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How Hotel Layout Shapes Staff Circulation: A Multi-Layer Space Syntax Protocol

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Abstract: ***Most hotel design rules are about making guests feel comfortable, arranging rooms, and making the hotel look good. Research in hospitality usually focuses on things like staff costs, how many rooms are filled, and how much money the hotel makes. But hardly anyone looks at how the hotel's layout and staff movement fit together, so we don't really know how the floor plan changes the way staff work. This study wants to find out how hotel layout affects the daily work of housekeeping and food and beverage staff. We'll look at five to eight full-service hotels in Delhi NCR, using different ways to collect information. We'll check the buildings, make separate maps for guest and staff routes, and follow staff as they move between places like kitchens, storage, and waste rooms. We'll also talk to staff and managers about what they experience. By looking at travel times and comparing different hotels and staff, we hope to see what parts of the layout make work easier or harder. Instead of just guessing, this study will test these ideas and give a simple guide for linking design choices to how hotels actually work every day.***
Keywords: Hotel Architecture, Spatial Configuration, Space Syntax, Operational Efficiency, Service Circulation, Staff Movement, Mixed-Methods Protocol

I. INTRODUCTION

In a full-service hotel, guests and staff use different parts of the building. Guests go through main areas like lobbies and hallways, while staff have their own paths through service passages, lifts, pantries, kitchens, and storage rooms. Most guides focus on planning rules and making guests happy [1]. Research in hospitality often looks at things like money, how many rooms are filled, and how staff perform [2]. Even though some studies talk about staff stress and workload [3], not many people think about how the hotel's layout changes daily work for staff.

We can learn about staff movement in hotels by looking at hospitals. In healthcare, studies show that how far nurses walk and how wards are set up changes their work [4], [5]. Hotels are similar because staff also move between places like linen rooms, lifts, and kitchens. Where these rooms are placed changes how much staff have to walk and where things get crowded. But hotel work is not the same as hospital work, so we can't just assume the same rules work for both without checking.

Space Syntax is a group of tools that help measure how buildings are set up [6], [7]. People have used it to study how people move in offices and public spaces [8]–[10]. Some say it doesn't always match real walking distances or how people actually move [11], [12]. Most studies using Space Syntax look at visitors, not staff doing their daily work, so we still don't know if these tools are good for understanding staff movement.

A. Problem Statement

Very little work has been done on hotel layouts, staff movement and staff workload in the same hotel. That gap will be confirmed through the systematic literature review described in Section II-A and will be further narrowed down following the screening process.

B. Research Objectives and Questions

This study has four main goals (Table I). First, we want to see how hotel layout changes the way staff move. Second, we'll look for design features that cause problems or slow things down between guests and staff. Third, we'll compare different types of hotels to see how layout and daily work are different. Last, we want to make a simple guide that helps connect early design choices to what hotels really need to work well.

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TABLE I
OBJECTIVES, RESEARCH QUESTIONS, METHODS, AND CONTRIBUTIONS

Objective & RQ	Data & Analytical Method	Intended Contribution
Obj 1 / RQ1: Layout vs. staff circulation	Dual-layer Space Syntax graphs + route shadowing; route-level linear mixed model (LMM).	Architectural: Defines route-relevant spatial descriptors for back-of-house (BOH) planning.
Obj 2 / RQ2: Features driving bottlenecks	Site audit + guest/service graph overlap + route wait and encounter coding.	Spatial: Models guest and service circulation as separate and overlapping graph layers.
Obj 3 / RQ3: Cross-typology comparison	Descriptive cross-case matrix across 5–8 typologies with effect sizes and 95% CIs.	Operational: Measures circulation workload directly instead of relying on rules of thumb.
Obj 4 / RQ4: Planning–operations guide	Convergent joint display merging route LMM, survey scales, and interview themes.	Methodological: Uses nested route-level modelling to support inference across few buildings.

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

A. *Systematic Literature Review Protocol*

A structured literature search has been developed across the three databases (Scopus, Web of Science and ScienceDirect) with manual citation searching and hospitality planning reports (Table II). Screening, full text review and final study selection will be captured in a PRISMA 2020 flow diagram at the end of the search.

TABLE II
SYSTEMATIC LITERATURE REVIEW SEARCH STRATEGY AND ELIGIBILITY CRITERIA

Protocol Element	Search and Screening Specification
Databases	Scopus, Web of Science, ScienceDirect, plus backward and forward citation searching.
Primary Query	TITLE-ABS-KEY (hotel* AND (layout OR "spatial configuration" OR "space syntax" OR circulation OR "floor plan") AND (staff OR employee* OR housekeeping OR "back-of-house" OR workload OR efficiency OR "operational performance"))
Companion Queries	Searches pairing "space syntax" with workplace or hospital circulation, and "walking distance" with hotel housekeeping.
Filters	Peer-reviewed journal articles and conference papers in English; foundational texts retained manually.
Inclusion Criteria	(1) Studies linking building layout or geometry to staff movement, service circulation, or workload; (2) studies using explicit spatial metrics.
Exclusion Criteria	(1) Papers focused only on guest marketing or satisfaction without movement data; (2) non-hotel building types.

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B. Architectural Planning and Hospitality Efficiency Streams

Most hotel planning guides say to keep front-of-house and back-of-house routes separate, put service areas in the centre, and place kitchens near dining areas and linen stores near guest rooms [1]. These rules are based on tradition, but they have rarely been tested to see if they actually make staff work easier or faster.

In hospitality management research frontier models estimate hotel level technical efficiency from labour, capital and room count against revenue or occupancy [2] with no measurement of internal layout. The same applies to workload studies which use the Job Demands–Resources model [3] or a multi-dimensional approach such as NASA-TLX [13] to capture the level of strain experienced, without any reference to the building layout.

C. Healthcare Precedents and Space Syntax Capabilities

Studies of ward layout suggest that the way the space is designed and arranged will have an impact on the amount of effort required by staff to do their daily work. Hendrich et al. [4] looked at the time nurses spent on various activities across 36 hospital units and found that a large proportion of their time was spent walking. Ulrich et al. [5] looked at the relationship between ward layout and staff outcomes. Pachilova and Sailer [14] looked at 31 NHS wards using Space Syntax measures based on visibility and found that a communication index predicted care quality, whilst walking distance did not. That finding is a warning against the assumption that shorter straight line distance will necessarily lead to better operational performance.

Space Syntax measures a range of relational layout properties (connectivity, integration, choice and intelligibility) [6]–[10], [15]–[17]. Critics have pointed out that axial graphs neglect physical distance, doors, service carts and lift waiting times [11], [12]. A recent scoping review of Space Syntax in the tourism context also reveals that the existing research is very much focused on the flows of tourists through the urban environment rather than the flows of staff within the hotel itself [18].

D. Research Disconnections and Theoretical Propositions

Three gaps drive this study: (1) measurement mismatch (layout is measured on the plans, operations are assessed via hotel level averages or surveys); (2) layer conflation (guest and service paths are folded into one graph, BOH routes are ignored); and (3) confounding (building size, staffing, service style and management are almost never looked at in conjunction with the floor plans (Table III)).

TABLE III
RESEARCH GAP MATRIX FROM LITERATURE STREAMS

Research Stream	Key Variables & Methods	Primary Limitation for Hotel Operations
Hotel Planning Guidance [1]	FOH/BOH zoning, service cores, room modules; normative precedent.	Rules of thumb rarely tested against measured staff travel times or workload.
Hotel Efficiency [2]	Labour, capital, rooms vs. revenue/occupancy; frontier models.	Internal building geometry treated as an unmeasured black box.
Occupational Workload [3], [13]	Job demands, resources, perceived effort; self-report surveys.	Spatial origins of physical walking and detour strain not operationalised.
Healthcare Layout [4], [5], [14]	Walking shares, visibility graphs, ward layout; time-and-motion.	Clinical care logic differs from hotel housekeeping and F&B workflows.
Building Space Syntax [8]–[12]	Integration, connectivity, depth; justified graphs vs. movement.	Service layers rarely modelled; critiques note metric distance omission.

Six theoretically derived propositions (Table IV) underpin our planned tests which are structured across three distinct levels of inference: Association (the covariation between layout and route metrics), Mechanism (how the available paths determine distance, conflict and effort, explored via shadowing and interviews) and Causation (this is not claimed at all as the study is observational and cross-sectional).

TABLE IV
THEORETICAL PROPOSITIONS, HYPOTHESISED MECHANISMS, AND PROTOCOL TESTS

Prop.	Hypothesised Relationship & Mechanism	Primary Analytical Test
P1	Longer shortest-path distance increases base walking duration and service travel time.	Fixed effect β1 in route-level LMM (log travel time).
P2	Higher detour ratio (observed ÷ shortest path) reflects discontinuous BOH corridors and dead ends.	Audit correlation + fixed effect β2 in route-level LMM.
P3	Higher guest/service overlap (GSO) increases guest–staff encounters and perceived conflict.	Route GSO/encounter counts + staff GC scale regression.
P4	Perceived staff workload correlates with objective route exposure after controlling for staffing/occupancy.	Staff-level cluster-robust regression of WL on route exposure.
P5	Topological metrics add explanatory power beyond metric distance and detour ratio (open question).	Nested model comparison (AIC/BIC) adding syntax terms.
P6	Between-hotel variation reflects non-spatial factors (size, staffing, service model, management).	LMM control covariates + reflexive thematic analysis.

III. METHODS

A. Research Design and Sampling Frame

We'll be using a mixed methods comparative case study design [19] with convergent integration of quantitative and qualitative data [20]. The individual hotel will be the case and floors, service routes and staff will be the embedded units of analysis. Five to eight full service hotels (40 to 180 rooms; 3 star to 5 star) will be recruited from the Delhi NCR region under a single municipal building code via purposive maximum variation sampling across the six layout types (Tables V and VI). Cross case inference will be analytic rather than statistical.

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TABLE V
SAMPLING FRAME, RECRUITMENT TARGETS, AND ELIGIBILITY CRITERIA

Sampling Element	Planned Protocol Specification
Study Setting	Delhi-NCR metropolitan region under unified commercial building bylaws.
Case Sample Size	5 to 8 full-service hotels representing distinct layout typologies (3-star to 5-star).
Inclusion Criteria	Operating full-service hotel; 40–180 rooms; in-house kitchen, housekeeping, and ≥1 F&B outlet; verified floor plans; management consent; ≥24 months operation; no structural changes in past 12 months.
Exclusion Criteria	Hotels under renovation; serviced apartments; outsourced kitchen/housekeeping; properties lacking service lifts or verifiable plans.
Staff Survey	Operational staff (housekeeping, F&B, kitchen, porters/maintenance, FOH supervisors) with ≥3 months tenure; census target ≥15 responses per hotel.
Manager Interviews	2–4 key managers per hotel (General/Operations Manager, Executive Housekeeper, Executive Chef/F&B Manager, Chief Engineer) until adequate information power.
Route Shadowing	20–25 time-stamped route observations per hotel across morning/evening shifts and high/low occupancy days (target N = 120–160 routes).

TABLE VI
TARGET HOTEL LAYOUT TYPOLOGIES FOR MAXIMUM-VARIATION SAMPLING

Layout Typology	Spatial & Service-Core Geometry	Hypothesised Circulation Vulnerability
Double-Loaded Corridor	Linear guest wings flanking a central corridor with end or mid-span service cores.	Long horizontal push distances from linen stores and peak checkout lift queues.
Atrium / Courtyard	Perimeter corridors overlooking a central atrium void or open courtyard.	Extended perimeter loop lengths and visual/physical FOH–BOH path overlap.
Tower & Podium	Vertical guestroom tower rising above a horizontal public and BOH podium.	High dependence on vertical service lifts and transfer bottlenecks at podium levels.
Podular / Cluster	Guest rooms grouped into semi-autonomous pavilions around distributed nodes.	Discontinuous BOH passages between clusters requiring returns to main spine.
Heritage Conversion	Adaptive reuse of historic structures with irregular plates and retrofit cores.	High topological depth, level changes, narrow doors, and elevated detour ratios.
Hybrid Low-Rise	Low-rise wings and dispersed F&B/banquet blocks linked by horizontal connectors.	Long kitchen-to-outlet transit runs and cross-zone coordination delays.

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B. Architectural Audit and Multi-Layer Graph Analysis

CAD or PDF floor plans will be compared to actual building conditions during an on-site architectural audit (Table VII). Using DepthmapX, two coders will each create FOH guest graphs, BOH service graphs, and combined graphs separately. They will report how much their results match (percent agreement and Cohen's kappa) before resolving any differences. Table VIII lists the operational definitions for all spatial, movement, perceptual, and control variables. Table IX explains the theoretical meanings of Space Syntax and metric predictors.

TABLE VII
PHYSICAL ARCHITECTURAL AUDIT CHECKLIST AND RECORDING INSTRUMENTS

Audit Domain	Inspected Spatial Elements	Recording Method
Zoning & Boundaries	Physical separation between FOH guest zones and BOH service corridors; fire/security doors.	Annotated CAD/PDF plans + photo log.
Vertical Circulation	Count, dimensions, and landing access of service lifts and service staircases.	Plan verification + laser distance meter.
Horizontal Corridors	Clear corridor widths, cart turning radii, dead-end branches, and pinch points.	Laser distance meter + plan markup.
Level Changes & Doors	Steps, ramps, split-level transitions, and manual/fire-rated doors on service paths.	Walkthrough tally sheet + photo record.
Resource & Storage	Locations of main kitchen, floor pantries, linen rooms, stores, and waste holding.	Adjacency audit + shortest-path trace.

TABLE VIII
OPERATIONALISATION OF SPATIAL, MOVEMENT, PERCEPTUAL, AND CONTROL VARIABLES

Construct	Variable	Operational Definition & Source
Zoning	FOH/BOH separation	Share of BOH corridor length physically separate from guest circulation (0–1) [Plans, audit].
Service continuity	Corridor continuity	Longest connected service-only path ÷ total service-network length [Plans].
Vertical circulation	Lift accessibility	Mean shortest path (m) from service spaces to nearest service lift; lifts per 100 rooms [Plans, audit].
Corridor form	Dead ends	Configuration class; count and mean length (m) of dead-end branches [Plans].
Kitchen–outlet	Path & barriers	Shortest path (m), level changes, and doors from kitchen pass to service points [Plans, audit].
Housekeeping	Store-to-room path	Shortest path (m) from linen/housekeeping store to farthest and median guest room [Plans].
Storage	Storage access	Mean shortest path (m) to central/floor storage from served rooms or outlets [Plans].

Construct	Variable	Operational Definition & Source
Space Syntax	Topological metrics	Connectivity, integration, choice, intelligibility, and mean depth on guest, service, and combined graphs [Plans, DepthmapX].
Movement	Distance & detour	Observed path length (m); detour ratio = observed ÷ shortest path length [Observation].
Movement	Travel time & backtracks	Net movement duration (s) excluding task work; count of rule-coded backtracks [Observation].
Conflict	Guest/service overlap	GSO = route length on guest-accessible segments ÷ total route length; guest encounter count [Observation, plans].
Objective efficiency	Task durations	Minutes per room turned; ticket-to-table time; labour hours per occupied room if supplied [Observation, records].
Staff perception	Seven survey scales	Mean scores on 1–5 Likert scales (CD, UW, AS, GC, CO, OE, WL; Appendix A) [Survey].
Controls	Contextual covariates	Room count, star category, occupancy, shift staffing, service model, department, tenure [Records, interviews].

TABLE IX
THEORETICAL MEANING OF SPACE SYNTAX AND METRIC PREDICTORS

Spatial Measure	Basis	Operational Meaning & Directionality
Connectivity	Topological (local)	Immediate path alternatives from a node; reflects local routing flexibility (neutral hypothesis).
Integration	Topological (global)	Systemic centrality (inverse mean depth); desirable for guest areas, not assumed optimal for BOH (neutral hypothesis).
Choice	Topological (betweenness)	Frequency of lying on shortest paths; identifies shared links and congestion bottlenecks (neutral hypothesis).
Intelligibility	Topological correlation	Correlation of local connectivity with global integration; indicates wayfinding clarity for new staff (neutral hypothesis).
Shortest-path distance	Metric (m)	Direct physical travel length between origin and destination; primary indicator of base walking effort.
Guest/service overlap	Combined metric ratio	Proportion of service route traversing guest spaces; empirically quantifies FOH/BOH separation.

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C. Route Observation, Staff Survey, and Interviews

Time-stamped route shadowing (Appendix B) will cover five core service workflows across shifts and occupancy levels (Table X). A pilot in one hotel will test inter-observer reliability using intraclass correlation coefficients (ICC) for durations and Cohen's kappa for event coding, while repeated shadowing will reduce staff reactivity.

TABLE X
OPERATIONAL ROUTE-SHADOWING CATEGORIES AND STRATIFICATION MATRIX

Workflow Category	Department	Origin–Destination & Stratification
Room Turnover & Linen	Housekeeping	Floor pantry / linen store ↔ guest rooms; morning checkout & afternoon shifts; high/low occupancy.
Kitchen-to-Outlet / Room Service	F&B & Kitchen	Main kitchen pass ↔ restaurant / guest room doors; meal peaks & off-peak periods.
Vertical Lift Transfers	Multi-department	BOH staging landings ↔ guest floors; peak morning linen/waste bank vs. midday off-peak.
Storage Replenishment	Stores / Kitchen / HK	Central receiving / main store ↔ floor pantries; scheduled morning/afternoon supply cycles.
Waste & Soiled Linen	HK / Stewarding	Guest floors / outlets ↔ BOH waste holding / laundry chute; post-checkout & post-meal clearing.

We will use a 22-question survey (see Appendix A) to understand how staff feel about their work, drawing on ideas from NASA-TLX [13] and the Job Demands–Resources model [3] (Table XI). After getting feedback from experts, talking through the questions with a few people, and testing the survey, we will check how reliable the results are using two common measures [21]. We will also talk to managers in interviews that last about half an hour (Appendix C). These conversations will be recorded, written out word for word, and then carefully analysed by two researchers to look for common themes [22].

TABLE XI
VALIDATION PLAN FOR STAFF SURVEY SCALES

Construct (Code)	Items	Theoretical Basis & Planned Psychometrics
Circulation Difficulty (CD)	4	Architectural barrier literature; expert review, cognitive interviews, ω, α, item–total r.
Unnecessary Walking (UW)	3	Time-and-motion backtrack studies; expert review, cognitive interviews, ω, α, item–total r.
Service Space Access (AS)	3 (R)	Service-core adjacency principles [1]; expert review, cognitive interviews, ω, α, item–total r.
Guest/Service Conflict (GC)	3	FOH/BOH separation principles; expert review, cognitive interviews, ω, α, item–total r.
Coordination Difficulty (CO)	3	Cross-departmental spatial handover logic; expert review, cognitive interviews, ω, α, item–total r.
Operational Efficiency (OE)	3	Task completion & spatial support; expert review, cognitive interviews, ω, α, item–total r.
Perceived Workload (WL)	3	NASA-TLX [13] & JD-R [3]; expert review, cognitive interviews, ω, α, item–total r.

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IV. STATISTICAL ANALYSIS AND VALIDITY PLAN

A. Multi-Level Quantitative and Mixed-Methods Integration

We will look at the data at different levels (see Table XII). Since we only have five to eight hotels [23], we cannot run some types of statistical tests at the hotel level. Instead, we will focus on differences within each hotel by using a linear mixed model [24]. This approach helps us make the most of the data we have.

$$log(TravelTime_ijk) = \beta0 + \beta1(ShortestPath) + \beta2(DetourRatio) + \beta3(GSO) + \beta4(LevelChanges) + \beta5(TaskType) + \beta6(Occupancy) + \beta7(Staffing) + u_j(hotel) + v_k(staff) + \varepsilon_ijk$$

We will compare different models using several checks to see which one fits best. Some advanced methods are not possible here because we do not have enough hotels in the study.

TABLE XII
PLANNED ANALYTICAL PROCEDURES

Analytical Level	Planned Method & Statistical Rationale
Data & Spatial	Missingness and outlier screening; inter-metric correlation matrices to check topological collinearity.
Psychometric	Item descriptives, McDonald's ω, Cronbach's α, item–total correlations, and hotel-level ICC(1)/ICC(2).
Route Level (Primary)	LMM on log(TravelTime_ijk) with random intercepts for hotel and staff; within-hotel routes supply statistical power [24].
Staff Level	Cluster-robust regression of perceived workload and efficiency on perceived difficulty and objective route exposure.
Hotel Level	Descriptive cross-typology comparison with effect sizes and 95% CIs; no inferential hotel-level regression [23].
Qualitative & Mixed	Reflexive thematic analysis [22] integrated with route findings via convergent joint displays [20].

B. Methodological Threats to Validity and Ethics Governance

We know there are some risks to the study, like people changing their behaviour when they are watched, or the small number of hotels making it hard to spot patterns. We have set up steps to reduce these problems (see Table XIII). The study has been approved by the ethics board. Everyone who takes part will sign a consent form, and we will use codes instead of names to keep things private. No one's movement data will be shared with hotel managers or used to judge staff performance.

TABLE XIII
METHODOLOGICAL THREATS TO VALIDITY AND PLANNED MITIGATION CONTROLS

Validity Threat	Planned Mitigation Control
Observer Reactivity	Run familiarisation shifts, stress non-evaluative research aims, and repeat observations across shifts.
Size–Typology Confounding	Control for room count, occupancy, and shift staffing in route LMM; restrict hotel-level comparisons to descriptive synthesis.
Spatial Collinearity	Inspect inter-metric correlation matrices before modelling; test topological metrics incrementally over metric distance.
Few Hotel Clusters	Use route-level random-intercept LMM and staff-level cluster-robust SEs rather than hotel-level regressions.
Survey Self-Report Bias	Administer anonymous coded surveys with written guarantees against sharing individual responses with management.

V. DISCUSSION AND ANTICIPATED CONTRIBUTIONS

1) *Why this approach matters:* By looking at hotel floor plans, timing staff routes, and asking staff about their workload all in the same place, we can connect building design with how hotels actually work. Comparing things like how central a location is and how far staff have to walk helps us see how the layout behind the scenes affects the way staff do their jobs.
2) *What this means for architects and managers:* For architects, our findings can show how things like where the service core is placed, how corridors connect, and how lifts are used can make staff routes longer or lead to more run-ins with guests. For hotel managers, understanding which problems come from the building itself and which come from how things are organised can help them make changes that improve workflow without needing expensive renovations.
3) *What the study cannot do:* We are only looking at five to eight hotels in Delhi-NCR, so the results might not apply to hotels in other places or to big resorts. We will watch staff during certain shifts to see what gets in their way, but we will not track them all the time. Because we are only looking at one moment in time and not making any changes, we can find patterns between hotel layouts and how things run, but we cannot say for sure that one causes the other.

VI. ACKNOWLEDGMENT

This research did not get any outside funding, and the authors have no conflicts of interest. The ethics board has approved the study. After we finish collecting data, anyone interested can ask for the anonymised datasets. We only used AI tools to check language and format tables.

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APPENDIX A: STAFF PERCEPTION QUESTIONNAIRE

Instructions: Please rate each statement based on your routine shift experience on a 5-point Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree). Items marked (R) are reverse-coded prior to computing construct mean scores. Statements are subject to expert panel validation and pilot reliability testing.

TABLE XIV
STAFF PERCEPTION QUESTIONNAIRE ITEM POOL ACROSS SEVEN CONSTRUCTS

Construct (Code)	Item	Survey Statement	Scoring
Circulation Difficulty (CD)	CD1	Moving between my work areas and the service lift is difficult.	Standard (1–5)
Circulation Difficulty (CD)	CD2	Corridors on my work floors are obstructed during my tasks.	Standard (1–5)
Circulation Difficulty (CD)	CD3	I often have to take a longer route than necessary to complete my tasks.	Standard (1–5)
Circulation Difficulty (CD)	CD4	Level changes or doors on my usual routes slow my work.	Standard (1–5)
Unnecessary Walking (UW)	UW1	I frequently return to the same store or area because supplies are not where I need them.	Standard (1–5)
Unnecessary Walking (UW)	UW2	I walk more than necessary during a normal shift.	Standard (1–5)
Unnecessary Walking (UW)	UW3	My work would need less walking if service areas were located differently.	Standard (1–5)
Service Space Access (AS)	AS1	Linen and supply stores are easy to reach from where I work.	Reverse (R)
Service Space Access (AS)	AS2	The service lift is available when I need it.	Reverse (R)
Service Space Access (AS)	AS3	Storage locations support my tasks.	Reverse (R)
Guest/Service Conflict (GC)	GC1	I share circulation routes with guests when carrying service items.	Standard (1–5)
Guest/Service Conflict (GC)	GC2	I have to wait or give way to guests during my routine tasks.	Standard (1–5)
Guest/Service Conflict (GC)	GC3	Guest and service movement interfere with each other on my floor.	Standard (1–5)
Coordination Difficulty (CO)	CO1	Coordination between kitchen and restaurant is hindered by the physical distance between them.	Standard (1–5)
Coordination Difficulty (CO)	CO2	Coordination between housekeeping and front desk is hindered by the physical layout.	Standard (1–5)
Coordination Difficulty (CO)	CO3	Handovers between departments require extra movement.	Standard (1–5)
Operational Efficiency (OE)	OE1	My tasks can be completed within the expected time.	Standard (1–5)
Operational Efficiency (OE)	OE2	The building layout supports efficient service delivery.	Standard (1–5)
Operational Efficiency (OE)	OE3	Delays in my work are rarely due to movement between locations.	Standard (1–5)
Perceived Workload (WL)	WL1	My work is physically demanding because of walking and carrying.	Standard (1–5)
Perceived Workload (WL)	WL2	I feel physically tired at the end of a shift.	Standard (1–5)
Perceived Workload (WL)	WL3	My workload is heavy.	Standard (1–5)

APPENDIX B: STRUCTURED ROUTE-SHADOWING OBSERVATION SHEET

Protocol Note: One observation sheet is completed per sampled staff trip. Timestamps are logged via digital stopwatch; travelled paths are traced directly onto scaled floor-plan printouts to calculate observed distance and guest/service overlap (GSO).

TABLE XV
STRUCTURED ROUTE-SHADOWING DATA RECORDING FIELDS

Field Group	Recorded Variables	Measurement Unit / Coding Rule
Session Metadata	Route ID; Observer ID; Hotel ID; Date; Day Type; Shift; Occupancy Rate	Alphanumeric IDs; Weekday/Weekend; Morning/Afternoon/Evening; % occupancy.
Staff & Task Profile	Staff Code; Department; Workflow Category; Origin Node; Destination Node; Load/Cart Type	De-identified ID; HK/F&B/Kitchen/Stores; 5 task classes; Empty/Tray/Linen Cart/Waste Bin.

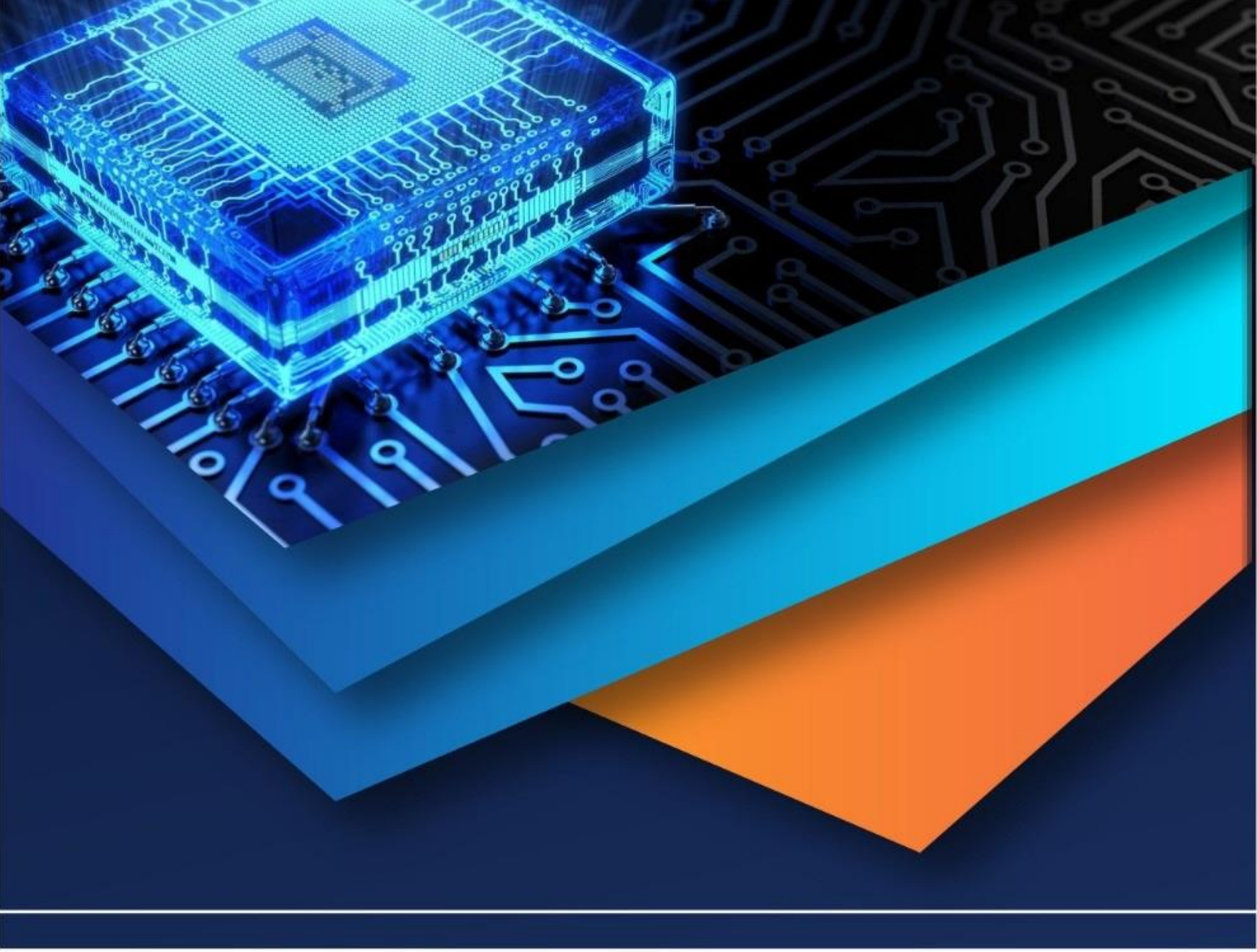
Field Group	Recorded Variables	Measurement Unit / Coding Rule
Spatial Trajectory	Traced Floor-Plan Path; Observed Distance; Shortest-Path Distance; Guest-Zone Segment Length	Metres (m) measured on calibrated CAD/PDF plan; Detour Ratio & GSO derived post-audit.
Time & Delays	Total Elapsed Time; Active Task Time; Net Movement Time; Lift Wait; Door/Passage Wait; Guest Yield Wait	Seconds (s) via split-lap stopwatch (Net Movement = Total Elapsed minus Active Task Time).
Friction Events	Backtrack Count; Guest–Staff Encounter Count; Physical Obstruction Notes	Integer counts using pre-defined rulebook + qualitative field note on bottlenecks.

APPENDIX C: SEMI-STRUCTURED MANAGEMENT INTERVIEW GUIDE

Protocol Note: Conducted individually with 2–4 department heads per hotel (30–45 minutes, audio-recorded with consent). Probes adapt to role responsibilities across Housekeeping, Food & Beverage, Kitchen, and Engineering.

TABLE XVI
SEMI-STRUCTURED MANAGEMENT INTERVIEW PROMPTS AND ANALYTICAL FOCUS

Q. No.	Core Interview Question	Target Analytical Construct
Q1	Walk me through the typical daily movement paths of your staff during a standard shift.	Baseline workflow mapping & functional zoning.
Q2	Where on the floor plan do staff experience the most frequent delays, queues, or congestion, and why?	Spatial bottlenecks & vertical/horizontal pinch points.
Q3	Which physical layout features—such as service lifts, pantry locations, corridor widths, or level changes—help or hinder daily service most?	Architectural enablers and physical barriers.
Q4	What operational workarounds (such as shift staggering, trolley staging, or task reassignment) do you use to overcome layout constraints?	Managerial adaptations vs. fixed structural limits.
Q5	How do circulation patterns and bottlenecks change during peak occupancy, checkout surges, or large banquet events?	Dynamic load effects & peak congestion triggers.
Q6	If you could modify one back-of-house layout connection in this hotel, what would you change first and why?	High-priority spatial intervention targets.
Q7	Were operational department heads consulted during the building's original design or past renovations? What input was included or missed?	Design–operations alignment in planning practice.



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