# *Decision Making Methods*

- The ELECTRE methods
- The PROMETHEE methods
- **Group decision making**
- **Sensitivity analysis** (...)

***Introduction to Decision Making Methods*, János Fülöp**
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http://academic.evergreen.edu/projects/bdei/documents/decisionmakingmethods.pdf

# 1. Group decision making

***Group decision*** is usually understood as aggregating ***different individual preferences*** on *a given set of alternatives* to ***a single collective preference***.

It is assumed that the individuals participating **in making a group decision** face ***the same common problem*** and **are** ***all interested in finding a solution***.

***A group decision situation*** involves **multiple** ***actors*** (***decision makers***), each with **different skills**, **experience** and **knowledge** relating to different aspects (**criteria**) of the problem.

In **a correct method** for synthesizing group decisions, the ***competence*** of the different actors to the different professional fields has also to be taken into account.

## … 1. Group decision making

We assume that:

- **each *actor*** considers **the same** sets of ***alternatives*** and ***criteria***,
- there is **a special *actor* with authority** for establishing ***consensus rules*** and determining ***voting powers*** to the group members on the different criteria – ***SDM*** = ***Supra Decision Maker*** (Keeney and Raiffa, 1976).

The **final decision** is derived by aggregating (***synthesizing***) the *opinions* of the group members *according* to the ***rules*** and ***priorities*** defined by the ***SDM***.

There are several approaches to **extend** the *basic multiattribute decision making techniques* for the case of ***group decision***. Some earlier MAUT methods of group decision are reviewed by Bose et al. (1997).

We present the method applied in the *WINGDSS* software (Csáki, 1995).

Consider a decision problem with $l$ group members (*decision makers*) $\mathbf{D}_1,\ldots,\mathbf{D}_l$, $n$ alternatives $\mathbf{A}_1,\ldots,\mathbf{A}_n$ and $m$ criteria $\mathbf{C}_1,\ldots,\mathbf{C}_m$. In case of a factual criterion the evaluation scores must be identical for any alternative and any decision maker, while subjective (judgmental) criteria can be evaluated differently by each decision maker. Denote ***the result of the evaluation*** of decision maker $\mathbf{D}_k$ for alternative $\mathbf{A}_j$ on the criterion $\mathbf{C}_i$ by $a^k_{ij}$.

Assume that the **possible problem** arising from the **different dimensions of the criteria** has already been settled, and the $a^k_{ij}$ values are the result of proper transformations.

The individual **preferences on the criteria** are expressed as ***weights***: let the ***weights of importance*** $w^k_i \geq 0$ be assigned at criterion $\mathbf{C}_i$ by decision maker $\mathbf{D}_k$, $i=1,\ldots,m$; $k=1,\ldots,l$.

The *different* ***knowledge*** *and* ***priority*** of the group members are expressed by ***voting powers*** both for *weighing* the *criteria* and *qualifying* (*scoring*) the *alternatives against the criteria*. For factual criteria only the preference weights given by the decision makers will be revised at each criterion by the voting powers for weighing. In case of subjective criteria, not only the weights but also the $a^k_{ij}$ values will be modified by the voting powers for qualifying.

Let

- $\mathbf{V}(w)^k_i$ denote the ***voting power*** assigned to $\mathbf{D}_k$ for *weighing* on criterion $\mathbf{C}_i$ ,
- $\mathbf{V}(q)^k_i$ the ***voting power*** assigned to $\mathbf{D}_k$ for *qualifying* (*scoring*) on criterion $\mathbf{C}_i$ ,

$i=1,...,m$; $k=1,...,l$.

The ***method of calculating the group utility*** (***group ranking value***) of alternative $\mathbf{A}_j$ is as follows:

For each criterion $\mathbf{C}_i$, the *individual weights* of importance of the criteria will be aggregated into the ***group weights*** $\mathbf{W}_i$ :

$$W_i = \frac{\sum_{k=1}^{l} V(w)_i^k w_i^k}{\sum_{k=1}^{l} V(w)_i^k}, \quad i = 1,\ldots,m .$$

The ***group qualification*** $\mathbf{Q}_{ij}$ of alternative $\mathbf{A}_j$ against criterion $\mathbf{C}_i$ is:

$$Q_{ij} = \frac{\sum_{k=1}^{l} V(q)_i^k a_{ij}^k}{\sum_{k=1}^{l} V(q)_i^k}, \quad i = 1,\ldots,m,\ j = 1,\ldots,n.$$

The ***group utility*** $\mathbf{U}_j$ of $\mathbf{A}_j$ is determined as the weighted algebraic mean of the aggregated qualification values with the aggregated weights:

$$U_j = \frac{\sum_{i=1}^{m} W_i Q_{ij}}{\sum_{i=1}^{m} W_i}, \quad j = 1,\ldots,n.$$

In addition to the weighted algebraic means used in the above aggregations, ***WINGDSS*** also offers the weighted geometric mean, but generalized means can also be applied. Csáki, 1995 also describes the ***formulas for computing in the case when the criteria are given in a tree-structure***.

**The best alternative** of group decision is the one associated with **the *highest group utility***. A correct *group utility function* for cardinal ranking must satisfy the axioms given in Keeney, 1976. *The utility function* computed by the ***WINGDSS*** *methodology* is appropriate in this respect.

The approach of the ***Analytic Hierarchy Process*** can also be extended to group decision support (Dyer and Forman, 1992; Lai, 2002) for a recent application and further references. Since the ***AHP*** is based on pairwise comparison matrices, the key question is how to synthesize the individual pairwise comparison matrices of the group members. Aczél and Saaty, 1983 showed that under reasonable assumptions (reciprocity and homogeneity) the only synthesizing function is the geometric mean. Another approach was proposed by Gass and Rapcsák, 1998 for synthesizing group decisions in ***AHP***. It consists of the aggregation of the individual weight vectors determined by singular value decomposition, taking the voting powers of the group members also into account.

The extensions of the outranking methods for group decision support have also been developed. Macharis, 1998 presents a ***PROMETHEE procedure for group decision support***.

Another method, based on ***ELECTRE methodology***, was proposed by Leyva-López and Fernández- González, 2003 ***for group decision support***.

## 2. Group Decision Support Systems (GDSS)

**Group Decision Support Systems** (**GDSS**) - An interactive, computer-based system that facilitates solution of unstructured problems by a set of decision-makers working together as a group. It aids groups, especially groups of managers, in analyzing problem situations and in performing group decision making tasks.

**Group Support Systems** has come to mean computer software and hardware used to support group functions and processes.

**Computer Supported Cooperative Work** (**CSCW**) is the scientific discipline that motivates and validates groupware design. CSCW is technology independent which means technology is not the major driving force behind the discipline. Instead, CSCW is socially dependent. It looks at the way people interact and collaborate with each other, and attempts to develop guidelines for developing technology to assist in the communication process.

**Groupware** is the hardware and software which supports and augments group work. Groupware applications are not meant to replace people in an interactive situation.

**Similarities** between **GDSS** and **DSS**:
both

- use models, data and user-friendly software
- are interactive with "what-if" capabilities
- use internal and external data
- allow the decision maker to take an active role
- have flexible systems
- have graphical output

**Why use GDSS**?

- High level managers can spend 80% of their time making decisions in groups. Applied correctly, GDSS can reduce this time, arriving at a better decision faster.
- GDSS provides the hardware, software, databases and procedures for effective decision making.

## Characteristics of GDSS:

- Special Design
- Ease of use
- Specific and general support
- Suppressing negative group behavior
- Supporting positive group behavior

## Typical GDSS Meeting Characteristics:

- Organizational commitment/support
- Trained facilitators or may be user driven
- User training
- Anonymity
- Appropriate tasks
- Dedicated decision rooms

## GDSS Time/Place Environment:

- Same-Time & Same-Place - Most widely used GDSS- computers with projectors, voting tools
- Same-Time & Different-Place - team room, tools, audio conferencing, screen sharing, chat
- Different-Time & Same-Place - audio/video conferencing, document sharing
- Different-Time & Different-Place - voice mail, email, bulletin boards

| | |
|---|---|
| Local area decision network | Wide area decision network |
| Decision room | Teleconferencing |

## Advantages of GDSS:

- **Anonymity** – drive out fear leading to better decisions from a diverse hierarchy of decision makers
- **Parallel Communication** – eliminate monopolizing providing increased participation, better decisions
- **Automated record keeping** – no need to take notes, they're automatically recorded
- **Ability for virtual meetings** – only need hardware, software and people connected
- **Portability** - Can be set up to be portable… laptop
- **Global Potential** - People can be connected across the world
- **No need for a computer guru** – although some basic experience is a must

## Disadvantages of GDSS:

- **Cost** –infrastructure costs to provide the hardware and software/room/network connectivity can be very expensive
- **Security** – especially true when companies rent the facilities for GDSS; also, the facilitator may be a lower-level employee who may leak information to peers
- **Technical Failure** – power loss, loss of connectivity, relies heavily on bandwidth and LAN/WAN infrastructure – properly setup system should minimize this risk
- **Keyboarding Skills** – reduced participation may result due to frustration
- **Training** – learning curve is present for users, varies by situation
- **Perception of messages** – lack of verbal communication could lead to misinterpretation

**Typical GDSS Process**:

- Group Leader (and Facilitator?) select software, develop agenda
- Participants meet (in decision room/Internet) and are given a task.
- Participants generate ideas – brainstorm anonymously
- Facilitator organize ideas into categories (different for user-driven software)
- Discussion and prioritization – may involve ranking by some criteria and/or rating to the facilitators scale
- Repeat Steps 3, 4, 5 as necessary
- Reach decision
- Recommend providing feedback on decision and results to all involved

**Choosing The Right GDSS**:

- Decision Task Type
- Group Size
- Location of members of the group

**Future Implications of GDSS**:

- Integrating into existing corporate framework
- GDSS brings changes which must be managed
- GDSS will incorporate Artificial Intelligence and Expert Systems – the software will "learn" and help the users make better decisions
- Decreasing cost will allow more organizations to use GDSS
- Increasing implementation of GDSS with the customer
- Customer voice their needs in non-threatening environment
- GDSS may play a large role in the future of the virtual companies
- GDSS can help the virtual companies do business in the global business environment
- GDSS can help promote a culturally diverse work environment
- Telework seems to make a lot of sense using GDSS

## Software:

- TeamWave Software - Workplace Screen Shots – Cool Demo
- Group Systems offers a collection of software tools to support group activities such as brainstorming, information gathering, idea organization, voting, preference aggregation, and consensus building. In addition to these tools, there are supplementary resources which aid the project teams in the course of the GDSS session. Two of these resources are 1) Opinion Meter, which helps you gauge group opinion on an informal basis; and 2) Handouts, which allow the group leader to post files on other relevant information to support the team.
- GroupKit - University Of Calgary - GroupKit has been used for prototyping groupware, investigating multi-user architectures and interfaces, and as a CSCW teaching tool.
- http://www.banxia.com/demain.html - Decision Explorer
- Delphi / Promethee
- http://www.teamwave.com/
- QuestMap v3.12
- Accrue(decision support analysis software)
- http://www.aliah.com/site/index.html
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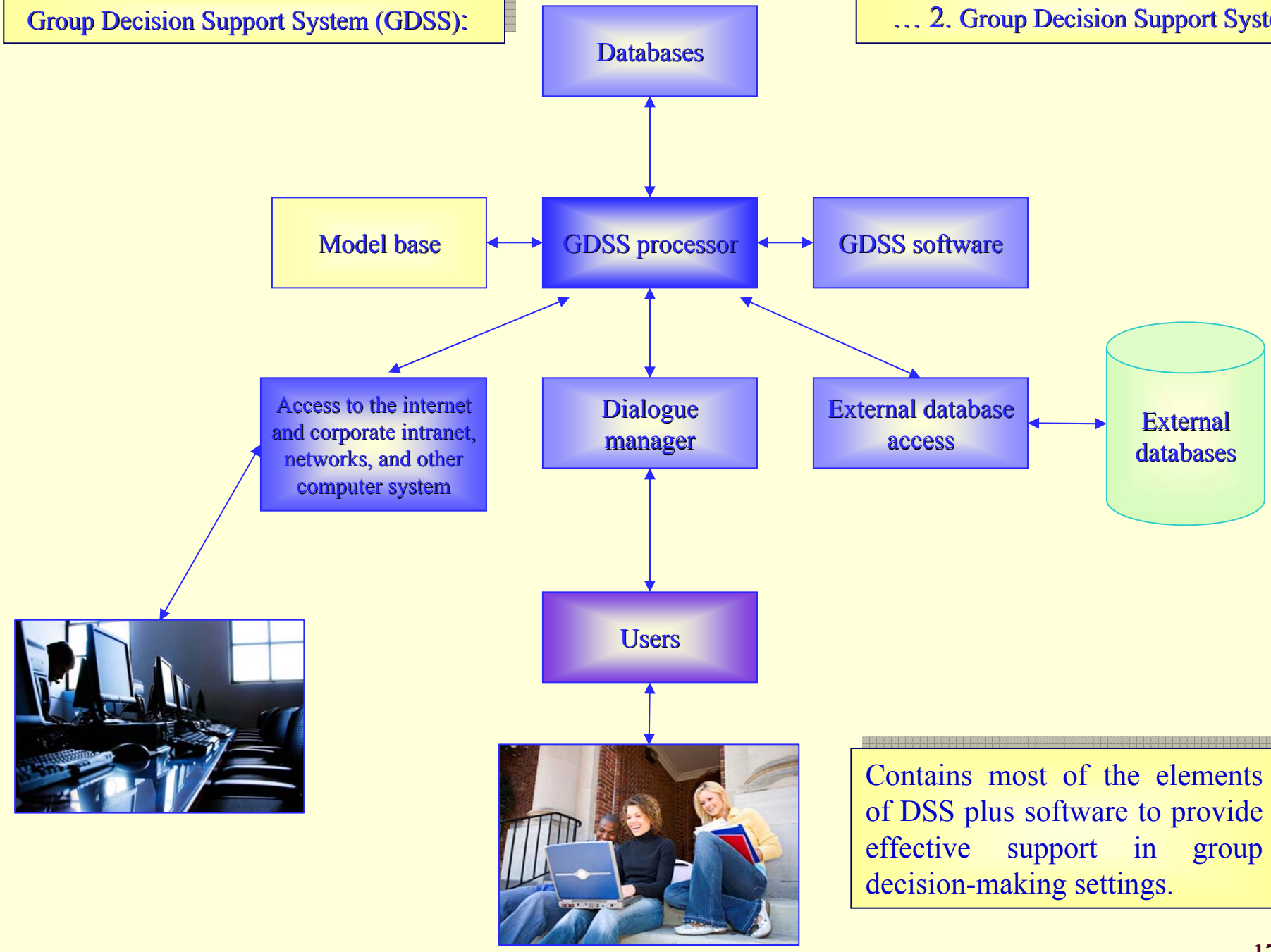
## Group Decision Support System (GDSS):




Contains most of the elements of DSS plus software to provide effective support in group decision-making settings.

## Characteristics of a GDSS :

- Special design
- Ease of use
- Flexibility
- Decision-making support
  - Delphi approach (decision makers are geographically dispersed)
  - Brainstorming
  - Group consensus
  - Nominal group technique
- Anonymous input
- Reduction of negative group behaviour
- Parallel communication
- Automated record keeping
- Cost, control, complexity factors

## Components of a GDSS and GDSS Software:

- Database
- Model base
- Dialogue manager
- Communication capability
- Special software (also called GroupWare)
- E.g., Lotus Notes

  - people located around the world work on the same project, documents, and files, efficiently and at the same time

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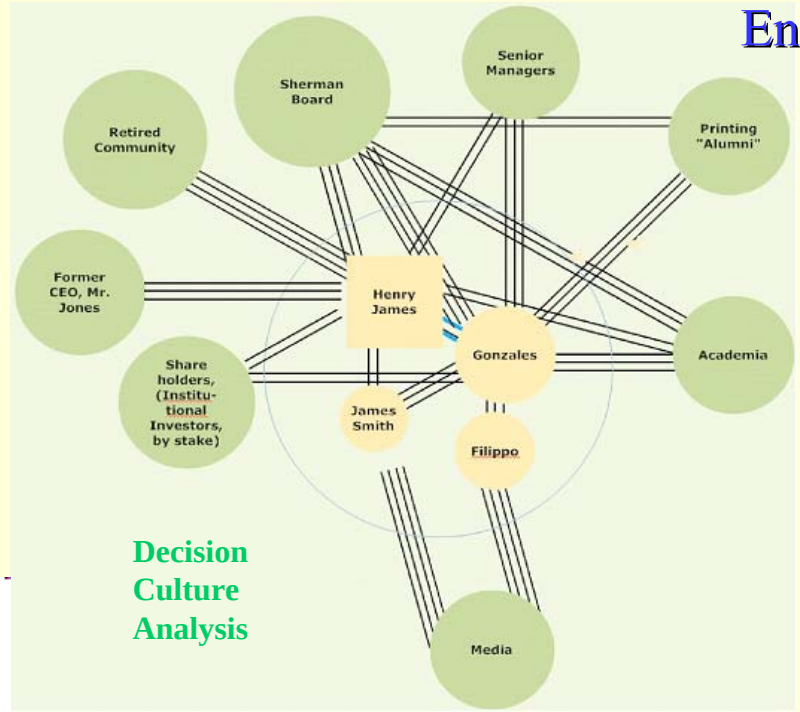


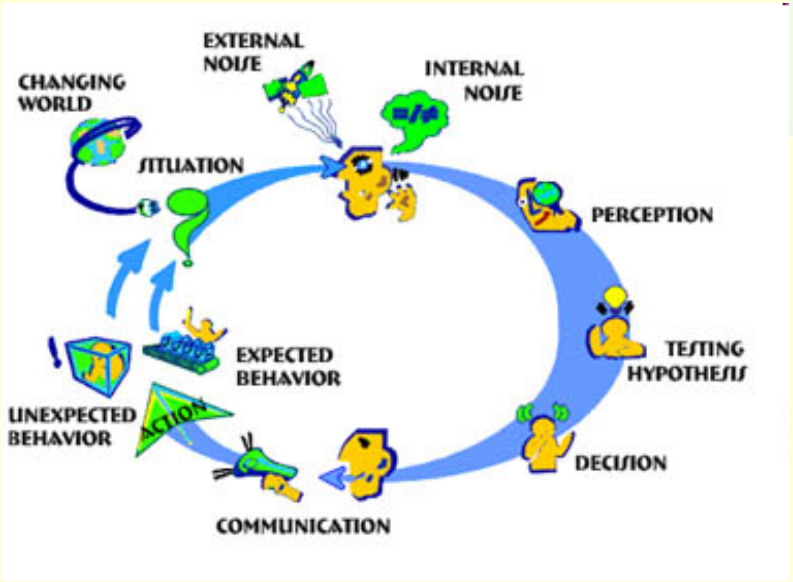


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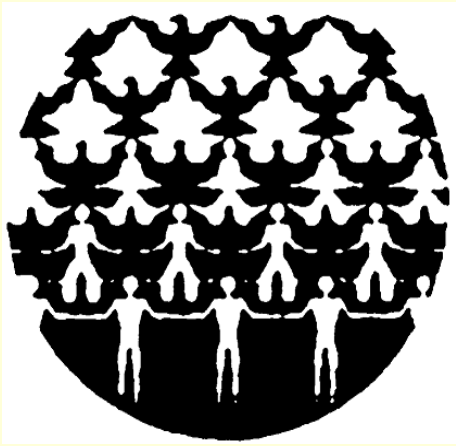

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