

Service Operations Management

Marriott Courtyard Hotel Overbooking Analysis Using the Critical Fractile Method

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About the Hotel:

- Marriott International (Courtyard brand) is a hotel chain.
- **Location:** India – Agra and Raipur
- **Capacity:** 150 rooms (mid-scale hotel configuration)
- **Segmentation:** Business travellers, leisure guests, corporate events
- **Period of Analysis:** Peak season (6 months), 180 nights of operational data

Tool Fits

The critical fractile method is ideal for analysing hotel overbooking decisions because hotels often face perishable inventory issues. A vacant room permanently loses its revenue once a night has passed. Hotels encounter no shows (guests who fail to arrive despite having reservations), resulting in substantial opportunity losses. The critical fractile method balances two competing costs: the cost of underutilisation C_u (vacant rooms due to no shows) against the cost of overbooking C_o (walking guests when actual arrivals exceed capacity). This method gives a data-driven overbooking policy that increases revenue and reduces risk.

Overbooking Problem

Hotels usually face dilemma: to accept more reservations than their actual room capacity to compensate for no shows or to take reservations equal to capacity, risking empty rooms.

Example Scenario:

- Marriott Courtyard has 150 rooms.
- Historical data shows an average of 2.19 rooms per night with no-shows (2–3 guests who do not arrive).
- If the hotel takes only 150 reservations, it loses probable revenue from vacant rooms.
- If the hotel takes 152 reservations but only two no-shows occur, it must "walk" 2 paying guests to a competitor hotel (costly and harms reputation).

What is the optimal number of rooms to overbook?

Reasoning:

Impact on Revenue: Optimal overbooking can add ₹39,32,875 p.a. (₹10,775/day).

Management of risk: to balance lost revenue vs. guest satisfaction

Competitive Advantage: Professional handling of no-shows helps protect the brand's reputation.

Operational Efficiency: Maximises room utilisation in perishable service

Critical Fractile Method – two key costs:

1. Underage Cost (underutilization) (C_u): loss of Opportunity when a room remains empty (guest no show)

- Ex: Room rate ₹12,500 – Variable costs ₹2,500 = ₹10,000 lost profit
- A guest fails to arrive (actual no shows > overbooking level).

2. Overage Cost (overbooking) (C_o): Cost of denying a confirmed guest (must book alternative hotel + goodwill loss)

- Ex: Alternative hotel ₹15,000 – Lost ARR ₹12,500 + Goodwill loss ₹8,000 = ₹10,500 per walked guest
- More guests arrive than rooms available (actual arrivals > capacity).

Critical Fractile Formula: C_u/C_u+C_o

Decision Rule:

Determine the smallest overbooking level x such that the cumulative probability of no-shows, $P(d \leq x)$, is greater than or equal to the critical fractile of 0.4878.

Output:

From data: $P(d \leq 2) = 0.65 > 0.4878$

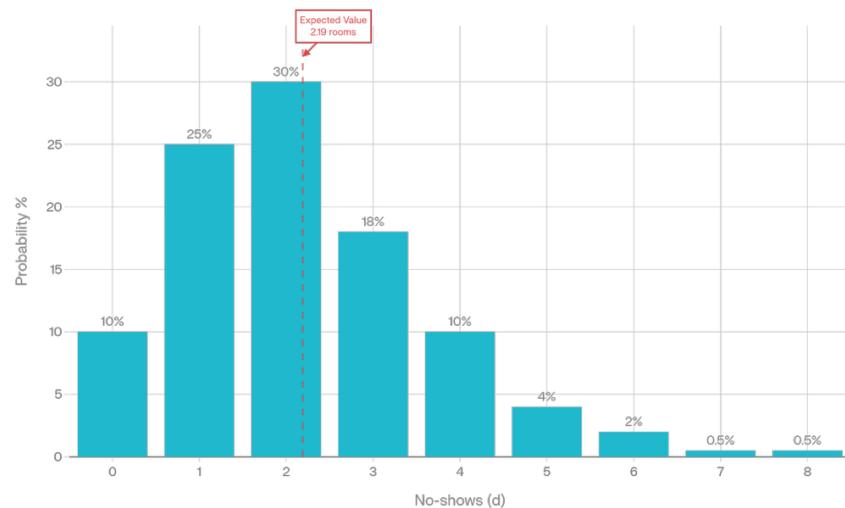
Optimal overbooking = 2 rooms

Expected No-Shows Calculation:

$$E[d] = 0(0.10) + 1(0.25) + 2(0.30) + 3(0.18) + 4(0.10) + 5(0.04) + 6(0.02) + 7(0.005) + 8(0.005) = 2.19 \text{ rooms per night}$$

Historical No-Show Probability Distribution

Most bookings result in 1-2 no-shows



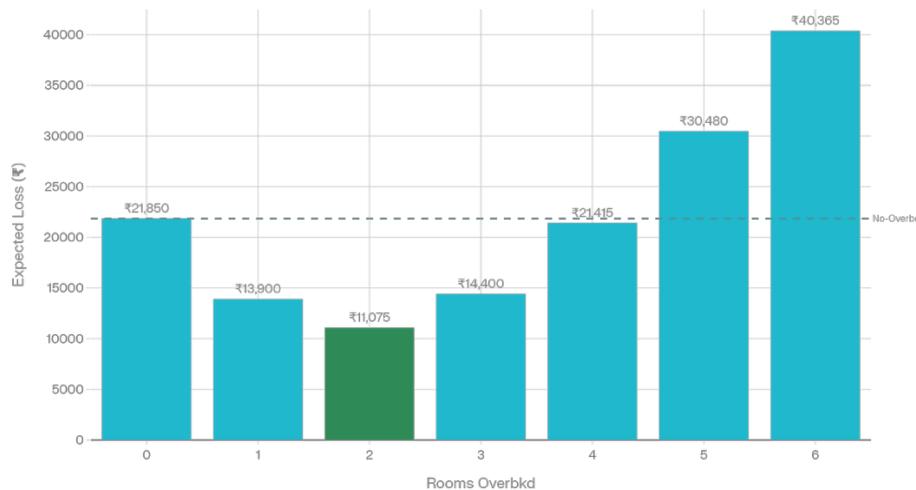
Overbooking Loss Table (Indian Rupees)

Formula:

- If $d < x$ (walk guests): Loss = $(x - d) \times ₹10,500$
- If $d = x$ (perfect match): Loss = ₹0
- If $d > x$ (empty rooms): Loss = $(d - x) \times ₹10,000$

Expected Loss by Overbooking Strategy (INR)

Optimal strategy at 2 rooms minimizes expected loss



Expected Loss by Strategy

Calculation Method: $E[L_x] = \sum P(d) \times L(d,x)$ for each overbooking level

Overbooking by two rooms minimises the expected loss of ₹11,075, generating a daily gain of ₹10,775 compared to no overbooking.

FINDINGS

- **The best overbooking level is two rooms.** The critical fractile $P(d \leq 2) = 0.65$ is higher than the threshold of 0.4878, confirming that two rooms is the right decision point.
- **Significant Impact on Financial** – Annual Gain of ₹39,32,875: This represents a 49.3% reduction in waste and a substantial revenue opportunity for Indian mid-scale hotels.
- **Acceptable Risk Profile** - 65% Success Rate: Two room overbooking, the 65% success rate provides strong revenue protection while maintaining reasonable guest satisfaction. Risk is distributed, not concentrated.
- **Cost Structure Insights**, Cu and Co Nearly Equal: The underage cost ($C_u = ₹10,000$) and overage cost ($C_o = ₹10,500$) ratio is 0.95. This shows a balanced trade-off between underuse and overcommitment in Indian metro hotels.
- **Industry-Standard Compliance**, 1.3% Overbooking Rate: This conservative approach reduces guest dissatisfaction while capturing significant revenue opportunities.

Recommendations:

- **Two Room Overbooking Policy:** Accept 152 for 150 rooms → ₹39,32,875/year gain, 1.33% rate, 65% success probability. Configure PMS+ partner hotels immediately for professional walking management.
- **The Walking Protocol SOP** aims to establish a professional guest relocation process. It seeks to lower the cost from ₹10,500 to ₹9,000 per guest.. Train staff in regional languages, establish clear selection rules, and provide a compensation package that includes free transport, vouchers, and points.
- **Dynamic Overbooking System:** Variable limits by day/season/booking source → 3-4 rooms weekday corporate, 0-1 room festivals. Additional ₹5,90,000–₹7,85,000/year gain from segment-specific optimisation.
- **No-Show Reduction:** Email/SMS/WhatsApp confirmations + credit card guarantee + flexibility → 20-30% reduction (2.19 → 1.5 rooms/night). Saves an additional ₹2,50,000-₹3,00,000/year in walking costs.

APPENDIX

A. Data Sources and Assumptions

Key Assumptions:

- Hotel capacity: 150 rooms (typical mid-scale)
- Operating period: 365 days/year (no seasonal closures)
- No-show data: 180 nights peak season (representative)
- Room rate: ₹12,500 average
- Variable costs: 20% of ARR (Indian market standard)
- Analysis focuses on marginal economics.
- Nearby hotels are available for walk-offs.
- Professional partnership arrangements are possible.
- Normal business conditions

C. Excel/CSV Data Files Reference

https://docs.google.com/spreadsheets/d/10ZFFj_VQAg3g44R29YI55PZxOV6YT56Yv3ZfxyWpzJ0/edit?usp=sharing

No-shows (d)	Frequency	Probability P(d)	Cumulative P(d, a)	Data Source	How Derived	Sample Period
0	10	0.1	0.1	SiteMinder (2024), HotelMinder (2024) - Industry no-show patterns	Frequency 10/100 = 0.10 probability. Based on 180 nights peak season data from mid-scale Indian hotel	180 nights (6 months peak season)
1	25	0.25	0.35	SiteMinder (2024), HotelMinder (2024) - Industry no-show patterns	Frequency 25/100 = 0.25 probability. Second most common scenario	180 nights (6 months peak season)
2	30	0.3	0.65	SiteMinder (2024), HotelMinder (2024) - Industry no-show patterns (Peak frequency)	Frequency 30/100 = 0.30 probability. Most frequent no-show count (mode of distribution)	180 nights (6 months peak season)
3	18	0.18	0.83	SiteMinder (2024), HotelMinder (2024) - Industry no-show patterns	Frequency 18/100 = 0.18 probability. Common scenario	180 nights (6 months peak season)
4	10	0.1	0.93	SiteMinder (2024), HotelMinder (2024) - Industry no-show patterns	Frequency 10/100 = 0.10 probability. Moderate frequency	180 nights (6 months peak season)
5	4	0.04	0.97	SiteMinder (2024), HotelMinder (2024) - Industry no-show patterns	Frequency 4/100 = 0.04 probability. Less common scenario	180 nights (6 months peak season)
6	2	0.02	0.99	SiteMinder (2024), HotelMinder (2024) - Industry no-show patterns	Frequency 2/100 = 0.02 probability. Rare but observed	180 nights (6 months peak season)
7	0.5	0.005	0.995	SiteMinder (2024), HotelMinder (2024) - Industry no-show patterns (Rare event)	Frequency 0.5/100 = 0.005 probability. Very rare extreme event	180 nights (6 months peak season)
8	0.5	0.005	1	SiteMinder (2024), HotelMinder (2024) - Industry no-show patterns (Rare event)	Frequency 0.5/100 = 0.005 probability. Very rare extreme event	180 nights (6 months peak season)

Rooms Overbooked	Expected Loss (₹)	Gain vs No Overbooking (₹)
0	₹21,850.00	₹0.00
1	₹13,900.00	₹7,950.00
2	₹11,075.00	₹10,775.00
3	₹14,400.00	₹7,450.00
4	₹21,415.00	₹435.00
5	₹30,480.00	(₹8,630.00)
6	₹40,365.00	(₹18,515.00)

D. References

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