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IMPACT OF SPEED BREAKERS ON FOOD DELIVERY SYSTEM PERFORMANCE IN THE GIG ECONOMY: A VASAI-VIRAR PERSPECTIVE

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Abstract:

The food delivery system has grown considerably in the gig economy, and the bike driver's efficiency depends on road infrastructure for timely deliveries. The efficiency of the delivery system is hindered by various stop–and–go driving conditions due to speed breakers, turns, signals, traffic etc. This paper specifically deals with the stop–and–go conditions due to speed breakers in the Vasai-Virar region. The study gives the effects of fuel consumption and its efficiency and examines its impact on gig economy operation. The result shows that frequent speed breakers raise operation costs and drastically decrease efficiency. The estimated loss of Rs.18871.13 in a month and for a year total loss of Rs. 226465.66 for 100 active food delivery bike riders covering an average distance of 500 km per day is reported and with the increase of speed breakers from 50 to 500 the loss increases from ₹ 60,465.13 to ₹ 6,04,651.32 per year.

Keywords: *Gig economy, fuel efficiency, speed breaker, stop–and–go.*

Introduction:

The last few decades have shown a wide transformation in transportation, with services like Ola, Uber, Yulu, Trintrin, Smart Bike, MYBYK, COO Ride, Charered Bike, and Rapido. The market size in 2023 was around USD 32.42 Million and it is expected to rise at a CAGR of 5% by 2030 (Stellar, 2024) Food delivery services like Zomato, swiggy and others heavily depend on the network of gig workers, and today these services have become an integral part of the urban economy. The productivity of this work heavily depends on the conditions of roads, the excessive speed breakers in various areas of the Vasai – Virar region have been a matter of concern for delivery services, which raises fuel consumption, and delays in deliveries. This study investigates how these speed breakers affect the overall earnings, increase in operational cost and their effect on the gig economy

Methodology:

The study gives the primary data collected by field survey observations which were conducted on a 2 km stretch in Vasai region from Vasai road railway station area to Suncity to examine the impact of speed breakers.

The basic physics formulas were utilised to calculate fuel consumption dynamics due to the speed breaker. As per the theory, (Heywood, 2018) (NAG, 2017) (Heywood, 2018) various formulas to calculate the consumption dynamics are given below,

1. Energy loss in braking: The kinetic energy is converted into heat due to braking. The energy lost is given by,

$$E_{loss} = \frac{1}{2}mv_i^2 - \frac{1}{2}mv_f^2 \quad \cdots\cdots\cdots (1)$$

Where,

$E_{loss} \rightarrow Energy\ loss\ due\ to\ braking$

$m \rightarrow mass\ of\ vehicle.$

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$v_i \rightarrow intial\ velocity\ of\ the\ vehicle$

$v_f \rightarrow final\ velocity\ of\ the\ vehicle$

2. Energy Consumption during Acceleration:

$$E_{acc.} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \quad \cdots\cdots\cdots (2)$$

3. Efficiency of acceleration:
   i. Useful energy

$$E_u = \frac{1}{2}mv^2 \quad \cdots\cdots\cdots (3)$$

   ii. Total fuel energy input

$$E_f = \frac{E_u}{\text{Engine overall efficiency}} \quad \cdots\cdots\cdots (4)$$

   iii. Engine overall efficiency, $\eta_E = \left(\frac{E_u}{E_f}\right) \times 100 \quad \cdots\cdots\cdots (5)$

   iv. Fuel burned during acceleration $= \frac{E_f}{\text{Energy in petrol in } (\frac{MJ}{L})} \quad \cdots\cdots\cdots (6)$

Primary data used for the calculation of different related factors were used as the honda2wheelersindia specification sheet (Honda, 2024) given in Table 1.

Table No.1: Engine specification of Honda Shine 123.94cc

Sr. No.	Engine specification	Values
1	Displacement	123.94 cc
2	Maximum Engine output	7.9kV@7500 rpm
3	Maximum Torque	11 N-m @ 6000 rpm
4	Bore x stoke	500 x 63.121 mm
5	Compression ratio	10.01

Results and Discussion:

1. Increased Travel Time

As observed each speed breaker causes a delay of ~ 5 seconds. For a delivery location of Suncity from the source point of Shastri Nagar, Vishal Nagar and the area close to Vasai Road railway station, there are about 19-speed breakers on the route, which adds up to nearly 1 minute and 35 seconds of total delay per trip. If a driver completes an average of 20 deliveries daily, then the time lost per shift is around 27 minutes, this reduces the number of deliveries and losses are inevitable.

2. Fuel Efficiency and Cost Implications

The case study was done on Honda Shine 123.94 cc bike of mass 133Kg having fuel efficiency average of 45 km/hr. moving at an average speed of 40 km/hr (11.1 m/hr.) for a distance of 2km.

Table No. 2: Details of energy dynamics for different driving conditions

Sr. No.	Driving Conditions	Initial Speed (m/hr.)	Final Speed (m/hr.)	Energy
1	Energy Loss in Braking	11.1	5.56	$E_{loss} = 5.2$ kJ
2	Energy Consumption During Acceleration	5.56	11.1	$E_{acc.} = 5.2$ kJ

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As seen from Table no.2 the energy loss in braking was calculated by using equation (1) while passing over a speed breaker for a vehicle having an initial speed of 11.1 m/hr. and after crossing the speed breaker the speed reduces to 5.56 m/hr. the calculated loss in energy for braking is found to be 5.2 kJ, and using equation (2) the calculated energy consumption during acceleration for an initial speed of 5.56 m/hr. final speed of 11.1 m/hr. is 5.2 kJ. Since this is the same as the energy lost in braking therefore $E_{acc.} =$ 5.2 kJ.

Engine overall efficiency was calculated by using equation (3), (4), (5) and standard data specification given in table 1. The overall engine efficiency was found to be $\eta = 11.94\%$ which means that only 11.94% of fuel energy is used by the vehicle to accelerate and rest is lost due to the heating effect. To calculate the actual fuel energy required to regain speed is the formula given by (NAG, 2017),

$$\text{Actual fuel energy to regain speed} = \frac{E_{acc.}}{\eta}$$

The amount of extra fuel consumption added up for each speed breaker $= \frac{\left(\frac{E_{acc.}}{\eta}\right)}{\text{Energy content of petrol}}$

and additional fuel burned for reacceleration after breaking

= Number of speed breaker

× Amount of extra fuel consumption

Table No. 3: Fuel cost increase and losses incurred for 12 months

The total length of urban roads in Vasai Virar Region	**17830 km (VVMC, 2023) (OGDPlatform, 2022)**
Price of Fuel in Vasai Virar Region	Rs. 104
Extra fuel cost required per trip (1km Stretch)	0.01259 Rs./L
Extra fuel cost per day (50km) 25 such trips per day	0.3146 Rs./L
For 30 working days extra fuel cost	9.4361 Rs./L
For 100 active food delivery bike riders	943.61 Rs./L
For 500 km per day	6.2908 Rs./L
For 30 working days extra fuel cost	188.7213 Rs./L
For 100 active food delivery bike rider	18872.13 Rs./L
For period of 12 months (1 Year)	226465.66 Rs./L

Table No.3 gives the details of fuel consumption and the losses incurred. As per the data, the table shows the extra fuel cost required per trip of the distance of 1 km in which the rider has to overcome around 10-speed breakers. The extra fuel cost is Rs. 0.01259 per litre. If on average if rider carries out 2 such trips per day covering 50 km the estimated increase in cost of fuel is Rs.0.3146 per litre. If there are 100 active food delivery bike riders operational in the region the excess fuel utilization increases and the fuel cost increases by Rs. 934.61 per litre for 30 working days. The estimated loss of Rs.18871.13 in a month and for a year total loss is Rs. 226465.66 for 100 active food delivery bike riders covering an average distance of 500 km per day.

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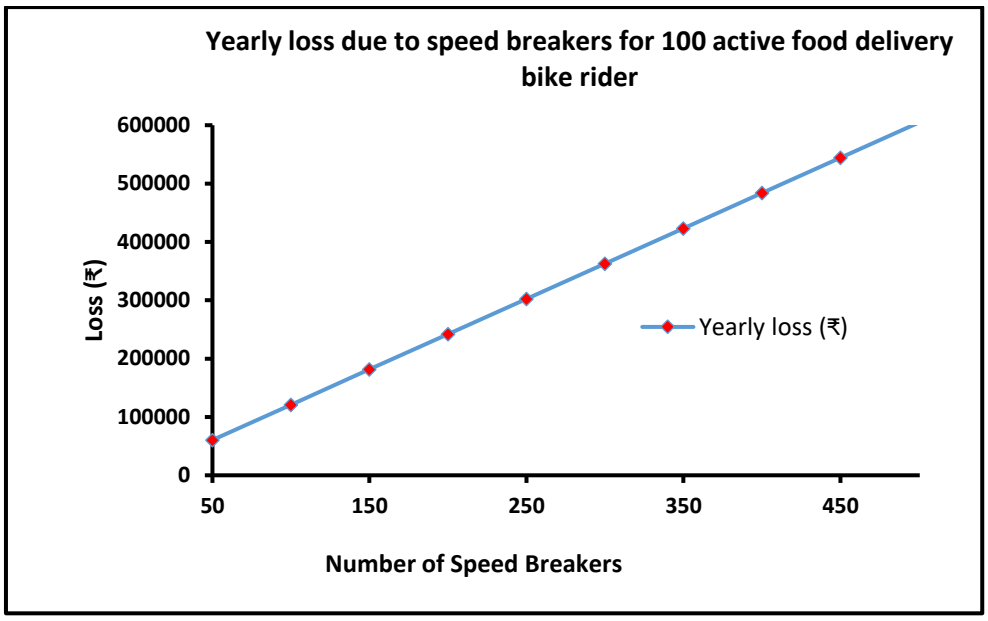

The breaking and acceleration dynamics due to the presence of excessive speed breakers reduce fuel efficiency due to a drop in mileage, which increases the additional burden of Rs. 188 to 200 per month in fuel cost per driver. Figure 1 shows that with the increase of speed breakers from 50 to 500 the loss increases from ₹ 60,465.13 to ₹ 6,04,651.32 per year. Thus we conclude that the presence of speed breakers impacts overall earnings and a total of additional Rs. 226464.66 per year is a loss which severely affects the gig economy.

Conclusion:

The study highlights how excessive placement of speed breakers can negatively impact the gig workers' earnings and efficiency by reducing a number of deliveries per shift and increasing fund expenses. So to overcome this loss the following recommendations are put forward;

1. Optimization of speed breaker placement to balance safety and efficiency.
2. Fuel cost reimbursement to riders working in areas with large number of speed breakers.
3. Switching to electric bikes.

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Conflicts of Interest:

There is no conflict of interest to declare.

Authors Contributions:

MPT - Conceptualize, Writing Original draft, Writing Review draft, Analysis, visualisation; **PAK** – Resources, Writing Original draft, Analysis ,Supervision, Data curation; **PJD** – Conceptualize, Writing Original draft, Validation, Analysis.

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