Resilience Informatics for Innovation  
— Social psychology and group performance —

RERC/TMI  
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Social aspects of decision-making

- Social (Collective) decision-making
  - decision-making by a group as consensus
  - Actual style of most decision-makings
  - Important for organizational operations

- Social influence on individual actions
  - Significant for individual decisions
  - Significant for organizational operations
Group processes

- Individual Factors
  (member ability, personality, biographical features, etc.)
- Group Factors
  (group size, structure, group cohesiveness, etc.)
- Environmental Factors
  (task demands, role system, available information, etc.)

Group Process
- Social Influence
- Individual Performance
- Social Decision Scheme
- Group Performance

Social influence

- Taxonomy by Deutsch & Gerald (1955)
- Informational influence
  - An influence to accept information obtained from another as evidence about reality
- Normative influence
  - An influence to conform with the positive expectations of another
Social psychology and group performance

- **Group characteristics**
  - Conformity, authority gradient, social loafing, social facilitation, risky shift, group polarization, groupthink

- **Leadership theory**
  - Two functions, PM theory, contingency theory

- **Communication network**

- **Steiner's group productivity theory**

- **Group reliability**

Conformity pressure

- **Asch experiment (1951)**
  - One subject and seven confederates
  - Line segment selection (obvious correct answer)
  - Common wrong answer by confederates
  - 37% of subjects conformed to wrong answers

Even though the correct answer is apparent, the conformity pressure from a group to an individual is enormous.
Authority gradient

- Milgram experiment (1963)
  - The participants were asked to impose electric shock to the answers (confederates) if they made mistakes in answering questions.
  - The experiment was finished when the participants refused to raise the voltage.
  - No less than 65% of participants raised the voltage to the upper limit.

- Many people obey the authority, though they know they must refuse an order.

Social loafing

- Ringelmann effect
  - 2, 3, 8 people pulled a rope and they showed an effort of 93%, 85%, 49% of an individual.

- Latanet experiment (1979)
  - Participants were asked to make a loud voice in a sound proof chamber. As participants increased, the loudness of an individual decreased.

- Decrease of individual efforts under the participation of others
  - Diffusion responsibility
  - Murder of Kitty Genovese, Toyota Corp.
Social facilitation an depression

- **Social facilitation**
  - Racehorses run faster with others than individually
  - Increase of performance in the presence of others
- **Social suppression**
  - Decrease of performance in the presence of others

- **Zajonc experiment (1965)**
  - Recall of meaningless sequence of words under different training levels
  - Facilitation in highly trained cases
  - Suppression in poorly trained cases

Risky shift

- **Kogan & Wallach experiment (1964)**
  - Choice of an action for 12 imaginary situations from high-risk / high-return or low-risk / low-return options
  - Individual choice → group discussion → individual choice
  - Group discussion facilitates preference of high-risk / high-return option.
  - Why does risky shift occur?
    - Diffusion of responsibility
    - Leadership (Aggressive opinions are likely to dominate)
    - Group wisdom (Anxiety is suppressed with many eyes)
Group polarization

- Group discussion sometimes enhances a risk averse conclusion.
- Group discussion is likely to result in an extreme conclusion in general.
- Group polarization seems a specific case of the amplifying effect of collective decision-making explained later.

Group thinking

- A highly qualified and cohesive group sometimes makes a serious decision failure.
- Janis (1971)
  - Analyses of historical fiascos such as the Bay of Pigs invasion by Kennedy administration
- Symptoms
  - Overestimations of the group: power and morality
  - Closed-mindedness: rationalizing warnings and stereotyping opponents
  - Pressure toward uniformity: self-censorship, illusion of unanimity, direct pressure, mind-guards
How to prevent groupthink

- Silent leader at the beginning
- Assignment of "Devil's advocate"
- Atmosphere that is easy to challenge
- Consideration of effective alternatives
- Parallel discussion by independent subgroups
- Invitation of outside opinions

Leadership style

- What is leadership?
  - Functions and actions of facilitating a group of people to act towards achieving a common goal
- Taxonomy by Cartwright & Zander (1960)
  - Achievement of goals (Task-oriented, P-function)
  - Maintenance of group (Relations-oriented, M-function)
- PM theory (1966)
  - Motivated group: $PM > M > P > pm$
  - Unmotivated group: $P > PM > M > pm$
Fiedler’s contingency model

LPC score: high LPC score ⇒ relations-oriented
low LPC score ⇒ task-oriented

Steiner’s group productivity theory (1)

- Task demands
  - Requirements imposed on the individual or group by the task (Relevant resources, information, procedure, etc.)

- Resources
  - Knowledge, abilities, skills, or tools possessed by the individuals attempting to perform a task

- Group processes
  - Intrapersonal and interpersonal actions by which people transform resources into a product
Steiner's group productivity theory (2)

- Actual productivity = Potential productivity - Losses due to faulty processes

- Potential productivity = \( f'(\text{Task demands, resources}) \)

Steiner's typology of tasks

- Unitary task
  - Disjunctive task
  - Conjunctive task
  - Additive task
  - Discretionary task

- Divisible (Complementary) task
Task type and productivity (1)

- **Disjunctive task**
  - If at least one member can successfully complete the task, the group can also complete it.
  - \( P_g = 1 - (1 - P)^N \) (Eureka type)

- **Conjunctive task**
  - Only if every member can successfully complete the task, the group can also complete it.
  - \( P_g = P^N \)

Task type and productivity (2)

- **Additive task**
  - The group product is a summative combination of the outputs of all members.

- **Discretionary task**
  - The group can choose an arbitrary scheme of aggregating its product as a weighted combination of members’ outputs.
  - \( R_g = \sum w_i R_i \)
Task type and productivity (3)

Divisible task

- The group can decompose the task into subtasks, each of which can be performed by a different individual.
- Achievement of the task requires achievement of all subtasks (conjunctive).
  - Fixed decomposition, fixed allocation.
  - Fixed decomposition, free allocation.
  - Free decomposition, free allocation.

Leavitt experiment (1951)

Groups of five people solved simple puzzles by passing hand-written memos.
Communication network

- Centralized networks are advantageous for solving simple problems (Leavitt)
  - Time required for solution
  - Number of messages exchanged
  - Number of errors

- Decentralized networks are advantageous for solving complex problems (Shaw & Mulder)

Group reliability analysis

- For assessing general features of group performance, but not for evaluating human error probability of a particular scenario.
  - Probabilistic modeling of group processes
  - Group as an information processing network
Model of group process

\[ \phi_i^k = \sum_{j \neq i} w_{ij} S_j^k + w_i \sigma_i \]

\[ p_i^k = \frac{1}{1 + \exp[-(\phi_i^k + \beta_i)]} \]

\[ S_i^k = \begin{cases} 0 & \text{fail} \\ 1 & \text{success} \end{cases} \]

State transition matrix

- If state \( k \) and \( l \) are neighboring in terms of \( S_i \)

\[ G_{kl} = \frac{\lambda_i}{1 + \exp[S_i^k(\phi_i^k + \beta_i)]} \]

- Otherwise

\[ G_{kl} = 0 \quad (k \neq l) \]

\[ G_{kk} = \sum_{i=1}^{N} \lambda_i - \sum_{l=1}^{N} \sum_{l \neq k} G_{kl} \]
Group dynamics

- Kolmogorov’s forward equation

\[ \frac{d \pi_i(t)}{dt} = \sum_{k=1}^{M} \pi_k(t)G_{kl} - \lambda \pi_i(t) \]

- Probability of group success

\[ P_s(t) = \sum_{l=1}^{M} T_{sl}(t)\pi_i(t) \]

\( T_s \) : Social decision scheme

Symmetric group

- Consensus function

\[ C_k = \frac{1}{2} \left[ \sum_{k<j} w_j S_i^k S_j^k + \sum_i (w_i \sigma_i + \beta_i) S_i^k \right] \]

- Asymptotic probability of group success

\[ \lim_{t \to \infty} \pi_k(t) = \frac{1}{\Theta} \exp(C_k) \]

\[ \Theta = \sum_{k=1}^{M} \exp(C_k) \]
Effect of cohesiveness

Leadership style
Response to emergency

![Graph showing probability of success vs. times of decision for different values of w (1.0, 1.5, 2.0)]