Optimizing Q-commerce Delivery: Unravelling The Interplay of Fee, Penalty, and Rider-Platform Collaborative Efforts

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Introduction

Traditional Supermarkets

The initial stage of retail with physical stores.

Quick-commerce Services

The latest development offering rapid delivery.

E-commerce Platforms

The shift to online shopping with broader access.

2010-11:

2025:

Introduction

Dark Store

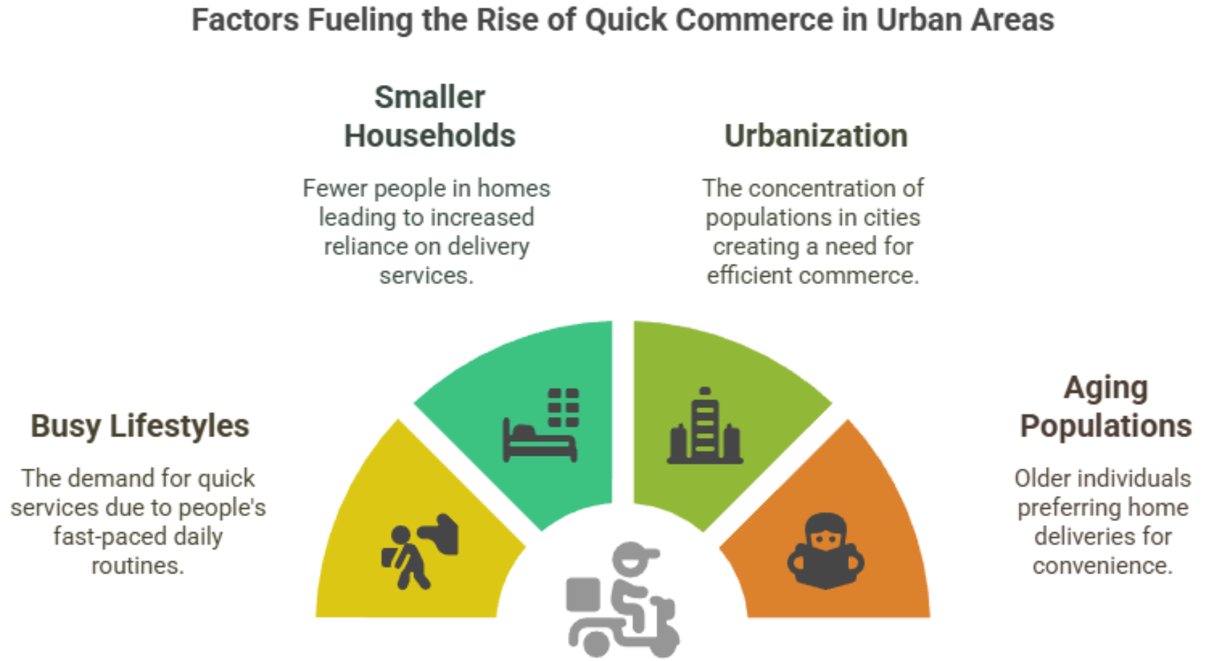
→ smaller in size

→ 300 to 5000 square feet of space

→ densely populated residential areas

→ within a radius of 3–4 km

→ small orders of high-demand products



Introduction

Challenges faced by delivery riders:

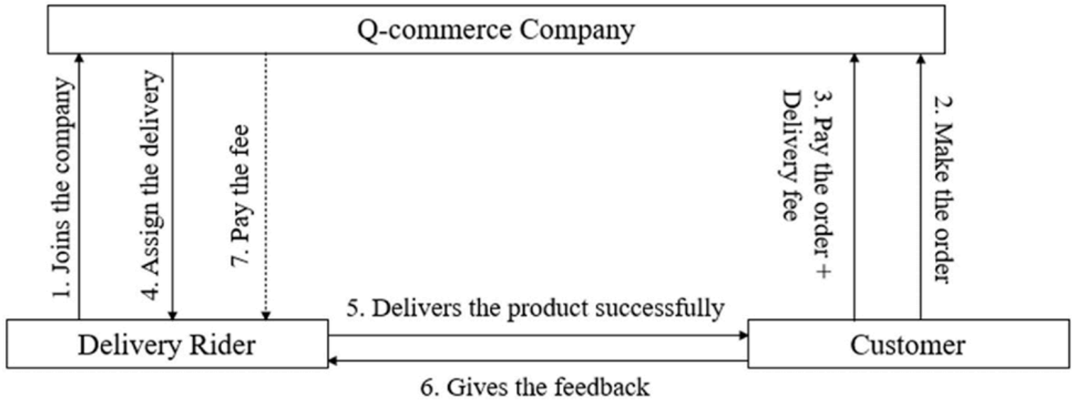
→ Job Insecurity

→ Pay Fluctuations

→ Low / No Base Pay

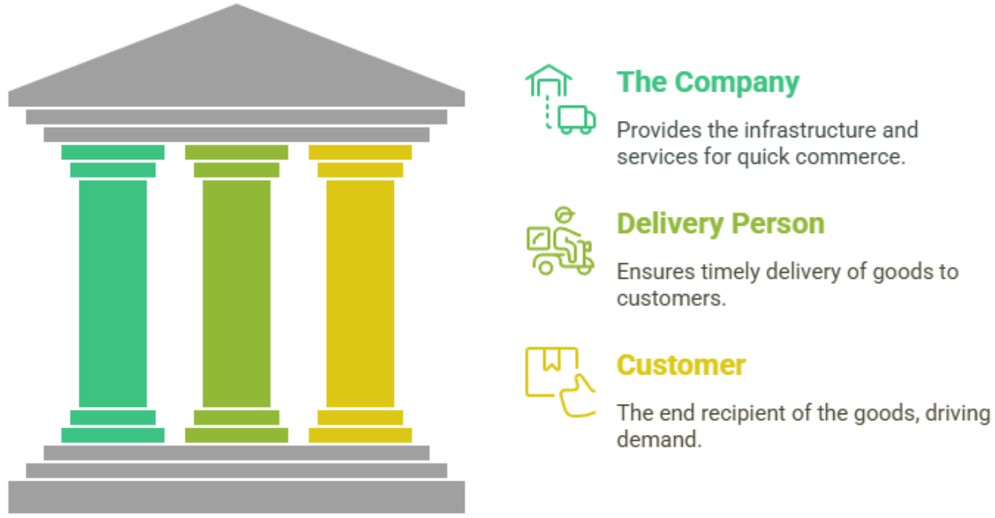
→ Long Working Hours

→ Increased Operating Cost



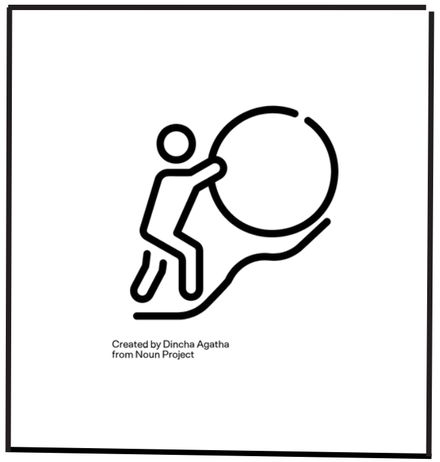
Challenges faced by Q - commerce companies

→ Delivery partners frequently switch companies



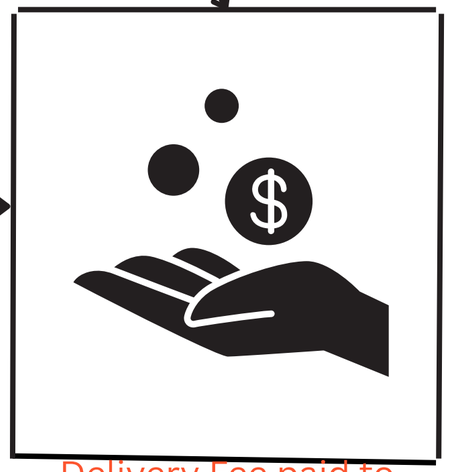
Research Questions

i)



Effort By Company

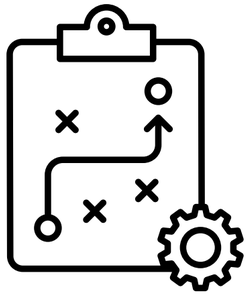
Effort By Delivery Partner



Delivery Fee paid to the partner

ii)

max



Strategy

Company

+

Delivery Partner

iii)

Performance of company

Penalty

Performance of delivery partner

Model Formulation and Analysis

Interaction between a Q-commerce company and a delivery rider

Under 2 different setups:

- with penalty
- without penalty

Joint Effort Function

$$\rho(a, b) = \delta a + \eta ab$$

a -Rider's Effort

b -Qcommerce Company's Effort

δ -Effectiveness of the rider's own effort

η -Synergy between the rider's effort and the Qcommerce company's effort

δa -Impact of rider's individual effort

ηab -Complementary effect of combined efforts

Assumptions:

- Effort levels normalized between 0 and 1
- $(\delta + \eta) \leq 1$

Non Penalty Setup - Rider's Perspective

$$\Delta_{DR} = (f - e)[\rho(a, b)] - da^2$$

$$\Delta_{DR} = (f - e)[\delta_a + \eta_{ab}] - da^2$$

Δ_{DR} -Payoff of the Rider

f -Delivery fee of the rider

e -Self-disbursement cost incurred by the rider

d -Constant associated with cost of effort of the rider

da^2 -Quadratic effort cost

Rider maximizes payoff by optimizing effort **a**

Non Penalty Setup - Qcommerce Company's Perspective

$$\Delta_{Qcomm} = (s - f)\rho(a, b) - qb^2$$

$$\Delta_{Qcomm} = (s - f)(\delta_a + \eta_{ab}) - qb^2$$

Δ_{Qcomm} -Payoff of the Company

f -Delivery fee of the rider

s -Total benefits to the Q-commerce company from the successful delivery

q -Constant associated with cost of effort of the Q commerce company

qb^2 -Quadratic cost of effort of the company

Company maximizes payoff by setting **f** and effort **b**

Penalty Setup - Rider's Perspective

The probability of the rider being liable for the penalty

$$\Pr(v > t) = 1 - \Pr(v < t) = \left(1 - \frac{t}{V}\right)$$

where $v \in U(0,V)$ and t is the threshold

$$\Delta_{DR}^{t} = (f - e - t)\,(\delta a + \eta a b)\left(1 - \frac{t}{V}\right) - d a^2$$

Δ_{DR} -Payoff of the Rider

f -Delivery fee of the rider

e -Self-disbursement cost incurred by the rider

d -Constant associated with cost of effort of the rider

da^2 -Quadratic effort cost for rider

V - Maximum perceived customer loss

Rider maximizes payoff by optimizing effort **a**

Penalty Setup - Qcommerce Company's Perspective

$$\Delta^{t}_{Qcomm} = (s - f)\,(\delta a + \eta ab)\left(1 - \frac{t}{V}\right) - qb^2$$

Δ_{Qcomm} -Payoff of the Company

f -Delivery fee of the rider

s -Total benefits to the Q-commerce company from the successful delivery

q -Constant associated with cost of effort of the Q commerce company

qb^2 -Quadratic cost of effort of the company

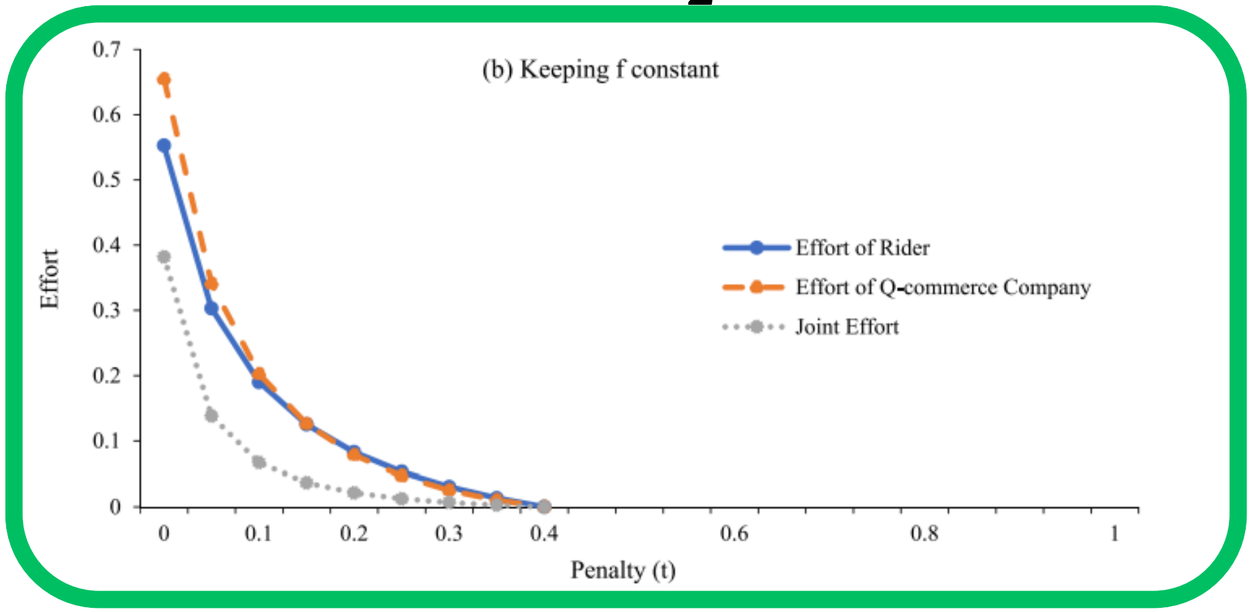
Company maximizes payoff by setting **f** and effort **b**

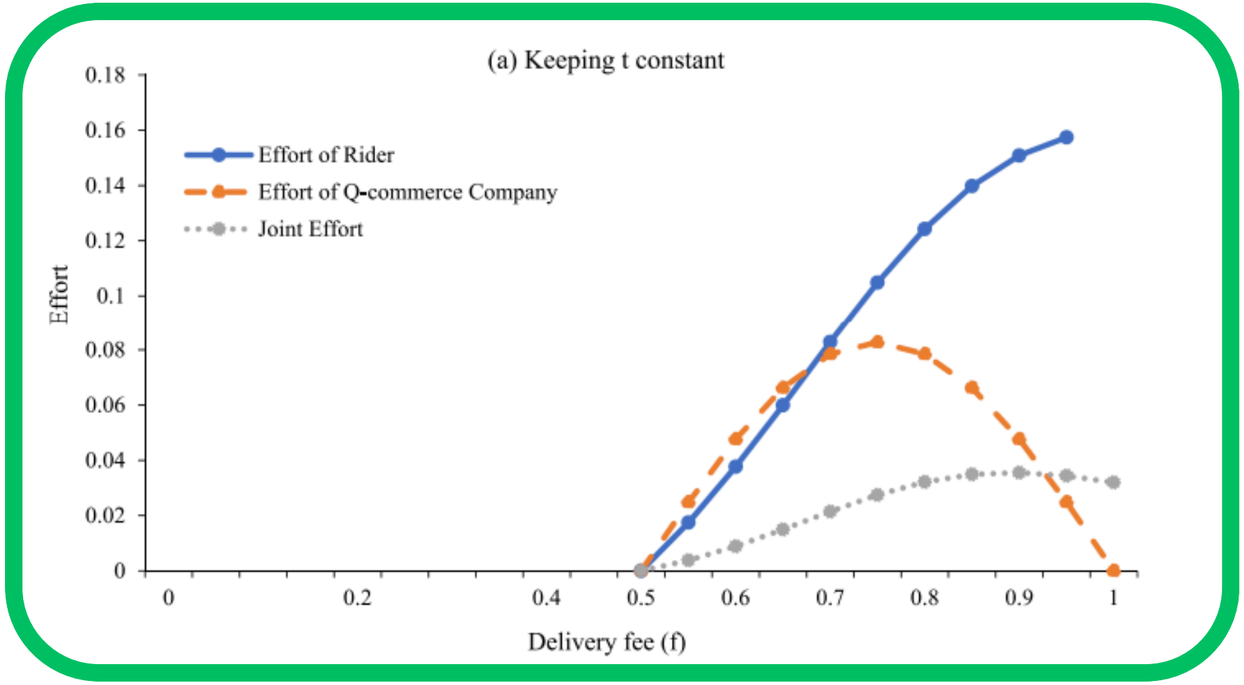
Company and rider interaction with penalty mechanism

- Effort increases with *f* up to an optimal point

$$t^* = \frac{(V + 2f - 2e)}{3}$$

$$f^* = \frac{(s + e + t)}{2}$$





- Higher **t** reduces efforts if **f** is fixed
- Optimal penalty balances motivation and retention

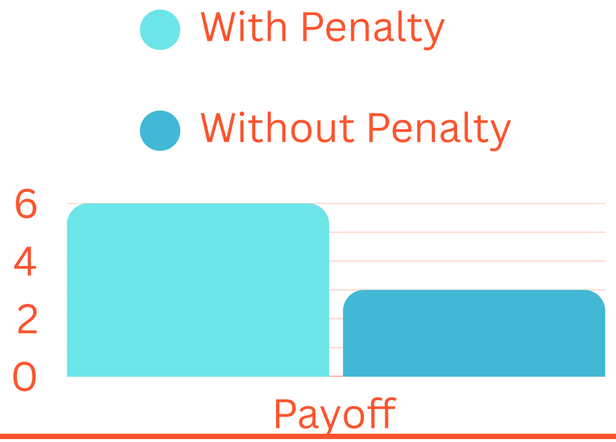
Reasons for Penalties in Q-commerce

Why Impose Penalties in Q-commerce?

- Late Deliveries: Missing the 10-20 min window
- Low Customer Satisfaction: Poor ratings or complaints
- Order Cancellation: Rejecting or failing to complete orders
- Traffic Violations: Speeding or unsafe driving
- Equipment Issues: Poor bike/phone maintenance
- Fraudulent Behavior: Faking deliveries or misreporting

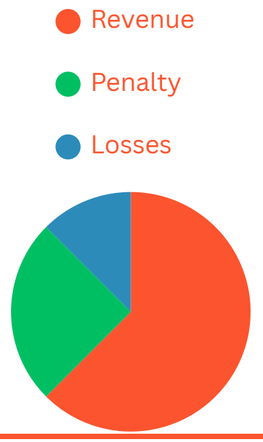
Financial Impact: Reduced earnings: Penalty *t* cuts payoff

- Increased Effort: Higher effort to avoid penalties, but at some cost
- Motivation vs. Stress: Drives timeliness but risks burnout or unsafe rushing
- Retention Risk: High ***t*** may push riders to quit or switch platforms
- Behavioral Shift: Selective order acceptance to minimize penalty risk



How Penalties Affect Q-commerce Companies

- Improved Service Quality: Higher rider effort boosts success rate
- Financial Benefit: Penalty revenue offsets losses
- Customer Satisfaction: Fewer delays enhance reputation and retention
- Risk of Rider Turnover: High ***t*** may reduce rider pool, disrupting operations
- Operational Complexity: Managing penalties requires monitoring and fairness



Side-by-side comparison:

Aspect	**Simultaneous Effort**	**Penalty-Based**
Decision Timing	Joint effort after fee	Rider reacts to potential penalty
Rider Incentive	Boosted by synergy (η)	Suppressed by penalty (t)
Effort Outcome	α, b increase with trust	α decreases with t
Optimal Control	Fee $f^* = \frac{s+e}{2}$	Penalty $t^* = \frac{V+2f-2e}{3}$
Managerial Tip	Collaborate	Penalize moderately

Implications for Practice in Q-commerce

1. **For Delivery Riders:**
    - Better payoffs
        - Overall combined payoff for customer and rider.
    - Seek prior commitment of effort from company
    - Informed decision-making weighing the balance between penalty and delivery fee.
2. **For Q-Commerce:**
    - Provide prior effort commitment:
        - health and wellbeing - workers
        - bike insurance
        - loans
        - trainings
    - Place optimal penalty
    - Optimal Delivery Fee and Effort

Conclusion

- How dynamic of mutual support can help to boost increased revenue generation
- Developed analytical model for two different decision-making model
    (i)With Penalty
    (ii)Without Penalty

Future Work

- AI/ML based algorithms to help in predicting the demand and optimizing the delivery fee
- Appropriate location of dark stores
- Investigate purchasing behaviour of customers, promotional offers and flash sales
- Develop a three-player game theoretic model also involving customer

Reference

Raj, A., & Das, D. (2025) Optimizing Q-commerce delivery: Unravelling the interplay of fee, penalty, and rider-platform collaborative efforts. International Journal of Production Economics, 281, p.109503