Jie Zhao[a], Ji Yun Lee[b]

[a]Graduate Research Assistant, Washington State University, Pullman, WA 99164, USA, E-mail: jie.zhao2@wsu.edu
[b]Assistant Professor, Washington State University, Pullman, WA 99164, USA, E-mail: jiyun.lee@wsu.edu

•

•

Estimate the delay time for damaged facilities and bridges

Facility delay time estimation

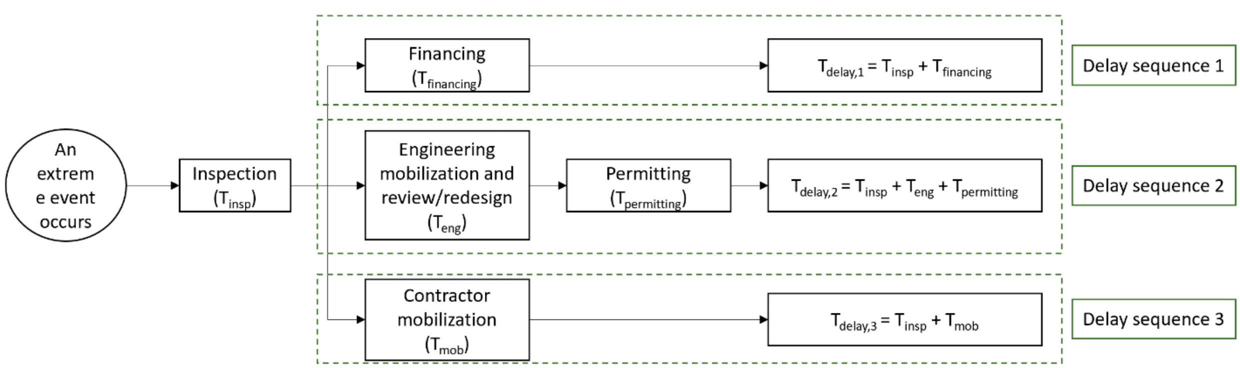
$$T_{delay,1} = T_{inspection} + T_{financing}$$

$$T_{delay,2} = T_{inspection} + T_{engineering} + T_{permitting}$$

$$T_{delay,2} = T_{inspection} + T_{mobilization}$$

$$T_{delay} = \max\left(T_{delay,i}\right), i = 1,2,3$$

	DS_0 DS_1
	DS_2 DS_3 DS_4
	DS_0
	DS_1
	DS_2 DS_3
	DS_4
	DS_0
	DS_1 DS_2
	DS_3 DS_4
	DS_0
	DS_1 DS_2
	DS_3 DS_4

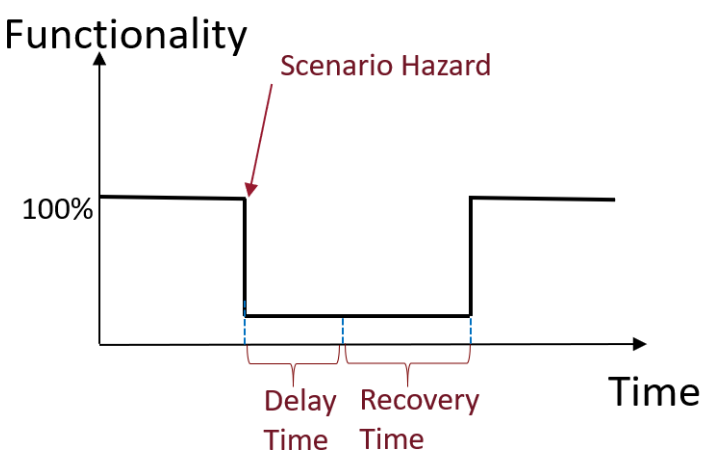


Bridge delay time estimation

DS_1
DS_2
DS_3
DS_4

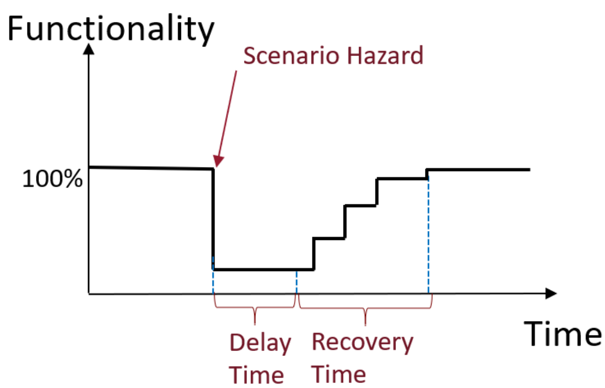
Estimate the recovery time for damaged facilities and bridges

One-step recovery process



	DS_1
	DS_2
	DS_3
	DS_4

Multi-step recovery process



DS_1	
DS_2	
DS_3	
DS_4	

Calculate the repair costs of damaged facilities

DS_1
DS_2
DS_3
DS_4

Modify facility and edge property tables

Modify the objective function of the FTOT optimization

$cost_{\,n}(t)$

$$cost_{\,n}(t) = \frac{cost_0 + w_R \cdot (cost_{R,n}\,(t) - reward_n\,(t))}{product_n(t)}$$

$cost_0$

$cost_{R,n}\,(t)$ *t* *n* $reward_n\,(t)$

t *n* w_R

$product_n(t)$

t *n* $cost_{R,n}(t)$

c_{UDP}

$c_{restoration}$ Δ $c_{transportation}$

$c_{operation}$ $reward_n(t)$

$$cost_R(t) = c_{UDP}(t) + c_{restoration}(t) + \Delta(c_{transportation}(t) + c_{operation}(t))$$

$$reward(t) = -UDR(t) \cdot r_{product}$$

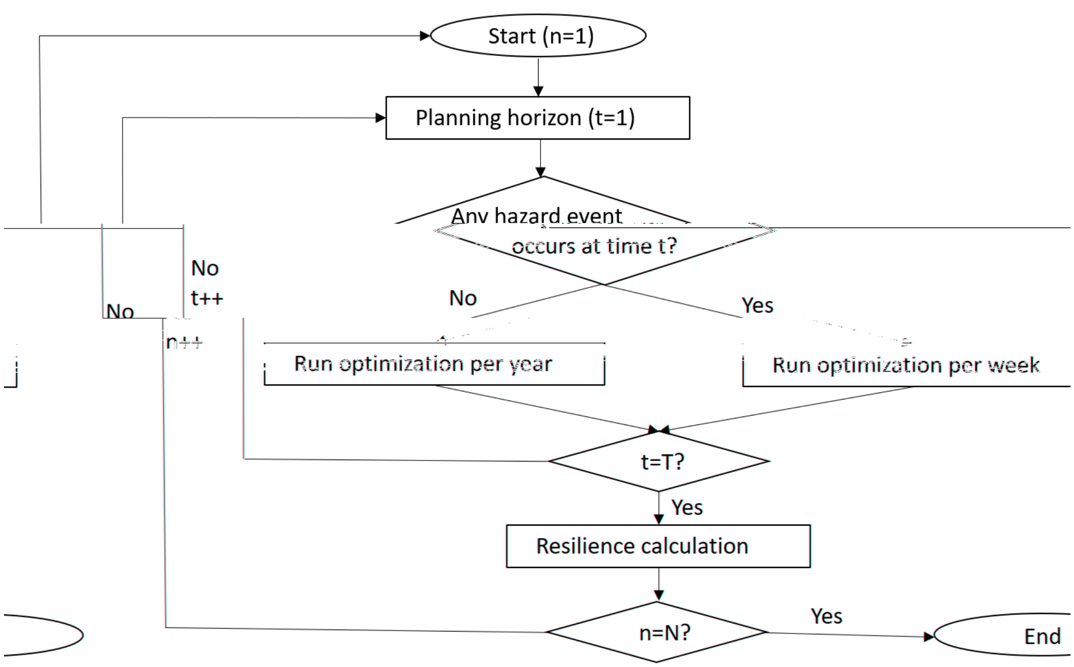
UDR $r_{product}$

Run optimization simulation at each time step over planning horizon for each scenario

t_h t_h

T

N



Calculate the supply chain resilience over planning horizon for each scenario

N

$R_{1,n}$ $R_{2,n}$ $R_{3,n}$

UDR

$$R_{1,n} = \sum_i \int_{t_{h,i}} cost_{R,n}(t_{h,i})dt_{h,i}$$

$$R_{2,n} = \sum_j \int_{t_{o,j}} reward_n(t_{o,j})dt_{o,j}$$

$$R_{3,n} = \int_{\overline{t_h}} cost_{R,n}(\overline{t_h})d\overline{t_h}$$

$R_{m,n}$ m n i
T n $t_{h,i}$ *UDR* i^{th} j
UDR T n $t_{o,j}$
j^{th} *UDR* $\overline{t_h}$ *UDR*
$R_{1,n}$ n
$R_{2,n}$ n $R_{3,n}$ n

n R_n

$$R_n = w_{1,n}R_{1,n} + w_{2,n}R_{2,n} + w_{3,n}R_{3,n}$$

$w_{m,n}$ m n

$$w_{1,n} \propto E_i\left[\frac{\int_{t_{h,i}} cost_{R,n}(t_{h,i})dt_{h,i}}{t_{h,i}}\right]$$

$$w_{2,n} \propto E_j\left[\frac{\int_{t_{o,j}} reward_n(t_{o,j})dt_{o,j}}{t_{o,j}}\right]$$

$$w_{3,n} \propto E_k\left[\frac{\int_{\overline{t_h}} cost_{R,n}(\overline{t_h})d\overline{t_h}}{\overline{t_h}}\right]$$

Generate the simulation structure for resilience assessment

N

Zhao, J., Lee, J. Y., Li, Y., & Yin, Y. J. (2020). Effect of catastrophe insurance on disaster-impacted community: Quantitative framework and case studies. *International Journal of Disaster Risk Reduction*, *43*, 101387.