Reviewer Report Doctoral Dissertation

A More-Generalized Multiple Suppliers, Single Manufacturer Inventory Control Model with Stochastic Demand, Variable Production Rate and Differing Supplier Delivery Times (by Kehinde Adekunle Adegbola)

Overall Assessment

The dissertation addresses an important problem in supply chain inventory management, namely the coordination of multiple (SME) suppliers and a single buyer under stochastic demand, variable production rates and distant-dependent lead times. It develops analytical inventory models, compares integrated and Stackelberg coordination mechanisms and subsequently employs simulation models to relax restrictive assumptions embedded in the analytical model. The dissertation demonstrates technical competence, strong knowledge of inventory theory and significant effort in mathematical modelling and simulation. It presents original modelling developments, demonstrates independent research capability and contributes to the literature on multi-supplier single-buyer integrated inventory systems. Nevertheless, several aspects should be addressed before the dissertation can be regarded as fully meeting the standard expected of a doctoral dissertation. These areas concern theoretical positioning and articulation of contribution, assumptions and methodological justification, validation and discussion of managerial implications. Those aspects will be detailed in the following.

Originality and Contribution

The research objective is identifiable, remains consistent throughout the dissertation, and the modelling effort and discussion is largely aligned with this. A further strength is that the objective is motivated by a genuine gap in the supply chain inventory management literature and the dissertation seeks to extend this body of knowledge by considering multi-supplier single buyer settings under stochastic demand, variable production rates, distant-dependent lead times, and alternative coordination structures within a unified modelling framework. While the ambition is both appropriate and sufficiently challenging for doctoral-level research, the motivation for the study requires considerably sharper articulation. Throughout the introductory chapter, the discussion occasionally refers to broader themes such as Internet of Things applications, international trade developments or supply chain disruptions. While these themes are important, their connection to objective of the dissertation is often unclear and sometimes appears peripheral to the core contribution. Similarly, several statements are presented without sufficient scholarly substantiation, including claims that material management has been neglected in production systems, or that large standardised production batches remain the dominant operating paradigm. Such statements weaken the precision of the argument and should either be supported by relevant literature or removed.

The motivation would benefit from focusing more directly on the specific decision context investigated in the modelling sections. The key issue is not supply chain analytics as such, nor the historical development of mathematical modelling in management, but rather the management of a multi-supplier-single-buyer system in which suppliers provide the same input material under uncertain demand conditions and flexible production capabilities. By concentrating on this setting from the outset, the dissertation could establish a much clearer narrative linking the research gap, research objectives, model development, and resulting contributions. Compared to more general themes, the motivation would also benefit from discussing the industrial context more explicitly,

as the practical applicability of the proposed modelling approach is currently left largely implicit. When presenting the model assumptions, there are several references to the food processing industry which, however, are not considered in the introduction or discussion. A stronger discussion of representative industrial settings would help readers understand where the proposed solution could be implemented and under which operating conditions it would be most valuable.

The motivation further suffers from some redundancy between the sections discussing motivation, objectives, research gap, and contributions. Similar arguments appear repeatedly throughout the introductory chapters, while the central research questions remain somewhat implicit. A more concise structure would improve readability and academic rigor. Related to this point, the problem statement itself should be defined more precisely. The dissertation clearly identifies the system configuration and operational assumptions but would benefit from explicitly stating the decision variables associated with each actor. For example, the reader should be informed early in the dissertation which decisions are controlled by the manufacturer, which are determined by suppliers, and which are jointly optimised under the integrated and Stackelberg coordination structures. And while the introduction lists the manufacturer batch size as decision variable, it rather seems to be a dependent variable which needs to be clarified. Such clarification would significantly strengthen the conceptual foundation of the research and improve understanding of the modelling choices that follow. At the same time, I would recommend avoiding detailed discussion of mathematical variables and notation within the introduction itself, reserving these aspects for the model development chapters where they can be presented more naturally.

The strongest contribution of the dissertation is the extension of stochastic integrated inventory modelling to a multiple-supplier, single-buyer environment and the practical decision support provided to a variety of industry settings. Collectively, these developments represent a body of original work and demonstrate the candidate's ability to conduct independent doctoral research. However, the contribution is not always articulated with sufficient clarity. The dissertation often lists contributions rather than explicitly demonstrating what knowledge did not previously exist, why current literature was insufficient and how the proposed work advances our understanding. The principal weakness under this criterion is that the originality claim is sometimes dispersed rather than sharply synthesized, i.e., the dissertation identifies several contributions, but their relative importance is not always clear. The reader would benefit from a more explicit hierarchy of contributions mapped against the supply chain inventory management literature. At present, these elements are interwoven throughout the text, making it difficult to assess the precise nature and significance of the contribution to knowledge. A precise comparative discussion summarising key characteristics of prior studies would enable readers to identify immediately where the dissertation extends existing knowledge and where genuinely novel insights emerge. In this context, it would also be helpful to distinguish clearly between extending an existing model and making a genuine contribution to knowledge.

Literature Review

The dissertation reviews several relevant streams of literatures, including variable production rates, multiple suppliers and single manufacturer systems, supply chain collaboration, game-theoretic approaches, and simulation of supply chain inventory problems. By highlighting the absence of models that combine multiple independent suppliers, stochastic demand, variable supplier and manufacturer production rates, and differing lead times, it further identifies a recognizable gap which provides a credible positioning within the literature and clear research objective.

The main weakness, however, is that the literature review is more descriptive than critical. Many quantitative studies are summarized sequentially rather than critically synthesized. There is insufficient discussion of application contexts, modelling assumptions, limitations, as well as methodological trade-offs. A stronger synthesis of the literature would improve the intellectual foundations of the research and might demonstrate why the proposed modelling choices follow logically from unresolved problems. This could be addressed by a comparative table summarising assumptions (e.g., demand, structure, production rate, transportation, etc.), decision variables, solution method, and limitations of prior studies, together with a stronger explanation of the research gap. Moreover, while the literature review appears to be substantial, it is not evident why some closely related articles (e.g., multi-supplier single buyer integrated inventory models under stochastic demand or supply chain inventory simulations) have not been considered in the review. Another concern is the need for careful verification of newer or less central references. Some references are presented briefly without sufficient explanation of their relevance to the specific research gap. It might be worth refining the literature review to prioritize the closest and most relevant studies. Less relevant citations can be moved to footnotes or removed, while the most important works should be discussed in more analytical depth.

Modelling and Simulation

The overall research design is appropriate for a doctoral dissertation in Operations Management and Inventory Control. The analytical modelling framework is systematically developed, key assumptions are explicitly stated, and the progression from analytical optimisation to simulation-based experimentation follows a logical research pathway. The combination of mathematical modelling, optimisation, and discrete-event simulation is well aligned with established approaches in inventory and supply chain research and demonstrates a high level of technical competence. A particular strength of the dissertation lies in the systematic development of increasingly complex coordination structures.

Notwithstanding these strengths, the dissertation relies on a large number of assumptions, several of which require stronger justification from both a managerial and theoretical perspective. While many assumptions are understandable from the standpoint of mathematical tractability, their practical implications and limitations are not discussed sufficiently. For example, the model assumes that the manufacturer bears all direct and indirect costs while suppliers are treated largely as autonomous entities whose primary objective is to remain operational and fulfil delivery commitments. In practice, many supply chains involve shared cost structures, contractual arrangements, incentive systems, transportation agreements, and risk-sharing mechanisms. Consequently, it remains unclear under which conditions the assumption of a cost-bearing manufacturer accurately represents real industrial settings (especially given the context that is indicated). Similarely, the model assumes that all suppliers make the same number of deliveries during a production cycle, that the time between deliveries from a given supplier remains constant, and that the manufacturer places a single joint replenishment order with all suppliers once the reorder level has been reached. While these assumptions create a mathematically elegant structure, they do not necessarily reflect operational realities. In practice, suppliers may operate under different delivery schedules, transportation constraints, or contractual agreements, and there may be situations where smaller and more frequent deliveries from selected suppliers create economic benefits. The consequences of imposing synchronised replenishment should therefore be examined more critically. This does not imply a change in the model but this should be discussed somewhere.

A second methodological question concerns the transparency of the optimisation procedures. Although the dissertation provides pseudocode and describes the use of local search techniques, the implementation details are not always sufficiently reported to permit a thorough assessment of solution quality. More information is needed regarding search bounds, step sizes, convergence criteria, stopping rules, computational complexity, numerical stability checks, and the extent to which global optimality can be claimed. For example, while conditions establishing optimality for the reorder point are discussed, the convexity or quasi-convexity properties of the remaining decision variables are not fully demonstrated. Consequently, it is difficult for the reader to evaluate the robustness of the search procedure and the likelihood that the reported solutions represent true optima rather than locally optimal solutions. At a minimum, additional numerical evidence supporting the effectiveness of the proposed optimisation procedure should be provided.

The modelling chapters would also benefit from a more rigorous review of notation and presentation. Throughout the analytical development there are occasional inconsistencies in notation, parameter definitions, and mathematical expressions. While these issues do not fundamentally compromise the models, they occasionally impede readability and increase the effort required to follow the derivations. Given the technical complexity of the dissertation, greater consistency in notation is particularly important.

Furthermore, the simulation requires more details. The dissertation states that OptQuest is employed to determine near-optimal solutions, but important aspects of the implementation remain unclear. Additional information should be provided regarding search configurations, optimisation settings, replication design, confidence intervals, random-number streams, seed selection, run lengths, convergence diagnostics, and robustness checks. Without such information, it is difficult to assess the statistical quality of the simulation results and the reliability of the outcomes. A related concern is that confirmation of analytical solutions through simulation does not automatically validate the simulation results obtained after analytical assumptions have been relaxed. Once new decision rules and operational dynamics are introduced, the simulation effectively becomes a new model requiring its own validation and verification procedures. More attention should therefore be devoted to explaining why the simulation results should be trusted under the modified system conditions. An additional methodological issue concerns the treatment of decision variables within the simulation model. In the analytical framework, batch sizes emerge as derived variables, whereas in the simulation optimisation phase they appear to be treated as decision variables. The rationale for this transition is not sufficiently explained and requires clarification. The reader should understand precisely how the analytical and simulation models differ and how these differences influence interpretation of the results.

The numerical analysis is extensive and demonstrates considerable effort. The sensitivity analyses cover a broad range of parameters including demand levels, demand variability, production rates, holding costs, and raw-material consumption coefficients. This provides useful insight into the behaviour of the proposed inventory policies and increases confidence in the robustness of the solution structure. Nevertheless, the empirical grounding of the numerical examples remains limited. Although the parameter values appear plausible, the dissertation does not consistently explain whether they originate from empirical observations, prior literature, industrial case studies, or hypothetical scenarios designed for illustration. This distinction is important because the

interpretation of the results depends heavily on the origin of the parameter values and readers may incorrectly infer that the results possess a stronger empirical basis than is actually the case.

Finally, while the dissertation demonstrates considerable analytical sophistication, there is occasionally a tendency to equate mathematical complexity with theoretical contribution. The analysis would benefit from a stronger conceptual discussion linking supplier heterogeneity, coordination mechanisms, governance structures, power asymmetries, and supply-chain resilience to the observed cost and operational outcomes. Developing such a conceptual framework would strengthen the integration between the analytical models and the broader business and management literature and would clarify the theoretical significance of the findings beyond their mathematical formulation.

Analysis and Discussion

The numerical experiments and sensitivity analyses are extensive. The investigation of demand, demand variability, holding costs, production-rate parameters and raw-material consumption coefficients demonstrates a robust analytical effort. However, transparency around data and parameter sources could have been improved. Even in theoretical modelling, research integrity requires clarity about whether numerical parameters are hypothetical, literature-derived, or empirically motivated (which would also help external validity). It might be worth adding a section that explains the origin of all numerical parameters. If they are illustrative, this should be said explicitly. If adapted from previous studies, the exact source and rationale should be stated.

The dissertation also seems to interpret numerical results in a deterministic or general way without sufficiently emphasizing that conclusions are based on specific parameter ranges and model assumptions. The results are informative, but their generality depends on the chosen parameters. It might be worth adding a section on the scope of (especially external) validity of the numerical findings. This should clarify which insights are structurally implied by the model and which are contingent on the numerical examples. For example, the proposition that dynamic replenishment timing can outperform rigid synchronized dispatch should be framed as supported by the modelled scenarios, rather than asserted as universally true across all cost and capacity conditions. Another related concern is about the statistical reporting in the simulation study. Although the dissertation states that a warm-up period of six months, a 50-year runtime, and 20 replications were used, the results would be more convincing if accompanied by confidence intervals, standard errors, and variance estimates for key cost outputs. This would allow readers to judge whether differences between policies are practically and statistically meaningful.

There are also concerns in terms of reproducibility. The dissertation uses pseudocode and describes Arena/OptQuest models, but the full computational implementation is not fully reproducible from the text alone. It might be worth including the exact code or at least detailed algorithmic settings in an online repository or appendix, of course subject to institutional rules. This would strengthen transparency and allow future researchers to replicate or extend the work.

Lastly, many results are described mathematically without being elevated to higher-level managerial insight. Chapter 6 would benefit from a more explicit explanation of why effects occur and what they imply for practice (as attempted in Chapter 5.5). The analysis produces several practically relevant findings that could inform supply chain and inventory managers. The integrated solution generally reduces total supply chain cost, while the Stackelberg solution often reduces

manufacturer costs but increases supplier costs. While generally observable in integrated inventory modelling, the result is relevant because it demonstrates the cost shift associated with decentralized power structures for the considered supply chain setting. The finding that Stackelberg may be advantageous when the raw material consumption coefficient is low is also useful because it identifies a boundary condition under which decoupled supplier production can be beneficial. The reported cost comparisons show that the dynamic replenishment policy with equal batch sizes and unsynchronized dispatch can outperform the analytical unequal-batch synchronized-dispatch policy. This supports the claim that timing flexibility may be more valuable than batch-size flexibility under certain heterogeneous supplier conditions. Thus, there is ample evidence for more detailed managerial insights.

Writing and Presentation

The dissertation is logically structured and chapters are organised coherently. There is nevertheless a significant degree of repetition across chapters and numerous paragraphs could be shortened without loss of meaning. For example, several sections restate the same motivation, especially concerning SMEs, collaboration, and the role of the manufacturer. While these points are important, repetition can obscure the central argument. Chapters 1, 4, 5, and 6 could be streamlined by reducing repeated background material and focusing the central arguments. Moreover, consistency in terminology could be improved. Terms such as manufacturer, producer, principal partner, supplier, vendor, batch, shipment, delivery, dispatch, arrival, lot size, and replenishment should be used consistently. Another concern is the clarity of the research questions. The objectives are stated, but the dissertation would benefit from explicit research questions that align with the methods and results.

Secondly, the use of references would benefit from substantial strengthening. Several sections of the introduction, for example, rely heavily on a limited number of sources, with some broad arguments appearing not to be supported by appropriate references. This is below the level of scholarly engagement normally expected in a doctoral dissertation, where major claims are typically triangulated across multiple authoritative sources. Furthermore, references are often used descriptively rather than critically, resulting in limited engagement with competing viewpoints, methodological debates, and alternative theoretical perspectives. The foundational literature should be revised, particularly within the introductory chapters, ensuring that key arguments are supported by a wider range of seminal and contemporary studies. Strengthening the breadth, depth, and critical integration of the literature would significantly enhance the academic rigor and credibility of the dissertation.

A third issue is presentation of the data and results. Some tables are dense, and the formatting sometimes makes them difficult to interpret. In places, table captions and table bodies appear visually compressed or misaligned. The reader may struggle to follow the relationship between decision variables, outputs, and percentage comparisons. Table formatting could be improved, key results could be separated from supporting results and summary figures could be added for readability purposes.

A fourth issue concerns proofreading, formatting, and typographical consistency. There are visible errors in headings and terms, for example supplychain, heterogenous, curiculum, and occasional spacing or formatting inconsistencies. These do not undermine the intellectual contribution, but they reduce the polish expected of a doctoral submission. A final professional proofreading pass

should focus on terminology, table formatting, captions, cross-references, mathematical notation, and grammar.

Summary Statement

This dissertation represents a substantial and technically ambitious contribution to the fields of supply chain inventory management by addressing coordination of multiple suppliers and a single manufacturer operating under stochastic demand, variable production rates, and differing delivery lead times. It demonstrates a high level of competence in modelling and simulation, and successfully develops a generalized inventory-control framework that extends existing research. The dissertation would, however, benefit from substantial revisions. In particular, the articulation of the theoretical contribution requires greater clarity, the literature review should be more critical and synthesising, model assumptions need stronger managerial justification, and the simulation methodology requires more comprehensive reporting to enhance transparency, reproducibility, and credibility. Greater emphasis should also be placed on managerial implications and external validation. Notwithstanding these shortcomings, which are remediable, the dissertation demonstrates the qualities expected of doctoral-level research and provides a substantial original contribution to knowledge. In my judgement, the thesis meets the standard required for the award of a PhD. I therefore recommend that the candidate be admitted to the doctoral defence and, subject to a satisfactory defence and the completion of major revisions addressing the issues identified, be awarded the PhD.