Economic Modeling of Commercial Vehicle Fleet Utilization and Revenue Optimization in Saudi Arabia: A Strategic Framework for Vision 2030

Abstract:

Commercial fleets are the glue that holds the entire transport system together, connecting production to ports, industrial clusters and the final market. The economic value of a vehicle is far less to do with its registered capacity than with its actual productive deployment. This is a critical integrative review of the interplay between fleet utilisation, pricing, empty running, demand uncertainty and asset ownership in the context of the transformation of transport in Saudi Arabia. It draws on a range of research published between 2020 and 2025 in the areas of freight forecasting, dynamic routing, carrier collaboration, vehicle economics and Saudi transport policy. It proposes a revenue-utilisation framework which distinguishes between vehicle availability, productive time, payload use and realised yield and then links these to route level contribution and fleet investment decisions. It identifies four key mechanisms: better forecasting protects dispatch capacity; network collaboration recovers movements that would otherwise be unproductive; pricing should be based on constrained vehicle-hours rather than distance; and alternative propulsion should be evaluated in terms of duty cycle feasibility and opportunity cost. A simple illustrative calculation is provided to show how changes in utilisation and backhaul recovery can impact on contribution, without in any way implying that these are the outcomes observed in the Saudi fleet. The review concludes with a research agenda for testing these mechanisms using anonymised dispatch, telematics and financial data. The central proposition is that alignment with Vision 2030 will only be achieved through sustainable productivity gains underpinned by tangible constraints on safety, service and the environment rather than through maximising fleet size or the volume of vehicles in movement.

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3. Introduction

Saudi Arabia's drive to build up its domestic supply chains and to play a bigger role as a regional logistics hub gives rise to a very practical economic question: how much value can the existing road fleet actually generate before the operator is forced to go and build more capacity? Road fleets provide the flexibility of access between industrial sites, ports, distribution centres and a host of dispersed customers. The sheer scale of the fleet is not necessarily an indicator of the amount of value being created. A company can be running a very high number of kilometres and yet be making very poor margins. On the other hand, with a good degree of scheduling and better contract discipline you can improve the economics of the operation dramatically without necessarily increasing the traffic at all. That's the fundamental issue when you're looking at transport development under Vision 2030 [13,19].

Research into dynamic vehicle routing has moved well beyond the simple 2ptimization of static distance. It now incorporates dynamic requests, uncertain travel times, service windows and sequential decisions [1–3]. There's also a good deal of work on collaboration and backhaul identification looking at how independent carriers can share loads, reduce empty miles and share the gains [4–8]. All of this is interesting, but it doesn't in itself provide the fleet owner with an answer to their revenue question. The lowest cost route is not necessarily the highest revenue route when prices differ from customer to customer, vehicle hours are at a premium and the acceptance of one order may in fact displace a more profitable one.

The Saudi context actually intensifies the issue as transport activity is determined by extensive intercity corridors, high levels of urban demand, industrial 2ptimization2n and investment in connectivity. Research into smart transport planning has identified issues of regulation, capacity and implementation, while research into the Saudi road network has demonstrated the potential gains from integrated operational and safety decisions [13,14]. The green logistics literature also points out that environmental commitments must be matched to the organisation's actual resources [15–17]. This is all consistent with the need for locally appropriate economic analysis

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and does not in any way provide a basis for assuming that findings from other countries can be simply transplanted.

The purpose of this paper is to develop a decision-oriented economic framework for the deployment of commercial fleets which links operational productivity to revenue and to strategic investment. The aims are to differentiate between competing measures of 3ptimizatio; to subject head on the various forecasting, routing, collaboration and pricing mechanisms; to specify an auditable profit model; and to identify the institutional and empirical conditions under which such a framework would be credible in the Saudi context. The contribution is purely conceptual and not an assessment of the profitability of the national fleet. It is about identifying the interaction effects which are typically lost when 3ptimizatio, route cost and revenue management are studied in isolation.

2. Review design and analytical method

A critical integrative review is the right approach as the topic is not confined to a single discipline but cuts across operations research, transport economics, energy systems and policy. The evidence base was deliberately constructed from research published between 2020 and 2025 with a focus on identifiable journal articles that have a DOI. The sources selected were those which were directly relevant to the topic of dynamic freight operations, carrier coordination, pricing information, vehicle technology economics or Saudi transport governance. The three exemplars provided were used to inform the structure and to ensure attention was paid to methodological limitations. Publications outside of the period specified were not used as evidence.

The review went through four analytical passes. The first was to categorise the studies according to the level of decision they informed: strategic (fleet composition), tactical (allocation and contracts) or operational (dispatch). The second was to map their stated performance measures to

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the five dimensions of 4ptimizatio, contribution, service reliability, emissions and capital exposure. The third was to examine the underlying assumptions (perfect information, identical vehicles, transferable demand patterns, fixed energy prices etc). The final pass was to assemble the compatible mechanisms into a multi-period economic representation. Table 1 contains the resulting evidence domains and their respective limits of transferability.

This is a transparent process which is not in any way an exhaustive database census, a bibliometric mapping or a pooled-effect meta-analysis. The studies vary enormously in terms of vehicle type, geographical coverage, constraints, datasets and objective functions so aggregating the reported % improvements would be completely misleading. What we do is analytical triangulation to identify the recurring causal mechanisms and to keep the disagreements. In particular the computationally derived savings, the policy aspirations and the field measured results are all kept separate. The numerical examples introduced later make use of explicitly assumed inputs and have no inferential value for the Saudi operators.

Evidence quality was assessed on the basis of whether it provided a formal mathematical specification, operational data, scenario testing or context specific institutional analysis. Papers on 4ptimization can establish internal feasibility under a set of assumptions but cannot in any way establish that the industry will adopt the solution spontaneously. Interviews and policy reviews can identify implementation barriers but won’t quantify the fleet contribution. Ownership cost comparisons can identify plausible break even drivers, the drivers being of course dependent on price and duty cycle. This is an important distinction when drawing conclusions from a range of disparate sources [20-22].

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3. Synthesis of the economic evidence

Table 1. Critical synthesis of evidence streams and implications for Saudi fleet decisions

Evidence stream	Relevant studies	Transferable mechanism / limitation
Routing under uncertainty	[1–3,20]	Sequential allocation manages new requests; gains depend on reliable service and demand inputs.
Forecasting and digital systems	[9–11,28]	Prediction can reduce misallocation; measured forecast accuracy is not equivalent to financial impact.
Collaboration and backhaul	[4–8,27]	Joint allocation can recover empty movements; compatibility, trust and gain sharing are binding.
Fleet ownership and energy	[21–26]	Total cost depends on duty cycle and downtime; overseas price assumptions need recalibration.
Saudi institutional context	[13–19,29–30]	National policy and infrastructure influence feasible decisions; firm profitability remains unmeasured.

3.1. Utilization as a multidimensional economic variable

Fleet utilisation is very often presented as a single figure, when in fact there are a number of possible denominators. Availability is the proportion of planned vehicle hours not lost to maintenance or administrative inactivity. Time utilisation is the proportion of time spent on transport work. Distance utilisation is the proportion of km travelled with a paying load. Payload utilisation is the proportion of tonnes carried to the legal payload. Revenue utilisation is the proportion of the vehicle's saleable capacity that is converted into revenue. It is entirely possible to have a high score on one of these metrics and a low score on another, which makes a composite figure of utilisation from all of them economically meaningless.

A good example is the intercity tractor which completes a full outbound journey and returns empty. It may have very good mechanical availability and very good driver activity but will have very limited revenue capture. The distribution vehicle making a number of short deliveries can have very high stop productivity despite relatively low distance utilisation. Capacity constraints will be in different units of course (tonnes, cubic metres, pallet positions, temperature controlled space, time access etc). The correct denominator is therefore the binding constraint for each service rather than some one universal tonne km target.

The review therefore recommends a usage dashboard with metrics for contracted productive vehicle hours, paid loaded kilometres, average payload fill, accepted service requests and revenue collected per deployable vehicle day. All of these should be broken down by vehicle class, corridor, account and season. This avoids the temptation of managers simply increasing nominal usage by taking on low yield work. It also makes it clear whether a poor performing asset is the result of lack of demand, dispatch failure, wrong specification or avoidable idling time.

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Another accounting issue arises when you have a mix of owned tractors, leased trailers and subcontracted capacity. You can end up applying the same utilisation figure to a number of different assets and thereby inflating the apparent productivity. The proposed reporting methodology therefore separates out tractor hours, trailer days and driver hours, reconciles each against a common journey and only allocates the net revenue once. This allows management to work out whether the real constraint is actually equipment, labour, loading access or customer timing. It also means you're not artificially ranking the long haul and urban fleets against each other on some common denominator.

3.2. Demand forecasts, dispatch and uncertainty

Freight demand is neither temporally constant nor fully transparent at the time dispatch decisions are being made. Al Hajj Hassan and co-workers demonstrate how adaptive forecasting can assist in operational planning as the flow patterns evolve [9]. Reviews of freight machine learning applications cover a range of use cases from arrival time prediction and anomaly detection to shipment forecasting [10,11]. The take away from these is that a forecast should not simply be a prediction of tonnes to be moved next month. It should be a forecast of order arrivals by lane, equipment required, requested service time, price sensitivity and cancellation risk.

Forecasting only creates value when it's coupled to a decision rule. A forecasted increase in port related demand might be sufficient to justify the reservation of chassis, a restructure of driver shifts or a renegotiation of subcontract capacity. An uncertain urban request on the other hand may be taken opportunistically if it fits into an existing tour. Dynamic routing results demonstrate why rolling horizon reassignment is preferable to the assumption that all requests are known in advance [1–3]. The constant reoptimisation of the route can be destabilising to the customer's promise so decisions need to be made with a freeze period, exception thresholds and penalties for avoidable service changes.

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The key economic driver is the protection of scarce vehicle-hours. If an operator takes on every available low rateconsignment then they may effectively lose the ability to serve the later, higher contribution demand. That's an opportunity cost rather than a cash outlay. Revenue management research has long warned that historical data used to build booking models needs to be carefully selected and that one should be very wary of simply extrapolating historical patterns when those patterns are going to change [12]. For the Saudi fleets the booking models need to be stress tested against the effects of religious holidays, corridor disruptions and industrial project cycles rather than just blindly extrapolated.

Forecast calibration should be judged on economic grounds as well as on statistical ones. A model which marginally improves on the average prediction error may be a bad one if its errors are all on the expensive peak capacity decisions. Decision weighted validation can be used to compare the actual contribution to performance of the dispatch policies that result from different forecasts against a consistent historical baseline. Operators should look at forecast bias by customer segment and by lane direction separately as a systematic under forecast on a return corridor could be hiding a number of commercially viable backhaul opportunities. Forecast retraining also needs to be guarded against data leakage from the orders that were recorded after the decisions had been made.

3.3. Collaboration and recovery of empty distance

Empty repositioning uses fuel, consumes maintenance life and driver hours without producing any direct freight revenue. The integration of recurrent lane detection with backhaul optimisation is therefore a very real route to improved commercial performance [8]. Large scale collaborative routing and heterogeneous multi-depot formulations demonstrate how co-operative allocation can harness synergies which are simply not available to the individual operator [4,5]. The amount of benefit that can be achieved of course will be contingent upon the compatibility of equipment, cargo handling, insurance, pickup windows and the direction of the regional freight imbalance.

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Collab also has a distributional issue. If one carrier does the attractive outbound leg and the partner does the return leg then a collective saving may still be unpalatable to one of the participants. Research into fair collaborative routing and profit sharing makes incentive compatibility absolutely fundamental to the sustainability of any collaboration [6,7]. A Saudi freight exchange would therefore need to have very clear settlement rules, very clear documentation of service quality, data governance and appropriate safeguards in place to prevent the disclosure of customer data. A mathematically optimal allocation which is not underpinned by commercial trust is not going to last.

Not all empty movements are recoverable. A refrigerated trailer may not be able to take a general cargo assignment; hazardous loads may need to be cleaned or segregated; and taking a cheap diversion can in fact delay the next contracted departure. The assessment therefore has to be of net contribution after the additional distance, handling, waiting and service risk has been taken into account. The appropriate target is not zero empty km but the economically justified minimum given the asymmetric nature of the demand and the safety constraints. Work on drayage operations further illustrates why the laden or empty state will have an impact on the energy outcome at the route level [27].

A practical collaboration contract requires an agreed counterfactual. The claimed savings have to be calculated against what each party could have earned on their own (using the same fuel, labour and service assumptions). Benefits can then be shared out in accordance with verified contribution, risk borne and equipment supplied, with appropriate dispute resolution for any missing data. This stops a platform from simply taking the total pooled turnover and presenting that as incremental social value. It also allows you to identify the situations in which bilateral contracting is actually more economical than a complex multilateral exchange as the coordination charges will be greater than the available backhaul margin.

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3.4. Pricing and realization of revenue

Standard haulage tariffs tend to be based on distance or a negotiated trip rate. Those are easy to understand but can mask the true cost of the trip in terms of time spent waiting, narrow booking windows, the difficulty of loading, tolls and capacity constraints. A contribution based tariff should take into account the actual incremental cost of the trip as well as the shadow cost of the vehicle hours used. The shadow cost of the vehicle hours will be higher when demand is strong, spare equipment is at a premium or customer commitments are hard to reschedule. It will be lower when demand is slack and it may be entirely appropriate to accept a lower contribution in those circumstances provided you don't in any way damage your reference prices or your service reliability.

Revenue optimisation is therefore very different from simply charging the maximum possible rate. It's about selecting a portfolio of orders which will deliver acceptable margins, contractual durability and probability of payment. Targeted surcharges can be applied for detention, special equipment and short notice dispatch to clarify the cost structure (as long as the terms are agreed in a transparent way). Longer contracts can provide a degree of stability in terms of utilisation but may pass on the risk of diesel price or congestion to the operator. Indexation and agreed adjustment triggers can go some way to distributing that risk. The historical demand selection is also important as apparent price elasticity may simply be a reflection of a change in the mix of customers rather than any real price elasticity of demand [12].

The economic result should be assessed on the basis of actual revenue rather than the quotations that were issued. Discounts, rejected invoices, bad debts and contractual deductions can all be the difference between the quoted tariff and the actual yield. Dispatch data therefore has to be joined to the billing and payment data. Pricing freedom also has to be examined in the context of the actual contractual and competitive environment. The fleet level decision engine should be recommending prices, not imposing some form of opaque discriminatory pricing or coordinating market rates between competing carriers.

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Price recommendations should also make the distinction between cost pass through and willingness to pay. Fuel escalation clauses are a mechanism for passing through an observable input shock, demand based premiums are a mechanism for reflecting customer alternatives and contractual expectations. Blending the two can be very damaging to trust and can lead to a lack of transparency as to why a tariff has changed. Any analysis system should have an audit trail of the rate offered, the rate accepted, the service delivered, the approved invoice and the cash receipt. That audit trail enables the manager to track down any revenue leakage and to assess whether the commercial policy is in fact improving both retention and contribution over the successive contract cycles.

3.5. Ownership costs, propulsion and local constraints

Fleet mix has a very long term impact on financial exposure. A lease can provide a lot of flexibility in a volatile market whereas a purchased vehicle can be very cost effective in a stable intensive use scenario. Ownership cost studies have shown that purchase price on its own is not a valid comparison as annual mileage, energy consumption, maintenance, residual value, financing and non-productive time all come into it [21,22]. The economic attractiveness of electric light commercial and logistics trucks is also shown to vary with application and with the availability of charging [23,24]. Results from a European or North American context will need to be adjusted before they can be applied to the Saudi tariff regime, climate and driving patterns.

Detailed levelised cost modelling points to the opportunity cost of charging and the impact of battery size [21]. A port drayage feasibility study shows the value in matching EVS to appropriate duty cycles rather than simply assuming you'd replace the entire fleet immediately [25]. Real world truck telematics data provides further evidence of the importance of a differentiated approach to deployment [26]. They don't tell you what the Saudi break even year

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is. The takeaway is that you need to look at fleet utilisation, operational flexibility and capital replacement together rather than treat electrification as a standalone procurement decision.

The local literature provides the necessary context. The Saudi transport planning papers cover the governance, safety, infrastructure and adoption issues [13-18]. The analysis of domestic road energy demand is the relevant basis for understanding why the economics of the vehicle have to be considered in the context of fuel and demand [29]. The national diversification modelling provides the wider investment context but cannot be taken as evidence of the margin of any one carrier [19]. The economic framework therefore treats the public strategy as a boundary condition and an investment signal, with the firm level performance being tested in the verifiable operating records.

Asset age introduces another layer of nonlinearity. The older the truck the lower the book depreciation will be, the higher the unscheduled maintenance, the more uncertain the resale proceeds and the greater the service disruption. The replacement appraisal therefore needs to compare the expected discounted contribution of the asset under a range of options: continued operation, refurbishment, leasing and purchase. If access to finance is restricted the option to delay commitment has value even if the new vehicle has a better average cost per km. Capital rationing should be directed at assets which are relieving the measured capacity constraints rather than those which have the highest isolated forecast utilisation.

4. Proposed revenue–utilization optimization framework

4.1. Decision architecture and variables

Figure 1 shows a three layer architecture connecting the measured operations to the decisions and financial outcomes. The first layer consists of orders, GPS traces, driver rosters, invoices,

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equipment specifications, energy costs and service incidents. The second layer makes an estimate of future lane demand, feasible assignments and route specific contribution. The third layer then makes the decisions of acceptance, assignment, pricing and replacement subject to service, safety and liquidity constraints. Feedback from the completed jobs is then fed into the next forecast cycle. The architecture only considers information as productive if it leads to an accountable decision. The architecture is only productive when it results in an accountable decision.



Figure 1. Proposed decision architecture connecting fleet records, allocation choices and economic performance. Author-developed conceptual diagram.

Let v denote vehicle class, l a service lane, t the decision period and s a demand scenario. x(v,l,t,s) is a binary variable indicating whether or not a movement is accepted and assigned; q(v,l,t,s) is the quantity transported; p(l,t,s) is the realised unit tariff; d(l) is the distance charged; h(v,l,t,s) is the committed vehicle time (including waiting). F(v,t) is the fixed ownership and overhead allocation, c(v,l,t,s) is the variable trip cost and a(v,t) is the available hours. b is the recovered backhaul activity. These are the variables that would be used in the proposed model (not an estimated Saudi dataset).

Expected operating contribution is $E[\Pi] = \sum_s w(s)\{\sum_{v,l,t}[p(l,t,s)q(v,l,t,s) - c(v,l,t,s)x(v,l,t,s)] - \sum_{v,t}F(v,t)\} - K$. The w(s) are the scenario probabilities and K comprises the platform, coordination and financing charges (which are not otherwise allocated). Revenue

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must be specified consistently with either tariffs being per trip or per unit (in which case p*q is replaced by the agreed trip invoice). Costs and/or revenue must not be double counted across a round trip.

For each period the allocated driving, loading, waiting and statutory rest all have to be within the available driver and vehicle hours. The payload, axle limits, route eligibility and customer delivery windows will all constrain the possible assignments. Minimum contribution requirements can in fact prevent a forecast optimizer from filling capacity with loads that are not economic. Service constraints will impose penalties for being late and for the rejection of contracted requests. A risk term may be used to penalise downside losses in adverse scenarios thereby preventing the optimiser from choosing a strategy which maximises average contribution at the expense of cash flow survival.

To avoid infeasible solutions the route network needs to encode directional links, legal driving restrictions and depot compatibility rather than just straight line distance. The model has to be able to differentiate between planned and actual journey times and will need to use conservative capacity allowances when there is a paucity of observations. There needs to be a fully transparent optimisation log which records the reasons why requests have been rejected, enabling the operations teams to inspect the output. This auditability is particularly important when a dispatch manager is required to explain why a seemingly profitable consignment has been rejected for the sake of another obligation.

4.2. Economic metrics and marginal decisions

Table 2 puts the formulation in terms of observable metrics. The key profitability metric is contribution per deployable vehicle day rather than gross turnover per truck. The other metrics are revenue per productive hour, net contribution per paid loaded km and cash contribution after debt service. The order of these metrics is important as an operator can increase their invoiced

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revenue by taking on more vehicles and at the same time reduce their returns on capital. Separating out the fixed from the incremental costs makes the difference between short run acceptability and long run fleet size very clear.

Table 2. Operationally observable variables for the proposed economic model

Metric	Operational definition	Decision purpose
Available vehicle-hours	Planned hours less verified technical downtime	Measure deployable capacity
Productive utilization (u)	Paying service-hours ÷ available vehicle-hours	Distinguish paid work from activity
Paid distance ratio	Loaded, invoiced kilometres ÷ total kilometres	Track economically useful movement
Payload fill	Accepted payload ÷ legal and serviceable capacity	Identify weight/volume underuse
Realized yield	Collected service revenue ÷ productive vehicle-hours	Monitor commercial revenue quality
Contribution	Collected revenue − incremental cost − allocated fixed cost	Compare dispatch and asset options
Backhaul recovery (b)	Eligible otherwise-empty capacity used by paying return work	Evaluate recoverable route imbalance

The acceptance rule is simple. A request is desirable if the expected collected revenue is greater than the incremental cost of execution (including the expected penalty for delay or failure) and the opportunity cost of the capacity displaced. The opportunity cost is derived from plausible alternative demand rather than being added in as some arbitrary premium. At the strategic horizon, fleet additions are only justified if the present value of the expected incremental

contribution is greater than the acquisition or lease obligations and the additional downside exposure. Disposal of underutilised equipment is just as much part of the optimisation as any other decision.

This is a joint demand and price problem for backhaul recovery. A return can be a source of revenue but it can also increase hours, change the unloading point or in some cases compromise a more valuable booking. The model looks at the incremental contribution of each possible pairing rather than simply going with the loaded return. The same applies to multi-carrier exchanges where the question of whether a technically better plan is viable as a contract is determined by settlement fairness and the cost of information sharing [4–8].

Working capital makes a further distinction between accounting profit and cash that can be actually used. A long distance customer may be a very good contributor but will have a very long collection period. Fuel and wages on the other hand are paid immediately. Fleet growth in that scenario can be very damaging to the financial position. The investment policy should therefore be one that monitors the ageing of the receivables, credit limits and financing headroom as much as it does route contribution. This is particularly important when you're running large projects on a payment schedule which is very different to the delivery schedule.

4.3. Transparent illustration and sensitivity

Figure 2 shows the proposed decision logic with the assumed (normalised) vehicle day economics. A fully utilised vehicle day generates SAR 2,600 of primary service revenue (SAR 740 of which is activity dependent) and SAR 620 of allocated daily fixed cost. The recovered backhaul work is SAR 300 per utilised day (multiplied by the assumed recovery factor). The resulting illustrative contribution is therefore $\Pi = 1{,}860u - 620 + 300bu$ where u is between 0 and 1 and b is the recovery factor. These are illustrative values chosen for clarity rather than actual tariffs, costs or fleet figures.

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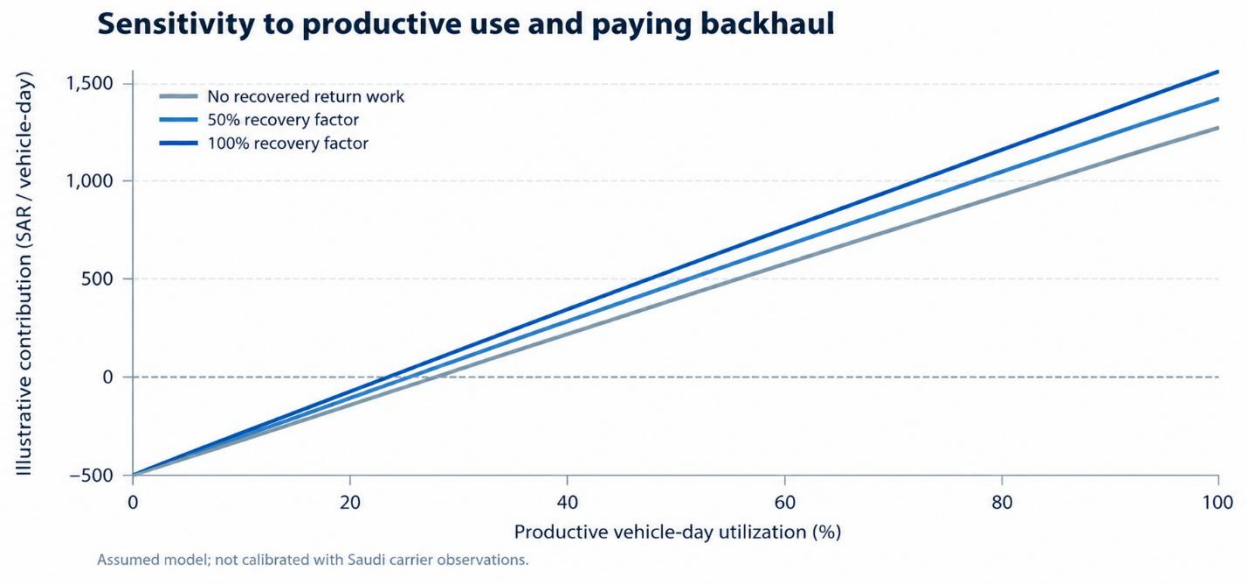


Figure 2. Hypothetical contribution response to utilization and recoverable backhaul. Assumptions: SAR 2,600 potential revenue, SAR 740 variable cost and SAR 620 fixed cost per vehicle-day; added backhaul potential SAR 300 × recovery factor. No observed fleet inputs.

The figure illustrates how the contribution curve rises as return work increases. At zero backhaul recovery the stylisedbreak evenutilisation rate is about one third of a vehicle day. That threshold is instantly affected by the way you allocate depreciation, the way you structure salaries, the load mix and the realisable tariff. It is not a sector benchmark. A model which simply reports a higher contribution because it assumes an infinite return load demand would be utterly unconvincing from an economic point of view. Feasible recovery has to be bounded by the actual origin-destination imbalance and the customer service windows.

Sensitivity analysis should start by varying the collected yield, fuel price, vehicle downtime and empty repositioning. You then need to test the correlated shocks. A rise in diesel price could have an impact on both cost and tariff; an infrastructure disruption could have an impact on both trip time and number of orders completed. Where you have sufficient local observations you can use Monte Carlo sampling or scenario trees to capture these dependencies. The output should be the downside contribution, cash coverage, missed deliveries and emissions per completed service along with mean profit. That's better than just presenting a single deterministic optimum as a forecast.

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Model validation should be against closed period accounts at both the trip and fleet level. The differences should be broken down into volume, yield, fuel, maintenance, waiting and billing. A statistically sound route forecast is of no use if the allocation of overhead is such as to lead to a persistent bias in the profitability estimates. Predefined acceptance criteria should cover forecast calibration, the feasibility of the dispatch rates and the materiality of the unexplained accounting differences. Only on that basis should a pilot move from being an advisory exercise to one where it's making more automated decisions.

5. Discussion and implications for Vision 2030

The synthesis shows that operational efficiency and revenue performance only reinforce each other under certain conditions. You get value from recovering empty km where the backhaul yield is greater than the incremental cost. You get value from better forecasts where the forecast actually secures capacity for work which is of value. You get value from more active vehicle hours where those vehicle hours are in fact generating positive contribution. These are the conditions which explain why utilization is best viewed as a portfolio of technical and commercial ratios. The framework moves the focus away from traffic volume to the quality of revenue, reliability and capital efficiency which are the more relevant metrics for assessing private sector involvement in national logistics development.

For the operator the credible implementation sequence starts with data reconciliation. Telematics IDs, vehicle registers, orders, driver shifts and invoices all need to match at journey level. Managers then need to establish a baseline across a representative set of peak and off-peak periods (a route that is quiet one week may be a very important route for network coverage). Pilot decision support can then be used to compare planned vs actual dispatch, logging all the overrides and missed opportunities. Only once you have a stable measurement can you go on to

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introduce dynamic pricing or automated order acceptance. The returns from the analytics are as much a function of governance as they are of the algorithms [10,11,28].

For shippers and logistics platforms the most promising area for coordination is where there is a repeated directional imbalance and high equipment compatibility. The contract templates should contain clear definitions of detention, fuel, proof of delivery, loss liability, payment timing and a fair way of sharing the benefits. Participation in the exchange should not be predicated on the wholesale disclosure of competitor pricing or sensitive customer lists. The research into collaborative routing confirms that gain sharing is a design parameter rather than something that is simply negotiated on a case by case basis [6,7].

For policy makers better outcomes don't necessarily require the subsidy of more trucks. Predictable access rules, appropriate truck parking, efficient terminal appointments, interoperable electronic documentation and published safety requirements can all reduce non-productive time. They can enable firms to get more contribution from their existing fleet and reduce the amount of traffic that is unnecessary. The Saudi evidence on integrated route choice and traffic control is in support of treating safety and network performance as a joint issue [14]. The green logistics literature is also clear in warning that the adoption of technology has to be underpinned by skills, institutional coordination and viable implementation routes [15,30].

A corridor level demonstration could link distribution demand in Riyadh to the industrial and port movements to Jeddah and the Eastern Province. The right design would be to compare otherwise similar fleets using pre and post records and where possible a matched comparison group. The outcomes would be vehicle day contribution, empty distance ratio, on time performance, incident exposure and emissions intensity. The pricing effects would have to be separated from the demand effects and any improvement attributable to the collaboration would have to be net of platform and settlement costs. Without such controls then any claims of efficiency would be based on a selection of customers which was favourable rather than any real improvement in productivity.

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The framework also has an equity dimension. The smaller carriers will benefit from access to the consolidated demand but will be at risk of becoming dependent on platforms that have the power to control the rankings or the payment terms. A commercially viable arrangement would be one that was transparent in terms of the basis of the fees, would have a mechanism for dispute resolution and would have accessible entry conditions. Customer service and worker safety should be the constraints rather than the afterthoughts. That's where the relevance of Vision 2030 comes in really, in that it's about enabling the reliable, competitive logistics capability rather than it being about every increase in asset intensity being a measure of progress.

6. Limitations and research agenda

This review makes no claim to being a comprehensive review of all the studies, no claim to having looked at the Saudi carrier accounting records and no claim to having estimated the elasticities from the transactions. DOI confirmation is useful for establishing bibliographic provenance but doesn't in any way validate the findings of the studies. The equations we propose are intentionally simple and do not include all the complexities (e.g. cross border customs delays, vehicle specific tax treatment, contractual exclusivity, labour turnover, endogenous competition). A stylised sensitivity figure in no way establishes causal effects and so without empirical validation it is not possible to use it to set tariffs, to finance new equipment or to assess public incentives.

Future work should be to build an anonymised panel of vehicle days across a range of fleet sizes, locations and seasons. A hierarchical model could be used to estimate utilisation and realised yield with equipment class, lane direction, customer, fuel price and contract type all as covariates. Field trials could be run to compare recommendation assisted dispatch against current practice in terms of both financial performance and compliance. The analysis should also look at whether the benefits of collaboration persist under a fair settlement arrangement, whether the

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case for electrification holds up in the face of charging delays and how forecast error impacts pricing decisions. A replication exercise across urban delivery, industrial haulage and port drayage would be useful to determine where a common model would need to be adapted locally.

7. Conclusion

Commercial fleet optimisation should be viewed as a joint problem of demand selection, productive capacity, realised pricing and risk-aware capital allocation. There is certainly a body of literature which provides good tools for forecasting, dynamic routing, backhaul collaboration and ownership cost evaluation. The extent to which these can be integrated into a viable profitability framework for the Saudi context has not been adequately tested to date. This review provides an auditably structured approach which clearly separates availability from income generating utilisation and links routing decisions to investment appraisal.

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