BPMSG's AHP Online System

Rational Decision Making Made Easy

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AHP-OS is a web-based tool to support rational decision making based on the Analytic Hierarchy Process (AHP). It allows you to define a hierarchy of criteria for a decision problem, to calculate priorities and evaluate a set of decision alternatives against those criteria.

1. Introduction

AHP stands for Analytic Hierarchy Process. It is a method to support multi-criteria decision making, and was originally developed by Prof. Thomas L. Saaty. AHP derives ratio scales from paired comparisons of criteria, and allows for some small inconsistencies in judgments. Inputs can be actual measurements, but also subjective opinions. As a result, ratio scales (weightings) and a consistency index will be calculated. A simple introduction to the method is given here.

Benefits of AHP

Using AHP as a supporting tool for decision making will help to gain a better insight in complex decision problems. As you need to structure the problem as a hierarchy, it forces you to think through the problem, consider possible decision criteria and select the most significant criteria with respect to the decision objective. Using pairwise comparisons helps to discover and correct logical inconsistencies. The method also allows "translating" subjective opinions, such as preferences or feelings, into measurable numeric relations. AHP helps to makes decisions in a more rational way and to make them more transparent and better understandable.

Method

Mathematically the method is based on the solution of an Eigen value problem. The results of the pair-wise comparisons are arranged in a matrix. The first (dominant) normalized right eigen vector of the matrix gives the ratio scale (weighting), the Eigen value determines the consistency ratio.

Programs

We have developed a web based AHP solution, as a supporting tool for decision making processes. Please feel free to try it out. It can not only be helpful in your daily work for simple decision problems, but also support complex decision making problems.

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Internationally AHP is used in a wide range of applications, for example for the evaluation of suppliers, in project management, in the hiring process or the evaluation of company performance.

To start a program, click on one of the links in the table on the entry page:

1. AHP Projects (AHP-OS)	Handle complete AHP projects including group decision support	**The complete AHP online program package** Manage complete AHP projects and *group sessions*. To use the full functionality, you need to login. Please register as new user, if you don't have an account yet. It's all free!
2. AHP Priority Calculator	Calculate priorities based on pairwise comparisons	The **AHP priority calculator** can be used to "translate" individual preferences into numbers. It calculates priorities or weights for a set of criteria based on pairwise comparisons.
3. AHP Hierarchies	Define complete hierarchies and evaluate priorities and alternatives	With **AHP Hierarchy** it is possible to handle complete decision problems under AHP. It allows you to define a hierarchy of criteria, calculate weights for all criteria based on pairwise comparisons, and evaluate alternatives.
4. AHP Group Session	Participate in AHP group sessions.	Participate in **AHP group sessions** to evaluate criteria or alternatives. The group session code is provided by your session chair.
5. Group Consensus Cluster Analysis	Analyze group Consensus	Cluster a group of decision makers into smaller subgroups with higher consensus using Shannon α- and β entropy.

Please make a reference to the author when using the tool:
Goepel, K.D. (2018). Implementation of an Online Software Tool for the Analytic Hierarchy Process (AHP-OS). *International Journal of the Analytic Hierarchy Process*, Vol. 10 Issue 3 2018, pp 469-487, https://doi.org/10.13033/ijahp.v10i3.590

2. User registration

To use the full features of the program, you need to register as a user.

When you click on "Register" a registration form will appear:

Provide a user name and your valid email address. You will receive an activation e-mail. When you click on the link in the activation e-mail, your account will be activated, und you can login.

3. AHP project administration

After login the AHP-OS project page is shown:

Stored AHP Project Sessions

0 projects. Create new hierarchy

No stored sessions

Once you have initiated new projects, they will be shown in the project table:

My AHP Projects

Click on the session link in the table below to open a project.
Create a new hierarchy.

No	Session	Project	Type[1]	Status	Description	Part.[2]	created
1	Py7ude	AHP-Project	A	open	Project for alternative evaluation	1	2022-02-19

A click on the session code will open the project.

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Session: Unique session code of the project

Project: Project title

Type: H = hierarchy priority evaluation, A = alternative evaluation

Status: Open/Closed: for closed projects, no pairwise comparison is allowed

Description: Short description of the project

Part.:   Number of participants

Created: Date, when the project was created

You can also open a project by selecting the session code from the selection list in the session administration menu.

| Session Administration Menu | | | | | |
| Project Session Code: | Apagyd ⌄ | Open Project | Import Project | New Project | Done |

Open Project: Opens the project summary page of the selected project

Import Project: New - Import a project from a json text file.

New Project: Opens the hierarchy page to define a new project.

When you open a saved project, a project summary is shown:

- Project Data: session code, project name, description, etc.
- Project Participants: list of participants with name and date of their input (if any)
- Project Alternatives: list of defined alternatives (if any)
- Group Input link: link for other participants, you want to give their judgment
- Decision hierarchy
- Hierarchy definition text

Project Summary Information:

Project Data

Field	Content
Session Code	arEqAh
Project Name	Supplier Selection
Description	Test Project
Author	Klaus
Date	2019-08-26 09:52:08
Status	open
Type	Alternatives

Project Alternatives

No	Alternatives
1	Supplier 1
2	Supplier2

Project Participants

No	Sel	Name	Date
1	☐	Klaus	2019-09-06

Refresh Selection   ☐ check all ☐ uncheck all

AHP project Import Menu

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AHP Project Import Menu

Browse... | sUmEtu-AHP-project.JSON | Import | Cancel

Browse: Select json file to upload (extension json)
Import: Import selected project

The project administration menu allows you to manage your existing projects.

Project Administration Menu

View Result | PWC Input | Use Hierarchy | Rename | Edit | Del Sel. Part.(s) | Delete Project | Toggle Project Status

Export Project | Done

- *View Result* - view the group results if the project has participants
- *PWC Input* - Input your judgments using pairwise comparisons
- *Use Hierarchy* – use the project's decision hierarchy to modify and save as a new project
- *Rename* – Rename project or modify short description
- *Edit* – edit hierarchy, alternatives or project description of a saved project
- *Del. sel. Participant(s)* – Remove selected participants input data
- *Delete* – delete the complete project with all its data
- *Toggle Project Status* – Toggle between open and closed. For a closed project no additional pairwise comparison inputs are possible.
- *Export Project* – New - Export current project as text file in json format.
- *Done*– close the currently opened project and go back to the project table

4. How to use the program

The online software is easy to use in five steps:

1. Define the objective and relevant criteria of your decision problem and structure them in a hierarchy.
2. Compare criteria in categories and sub-categories with respect to the objective to find their weights based on pairwise comparisons.
3. View the results.
4. Name a set of alternatives.
5. Compare, how good they match your decision criteria. Again pairwise comparisons based on the AHP are used.

Once completed, you will get a total weight for each alternative, which could help you to select the appropriate alternative and make the final decision.

Step 1 – Define a hierarchy

Hierarchies are defined in a text field using the following simple syntax:

Each branch in the hierarchy is defined by its node (the category) and the node's leafs (the sub-categories). The node is followed by a *colon*, leafs are separated by *comma*, and a branch is closed by a *semicolon*:

```
category: sub-category 1, sub-category 2, sub-category 3;
```

If a sub-category branches out in further sub-categories, you add a line, repeating the sub-category's name as a new node (followed by a colon):

```
sub-category1: sub-sub-1, sub-sub-2;
```

Note: Text input is case sensitive.

Input a new hierarchy

Input new text in the text field below. (See examples)

```
Buy tablet computer: display size, battery life, weight, design;
```

Hierarchy Input Menu

Submit   Save/Update   Download (.csv)   ☐ dec. comma   Reset Priorities   Reset All   Done

Then press *Submit new hierarchy* and the hierarchy table will be displayed:

Decision Hierarchy

Level 0	Level 1		Global Priorities
Buy tablet computer	display size	0.25	25.0 %
	battery life	0.25	25.0 %
	weight	0.25	25.0 %
	design	0.25	25.0 %
			1.0

Note: If you have a project with already defined criteria, you can skip Step 2 (compare criteria) and go immediately to Step 5 and define your alternatives.

Predefine criteria cam be set by adding a "=" and the priority into the hierarchy definition:

Input new text in the text field below. (See examples)

```
Buy tablet computer: display size=0.46, battery life=0.16, weight=0.31,
design=0.07;
```

The predefined weights in each category have to sum-up to 100%.

Press *Save/Update* to save the hierarchy into your project list.

```
┌ Participant's Session Data ─────────────────────────────────────────────────┐
│                                                                              │
│  Session Code:                                                               │
│  rAzAvA                                                                      │
│  Please provide your session code to participate in the AHP group session    │
│                                                                              │
│  Your Name:                                                                  │
│  Klaus                                                                       │
│  Logout as session chair to input another participant's name.                │
│                                                                              │
│  New project, click "Go" to save                                            │
│                                                                              │
└──────────────────────────────────────────────────────────────────────────────┘
```

The new project session code (a unique 6 letter identifier for each project) is shown with your login name as project author.

```
┌ Project Data ──────────────────────────────────────────────────────────────┐
│                                                                              │
│  AHP Project Name:                                                          │
│  Buy tablet computer                                                        │
│                                                                              │
│  Project Short Description:                                                  │
│  ┌──────────────────────────────────────────────────────────┐              │
│  │                                                            │              │
│  │                                                            │              │
│  │                                                            │              │
│  │                                                            │              │
│  └──────────────────────────────────────────────────────────┘              │
│  Text will be displayed to participants of the group session, 400 chars max.│
│                                                                              │
└──────────────────────────────────────────────────────────────────────────────┘
```

You can add a project short description in the text field below. Then press Go to save the project.

```
┌ Session Input Menu ────────────────────────────────────────────────────────┐
│                                                                              │
│  Check input   Go                                         Reset    Cancel    │
│                                                                              │
└──────────────────────────────────────────────────────────────────────────────┘
```

Step 2 – Compare criteria

Open the newly saved project from the project list. Click on *PWC Input* in the Project Administration menu.

A new page will open showing the project's session code and your name, as well as the Participant's Input Menu.

Note: You need to logout, if you want to input your judgment under a different name.

Click on Go. The hierarchy will now show an additional "AHP" button with red outline:

You can now start to compare the criteria.

To find the weight (importance) of criteria, click *AHP* to start pairwise comparisons. The following form is shown:

Compare each pair of criteria with respect to the project and category: which criterion in each pair is more important, and how much more on a 1 - 9 scale? Once you have finished click *Check Consistency*. A table with priorities for each criterion is shown:

	Category	Priority	Rank
1	display size	46.4%	1
2	battery life	16.3%	3
3	weight	30.8%	2
4	design	6.5%	4

It could happen that your pairwise comparisons are not consistent; then the most inconsistent judgments are highlighted, and the consistent judgments are marked light green:

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In order to improve consistency, check whether you are able to adjust your original mark by ± two points on the scale. Click *Calculate* to re-calculate. Once finished, and you are satisfied with you answers, press *Submit* to submit.

Completed branches in the hierarchy tree are marked green, and global priorities are calculated and color-coded according to their rankings.

Once you have completed the judgments, click on *Save judgments* to store them with the project.

Step 3 – View the Results
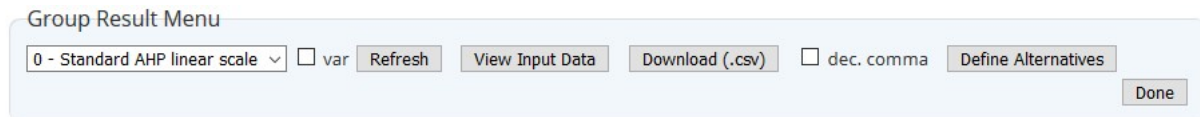
You then can view the (group) result.

The decision hierarchy will be shown with local and global priorities, and a breakdown by the nodes with their corresponding priority vector and their (consolidated) decision matrix. Data can be downloaded in csv format for further use in a spreadsheet program.

Step 4 – Definition of Alternatives

From the *Group Result Menu* it is possible to use the calculated priorities of the decision hierarchy for further alternative evaluation.

In the *Group Result Menu* click on *Define Alternatives*.

The decision hierarchy will be show with a button *Alternatives*. From there you can define the number and names of alternatives.

Enter required number of alternatives and press *Go* to get the following screen:

Input the names of alternatives, then press *ok*. Once defined, save the project with *Save as project* in the Alternative Menu.

The project will be stored under a new session code with Type "A" (Alternative Evaluation).

Step 5 – Alternative Evaluation

Open a project of Type "A" (alternative evaluation) with the group input link, or click on the *Group Input* button. A table with criteria and alternatives will be displayed:

	Criterion	Node	Glb Priori ties	Compare	Alt-1	Alt-2
1.	display size	Buy tablet computer	46.9%	AHP	0.5	0.5
2.	battery life	Buy tablet computer	24.6%	AHP	0.5	0.5
3.	weight	Buy tablet computer	21.7%	AHP	0.5	0.5
4.	design	Buy tablet computer	6.8%	AHP	0.5	0.5
		Total weight of alternatives:			0.5	0.5

The procedure of pairwise comparisons is exactly the same as for criteria. Each completed comparison is highlighted in green:

	Criterion	Node	Glb Priori ties	Compare	Model 1	Model 2	Model 3
1.	display size	Buy tablet computer	46.4%	AHP	0.333	0.333	0.333
2.	battery life	Buy tablet computer	16.3%	AHP	0.667	0.167	0.167
3.	weight	Buy tablet computer	30.8%	AHP	0.333	0.333	0.333
4.	design	Buy tablet computer	6.5%	AHP	0.333	0.333	0.333
		Total weight of alternatives:			0.388	0.306	0.306

When all evaluations are done, the result is shown:

Ranking for Buy tablet computer:

	Category	Priority	Rank
1	Model 1	28.7%	3
2	Model 2	34.2%	2
3	Model 3	37.1%	1

Click on *Submit for group eval* to submit and save your judgments.

In this case, alternative 1 (Model 1) gets a weight of 28.7%, alternative 2 (Model 2) 34.2%, and alternative 3 (Model 3) 37.1%.

Decision Hierarchy					
Level 0	Level 1	Global Priorities	Model 1	Model 2	Model 3
Buy tablet computer AHP	display size 0.4644	46.4 %	0.0634	0.1107	0.2902
	battery life 0.1633	16.3 %	0.1089	0.0272	0.0272
	weight 0.3077	30.8 %	0.0983	0.1718	0.0375
	design 0.0646	6.5 %	0.0161	0.0323	0.0161
OK. Submit for group eval or alternative eval. Evaluate Alternatives		1.0	28.7 %	34.2 %	37.1 %

6. Download

You might download the data in csv format (comma separated values) for further processing in a spread sheet program.

Download complete project for import in Excel: Download (.csv) ☐ dec. comma

Format:

Project: AHP Project - bpmsg.com						
Level 1	p (L1)	Glb. Pr.	Alt-1	Alt-2	Alt-1	Alt-2
Crit-1	0.652631	0.652631	0.9	0.1	0.587368	0.065263
Crit-2	0.285112	0.285112	0.1	0.9	0.028511	0.256601
Crit-3	0.062256	0.062256	0.8	0.2	0.049805	0.012451
Total					0.665685	0.334315

Title line, then each row shows one criterion with the columns: (hierarchy level, local priority), global priority, alternatives (local and global priority).

All (decision) matrices are shown below, with category name as heading and criteria for the matrix rows.

AHP Project		
Crit-1	1	3	8
Crit-2	0.333333	1	6
Crit-3	0.125	0.166667	1

Alternatives show the heading "Alternatives for" and the respective criterion:

Alternatives for Crit-1		
Alt-1	1	9
Alt-2	0.111111	1

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7. AHP Group Sessions

The software allows for group inputs, to calculate consolidated weights for priorities or alternatives. When you open a saved project from your project list, the session code and a link is provided in the project summary:

Group Input Link

The session code is Egaber. Provide this session code or the following link to your participants:

http://bpmsg.com/academic/ahp-hiergini.php?sc=Egaber

Copy and Paste the link and provide it to your participants. **Note:** Participants don't need to register for the software. You can also just provide the session code to them.

Group members can participate by either following the given link, or going to the AHP-OS main site, and click on *AHP Group Session*, providing the session code and their name.

Participant's Session Data

Session Code:

Egaber

Please provide your session code to participate in the AHP group session

Your Name:

Your name as it will be reflected in the group session (3 - 25 alpha num char).

Please provide name.

Participant's Input Menu

check input   Go   Reset   cancel

Once they have entered their name, they can start the pairwise comparisons as described under step 2 above. Results can be called from project administration menu by clicking on *View Result*.

Project Administration Menu

View Result   PWC Input   Use Hierarchy   Rename   Edit   Del Sel. Part.(s)   Delete   Toggle Project Status   Done

Selection of participants

All participants are shown on the project summary page and the group result page. You can select individual participants and, after a click on *Refresh selection*, only the consolidated result of the selected participants is calculated.

Project Participants

No	Sel	Name	Date
1	☐	Emil	2017-04-06
2	☑	Werner	2014-06-08
3	☑	Klaus	2014-06-08

Refresh selection   ☐ check all ☐ uncheck all

The consolidated result is shown in the hierarchy (local and global priorities), as well as in a diagram for the selected participants only. This is indicated with a message

Selected participants: Werner, Klaus

above the Decision Hierarchy.

A breakdown for each node of the hierarchy is given in table form, showing the resulting priorities for each individual group member, as well as the consolidated priorities under the node.

Click on *Download (.csv)* in the *Group Result Menu* to download the results as csv text file.

Group Result Menu

| 0 - Standard AHP linear scale ▾ | ☐ var | Refresh | View Input Data | Priorities (json) | Download (.csv) | ☐ dec. comma |

Define Alternatives

Done

Priorities (json) will download the resulting priorities as json text file. This exported file can be used for the Group Consensus Cluster analysis.

View Input Data will display the decision matrices from each participant and make them available for download.

	Category	Consol. Priorities		P-1	P-2
1	display size	3	24.4%	25.9%	21.7%
2	battery life	2	29.3%	19.9%	41.2%
3	weight	1	39.6%	47.5%	30.5%
4	design	4	6.7%	6.6%	6.6%
5	Consistency Ratio		3.4%	6.2%	6.1%

(P-1: participant 1, P-2: participant 2 etc,)

AHP Group Consensus

For more than one participant, the software calculates an AHP consensus indicator to quantify the consensus of the group, i.e. to have an estimate of the agreement on the outcoming priorities between participants. This indicator ranges from 0% to 100%. Zero percent corresponds to no consensus at all, 100% to full consensus. This indicator is derived from the concept of diversity based on Shannon alpha and beta entropy. It is a measure of homogeneity of priorities between the participants and can also be interpreted as a measure of overlap between priorities of the group members.

If we would categorise group consensus in the three categories low, moderate and high, I would assign the following percentages to these categories:

- Very low consensus: below 50% (disagreement)
- Low consensus: 50% to 65%
- Moderate consensus: 65% to 75%
- High consensus: 75% - 85%
- Very high consensus: above 85% (excellent agreement)

Values below 50% indicate that there is practically no consensus within the group and a high diversity of judgments. Values in the 85% – 95% range indicate a high overlap of priorities and excellent agreement of judgments from the group members.

8. Group Consensus Cluster Analysis

Based on the AHP consensus indicator, this program clusters a group of decision makers into smaller subgroups with higher consensus. First you need to load a priority json file exported from the Group result menu, containing the priorities of all participants. Click on *Browse…* to select the file; then click *Analyze*.

AHP Group Consensus Menu
Browse… No file selected.   Analyze   Done

As a result, input data, consensus threshold, result for nodeand a similarity matrix will be displayed.

Input data

Project session code, selected node (default: pTot), number of categories, number of participants and scale are shown.

Threshold table

The program calculates the number of clusters and number of unclustered participants based on a similarity threshold in the range between 70% and 97.5% in steps of 2.5%. For each step the values are displayed in the threshold table.

Threshold	0.975	0.95	0.925	0.9	0.875	0.85	0.825	0.8	0.775	0.75	0.725	0.7
Cluster	6	6	4	3	2	2	2	1	1	1	1	1
Unclustered	7	3	4	1	1	0	1	1	0	0	0	0

Automatically the optimal threshold is determined.

Consensus threshold for clustering is determined as 0.85

In this case as 0.85 with 2 clusters and no unclustered members.

If you want to change, for example the number of clusters to 3, you can enter 0.9 as new threshold in the *AHP Group Consensus Menu* manually.

AHP Group Consensus Menu
Selected node: [pTot ⌄] [Analyze] Threshold (optional): [_____]
[Load new data] [Done]

In the menu you also find a drop-down selection list for all nodes of the project. With *Load new data* another json file can be loaded.

Result for node

First the AHP group consensus $S*$ or relative homogeneity S for the whole group is shown, followed by the number of clusters. Next for each cluster (subgroup) $S*$ or S of the subgroup and the number of members in this cluster are displayed. Individual members are shown with a number and their name. The participants number corresponds to the number displayed on the project result page (Project Participants), so it is easy to select or deselect them by their number on based on the result of the cluster analysis.

Similarity Matrix

The similarity matrix is a visualisation of the clusters.

Each cell (i,j) contains the AHP consensus $S*$ or relative Homogeneity S for the pair of decisionmakers i and j in percent. Darker green color means higher values as show in the scale above the matrix. Clusters are always rectangulars along the diagonal of the matrix, and are framed by borders.

Scale	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	50%	53%	55%	58%	60%	63%	65%	68%	70%	73%	75%	78%	80%	83%	85%	88%	90%	93%	95%	98%	100%

	1	3	6	7	10	11	12	2	4	5	8	9	13
1	100%	93%	90%	92%	93%	88%	89%	55%	51%	63%	50%	68%	69%
3	93%	100%	79%	93%	85%	85%	76%	72%	59%	79%	60%	71%	68%
6	90%	79%	100%	78%	92%	86%	100%	56%	66%	62%	63%	80%	75%
7	92%	93%	78%	100%	94%	96%	77%	64%	51%	67%	57%	55%	83%
10	93%	85%	92%	94%	100%	98%	92%	58%	58%	61%	61%	64%	88%
11	88%	85%	86%	96%	98%	100%	85%	64%	59%	65%	66%	59%	94%
12	89%	76%	100%	77%	92%	85%	100%	52%	63%	58%	60%	77%	74%
2	55%	72%	56%	64%	58%	64%	52%	100%	90%	98%	93%	77%	66%
4	51%	59%	66%	51%	58%	59%	63%	90%	100%	89%	97%	88%	65%
5	63%	79%	62%	67%	61%	65%	58%	98%	89%	100%	89%	84%	63%
8	50%	60%	63%	57%	61%	66%	60%	93%	97%	89%	100%	78%	75%
9	68%	71%	80%	55%	64%	59%	77%	77%	88%	84%	78%	100%	53%
13	69%	68%	75%	83%	88%	94%	74%	66%	65%	63%	75%	53%	100%

As you can see in the figure shown above, the program found two clusters with members 1,3,6,7,10,11,12 respectively 2,4,5,8,9, and one unclustered member 13. In this case the AHP group consensus without clustering is 52.4% (low), the consensus for subgroup 1 is 80.5% (high) and subgroup 2 80.7% (high). This means that within the group there are two individual parties in higher agreement. You can easily go back to the project's group result page to analys the consolidated priorities for each group by selecting the individual participants.

Once the number of participants exceeds 25, the similarity matrix is shown without values in order to better fit on the ouput page.

Scale	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	18%	22%	26%	30%	34%	39%	43%	47%	51%	55%	59%	63%	67%	71%	75%	80%	84%	88%	92%	96%	100%
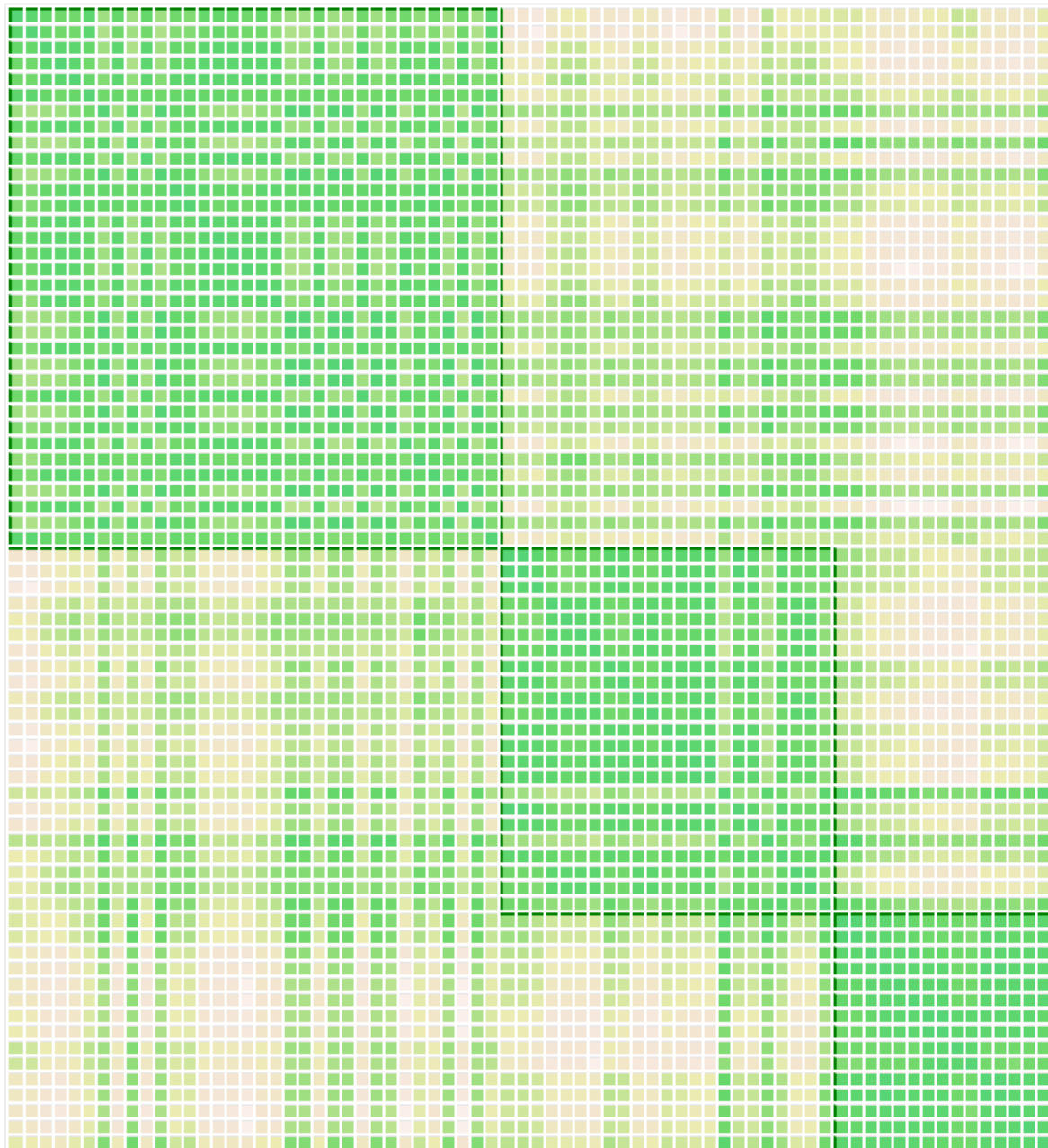
Example with 72 participants within 3 clusters.

References

In your work please cite:

Goepel, K.D. (2018). Implementation of an Online Software Tool for the Analytic Hierarchy Process (AHP-OS). *International Journal of the Analytic Hierarchy Process*, Vol. 10 Issue 3 2018, pp 469-487, https://doi.org/10.13033/ijahp.v10i3.590

The article describes the implementation of AHP-OS with all mathematical calculations and further references.

Other

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Annex 1: AHP-OS Menus

1. Session Administration

The **Session Administration Menu** allows you to open your AHP projects. You can also open a project by *clicking on the link of the session code in the project table*.

Session Administration Menu		
Project Session Code: Adyzen ∨ Open Project		New Project Done

Open Project	Open project summary of selected project session.
Import Project	Import project from json text file
New Project	Start a new project (hierarchy definition) – opens hierarchy page.
Done	Back to AHP main page.

2. Project Administration

The **Project Administration Menu** allows you to manage a selected AHP project.

Project Administration Menu							
View Result	PWC Input	Use Hierarchy	Rename	Edit	Del Sel. Part.(s)	Delete	Toggle Project Status	Done

View Result	View result (greyed, if no result available).
PWC Input	Start your pairwise comparisons input as participant.
Use Hierarchy	Use decision hierarchy of the selected project to define a new one.
Rename	Rename project name or edit project description.
Edit	Edit a saved project (greyed, when project has participants' inputs).
Del Sel. Part.(s)	Delete selected participant(s) (greyed, if no participant is selected.) Select participants in the participants table and refresh.
Delete Project	Delete the whole project.
Toggle Project Status	New: Toggle project status between open and closed
Export Project	Import project from json text file
Done	Close the selected project. Go back to session table.

3. Decision Hierarchy

Input new text in the text field below. (See examples)

```
AHP-Project:Crit-1,Crit-2,Crit-3;
Crit-1:a=.6,b=.4;
Crit-2:c,d;
Crit-3:e,f;
```

The syntax is defined as follows:

```
<hierarchy> → <branch>; [{<branch>;}]
<branch>    → <node>: <leafs>, <leafs> [,<leafs>]
<leafs>     → {<leaf> [ = <weight>]}
```

For all `<leafs>` in a `<branch>` the sum of `<weight>` has to be one. A `<node>` of the second and any further `<branch>` has to be one of the `<leaf>` in `<leafs>`. Each `<node>` represents a decision matrix, and the corresponding priority vector's dimension is the number of `<leafs>`. The example shown has defined weights for the two criteria a (60%) and b (40%. For all other criteria weights are automatically set to the default value 1/n_{leaf}.

In the **Hierarchy Input Menu** you can define a new hierarchy and save it as new project.

Submit	Submit new hierarchy text input
Save/Update	Save hierarchy definition as new project
Download (.csv)	Export data as comma separated value file
dec. comma	Export with "," as decimal separator when checked
Reset Priorities	Reset all priority values given within the hierarchy text input. Clears also alternative names
Reset all	Reset hierarchy definition and all other session parameter
Done	Go back to Session Administration

4. Save New/Modified Projects

When you want to save a new or modified project, or rename the project name or description, the AHP Session Input Page will open. You can edit the AHP Project Name and input a Project Short Description. The project short description (max. 400 chars) will be shown to the participants/respondents.

AHP Project Name:
Vendor Selection

Project Short Description:

Session Input Menu

Go   Reset   Cancel

5. Group Input (Participants)

Start project evaluation inputs as participant: Click on *Group Input* in the project administration menu, or follow the group link provided on the project administration page.

The session code is sUhYmA. Provide this session code or the following link to your participants:

https://bpmsg.com/academic/ahp-hiergini.php?sc=sUhYmA

Session Input Menu

Check input   Go   Reset   Cancel

Check Input	Check your input (session code and participants' name. Red outline when required.
Go	Start: will show decision hierarchy with AHP buttons to click and start pairwise comparisons.
Reset	Reset form.
Cancel	Cancel input.

6. Pairwise Comparisons

AHP AHP	Start pairwise comparison (red) for selected node of the hierarchy. Once the comparison is done, the button outline will be green.
Check Consistency	Check consistency of the pairwise comparison.
Submit_Priorities	Submit priorities and go back to the hierarchy to continue evaluation.

Once all judgments are completed, they can be saved to the database.

Group Input Menu

Save Judgments   View Group Result   Done

| Save Judgments | Submit judgment for group evaluation – red outline, when all comparisons are completed. |

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View Group Result	View consolidated group results.
Done	Exit the Group input page – red outline, when judgments are saved.

7. Group Results

Group Result Menu

0 - Standard AHP linear scale ⌄ ☐ var Refresh View Input Data Priorities (json) Download (.csv) ☐ dec. comma
Define Alternatives

Done

The **Group Result Menu** allows you to analyse the results and download them as csv text file.

0 - Standard AHP linear scale ⌄	Scale selection
☐ var	Uncertainty evaluation and sensitivity analysis (alternatives).
☐ wpm	Weighted product method instead of weighted sum method.
Refresh	Refresh page – outlined red when required.
View Input Data	View participants input data.
Priorities (json)	Export priorities as json file for Group Consensus Analysis
Download (.csv) ☐ dec. comma	Download results as csv text file.
Define Alternatives	Use hierarchy with resulting priorities for definition of alternatives.
Done	Go back to project list.

8. Define Alternative Project

Click *Use Consol. Prio* in the Group Result Menu and click on *Alternatives* in the hierarchy table. Define number and names of alternatives.

Input number and names (2 – 12) 2   Go

Save as new project.

Alternative Menu

Save as Project   Reset Alternatives   Done

Save as Project	Hierarchy with consolidated priorities and defined alternatives will be saved as a new project (mode alternative evaluation).
Reset Alternatives	Reset al defined alternative names to input new ones.
Done	Go back to hierarchy page.

Decision hierarchy (table)

AHP AHP	Start pairwise comparison (red) for selected node of the hierarchy, once the comparison is done, the button outline will be green.
Alternatives	Switch to alternative display to start definition and evaluation of

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alternatives (only, when pairwise comparison completed)

AHP Pairwise comparison menu

| Check Consistency | Calculate priorities based on pairwise comparisons and check consistency of judgment |
| Submit_Priorities | Submit calculated priorities for further calculation |

9. Results Page

On the result page following details are shown:

Project result data	Selected judgment scale, Number of judgment variation for uncertainty estimation, Weighted Product Method (WPM) if selected. - Project summary table, - Alternative table (if any), - Project participants table with checkbox for selection of individual participants.
Hierarchy with consolidated priorities	"All" or selected participants from participant's table, decision hierarchy table with alternatives (if any) and consolidated weights from all or selected participants.
Consolidated global priorities or weights of alternatives	Graph with priorities and uncertainties (if selected).
Sensitivity analysis	1. Weight uncertainties overlap, 2. Robustness (for alternative evaluation).
Alternatives by Participants (alternative evaluation)	Group result of alternative weights, uncertainties and breakdown by participant.
Breakdown by nodes (Details/Hide)	Consistency Ratio CR, AHP group consensus, Table with weights and uncertainties, Consolidated decision matrix, Group result and weights for individual participants.
Global priorities (hierarchy evaluation)	Group consensus and global weights, uncertainties and breakdown by participants.

Annex 2: AHP Hierarchy Example

Decision Hierarchy (table)

			Global Priorities
Decision Hierarchy			
Level 0	Level 1	Level 2	Global Priorities
Supplier Selection	Quality 0.3333	Product Variety 0.3333	11.1 %
		Product Quality Features 0.3333	11.1 %
		Production Quality 0.3333	11.1 %
	Reliability 0.3333	Management & Organization 0.25	8.3 %
		References 0.25	8.3 %
		Capital 0.25	8.3 %
		Annual Turnover 0.25	8.3 %
	Service 0.3333	Communication 0.3333	11.1 %
		Delivery Lead Time 0.3333	11.1 %
		Customization Capability 0.3333	11.1 %
			1.0

Text field input for hierarchy above

Input new text in the text field below. (See examples)

```
Supplier Selection: Quality, Reliability, Service;
Quality: Product Variety, Product Quality Features, Production Quality;
Reliability: Management & Organization, References, Capital, Annual Turnover;
Service: Communication, Delivery Lead Time, Customization Capability;
```

Annex 3: Conducting a group session

The figure below shows how a group session is conducted to determine group priorities using BPMSG's AHP online system. The group session chair must be a registered user to initiate a group sessions. A six character session code is generated. Participants can use this session code to log into the group session and provide their judgements.
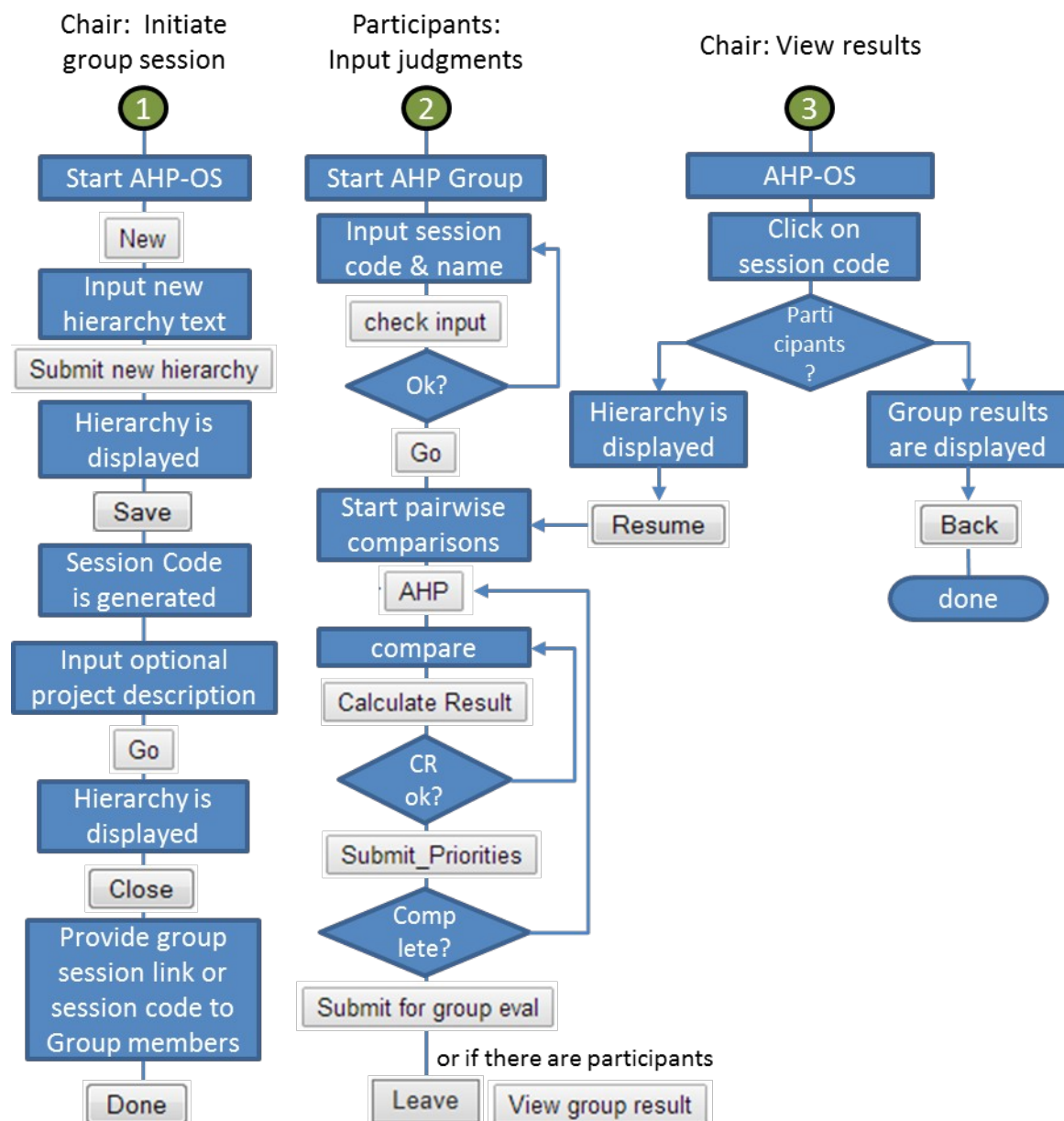
Annex 4: Evaluation of Alternatives Example

Evaluation of Alternatives

	Criterion	Node	Glb Priorities	Compare	House A	House B	House C
1.	Size of house	Satisfaction with house	17.3%		0.333	0.333	0.333
2.	Transportation	Satisfaction with house	5.4%		0.333	0.333	0.333
3.	Neighborhood	Satisfaction with house	18.8%		0.333	0.333	0.333
4.	Age of house	Satisfaction with house	1.8%		0.333	0.333	0.333
5.	Yard space	Satisfaction with house	3.1%		0.333	0.333	0.333
6.	Modern facilities	Satisfaction with house	3.6%		0.333	0.333	0.333
7.	General condition	Satisfaction with house	16.7%		0.333	0.333	0.333
8.	Financing	Satisfaction with house	33.3%		0.333	0.333	0.333
	Total weight of alternatives:				0.333	0.333	0.333

0 out of 8 comparisons completed

How to make a decision? The analytic hierarchy process. Saaty, European Journal of Operational Research 48 (1990) 9 - 26 - Alternative evaluation

Annex 5: Data Structure

Pairwise Comparisons:

Array['pwc'][$node]['a']{0,1,0}['Intense']{3,6,2}

'pwc'																	
Delivery						'Color'								'Memory'			
'A'			'Intense'			'A'				'Intense'				'A'			'Intense'
0	1	0	3	6	2	0	1	0	0	2	4	1	7	0	1	0	3	6	1	7

```
1. function convertPwcToString($pwc) from Array to SQL
2. function convertPwc($pwc) from SQL format to Array
3. function getPwc($sc, $participant, $nod)
```

SQL table pwc					
Project_sc	**pwc_part**	**pwc_timestamp**	**pwc_node**	**pwc_ab**	**pwc_intense**
expl02	Klaus	1397794301	Delivery	010	362
expl02	Klaus	1397794302	Color	0100	2417
expl02	Klaus	1397794303	Memory	010	3617

Class ahpGroup

Priorities in ahpGroup->prio

ahpGroup->prio	participant	[$node]	[branch]	priority
ahpGroup->prio	0	Color	red	0,6
			blue	0,4
		Memory	16MB	0,2
			32MB	0,5
			64MB	0,3
		pGlb	all leafs	
	1	Color	red	0,4
			blue	0,6
		Memory	16MB	0,1
			32MB	0,6
			64MB	0,3
		pGlb	all leafs	
	2	…	…	…

Participant with index 0 contains consolidated result

CR in ahpGroup->cr

ahpGroup->cr	participant	[$node]	CR
ahpGroup->cr	0	Color	0,1
		Memory	0,05
		pGlb	avgCR
	1	Color	0,07
		Memory	0,12
		pGlb	avgCR
	2	Color	0,03
		Memory	0,05
		pGlb	avgCR

For alternatives

ahpGroup->prio	participant	$leaf	$alt	priority
ahpGroup->prio	0	blue	0	0,6
			1	0,4
		red	0	0,2
			1	0,5
	1	blue	0	...
			1	
		Color	0	
			1	
	2	blue	0	
			1	
		Color	0	
			1	
	3	...	...	...

Annex 6: Project Export Example

```
    {
    "pj": [
        {
            "project_id": "6512",
            "project_sc": "Ubates",
            "project_name": "Compromise",
            "project_description": "Compromise Problem 3 alternatives\r\
nWPM gives the correct results",
            "project_hText": "Compromise: Sales Skills=0.5, Engineering
skills=0.5;",
            "project_datetime": "2017-06-30 09:06:21",
            "project_author": "Klaus",
            "project_status": "0"
        }
    ],
    "pwc": [
        {
            "project_sc": "Ubates",
            "pwc_part": "Klaus",
            "pwc_timestamp": "1498813840",
            "pwc_node": "Sales Skills",
            "pwc_ab": "000",
            "pwc_intense": "494",
            "pwc_id": "794"
        },
        {
            "project_sc": "Ubates",
            "pwc_part": "Klaus",
            "pwc_timestamp": "1498813840",
            "pwc_node": "Engineering skills",
            "pwc_ab": "111",
            "pwc_intense": "494",
            "pwc_id": "795"
        },
        {
            "project_sc": "Ubates",
            "pwc_part": "Klaus1",
            "pwc_timestamp": "1560243394",
            "pwc_node": "Sales Skills",
            "pwc_ab": "000",
            "pwc_intense": "397",
            "pwc_id": "2755"
        },
        {
            "project_sc": "Ubates",
```

```
                "pwc_part": "Klaus1",
                "pwc_timestamp": "1560243394",
                "pwc_node": "Engineering skills",
                "pwc_ab": "111",
                "pwc_intense": "892",
                "pwc_id": "2756"
            }
        ],
        "alt": [
            {
                "project_sc": "Ubates",
                "alt": "A"
            },
            {
                "project_sc": "Ubates",
                "alt": "B"
            },
            {
                "project_sc": "Ubates",
                "alt": "C"
            }
        ]
}
```