Multi-criterion evaluation of investment attractiveness

Analytical hierarchy process (AHP)

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- applicability;
- basic facts;
- existing models and why do we need to develop new one?
- new model;
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Introduction to AHP
Analytic Hierarchy Process


AHP is one of the most extensively used multi-criterion decision making methods.

It is used to solve complex decision-making problems and has been applied in variety of decisions.

AHP useful for evaluating relative value of quantitative and qualitative criteria.

It’s different to other methods by its system wide approach, the possibility of using quantitative and qualitative criteria, by its demonstrativeness, apprehensibility and wide popularity.
The primary goal of the AHP is to select an alternative that best satisfies a given set of criteria out of a set of alternatives or to determine the weights of criteria in any application.

AHP scales the weights of attributes at each level of the hierarchy with respect to a goal using the decision maker’s (experts’) experience and knowledge in a matrix of pair-wise comparison of attributes.

The usual application of AHP is to select the best alternative from a discrete set of alternatives.
AHP decision making method:

- Helps decision makers identify the best alternative to support their goals;
- Decomposes the decision problem into a hierarchy of sub-problems to be analyzed independently;
- Uses Pairwise comparisons.
AHP has been continuing to grow through the efforts of hundreds of authors in thousands of papers, and nowadays tons of theoretical and applied works on AHP can be found on the Internet, in books, and in professional journals in practically any area of human interests and activities.

A group of professors lead by prof. Emilio Esposito from University of Naples «Federico II» have organized a biennial conference called The International Symposium on the Analytic Hierarchy Process (ISAHP) – URL: www.ISAHP.org.
AHP applications

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. Decision situations to which the AHP can be applied include:

- **Choice** (selection of one alternative from a given set of alternatives);
- **Prioritization / Ranking** (Putting a set of alternatives in order of most to least desirable);
- **Resource Allocation** (Apportioning resource to a set of alternatives);
- **Benchmarking** (Comparing processes between entities);
- **Quality Management** (dealing with quality and quality improvement).
AHP applications (cont.)

For example, the AHP can be applied for:

- Choosing which employment offer to accept.
- Picking which computer (or car, etc.) to buy.
- Choosing a new software package for your company.
- Deciding which new product to launch first.
- Selecting a site for a new restaurant, hotel, etc.
- Rating the best cities in which to live.
- Selecting a projects, sources, etc.
- etc.
Interesting cases of AHP

Xerox Corporation uses AHP for R&D decisions on portfolio management, technology implementation, and engineering design selection.

British Columbia Ferries Corporation in Canada use AHP in the selection of products, suppliers and consultants.

NASA used AHP to consider criteria for Safety, Performance, Reliability and Flexibility in recommending a power source for the first lunar outpost.

General Motors use AHP to evaluate design alternatives, perform risk management, and arrive at the best and most cost-effective automobile designs.

Microsoft Corporation use AHP to Quantify the overall quality of software systems.

Bloomsburg University of Pennsylvania used AHP to select university faculty.

Etc.
Advantages of the AHP

Unity

Process Repetition

Judgment and Consensus

Tradeoffs

Synthesis

Consistency

Complexity

Interdependence

Hierarchic Structuring

Measurement
AHP Disadvantages

- Subjective evaluation;
- Conversion from verbal to numeric scale;
- Inconsistencies imposed by scale;
- Conflict between decision maker;
- Decision maker capacity.
- When the number of the levels in the hierarchy increase, the number of pair comparisons also increase, so that to build the AHP model takes much more time and effort.
The stages of AHP
AHP Step 1: Structure a hierarchy. Define the problem, determine the criteria and identify the alternatives.

**OBJECTIVE**

**CRITERIA**

**ALTERNATIVES**

- Goal
  - Factor 1
    - Subfactor 11
    - Subfactor 12
    - Subfactor 13
  - Factor 2
    - Subfactor 21
    - Subfactor 22
  - Factor 3
    - Subfactor 31
    - Subfactor 32
    - Subfactor 33

- Alt 1
- Alt 2
- Alt 3
AHP uses 1-9 scale for the prioritization process.

The 9-point comparison scale:

<table>
<thead>
<tr>
<th>Numerical ratings</th>
<th>Verbal judgments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equally important (preferred)</td>
</tr>
<tr>
<td>3</td>
<td>Moderately more important</td>
</tr>
<tr>
<td>5</td>
<td>Strongly more important</td>
</tr>
<tr>
<td>7</td>
<td>Very strongly more important</td>
</tr>
<tr>
<td>9</td>
<td>Extremely more important</td>
</tr>
<tr>
<td>2,4,6,8</td>
<td>Intermediate values: when compromise is needed</td>
</tr>
</tbody>
</table>

Note: In comparing elements i and j. If i is 3 compared to j, then j is 1/3 compared to i.
AHP Step 3: Evaluation of Pairwise Comparisons

- Extract standardized eigenvector for each group of factors or subfactors.
- The eigenvector can be interpreted as the weight, or importance of a specific factor relative to all other factors.
- These weights reflect the full information contained in the pairwise comparison matrix.

Synthesize the results to determine the best alternative. Obtain the final results.
The output of AHP is the set of priorities of the alternatives.
Why we use AHP?

- AHP is simple, practical and handy;
- The one-to-one qualitative and quantitative comparison is clear and easy to digest by decision maker;
- AHP could apply jointly with other decision making tools such as SWOT analysis, which will generate better result;
- AHP is being widely used and accepted by various organization, enterprises and country all over the world;
- AHP actively nurture intellectual discussion, debate and research on various field and study.
Multi-criterion evaluation of investment attractiveness
the need of increasing the economic potential of the mobile telecommunication company;
provision of competitiveness of the mobile telecommunication company;
the need of increasing key performance indicators of the mobile telecommunication company.
the *investment attractiveness* is a combination of factors, which describe the investment qualities of the specific object;

the feature of the telecommunications industry is the importance of new technologies for the future development;
Existing models

- There are 2 classes of models for evaluating investment attractiveness:
  - WB models;
  - Models based on investment climate.
Reasons for developing new model

- Taking into account the balance of interests of individuals interested in enhancing the economic potential of the telecom company;
- Taking into account different stages of maturity of the telecom company;
- Taking into account company’s objective key performance indicators.
The levels of hierarchic model

Directions of investment attractiveness of mobile telecommunication companies

Set of evaluation criteria

The levels of organizational maturity of mobile telecommunication companies

Interests of groups of individuals

The levels of profitability of mobile telecommunication companies

Possible alternative factors of investment attractiveness of mobile telecommunication companies
The following aspects of PEST analysis have been selected as directions of the investment attractiveness of telecom companies:

- economic (E):
- social (S);
- technological (T);
- the Political aspect (P) was excluded from consideration in order to avoid its duplication on the other levels of the hierarchy.
The second level of the model consists of company’s objective key performance indicators such as:

- maximum of new technologies;
- minimum of liabilities;
- maximum of net assets;
- maximum of social responsibility;
- maximum of information transparency.
The elements of 3rd level

The following 5 stages have been selected as the levels of organizational maturity:
# Company maturity stages

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>processes are ad-hoc, chaotic, or actually few processes are defined</td>
</tr>
<tr>
<td>Repeatable</td>
<td>basic processes are established and there is a level of discipline to stick to these processes</td>
</tr>
<tr>
<td>Defined</td>
<td>all processes are defined, documented, standardized and integrated into each other</td>
</tr>
<tr>
<td>Managed</td>
<td>processes are measured by collecting detailed data on the processes and their quality</td>
</tr>
<tr>
<td>Optimizing</td>
<td>continuous process improvement is adopted and self-adaptation of the system</td>
</tr>
</tbody>
</table>
In the level of the balance of interests has been presented by the persons whose interests must be observed while distributing factors of investment attractiveness by priorities:

- shareholders;
- owners;
- government;
- investors;
- society.
The following table defines the scale for return on assets (ROA):

<table>
<thead>
<tr>
<th>Definition</th>
<th>ROA, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
<td>&lt; 4</td>
</tr>
<tr>
<td>Average</td>
<td>5-25</td>
</tr>
<tr>
<td>Superior</td>
<td>&gt; 25</td>
</tr>
</tbody>
</table>
The elements of 6th level

**Financial factors**
- The return on investment (ROI)
- The dividend yield (DY)
- The payback period (PP)

**Innovation factors**
- The frequency of staff development courses (FS)
- The numbers of implemented technologies (ITI)
- The quality of products or services (QS)

**HR factors**
- The number of employees (NE)
- The labor productivity (LP)
- The number of highly qualified staff (NHS)

**Location factors**
- The proximity to the necessary objects (P)
- The environmental conditions at the site (EC)
The model of increasing the investment attractiveness of mobile-telecommunication companies

<table>
<thead>
<tr>
<th>The level of direction</th>
<th>Social (0.331)</th>
<th>Economic (0.289)</th>
<th>Technological (0.379)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>The level of criteria</th>
<th>Max of new technologies (0.378)</th>
<th>Min of liabilities (0.137)</th>
<th>Max of net assets (0.287)</th>
<th>Max of social responsibility (0.088)</th>
<th>Max information transparency (0.110)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>The level of maturity of the company</th>
<th>Initial (0.386)</th>
<th>Repeatable (0.249)</th>
<th>Defined (0.148)</th>
<th>Managed (0.132)</th>
<th>Optimizing (0.085)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>The level of balance of interests</th>
<th>Shareholders (0.283)</th>
<th>Owners (0.257)</th>
<th>Staff (0.167)</th>
<th>Investors (0.124)</th>
<th>Government (0.082)</th>
<th>Society (0.087)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>The level of return on assets</th>
<th>Large (0.637)</th>
<th>Small (0.258)</th>
<th>Average (0.104)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>The level of factors</th>
<th>Financial (0.953)</th>
<th>HR (0.933)</th>
<th>Innovative (0.157)</th>
<th>Location (0.077)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROI (0.253)</td>
<td>PP (0.148)</td>
<td>NHS (0.133)</td>
<td>MIT (0.056)</td>
<td>P (0.042)</td>
</tr>
<tr>
<td>DY (0.152)</td>
<td>NE (0.015)</td>
<td>FS (0.021)</td>
<td>CS (0.078)</td>
<td>EC (0.085)</td>
</tr>
</tbody>
</table>
The investment attractiveness Hierarchy

Level 1: Goal
Definition the investment attractiveness of enterprises

Level 2 criteria
- Financial factors
- Human Resource factor
- Innovation factors
- Territorial factors

Level 3 criteria
- Financial factors:
  - index return on investment (ROI),
  - payback period (PP),
  - dividend yield (DP).
- Human Resource factor:
  - The number of highly qualified staff (FAC),
  - Staffing (S),
  - Labor productivity (LP).
- Innovation factors:
  - The number of implemented technologies (NIT),
  - Frequency of implementation staff development courses (FDC),
  - The quality of products or services (QS).
- Territorial factors:
  - Proximity to the necessary objects (P),
  - Ecological situation in the location (EC).

Alternatives
- Enterprise 1
- Enterprise 2
- Enterprise 3
- Enterprise 4
- Enterprise 5
The priorities of alternatives received with the help of using the AHP

![Bar Chart]

- Enterprise 1
- Enterprise 2
- Enterprise 3
- Enterprise 4
- Enterprise 5

Aminov Hakim, Kosuhina Mariya 09.11.12
Conclusions

- Calculations have shown that the group of financial factors has the highest priority (0,553) in the model.
- Return on investments (ROI) has the highest priority (0,253) among the financial factors. So we could manage the investment attractiveness by increasing ROI;
- The consistency ratio of the constructed hierarchy does not exceed 10%, which demonstrates possibility of using the results.


Thank you!
Q&A