Bayesian Decision and Risk Analysis

System Safety Analysis

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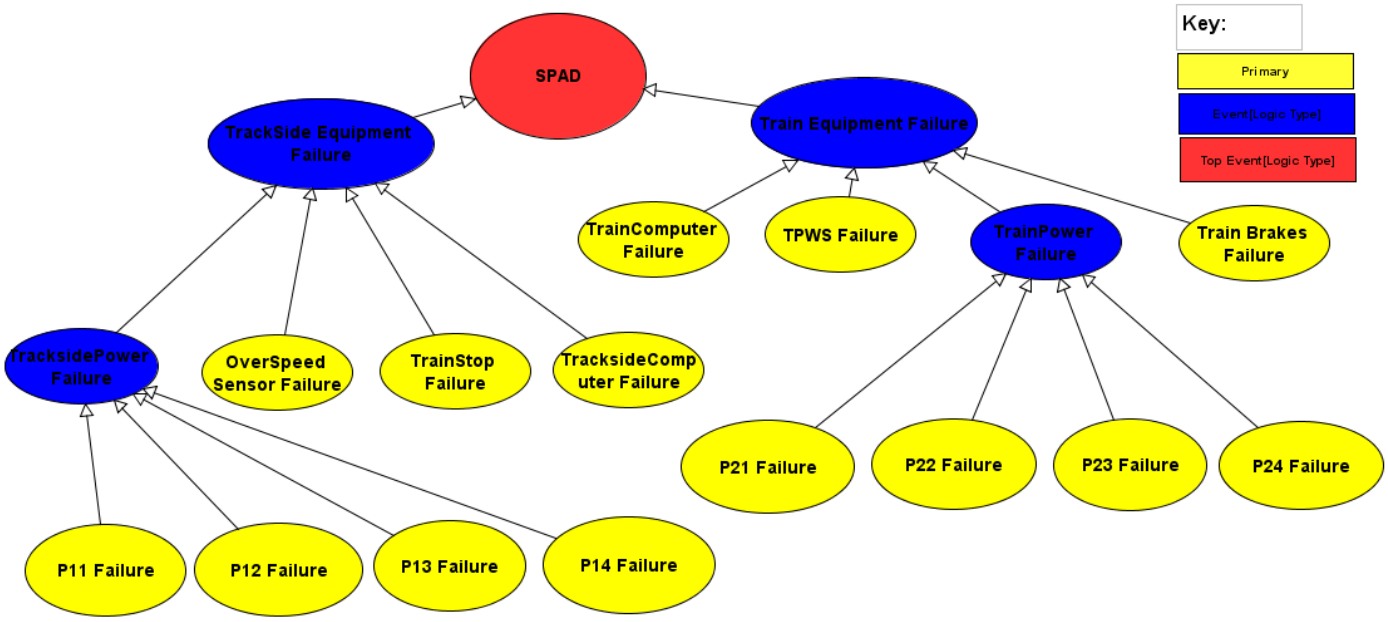
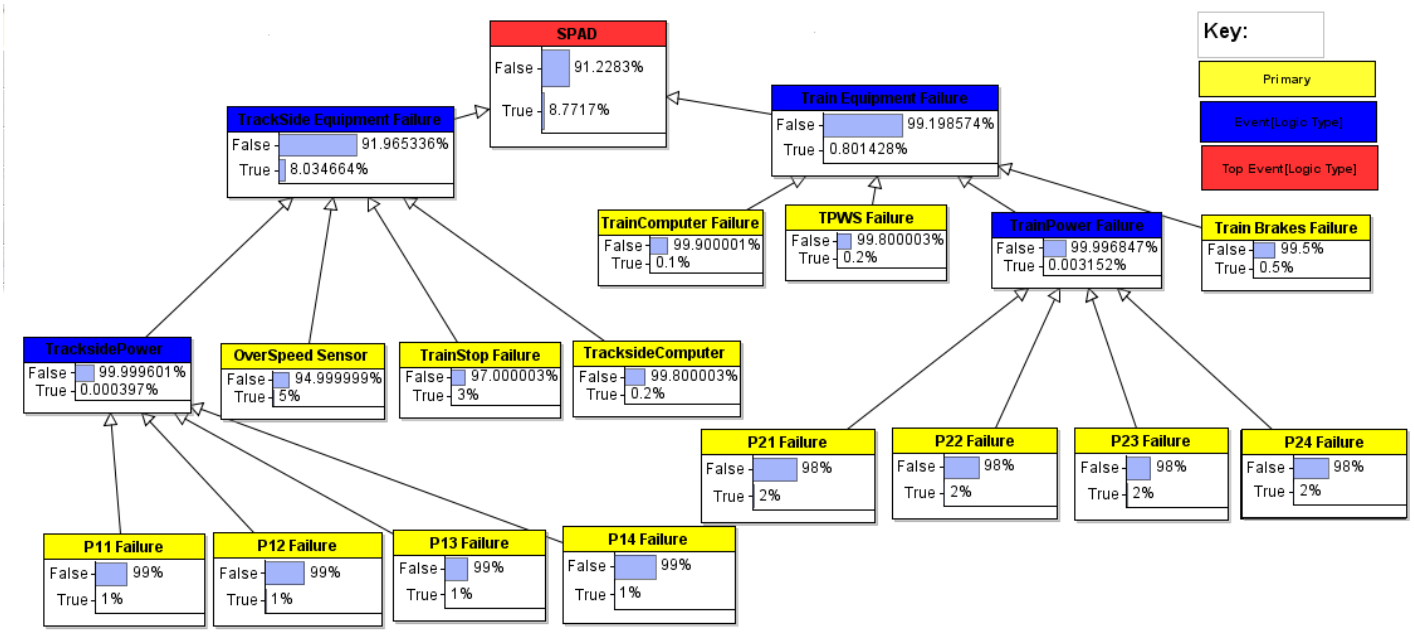
Part I – Fault Tree [50]

1. Show a graph of the fault tree with the fault tree logic clearly shown alongside meaningful node names



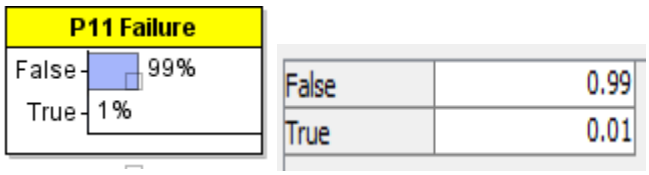
2. Show the marginal probability risk graphs for each node in the fault tree



3. Document all NPTs or expressions used

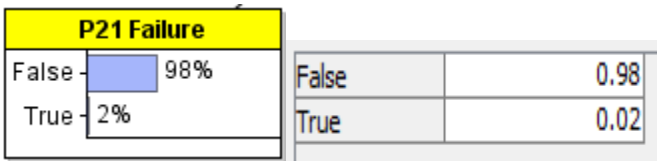
Power Units of Trackside equipment:

Trackside section contains 4 power units and they have the same NPT:



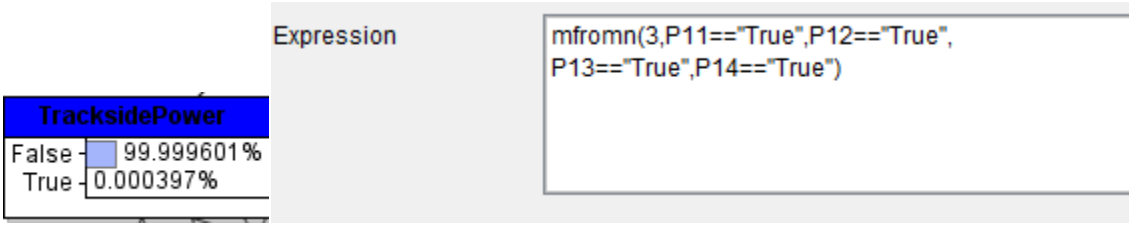
Power Units of Train equipment:

Train section contains 4 power units and they have the same NPT:

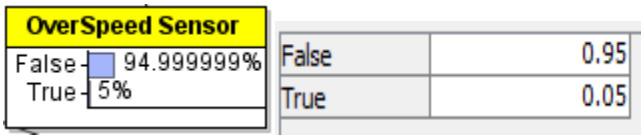


Trackside Power Supply:

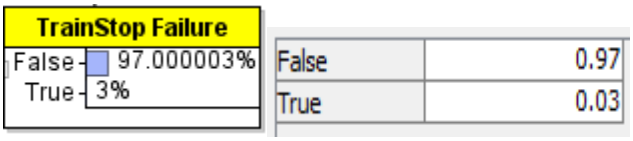
This power supply is composed of 4 power units and it will be available if at least two units are operating, so we need to use an expression for its probability table which is saying 3 of the power units should be True (failed) then we have True (fail) in power supply:



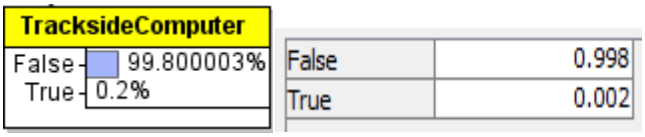
TrackSide Overspeed Sensor:



TrackSide train stop loop:

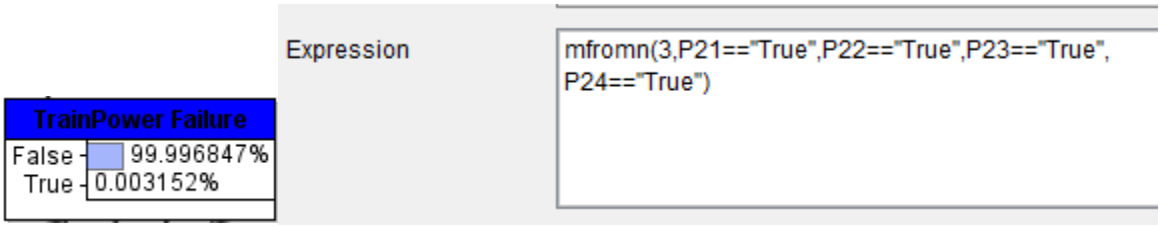


TrackSide Computer controlling:

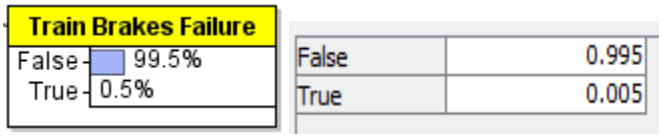


TrainSide Power Supply:

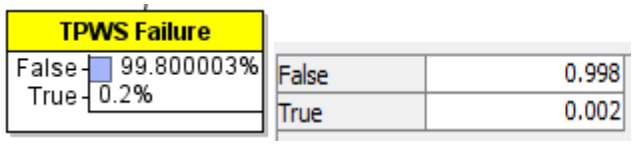
This power supply is composed of 4 power units and it will be available if at least two units are operating, so we need to use an expression for its probability table which is saying 3 of the power units should be True (failed) then we have True (failure) in power supply:



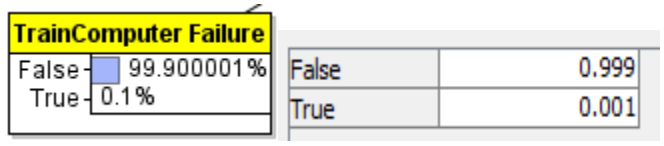
TrainSide Brakers:



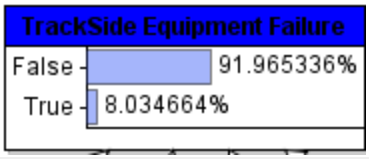
TrainSide TPWS:



TrainSide computer controlling:



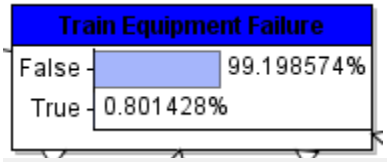
TrackSide Equipment:



Expression

```
if(TracksidePower=="True" || OverSpeed_Sensor=="True" ||
 TrainStop=="True" || TracksideComputer=="True","True","False")
```

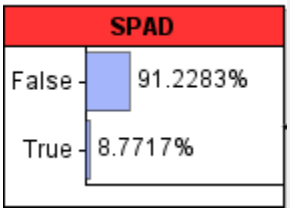
TrainSide Equipment:



Expression

```
if(TrainComputer=="True" || TPWS=="True" ||
TrainPower=="True" || Brakes=="True","True","False")
```

SPAD:

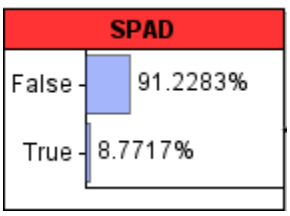


Expression

```
if(TrackSide=="True" || Train_Equipment=="True",
"True","False")
```

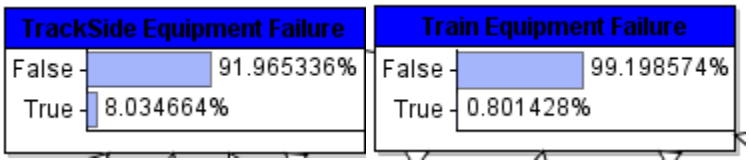
4. Calculate the probability of the top event

If we run our model we can see the probability of the top event(SPAD) is: 91.22%



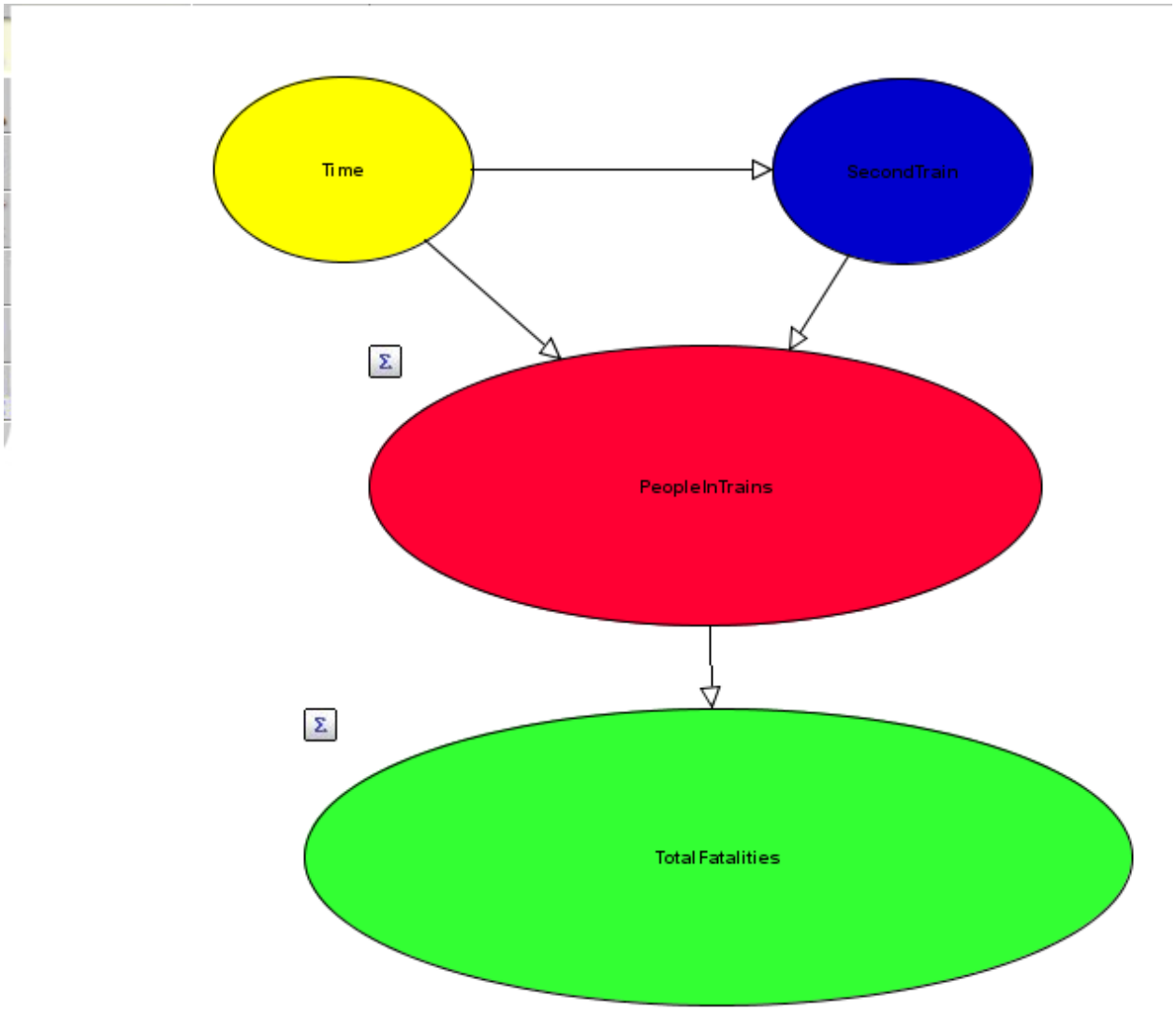
5. Identify which is the least safe: the trackside or train subsystems?

The section is the least safe if it is more likely to fail. The probability of Trackside subsystem failure is 8.03% and this amount for the Trainside is 0.8%. So the Trackside subsystem is more likely to fail, therefor trackside is least safe.



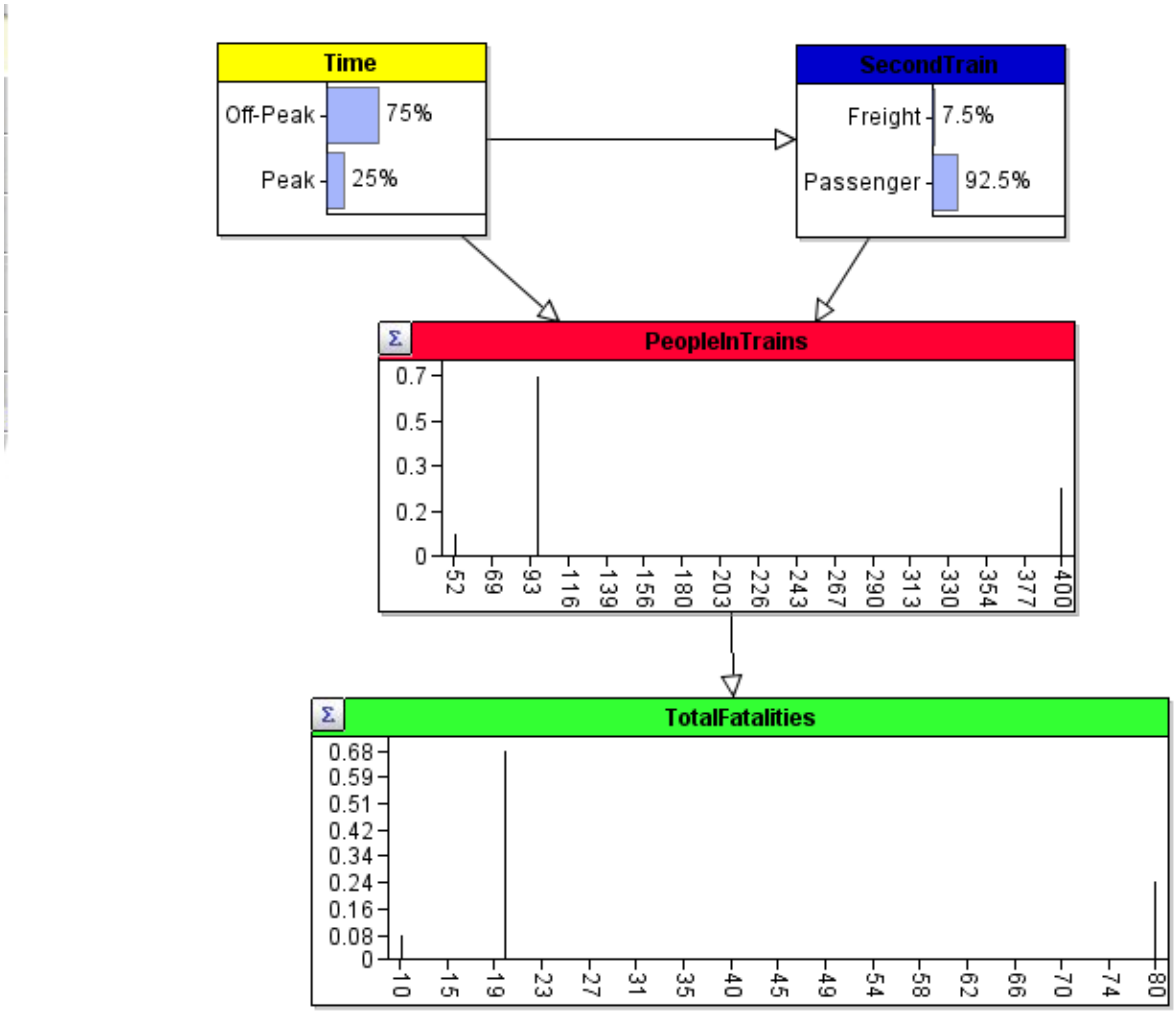
Part II – Event Tree [20]

1. Show a graph of the event tree as a Bayesian Network



We assume that SPAD is activated and collision has occurred, so one of the trains was passenger train. Passenger train can carry 50 or 200 people which are related to the time.

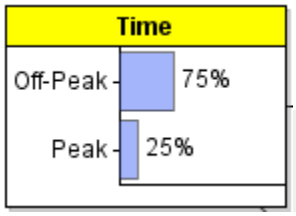
2. Show the marginal probability risk graphs for each node in the event tree



3. Document any NPTs or expressions used

Time:

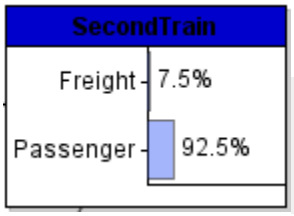
This node shows that time of collision is in peak time or off-peak time



Off-Peak	0.75
Peak	0.25

Second Train:

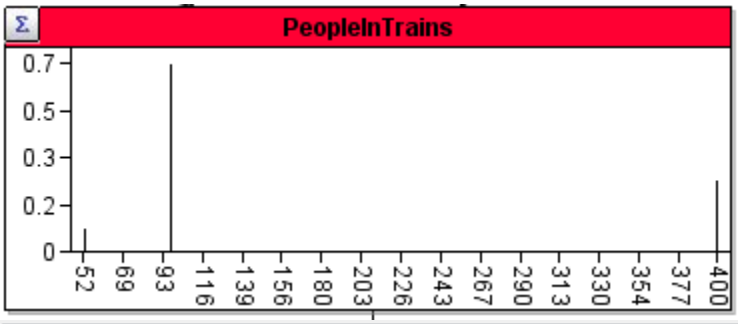
This node shows the type of the second train.



Time	Off-Peak	Peak
Freight	0.1	0.0
Passenger	0.9	1.0

People in Trains:

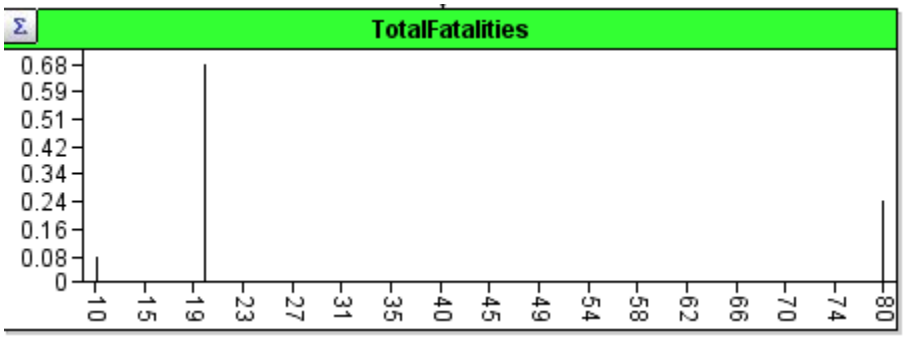
This node determines the number of people who are in the trains(the passenger train + the second one)

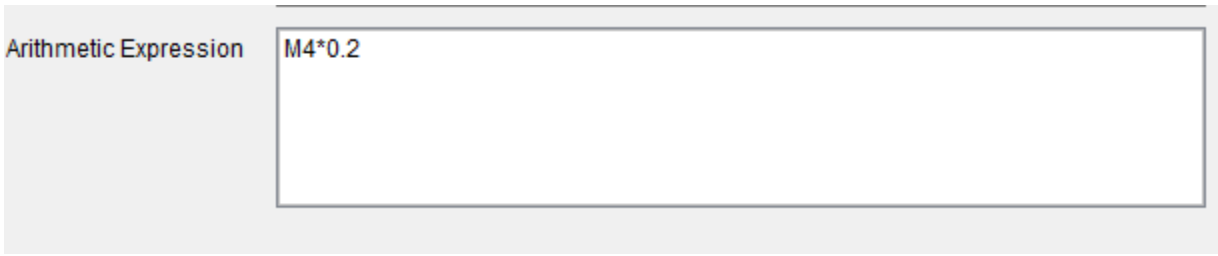


Time	Off-Peak		Peak	
SecondTrain	Freight	Passenger	Freight	Passenger
Expressions	Arithmetic(52)	Arithmetic(100)	Arithmetic(0)	Arithmetic(400)

Total number of fatalities:

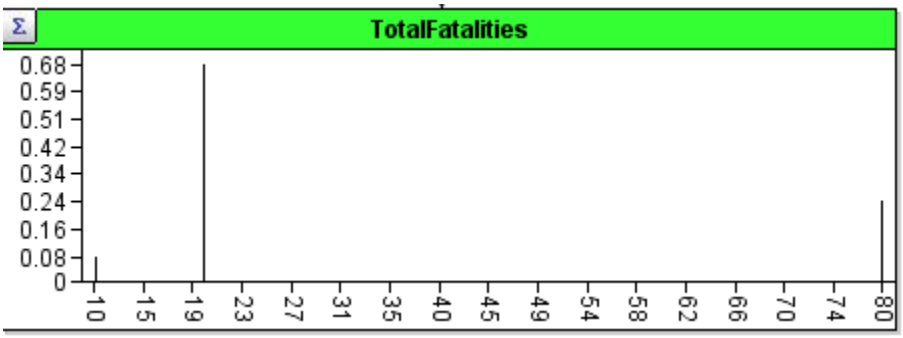
This node indicates the number of people have died in the collision





4. Calculate the expected casualty rate

Based on what we got in the TotalFatalities :



The expected casualty rate for off-peak and passenger-freight collision is 0.08

The expected casualty rate for off-peak and passenger-passenger collision is 0.68

The expected casualty rate for peak and passenger-passenger collision is 0.16