Institut für Logistik- &
Dienstleistungsmanagement
der FOM University of Applied Sciences

# Data Envelopment Analysis for Humanitarian Logistics

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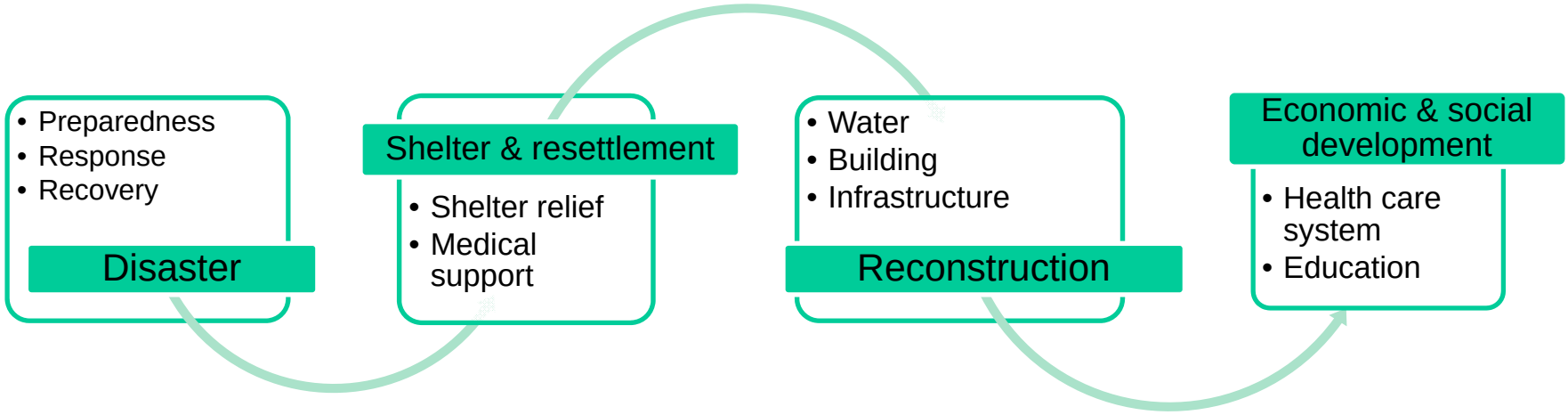
# Agenda

1. **Introduction**
2. **Literature Review**
3. **Humanitarian Relief Chain**
4. **DEA Method**
5. **DEA Analysis**
6. **Outlook**

# 1. Introduction

Humanitarian Logistics is defined as the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from the point of origin to the point of consumption for **the purpose of alleviating the suffering of vulnerable people**.

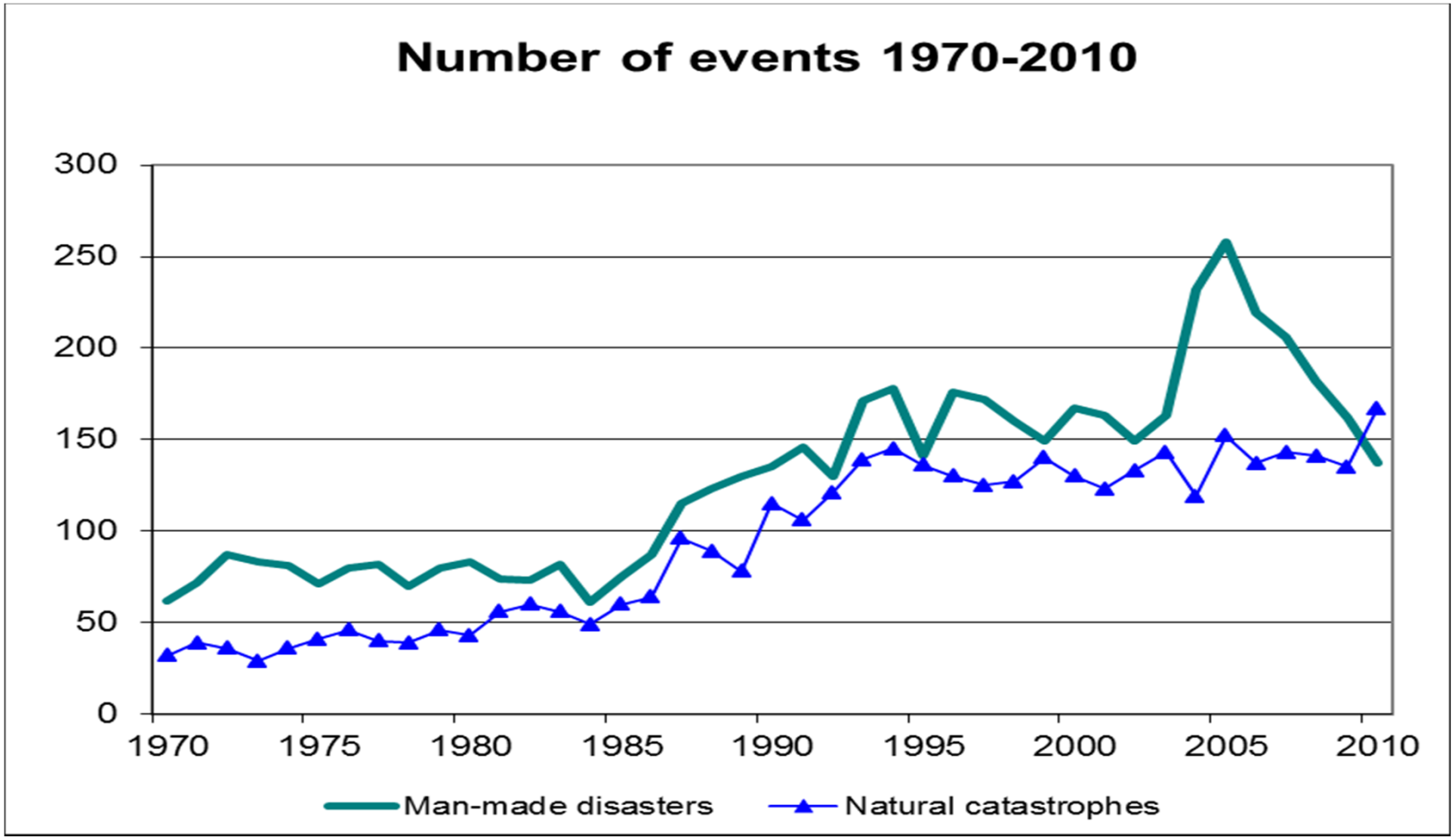
Broder definition for this paper:



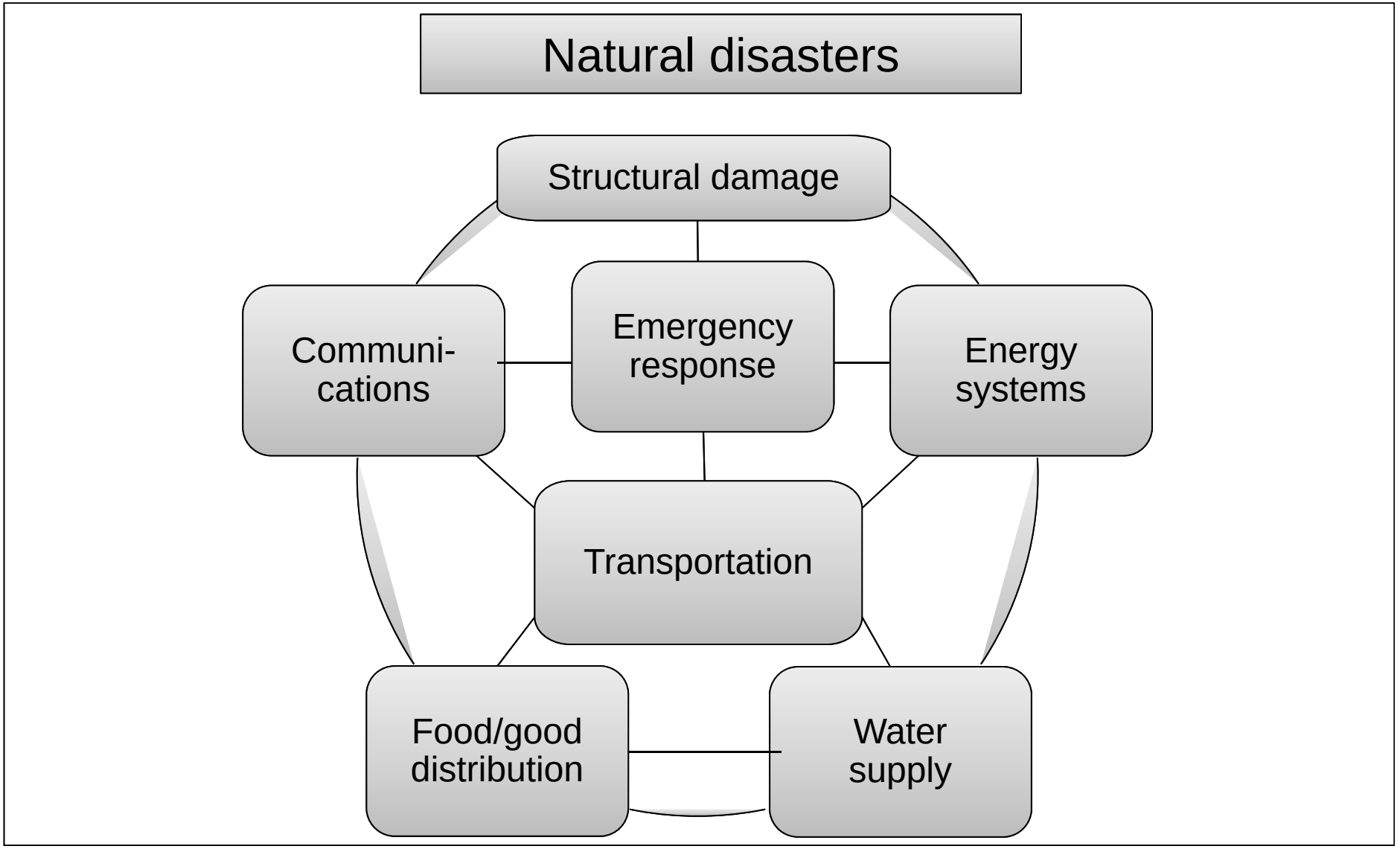
# 1. Introduction

| Natural Disasters | Technological | Human |
|---|---|---|
| Biological | Aircraft crash | Sabotage |
| Drought, sand storm | Structural and financial collapse | War |
| Earthquakes, flood | Explosion | Terrorism |
| Heat and cold wave | Dam failure | Mass hysteria |
| Tsunami, hurricane | Air pollution | Violence |
| Landslide | Fuel shortage | Strike |
| Volcanic eruption | Hazardous good | |
| Tornado | Nuclear and transportation accident | |
| Fire | | |

# 1. Introduction



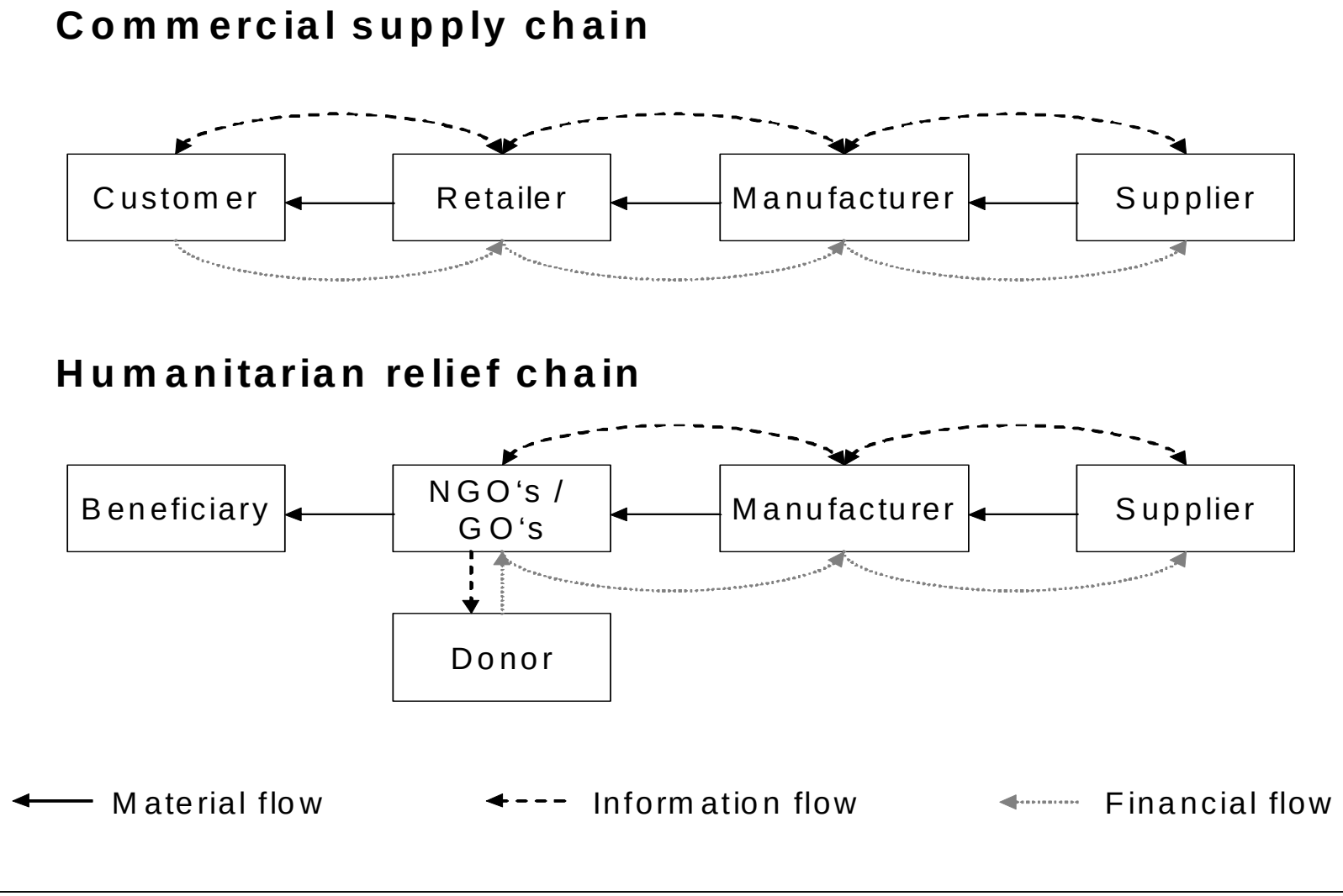
# 1. Introduction



# 2. Literature Review

| Key Term | Quantity | Example(s) |
|---|---|---|
| Coordination | 3 | Tatham and Kovacz (2010), Balcik et al. (2010) |
| Challenges in humanitarian logistics | 4 | Kovacs and Spens (2009), Chandes and Pache (2010) |
| Customer service | 1 | Olortunba and Gray (2009) |
| Distribution | 1 | Balcik (2008) |
| Facility location | 1 | Balcik and Beamon (2008) |
| Humanitarian logistics relief model | 9 | Petit and Beresford (2005), Tovia (2007), Maon et al. (2009) |
| Inventory management | 5 | Beamon and Kotleba (2006), Taskin and Lodree (2009) |
| Performance management | 5 | Schulz and Heigh (2009), Beamon and Balcik (2008) |
| Promoting humanitarian logistics | 2 | Kumar et al. (2008), Whiting and Ostrom (2009) |
| Purchasing | 2 | Trestrail et al. (2009) |

# 3. Humanitarian Relief Chain



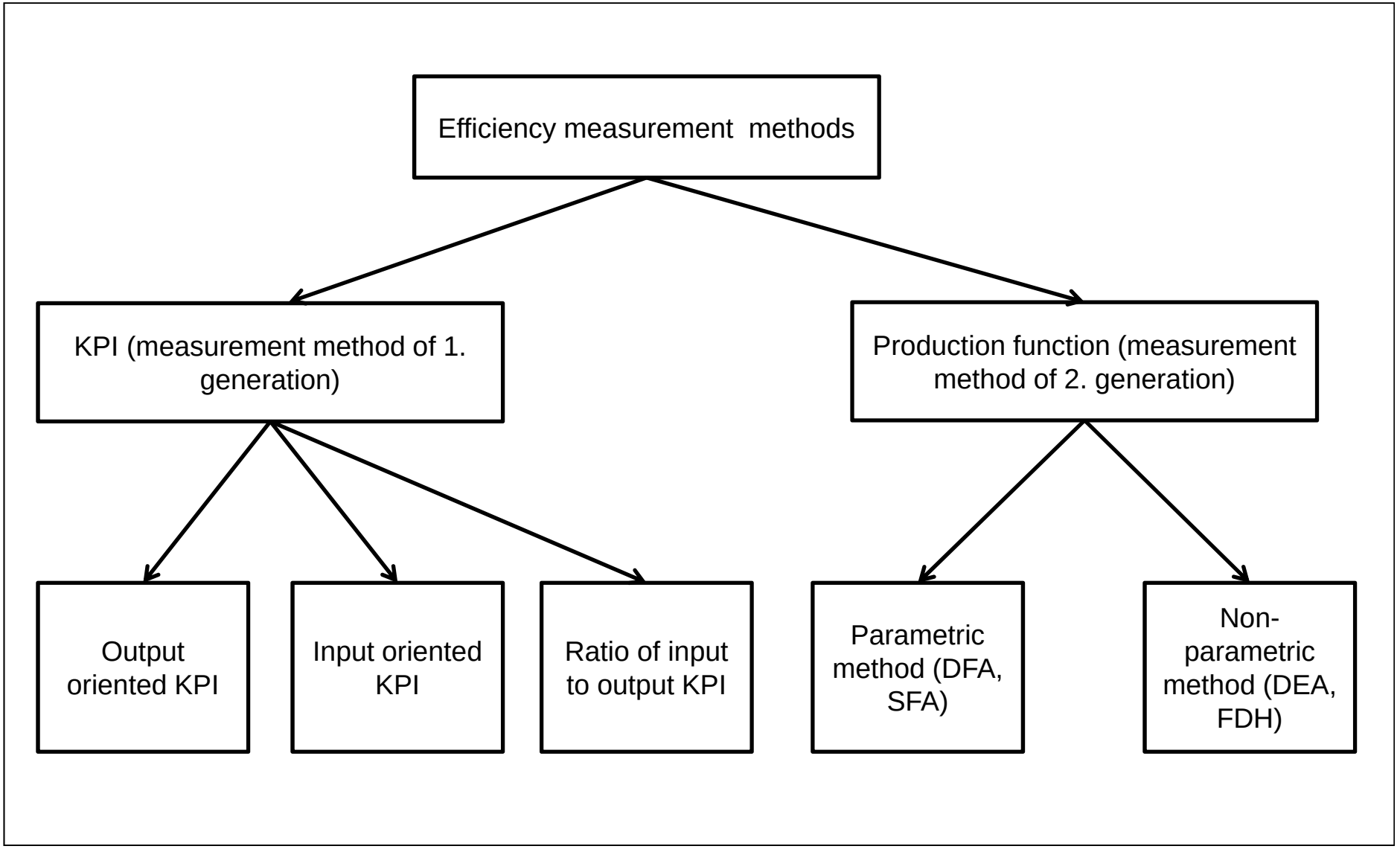
# 3. Humanitarian Relief Chain

| **SCM functions** | Cost and inefficiency drivers |
|---|---|
| **Planning** | - Demand arises sporadically and suddenly<br>- Accurate demand planning is not possible due to highly volatile demand patterns<br>- High storage costs as Just-in-Time concept is too time consuming and inflexible |
| **Organizing** | - Low level of standardisation due to changing environmental, social, political and technological conditions |
| **Staffing** | - high staff costs |
| **Leading** | - high coordination effort due to multiple non-governmental and governmental actors<br>- IT and communication systems not state-of-the-art → material flow is not properly documented and controlled |
| **Controlling** | - No controlling efforts due to lack of incentives<br>- Lessons learnt difficult to transfer to other regions with other conditions and circumstances |

# 4. DEA Method

- Measurement of relative efficiencies of organizations (decision-making units, or DMUs) with Data Envelopment Analysis (DEA) with multiple inputs and multiple outputs
- 1978 non-parametric method DEA by Charnes, Cooper and Rhodes
  → multicriteria approach
- Application of DEA in Benchmarking and Operations Research
  → Controlling instrument
- CCR Model based on constant returns to scale

# 4. DEA Method


Efficiency measurement methods
KPI (measurement method of 1. generation)
Production function (measurement method of 2. generation)
Output oriented KPI
Input oriented KPI
Ratio of input to output KPI
Parametric method (DFA, SFA)
Non-parametric method (DEA, FDH)

# 4. DEA Method

## Advantages

- DEA method takes account of multiple inputs und outputs simultaneously
- Inputs and outputs with different measurement unit: Currency, per cent or other
- Non requirement on relating inputs to outputs
- Determination of ‚best performing' DMU und developement of an efficiency frontier – Comparison the best DMU with other remaining DMU

→ Judgement of non efficient DMU is possible (efficiency potential)

# 4. DEA Method

## Disadvantages

- Data selection plays a huge role for DEA application
- Respect of data amount
- High time effort and complex → normally a software is needed
- Measurement error causes significant problems
- Large problems can be computationally intensive
- DEA does not measure "absolute" efficiency

# 5. DEA Analysis

Establishment of coherent metrics and performance management framework in humaniatrian relief

**Input metric**

- Handling costs, inventory costs, warehouse costs, transport costs and process costs = Total logistics costs
- Economic (e.g. budget), humaniatrian, social, environmental and political aspects

**Output metric**

- Service level in logistics
  - Delivery reliability: delivery date, delivery quantity and delivery quality, throughput time

- The provided help (water, shelter, medicine, sanitary..) for a specified number of persons

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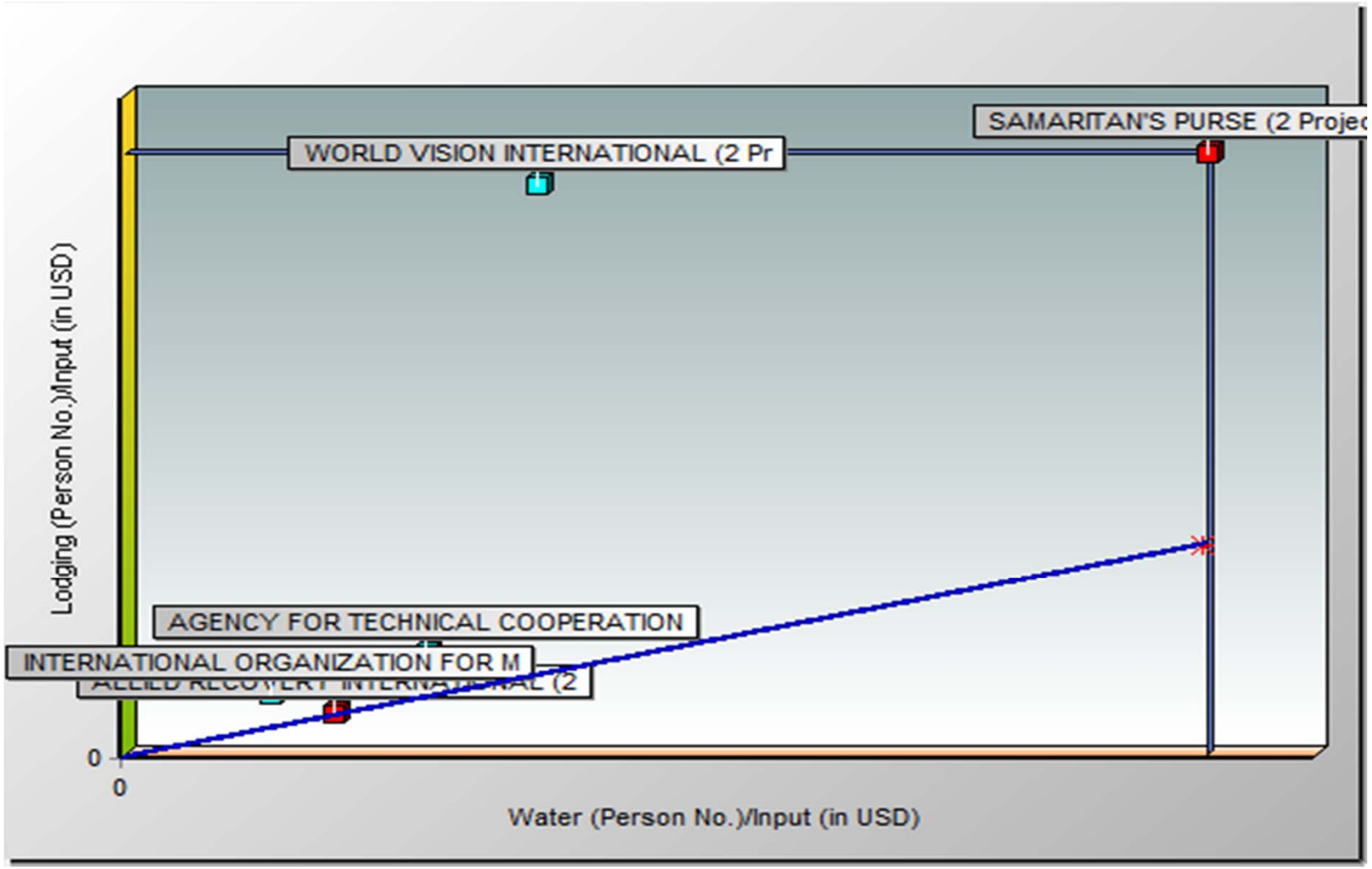
# 5. DEA Analysis

| Project (Name of Organization and No.) | Score | Project (Name of Organization and No.) | Score | Project (Name of Organization and No.) | Score |
|---|---|---|---|---|---|
| DEEP SPRINGS INTERNATIONAL (P4) | 100,00% | FEED THE CHILDREN (P12) | 8,10% | FHED-INC (P1) | 3,00% |
| HAITIAN RELIEF ORGANIZATION (P19 | 100,00% | TEARFUND (P6) | 7,40% | ALLIED RECOVERY INTERNATIONAL (P22) | 2,30% |
| SAMARITAN'S PURSE (P24) | 69,90% | DEUTSCHE WELTHUNGERHILFE E.V. (P28) | 6,50% | CONCERN WORLDWIDE (P5) | 2,30% |
| AMERICAN INSTITUTES FOR RESEARCH (P14) | 53,50% | INTERNATIONAL RELIEF&Dev. (P21) | 6,40% | INTERNATIONAL ORGANIZATION FOR MIGRATION (P25) | 2,30% |
| WORLD VISION INTERNATIONAL (P29) | 32,50% | UN TECHO PARA MI PAIS (P20) | 5,40% | ACTS OF MERCY INTERNATIONAL (P31 | 2,20% |
| WORLD VISION INTERNATIONAL (P9) | 27,90% | ALLIED RECOVERY INTERN. (P3) | 4,60% | URBANISATION ET AIDE TECHNIQUE EXPÉRIMENTALE RELIEF INTERNATIONAL (P11) | 2,10% |
| SAMARITAN'S PURSE (P16) | 11,40% | CARE USA (P8) | 4,50% | URBANISATION ET AIDE TECHNIQUE EXPÉRIMENTALE (P18) | 2,00% |
| ASSOCIAZIONE VOLONTARI (P26) | 8,70% | ARCHE NOVA E.V. (P2) | 4,40% | TEARFUND (P27) | 1,70% |
| WORLD VISION INTERNATIONAL (P29) | 8,60% | AGENCY FOR TECHNICAL COOP. (P32) | 3,80% | ACTION CONTRE LA FAIM (P17) | 1,50% |
| AGENCY FOR TECHNICAL COOP.(P15) | 8,40% | ARBEITER-SAMARITER-BUND (P23) | 3,60% | FEED THE CHILDREN (P13) | 0,60% |
| FOOD FOR THE HUNGRY (P30) | 8,30% | CARE USA (P7) | 3,60% | | |

# 5. DEA Analysis

| Project (Name of Organization and No.) | Score | Institution |
|---|---|---|
| AGENCY FOR TECHNICAL COOPERATION AND DEVELOPMENT (2 Projects: P15, P32) | 27,60% | Private |
| ALLIED RECOVERY INTERNATIONAL (2 Projects: P3, P25) | 19,30% | Private |
| INTERNATIONAL ORGANIZATION FOR MIGRATION (2 Projects: P10, P25) | 13,30% | Public |
| SAMARITAN'S PURSE (2 Projects: P16, P24) | 100,00% | Eclesial |
| WORLD VISION INTERNATIONAL (2 Projects: P9, P29) | 94,80% | Eclesial |

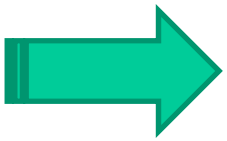
# 5. DEA Analysis



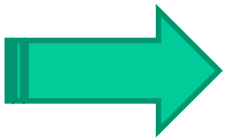
# 6. Outlook

Aim of performance measurement in humanitarian logistics:

- Optimization of logistics process and determination of efficiency
- Increase providness of benefeciaries with water, shelter and medicine supply
- Cooperative network of humanitarian organization and donor
- Mitigation of logistics costs
- Transparence along the humanitarian relief chain, high flexibility and reliability



*DEA Method is ideal efficiency measurement tool to measure logistics processes of several DMU with multiple input and output metrics*



*Benchmarking, Logistics Consulting, Operations Research*

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