INTERNATIONAL ROAD DYNAMICS INC.

QUARTERHILL TEAM MEMBER

UGANDA VIRTUAL WIM ENFORCEMENT PROJECT

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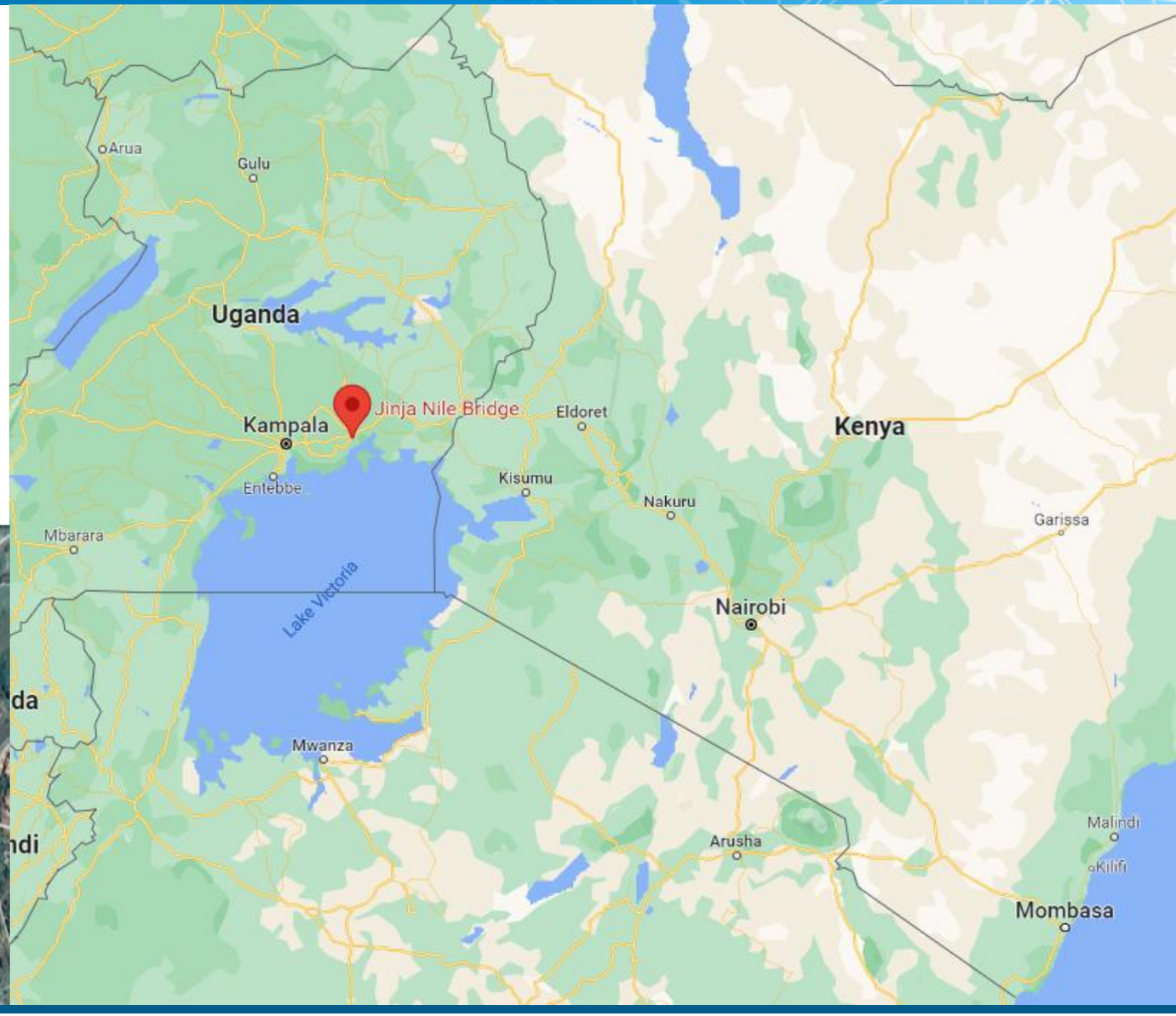
The Nile Bridge (Jinja) Project: Background

- Built across the River Nile, located at Jinja to:
  - Reduce traffic at the eastern part of Uganda
  - Ease road safety issues
  - Create a reliable and faster connection to other parts of the country
- The 5th largest bridge in Africa: 525m long and 22.9m wide
- The bridge was built to last for 120 years
- Serves as a tourist attraction

The Nile Bridge (Jinja) Project: Background

- Economic importance:
  - Uganda is a **landlocked country**, so the bridge serves as the major import and export route through the coast of Kenya (**Port Mombasa** precisely)

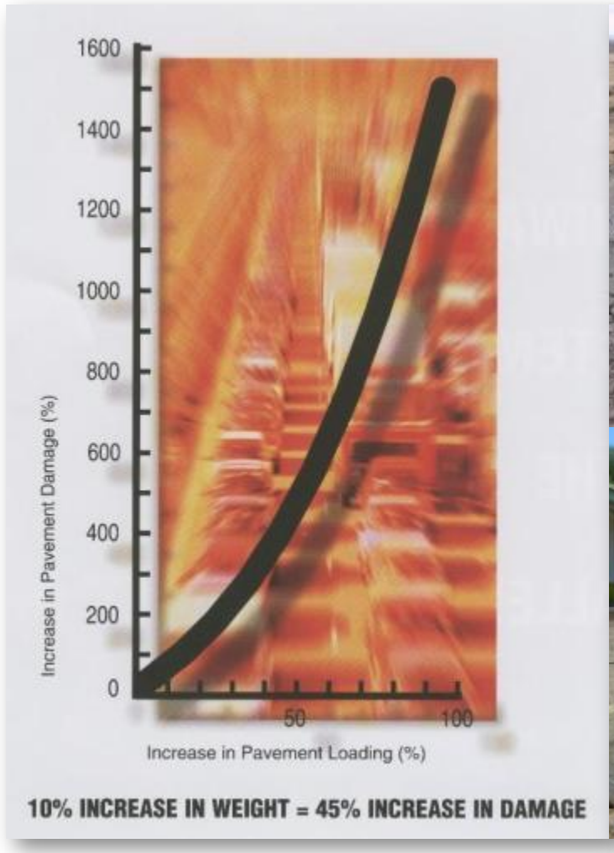


Overloaded Vehicles

- Commercial vehicle traffic at the bridge includes a high volume of heavy trucks transporting goods
- Axle overloading has ripple effect on premature pavement damage

Why WIM?

- Monitors heavy vehicles which cause greater **damage** to roads (damage increases **exponentially** by weight)[1]
- Integration with a Virtual Weigh Station (VWS) system allows law enforcement to **identify overweight** vehicles and target them for enforcement
- Quantifies the **traffic count**, **classification** and **weights** that the roadway is experiencing



1 Yiu, Yuen. 2020. "How Much Damage Do Heavy Trucks Do to Our Roads?" (online). Inside Science. 2020-10-12. https://www.insidescience.org/news/how-much-damage-do-heavy-trucks-do-our-roads

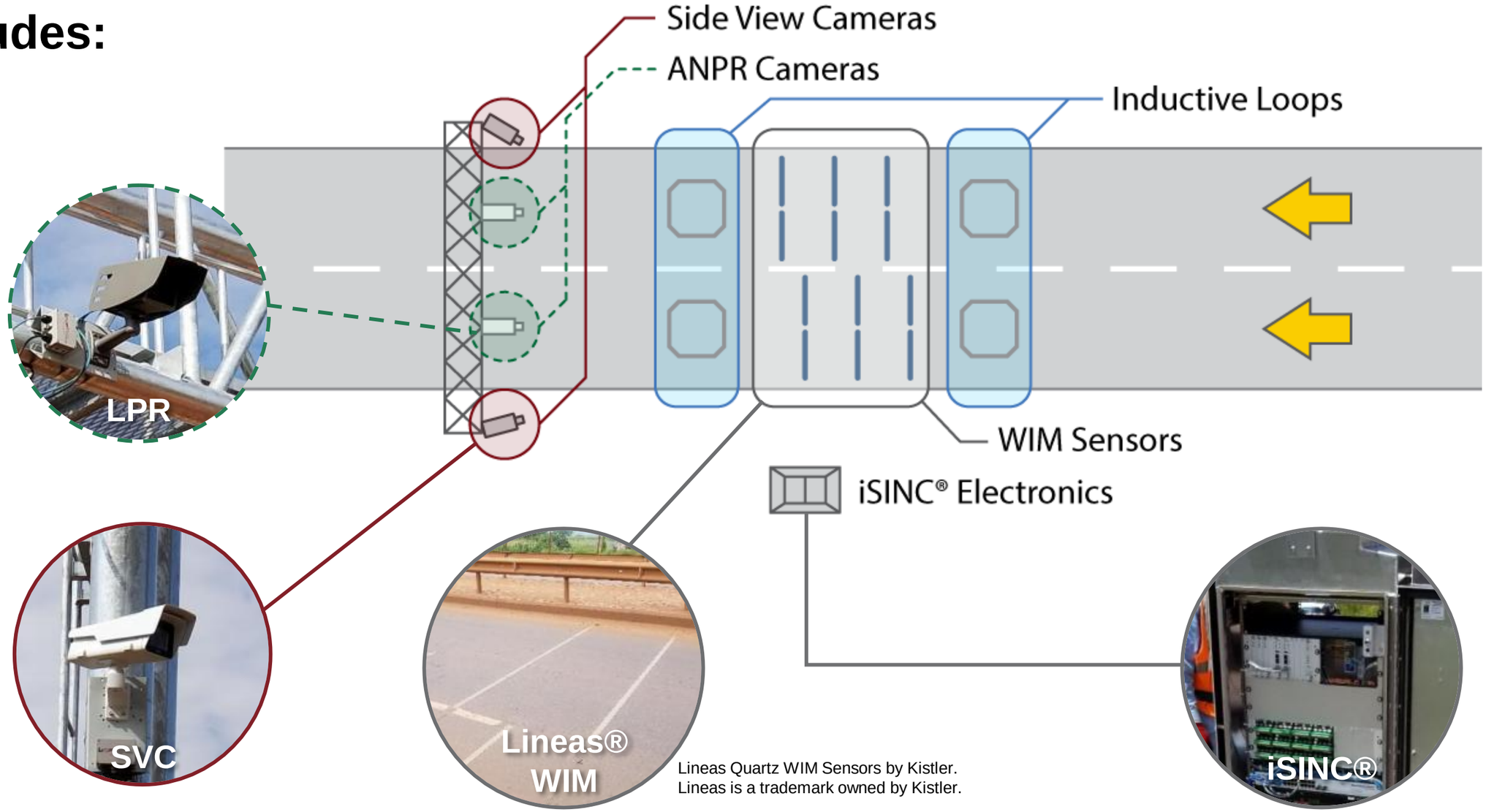
Adding WIM to the Project

- **WIM enforcement was not part of the original contract**
- WIM was recommended and included through a **supplementary budget** to **protect** the bridge structure and pavement from damage due to vehicle overload
- WIM systems were determined to be needed at **both approaches** to the bridge to protect the investment
- IRD was approached to recommend a solution that will **meet that objective**
- Through extensive **consultation and discussions**, we determined that a Virtual WIM system design would be most appropriate
- The recommendation was reviewed and approved by the chief project engineer and consultant

High Speed Virtual WIM Enforcement: SITE LAYOUT

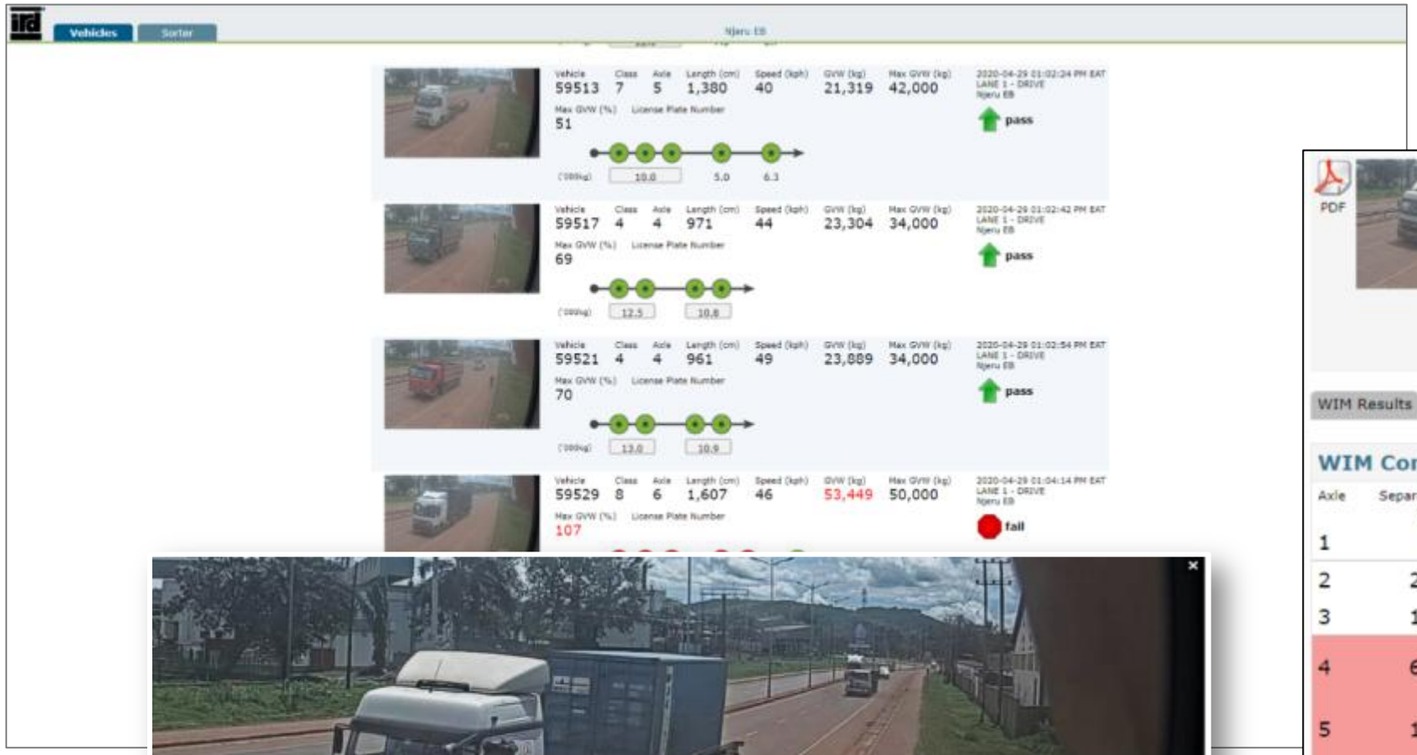
Each Side Includes:

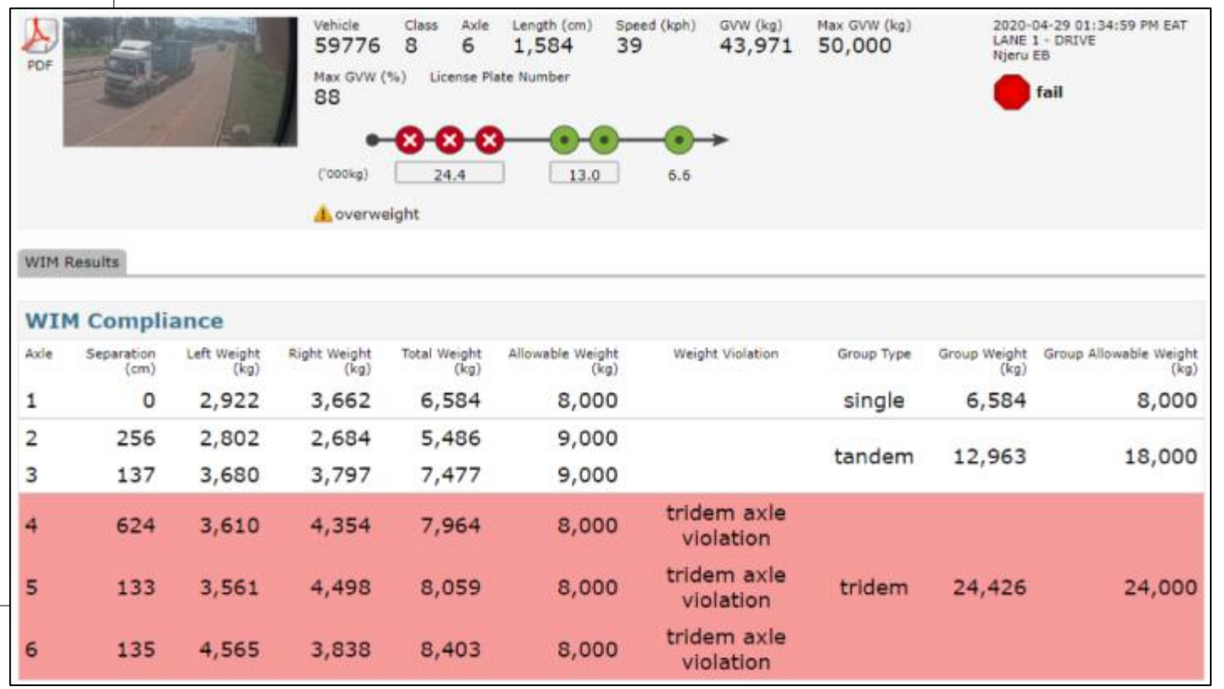
- ASTM Type III / COST 323 A[5] WIM accuracy
- Triple threshold Kistler Lineas® Quartz sensors
- Virtual Weigh Station (VWS) – web-based software
- VI2M™ data reporting
- iMMS™ maintenance management system
- Portable scales (SAWIII 15C) with static weighing software for use by UNRA's Mobile enforcement Team
- Off-scale detection functionality



Lineas Quartz WIM Sensors by Kistler.
Lineas is a trademark owned by Kistler.

VWS - Live Vehicle DISPLAY

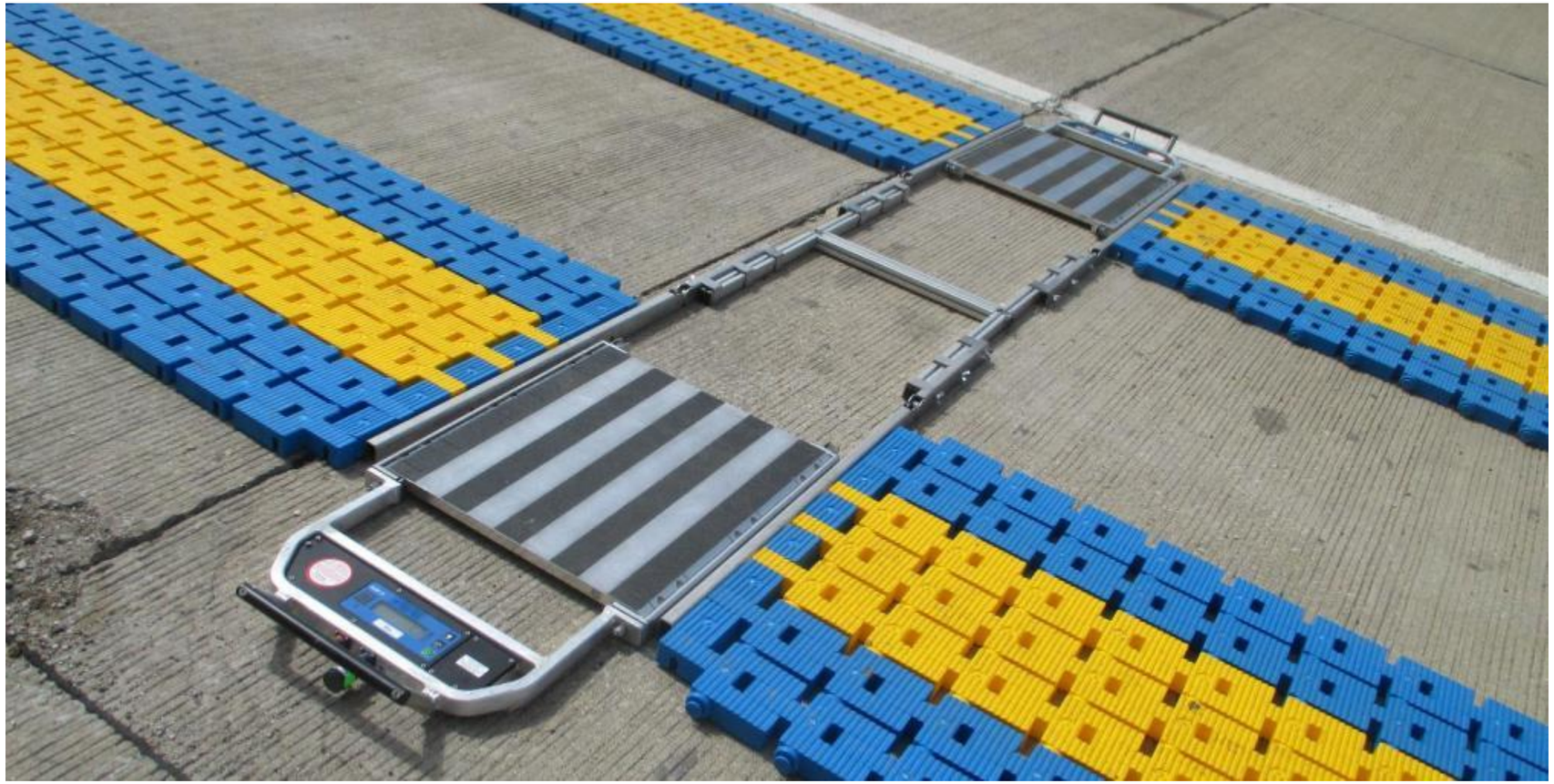




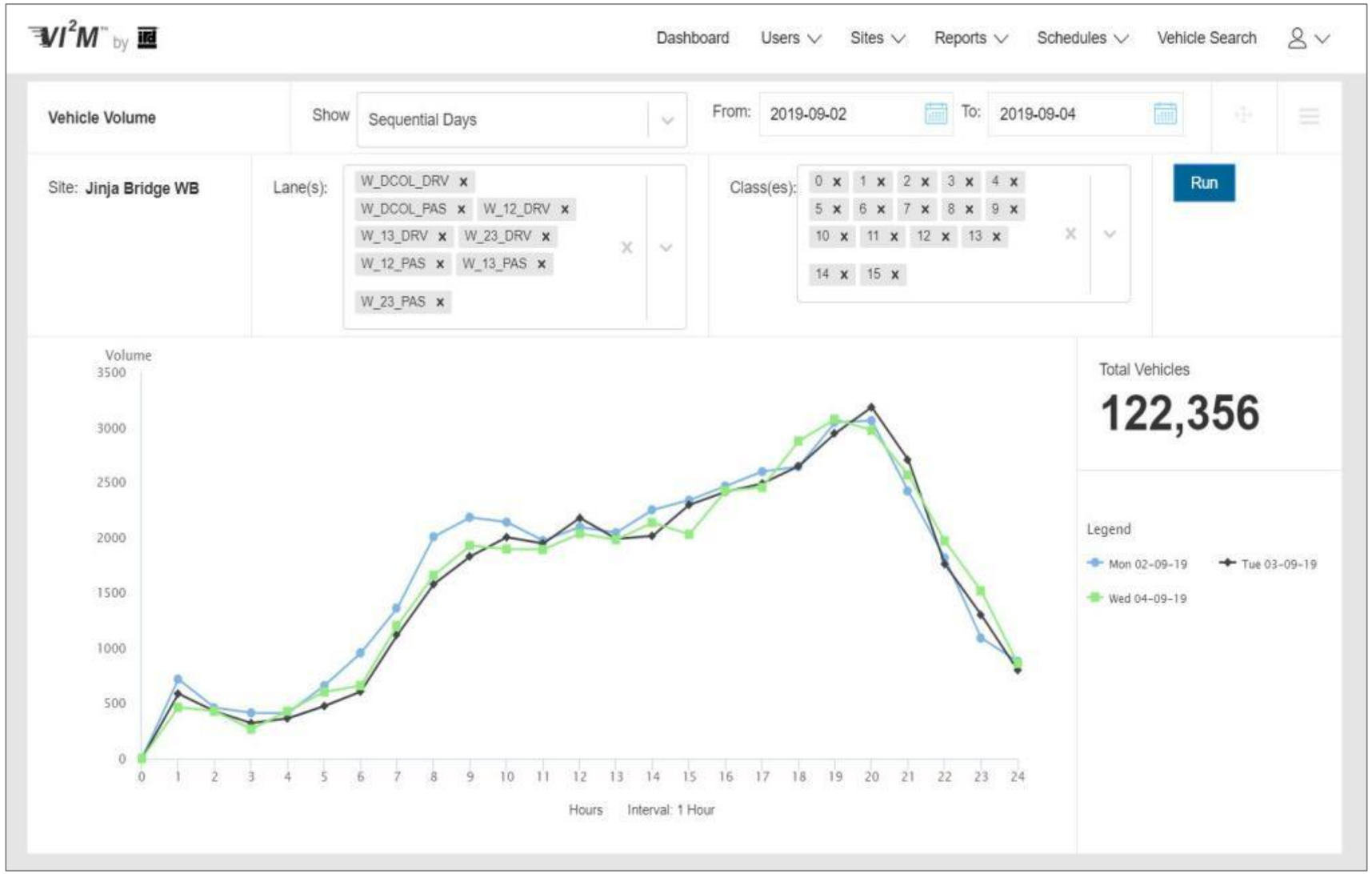
Axle	Separation (cm)	Left Weight (kg)	Right Weight (kg)	Total Weight (kg)	Allowable Weight (kg)	Weight Violation	Group Type	Group Weight (kg)	Group Allowable Weight (kg)
1	0	2,922	3,662	6,584	8,000		single	6,584	8,000
2	256	2,802	2,684	5,486	9,000		tandem	12,963	18,000
3	137	3,680	3,797	7,477	9,000				
4	624	3,610	4,354	7,964	8,000	tridem axle violation	tridem	24,426	24,000
5	133	3,561	4,498	8,059	8,000	tridem axle violation			
6	135	4,565	3,838	8,403	8,000	tridem axle violation			

Portable Scales Enforcement

- IRD SAW III Scales is being used for weighing by mobile enforcement teams who can issue overweight citations



VI²M™ Reports: Vehicle Volume/Class



VI²M™ Reports: Weight Violations (by hour)

Weight Violation by Hour

Site Jinja Bridge EB **Class** 0 to 15 **Date** 2020-Mar-01 to 2020-Mar-16
Lanes E_12_DRV, E_12_PAS, E_13_DRV, E_13_PAS, E_23_DRV, E_23_PAS, E_DCOL_DRV, E_DCOL_PAS

Hour	Total Non-Error Vehicles	Invalid Weight Vehicles	Good Weight Vehicles	No Weight Violation	Weight Violation	Weight Violation %	Steering Axle Violation	Single Axle Violation	Tandem Axle Violation	Tridem Axle Violation	Quadrem Axle Violation	Axle Balance Violation	Axle Group Individual Violation	Axle Group Combination Violation	Axle Unit Individual Violation	GVW Violation
0-1	2,345	724	1,621	1,204	417	25.72%	74	304	52	83	0	0	0	0	0	417
1-2	2,981	896	2,085	1,698	387	18.56%	61	243	78	101	0	0	0	0	0	387
2-3	5,465	1,550	3,915	3,534	381	9.73%	31	214	55	110	0	0	0	0	0	381
3-4	9,082	2,309	6,773	6,424	349	5.15%	42	239	48	79	0	0	0	0	0	349
4-5	17,758	3,948	13,810	13,440	370	2.68%	53	228	74	91	0	0	0	0	0	370
5-6	18,247	3,913	14,334	14,050	284	1.98%	61	132	75	106	0	0	0	0	0	284
6-7	15,223	3,150	12,073	11,805	268	2.22%	76	165	47	49	0	0	0	0	0	268
7-8	14,172	2,309	11,863	11,569	294	2.48%	63	186	52	85	0	0	0	0	0	294
8-9	14,142	2,656	11,486	11,126	360	3.13%	67	171	87	114	0	0	0	0	0	360
9-10	14,356	2,648	11,708	11,428	280	2.39%	39	118	59	115	4	0	0	0	0	280
10-11	13,238	2,859	10,379	10,093	286	2.76%	60	137	90	93	0	0	0	0	0	286
11-12	14,120	3,414	10,706	10,303	403	3.76%	98	171	106	126	4	0	0	0	0	403
12-13	13,876	3,438	10,438	10,117	321	3.08%	63	188	69	74	4	0	0	0	0	321
13-14	14,998	3,829	11,169	10,775	394	3.53%	71	196	89	132	0	0	0	0	0	394
14-15	15,295	3,764	11,531	11,144	387	3.36%	97	221	60	94	0	0	0	0	0	387
15-16	15,116	4,248	10,868	10,471	397	3.65%	94	150	105	146	0	0	0	0	0	397
16-17	14,480	4,005	10,475	10,082	393	3.75%	85	178	96	124	0	0	0	0	0	393
17-18	11,612	3,265	8,347	7,900	447	5.36%	104	195	144	139	0	0	0	0	0	447
18-19	9,473	2,627	6,846	6,390	456	6.66%	56	249	124	152	0	0	0	0	0	456
19-20	8,463	2,279	6,184	5,631	553	8.94%	152	316	117	104	0	0	0	0	0	553
20-21	6,383	1,751	4,632	4,196	436	9.41%	119	289	83	92	0	0	0	0	0	436
21-22	5,585	1,642	3,943	3,424	519	13.16%	129	365	87	92	0	0	0	0	0	519
22-23	3,445	966	2,479	1,989	490	19.77%	104	388	64	61	0	0	0	0	0	490
23-24	2,494	686	1,808	1,362	446	24.67%	105	396	29	26	0	0	0	0	0	446
Total	**262,349**	**62,876**	**199,473**	**190,155**	**9,318**	**4.67%**	**1,904**	**5,439**	**1,890**	**2,388**	**12**	**0**	**0**	**0**	**0**	**9,318**

Percent Vehicles with Warnings 24.0%

VI²M™ Reports: Weight Violations (by class)

Weight Violation by Class

Site Jinja Bridge EB **Class** 0 to 15 **Date** 2020-Mar-01 to 2020-Mar-16
Lanes E_12_DRV, E_12_PAS, E_13_DRV, E_13_PAS, E_23_DRV, E_23_PAS, E_DCOL_DRV, E_DCOL_PAS

Class	Total Non-Error Vehicles	Invalid Weight Vehicles	Good Weight Vehicles	No Weight Violation	Weight Violation	Weight Violation %	Steering Axle Violation	Single Axle Violation	Tandem Axle Violation	Tridem Axle Violation	Quadrem Axle Violation	Axle Balance Violation	Axle Group Individual Violation	Axle Group Combination Violation	Axle Unit Individual Violation	GVW Violation
0	0	0	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0
1	181,792	19,933	161,859	161,823	36	0.02%	7	31	0	0	0	0	0	0	0	36
2	29,120	5,448	23,672	18,493	5,179	21.88%	993	5,162	0	0	0	0	0	0	0	5,179
3	6,594	5,109	1,485	848	637	42.90%	298	9	374	0	0	0	0	0	0	637
4	1,342	748	594	368	226	38.05%	74	0	168	46	0	0	0	0	0	226
5	4,692	4,625	67	67	0	0.00%	0	0	0	0	0	0	0	0	0	0
6	827	651	176	158	18	10.23%	14	4	4	8	0	0	0	0	0	18
7	9,292	5,303	3,989	3,705	284	7.12%	167	209	16	137	0	0	0	0	0	284
8	16,699	9,348	7,351	4,537	2,814	38.28%	276	0	1,241	2,197	0	0	0	0	0	2,814
9	14	14	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0
10	101	100	1	1	0	0.00%	0	0	0	0	0	0	0	0	0	0
11	133	121	12	12	0	0.00%	0	0	0	0	0	0	0	0	0	0
12	615	542	73	36	37	50.68%	25	23	37	0	0	0	0	0	0	37
13	991	830	161	74	87	54.04%	50	1	50	0	12	0	0	0	0	87
14	10,137	10,104	33	33	0	0.00%	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0.00%	0	0	0	0	0	0	0	0	0	0
Total	**262,349**	**62,876**	**199,473**	**190,155**	**9,318**	**4.67%**	**1,904**	**5,439**	**1,890**	**2,388**	**12**	**0**	**0**	**0**	**0**	**9,318**

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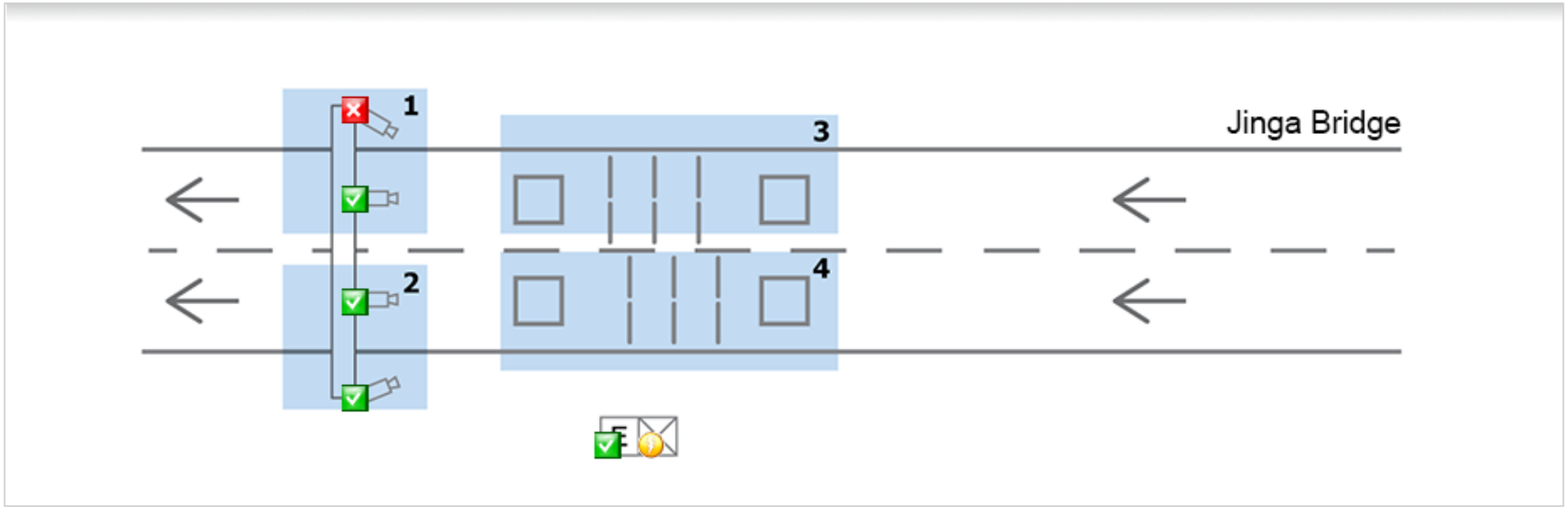
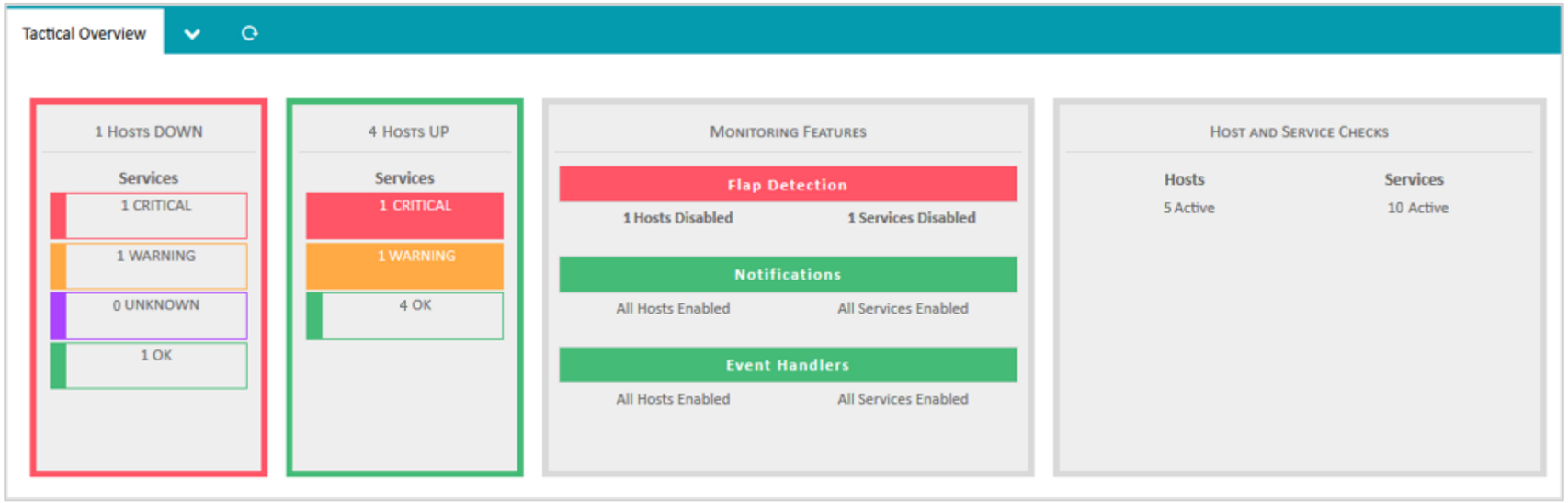
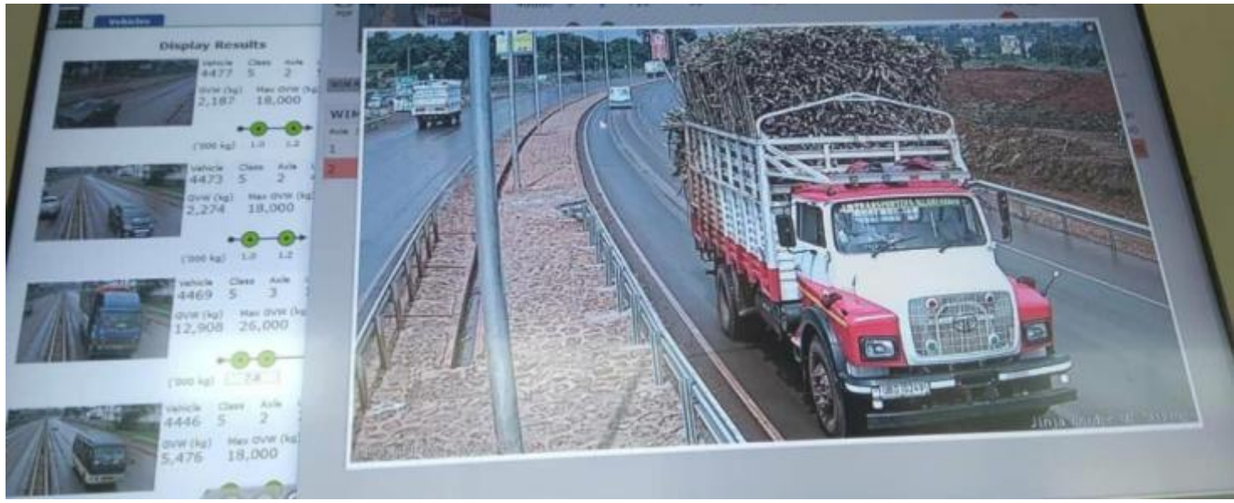
IMMS [intelligent Maintenance Management Service]





Positive Outcomes

- Effective, accurate enforcement operation
- Real-time traffic monitoring - viewable anywhere via internet
- Protects bridge and road infrastructure
- Measures bridge weight loading
- Generates data and reports for planning purposes
- Alternative to fixed weigh stations:
  - Economical – lower CAPEX/OPEX compared with traditional weigh stations



Project Partners/Team

THANK YOU

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