

Modeling to Support Acceleration of Restoration of A Building System due to Flooding



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INTRODUCTION

- Fraser river flood scenarios for present days estimated to have a return period of **1 in 500 years** (equivalent to 1894 flood record)
- Flood being a wicked problem, strategic post-disaster restoration can bring back the systems and people at their initial functional capacity at shortest possible time to reduce further losses.

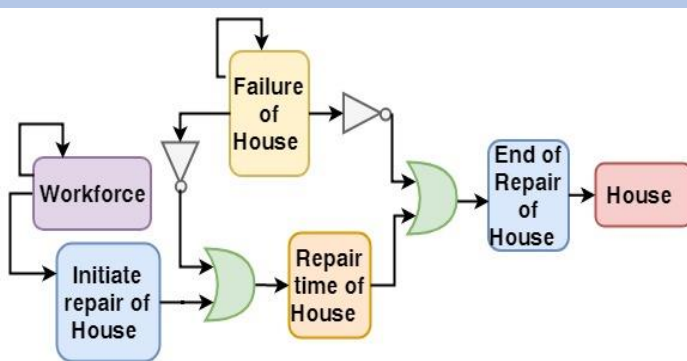
OBJECTIVE

- To develop a physical restoration model of a residential building, post disaster.
- Determine the restoration time of building components and total building recovery timeline.

CASE STUDY

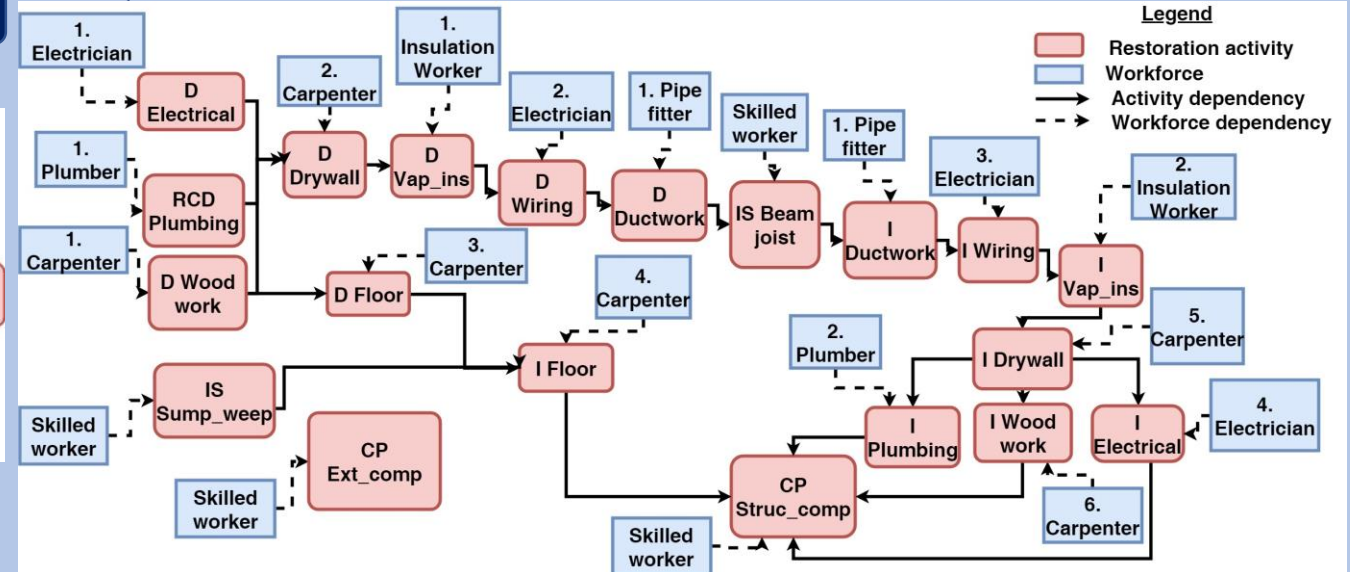
Methods

1. BASIC GMOR STRUCTURE



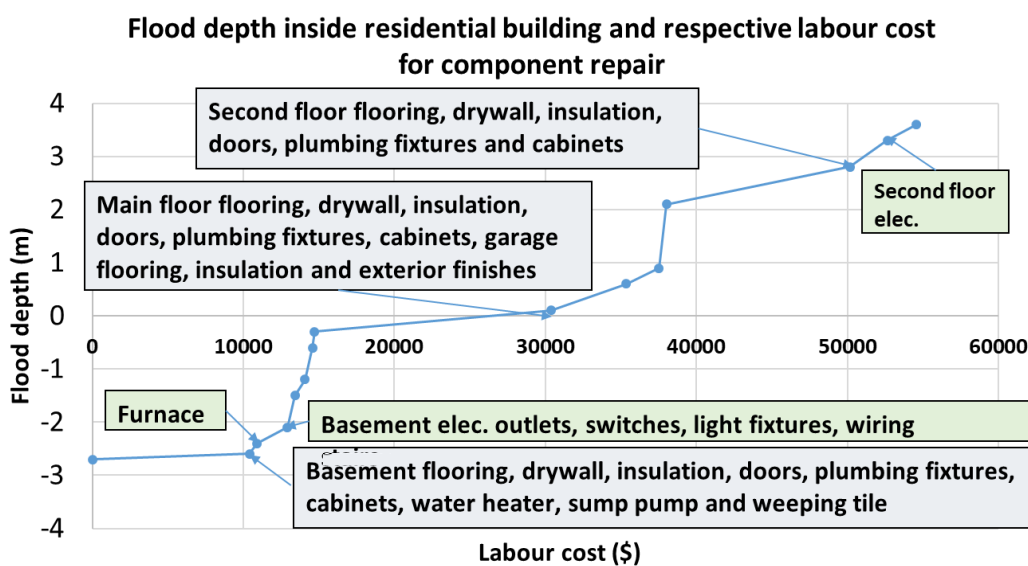
**GMOR structure consists of: Entity, Event, Resource, Time and State. Arrow head signifies dependency relationship (Bristow & Hay, 2017).

2. SEQUENCED MODEL TO SIMULATE COMPLEX BUILDING RECOVERY



**D= Demolish, I= Install, IS= Inspect and service, CP= clean and paint and RCD= Remove, clean and demolition

3. COMPONENT RESTORATION REQUIREMENT AT DIFFERENT FLOOD LEVEL



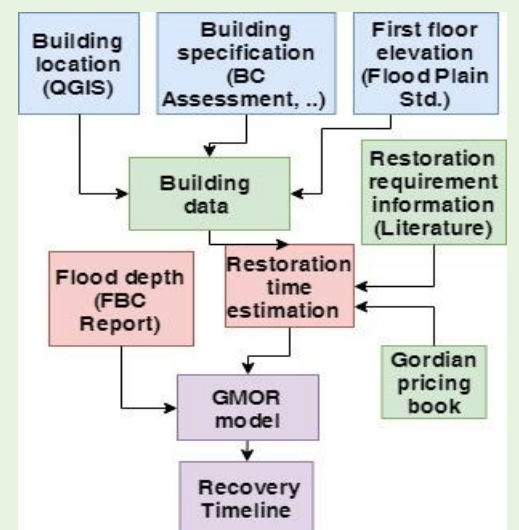
(NRCan 17, Hazus 13 and Deniz, Arneson, Liel, Dashti, & Javernick-Will 2017)

4. COMPONENT RESTORATION TIME

Time (Day) = (per unit cost of labour (\$) * total unit) / Labour rate (\$/Day)
 **Gordian 2018 (contractors pricing guide with RSMMeans data)

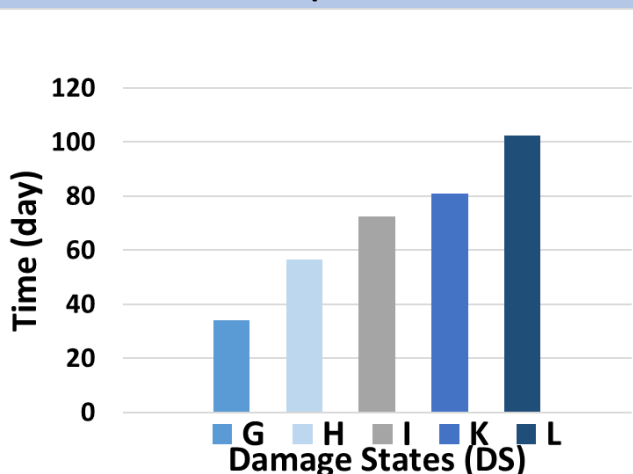
5. DAMAGE STATE AND RECOVERY MODELING

Flood depths (m)	Damage States (DS)
-0.3	G
0.1	H
0.6	I
0.9	J
2.1	K
2.8	L

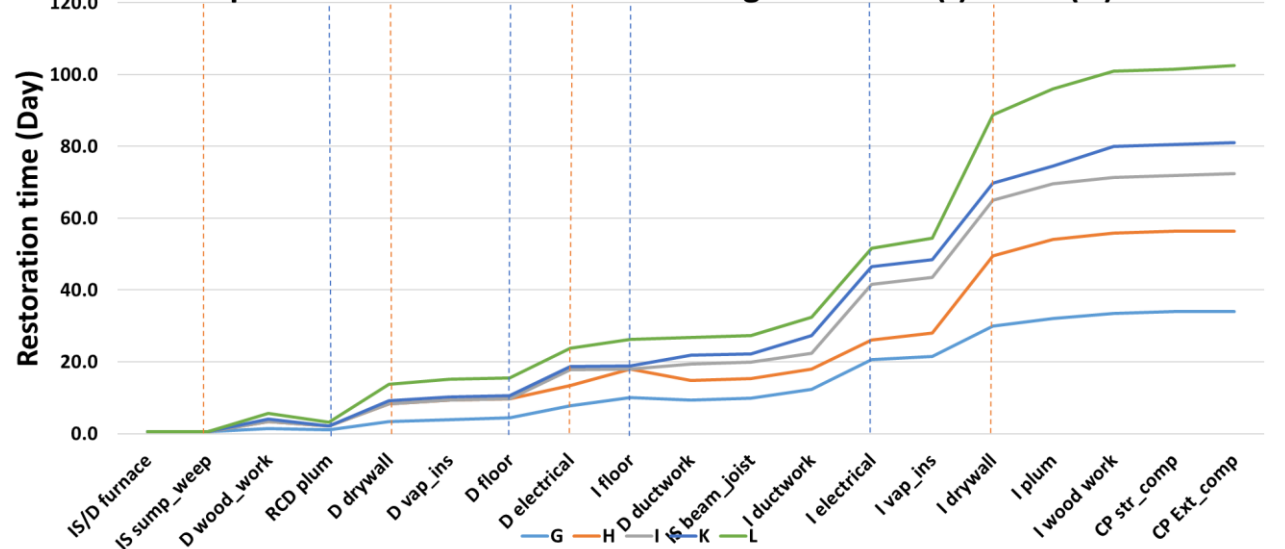


Results

BUILDING RECOVERY (TWO STOREY, DETACHED)



Component restoration time for damage states DS (J) to DS (N)



Discussion

- "Carpenters" are critical to the restoration pathways and optimization of the recovery timeline is possible by focusing on ordering of carpenters used.
- Complete building recovery for the highest damage is calculated 103 days for 2.8 m flood depth inside the building (from main floor level)
- Among all the components, electric works and drywall are the two most critical building components to the restoration timeline.

Future Study

- Community level building restoration model development and acceleration of community recovery by resource optimization.
- Overall community level post disaster recovery pathways development by collaborating with critical infrastructure restoration.

Reference

- Bristow, D. N., & Hay, A. H. (2017). Graph Model for Probabilistic Resilience and Recovery Planning of Multi-Infrastructure Systems. *Journal of Infrastructure Systems*, 23(3), 04016039. [https://doi.org/10.1061/\(ASCE\)IS.1943-555X.0000338](https://doi.org/10.1061/(ASCE)IS.1943-555X.0000338)
- Deniz, D., Arneson, E., Liel, A., Dashti, S., & Javernick-Will, A. (2017). Flood loss models for residential buildings, based on the 2013 Colorado floods. *Natural Hazards*, 85, 977-1003. <https://doi.org/10.1007/s11069-016-2615-3>
- Hazus-MH 2.1 Canada, user and technical manual: Earthquake module. [by] M. Ulmi ... [et al.]: M183-2/7474E-PDF - Government of Canada Publications - Canada.ca. Retrieved September 3, 2019, from <http://publications.gc.ca/site/eng/9.819558/publication.html>