Multi-criterion evaluation of investment attractiveness

Analytical hierarchy process (AHP)

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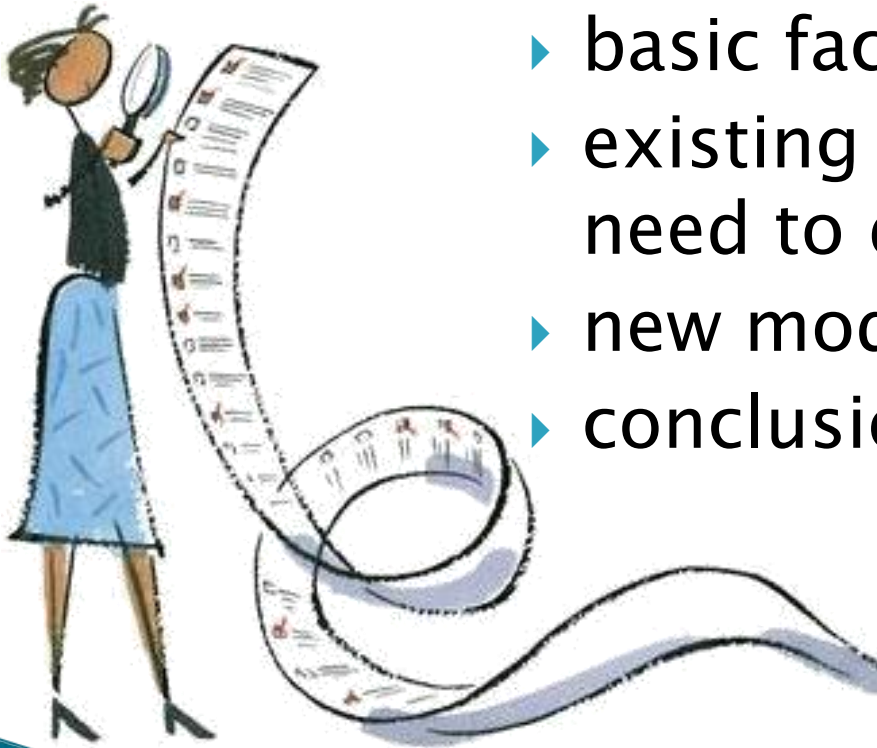Kosukhina Mariya
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Introduction to AHP

Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is a methodology and a group of methods for multi-criterion decision making suggested and developed by Thomas Saaty (Saaty, 1977, 1980, 1994, 1996, 2000).

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

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.

Development of AHP

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 Hierarhy 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.

I SEE A NEW CAR IN YOUR FUTURE

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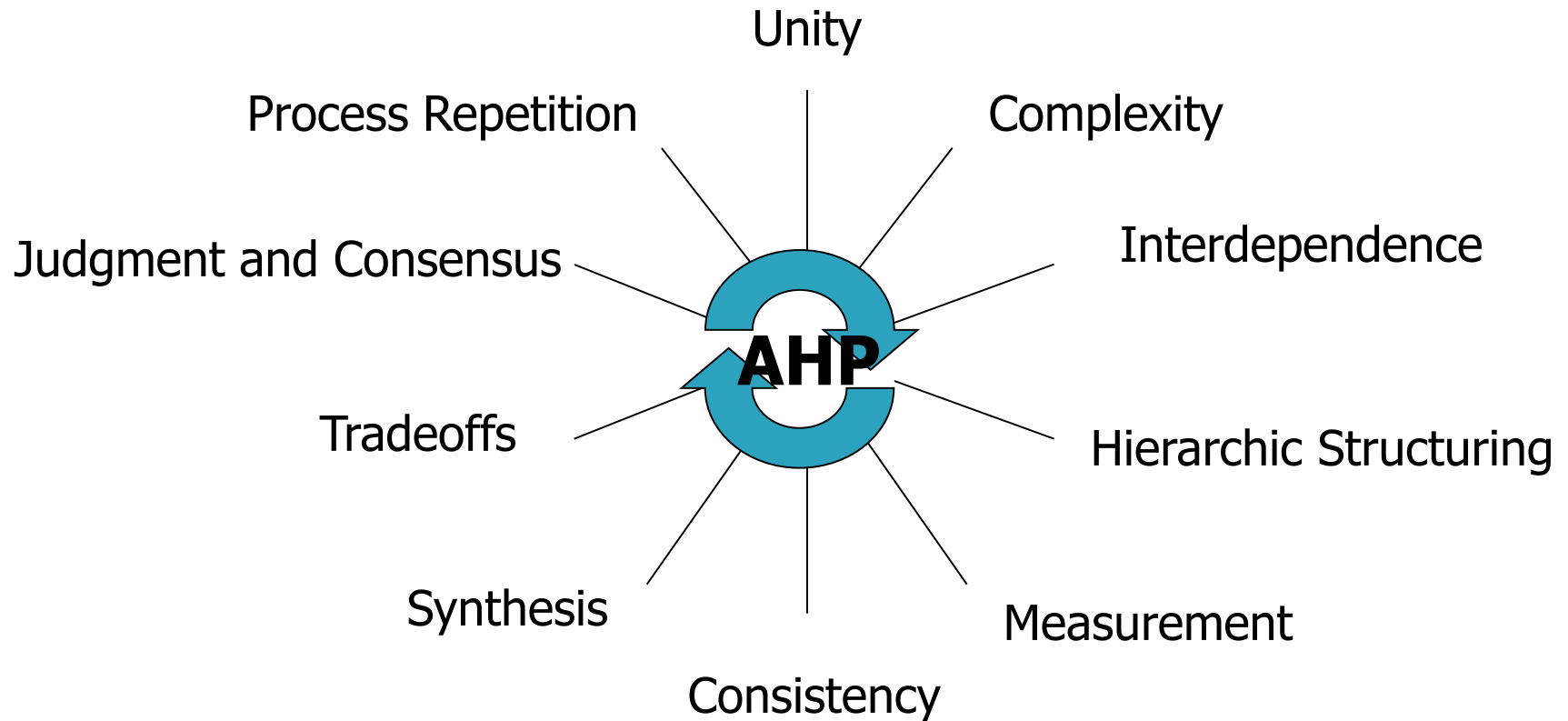
General Motors use AHP to evaluate design alternatives, perform risk management, and arrive at the best and most cost-effective automobile designs.

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

Complexity

Interdependence

Process Repetition

Judgment and Consensus

Hierarchic Structuring

Tradeoffs

AHP

Synthesis

Measurement

Consistency

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.
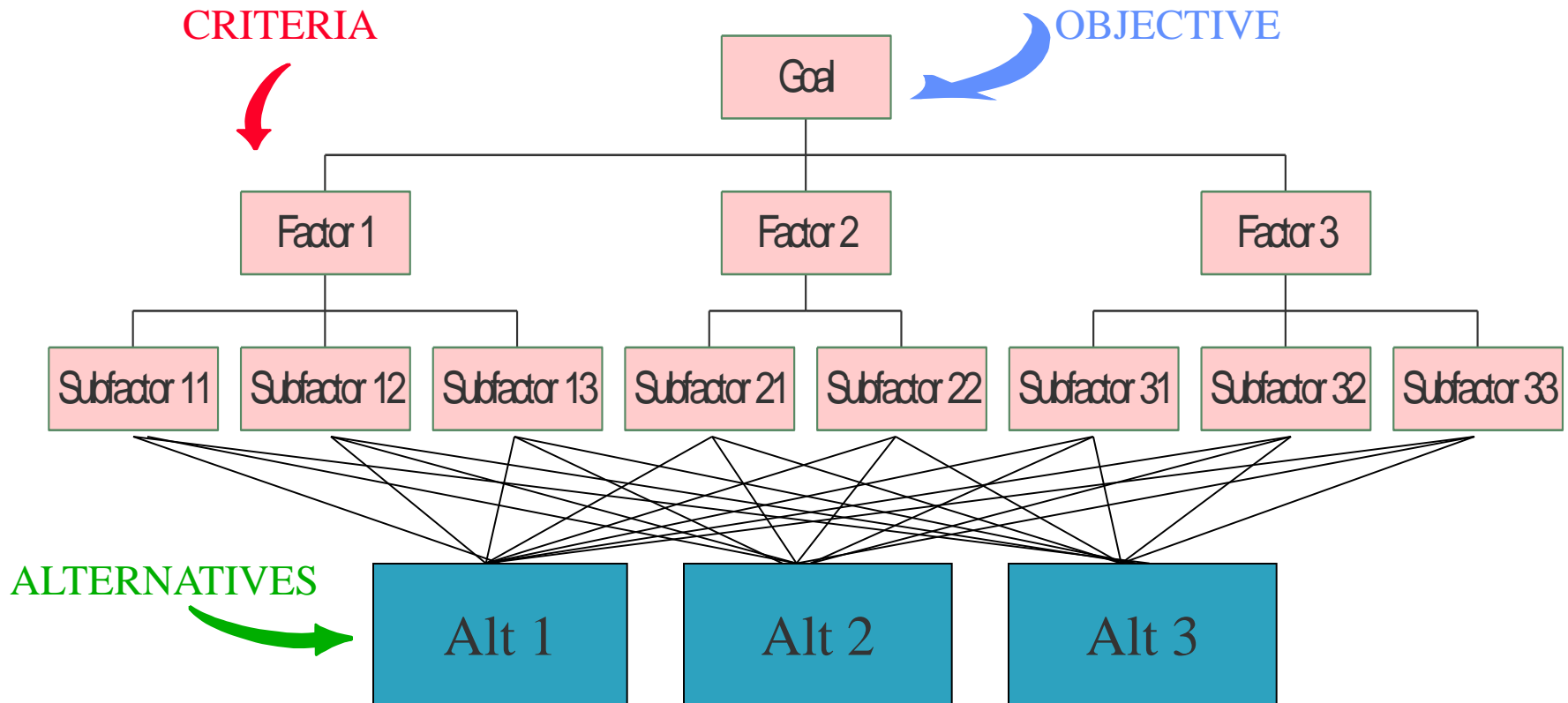
AHP Step 2: Make pairwise comparisons (Saaty). Rate the relative importance between each pair of decision alternatives ad criteria.

AHP uses 1-9 scale for the prioritization process.

The 9-point comparison scale:

Numerical ratingsI	Verbal judgments
1	Equally important (preferred)
3	Moderately more important
5	Strongly more important
7	Very strongly more important
9	Extremely more important
2,4,6,8	Intermediate values: when compromise is needed

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 qualitive and quantitive 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

Applicability

- the need of increasing the economic potential of the mobile telecommunication company;
- provision of competitiveness of the mobile telecommunication company;
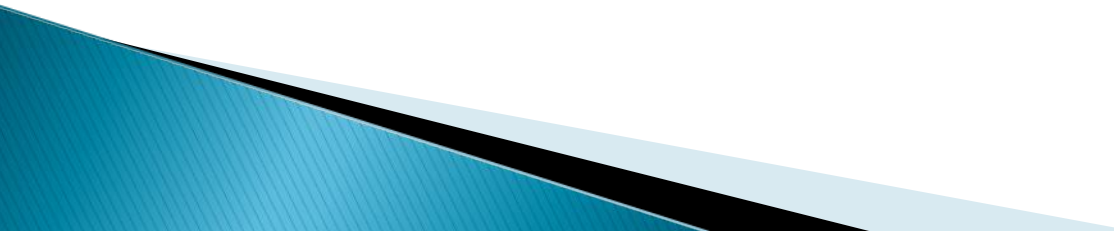- the need of increasing key performance indicators of the mobile telecommunication company.
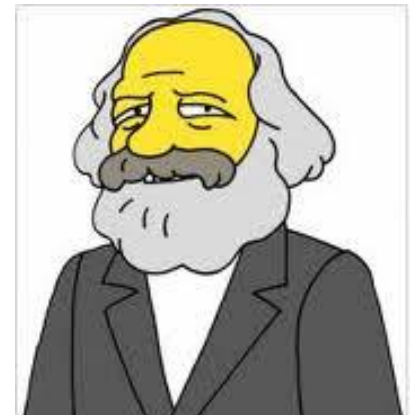
Basic facts
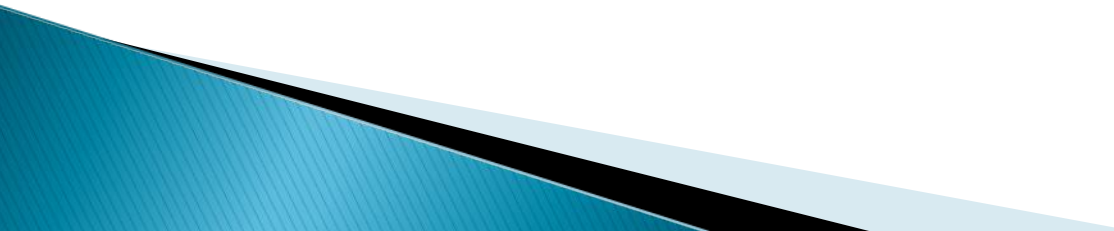
- the *investment attractiveness* is a combination of factors, which describe the investment qualities of the specific object;

- 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 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
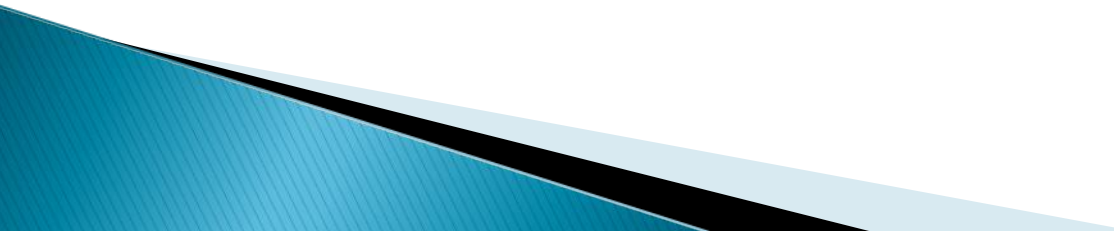
The elements of 1st level

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 elements of 2ndlevel

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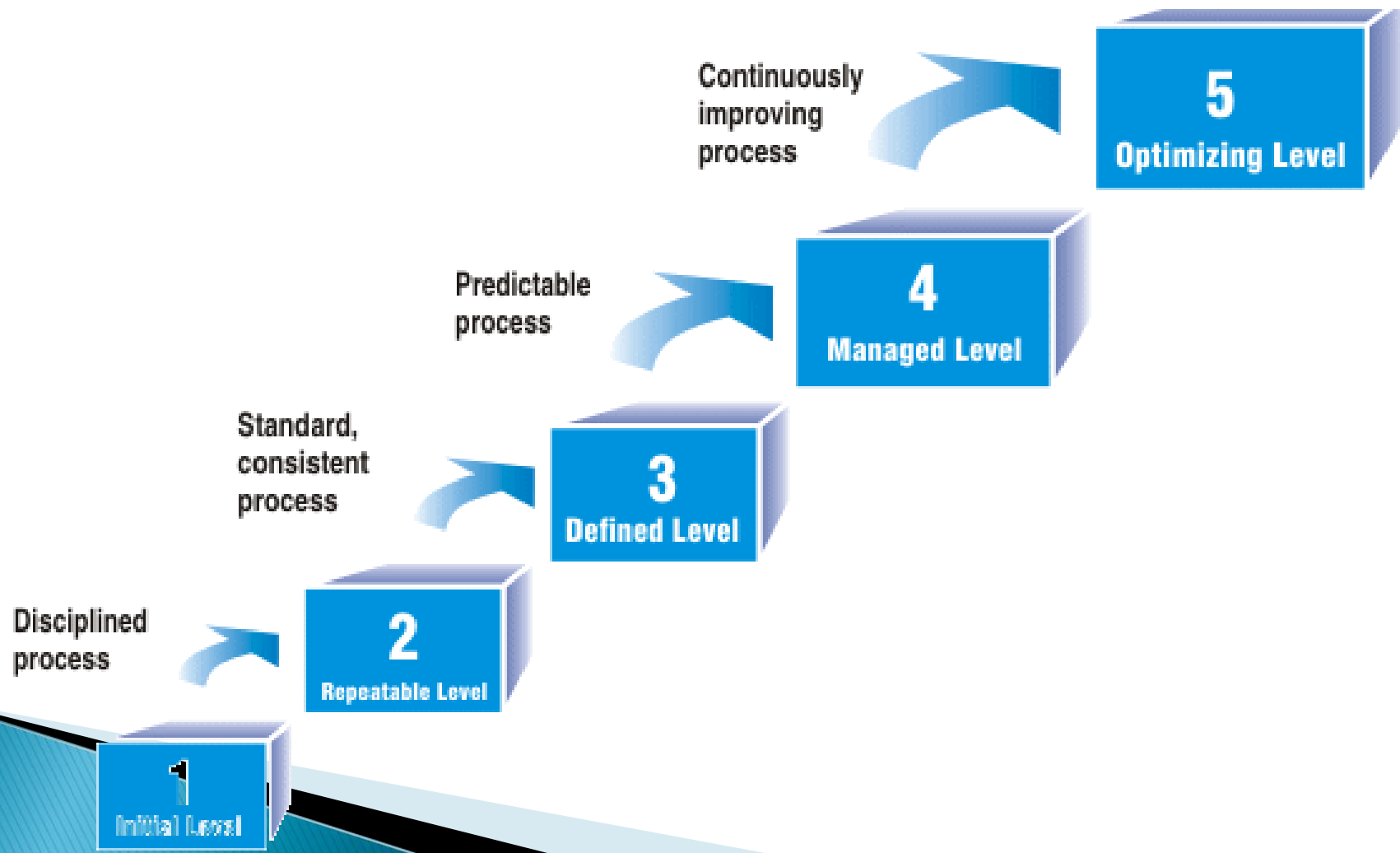
Company maturity stages

Stage	Definition
Initial	processes are ad-hoc, chaotic, or actually few processes are defined
Repeatable	basic processes are established and there is a level of discipline to stick to these processes
Defined	all processes are defined, documented, standardized and integrated into each other
Managed	processes are measured by collecting detailed data on the processes and their quality
Optimizing	continuous process improvement is adopted and self-adaptation of the system

The elements of 4th level

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.
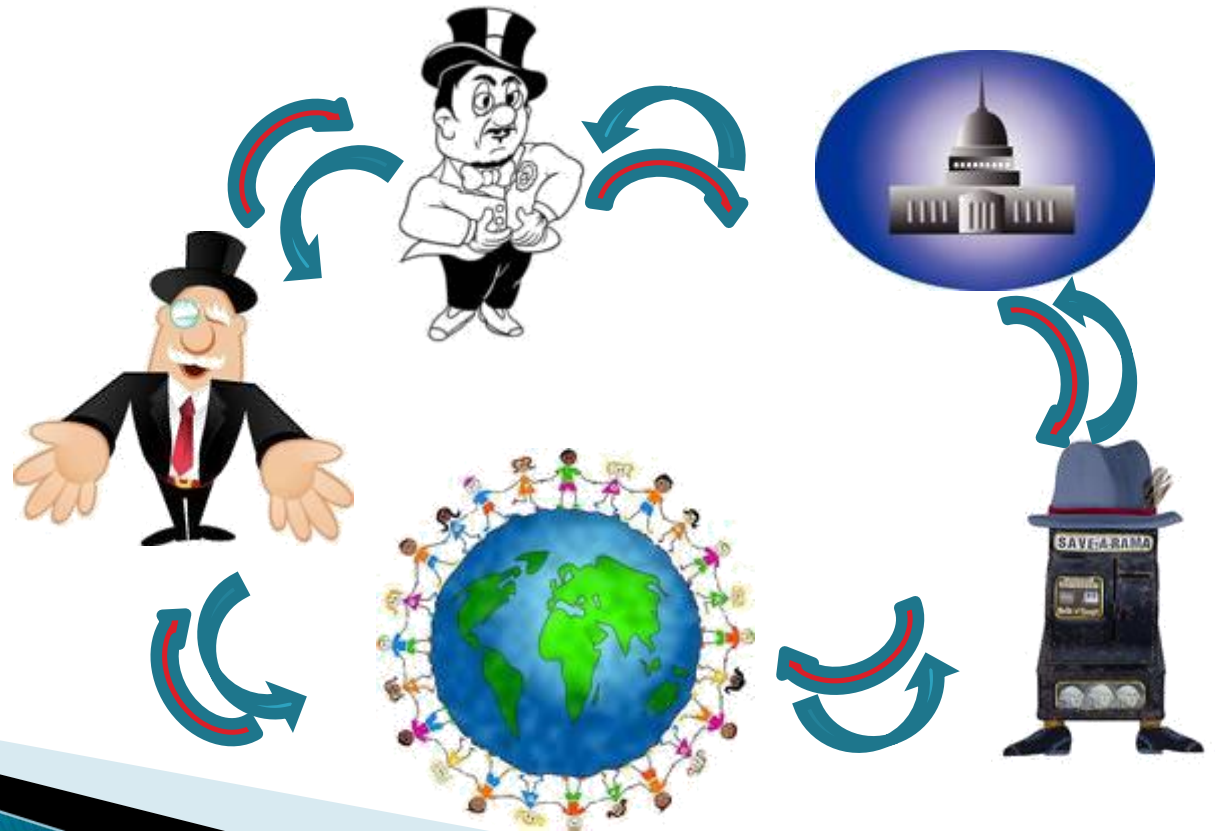
The elements of 5th level

The following table defines the scale for return on assets (ROA)

Definition	ROA, %
Poor	< 4
Average	5-25
Superior	> 25

The elements of 6th level

The return on investment (ROI)

The payback period (PP)

The dividend yield (DY)

Financial factors

The numbers of implemented technologies (NIT)

The frequency of staff development courses (FS)

The quality of products or services (CS)

Innovation factors

The number of highly qualified staff (NHS)

The number of employees (NE)

The labor productivity (LP

HR factors

The proximity to the necessary objects (P)

the environmental conditions at the site (EC)
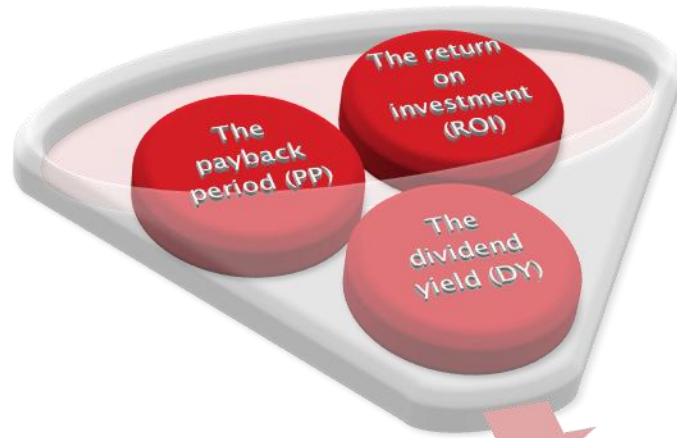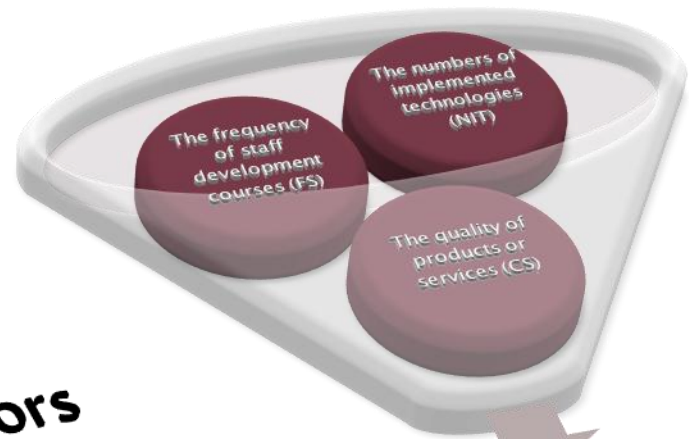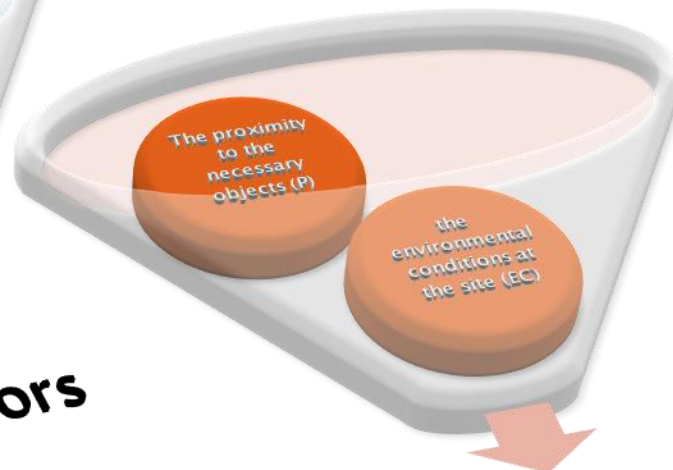
Location factors

The model of increasing the investment attractiveness of mobile-telecommunication companies

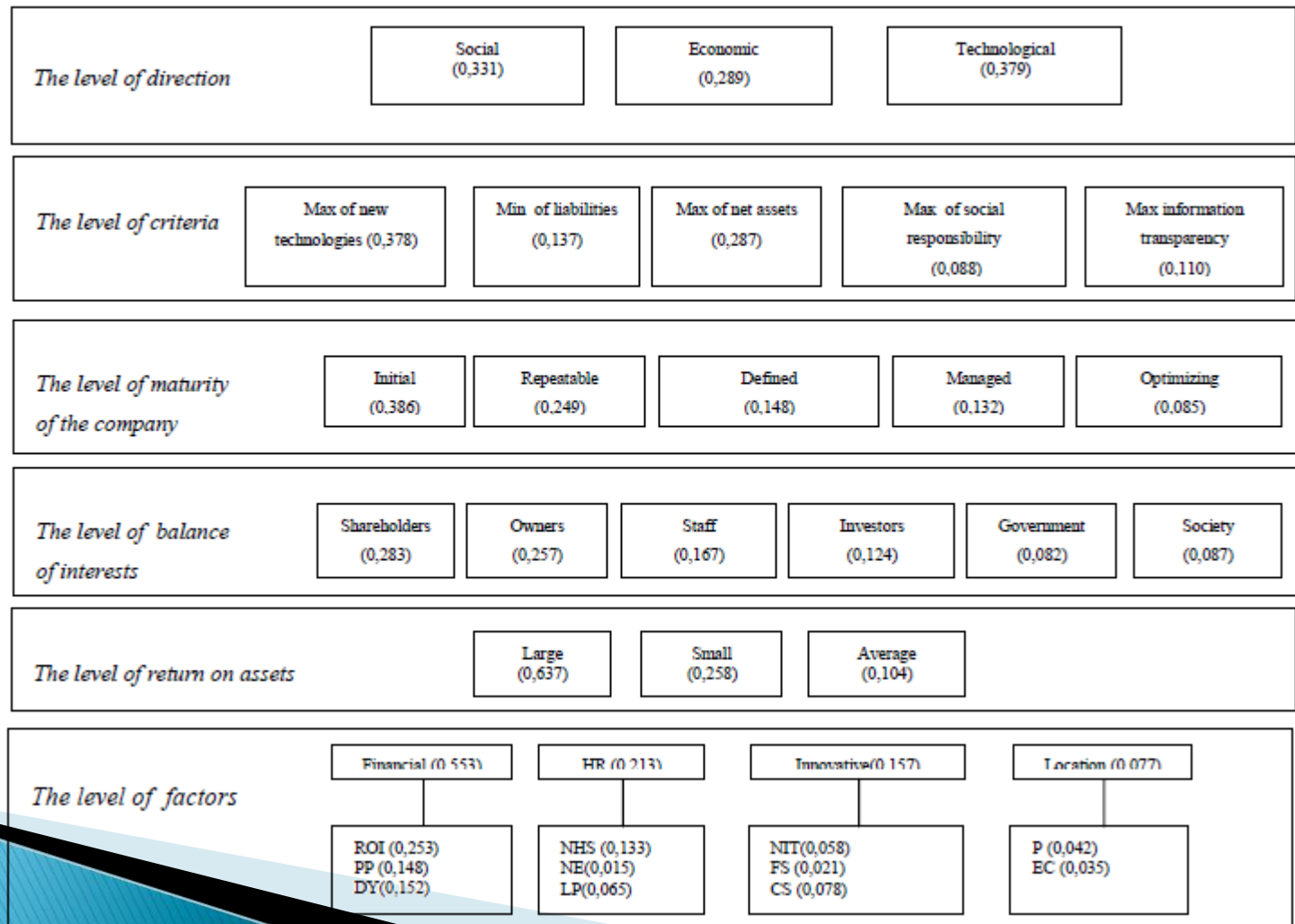| The hierarchy focus: priorities-based distribution of telecommunications companies' investment attractiveness					

The level of direction		Social (0,331)	Economic (0,289)	Technological (0,379)	

The level of criteria	Max of new technologies (0,378)	Min of liabilities (0,137)	Max of net assets (0,287)	Max of social responsibility (0,088)	Max information transparency (0,110)

The level of maturity of the company	Initial (0.386)	Repeatable (0.249)	Defined (0.148)	Managed (0.132)	Optimizing (0.085)

The level of balance of interests	Shareholders (0,283)	Owners (0,257)	Staff (0,167)	Investors (0,124)	Government (0,082)	Society (0,087)

The level of return on assets	Large (0,637)	Small (0,258)	Average (0,104)

The level of factors	Financial (0.553)	HR (0.213)	Innovative(0.157)	Location (0.077)
	ROI (0,253) PP (0,148) DY(0,152)	NHS (0,133) NE(0,015) LP(0,065)	NIT(0,058) FS (0,021) CS (0,078)	P (0,042) EC (0,035)

The investment attractiveness Hierarchy

Level 1: Goal

Definition the investment attractiveness of enterprises

Level 2 criteria

Financial factors	Human Resource factor	Innovation factors	Teritorial factors

Level 3 criteria

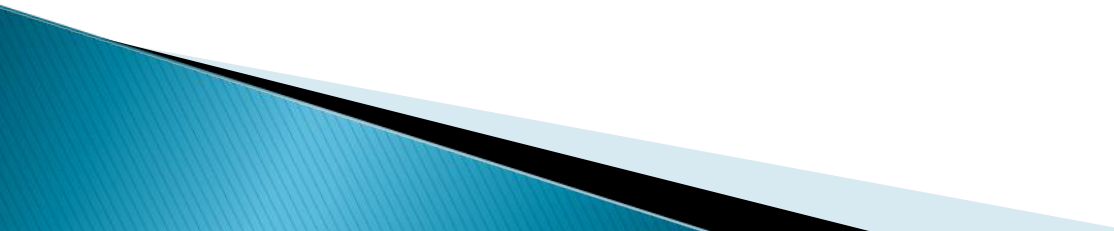|			
• index return on investment (ROI), • payback period (PP), • dividend yield (DP).	• The number of highly qualified staff (FAC), • Staffing (S), • Labor productivity (LP).	• The number of implemented technologies (NIT), • Frequency of implementation staff development courses (FDC), • The quality of products or services (QS).	• 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
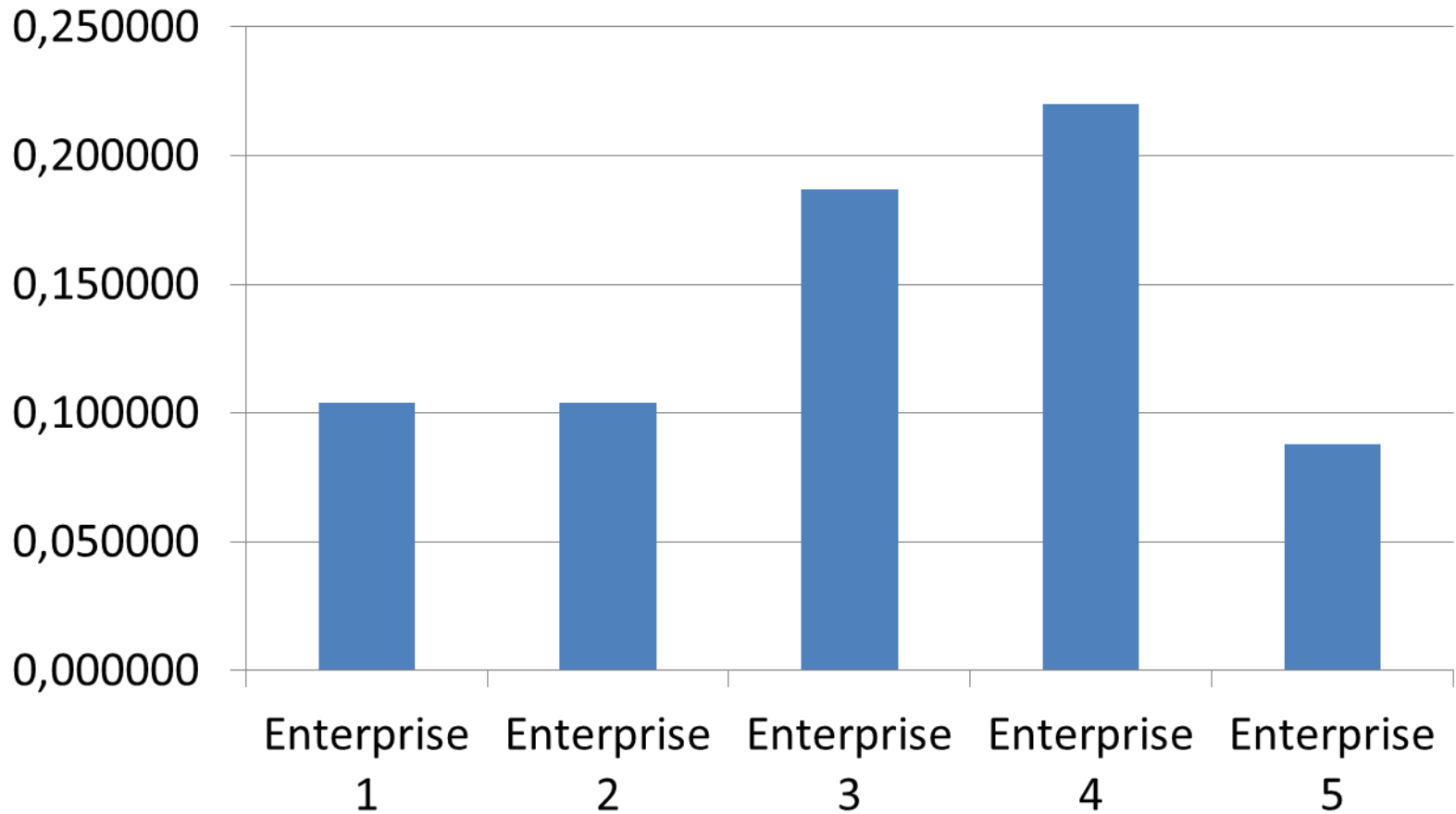
Conclusions

- 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.

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Thank you!
Q&A