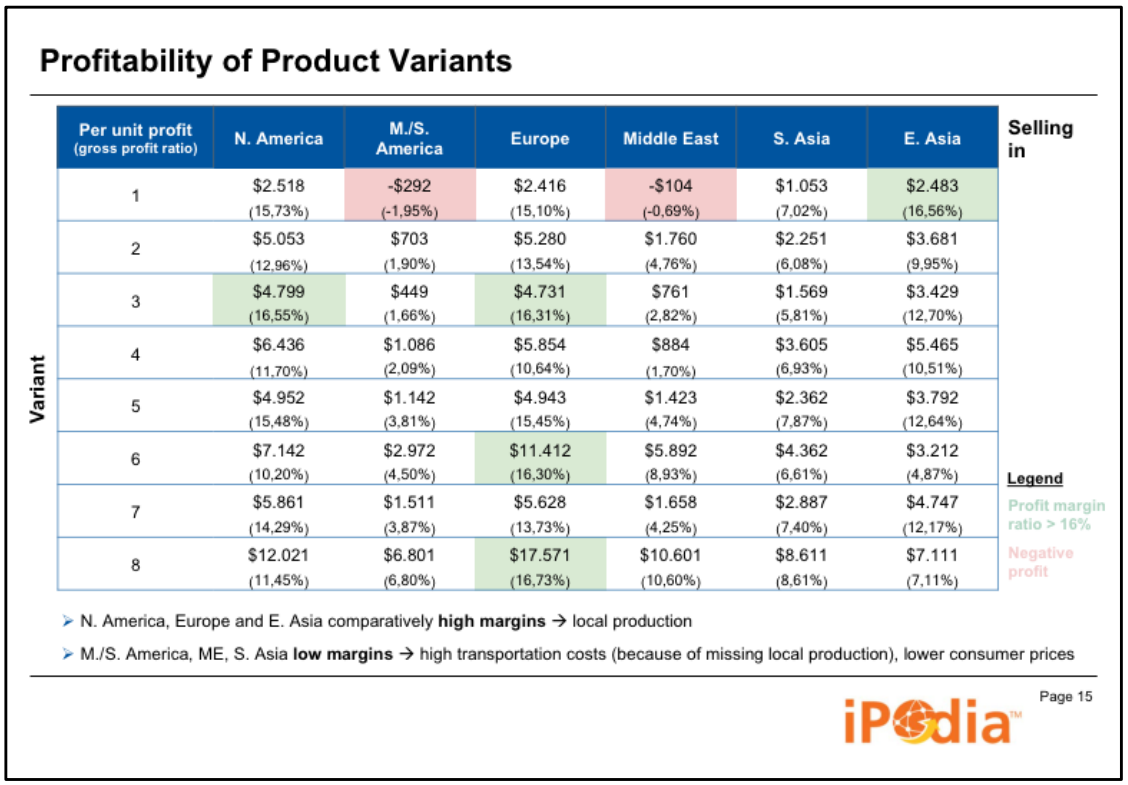
4. Outlook and Management Summary



## Profitability of Product Variants

| Variant: Per unit profit (gross profit ratio) | N. America | M./S. America | Europe | Middle East | S. Asia | E. Asia |
|---|---|---|---|---|---|---|
| 1 | $2.518 (15,73%) | -$292 (-1,95%) | $2.416 (15,10%) | -$104 (-0,69%) | $1.053 (7,02%) | $2.483 (16,56%) |
| 2 | $5.053 (12,96%) | $703 (1,90%) | $5.280 (13,54%) | $1.760 (4,76%) | $2.251 (6,08%) | $3.681 (9,95%) |
| 3 | $4.799 (16,55%) | $449 (1,66%) | $4.731 (16,31%) | $761 (2,82%) | $1.569 (5,81%) | $3.429 (12,70%) |
| 4 | $6.436 (11,70%) | $1.086 (2,09%) | $5.854 (10,64%) | $884 (1,70%) | $3.605 (6,93%) | $5.465 (10,51%) |
| 5 | $4.952 (15,48%) | $1.142 (3,81%) | $4.943 (15,45%) | $1.423 (4,74%) | $2.362 (7,87%) | $3.792 (12,64%) |
| 6 | $7.142 (10,20%) | $2.972 (4,50%) | $11.412 (16,30%) | $5.892 (8,93%) | $4.362 (6,61%) | $3.212 (4,87%) |
| 7 | $5.861 (14,29%) | $1.511 (3,87%) | $5.628 (13,73%) | $1.658 (4,25%) | $2.887 (7,40%) | $4.747 (12,17%) |
| 8 | $12.021 (11,45%) | $6.801 (6,80%) | $17.571 (16,73%) | $10.601 (10,60%) | $8.611 (8,61%) | $7.111 (7,11%) |

Selling in

Legend
Profit margin ratio > 16%
Negative profit

- N. America, Europe and E. Asia comparatively **high margins** → local production
- M./S. America, ME, S. Asia **low margins** → high transportation costs (because of missing local production), lower consumer prices

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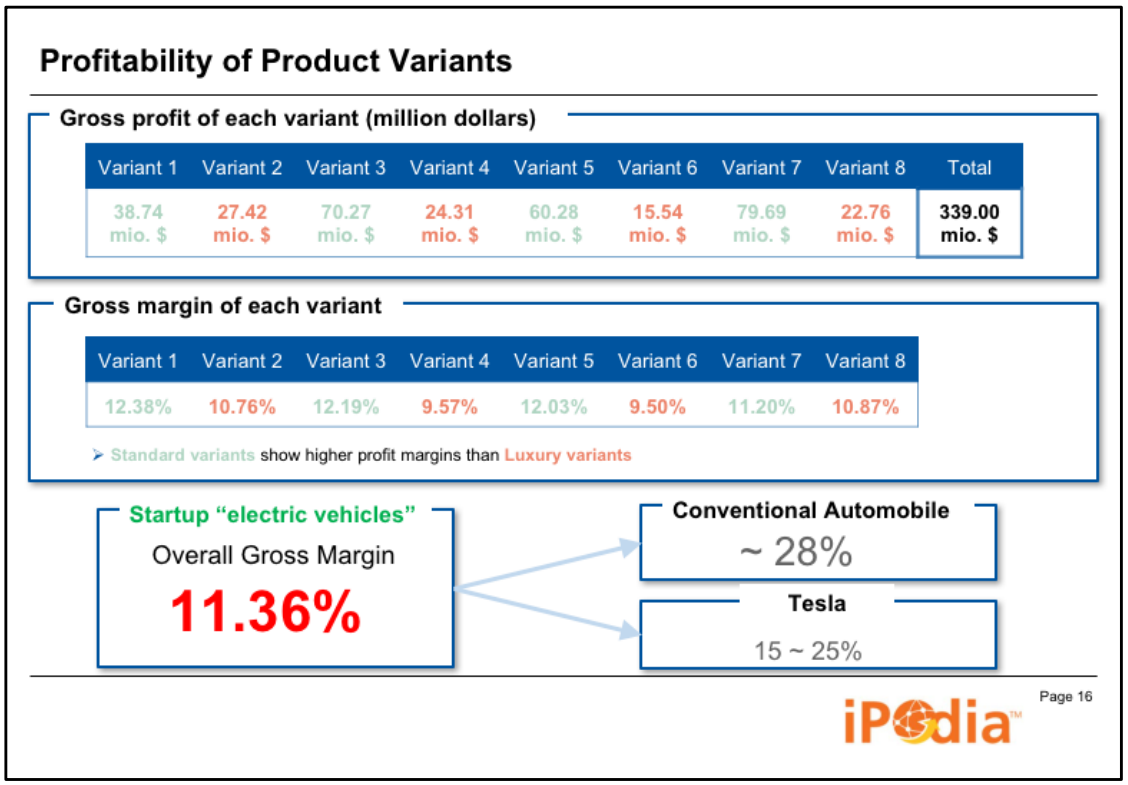
In the following table the profit per unit and gross profit ratio for each variant for each consumer country is presented.

By analyzing the profitability of the different variants, it is possible to deduce the following aspects. In general, goods sold locally can bring more profit. The table shows that goods sold to North America, Europe, and East Asia have the highest per unit gross margin and gross profit ratios. Also, products sold in Middle/South America and Middle East show that occasionally negative profits (red cells). A possible reason for this is the lower demand in these regions comparatively to the other markets. Due to the lower demand there is no local supply and the transportation cost from other regions is relatively high. Furthermore, the consumer prices are lower in these regions; possibly because they are considered to be developing countries.

Lastly, red cells have negative gross profit while green cells have per unit gross margin > 16%.




In this slide, the profitability of the product variants has been summed up and can be compared to the variants amongst each other. One particular relation that can be perceived is that the standard variants (green) have higher gross profit and higher gross profit rate in comparison to luxury variants (red).

The overall gross profit rate for the electric company considering the ideal production network is around 11%. This is considerably less that the usual gross profit rate for automotive brands that sell conventional cars (~28%). However, by comparing the gross margin ratio of our startup with an established electric car manufacturer, such as Tesla, it can be seen that the lower gross margins are currently typical for electric car companies expanding globally. This can be due to the higher material costs of electric cars that come from the expensive battery component.

However, it also can be assumed that these margins will improve with increasing scaling effects on the battery production, which leads to reduced battery costs. Aside from the material costs, the production site, production overhead, manufacturing and transportation should be similar among conventional and electric cars.

Reference for automobile profit rate:
http://www.autonews.com/article/20170417000100/RETAIL06/304179922
Tesla profit rate: https://ycharts.com/companies/TSLA/gross_profit_margin

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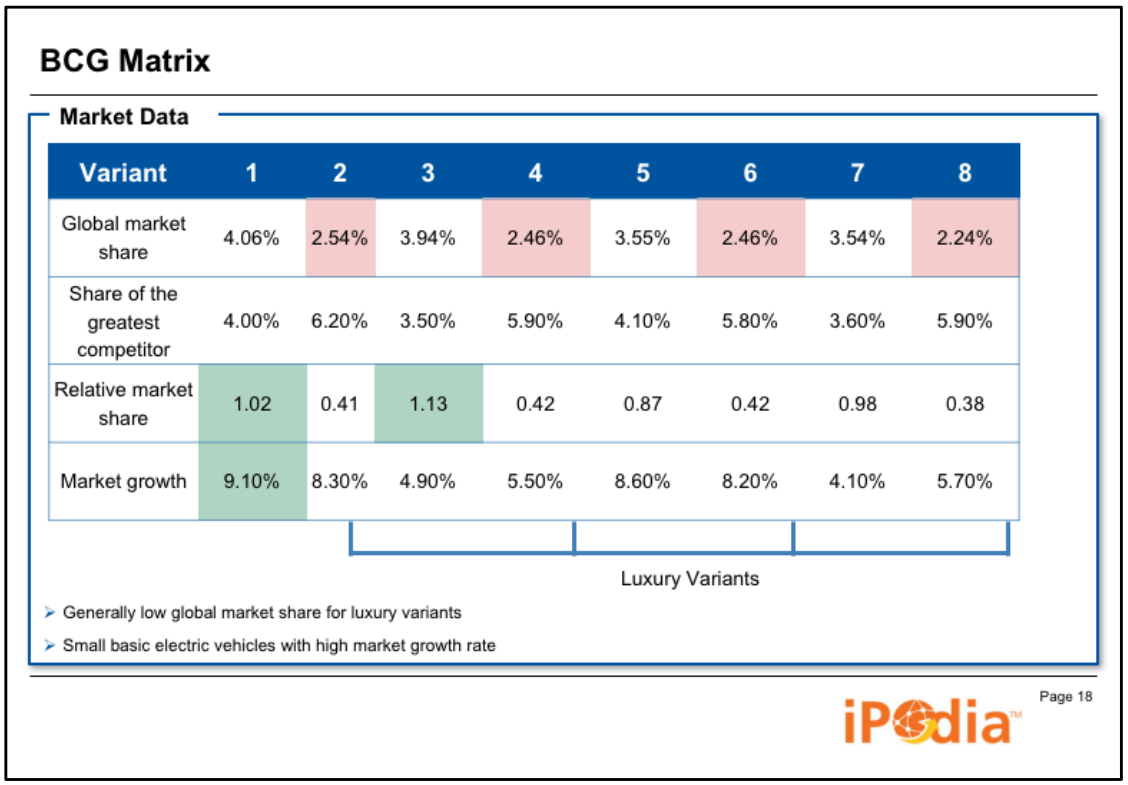



In order to align the variants within the BCG-portfolio matrix, the global market share per variant and subsequently the relative market share per variant needs to computed.

The global market share can be computed in the following way:

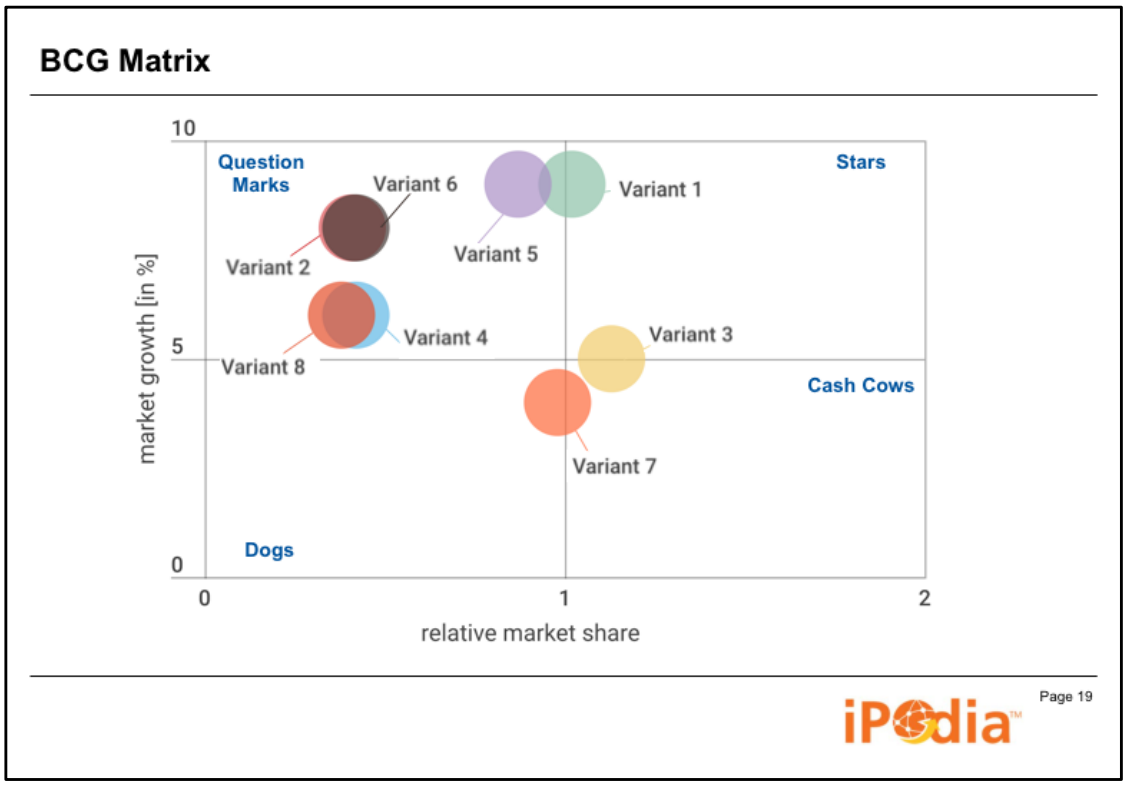
$$Global\ market\ Share = \frac{brand's\ expected\ sales\ in\ the\ Market}{Global\ market\ volume}$$

With that, the $Relative\ market\ Share = \frac{brand's\ global\ market\ share}{market\ share\ of\ the\ greatest\ competitor}$ can be calculated.

This table shows that for luxury variants the global market share is significantly lower than for the standard variants. This seems intuitive, because the demand for luxury cars is usually lower.

Furthermore it can be noticed that for the luxury variants the relative market share of our startup is considerably lower that the one of the greatest competitor. This means, that it is hard for our startup to compete in the market of luxury variants due to a stronger competition. This is reasonable, since brand matters when it comes to high-end products. Essentially, people would be less likely to choose high-class products from a startup like us. The greatest competitor may be a company such as Mercedes-Benz.

However, it can also be seen that small electric vehicle variants have a comparatively high market growth rate. Note that in the next slide we are going to analyze the variant the show the best opportunities for our startup to be successful.




The BCG-matrix (product portfolio matrix), helps corporations analyze their product lines and allocate resources strategically. In order to be competitive in the market, it is important to focus on variants with a good market growth and for companies that possess a significant relative market share. Most of the given variants are question marks. Question marks are characterized to be operating with a low market share in a high-growth market. They are a starting point for most businesses and have a potential to gain market share and become stars. Finding the successful question marks is a difficult task, because they could easily be converted into dogs. Variants 1 and 5 can be interpreted as question marks which are currently converting into stars. Whereas variants 3 and 7 can be considered to be cash cows that are worth exploiting. Thus, the startup should exploit the variants 3 and 7 (reduce costs, modularization, outsourcing) and explore how to improve the relative market share on the variants 1 and 5.

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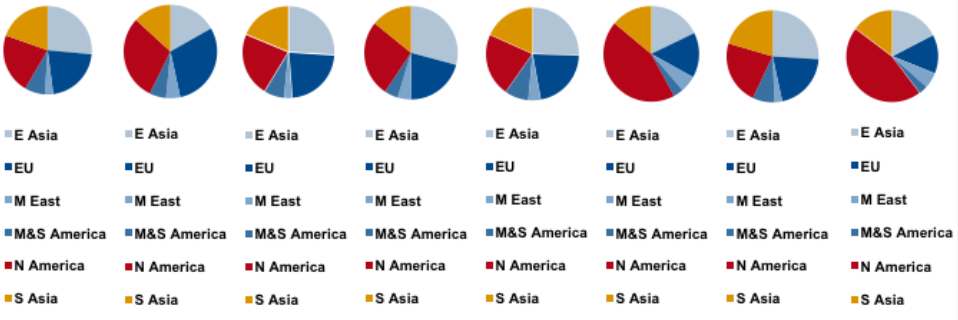
## Management Summary

| | 100 kW 2 seater basic | 100 kW 2 seater luxury | 100 kW 4 seater basic | 100 kW 4 seater luxury | 200 kW 2 seater basic | 200 kW 2 seater luxury | 200 kW 4 seater basic | 200 kW 4 seater luxury |
|---|---|---|---|---|---|---|---|---|
| Total sales | 20280 | 6672 | 20661 | 4757 | 16236 | 2393 | 17849 | 2035 |
| Global market share | 4.06% | 2.54% | 3.94% | 2.46% | 3.55% | 2.46% | 3.54% | 2.24% |
| Market Share |  | | | | | | | |

# Outlook

**Production and Sale in the largest markets**

- Highest amount of market share per variant
- Highest profit margins
- Benefits of purely local production (low transportation costs)

**Focus on:**
North America
Europe
East Asia

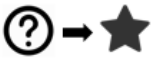
**Short Term Strategie**

- Focus on the product variants with high relative market share and high market growth
- ***Target:*** Exploite stars and increase relative market share!

**Focus on:**
Variant 1 & 5

**Long Term Strategie**

- Variants 2 and 6 show a high market growth rate, but only a small relative market share
- Make them get from question marks to stars
- ***Look ahead***: Build variants 1 and 5 in a modularized way in order to easily expand to the luxury variants 2 and 6 (use the same production platform respectively)



**Focus on:**
Variant 2 & 6

## Presentation of the team

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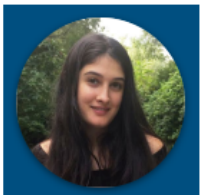

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