

Structural Equation Modeling & Artificial Intelligence-based Perceived Motorcycle Risk Prediction in Bangladesh's Urban Driving Environment

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Abstract According to data from the BUET Accident Research Institute (ARI), in 2022, motorbikes accounted for **62%** of all vehicles on the road, with **26** accidents occurring for every **10,000** motorcycles making up the majority of all traffic accidents in Bangladesh. This is due to their **accessibility, affordability, and ride-sharing use**. Hence, it is essential to investigate the risk factors that contribute to motorcycle accidents, how they affect risk assessment, and how to develop the necessary policy implications. Data on perceived risk was gathered for this study from **1,559** participants in offline and online questionnaire survey. Demographic data together with ratings on the perceived risk of **37** precursors to motorcycling accidents in the setting of Dhaka were gathered. Then **ten** combined attributes were identified from all precursors. With a **73%** prediction accuracy, the **Random Forest algorithm** has been utilized to predict perceived risk. Moreover, contribution of different precursors on safety status have been demonstrated by **structural equation modelling**. Lastly, different contour maps for features' correlation, heat map, deployment of result using flask in public server for user interface (which allows model accessible to a wider audience & receive predictions), policy implications have been analysed in this study. In conclusion, any developing country's urban context will benefit greatly from the provided prediction tools for accident analysis and prevention.

Objective

- 01 Finding out the **major precursors' comparative analysis** and building up a **representative & trustworthy model** which can be implemented in **planning and management** later for the curtailment of the accident rates utilizing significant public opinion.
- 02 Implications of output in Road safety policy and practice.
- 03 Implementation of **Deployed machine learning model's user interface** in public server to predict perceived risk rating of different corridors, regions of Bangladesh.

Sample Question of Forms

Your thinking about impact of sharing same roadway with other road users of different vehicles on motorbike accident means non lane based heterogeneous traffic movement :
[সেইসবাইক দুটিশা অন্যানা যান ব্যবহারকারীদের সাথে একই লেন ভাগাভাগি করার শ্রদ্ধার সম্পর্কে :]



1. Strongly Disagree
2. Disagree
3. Neutral
4. Mostly Agree
5. Completely Agree

Questionnaire Items

01

Demographic

- Occupation
- Gender
- Division
- Age of respondents
- Usage of motorcycle : rider/user/nonuser
- Ride share app usage or not
- Frequency of motorbike usage



02

Bikers' driving behavior

- Drug Addiction
- Overloading
- Competitive Riding
- Mobile Phone (call, blog, music)
- Panic Braking (less maneuvering space)
- Traffic Law Disregard
- Overconfidence
- Inexperience
- Overspeed



03

Sign, Lighting

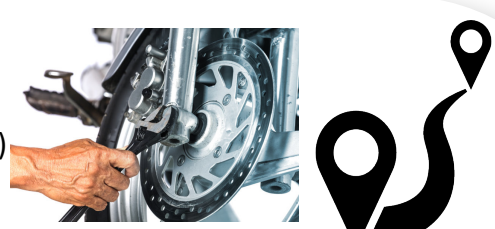
- Lighting
- SignMark



04

Motorbike condition

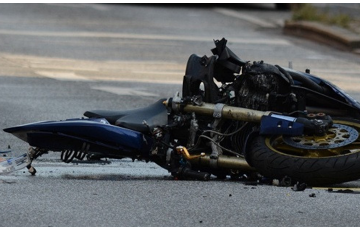
- More CC Bike
- Mechanical Problem (brake, indicator)
- Overloading (pillion, heavy loads)
- Travel Distance



05

Safety Status

- Accident Experience (number)
- Perceived Risk (rating)



06

Weather environment

- Rainyweather (rain, storm, flooding)
- FogDust
- Hightemp



07

Pavement

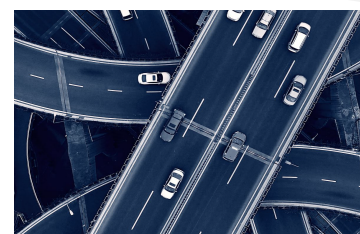
- Distress Drainage (crack, cut, failure)
- Level Crossing (pedestrian, pavement)



08

Driving environment

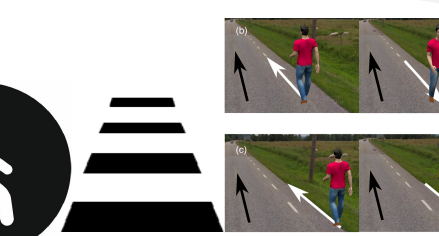
- Problematic Curb
- Curve (turn, bend)
- Flyover bridge Culvert
- Divider Median Guardrail



09

Pedestrian activity

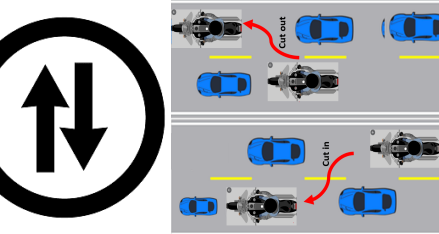
- Pedestrian Activity Footpath
- Pedestrian Crossing
- Same Direction Pedestrian
- Reverse Direction Pedestrian



10

Traffic movement

- Side road Entry
- Cut in/out Movement
- Right Turn Merge Movement
- Two-way Traffic



11

Traffic control & Law

- Intersection Problem (signal, device, police)
- Heterogenous Traffic (no lane)
- Onstreet Parking Bus Stop
- Law Enforcement (drug, speed, license, training)



Methodology

Attributes from Literatures, Newspapers, ARI reports Expert opinions

Data Processing

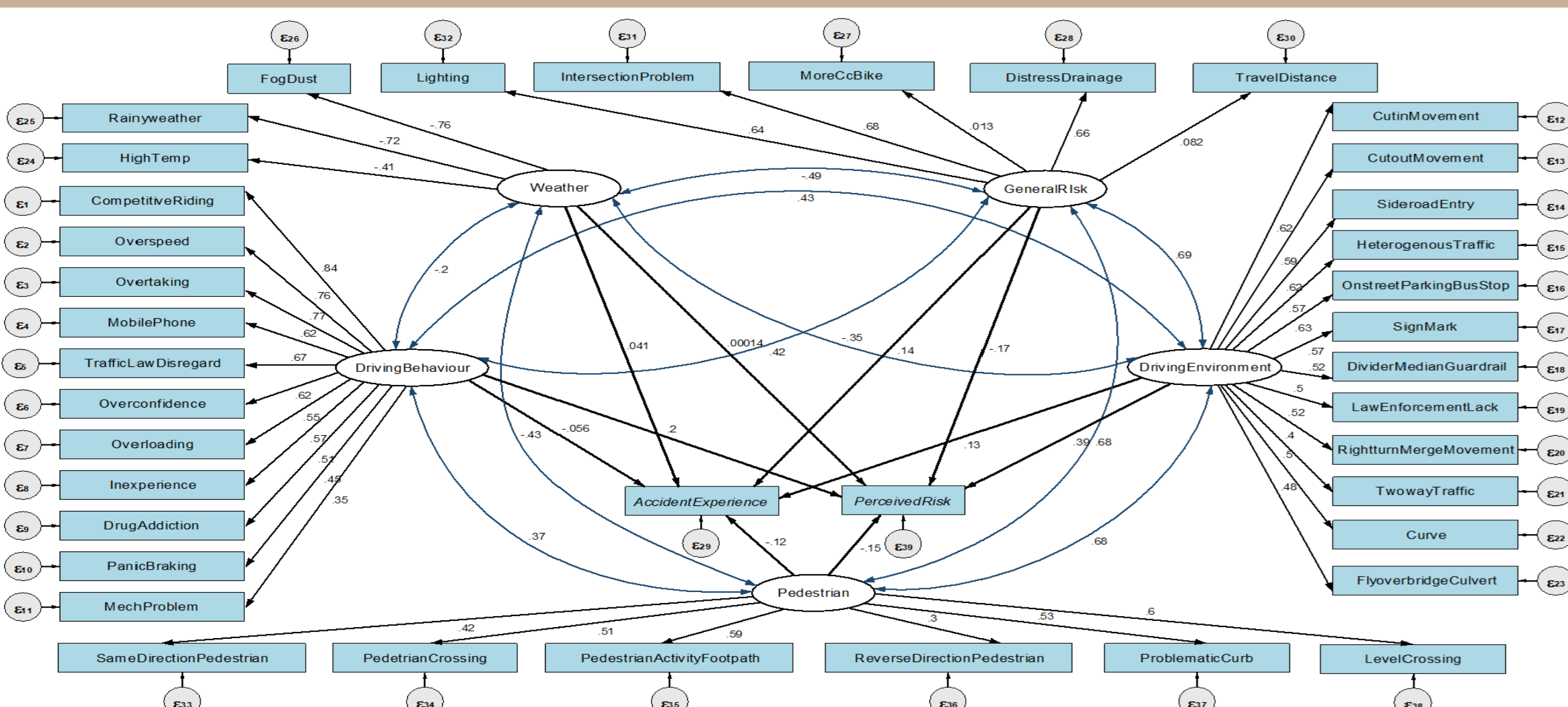
Model Analysis & Policy Implications



Questionnaire Form Design

Structural Equation & Machine Learning Model

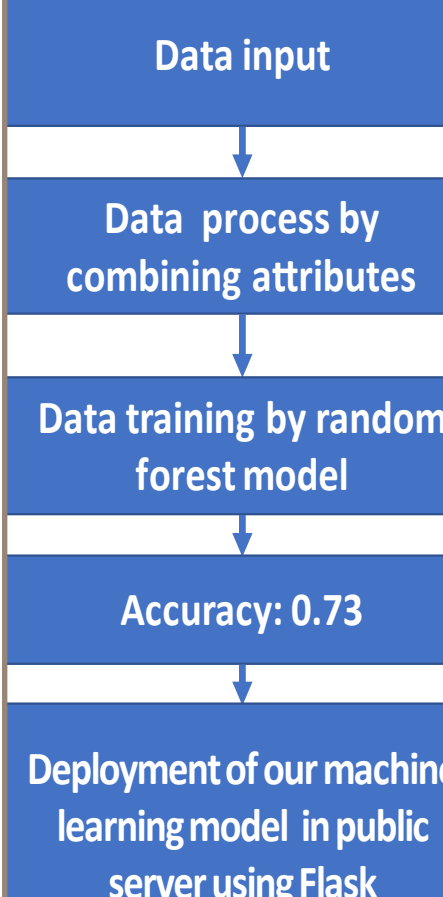
SEM Model



Results of SEM

Latent Variable	Observed Variable	Coeff.	p value	Latent Variable	Observed Variable	Coeff.	p value
DrivingBehaviour	CompetitiveRiding	0.84	0.000	DrivingEnvironment	OnstreetParkingBusStop	0.63	0.000
	Overtaking	0.77	0.000		SideroadEntry	0.62	0.000
	Overspeed	0.76	0.000		CutinMovement	0.62	0.000
	TrafficLawDisregard	0.67	0.000		CutoutMovement	0.59	0.000
	MobilePhone	0.62	0.000		SignMark	0.57	0.000
	Overconfidence	0.618	0.000		HeterogenousTraffic	0.57	0.000
	Inexperience	0.57	0.000		DividerMedianGuardrail	0.52	0.000
	Overloading	0.55	0.000		RightturnMerge	0.52	0.000
	DrugAddiction	0.51	0.000		Curve	0.50	0.000
	PanicBraking	0.45	0.000		LawEnforcementLack	0.50	0.000
MechProblem	0.35	0.000	FlyoverbridgeCulvert	0.48	0.000		
Weather	FogDust	-0.76	0.000	TwoWayTraffic	0.40	0.000	
	Rainyweather	-0.72	0.000	LevelCrossing	0.60	0.000	
	Hightemp	-0.41	0.000	Ped. ActivityFootpath	0.58	0.000	
GeneralRisk	IntersectionProblem	0.68	0.000	ProblematicCurb	0.53	0.000	
	DistressDrainage	0.66	0.000	PedestrianCrossing	0.51	0.000	
	Lighting	0.64	0.000	SameDir. Pedestrian	0.42	0.000	
	TravelDistance	0.08	0.004	ReverseDir. Pedestrian	0.29	0.000	
	MoreCcBike	0.01	0.652				
AccidentExperience	GeneralRisk	0.14	0.022	PerceivedRisk	DrivingEnvironment	0.39	0.000
	DrivingEnvironment	0.13	0.013		DrivingBehaviour	0.20	0.000
	Pedestrian	-0.12	0.042		GeneralRisk	-0.17	0.002
	DrivingBehaviour	-0.06	0.069		Pedestrian	-0.15	0.006
	Weather	0.04	0.278				

Machine Learning Process Model



Machine Learning Deployment

Prediction

Please give us rating between 1 to 5

1. Strongly Disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

biker's driving behaviour

motorbike condition

weather environment

Driving environment

pavement condition

sign, marking & lighting of road

traffic control

traffic movement

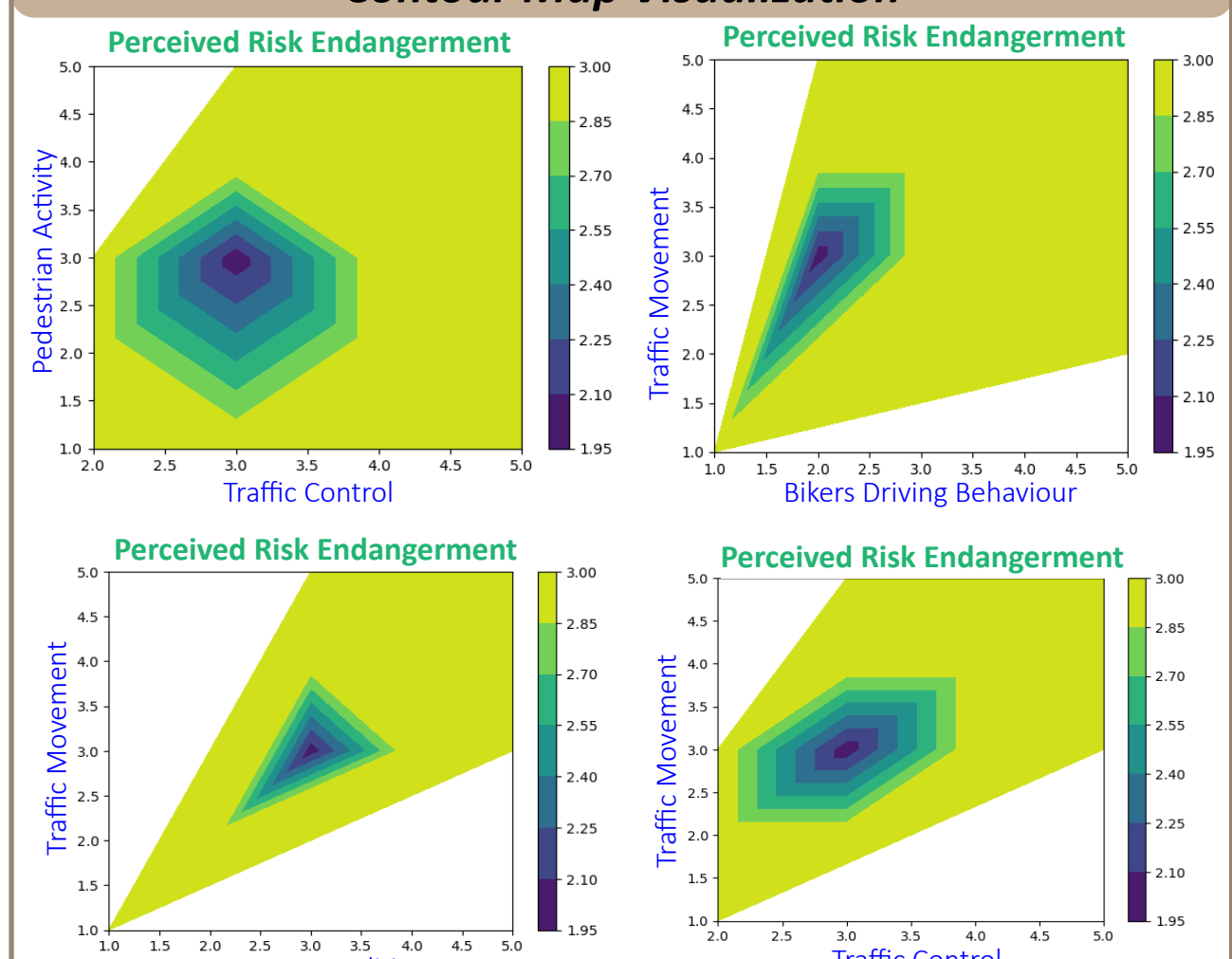
pedestrian activity

Prediction

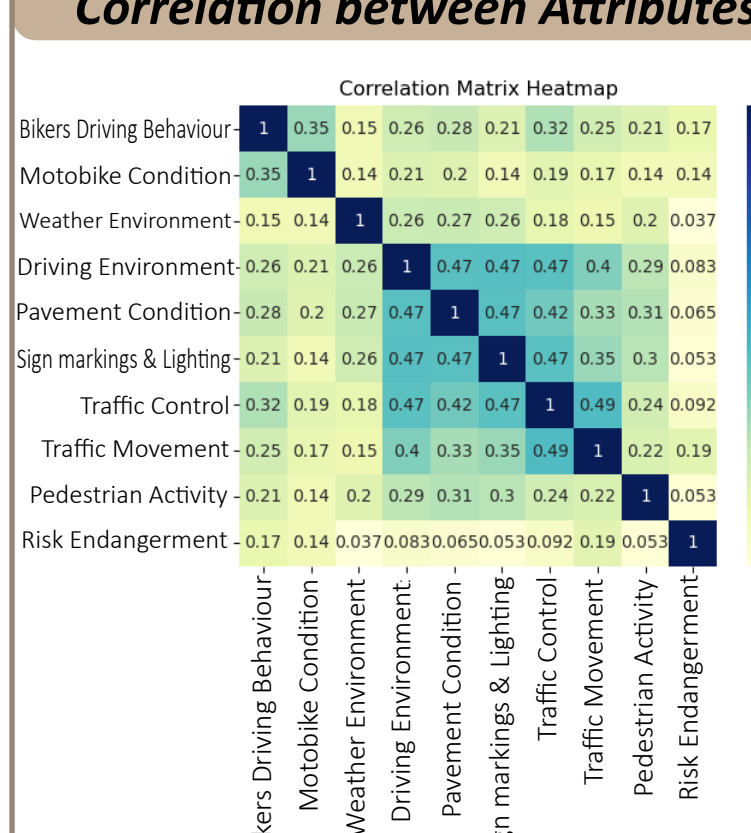
Research Outcome & Implications

- 01 The first work on perceived risk of motorbike accident & it can be used for future research to assess the perceived safety of other cities in developing countries.
- 02 Pedestrian, weather related features are not significant as actors of accident hotspots and perceived risk. General risk and driving environment factors are more dominant actors in hotspots whereas driving environment and driving behavior are more dominant imposing threats for perceived safety.
- 03 Presenting the attributes affecting Accident Experience & Perceived Risk and to examine the structural relationships among these attributes.
- 04 Ranking of attributes on the basis coefficient loading from SEM analysis.
- 05 Different models can be prepared with different sample size of different locations, usage criteria, occupation etc.
- 06 From contour map, Traffic control attribute is more dominant over pedestrian activity which tells pedestrian activity creates less impact on perceived safety.
- 07 Bikers driving behavior also creates more impact on perceived safety than traffic movement.
- 08 Pavement condition & traffic movement, traffic control & traffic movement create almost similar contribution on perceived safety.
- 09 Correlations between attributes from heatmap.
- 10 By collection of more specific data in model's Data Frame on respective region, user & planner can get risk level after introducing rating on the server website.

Contour Map Visualization



Correlation between Attributes



References

