COMPETING FOR SCARCE RESOURCES DURING HUMANITARIAN EMERGENCIES

Supporting Materials

Appendix A. System Dynamics Model Documentation

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Beneficiaries
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Beneficiaries = INTEG (Migration from Neighbor Area - Beneficiaries Served, Initial Beneficiaries)
~ People

Beneficiaries Previous Period = Beneficiaries + Beneficiaries Served This Period
~ People

Beneficiaries Served = Min(Max Beneficiaries Served, Desired Beneficiaries Served)
~ People/Month

Beneficiaries Served Previous Period = INTEG (This Period Outflow - Previous Period Outflow, 0)
~ People

Beneficiaries Served This Period = INTEG (Inflow of Beneficiaries this Period - This Period Outflow, 0)
~ People

Desired Beneficiaries Served = Relief Workers Allocated * Relief Worker Effectiveness
~ People/Month

Inflow of Beneficiaries this Period = Beneficiaries Served
~ People/Month

Initial Beneficiaries = 20000
~ People

Max Beneficiaries Served = Beneficiaries / Min Time to Serve
~ People/Month

Migration from Neighbor Area = Migration Inflow
~ People/Month

Migration Inflow = 500
~ People/Month

Min Time to Serve = 1
~ Month

Previous Period Outflow = Beneficiaries Served Previous Period / TIME STEP
~ People/Month
This Period Outflow = Beneficiaries Served This Period / TIME STEP
   ~ People/Month

************************************************************************************
Relief Workers
************************************************************************************

Confirmed Fired = DELAY FIXED (Firing Decision, Time to Fire, Firing Decision)
   ~ People/Month

Confirmed Hired = DELAY FIXED (Hiring Decision, Time to Hire, Hiring Decision)
   ~ People/Month

Effect of Beneficiary Density on Effectiveness([0,0)-(1,200],(0,0),(1,150))
   ~ 1/Month

Fired Leaving = Confirmed Fired
   ~ People/Month

Hired Arriving = Confirmed Hired
   ~ People/Month

Initial Relief Workers = 20
   ~ People

Nominal Funding per Beneficiary = 15
   ~ $/People

Relief Worker Effectiveness = Effect of Beneficiary Density on Effectiveness (Beneficiaries / Initial Beneficiaries)
   ~ 1/Month

Relief Workers = INTEG (Hired Arriving - Fired Leaving, Initial Relief Workers)
   ~ People

Relief Workers Allocated = Relief Workers * Worker Allocation Decision
   ~ People

Relief Workers Idle = Relief Workers - Relief Workers Allocated
   ~ People

Time to Fire = 2
   ~ Month

Time to Hire = 1
   ~ Month

************************************************************************************
Decisions
************************************************************************************

Firing Decision = GAME(0)
   ~ People/Month
Hiring Decision = GAME(0)
  ~ People/Month

Worker Allocation Decision = GAME(0)
  ~ Dmnl

********************************************************************
Financials
********************************************************************

Actual Funding per Beneficiary = Nominal Funding per Beneficiary - Funding Deduction from Suffering
  ~ $/People

Cash Position = INTEG (Change in Cash, Initial Cash Position)
  ~ $

Change in Cash = Net Income
  ~ $/Month

Cost of Being Idle = Relief Workers Idle * Unit Cost of Being Idle
  ~ $/Month

Cost of Firing = Firing Decision * Unit Cost of Firing
  ~ $/Month

Cost of Hiring = Hiring Decision * Unit Cost of Hiring
  ~ $/Month

Cost of Operation = Relief Workers Allocated * Unit Cost of Operation
  ~ $/Month

Funding Deduction from Suffering = Relative Suffering * Unit Deduction due to Suffering
  ~ $/People

Funding Received = Desired Beneficiaries Served * Actual Funding per Beneficiary
  ~ $/Month

Initial Cash Position = 4000
  ~ $

Net Income = Funding Received - Total Operating Costs
  ~ $/Month

Total Operating Costs = Cost of Operation + Cost of Hiring + Cost of Firing + Cost of Being Idle
  ~ $/Month

Unit Cost of Being Idle = 250
  ~ $(Month*People)

Unit Cost of Firing = 500
  ~ $/People

Unit Cost of Hiring = 1000
Unit Cost of Operation = 750 $/(Month*People)

Unit Deduction due to Suffering= 1 $/People/Suffering

Deprivation Level= Effect of Time on Deprivation Level (Time) Suffering

Effect of Time on Deprivation Level:

\[(0,0)-(10,10)\],(0,2),(1,2.6),(2,4),(4,7),(6,9),(7.52294,9.82456),(10,10)

Fraction Allocation to Meet Need= Relief Workers Allocated / Relief Workers

Fraction Beneficiaries in Need= Beneficiaries / Beneficiaries Previous Period

Relative Suffering= Suffering * Weighted Need

Suffering = Deprivation Level * Fraction Beneficiaries in Need

Weighted Need= MAX(0,(Fraction Beneficiaries in Need - Fraction Allocation to Meet Need)/Fraction Beneficiaries in Need)

Simulation Control Parameters

FINAL TIME = 10 Month

INITIAL TIME = 0 Month

SAVEPER = TIME STEP

TIME STEP = 1
~ Month \([0,?]\)
~ The time step for the simulation.
Appendix B. Instructions for the Humanitarian Relief Game

HUMANITARIAN RELIEF GAME
Instructions

1. CONTEXT
Subjects in the “Humanitarian Relief” game play the role of a health NGO providing medical relief to beneficiaries after a devastating earthquake. The earthquake hitting Kaiho, a small developing country, affected two major regions: Lejeme city (Region 1), the epicenter and Prince-de-Paix (Region 2). Beneficiaries in both regions are in dire need of assistance. Health NGOs provide medical assistance by deploying their relief workers to each of the regions. Each period, NGOs decide in which region they will allocate their relief workers and if they would like to hire or fire them.

NGOs have an equal amount of resources (e.g., relief workers) and face the same operating costs. Humanitarian relief provided to beneficiaries allows NGOs to receive funds from donors. Funds can be used to cover the costs of humanitarian relief (e.g., operational costs) and can be used to hire or fire workers. The game lasts 8 simulated periods. Once a beneficiary receives humanitarian relief, her needs are met and she is out of the system.

2. GAME OBJECTIVE
NGOs must meet the following objective
- Maximize the number of beneficiaries served, while finishing the game with a positive cash position
- (Minimize the suffering of beneficiaries, while finishing the game with a positive cash position)

3. GAME SETUP
At the beginning of the game, each participant takes up the role of one NGO. Each NGO begins with an equal amount of resources (e.g., money and relief workers). Due to higher initial beneficiary density in Lejeme city (Region 1), a humanitarian worker providing relief there is more effective than in Prince-de-Paix (Region 2). That is, humanitarian relief workers can support and assist more beneficiaries per period in Lejeme city (R1) than in Prince-de-Paix (R2). In addition, better infrastructure and logistics access ensures that operating costs are also lower in Lejeme city (R1) than in Prince-de-Paix (R2). At the start of the game, Lejeme city (R1) is more attractive than Prince-de-Paix (R2).

TABLE 1 – BASE PARAMETERS FOR HUMANITARIAN RELIEF GAME

<table>
<thead>
<tr>
<th>Variables</th>
<th>Lejeme city (R1)</th>
<th>Prince-de-Paix (R2)</th>
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<tr>
<td>Beneficiaries (#)</td>
<td>12'000</td>
<td>8'000</td>
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<tr>
<td>Operating costs ($/relief worker/period)</td>
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<td>Donations ($/beneficiary)</td>
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<td>Relief worker effectiveness (beneficiary/relief worker)</td>
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<tr>
<td>Inflow of beneficiaries/period</td>
<td>300</td>
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4. SEQUENCE OF PLAY
The following steps of play capture the core mechanics of play in each round of play (each period or simulated week).

1. Beneficiaries from neighboring areas migrate to R1 and R2;
2. NGOs analyze incoming information (statistics);
3. NGOs allocate relief workers (among regions R1, R2, or idle);
4. NGOs hire or fire relief workers;
5. NGOs record and submits decisions; and
6. NGOs incur operational costs, receive funds and learn about end of period cash.

Each round of play (simulated period), NGOs must make two decisions: (i) the number of relief workers they will hire/fire, and (ii) where they will allocate their relief workers (among regions R1, R2, or idle).
5. INFORMATION

5.1. Beneficiaries in a Region
Beneficiaries receive humanitarian relief from health NGOs a single time. When this takes place, their needs are met and they leave (exit) the system. In each simulated period, beneficiaries \( B \) from neighborhood areas migrate to the two regions (R1 and R2) to have access to humanitarian relief provided by health NGOs. Hence, the number of beneficiaries of a region at time \((t+1)\) is given by the number of beneficiaries in that region \((i)\) at a previous period \((t)\) minus the outflow of beneficiaries served \((O_t)\) plus the inflow of beneficiaries \((I_t)\) migrating from a nearby area.

\[
B_{i,t+1} = B_{i,t} - O_t + I_t
\]

5.2. Funding
NGOs receive funding based on how many beneficiaries they attend and what is the level of suffering. On default, NGOs will receive $15 for each attended beneficiary; this does not change if they are in R1 or R2. But, depending on the suffering of the beneficiaries, this value can be reduced.

5.3. Hiring and firing
To hire or fire relief workers the NGO must pay an amount per worker – Table 2. The effectiveness of the workers depends on the process. The hiring process is fast: workers hired in period \((t)\) will be available in period \((t+1)\). The firing process is slow: workers fired in period \((t)\) will still be available during periods \((t)\) and \((t+1)\) incurring the normal costs; the effect of the firing decision will occur in \((t+2)\).

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<td>Firing</td>
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5.4. Idle workers
Idle workers are those that are not allocated to Regions 1 or 2. They continue to be part of the NGO, but attend no beneficiaries. The cost of an idle worker is of $250 per worker per period.

5.5. Relief worker effectiveness
As the number of beneficiaries in a region changes, so does beneficiary density, and the effectiveness of relief provided by a humanitarian worker. Figure 1 below captures the relationship of number of beneficiaries in a region and relief worker effectiveness.

**Figure 1 – Effectiveness of relief workers according to regions**
5.6. **Deprivation**
   The level of deprivation of beneficiaries increases as time passes by; it ranges from 0 to 10. The longer a beneficiary endures without assistance, the bigger the level of deprivation. Migrants of the neighborhood entering Regions 1 and 2 have already suffered hardships on the outside; thus, their contribution to the level of deprivation is equal to the contribution of the beneficiaries in the system at that point in time.

5.7. **Beneficiaries Suffering**
   The beneficiaries suffering depends on how much deprivation could be avoided in a region considering available workers.
Appendix C. Microsoft Excel Setup for the Humanitarian Relief Game

Participant view

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Appendix D. Humanitarian Relief Game Exit Questionnaire

1) Please insert your name

2) What was your group?
   • 1
   • 2
   • 3
   • 4

3) What was the objective you were trying to achieve?
   • Maximize NGOs funds
   • Minimize the suffering
   • Maximize quantity of assisted people
   • Maximize NGOs efficiency

4) How did you decide how many people to hire/fire?
5) How did you decide where to allocate people?
6) Did you change your strategy during the game?
   • Yes
   • No

7) Does the visualization of the territory influence your decisions? If yes, how?

8) Considering the humanitarian relief effort, how do you rank the following factors in the game? (1 - most challenging; 5 - least challenging)
   • conflict of interests
   • limited information sharing
   • tradeoffs in allocating resources
   • competition for scarce resources
   • interaction among different actors

9) Do you see any of the factors as equal/similar? If yes, which ones?

10) This factor was very challenging.

<table>
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<th>Factors</th>
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<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
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</table>
11) According to your assessment, did the environment lead to competition between NGOs?
12) According to your assessment, did the environment lead to coordination between NGOs?
13) Did you feel that the environment contributed more to competition or to coordination?
   - Competition
   - Coordination

14) Explain your reasoning for the last answer.
15) What do you think would enhance competition?
16) What do you think would enhance coordination?
17) Did you feel you needed more information to make the decisions? If yes, how would it be useful?
18) Did you learn something by playing the game? What?
19) Would you play the game again? Why?
20) Did you peek at your neighbor’s data or decisions? (no points will be deduced for sincerity!)
   a. Yes, every round
   b. Yes, a few times
   c. No, we weren’t allowed

21) If you did peek, what information did you look for?
22) Are the excel sheets easy to handle/understand? What could be further developed?
23) What would you change to improve the game? What would this achieve?