APPENDIX B

THE AHP DETERMINATION

The following example of pair-wise comparisons as developed in Level 2: *Lean Manufacturing Perspective* of KBCLMM is used to demonstrate the procedure of the AHP determination (Table B.1).

Table B.1: Matrix of AHP Pair-Wise Comparisons

	Product Design for Manufacture (PDfM)	**Internal Lean Chain (ILC)**	**External Lean Chain (ELC)**
Product Design for Manufacture (PDfM)	1	½	1/3
Internal Lean Chain (ILC)	2	1	½
External Lean Chain (ELC)	3	2	1

This matrix should be synthesised and normalised before the calculation for its consistency could be done. In order to synthesise the judgements in this matrix, the value in each column is added up to get a total value for each column as shown in Table B.2.

Table B.2: Matrix of AHP Pair-Wise Comparisons with Total Value for Each Column

	PDfM	**ILC**	**ELC**
PDfM	1	½ = 0.5	1/3 = 0.3333
ILC	2	1	½ = 0.5
ELC	3	2	1
$\sum a_{ij}$ =	6	3.5	1.8333

In order to normalise the matrix, each entry in each column must be divided by the total of the column (shown in Table B.3).

Table B.3: Normalised Matrix of Pair-Wise Comparisons

	PDfM	**ILC**	**ELC**
PDfM	1/6	0.5/3.5	0.3333/1.8333
ILC	2/6	1/3.5	0.5/1.8333
ELC	3/6	2/3.5	1/1.8333
$\sum a_{ij}$ =	6/6 = 1	3.5/3.5 = 1	1.8333/1.8333 = 1

The calculation for average for each row is done as follow. Firstly, adding all the entry in each row before divided by the number of elements or entries in the row. In this case, the number of entries is three. The average for each row is known as priority vector (Table B.4).

Table B.4: Calculation of Priority Vector

				Total	**Average**
PDfM	0.1667	0.1429	0.1818	0.4914	0.1638
ILC	0.3333	0.2857	0.2727	0.8917	0.2972
ELC	0.5	0.5714	0.5455	1.6169	0.539

Based on the normalised matrix, the test of consistency is done to ensure the judgement that made by the decision maker is good and acceptable. The AHP measures the judgement that presented in the matrix by using Consistency Ratio (CR) [Saaty (2001)]. The value of CR should be $\leq 10\%$, and if it is $> 10\%$, then the judgement should be reviewed. The mathematical process integrates the weights and develops the overall evaluation of the decision alternatives.

The process in calculating the Consistency Index (CI), which is by convention known as λ_{max} (lambda max) is shown as follow. Firstly, each entry in the matrix is multiplied by the priority vector (Table B.5).

Table B.5: Multiplication of Entries

PDfM	1 x 0.1638	0.5 x 0.2972	0.3333 x 0.539
ILC	2 x 0.1638	1 x 0.2972	0.5 x 0.539
ELC	3 x 0.1638	2 x 0.2972	1 x 0.539

All the values in each row are added up to get the total value of the row. Then each of the total value of the row is divided by the corresponding priority vector to obtain a new vector which is called D as shown in Table B.6.

Table B.6: Matrix of AHP Pair-Wise Comparisons

				Total	**D**
PDfM	0.1638	0.1486	0.1797	0.4921	3.004
ILC	0.3276	0.2972	0.2695	0.8943	3.009
ELC	0.4914	0.5944	0.5390	1.6248	3.014

$$\lambda_{max} = \frac{3.004 + 3.009 + 3.014}{3}$$

$$= 3.009$$

Consistency Index (CI) = $(\lambda_{max} - N)/ (N - 1)$; N = matrix size

$$CI = \frac{3.009 - 3}{2}$$

$$= 0.0045$$

The Random Index (RI) for the various matrix sizes, N, have been approximated by Saaty (2001), based on a large simulation runs. These values are illustrated in Table B.7.

Table B.7: Random Index (RI)

N	1	2	3	4	5	6	7	8
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.41

Based on Table B.7, the calculation to get a CR with RI = 0.52 (N=4) is as follows:

$$CR = CI / RI$$

$$= 0.0045/0.52$$

$$= 0.0087 (= 0.87\%)$$

Since the CR value is ≤ 10%, then the judgement made by the KBCLMM is consistent and decision could be made based on the highest priority vector.