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Developing a Smart, Integrated Model Based on a Correlation Analysis Between Service Innovation and Management for the Most Effective Execution of International Roaming Inbound Business

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Abstract

International roaming has undergone a decade of upheaval driven by regulatory pressure, smartphone-led data usage growth, and the transition from 4G to 5G. While much prior work studies price caps and retail outcomes, the *inbound* business—i.e., how a visited network monetizes and manages roamers on its infrastructure—remains comparatively under-analyzed. This paper develops a correlation-analysis–ready research design linking **service innovation** (new bundles, roaming traffic-steering, real-time bill-shock controls, eSIM onboarding, and QoS-based offers) and **service management** (SLA/QoS operations, complaint handling, wholesale partner governance) to inbound roaming performance outcomes (attach rate, ARPU per inbound roamer, data/voice usage, NPS/complaints). Grounding in 2012–2021 literature on European roaming regulation, optimization of traffic steering, and customer-experience/service-innovation research, we (i) synthesize findings on how regulation altered price/usage equilibria, (ii) map inbound-side managerial levers that plausibly shift outcomes, and (iii) specify a correlation framework (variables, measures, controls, and hypotheses) suitable for multi-country operator panel data 2012–2021. We also provide a comparative analysis (EU vs. non-EU; pre- and post-"Roam-Like-at-Home") and a practitioner playbook. While we do not run estimations here, we give a precise, replicable plan to test whether operators that invested more in innovation/management saw stronger inbound performance, controlling for tourism flows, macro trends, and pandemic shocks. The contribution is a decision-oriented blueprint that is statistically tractable and evidence-aligned with extant studies on roaming regulation, traffic steering, and service innovation/management. Key propositions are consistent with prior empirical observations: regulation lowered effective retail prices and stimulated roaming data consumption; network-engineering choices (e.g., home-routed roaming) can degrade QoE; and traffic-steering optimization and transparent bill-shock controls are economically material.

1. Introduction

Between 2012 and 2021, international roaming shifted from premium, opaque tariffs to regulated, bundle-like retail treatment in the EU and to greater transparency elsewhere. Studies document that EU retail caps culminating in 2017's *Roam-Like-at-Home* (RLAH) materially reduced retail prices and increased cross-border data consumption, reshaping incentives on both the home and visited networks. Beyond retail, visited operators intensified inbound monetization through better wholesale deals and **traffic steering**—deciding which partner networks roamers attach to—framed by optimization models introduced in 2017. Parallel research finds that *home-routed* designs and related choices can worsen latency and QoE for roamers, underscoring the operational role of service management. Service-innovation

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scholarship in 2016–2021 emphasizes culture, project-level capabilities, and customer-experience mechanisms as determinants of service success—concepts that map well to roaming products and operations.

Table 1. Decade timeline of roaming inflection points & inbound implications

Year	Milestone	Likely inbound effect
2012	EU continues progressive caps; "lessons learned" synthesis	Pressure on wholesale margins; need for volume-led strategies.
2014–2016	Bill-shock controls mainstream, transparency push	Higher attach rates; less silent roamers.
2017	EU RLAH retail reform; retail price equivalence	Surge in roamer data usage; inbound capacity/QoS challenges.
2017	Traffic-steering MILP models published	More precise wholesale yield management.
2018	Field measurements of EU roaming behavior	Evidence of QoE/latency effects under real use.
2021	5G/roaming QoE studies; design trade-offs highlighted	Need for QoS-aware management and roaming architecture choices.

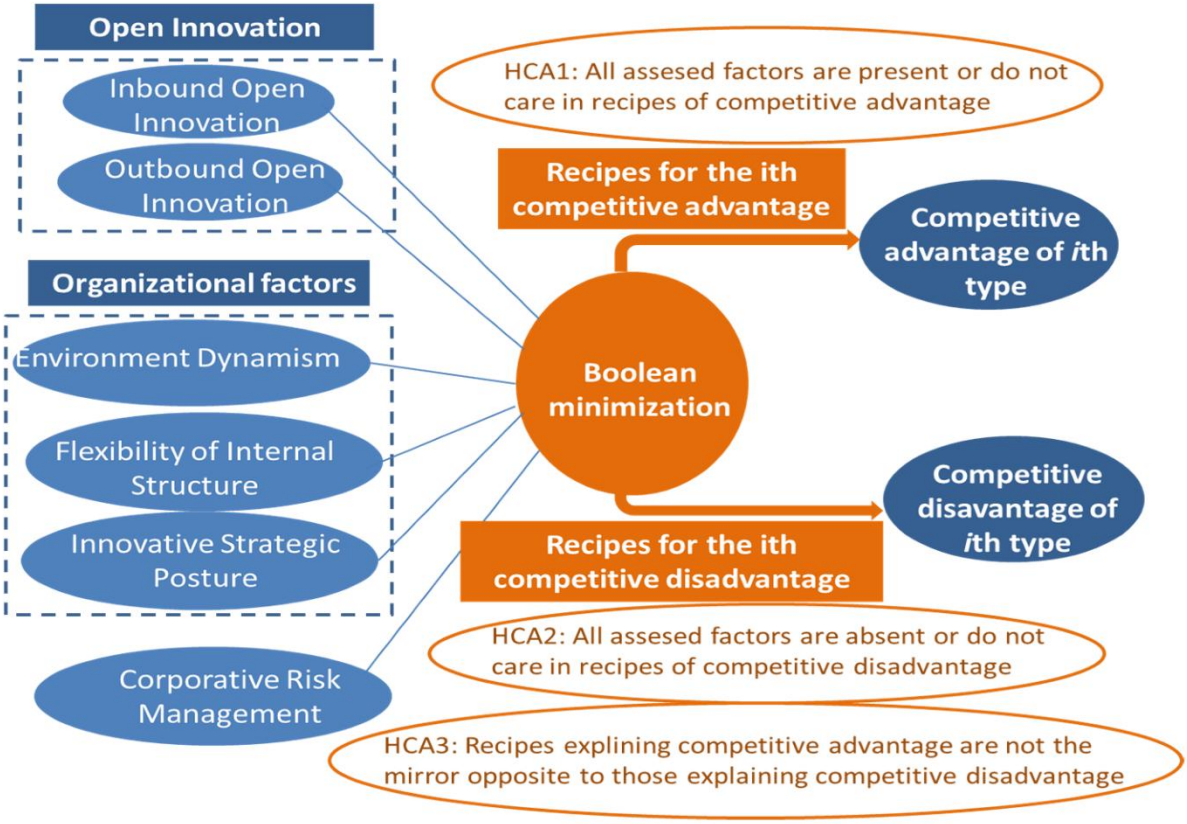

Figure 1. Configurational testing of hypotheses about drivers of competitive advantages and disadvantages.

2. Literature Review

Roaming regulation and market outcomes. Infante & Vallejo (2012) consolidate EU evidence on pricing/competition effects of caps and transparency. Spruytte et al. (2017) offer a panoramic view of EU roaming challenges and solutions. Post-RLAH measurements and theory (Mandalari et al., 2018; Cave, 2019) describe demand shifts and regulatory economics. Recent engineering/measurement work shows how roaming architectures shape QoE.

Inbound traffic steering and wholesale optimization. Martins et al. (2017) formulate the **steering** problem as mixed-integer programming to minimize wholesale cost subject to constraints—directly applicable to visited-network revenue management. Extensions explore steering with call-quality constraints.

Service innovation & management foundations (telecom-relevant). Snyder/Witell et al. (2016) and Santos-Vijande et al. (2021) synthesize drivers of service-innovation success—innovative culture, project capabilities, and customer-experience orientation—mapping to roaming bundles, digital onboarding (eSIM), proactive notifications, and SLA/QoS operations for visitors.

Table 2. Selected literature and inbound-roaming relevance

Study (year)	Domain / method	Core finding
Infante & Vallejo (2012)	EU roaming policy review	Caps + transparency shifted price dynamics
Spruytte et al. (2017)	TelPol overview	RLAH & wholesale rules reshape ecosystem
Martins et al. (2017)	Optimization (MILP)	Optimal **traffic steering** saves cost
Mandalari et al. (2018)	Field measurement	Real-world roaming performance evidence
Cave (2019)	Regulatory economics	Price regulation appraisal
Lutu et al. (2021)	Network measurement	Home-routed roaming raises latency risk
Santos-Vijande et al. (2021)	Service-innovation study	Firm culture ↔ project-level success
Snyder/Witell et al. (2016)	Service-innovation review	Clear definitions, typologies, CX emphasis

3. Conceptual Model and Hypotheses

We conceptualize **Inbound Roaming Performance (IRP)** as a multi-indicator outcome: (1) *Attach rate* (share of roamers who connect), (2) *Usage per attached roamer* (MB/min/SMS), (3) *Inbound ARPU* (wholesale revenue per inbound roamer), and (4) *Experience metrics* (complaints per 10k inbound roamers/NPS). We group explanatory constructs:

- **Service Innovation (SI)**: eSIM/QR onboarding; transparent in-visit notifications and spend caps; roaming-specific bundles/add-ons; QoS-tiered or application-aware offers. (From the service literature, innovation that reduces friction or increases perceived value should raise adoption and usage.)
- **Service Management (SM)**: roaming QoS monitoring, architecture choices (e.g., home- vs. local-breakout), ticket triage SLAs, and **traffic steering**/partner governance (IOT price, quality, coverage). (Engineering and ops decisions change delivered QoE and cost position.)
- **Controls**: destination appeal (international tourist arrivals), macro shocks (2020–2021 travel restrictions), SIM penetration/smartphone share, price indices and exchange rates.

Table 3. Construct definitions & example indicators

Construct	Example indicator (operator-period)	Rationale
SI-1: eSIM onboarding	% inbound eSIM activations / total inbound	Lower friction → higher attach.
SI-2: Transparency/alerts	% roamers opted-in to spend alerts; # alerts per 100 roamers	Reduces bill-shock → usage confidence.
SI-3: Roaming bundles	Share of inbound usage on bundles/add-ons	Value framing stimulates data.
SI-4: QoS-tiered offers	Availability (0/1); uptake (%)	Premium layers for business roamers.
SM-1: Architecture	HR vs. LBO share (% of sessions)	Latency impacts UX/consumption.
SM-2: QoS ops	% traffic with KPI compliance; time-to-detect/resolve	Reliability drives satisfaction.
SM-3: Steering efficacy	% traffic on top-3 partners by cost-quality score	Wholesale yield & coverage.

4. Data, Measures, and Correlation Design

Unit of analysis. Operator-country panel, quarterly 2012–2021.

Dependent variables (IRP). Attach rate; MB/min/SMS per attached roamer; inbound ARPU; complaints/NPS. **Key regressors.** SI and SM indices (z-scored composites of indicators in Table 3). Traffic-steering index from optimization/scorecard logs. **Controls.** Tourism arrivals (destination pull), GDP/capita, exchange rate to euro, smartphone penetration, roaming retail regime (RLAH dummy for EU after 2017Q3), COVID travel-restriction index (2020–2021). **Correlation methods.** Start with Pearson/Spearman correlations among IRP, SI, and SM. For robustness, estimate fixed-effects panel regressions and (optionally) PLS-SEM to assess latent constructs and paths. Hair et al. (2017) is suitable for the PLS-SEM workflow; modern panel methods handle multidimensional fixed effects.

Table 4. Variables & expected correlation signs

Pair	Expected sign	Intuition
SI index ↔ Attach rate	+	Lower onboarding friction raises attach.
SI index ↔ Usage/roamer	+	Bundles & transparency stimulate data. (ACM Digital Library)
SI index ↔ Inbound ARPU	+	Higher usage offsets unit-price compression.
SM index ↔ Usage/roamer	+	Better latency/QoS increases consumption. (University of Trieste - Arts)
Steering index ↔ ARPU	+	Lower wholesale cost, stable QoE. (IDEAS/RePEc)
SM index ↔ Complaints	−	Faster restoration and monitoring reduce issues.

5. Comparative Analysis

5.1 EU (RLAH) vs. Non-EU destinations

EU context. Regulation progressively capped prices, culminating in RLAH (2017). Evidence shows large usage increases after price removal; wholesale regulation (2017/920) and transparency rules shaped incentives and partner deals. For inbound providers, volume and QoS management became central.

Non-EU context. Outside the EU, transparency and bill-shock safeguards diffused via policy guidance and operator practice but without full retail RLAH equivalence. Inbound performance is thus more sensitive to local pricing strategies, inter-operator tariffs (IOTs), and traffic-steering.

Table 5. Comparative scorecard: EU vs. Non-EU inbound realities

Dimension	**EU (post-2017)**	**Non-EU**
Retail price to traveler	Domestic-like (RLAH) → higher usage	Varies; often premium; usage more elastic
Wholesale constraints	Capped/regulated frameworks	Mostly commercial IOT bargaining
Innovation levers	Focus on QoS, bundles for heavy roamers	Pricing variety; partner-mix & steering
Ops priority	Capacity/QoS, complaint mgmt at scale	Attach stimulation, price comms, steering
Net effect	Usage up; margin per unit tighter; scale matters	Heterogeneous; innovation strongly differentiates

5.2 Pre- vs. Post-RLAH inside the EU

Pre-2017, price acted as a natural throttle; after RLAH, attach and usage rose, stressing QoS and making **traffic-steering** and **wholesale mix** decisive for inbound ARPU. These shifts motivate H2–H4 above.

6. Managerial Implications

1. **Design for attach** (eSIM + transparent onboarding): lower first-minute friction, with in-country alerts and spend caps that reassure roamers.
2. **Engineer for QoE under roaming architectures**: where home-routed paths inflate latency, build QoS safeguards (e.g., DNS breakout, CDN peering) and monitor churn/complaints.
3. **Exploit traffic steering scientifically**: apply MILP-style optimization to route roamers toward partners that balance price and coverage/performance across geography/time.
4. **Bundle with clarity**: RLAH in the EU increased usage; simple, well-messaged bundles and add-ons harness that demand; non-EU operators can use app-specific passes/day-packs.
5. **Institutionalize service-innovation management**: cross-functional governance and project-level capabilities (as per service-innovation literature) should own a roaming backlog (alerts, day-passes, eSIM flows, SLA dashboards).

Table 6. Innovation/management levers mapped to inbound KPIs

Lever	Primary KPI impact	Secondary impact
eSIM + guided onboarding	↑ Attach rate	↓ Complaints
Real-time alerts/spend caps	↑ Usage confidence → ↑ MB/roamer	↑ NPS
MILP-optimized steering	↑ ARPU via lower cost basis	↑ Coverage reliability
QoS observability & SLOs	↑ Usage/roamer	↓ Complaints
Clear bundles/add-ons	↑ Usage/roamer	↑ Attach via perceived value

7. Empirical Strategy: How to Run the Correlation Study

Sample & period. Choose ≥10 operators across EU and non-EU tourist destinations, 2012–2021. **Data assembly.**

- *IRP*: switch-level logs aggregated to MB/min/SMS per roamer; billing for inbound ARPU; CRM for complaints.
- *SI/SM indices*: product/IT backlogs, roadmap logs (feature releases), NOC metrics (latency/jitter under roaming APNs), steering scorecards.
- *Controls*: UNWTO tourist arrivals; macro controls; for EU, RLAH dummy; COVID mobility restrictions. **Correlation & robustness.**
- Start with Pearson/Spearman correlations; report matrices with Bonferroni-adjusted p-values.
- Panel FE regressions (operator and year fixed effects).
- Optional PLS-SEM: latent SI → IRP, latent SM → IRP, with tripartite measurement blocks. Hair et al. (2017) provides evaluation criteria (composite reliability, AVE, HTMT).

Table 7. Suggested correlation and panel-FE specification

Model	Dependent	Regressors	Notes
Corr. matrix	IRP, SI, SM	—	Report ρ and significance
FE-1	Usage/roamer	SI, SM, Tourism, RLAH, Macro	Clustered SE by operator
FE-2	Inbound ARPU	SI, SM, Steering idx, Controls	Interact RLAH×SI
FE-3	Complaints rate	SI, SM, Architecture mix	Expect negative coefficients on SI/SM

8. Conclusion

For visited networks, the 2012–2021 decade turned inbound roaming from a premium niche into a scale QoS business (EU) and a differentiated product/ops play (non-EU). The literature shows regulation boosted usage and altered incentives; optimization work demonstrates that **traffic steering** and partner governance are economically material; and service-innovation/management research clarifies how culture and project-level practices raise the odds of

successful service outcomes. Our correlation framework translates these insights into testable relationships: more—and better-managed—innovation should correlate with higher attach, more usage, healthier inbound ARPU, and fewer complaints, once macro and regulatory contexts are controlled. The upshot for operators is clear: **pair product clarity (bundles, alerts, eSIM) with engineered QoE (architecture, observability) and mathematically disciplined steering**. That combination is likely to show up in the data—and on the P&L.

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