House of Quality and FMECA

For a PC Multi-Port Adapter

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0. INTRODUCTION

In 1965, Gordon E. Moore, co-founder of Intel, postulated that the number of transistors that can be packed into a given unit of space will double about every two years. This simple idea was then generalized and formalized into a rule that helps us understand the trend that tech is following.

According to Moore's Law each year the performance of tech products improves exponentially while their cost of production decreases just as rapidly.

With this in mind it's interesting to analyse our everyday life experience and notice that as technology improves it enhances the features, the shape and the characteristics of all of our tech devices but that sometimes it sacrifices useful features that then need to be "delegated" to external accessories.

To go deeper into the object of our analysis let's dive into the world of laptops and personal computers where a trend is clearly emerging: customers value the compactness of a PC and thanks to modern components laptops are becoming increasingly thinner and smaller without losing in performance.

From the customer point of view thin and light laptops are great but this gives producers a new challenge: where to put connection ports. In the last years we observed a clear trend in the reduction of the number of ports per computer.

The lack of connection ports might be perceived as an inefficiency for some customers, especially for professionals who need to deal daily with great amounts of data and need information to flow rapidly and easily.

To solve this new problem the clear solution are specific accessories called: **multiport adapters**. Multiport adapters are accessories used to easily connect a laptop to multiple devices at once. They expand a computer's USB-C port into HDMI, USB-A, more USB-C's, Ethernet ports or as well into SD card readers and basically giving back to the user the ports that newer laptops have eliminated in recent years due to the lack of a unique standard port. They usually also support pass-through charging, eliminating the need to choose between port expansion and power.

The purpose of the following analysis is to underline the characteristics of a PC multi-port adapter in relation to the customer's requirements and its technical characteristics.
To perform our analysis, we've constructed a **HoQ (house of quality)**.
We then analysed how it could fail and all its criticalities with a **FMECA** analysis.

1. DETERMINATION OF CRs (WHATs)

The first thing we did was to analyse the market where we identified 3 main segments in which we can sharply divide it. They mainly depend on types of user and the use they make of their computer.

- **Segment 1: High performing multi-ports adapter**
  This kind of product is used by developers and designers who need the most performing and efficient product on the market. The price range is around 100-200 euros.
- **Segment 2: Standard performing multi-ports adapter**
  The medium quality multiport adapter is used mainly by professionals who need to cope with work needs on a daily basis caused by the lack of ports of their laptops. The price range is around 50-100 euros.
- **Segment 3: Low performing multi-ports adapter**
  Products mainly used by students or adults that need more ports to duplicate screen, to implement ports they lack on their PCs, etc. The price range is around 15-40 euros.

After an internal analysis we have decided to take into consideration the **standard performing multi ports adapter** since the customer base associated with is the widest on the market.

Once we identified the market segment and subsequently our customers we proceed with the **collection of the Voice of Customers**.

To practically conduct this survey, we developed a form with simple questions about what people want from their Multiport Adapter and we've distributed it to that part of our customer base that we think falls into the parameters of market segment 2. We also conducted oral interviews in front of electronic stores to gather unbiased information from users not previously related to our brand. We have then deepened our knowledge about what people think about the product performing focus groups with 8 customers per group. We report here some VoC's examples:

- "It should have all types of port"
- "It should last long time"
- "It should not be too heavy"
- "It should be aesthetically appealing"
- "It must be easy to carry around"
- "It must not overheat"
- "It should be universally adaptable"
- "It should have a long warranty period"
- "It must transmit data rapidly"
- "It must be resistant"
- "It should be waterproof"

We then constructed CRs-trees to translate and interpret the Voice of customer and come down to a list of specific Customer Requirements. We here include two examples of the method used, CRs-trees (figure 1), to interpret the voice of customer and resume it in a list of final Customer Requirements.

figure 1 (**Customer Requirements Tree**)

We report here the list of final Customer Requirements with a short description of each one. We divided them into macro groups.

STRUCTURAL NEEDS

- **Impact resistance**: it resulted essential to the customer that the multi porter is resistant, especially during transport when it is most prone to shocks.
- **No overheating**: since the customer base is composed by professionals it's necessary to achieve good performance in connecting several devices without overheating and consequently slowing down connections.
- **Long lasting**: customers want to have to buy the multi-port adapter once, and therefore expects it to have a long-life span in terms of performance.
- **Waterproof**: customers are conscientious about the presence of liquids (coffee, water) in their work environment and value the fact that all devices are waterproof.

TECHNICAL FEATURES

- **All types of port**: to achieve the best working efficiency, it is essential to customers that all the devices, that have different types of port, can be connected.
- **Rapid data transmission**: there's a clear necessity for professionals to lose the least amount of time in moving data between devices, regardless of the dimensions.

USABILITY

- **Universal adaptability**: we detected that it's important to customers that different types of devices, with different software can be easily connected.
- **Lightweight**: customers value the fact that the multi-port adapter is light because they often need to carry it around.
- **Easy to carry around**: it resulted important that the multi-port adapter is small enough to be easily carried around and/or fit in a briefcase.

OTHERS

- **Aesthetically appealing**: we detected that the multi-port adapter looks are important to the customer and can strongly influence in the purchase decision process.
- **Warranty Period**: customers expressed that they feel more comfortable if their multi-port adapter is covered by warranty because it's a relatively expensive object.

2. CRs PERCEIVED QUALITY DEPLOYMENT

PRIORITISATION OF CUSTOMER REQUIREMENTS

At this point, through a questionnaire, we asked users to **assess the degree of importance they attach to each one of the Customer Requirements** we identified. They were asked to evaluate each CR with a degree of influence between "No influence at all" and "Very strong influence". Analysing the results, we were able to identify the most relevant CRs.

BENCHMARKING ON THE BASIS OF PERCEIVED QUALITY

We also asked to evaluate each CR with a degree of influence between: "No influence at all", "Minor influence", "Some influence", "Strong influence" and "Very strong influence". We converted these values with numbers ranging from 0 (no influence) to 5 (very strong influence). We decided to summarize the results using the MEDIAN.
Our product is the HP Universal USB-C Multiport Hub, meanwhile our competitors' are the Anker 655 USB-C Hub and the Apple USB - C Digital AV Multiport Adapter.

TARGET VALUE OF EXPECTATIONS

Our team has now defined the target values for the new model of our PC-multi port adapter by taking into consideration benchmarking and strategic considerations. The values are always on a scale from 1 to 5 and the results are indicated in the "Targets" (New Model) column.
The **improvement ratio** is supposed to show the improvement priorities and it is calculated by dividing **target** performance level by the importance of the **current model**.

STRENGHTS

We were now supposed to make an evaluation on all the CRs based on how important they are for our company. We assign 1.5 to aspects that define us, 1.2 to aspects we want to invest on and 1.0 to what's not relevant. We add a resume about our company, to explain our choices.

Hp Inc. is an American multinational information technology company that offers a big quantity and variety of products. Customers can always find the most suitable product for their needs. A strength of this company is the products' quality, which is a guarantee for the customer to buy a resistant and **long-lasting** product. They are also famous for the high performance of their devices in terms of **rapid data transmission**. They are also strategically investing to be perceived as a company that produces **aesthetically appealing** and **waterproof** products to compete respectively with the strengths of Apple and Anker.

ABSOLUTE WEIGHT

The "absolute weight" is the definitive term for determining the importance of a CRs:

*Absolute weight = degree of importance * improvement ratio * strength*

It resulted especially important to improve in the aspect: **long lasting.**

3. DETERMINATION OF TCs (HOWs)

We now have a detailed and organized list of characteristics that represents the Voice of Customer. However, customers are not technicians and they expressed to us what their desires are but not the way to satisfy them. We, as a team of engineers, worked to translate the Customers' Requirements into a list of Technical Characteristics, which represent the Voice of Engineer (VoE).

We worked assigning to each Customer Requirement a list of measurable and objective properties that we can control by defining and changing the production process. We will elaborate more on this point when talking about the relationship matrix [pg.09].

Here's an example:

Impact resistance → Case Thickness, Case Material, Case Geometry

With this process we determined a list of Technical Characteristics. Here follows a brief description of each one of them, with their corresponding unit of measurement.

1) **Expected life** [*years*]: it's the time interval during which our product is expected to work in proper conditions and there is no need to replace it with a new one since it is operating at full potential. The average expected life falls into a 4-6 years range.

2) **Case Thickness** [*mm*]: related to the material chosen and its ductility. To reduce the overall weight you should go for a thin outer layer that at the same time it's able to protect internal components from impacts and atmospheric agents.

3) **Case Material** [-]: it's the specific mechanical property depicting the resistance of the frame when subjected to stress or deformation. A ductile material can withstand large strains even after it has begun to yield.

4) **Case Geometry** [-]: the point is to guarantee the best possible handling and a fit that allows customers to manoeuvre it easily. The outer frame can be characterized by soft pads, to avoid the presence of sharp edges and to reduce the probability of breaking after impact.

5) **Weight** [*g*]: it should be as light as possible with a well-balanced centre point of mass, to give the hardware the right handling in different positions.

6) **Thermal paste and alloy** [*Watt/inches * °C*]: the thermal paste is the substance applied to a processor before installing a cooling solution. It can be active (fan) or passive like in our product (cooling materials). It allows for an efficient transfer of heat from the processor to the base plate that is designed to dissipate that heat. The higher the thermal conductivity the better it will prevent overheating and decrease the possibility of damage.

7) **Degree of protection to water** [*IP00*]: the IP rating is a parameter used to assess the degree of protection or sealing effectiveness of electrical enclosures against the intrusion of objects, water, dust or accidental contact. The IP code always consists of the letters IP, Ingress Protection, followed by two digits, where the first digit indicates the level of protection of the equipment against the ingress of solid foreign bodies,

while the second indicates the level of protection of the equipment against the ingress of moisture and water.

8) **Anti-scratch treatment** [*Mohs*]: it gives the product a particular resistance to abrasion and, in aesthetic terms, improves the shine of the treated surfaces. It's tested with the Mohs scale.

9) **Number of available colours** [-]: the possibility of having a wide range of colours allows it to be matched to the devices to which it is connected.

10) **Thunderbolt's version** [*Gigabit*]: in products like this, fast data transferring can be achieved installing fast connection types. Customers should be able to transfer files with a speed up to 10Gbps via USB type A (USB 3.2 Gen 2), 40Gbps via USB type C (Thunderbolt 4), 2.5 Gigabit with the ethernet port (802.3bz). Through HDMI 2.0 connections they should be able to connect a 4K monitor at a maximum frame rate of 60 fps.

11) **Number of ports** [-]: it's a key feature to achieve high performance, allowing several devices to be connected at the same time even if they require the same port.

12) **Number of different port types** [-]: useful to connect different devices. Basic needs: USB type-A, USB C Thunderbolt, HDMI, Ethernet, SD port, USB C Power Supply, Jack 3.5 mm.

13) **Size of components** [μm]: smaller electrical components allow smaller circuit boards and to pack everything closer and more conveniently.

14) **Warranty Cost** [-]: the legal guarantee must always be given to the consumer. The longer it is the costly it is for the company providing it, 2yrs is the legal minimum. The company allocates a % of the cost of the product depending on how many units are expected to fail during the warranty period.

As a last point we analysed how increasing each TC in value effects the perception of the customer. Some of them vary in a directly proportional manner, others inversely.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Expected life	Case thickness	Case material	Case geometry	Weight	Thermal paste and alloy	Degree of protection to water	Anti-scratch treatment	Number of available colours	Thunderbolt's version	Number of ports	Number of different ports types	Size of components	Warranty cost
↑	↑	↑	↑	↓	↑	↑	↑	↑	↑	↑	↑	↓	↓

figure 2

4. RELATIONSHIP MATRIX & CORRELATION MATRIX

RELATIONSHIP MATRIX

Here's a list of the relationships between CRs and TCs:
STRUCTURAL NEEDS

- *Impact resistance* → Case Thickness, Case Material, Case Geometry
- *Long lasting* → Expected life, Case Thickness, Case Material, Case geometry, Thermal paste and Alloy, Degree of protection to water, Warranty cost
- *No overheating* → Case Thickness, Case Material, Thermal paste, Size of components
- *Waterproof* → Case Thickness, Case Material, Water protection, Number of ports

TECHNICAL FEATURES

- *All types of port* → Case Geometry, Number of ports, Number of different ports types
- *Rapid data transmission* → Thunderbolt's version, Number of ports

USABILITY

- *Universal adaptability* → Number of ports, Number of different ports types
- *Lightweight* → Case material, Case thickness, Weight, Size of components
- *Easy to carry around* → Case thickness, Case geometry, Weight

OTHERS

- *Aesthetically appealing* → Case geometry, Anti-scratch treatment, Number of colours
- *Warranty Period* → Expected life, Warranty cost

At this point we studied the degree of correlation of each relationship and assigned to it a symbol, each one has a corresponding value used to calculate the absolute weight:

● : 9 Strong correlation ○ : 3 Medium correlation ▼ : 1 Weak correlation

For example, the CR **lightweight** is strongly correlated with the TC **weight,** mediumly with the TC **case thickness** and weakly with the TCs **case material** and **size of components**.

CORRELATION MATRIX

We then analysed manually the **possible correlations between pairs of TCs** to understand how much we can improve the performance of a TC without having a bad effect on another one. We have assigned a **+** where the improvement of a TC increases the performance of the second one and a **-** where improving the first has a negative impact on the second.
For example, using a better thermal paste and alloy increases the expected life of the product, meanwhile increasing the case thickness increases the weight of the product, so it has a negative effect on the performance of this TC.

5. TCs PRIORITIZATION & CONCLUSIONS

In order to determine the features that we need to improve, we created a priority list of the TCs evaluating their impact on the CRs and compared the TCs of our product with those of Apple and Anker.

First of all, we translated the relationship matrix coefficients into weights.

● : 9 Strong correlation ○ : 3 Medium correlation ▼ : 1 Weak correlation

We then used the Independent Scoring Method (ISM) to calculate the Absolute Weight and the Relative Weight of each TC. We obtained that the Number of different port types has the maximum Absolute Weight which is 2,039.

After we associated each TC with its correct unit of measurement and compared the TC of our product with those of the Apple's and Anker's products.
When using a number to quantify the TC wasn't possible, we defined a qualitive measurement that could be the best way to evaluate it, such as for the Case Geometry or the Case Material.

We looked for technical information and reported them in the HoQ.
Thanks to the comparison with our competitors' products, for each TC we determined the **target values** to be used as input data for designing the new model, according to their importance and the benchmarking.

We decided to decrease the **weight** because our product is the heaviest, meanwhile, evaluating where it was worth investing in it, to increase the **number of different port types** to achieve the number of Anker's product.

Since our **thunderbolt's version** was better than those ones of our competitors' products, we won't improve it because it would be a waste of money and of time.

Additionally, it is inconvenient to increase the **anti-scratch treatment** because our value is similar to the ones of our competitors and the technical importance of this characteristic is very low.

In conclusion, evaluating the target of the new model we found that we should improve 7 TCs over 14: **Case Thickness, Weight, Degree of protection to water, Number of available colours, Number of ports, Number of different port types and Warranty cost.**

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Technical Characteritics / Customer Requirements	Expected life	Case thickness	Case material	Case geometry	Weight	Thermal paste and alloy	Degree of protection to water	Anti-scratch treatment	Number of available colours	Thunderbolt's version	Number of ports	Number of different ports types	Size of components	Warranty cost	
Absolute Weight	1,891	1,923	1,371	2,157	1,95	0,867	0,441	0,266	0,798	0,798	1,217	2,039	0,177	0,946	16,840
Relative Weight	11%	11%	8%	13%	12%	5%	3%	2%	5%	5%	7%	12%	1%	6%	100%
Unit of measurement	yrs	mm	-	-	g	W/ " * °C	IP	Mohs	-	Gigabit	-	-	µm	-	
Current Model (HP)	5	22	A	RE	130	0,052	43	6	3	40	6	6	3	4,5%	
Competitor #1: Anker	3	42	P	RO	127	0,019	65	7	5	10	10	8	3	5,2%	
Competitor #2: Apple	5	40	A	RE	121	0,074	43	7	10	20	8	3	1	3,3%	
TARGET (New model)	5	22	A	RE	121	0,052	64	6	5	40	8	8	3	3,3%	

P	Plastic	+
A	Alluminium	-
RO	Rounded	-
RE	Rectangular	+

6. FMECA (Failure Modes, Effects and Criticality Analysis)

Finally, we have applied the FMECA methodology to identify and analyse all of the potential failure modes of our product and the effects they may have on the system. To perform this analysis, we have decided to adopt the top-down approach, given the fact that we are still in an early design phase. The goal of this analysis is to improve the degree of reliability of our product by introducing improvements on the part of the system where failures result the most critical.

In our FMECA analysis (see Table N. 2) we have identified four major failure modes. The identified failure modes are the following:

1. **Slow data transmission** → We determined the slowness of our product to be one of the possible failures that might affect many customers. This would be a really annoying problem since we developed a multi- port adapter with the latest standard in data transmission. We have to inform the customer about the technical features that other devices must have when used with our product.
2. **Interruption of data transmission** → As a second point we found that an interruption of data transmission might occur in different situations, linked or not with the customer behaviour.
3. **Unexpected drop in performance during transmission** → We decided to distinguish this type of low performance from a general "slow data transmission" because they depend on different factors. As told before, the general slow data transmission is constant, while an unexpected drop in performance during transmission can suddenly happen due to external factors, not depending directly upon the customer.
4. **Data loss on connected devices** → The data loss is the failure mode that affects most customers directly and it is the least expected from a multi-port adapter. This failure mode impacts with a high negative connotation on the customer satisfaction since it might be the cause of relevant problems for customers and companies.

We have then identified for each failure mode the potential causes of failure, the effects they may have on other components or on the entire system and our current detection system.

The RPN is a numerical value that represents the risk level of a certain combination of input factors. These input factors are the Severity (S) of the risk and the Occurrence (O) of the risk and its Detectability (D).

The Severity index, which is an integer number between 1 and 10, shows the criticality of the effects for the customers. The severity index has a negative connotation.

The occurrence index (it is an integer number between 1 and 10) rates the likelihood of occurrence of each cause of failure while the detectability index (it is an integer number between 1 and 10) rates the likelihood of prior detection for each cause of failure.

The RPN is simply obtained by multiplying the three measurements.

By aggregating these dimensions, we were able to order on a priority scale the failure causes and failure modes. In order to improve our product from a reliability point of view

we decided to focus on those combinations of failure modes and failure causes with the highest RPN score.

To perform a further analysis, we have built the Pareto Chart and the Risk Matrix to visualise the risk associated with each failure mode. The risk is expressed as a function of the frequency of the failure mode and the potential end effects (severity) of the failure mode. To embed detectability, we have used different font sizes according to the detectability rate.

Actions and Improvements

Lastly, we have identified feasible improvements to reduce most impacting risks. As shown through the Pareto Chart we should focus on improving and preventing the connected device breakage, damage caused by water.

To prevent the breakage of external devices (USB-A sticks, USB-C, etc.) connected to the multiport, we will balance the spacing between the different ports to avoid contact between two adjacent cables. Regarding the potential damage caused by water we will further improve the degree of protection defined by the IP index.

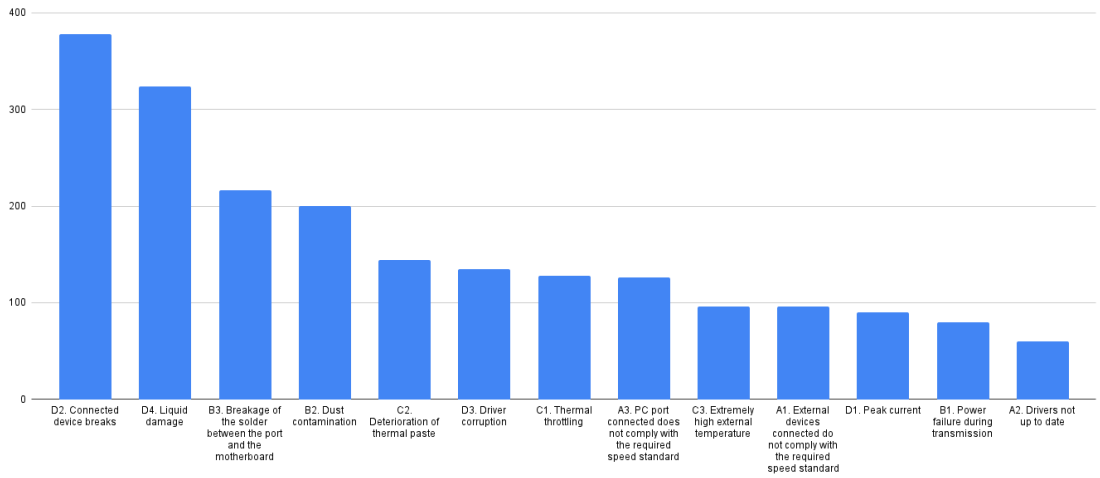


figure 3 (**Pareto Chart**)

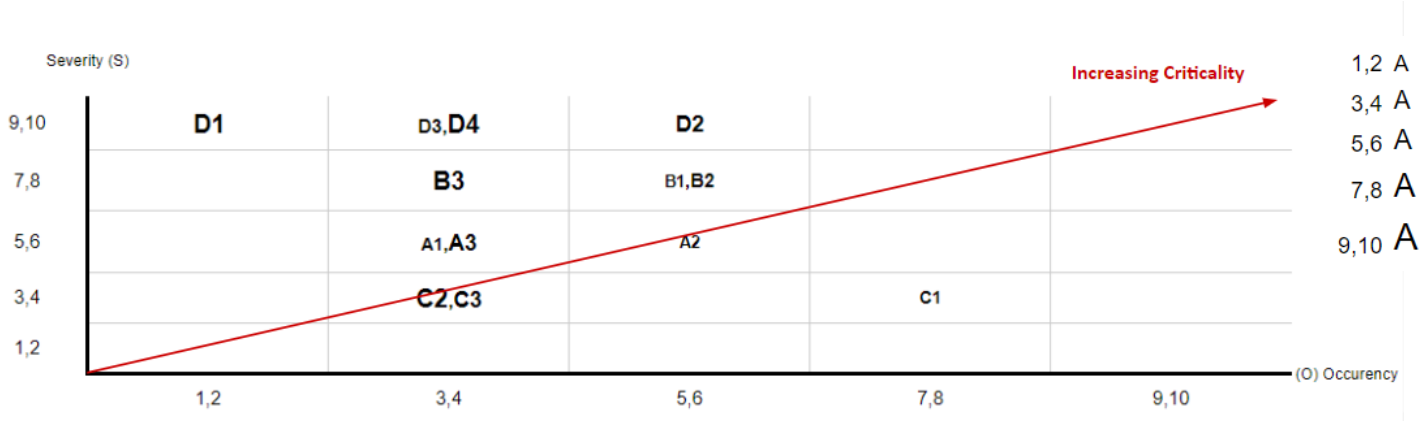
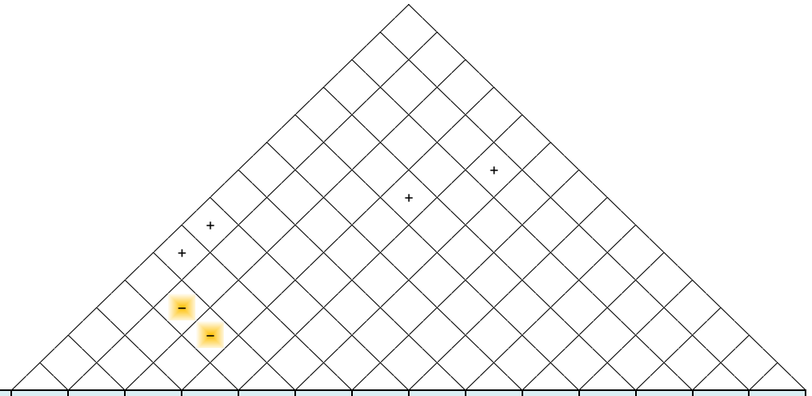


figure 4 (**Risk Matrix**)

HOUSE OF QUALITY – Table 1



Correlations	
Positive	+
Negative	–
No Correlation	

Relationships	
Strong	●
Moderate	○
Weak	▽

Direction of Improvement	
Maximize	↑
Minimize	↓

Row #	Relative Importance	Degree of importance	Customer Requirements / Technical Characteritics	Expected life	Case thickness	Case material	Case geometry	Weight	Thermal paste and alloy	Degree of protection to water	Anti-scratch treatment	Number of available colours	Thunderbolt's version	Number of ports	Number of different ports types	Size of components	Warranty cost	Current Model (HP)	Competitor #1: Anker	Competitor #2: Apple	Targets	Improvement ratio	Strenght	Absolute weight	Relative weight
Column #				**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**								
1	8%	3	Impact resistance		●	●	▽											4	4	2	4	1	1	3	5,91%
2	11%	4	Long lasting	●	○	○	▽		▽	▽							○	3	4	2	4	1,3	1,5	8	15,76%
3	11%	4	No overheating		○	○			●							▽		4	4	2	4	1	1	4	7,88%
4	3%	1	Waterproof		▽	▽				●				○				3	5	3	4	1,3	1,2	1,6	3,15%
5	11%	4	All types of ports				▽							●	●			2	2	2	2	1	1	4	7,88%
6	8%	3	Rapid data transmission										●	○				4	3	3	4	1	1,5	4,5	8,86%
7	14%	5	Universal adaptability											▽	●			2	3	2	3	1,5	1	7,5	14,77%
8	14%	5	Lightweight		○	▽		●								▽		3	3	2	3	1	1	5	9,85%
9	8%	3	Easy to carry around		○		●	●										1	2	3	2	2	1	6	11,82%
10	8%	3	Aesthetically appealing				●				○	●						4	4	5	5	1,3	1,2	4,5	8,86%
11	5%	2	Warranty period	●													●	3	4	3	4	1,3	1	2,7	5,25%
	100%	37	**Total**	↑	↓	↑	↑	↓	↑	↑	↑	↑	↑	↑	↑	↓	↓							51	100%
			Absolute Weight	1,891	1,923	1,371	2,157	1,95	0,867	0,441	0,266	0,798	0,798	1,217	2,039	0,177	0,946	16,840							
			Relative Weight	11%	11%	8%	13%	12%	5%	3%	2%	5%	5%	7%	12%	1%	6%	100%							
			Unit of measurement	yrs	mm	-	-	g	W/ " * °C	IP	Mohs	-	Gigabit	-	-	µm	-								
			Current Model (HP)	5	22	A	RE	130	0,052	43	6	3	40	6	6	3	4,5%								
			Competitor #1: Anker	3	42	P	RO	127	0,019	65	7	5	10	10	8	3	5,2%								
			Competitor #2: Apple	5	40	A	RE	121	0,074	43	7	10	20	8	3	1	3,3%								
			TARGET (New model)	5	22	A	RE	121	0,052	64	6	5	40	8	8	3	3,3%								

P	Plastic	+
A	Alluminium	-
RO	Rounded	-
RE	Rectangular	+

FMECA – Table 2

***Thermal Throttling**: It can be described as a sudden drop of performance due to multi-port adapter's CPU medium-high temperature when multiple ports are used at a high speed

Function	Potential Failure mode	Potential Effect(s) of Failure	S (severity index)	Potential Failure Cause(s)	O (Occurence)	Detection System	D (detectability)	RPN
Connecting multiple external devices to a PC for and data transmission.	**A.** Slow data transmission	• Customer somewhat annoyed • Customer might lose a lot of time in case of a big data transfer	6	**A1**. External devices connected do not comply with the required speed standard	4	Develop a simple free-to-use app to perfrom speed tests	4	**96**
				A2. Drivers not up to date	5	Verify updates on the PC's OS	2	**60**
				A3. PCport connected does not comply with the required speed standard	3	Instert on the website and the packaging the indication "compatible port required"	7	**126**
	B. Interruption of data transmission	Customer's workflow lost	8	**B1**. Power failure during transmission	5	PC battery indicator	2	**80**
				B2. Dust contamination	5	Cleaning tool	5	**200**
				B3. Breakage of the solder between the port and the motherboard	3	None	9	**216**
	C. Unexpected drop in performance during transmission	Customer might not respect his deadlines	4	**C1**. Thermal throttling*	8	Diagnostic Testing through the developed speedtest app	4	**128**
				C2. Deterioration of thermal paste	4	None	9	**144**
				C3. Extremely high external temperature	3	Instert on the website and the packaging the indication of working temperature	8	**96**
	D. Data loss on connected devices	• Customer really dissatisfied • Migh generate big business problem for the customer	9	**D1**. Peak current	1	None	10	**90**
				D2. Connected device breaks	6	None	7	**378**
				D3. Driver corruption	3	Diagnostic Testing	5	**135**
				D4. Liquid damage	4	None	9	**324**

APPENDIX

For reference we add here photos of our product and our competitors':

Our product – HP

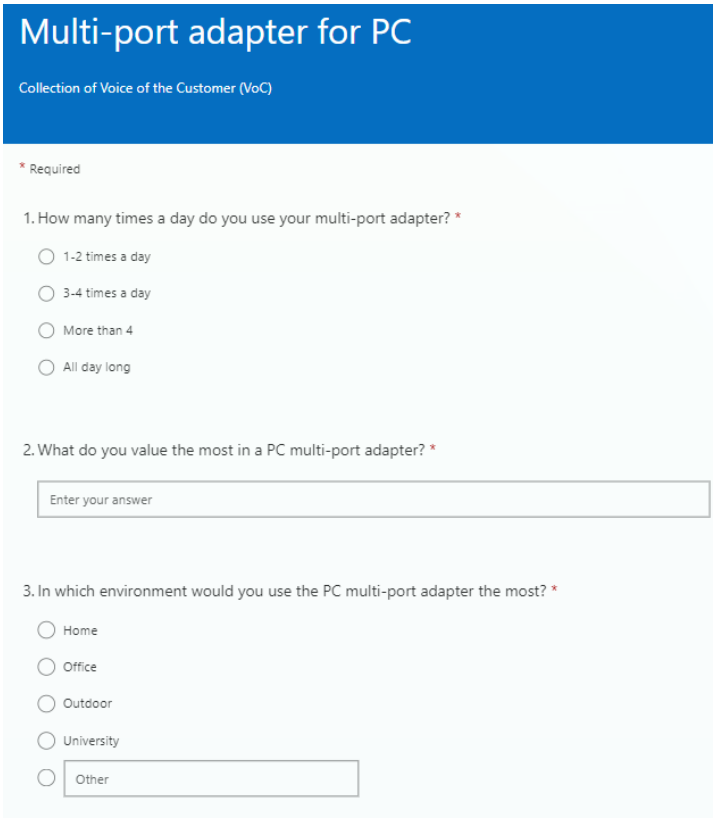
Anker

Apple*

When referring to the Apple product we intended this one: produced by another company but sold only on the Apple website.

We add here the link and a screenshot of the form we used to conduct the surveys to collect the initial Voice of Customers.

https://forms.office.com/r/vSNeSdNkZF



Multi-port adapter for PC

Collection of Voice of the Customer (VoC)

* Required

1. How many times a day do you use your multi-port adapter? *

- 1-2 times a day
- 3-4 times a day
- More than 4
- All day long

2. What do you value the most in a PC multi-port adapter? *

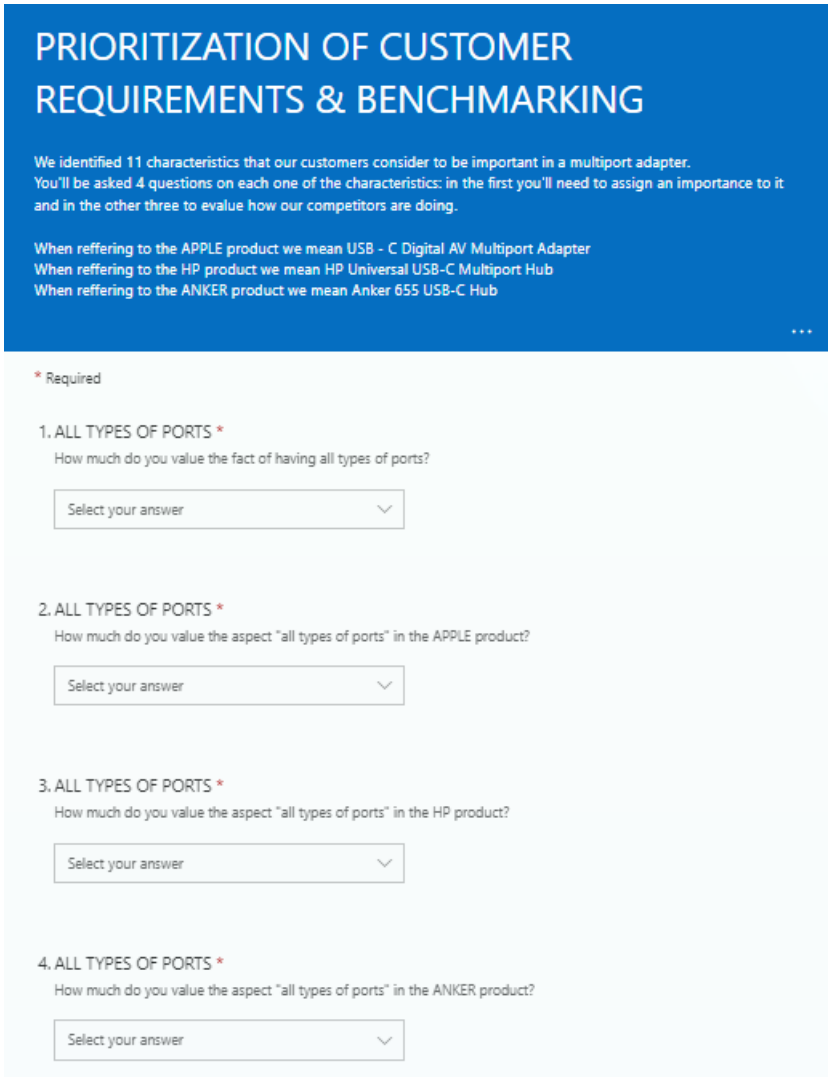
Enter your answer

3. In which environment would you use the PC multi-port adapter the most? *

- Home
- Office
- Outdoor
- University
- Other

We add here the link and a screenshot of the form used to collect data about CRs perceived quality to perform prioritization and benchmarking.

https://forms.office.com/r/RTpp5xprFk



We also add the results of this form:

DEGREE OF IMPORTANCE

Customer requirements		U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13	U14	U15	U16	U17	U18	U19	U20	U21	U22	U23	U24	U25	AVG	MEDIAN
1	Impact Resistance	3	2	4	4	3	2	3	3	2	1	3	3	4	3	2	3	4	4	5	4	3	2	2	2	3	2,96	3
2	Long lasting	4	1	5	5	4	5	4	5	4	4	3	5	4	3	4	2	5	3	4	4	4	5	4	5	5	4,04	4
3	No overheating	1	5	4	4	3	5	4	4	3	4	3	5	3	5	2	4	5	3	2	4	5	3	4	4	4	3,72	4
4	Waterproof	2	1	3	1	2	1	3	2	1	1	3	1	1	1	1	1	1	2	1	1	1	2	1	1	3	1,52	1
5	All types of port	4	3	4	2	5	3	1	5	5	4	5	4	5	3	2	5	5	4	5	4	5	4	4	3	5	3,96	4
6	Rapid data transmission	4	3	2	1	1	2	3	2	2	3	4	4	5	4	3	4	3	3	4	5	3	2	4	5	3	3,16	3
7	Universal adaptability	5	4	5	4	5	4	5	5	5	4	1	4	3	4	5	5	4	5	3	4	5	5	4	5	5	4,32	5
8	Lightweight	5	5	2	5	3	4	4	4	5	4	5	5	4	4	5	5	5	5	5	5	5	5	5	5	4	4,52	5
9	Easy to carry around	2	3	4	3	2	3	2	3	2	1	2	3	4	5	5	4	3	2	3	2	1	1	3	2	1	2,64	3
10	Aesthetically appealing	2	2	4	3	4	5	4	3	2	1	3	2	1	4	3	2	3	2	3	4	5	4	3	2	3	2,96	3
11	Warranty period	2	2	2	2	2	1	1	1	2	1	1	3	2	1	3	1	2	1	3	2	1	1	3	1	2	1,72	2

BENCHMARKING

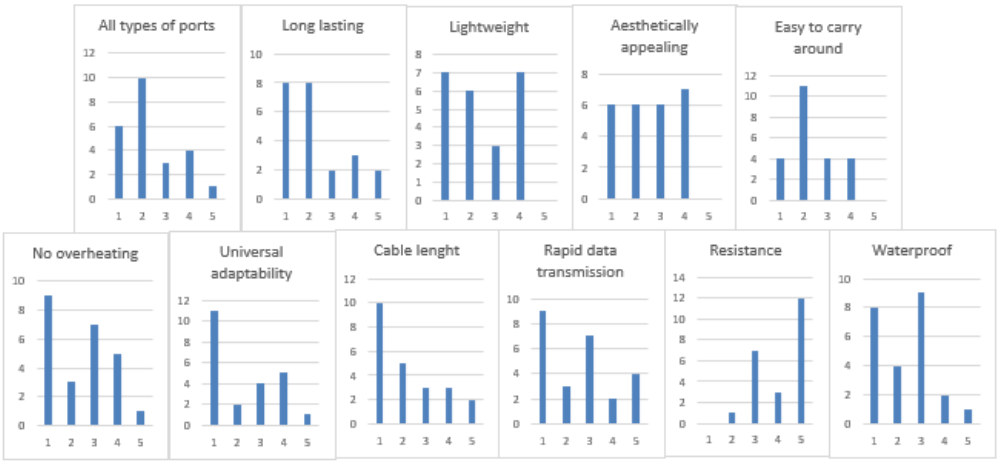
PREVIOUS MODEL

	Customer requirements	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13	U14	U15	U16	U17	U18	U19	U20	U21	U22	U23	U24	U25	AVG	MEDIAN
1	Impact resistance	5	4	1	1	1	5	5	2	4	1	5	2	3	5	5	2	4	2	4	2	2	5	5	4	3	3,28	**4**
2	Long lasting product	2	4	3	4	5	1	4	3	5	2	2	2	5	3	3	1	3	2	5	4	1	2	2	2	2	2,88	**3**
3	No overheating	1	2	4	5	5	2	5	4	4	1	1	3	1	4	1	5	1	3	1	1	4	5	4	4	4	3	**4**
4	Waterproof	4	1	5	4	2	1	3	4	3	4	4	1	5	5	2	4	2	5	2	3	1	2	3	3	3	3,04	**3**
5	All types of port	2	1	5	1	5	2	5	3	2	1	1	1	3	4	2	1	5	2	5	3	1	4	1	2	5	2,68	**2**
6	Rapid data transmission	2	4	1	2	1	5	5	5	5	5	5	5	5	5	2	2	1	5	1	4	1	4	1	3	5	3,36	**4**
7	Universal adaptability	3	4	1	3	1	1	5	2	3	1	1	3	5	3	5	4	2	3	2	4	1	1	2	1	1	2,48	**2**
8	Lightweight	3	5	1	3	2	5	2	4	2	3	3	3	5	2	2	3	3	3	1	3	2	5	2	5	3	3	**3**
9	Easy to carry around	2	1	1	1	1	1	1	2	3	4	3	1	2	3	1	1	1	1	1	2	5	5	1	3	5	2,08	**1**
10	Aesthetically appealing	3	2	5	2	4	4	4	3	1	3	1	3	3	5	2	4	4	5	5	3	5	5	5	2	4	3,48	**4**
11	Warranty period	3	3	4	4	1	2	2	4	1	3	1	5	1	2	4	3	3	3	5	2	2	3	1	2	1	2,6	**3**

ANKER PRODUCT

	Customer requirements	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13	U14	U15	U16	U17	U18	U19	U20	U21	U22	U23	U24	U25	AVG	MEDIAN
1	Impact Resistance	4	4	5	5	2	4	4	3	2	2	5	5	5	3	2	5	2	5	3	3	5	4	2	4	5	3,72	**4**
2	Long lasting product	4	1	4	4	5	3	5	4	2	3	5	5	2	3	3	3	4	4	2	4	2	4	2	2	5	3,4	**4**
3	No overheating	2	5	3	5	3	4	3	5	4	2	3	4	2	5	4	4	4	2	1	3	4	3	4	4	3	3,44	**4**
4	Waterproof	4	2	3	5	5	5	5	5	5	5	5	3	5	4	5	5	5	5	5	5	5	3	3	1	3	4,24	**5**
5	All types of port	2	5	2	3	4	4	5	3	2	3	3	4	2	1	2	1	2	2	1	3	2	2	5	3	1	2,68	**2**
6	Rapid data transmission	2	5	3	2	4	3	1	3	2	5	2	3	5	5	5	2	3	4	3	3	5	2	1	5	3	3,24	**3**
7	Universal adaptability	2	4	5	5	1	3	4	3	2	4	4	3	2	4	5	3	2	2	3	5	3	2	3	4	4	3,28	**3**
8	Lightweight	2	2	3	4	4	3	1	4	5	4	5	4	4	3	5	3	2	3	5	3	1	5	1	2	4	3,28	**3**
9	Easy to carry around	4	3	2	4	5	4	2	4	4	1	1	1	1	1	2	2	3	2	3	4	3	1	1	1	5	2,56	**2**
10	Aesthetically appealing	4	3	5	4	3	1	2	2	5	4	3	3	3	2	5	2	5	4	5	3	5	5	2	4	4	3,52	**4**
11	Warranty Period	4	2	4	1	3	4	1	5	3	5	5	2	2	2	2	5	2	2	2	4	4	4	4	4	5	3,24	**4**

APPLE PRODUCT

	Customer requirements	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13	U14	U15	U16	U17	U18	U19	U20	U21	U22	U23	U24	U25	AVG	MEDIAN
1	Impact Resistance	1	3	2	2	1	1	1	5	1	2	1	2	4	4	4	3	2	4	2	2	2	2	3	3	2	2,36	**2**
2	Long lasting product	3	4	3	1	2	4	1	1	1	4	2	4	1	2	2	5	5	3	2	2	2	1	2	1	1	2,36	**2**
3	No overheating	4	4	2	4	2	1	4	1	3	4	2	4	3	4	3	1	2	1	1	2	2	1	4	1	4	2,56	**2**
4	Waterproof	3	1	3	2	2	1	4	2	3	3	4	2	4	4	3	1	4	2	2	1	1	1	4	3	4	2,56	**3**
5	All types of port	3	4	2	2	3	3	2	4	2	1	4	2	2	2	1	1	2	2	3	4	2	4	3	1	2	2,44	**2**
6	Rapid data transmission	1	4	1	1	1	2	3	1	5	2	2	3	3	4	4	3	4	3	1	3	1	1	4	4	1	2,48	**3**
7	Universal adaptability	3	4	1	1	2	1	1	1	1	4	3	2	1	3	4	4	1	4	1	5	3	4	1	1	3	2,36	**2**
8	Lightweight	2	1	5	3	2	2	2	1	4	2	1	1	5	5	1	1	1	4	1	3	4	1	1	3	2	2,32	**2**
9	Easy to carry around	3	1	3	3	5	5	3	2	2	1	1	1	3	5	1	5	1	1	3	1	4	2	1	3	4	2,56	**3**
10	Aesthetically appealing	5	5	5	3	5	3	5	4	5	3	5	5	5	3	5	5	3	3	2	4	3	5	5	5	4	4,2	**5**
11	Warranty Period	3	4	1	1	2	3	3	2	1	5	3	1	4	1	3	3	2	2	1	3	1	1	3	3	4	2,4	**3**

To decide to use the median we analysed the distribution of these results with graphs. We add here, as an example, the ones of Apple