FRARS-2 (Future Regional Aircraft Requirements Survey - Part 2)

D4.2 Excel Based AHP Tool

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Contact for AHP prototype request

This document provides a summary of an Excel based tool for completing Analytical Hierarchy Process which was used in the CleanSky funded FRARS2 project – a surveying exercise to try and ascertain both the criteria and relative importance of criteria for the selection of suitable designs and technologies for regional aircraft.

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1 Introduction

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions. Based on mathematics and psychology, it was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then.

It has particular application in group decision making, and is used around the world in a wide variety of decision situations, in fields such as government, business, industry, healthcare, and education.

Rather than prescribing a "correct" decision, the AHP helps decision makers find one that best suits their goal and their understanding of the problem. It provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions.

This methodology was used in the FRARS2 project. The purpose was try and establish the relative importance of various criteria that are considered important features of decision making for the selection of which technologies and design best suit future regional aircraft (2020+).

While the completion of the pairwise comparisons that are used in AHP is relatively simplistic, the mathematics that converts these answers into a statistically valid set of weightings can be time consuming.

To simplify this process, a tool was written in Excel that performs these calculations automatically. This document provides a brief introduction on how to use the tool.

2 Using Excel AHP Tool

2.1 Creating a hierarchy

Sheet 1 of the Excel file is used to set up the hierarchy of the AHP study. A screen shot of this sheet is shown below:

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The structure of this sheet is as follows:

- Column B: Category – this is the parent that each criterion relates to. For example, Operating Cost falls under the parent 'Costs'. This is for reference only and not used by the macro.
- Column C: Name – the name of the criterion that is to be part of the pairwise comparison. This is used by the macro to generate the pairwise comparison matrices.
- Column D: Code – A unique auto incrementing ID number assigned to each criterion. This is used by the macro to generate the pairwise comparison matrices.
- Column E: Parent ID – the ID of the parent item the criterion is a sub-criterion of. This is used by the macro to generate the pairwise comparison matrices.
- Column F: Description of the criterion.

By Example:

CATEGORY	NAME	CODE	PARENT	DESCRIPTION
Objective	Buy New Car	1	-	We would like to establish which criteria are most important to us in deciding which new car we are going to buy
Top Level	Cost	2	1	All costs associated with the purchase, running and resale of the car
Top Level	Safety	3	1	All aspects associated with the safety of the car
Cost	Purchase cost	4	2	The initial cost of acquisition of the vehicle
Cost	Running cost	5	2	The day-to-day running cost of the vehicle (fuel, tax, maintenance etc.)

Would describe a hierarchy that looks like this:
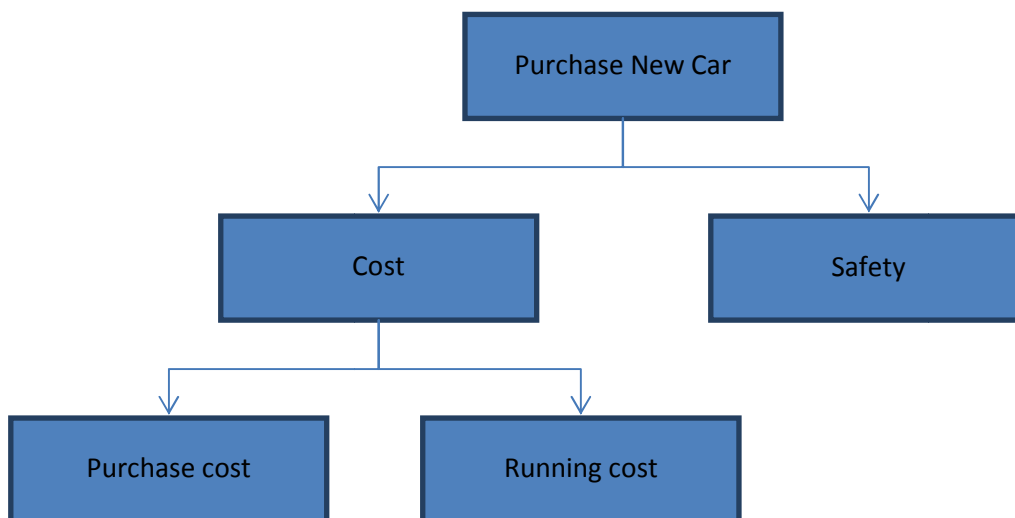
The hierarchy can have as many as 100 criterions, however, it is recommended that the number of elements in each category is kept less than 6 to avoid having very large pairwise comparison lists.

When the hierarchy is completely defined, click the button to the right of the list marked "Populate Qeustions" to automatically generate a list of pairwise comparisons that need to be answered to establish the weighting of each.

2.2 Pairwise Comparisons

Sheet 2 will automatically be selected when after the "Populate Questions" button has been selected. This will present a list of pairwise comparisons that must be made before weightings can be established. An example of this screen can be seen below:
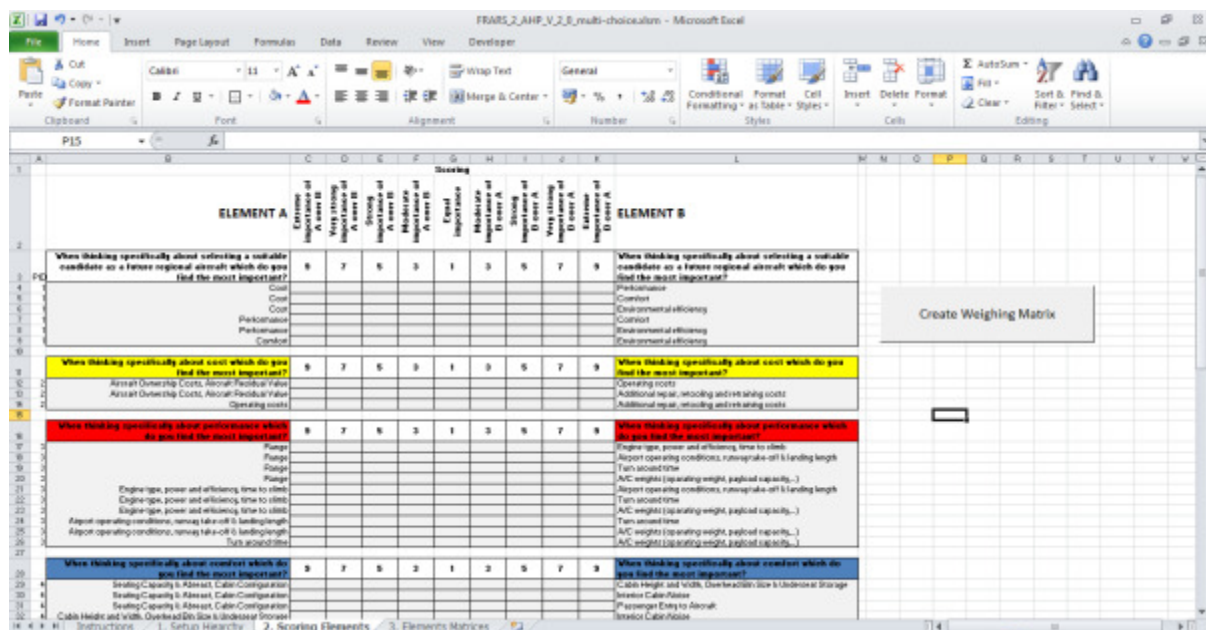
The user must then complete each of the pairwise comparisons by selecting the correct score. This is done by clicking in the appropriate column for the required score, which will place a tick in that box.

When all scores are competed, the user will click the button "Create Weighting Matrix" to be taken to the next screen, where they can evaluate the consistency of their answers and establish the weightings of each element.

2.3 Consistency and Weightings

The final screen of the analysis presents the results of the AHP comparison for each of the categories. There are two important steps in interpreting these results:

1. The coloured cells provide an indication of the consistency of the answers provided. If these cells are red, then it is recommended that the user goes back and reviews the answers they have supplied for a given category because they display some inconsistency.

2. For categories whose cells are green, the column marked "Priority Vector" gives the **relative importance** of each criterion, which is relative to all criterion in the same category and at the same level.

It must be noted that this relative importance is not the same as the **overall importance**. Using the example above: If cost and safety received weightings of 60% and 40% respectively, and purchase cost and running cost received weightings of 70% and 30% respectively, then:

- Safety has a 40% **relative importance** (relative to cost) and because it is a top level domain, it also has a 40% **overall importance**.

- Purchase cost has a 70% **relative importance** (relative to running cost), and a 0.6 * 0.7 = 0.42 = 42% **overall importance** (relative to safety).

- Running cost has a 30% **relative importance** (relative to purchase cost), and a 0.6 * 0.3 = 0.18 = 18% **overall importance** (relative to safety).