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PLANNING POST-DISASTER RECOVERY AND RECONSTRUCTION FOR TRANSPORT INFRASTRUCTURE CONSIDERING TIME AND COST

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INTRODUCTION

After the event of a natural disaster, repair of fundamental infrastructure is required. The transport system is the most important lifeline system, as any disruption or damage to it imposes damage to other systems. This study focuses on regular humanitarian response: which consists on long-term recovery of the transportation network.

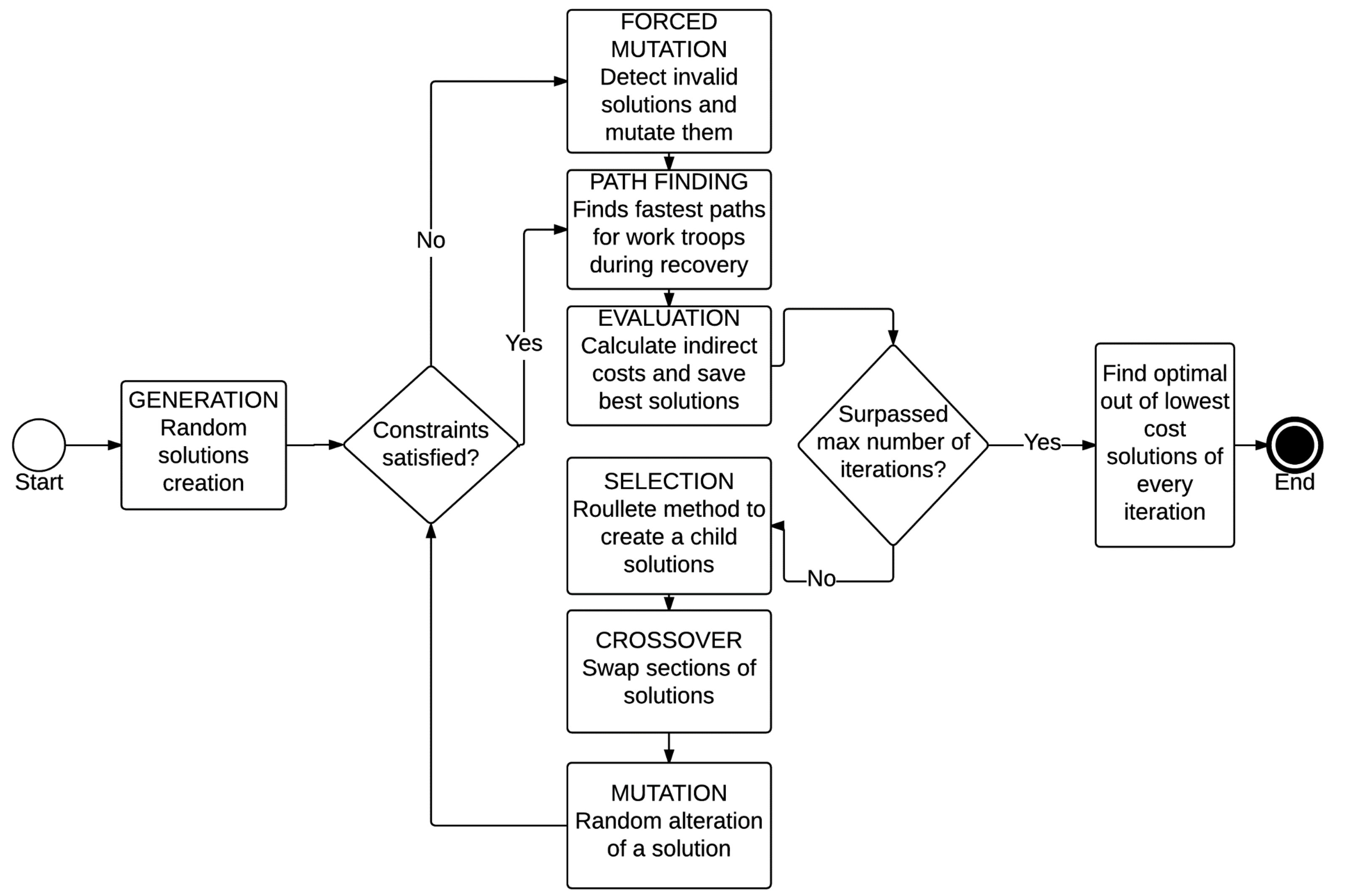
Examples	
Kobe (1995)	Permanent loss of transhipment market share to other countries[1]
New Madrid	Estimated increase in shipment length by 283 billion ton-miles[3]
Midwest Floods *(1993)*	Business interruption was mainly caused by lifeline services disruption (like electricity and transport)[4]

METHOD: GENETIC ALGORITHM

A Genetic Algorithm (GA) is a search heuristic that mimics the process of natural selection, and searches to optimise a system. A GA requires an objective to be defined for optimisation.

Objective: Minimise Fitness Value *(Z)*	
Indirect Costs *(IC)*	Excess travel time induced to road users by disruptions in the network
Direct Coss *(DC)*	Reconstruction costs (material and labour)
Travel Costs *(TC)*	Transportation of material and labour to disrupted points
Weighted Time *(wT)*	Relative value of each day of reconstruction
Fitness Value *(Z)*	Weighted summation of costs: $Z = IC + DC + TC + wT$

The flowchart shows how the GA works. Solutions are generated and evaluated according to their fitness value, then are subject to crossover and mutation to create child solutions. If child solutions are deemed invalid as they don't satisfy the constraints, they are forced to mutate.



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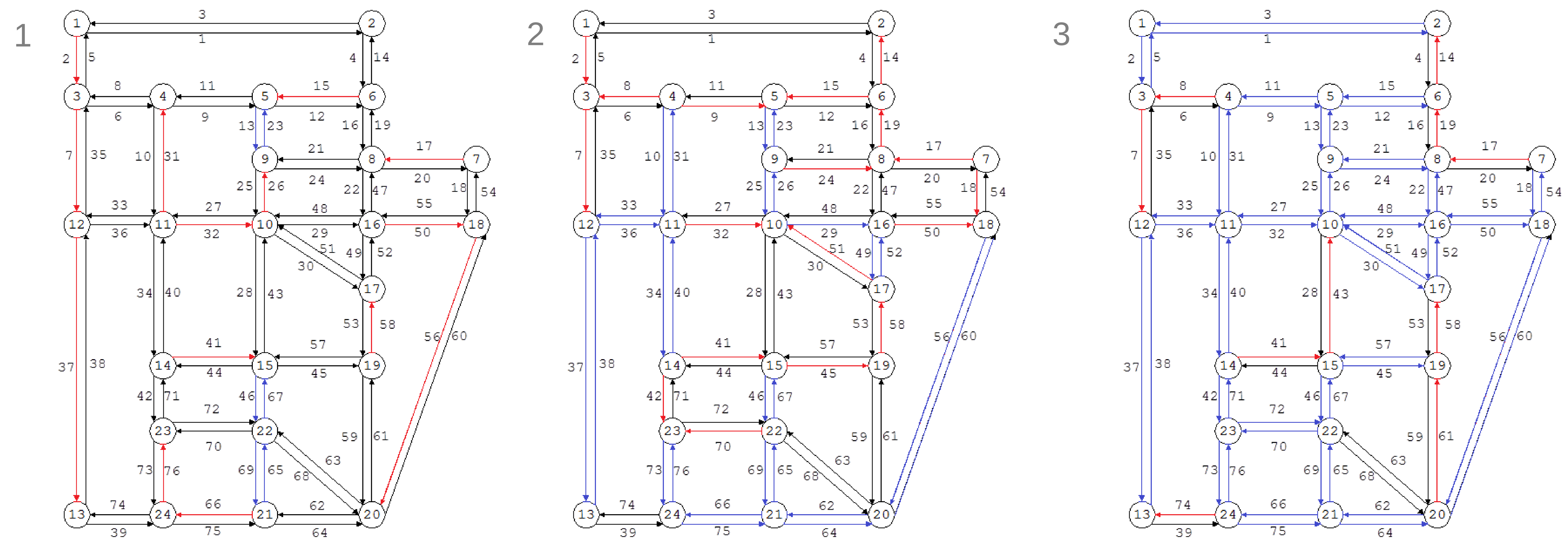
RESULTS

Comparison with the scenario created by Chen and Tzeng [2]. 10 links disrupted in the Sioux Falls Network.

	Chen and Tzeng's[2] proposal	**Proposed model**
Total Fitness Value (US$ million)	2.03	1.29
Total Recovery Time (days)	140	110
Maximum work troop idle time (days)	70	50

NETWORK RECOVERY FROM TOTAL DISRUPTION



Reconstruction of the Sioux Falls network from total disruption. Black, red and blue lines mean zero, partial and complete restoration of links. Figures 1, 2 and 3 represent t=180, 360 and 540 days respectively.

VARIATION OF WEIGHTING FACTOR *w*

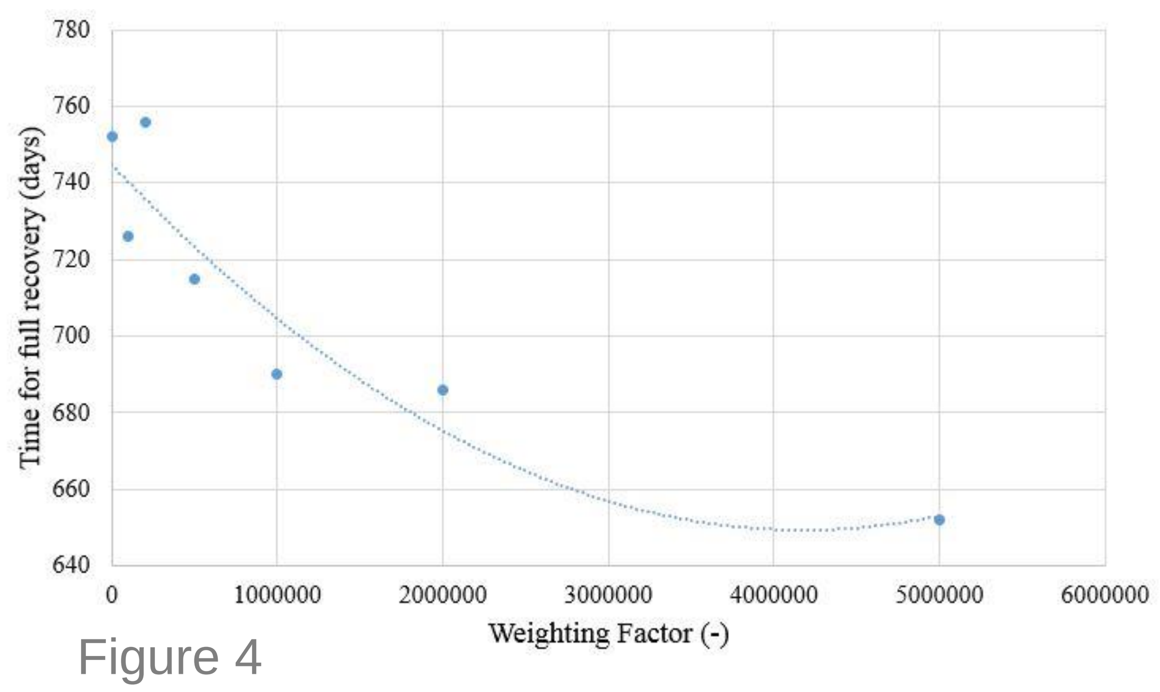


Figure 4

Figure 4 shows the variation of reconstruction time with the weighting value *(w)*. As it can be observed, the reconstruction time decreases as weighting factor increases, meaning that one can manipulate the priorities of the algorithm. The averge computational time for each iteration was 166 seconds.

REFERENCES

[1]Chang, S. 2000. Disasters and transport systems: loss, recovery and competition at the port of Kobe after the 1995 earthquake. Journal of transport geography, 8(1), 53–65.

[2]Chen, Y.W., & Tzeng, G.H. 1999. A fuzzy multi-objective model for reconstructing the post-quake road-network by genetic algorithm. International journal of fuzzy systems, 1(2), 85–95.

[3]Kim, T.J., Ham, H., & Boyce, D.E. 2002. Economic impacts of transportation network changes: Implementation of a combined transportation network and input-output model. *Papers in regional science*, 81(2), 223–246.

[4]Tierney, K. J. 1995. Impacts of recent US disasters on businesses: the 1993 Midwest floods and the 1994 Northridge earthquake.