## 1.6 Concept Selection

Once the concept generation process was completed, the concept selection process began by using standard design selection methods including binary pairwise comparison of design criteria, House of Quality, Pugh charts, and the Analytical Hierarchy Process. These tools were used to minimize bias during the selection phase and improve the feasibility of the final design.

**Binary Pairwise**

The binary pairwise comparison chart, shown below in Table 7, was used to analyze the customer needs obtained from the project sponsor. A more detailed list of customer needs can be found in Table 6.

Table 6: Customer Requirements and Engineering Characteristics

|  |  |  |
| --- | --- | --- |
| **#**  | **Customer Requirements**  | **Engineering Characteristics**  |
| 1  | The compressor and all ductwork will be adequately supported  | Provide support  |
| 2  | The control volume will reach 10-50C and 0-95% relative humidity  | Manipulate temperature and humidity  |
| 3  | The air flow will be controlled  | Regulate air circulation  |
| 4  | The compressor will be accessible within a reasonable amount of time  | Provide access  |
| 5  | Clearance will be provided for the overhead crane  | Provide clearance  |
| 6  | The temperature and humidity of the control volume will be displayed  | Display conditions  |
| 7  | The temperature and humidity of the control volume will be measured  | Monitor conditions  |
| 8  | The compressor will be visible at all times during testing  | Provide visibility  |
| 9  | The conditions of the chamber will be automatically adjusted  | Automate control  |

This comparison chart works by judging if the row is more important than the column (1) or vice versa (0). These results provided an importance weight factor for each criterion, showing that manipulating temperature and humidity is the highest priority of the design. This importance weight factor was then utilized in the house of quality chart, shown in Table 8, to rank the outcomes of the environmentally controlled test chamber. Further detail of the engineering characteristics can be found in Table 6.

Table 7: Binary Pairwise Comparison

|  |
| --- |
| Binary Pairwise Comparison  |
| Customer Needs  | #1  | #2  | #3  | #4  | #5  | #6  | #7  | #8  | #9  | Total  |
| #1  | -  | 0  | 0  | 0  | 0  | 1  | 0  | 0  | 0  | 1  |
| #2  | 1  | -  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 8  |
| #3  | 1  | 0  | -  | 0  | 0  | 1  | 0  | 1  | 0  | 3  |
| #4  | 1  | 0  | 1  | -  | 0  | 1  | 0  | 1  | 0  | 4  |
| #5  | 1  | 0  | 1  | 1  | -  | 1  | 0  | 1  | 0  | 5  |
| #6  | 0  | 0  | 0  | 0  | 0  | -  | 0  | 0  | 0  | 0  |
| #7  | 1  | 0  | 1  | 1  | 13  | 1  | -  | 1  | 0  | 6  |
| #8  | 1  | 0  | 0  | 0  | 0  | 1  | 0  | -  | 0  | 2  |
| #9  | 1  | 0  | 1  | 1  | 1  | 1  | 1  | 1  | -  | 7  |
| Total  | 7  | 0  | 5  | 4  | 3  | 8  | 2  | 6  | 1  | n-1=8  |

**House of Quality**

The House of Quality chart compares the engineering characteristics, or decomposed functions, against the requirements expressed by the customer. The importance weight factor of each requirement is used to rank how well each characteristic fit that need. The result is a complete ranking of engineering characteristics by importance of the final chamber design.

Table 8: House of Quality

|  |  |
| --- | --- |
| **House of Quality**  | Engineering Characteristics  |
| Improvement Direction  | ↓  | ↑  |   | ↑  | ↓  | ↑  |   |   | ↑  |   |
| Units  |   | m  | °C %  | cfm  | t  | m  | -  | -  | %  | -  |
| Customer Requirements  | IPF  | #1  | #2  | #3  | #4  | #5  | #6  | #7  | #8  | #9  |
| #1  | 1  | 9  |   |   | 1  | 1  |   |   |   |   |
| #2  | 8  |   | 9  | 3  | 1  |   | 3  | 3  | 1  | 3  |
| #3  | 3  |   | 9  | 9  | 3  |   |   | 1  | 3  | 3  |
| #4  | 4  |   |   |   | 9  |   |   |   |   | 3  |
| #5  | 5  | 1  |   |   |   | 9  |   |   |   |   |
| #6  | 0  |   | 3  |   |   |   | 9  | 9  |   | 3  |
| #7  | 6  |   | 3  | 1  | 3  |   | 9  | 9  | 1  | 3  |
| #8  | 2  |   | 1  | 1  |   |   |   | 1  | 9  |   |
| #9  | 7  |   | 3  | 3  | 3  |   | 3  | 3  |   | 9  |
| Raw Score  | 743  | 14  | 140  | 80  | 93  | 46  | 99  | 104  | 41  | 126  |
| Relative Weight   |   | 1.9  | 18.8  | 10.8  | 12.5  | 6.2  | 13.3  | 14.0  | 5.5  | 17.0  |
| **Rank Order**  |   | **9**  | **1**  | **6**  | **5**  | **7**  | **4**  | **3**  | **8**  | **2**  |

From the results presented in the House of Quality chart, the most important functions are manipulating temperature and humidity, automatic control, monitoring the chamber conditions, and displaying those conditions. These top four functions were later used as criteria for AHP comparison charts and subsequently the alternative value chart. On the other hand, the least important functions are providing clearance, visibility, and support. This information helps to evaluate the viability of each concept objectively and quantitatively. By using this process, concepts that may seem favorable at first glance can be judged more accurately in comparison to other concepts.

**Pugh Chart**

A Pugh chart is a method of design selection which compares a set of medium and high-fidelity designs and compares each of them to a selected datum or reference. The chart indicates whether a concept is favorable by determining if each criterion is met better (+), worse (-), or satisfactorily (S) when compared to this reference.

The top concepts generated from the previous section are compared to the design functions of each. The to a visit eight concepts that were chosen from concept generation have been adjusted to represent a floor-mounted this is due to a visit that occurred over at the Danfoss lab facility, where the wall space did not seem suitable to mount an air-handling unit. The floor mounted unit was favored when discussing and visiting with Jerry Huang the paired engineer.

Table 9: Top Design Concepts

|  |
| --- |
| **Top 8 Concepts**  |
| **#**  | **Description**  | **Fidelity**  |
| 1  | Floor-mounted AHU with duct insulation  | Medium  |
| 2  | Floor-mounted AHU with increased wall thickness  | Medium  |
| 3  | Floor-mounted AHU with heater inside duct  | Medium  |
| 4  | Floor-mounted AHU with hotplate and water dropper humidifier  | Medium  |
| 5  | Floor-mounted AHU with vein-like inner surface of chamber  | Medium  |
| 6  | Wall-mounted AHU with detachable overhead ducts, putty infiltration seals, rubber inserts, and dips inside ductwork  | High  |
| 7  | Floor-mounted AHU with fixed side ducts, putty infiltration seals, double-layered walls, and sponges inside ductwork  | High  |
| 8  | Floor-mounted AHU with detachable overhead ducts, putty infiltration seals, rubber inserts, and a duct close off inside ductwork  | High  |

In the first iteration of the Pugh chart, shown in Table 10, the datum was selected to be the existing design chosen by the previous team. The results from this chart clearly show that concepts 6, 7, and 8 were most favorable, which were chosen for the second iteration of the Pugh chart in Table 17. Concept 1 became the datum since it was the least polarizing design along with concept 3, and was the simpler of the two.

Table 10: Pugh Chart Iteration 1

|  |
| --- |
| **Pugh Chart: Iteration 1**  |
|  **Function**  |   | **Concepts**  |
| **1**  | **2**  | **3**  | **4**  | **5**  | **6**  | **7**  | **8**  |
| Provide support   | Datum             | S  | S  | S  | S  | S  | S  | -  | S  |
| Manipulate conditions  | +  | +  | +  | +  | +  | +  | +  | +  |
| Regulate circulation  | S  | S  | S  | S  | S  | +  | +  | +  |
| Provide access  | S  | S  | S  | S  | S  | +  | +  | +  |
| Provide clearance  | S  | S  | S  | S  | S  | S  | S  | S  |
| Display conditions  | S  | S  | S  | S  | S  | S  | S  | S  |
| Monitor conditions  | S  | S  | S  | S  | S  | S  | S  | S  |
| Provide visibility  | S  | -  | S  | -  | -  | S  | +  | S  |
| Automate control | S  | S  | S  | S  | S  | S  | S  | S  |
| **Plus (+)**  | 1  | 1  | 1  | 1  | 1  | 3  | 4  | 3  |
| **Satisfactory (S)**  | 8  | 7  | 8  | 7  | 7  | 6  | 4  | 6  |
| **Minus (-)**  | 0  | 1  | 0  | 1  | 1  | 0  | 1  | 0  |

The second iteration of the Pugh chart consisted of the concepts which were at least satisfactory for the criteria that were deemed highly important. This was done in order to prevent criteria of low importance from causing a design to be overlooked.

A third iteration of the Pugh chart was also performed to do an analysis on two of the top 3 design concepts, using concept 8 as datum, as well as concept 1 to see how the less polarized concepts from chart 1 would fare in comparison to the others. It was determined that Concept 1 was insufficient for the final design. However, concept 3, which had a similar score to concept 1 in Pugh chart 1, is still used later in the AHP Design Alternatives charts.

Table 11: Pugh Chart Iteration 3

|  |
| --- |
| **Pugh Chart: Iteration 3**  |
| **Function**  | **Concept 8**  | **Concept 1**  | **Concept 7**  |
| Provide Support  | Datum           | S  | -  |
| Manipulate conditions  | S  | S  |
| Regulate circulation  | -  | -  |
| Provide access  | S  | +  |
| Provide clearance  | +  | +  |
| Display conditions  | S  | S  |
| Monitor conditions  | S  | S  |
| Provide visibility  | -  | +  |
| Automate control  | S  | S  |
| **Plus (+)**  | 1  | 3  |
| **Satisfactory (S)**  | 6  | 4  |
| **Minus (-)**  | 2  | 2  |

 **Analytical Hierarchy Process**

Another method that was used for determining the importance of the chosen criteria was an analytical hierarchy process (AHP), which determines the importance of each of the criteria relative to its other. These criteria are compared on a scale of odd numbers from 1 to 9. When comparing two criteria, A and B, a 9 means criteria A is much more important than criteria B, while if the comparison is given a 1, the two criteria are equally important. The inverse value was then placed on the opposite side of the table, as seen in Table \_. The columns represent criteria A, and the rows represent criteria B. After summing each column, the most important criteria were determined to be manipulating temperature and humidity, which corresponds to the lowest sum of the columns. The least important, on the other hand, was found to be providing visibility.

Table 12: Criteria Comparison Matrix

|  |
| --- |
| **Criteria Comparison Matrix**  |
| **Customer** **Needs**  | **#1**  | **#2**  | **#3**  | **#4**  | **#5**  | **#6**  | **#7**  | **#8**  | **#9**  |
| #1  | 1.00  | 0.11  | 0.33  | 1.00  | 1.00  | 3.00  | 0.33  | 1.00  | 0.33  |
| #2  | 9.00  | 1.00  | 3.00  | 5.00  | 5.00  | 9.00  | 1.00  | 7.00  | 3.00  |
| #3  | 3.00  | 0.33  | 1.00  | 3.00  | 3.00  | 5.00  | 1.00  | 7.00  | 1.00  |
| #4  | 1.00  | 0.20  | 0.33  | 1.00  | 1.00  | 3.00  | 0.33  | 1.00  | 0.33  |
| #5  | 1.00  | 0.20  | 0.33  | 1.00  | 1.00  | 1.00  | 0.20  | 0.33  | 0.14  |
| #6  | 0.33  | 0.11  | 0.20  | 0.33  | 1.00  | 1.00  | 0.14  | 0.33  | 0.14  |
| #7  | 3.00  | 1.00  | 1.00  | 3.00  | 5.00  | 7.00  | 1.00  | 5.00  | 0.33  |
| #8  | 1.00  | 0.14  | 0.14  | 1.00  | 3.00  | 3.00  | 0.20  | 1.00  | 0.14  |
| #9  | 3.00  | 0.33  | 1.00  | 3.00  | 7.00  | 7.00  | 3.00  | 7.00  | 1.00  |
| **Sum**  | **22.33**  | **3.43**  | **7.34**  | **18.33**  | **27.00**  | **39.00**  | **7.21**  | **29.67**  | **6.43**  |

In order to ensure consistency, the table was normalized by dividing each cell in each column by the sum of that column. Then each row was averaged to get the criteria weight (W) for each row.

Table 13: Normalized Comparison Matrix

|  |
| --- |
| **Normalized Criteria Comparison**  |
| **Criteria**  | **#1**  | **#2**  | **#3**  | **#4**  | **#5**  | **#6**  | **#7**  | **#8**  | **#9**  | **Criteria** **Weight**  |
| **#1**  | 0.04  | 0.03  | 0.05  | 0.05  | 0.04  | 0.08  | 0.05  | 0.03  | 0.05  | 0.05  |
| **#2**  | 0.40  | 0.29  | 0.41  | 0.27  | 0.19  | 0.23  | 0.14  | 0.24  | 0.47  | 0.29  |
| **#3**  | 0.13  | 0.10  | 0.14  | 0.16  | 0.11  | 0.13  | 0.14  | 0.24  | 0.16  | 0.14  |
| **#4**  | 0.04  | 0.06  | 0.05  | 0.05  | 0.04  | 0.08  | 0.05  | 0.03  | 0.05  | 0.05  |
| **#5**  | 0.04  | 0.06  | 0.05  | 0.05  | 0.04  | 0.03  | 0.03  | 0.01  | 0.02  | 0.04  |
| **#6**  | 0.01  | 0.03  | 0.03  | 0.02  | 0.04  | 0.03  | 0.02  | 0.01  | 0.02  | 0.02  |
| **#7**  | 0.13  | 0.29  | 0.14  | 0.16  | 0.19  | 0.18  | 0.14  | 0.17  | 0.05  | 0.16  |
| **#8**  | 0.04  | 0.04  | 0.02  | 0.05  | 0.11  | 0.08  | 0.03  | 0.03  | 0.02  | 0.05  |
| **#9**  | 0.13  | 0.10  | 0.14  | 0.16  | 0.26  | 0.18  | 0.42  | 0.24  | 0.16  | 0.20  |
| **Sum**  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |

 A consistency vector was then created by dividing the weighted sum vector by the criteria weight as shown in the table below. Finally, a consistency ratio was calculated, which is ideally below 0.1. Since the consistency ratio was found to be 0.05, the results are acceptable.

Table 14: Consistency Check

|  |
| --- |
| **Consistency Check**  |
| **Customer** **Needs**  | **Weighted Sum** **Vector (Ws)**  | **Consistency** **Vector (Cons)**  |
| #1  | 0.45  | 9.60  |
| #2  | 2.88  | 9.84  |
| #3  | 1.45  | 10.05  |
| #4  | 0.48  | 9.57  |
| #5  | 0.34  | 9.35  |
| #6  | 0.22  | 9.51  |
| #7  | 1.54  | 9.55  |
| #8  | 0.45  | 9.29  |
| #9  | 1.97  | 9.95  |
| **Lambda:**  | 9.63  |
| **Consistency Index:**  | 0.08  |
| **Random Index:**  | 1.45  |
| **Consistency Ratio:**  | 0.05  |
| **Is it consistent?**  | YES  |

The process described above was completed for each criterion and used to evaluate the final 4 concepts: Concept #3: Floor-mounted AHU with heater inside duct, Concept #6: Wall-mounted AHU with detachable overhead ducts, putty infiltration seals, rubber inserts, and dips inside ductwork, Concept #7: Floor-mounted AHU with fixed side ducts, putty infiltration seals, double-layered walls, and sponges inside ductwork, and Concept #8: Floor-mounted AHU with detachable overhead ducts, putty infiltration seals, rubber inserts, and a duct close off inside ductwork. The computed consistency ratios along with all the comparison charts are shown in Appendix E.

 The final rating matrix, shown in Table 15, displayed the weight of criteria for each of the 4 concepts. These weights were calculated using the criteria comparison matrices, which are then used in the following chart to compute the alternate value.

Table 15: Final Rating Matrix Transpose

|  |
| --- |
| Final Rating Matrix Transpose  |
|   | Criteria #1  | Criteria #2  | Criteria #3  | Criteria #4  |
| Concept #3  | 0.250  | 0.100  | 0.100  | 0.129  |
| Concept #6  | 0.250  | 0.300  | 0.300  | 0.388  |
| Concept #7  | 0.250  | 0.300  | 0.300  | 0.304  |
| Concept #8  | 0.250  | 0.300  | 0.300  | 0.179  |

Table 16: Alternate Value Chart

|  |  |
| --- | --- |
| Concept  | Alternative Value  |
| Concept #3: Floor-mounted AHU with heater inside duct  | 0.145  |
| Concept #6: Wall-mounted AHU with detachable overhead ducts, putty infiltration seals, rubber inserts, and dips inside ductwork  | 0.321  |
| Concept #7: Floor-mounted AHU with fixed side ducts, putty infiltration seals, double-layered walls, and sponges inside ductwork  | 0.296  |
| Concept #8: Floor-mounted AHU with detachable overhead ducts, putty infiltration seals, rubber inserts, and a duct close off inside ductwork  | 0.272  |

The alternate value chart compares each criterion weight with the score that each concept received in the final rating matrix. The results showed that concept 6 was the most viable concept to move forward with due to its high score.

**Final Selection**

Team 503’s final selection was chosen as concept 6, which was a wall-mounted AHU with detachable overhead ducts, putty infiltration seals, rubber inserts, and dips inside ductwork. However, due to a recent visit to Danfoss’s facility, having a wall-mounted unit has been determined to be undesirable. However, switching to a floor-mounted version of the same concept is a negligible change, as the primary aspects of the design are the attachments and additional equipment. The design is the best because the dipping ductwork provides an effective manner of releasing excess duct moisture while the detachable manner of the ducts allows it to be better at providing access to the chamber and slightly improving the ability to monitor the internal conditions of the chamber. 

Figure 11: Final Design Selection

# Appendix E: Concept Selection Tables

Table : Pugh Chart Iteration 2

|  |
| --- |
| **Pugh Chart: Iteration 2**  |
| **Function**  | **#1**  | **Concepts**  |
| **6**  | **7**  | **8**  |
| Provide support   | Datum             | S  | -  | S  |
| Manipulate conditions  | S  | S  | S  |
| Regulate circulation  | +  | +  | +  |
| Provide access  | S  | +  | S  |
| Provide clearance  | -  | +  | -  |
| Display conditions  | S  | S  | S  |
| Monitor conditions  | S  | S  | S  |
| Provide visibility  | S  | +  | +  |
| Automate control  | S  | S  | S  |
| **Plus (+)**  | **1**  | **4**  | **2**  |
| **Satisfactory (S)**  | **7**  | **4**  | **6**  |
| **Minus (-)**  | **1**  | **1**  | **1**  |

Table : Temperature and Humidity Manipulation Comparison

|  |
| --- |
| Temperature and Humidity Manipulation Comparison  |
|   | Concept #3  | Concept #6  | Concept #7  | Concept #8  |
| Concept #3  | 1.000  | 1.000  | 1.000  | 1.000  |
| Concept #6  | 1.000  | 1.000  | 1.000  | 1.000  |
| Concept #7  | 1.000  | 1.000  | 1.000  | 1.000  |
| Concept #8  | 1.000  | 1.000  | 1.000  | 1.000  |
| Sum  | 4.000  | 4.000  | 4.000  | 4.000  |

Table : Temperature and Humidity Manipulation Normalized

|  |
| --- |
| Temperature and Humidity Manipulation Normalized  |
|   | Concept #3  | Concept #6  | Concept #7  | Concept #8  | Weight {W}  |
| Concept #3  | 0.250  | 0.250  | 0.250  | 0.250  | 0.250  |
| Concept #6  | 0.250  | 0.250  | 0.250  | 0.250  | 0.250  |
| Concept #7  | 0.250  | 0.250  | 0.250  | 0.250  | 0.250  |
| Concept #8  | 0.250  | 0.250  | 0.250  | 0.250  | 0.250  |
| Sum  | 1.000  | 1.000  | 1.000  | 1.000  | 1.000  |

Table : Temperature and Humidity Manipulation Weights

|  |
| --- |
| Temperature and Humidity Manipulation Weights  |
| Concepts  | Weighted Sum Vector  | Consistency Vector  |
| Concept #3  | 1.000  | 4.000  |
| Concept #6  | 1.000  | 4.000  |
| Concept #7  | 1.000  | 4.000  |
| Concept #8  | 1.000  | 4.000  |

Table : Consistency Check #1

|  |
| --- |
| Consistency Check #1  |
| Lambda:  | 4.000  |
| Consistency Index:  | 0.000  |
| Random Index:  | 0.890  |
| Consistency Ratio:  | 0.000  |
| Is it consistent?  | Yes  |

Table : Automatic Control Comparison

|  |
| --- |
| Automatic Control Comparison  |
|   | Concept #3  | Concept #6  | Concept #7  | Concept #8  |
| Concept #3  | 1.000  | 0.333  | 0.333  | 0.333  |
| Concept #6  | 3.000  | 1.000  | 1.000  | 1.000  |
| Concept #7  | 3.000  | 1.000  | 1.000  | 1.000  |
| Concept #8  | 3.000  | 1.000  | 1.000  | 1.000  |
| Sum  | 10.000  | 3.333  | 3.333  | 3.333  |

Table : Automatic Control Normalized

|  |
| --- |
| Automatic Control Normalized  |
|   | Concept #3  | Concept #6  | Concept #7  | Concept #8  | Weight {W}  |
| Concept #3  | 0.100  | 0.100  | 0.100  | 0.100  | 0.100  |
| Concept #6  | 0.300  | 0.300  | 0.300  | 0.300  | 0.300  |
| Concept #7  | 0.300  | 0.300  | 0.300  | 0.300  | 0.300  |
| Concept #8  | 0.300  | 0.300  | 0.300  | 0.300  | 0.300  |
| Sum  | 1  | 1  | 1  | 1  | 1  |

Table : Provide Access Weights

|  |
| --- |
| Provide Access Weights  |
| Concepts  | Weighted Sum Vector  | Consistency Vector  |
| Concept #3  | 0.400  | 4.000  |
| Concept #6  | 1.200  | 4.000  |
| Concept #7  | 1.200  | 4.000  |
| Concept #8  | 1.200  | 4.000  |

Table : Consistency Check #2

|  |
| --- |
| Consistency Check #2  |
| Lambda:  | 4.000  |
| Consistency Index:  | 0.000  |
| Random Index:  | 0.890  |
| Consistency Ratio:  | 0.000  |
| Is it consistent?  | Yes  |

Table : Display Conditions Comparison

|  |
| --- |
| Display Conditions Comparison  |
|   | Concept #3  | Concept #6  | Concept #7  | Concept #8  |
| Concept #3  | 1.000  | 0.333  | 0.333  | 0.333  |
| Concept #6  | 3.000  | 1.000  | 1.000  | 1.000  |
| Concept #7  | 3.000  | 1.000  | 1.000  | 1.000  |
| Concept #8  | 3.000  | 1.000  | 1.000  | 1.000  |
| Sum  | 10.000  | 3.333  | 3.333  | 3.333  |

Table : Display Conditions Normalized

|  |
| --- |
| Display Conditions Normalized  |
|   | Concept #3  | Concept #6  | Concept #7  | Concept #8  | Weight {W}  |
| Concept #3  | 0.100  | 0.100  | 0.100  | 0.100  | 0.100  |
| Concept #6  | 0.300  | 0.300  | 0.300  | 0.300  | 0.300  |
| Concept #7  | 0.300  | 0.300  | 0.300  | 0.300  | 0.300  |
| Concept #8  | 0.300  | 0.300  | 0.300  | 0.300  | 0.300  |
| Sum  | 1.000  | 1.000  | 1.000  | 1.000  | 1.000  |

Table : Provide Visibility Weights

|  |
| --- |
| Provide Visibility Weights  |
| Concepts  | Weighted Sum Vector  | Consistency Vector  |
| Concept #3  | 0.400  | 4.000  |
| Concept #6  | 1.200  | 4.000  |
| Concept #7  | 1.200  | 4.000  |
| Concept #8  | 1.200  | 4.000  |

Table : Consistency Check #3

|  |
| --- |
| Consistency Check #3  |
| Lambda:  | 4.000  |
| Consistency Index:  | 0.000  |
| Random Index:  | 0.890  |
| Consistency Ratio:  | 0.000  |
| Is it consistent?  | Yes  |

Table : Monitor Conditions Comparison

|  |
| --- |
| Monitor Conditions Comparison  |
|   | Concept #3  | Concept #6  | Concept #7  | Concept #8  |
| Concept #3  | 1.000  | 0.333  | 0.333  | 1.000  |
| Concept #6  | 3.000  | 1.000  | 1.000  | 3.000  |
| Concept #7  | 3.000  | 1.000  | 1.000  | 1.000  |
| Concept #8  | 1.000  | 0.333  | 1.000  | 1.000  |
| Sum  | 8.000  | 2.667  | 3.333  | 6.000  |

Table : Monitor Conditions Normalized

|  |
| --- |
| Monitor Conditions Normalized  |
|   | Concept #3  | Concept #6  | Concept #7  | Concept #8  | Weight {W}  |
| Concept #3  | 0.125  | 0.125  | 0.100  | 0.167  | 0.129  |
| Concept #6  | 0.375  | 0.375  | 0.300  | 0.500  | 0.388  |
| Concept #7  | 0.375  | 0.375  | 0.300  | 0.167  | 0.304  |
| Concept #8  | 0.125  | 0.125  | 0.300  | 0.167  | 0.179  |
| Sum  | 1.000  | 1.000  | 1.000  | 1.000  | 1.000  |

Table : Monitor Conditions Weights

|  |
| --- |
| Monitor Conditions Weights  |
| Concepts  | Weighted Sum Vector  | Consistency Vector  |
| Concept #3  | 0.539  | 4.172  |
| Concept #6  | 1.617  | 4.172  |
| Concept #7  | 1.258  | 4.137  |
| Concept #8  | 0.742  | 4.140  |

Table : Consistency Check #4

|  |
| --- |
| Consistency Check #4  |
| Lambda:  | 4.155  |
| Consistency Index:  | 0.052  |
| Random Index:  | 0.890  |
| Consistency Ratio:  | 0.058  |
| Is it consistent?  | Yes  |

Table : Final Rating Matrix Transpose

|  |
| --- |
| Final Rating Matrix Transpose  |
|   | Criteria #1  | Criteria #2  | Criteria #3  | Criteria #4  |
| Concept #3  | 0.250  | 0.100  | 0.100  | 0.129  |
| Concept #6  | 0.250  | 0.300  | 0.300  | 0.388  |
| Concept #7  | 0.250  | 0.300  | 0.300  | 0.304  |
| Concept #8  | 0.250  | 0.300  | 0.300  | 0.179  |

Table : Concept Alternative Value

|  |  |
| --- | --- |
| Concept  | Alternative Value  |
| Concept #3  | 0.145  |
| Concept #6  | 0.321  |
| Concept #7  | 0.296  |
| Concept #8  | 0.272  |