Int. J Sup. Chain. Mgt Vol. 7, No. 5, October 2018

Precursors of Warehousing Efficiency: An Empirical Study and Evaluation within an Industrialized Hub of a Developing Economy, Ghana

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Abstract: The current study aims to investigate the mediating role of transportation on the relationship between inventory management and warehousing efficiency. Using self-administered questionnaires, the study's theoretical model is tested on a sample of 216 firms operating a warehouse within the free zones enclave located at Tema, Ghana. First, the study reveals that inventory management is a significant antecedent to warehousing efficiency. Second, findings suggest that achieving transport objectives is reliant on inventory management. Third, the findings also indicate that greater transportation is associated with an improved warehousing performance. Though the study finds support that pursuing good inventory management practice and optimum transportation independently yield efficiency in warehousing, we infer from our proposed superior mediation model that aptitude on firm's inventory management practices is driven through transportation initiatives which largely influence success in warehousing operations.

Accordingly, this paper specifically addresses this gap; scholars are yet to determine the precedence conditions in firms' level of investment in either transportation or inventory management in achieving overall warehousing efficiency. Based on empirical data from the environs of a developing economy, this study informs organizations and the broader academic environment on investment priorities and the decision theory respectively regarding warehousing efficiency.

Keywords— *Inventory management, Transportation, Warehousing performance, Inventory Review Systems, Forecasting, Data/ Information Management, Delivery Time***,** *Defects per Transit, Aggregate Efficiency*

1. Introduction

Warehouses are pivotal in the provision of value-added services in the supply chain [1]. Warehousing operations is very important in today's operations and its prudent use has helped move organizations from paper to profit [2]. The warehouse is the interface area for production lines, market, customers and suppliers, and the business environment in general. The prime objective of most warehouses is to facilitate the movement of goods through the supply chain to the end consumer. Warehouses are fundamental components of most modern supply chains.

They are likely to be involved in the handling of raw materials, work-in-progress, sourcing, production and distribution of goods through to finished products. Warehousing generally involves the performance of administrative and physical functions associated with storage of goods and materials. These functions include receipts, identification, inspection, verification, retrieval for issue etc. Warehouses are generally located in different settings such as in the urban, rural, or international locales and impact differently on the costs of the resources used such as labor and building space.

Performance assessments in warehousing provides viable options in its design and operations which actually confer many benefits such as speeding up the supply chain and minimizing order picking costs [3]. According to [4] there are two main approaches by which warehousing performance could be measured: 1) Economic - revenue related to cost and 2) Technical - outputs related to inputs. However, [4] acknowledged that the economic assessment of warehousing performance is very difficult since warehouses typically do not generate revenues but rather support the supply chain. The technical assessment in essence involves internal issues e.g. space utilization, inventory accuracy, safety and housekeeping and external issues e.g. order accuracy, stock-outs, and complaints as well as performance issues e.g. goals, feedback, competence. However, some organizations tend to measure their progress against fiscal measures such as; return on investment, cash flow, sales growth, although those measures are irrelevant and do not truly refer to the issues of quality, service, and continuous improvement. Generally, performance evaluation provides feedback on

IJSCM, ISSN: 2050-7399 (Online), 2051-3771 (Print)

the quality of a proposed design and/or operational policy, and more importantly, on how to improve it [5].

In this paper, we affirm that lacking a general understanding of the technical efficiency of warehouses and its associated causal factors hinders industry's ability to identify the best opportunities for improving warehouse performance. Based on this, we address these research gaps in the literature by examining two key logistic functions: inventory management and transportation. These two are conjectured in examining warehouse efficacy. Pragmatically, to meet high performance goals, research should adhere to streamlining warehousing and its operations by robustly improving and validating measures in every aspect of warehousing efficiency. Most importantly, we emphasize that to the best of our knowledge, not many studies have examined the antecedents to, and warehousing efficiency outcomes of transportation especially in institutionally underdeveloped societies.

Accordingly, this study seeks to provide the following contributions to the supply chain literature. First, [6] describes supply chains as becoming more complex, therefore the variety of indicators and tools used to measure warehouse performance has also increased. Further, the metrics that are used for performance evaluation are assessed in different manners and hence there is not clear definition for some of these metrics. Despite the lack of a consensus of a group of measures to assess warehouse efficacy [7], our methodology draws attention to a rigorous but empirical approach to this concept.

Second, [8] posit that supply chain management unlike other disciplines is in a relatively early stage and makes a strong call for the development of its own conceptual and context-specific theories. In spite of increasing complexity of logistics networks, warehouse performance analysis has become an important issue [9] which [10] asserts the need to study key practices and decisions of firms that drive the performance of supply chains. It is also observed that the research effort focusing on warehousing is a very small fraction of the overall supply chain research [5]. Hence this paper's theoretical contribution rests on the investigation of the separate effect of inventory management and transportation as well as their precedence effects on warehousing efficiency.

Third, institutional literature gives clarity that organizational performance is dependent on their internal resources which emanates from their core competences and assets [11]. According to [12] firms that complement their internal resources gain synergies and get the edge over their under resourced competitors. Thus, they have the ability to deliver at the right time, at the right place and with the right quantity [13]. Different from previous works, this study took interest in examining the antecedents of warehousing efficiency by means of complementary resource – capability measures such as forecasting, review systems and data management as measures of inventory management, with delivery time, defects per transit and aggregate efficiency as transportation measures. Empirically, scholars are yet to determine the precedence conditions or priorities in firms' level of investment in either transportation or inventory management in achieving overall warehousing efficiency. This study informs organizations about these investments level. Accordingly, this paper sheds light for industry players on this decision theory regarding warehousing efficiency

Last, the majority of present works on warehousing efficiency has its data sets emanating from western economies which are mostly characterized by quite improved logistics planning and strategy. It is left to underscore the importance of such researches to developing economies. The tilt of this research imbalance is reduced by this paper's contribution to the global supply chain literature by providing evidence also from a developing economy.

With many warehouses, it is contended that the unique environment of Ghana's industrial hub, Tema will provide useful insights for academia and practitioners. This paper addresses these gaps by describing a different but robust methodology for assessing warehouse efficacy based on empirical data from the environs of a developing economy. Several multivariate statistical techniques are applied to data from large sample of warehouses. As warehouses support manufacturing and service processes, much needs to be done in advancing research on its effectiveness and efficiency. It has been purported in developing economies like Ghana that warehousing is a mere staff function and a place of work for the little minds. It has been tagged as a place to keep dysfunctional and outmoded goods. This problem is worsened by the significant gap in the education and training of the industry's professionals. Despite the advances in technology, most Ghanaian warehouses are still in stagnation which hinders their efficiencies in contributing to the overall supply chain performance of their companies. A visit to most warehouses informs the neglect of basic metrics which cannot be even termed a microcosm of efficiency. The outcome of an inefficient warehouse is envisaged in the following; reduced operating expenditures, worsened customer relationships and service, increased unnecessary costs, shortened fulfillment lead times, manual data inaccuracies, inability to track inventory in real-time, reduced employee productivity, reduced profits in the long-term among others. The study specifically investigates the extent to which the effect of inventory management on warehousing efficiency is mediated by transportation using Tema free zones area as a case. Validation is made for key measures of study constructs in the ensuing section.

2. Theoretical Review

2.1 Inventory Management

Inventory management has been posited as an important function in determining warehouse performance [14]. Inventory management strategy has been discussed among scholars in contemporary supply chains and practitioners have been more concerned about their impact on business performances [15]. According to [16], at each point in the inventory system the operations managers need to manage the day–to-day tasks of running the system. Orders will be received from internal or external customers; these will be dispatched and demand will gradually deplete the inventory. Orders will need to be placed for replenishment of the stocks; deliveries will arrive and require storing. Despite these tasks, models have been proposed to address problems in inventory control. Pioneered by [17], inventory management basically considers the decision of when to order and how much to order. Today, the most economic approach is needed to determine the optimum quantity and best price to be paid for orders under demand uncertainties and other constraints. Essentially the best inventory management approach attempts to find the best balance between the advantages and disadvantages of holding stock and paying the best price in terms of discount enjoyed from bulk buying.

2.1.2 Inventory Review Systems

It is essential to hold the best possible levels of inventory. Holding too much inventory creates holding costs on inventory. These costs come by way of variable and fixed costs such as inventory space/rent, cost from items sitting on shelves, utility charges: power and water, item damages as well as pilfering. However holding little inventory is very costly during times of unexpected demands. Unable to meet consumers' need may trigger customers to go to competitors [18]. The primary objective of good inventory management is to ensure customer satisfaction and respond efficiently to customers' requisition, thereby having optimum stock and meeting demands. Good customer service results from ordering the right quantities of the stock at the right time.

Inventory optimization tools help organizations to generate consistent decisions in ordering products. According to [19], there are two most known inventory review systems dependent on demand fluctuation; the periodic and continuous (perpetual) inventory systems. In a continuous inventory system, purchase order is placed for the continual quantity each time the inventory on hand reaches the reorder point level, whereas in periodic inventory system, purchase order is placed for a variable quantity after the definite fixed time interval [20]. According to [21], continuous system is normally used for Class A items, which form the greater percentage of the total value of the inventory in stock. Contrary, it was earlier stated that the periodic review is used with medium to low value items in high volume [22]. The Class A inventory form the least in terms of stock quantity and damages to these items put them at the highest risk. Inventory fulfils many important functions in an organization and tend to keep total costs at the minimum.

2.1.3 Forecasting

Traditionally, the relevant literature treats inventory management and demand forecasting as independent problems [23]. The choice of forecasting method is shown to be an important determinant of the customer service that can be obtained from a given level of inventory investment. Since the early work of [24], forecasting for inventory items has attracted an enormous body of academic research. Firms which are unable to forecast accurately faces high risks with stock obsolescence when they are not demanded. Case studies (eg. [25] have documented large proportions of dead stock in many different industrial contexts. Improvements in forecasting may be translated to significant reductions in wastage or scrap with further environmental implications. Despite the proposition of several forecasting models, we are left to wonder whether one should make point forecasts of the mean and variance of intermittent demand with a simple parametric method or use bootstrapping to simulate an entire distribution of demand during lead time. Demand is uncertain mostly due to changes from purchase orders and unpredictable events. Forecasting as close to accurateness with regards to time helps make better decisions under uncertainty [26].

2.1.4 Data/ Information Management

Scholarly works in extant literature on managing of information in supply chains is diverse. Several researchers study warehousing efficacy but a few incorporates the issue of data management or information sharing. Studies (eg. [27], [28] have observed the importance of shared information in supply chains. Information sharing along supply chain alerts actors to become very responsive to changing demands and requisitions especially after orders are en route to customers. Information sharing is particularly useful to prevent bullwhip effect [29], [30]. Quantitatively, the reported benefits of information sharing vary considerably eg. [31] finds that supply chain costs are lowered up to 9%, and on average by 1.8%. [32] report benefits of 0%–5%. In contrast, [33] find that information sharing lowered supply chain costs by about 23%. However, [34] concludes that information sharing provides no benefit to the supply chain. [35] report that sharing the retailer's demand data reduced the supplier's cost by 1%–35%.

2.2 Transportation

Warehousing efficiency cannot downplay the importance of transportation (see [36], [37]). A critical transportation management issue is modal selection, it affects how quickly and efficiently goods and services will flow across portions of supply chain. Numerous works (eg. [38] have identified the most important performance capabilities in modal selection. These studies commonly identify accessibilities, transit time, reliability, and product safety as the key determinants in choosing a mode. Of course, cost is another critical consideration in modal selection [39. The "Seven Rs" [40] effectively identify the focus and scope of transportation service quality KPIs-"at the right time" targets transit time, "in the right condition" concentrates on freight protection, and "at the right cost" pertains to billing accuracy issues.

2.2.1 Delivery Time

The focus on lean supply chains and just-in-time operations makes consistent, on-time delivery a critical requirement. Multiple studies suggest that on-time delivery is one of the most important KPI used by transportation buyers to evaluate their carriers (eg. see [41], [42], [43]. Timely service facilitates inventory rationalization through lower safety stock levels, provides consistent replenishment to reduce out-of-stock problems, and reduces supply chain uncertainty and the resulting bullwhip effect. On-time delivery measures the ratio of shipments delivered in a timely fashion (i.e. the date and time promised by the carrier) to the total shipments delivered by the carrier [39]. Most transportation buyers set 95 percent as a minimum acceptable level of performance from their motor carriers, with goals of 98 percent or above. Delivery consistency compares the average origin-destination transit time of shipments to the transit time promises made by carriers [39]. Sizable deviations from these carriers are not providing adequate service and corrective action should be taken.

2.2.2 Defects per Transit

Freight protection is another key element of transportation service quality appraisal [44] as damaged goods in -transit can lead to product returns [45]. It is not enough to get the shipment to its destination quickly: It has to get there safely and completely. Time and money are sacrificed when freight is damaged or lost. Supply chains supporting just-in-time operations and continuous replenishment retail distribution systems are especially vulnerable to delivery disruptions, as they keep little to no safety stock on hand to replace the unavailable goods [10]. Claims-free delivery is a primary freight protection indicator. The ratio of claims-free deliveries (no need for a freight claim due to loss, damage, or any other reason) to the total number of deliveries is evaluated by the transportation buyer [39]. Perfection is the goal - most organizations will accept nothing less than 99 percent claims-free deliveries. A high level of claims indicates that carriers are not taking adequate steps to protect the freight or that the freight packaging is insufficient. Service failures must be diagnosed and corrected immediately to prevent future claims. The ultimate service level is the execution of perfect deliveries [41]. Transportation buyers are constantly seeking out high-quality carriers that are capable of consistently providing flawless service that is on time, damage free, accurate, responsive, and cost effective [46]. Defect-free transportation eliminates the need for rework, reduces administrative intervention as well as promote customer satisfaction, inventory reduction, and reduced variation in the supply chain.

2.2.3 Aggregate Efficiency

Logistics service quality is critically important for customer satisfaction [47], hence firms need to balance their service requirements and the expenses related to moving freight. Transportation costs must be kept low in proportion to the value of the goods or they will not have a competitive landed cost. Transportation is the single largest expense in logistic services [48], and it is important that organizations get the greatest "bang for their buck" when using transportation services. According to [39], aggregate efficiency measures focus on the transportation expense per unit of measure. It is a calculation of total freight cost divided by the number of units shipped. This measure also provides a baseline from which improvement efforts can be made.

Efficiency measures can also be used to evaluate and improve the performance of carriers and private fleets. Other works (eg. [49], [50] considers labor productivity measures to ensure that equipment operators, freight handlers, and other personnel are performing at optimal levels. Minimization of loading and unloading time improves carrier employee and the equipment turnaround time, keeping both in productive use [51]. These and similar factors directly benefit carriers by focusing on cost control. Freight buyers that contribute to efficient carrier operations reduce their exposure to equipment detention and accessorial charges, as well as put themselves in a solid position to negotiate more advantageous freight rates [39]. These three factors; aggregate efficiency, delivery time, defects per transit can help organizations take a proactive, knowledge-based approach to transport decision making. These factors are instrumental for monitoring quality and dealing with service issues in a timely fashion before they have a major impact on the supply chain. These help organizations pinpoint inefficiencies and develop strategies for supply chain cost reduction. Finally, they can be used to analyze cost-service level tradeoffs. It is contended that this knowledge can be used to make better carrier selection and assignment decisions in a reactive mode and limits the transportation manager’s ability to make informed, timely decisions.

2.3 Empirical Review: Warehousing Efficiency

Many studies have discussed the subject of warehouse efficacy in different industrial settings. Aside external issues, trends have evolved where firms consider efficacy holistically by looking at other internal functions in measuring warehouse performance [52]. [53] in their measurement of warehouse efficacy propose performance indicators: on time delivery, number of orders and damaged inventory as well as process mapping. These two solutions complete each other. They established key performance indicators for a warehouse after a process map was drawn, considering also other indicators used at international level. The process map was a helicopter view needed for establishing relevant performance indicators. Performance indicators were useful for identifying the problems – red or abnormal values of the indicators were as a control system for a warehouse. Solving the problems, they used a very simple methodology: identify the causes of the problems and then try to diminish their impact or just eliminate the causes. [53] defined warehouse performance measurement as discovering the problems of the warehouse and solving them before is too late. Further, it is a way to reduce costs by improving operations that take place in a warehouse, and having low costs is an essential feature of differentiating logistics firms.

As far as warehouse performance dimensions are concerned, [54] study in an African context involved four key indicators; quality, response time, total warehouse cost, and productivity. Generally, the study findings have suggested that the levels of warehouse performance is moderate in the case of Ethiopian Trading Enterprise in terms of the four key performance indicators. The study also revealed that measurement of warehouse performance based on dimension of response time is comparatively in a better position. The study implied that the performance implication of capacity of warehouse is based on the status quo and they all have different point of view among the four key performance indicator that can heavily contributed to the overall performance of a warehouse.

[6] made a synthesis of the measures found in literature; time, productivity, cost and quality to evaluate warehouse performance, defining their boundaries and equations. The indicators are classified and grouped according to the dimensions of time, quality, cost and productivity. To transform the indicator definitions, they used a standard warehouse to define its layout, activities and indicators measurement units. Then, the indicator definitions found in the literature were analyzed, considering the measurement units defined in the standard warehouse, in order to state indicators with mathematical expressions. The result was a well-defined set of metrics available to companies for a more accurate warehouse management.

[55] in an emerging economy context investigated the relationship between the influential warehouse efficiency and warehousing operations, applied by the Small-Medium Enterprises (SMEs) manufacturing firms in Malaysia. The study meant to determine whether there was any relationship between the warehousing operations, and warehousing Management Information System (MIS).It also examined the mediating effect of warehousing MIS in the relationship between warehousing attributes and warehouse efficiency. Using a quantitative approach, three hypotheses were proposed for the research with data collected from the survey of 182 SME manufacturing firm owners in Malaysia as listed in the SME Directory. The findings indicate that the warehousing MIS significantly mediates and has an effect on the warehousing operations and their relationship with warehouse efficiency in the SME manufacturing firms. Theoretically, the research contributed to the growth development of the warehouse efficiency theories.

[56] work on warehouse efficiency followed a rigorous study conducted in 2000 by VTT Technical Research Centre on warehousing. The objective of the study was to examine the present state of Finnish warehouses and to create guidelines for improving warehousing. Forty-five Finnish warehouses, including wholesalers, industrial companies and contract warehouses, participated in the study. A group benchmarking method [57] developed at VTT was used in the study. The study concentrated on the following areas: warehouse efficiency (work efficiency, space utilization, and cost efficiency); warehousing costs calculated by activity-based costing method; service level; and working methods. As required by benchmarking theory, some best practices were also defined. The best practices include, for instance, IT solutions, tracking and control systems, working methods and an efficient warehouse. Building on VIT research, they found that the efficiency of warehouses was strongly related to order structure, especially the order structure of the outbound flow. By considering the order structure, the relative

efficiencies of warehouses can be compared. The study also revealed that space utilization and work efficiency in picking, packaging and shipping affect warehousing efficiency. The major problems in warehouses were related to the inefficiency of the IT and control systems resulting in a lot of unnecessary work being done, which in turn affects both the overall efficiency and service level. Although the importance of good customer service was known in the companies, only a few companies had a proper control system for service level.

[5] attempted a thorough examination of the published research related to warehouse design and performance, and classified papers based on main issues addressed. There were 50 papers directly addressing warehouse design decisions. There were an additional 50 papers on various analytic models of travel time or performance for specific storage systems or aggregates of storage systems. They established benchmarking, case studies and other surveys accounted for 18 more papers. One clear conclusion was that warehouse design related research has focused on analysis, primarily of storage systems rather than synthesis. While this was somewhat surprising, an even more surprising observation is that only 10% of papers directly addressing warehouse design decisions have a publication date of 2000 or later.

This study proposes a conceptual model (see figure 1) and develop a series of hypotheses to support our argument that warehousing efficiency is consequential of effective inventory management and transportation, however transportation mediates the relationship between the two. The logical arguments backing these hypothesis are explained in the next section.

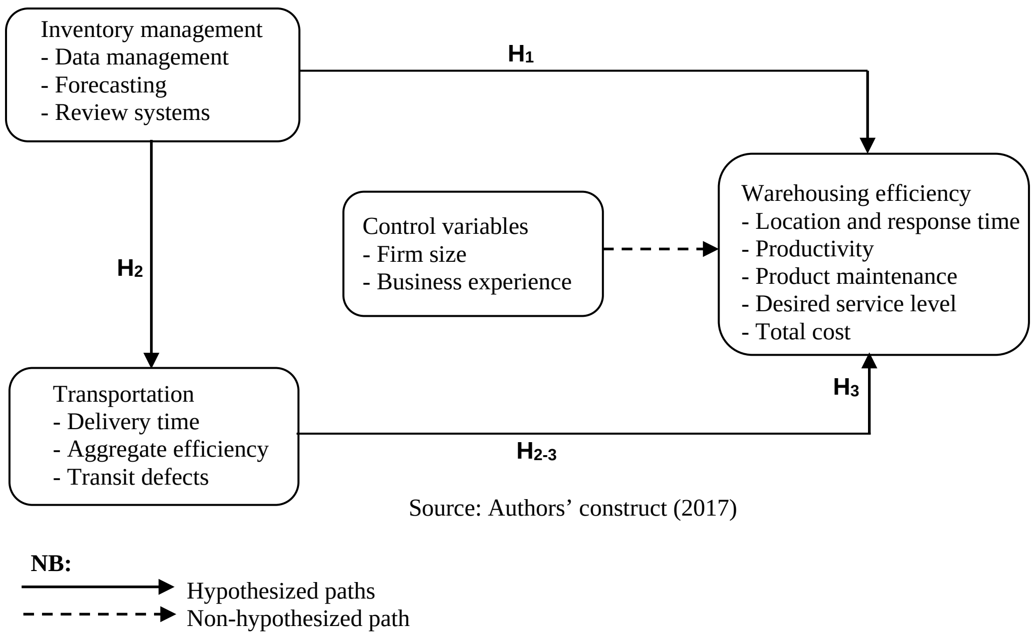


Figure 1: Proposed Mediator Model for Warehouse Efficacy

2.4 Hypothesis Development

2.4.1 Inventory Management and Warehousing Efficiency

Traditionally, warehouses have been places of storage and within it undergoes most inventory practices [58]. Through simulation, [59] depicted that inventory management has been one of the determinants of warehouse efficiency. [60] stipulates that warehousing involves complexity of operations. Thus items can be misplaced or untraced. In improving efficiency in-house, it is inventory management that basically ensures identification of items. [61] posit that inventory cost component i.e. holding costs are directly related to warehousing costs, therefore holding lots of inventory comes with more costs for storage and space. In improving warehouse performance, the trend is to maximize warehouse capacity [5], which can be achieved, for example, by the block storing, efficient shelving and palletizing. This facilitates order identification and picking in-house.

The theory of working capital management (WCM) also provides useful insights on why robustness in inventory management leads to an increase in warehousing efficiency. Studies have defined working capital in terms of variations in assets and liabilities eg. [62], risks and turn overs eg. [63]. Effective management of working capital has been posited to affect liquidity and profitability of firms

[64]. Nevertheless, warehouses come with potential liabilities; stock obsolescence, rent, lightening, salary and insurance. Blending insights from Fisher's separation theorem, conservative strategies on distinctness of working capital investments from financing must gear towards lower risk to effectively improve warehousing efficiency [65]. This involves a turn of attention to short term assets such as inventory [66]. Disposing of items rapidly leads to quick turn over to make up for potential liabilities associated with warehousing.

Further, key inventory management decisions typically involve how much to order every time a replenishment order is placed, how big should it be (sometimes called the volume decision), when to order at what point in time, what level of stock the replenishment order should be placed (sometimes called the timing decision), and how to control the system with routinely installed procedures to help make accurate decisions in-house [67]. In achieving warehousing efficiency, inventory management ensures that different priorities are allocated to different stock items and decides how information about these stocks is stored and retrieved on requisitions. According to [68], the most economic and robust inventory approach is needed to determine the optimum quantity to meet projected demand. This helps to reduce overall warehousing costs as a result of stock obsolescence. Accordingly it is hypothesized that;

H1: Inventory management is positively related to warehousing efficiency

2.4.2 Inventory Management and Transportation

Studies eg. [69], [70] have recognized inventory management and transportation to have productive logistic interdependencies. Supply chain management embraces competitiveness in achieving customer's satisfaction [10]. To reform its services to fit customer desire, the organization has to improve its service level and decrease costs regularly. Hence in-house inventory management should match transportation decisions. And so, based on customer requisitions and specifications, accuracy on item identification and order picking in-house support speedy delivery of items at the right time and at the right place [71]. [72] states that inventory management systems such as just in-time systems (JIT) should always be poised to meet pressures from increasing demand of time accuracy and decentralization of production in order to enhance service performance. Ensuring this feat comes with frequent deliveries and traceability which are reliant on reliable and rapid transportation [73].

The renewal theory eg. see [74] and the shipment consolidation strategy eg. [75] both provides useful insights on inventory-dependency transport approach that increases service levels whilst reducing transport costs. The renewal theory considers an optimal cumulative order quantity in obtaining an optimal consolidation cycle length. The shipment consolidation strategy takes multiple shipments of small quantities and combine them into single large quantity to be dispatched by a large vehicle.

Contemporary SCM requires an integrated plan for the chain actors as a whole [76], [77]. Consequently, supply chain coordination has been gaining emphasis in recent years eg. see [78], [79], [80]. Coordination effort by the use of vender managed inventory (VMI) is aimed at integrating inventory management and transportation. For VMI applications, the supplier via inventory management approaches is empowered to control the timing and quantity of downstream resupply decisions over time at retail locations [81]. Full truck loads are more likely to be dispatched, it is easier to achieve transportation scale economies, and there is enough time opportunity to synchronize the inventory and transportation decisions [81]. Inventory centralization (eg. see [82], [83] and [84] have been observed as a means to reduce factory-to-warehouse transport costs, improve inventory management, reduce safety stock and better opportunity for negotiating transport services [85]. In achieving operational efficiency of centralization aside customer groupings, [86] considers inventory-location analysis which incorporates location-specific transportation and inventory costs. As a routing problem, this simultaneously considers first, delivery quantities and then, vehicle routes [87]. Further, one of the distinguished components of logistics costs are transportation and costs associated with holding inventory [71], [88]. Suffice to this, ordering more inventory implies paying for higher transportation costs [39].

H2: Inventory management is positively related to transportation

2.4.3 Transportation and Warehousing Efficiency

Everyday task of logistic warehousing is to provide the transport of material and products within it to the required amount and quality to the required place – from warehouse to production workstations. Nowadays, transportation has enabled seamless product replenishment (SPR) which has increased efficiency of the logistic chain. SPR includes automated store ordering, continuous replenishment, cross docking, integrating suppliers by synchronizing production and actual demand, and increasing the reliability of operations [89]. The optimization of outbound logistics operations through consolidation and collaboration using a third party logistics provider has potential to contribute to the profitability of an organization by lowering the cost of transportation and warehousing [90].

The customer requires still larger range of products, therefore, it is necessary to synchronize the logistics with customer's requirements. By the efficient transport, handling and storing, it is possible to solve the issue of increase in customer service level [91]. Today SCM has given way to efficient consumer response (ECR) and efficient foodservice response (EFR), quick response (QR), continuous flow manufacturing (CFM), and Just-in-time (JIT) [92] which all depend on material movement through transport systems to warehouse and to customers. Warehouses have been used as buffer zones to mitigate risk of stockouts due to uncertainties in supply and demand. Pull and push production is one of the most important aspects of lean production. Both principles are based on either or neither having an upper limit on inventory that is not to be exceeded [93]. It is argued that demand driven (pull) from customer to warehouses and production centres or forecast-based (push) from internal firms to customers are dependent on efficient transportation. Even in-house, there is the trend of achieving warehouse efficacy with flexible transport. Here, quite wider aisles enables large volumes of high count of items to be transported comfortably inside the enterprise (e.g. from a warehouse to manufacturing workstations) in short, predefined times, and with minimal loading and unloading times along exactly determined routes [94]. It is contended that;

H3: Transportation is positively associated with warehousing efficiency

2.4.4 Inventory Management, Transportation and Warehousing Efficiency

[91] states that warehousing is focused on operational efficiencies and cross docking requirements, wherein a product is received in a facility, occasionally grouped with other products going to the same destination, and then shipped at the earliest opportunity without going into long-term storage. Thus, inventory management prepares specific raw materials and work-in-progress goods en route to production centres/warehouse to be converted into finished goods.

The "value of added role of logistics" provide reasons for the relations between inventory management, transportation and warehousing efficacy. Logistics contributes to time utility by admitting that different products have different sensitivities to time. Sensitivity varies in terms of the shelve life of items and as such late delivery of items has more serious consequences for the firm. Uncalled-for items just sitting on the shelves have cost implications for firms and needs to be delivered by indulging in rudimentary marketing activities such as promotion [95]. This increases the customer desire to possess the item -possession utility. Place utility facilitates movement of items to less value points to places of greater value [39]. Contemporary business environment requires that products not only be delivered on time to the correct destination but also delivered in the correct quantities to prevent stockouts and inventory costs. The utilities of when and where should complement how much. From warehouses based on customer order requisitions, inventory management create first, quantity and then, time utility by delivering the required quantities to where it is needed via transportation means. In achieving form utility through an assembly or manufacturing process, inbound logistics help cushions firms against stockouts by bringing in finished goods to the warehouse which are kept for inventory control. It has been opined that ultimate value of supply chain management is to deliver value creation and provide superior customer satisfaction [96]. Hence via inventory management decisions and customer-centric, outbound logistics specifically fulfils quantity, time, form, possession and place utility from warehouses.

Studies eg. [37] have confirmed the impact of inventory management and transportation in "the work of logistics". [37] opines that inventory management basically considers the decision of how much to order and when to order, transportation is the active logistic function that supports these decisions in fulfilling customers' requirement by placing emphasis on efficient movement and storage [97]. Inventory management involves the deployment of strategies; control policies (determining optimal levels of order quantities and reorder points), and safety stock level setting at each stocking location. Transportation pushes these safety stock levels and are very critical, since they are the primary determinants of customer service levels [98]. [99] refer to transportation management system as the "glue" that holds the supply chain together by tracking the physical flow of goods from in-house subject to inventory decisions. Formally stated;

H4: The positive relationship between inventory management and warehousing efficiency is mediated by the role of transportation.

3. Methodology and Study Settings

This study resorted to collecting data using self-administered questionnaires. Almost all the questions were closed-ended [100]. Likert scale with anchors suitable to each question were used. [101] argue that closed ended formats reduces the time for completion of the questionnaires. According to [102], measurement error averages out when single scores are summed to obtain a total score. From a broader perspective, the study's population consisted of all firms within Tema free zones area that operate a warehouse. Due to limited tax impositions at Free zones to encourage economic activities, Tema has a lot of warehouses. The importance of Tema as a port and industrial hub is reflected by the fact that the town's chief industrial products include aluminum, steel, processed fish, refined petroleum, textile, chemicals, food products, and cement. Major companies operating in Tema include Volta Aluminium (VALCO), Tema oil Refinery (TOR), Nestlé Ghana Ltd., Wahome Steel Ltd, Tema Shipyard. Target respondents were mostly employees with managerial role as well as other workers of these logistic firms. Since managers are key role players with regard to their firms' business operations, the study sought to collect responses from them, with believe that they gave appropriate responses pertaining to the questions asked.

A random sampling technique was used to select the respondents. [103] argues that between 100 to 200 cases are needed in order to adequately evaluate the reliability and validity of measures. Accordingly, a number of steps were taken to ensure that a minimum of 200 responses were received. Considering the various data analysis techniques, several scholarly articles eg. [104] recommends a minimum of about 15 participants per predictor variable as suitable for a reliable regression output. Thus with 9 predictor variables a minimum of 135 respondents is adequate to achieve reliability and validity. Accordingly 216 responses were usable for this study.

3.1 Measures and their Operationalization

Selecting appropriate performance measures is challenging, due to the inherent complexity and the interdependence of supply chains [105]. [106] argue that performance related measures should mostly be linked to fiscal performance however [107] disregards this assertion because financial measures ignores opportunity costs and the time value of money. We insights from extant literature to measure most of the study's construct. First, the items used in measuring inventory management were adapted from extensively revealed literature of prior research [35], [10], [108]. Specifically, four key items adapted were in reference to; data/information management, forecasting and inventory management and review systems. These four items were measured on a 7-point scale which ranged from 1= "not at all" through to 4= "to a moderate extent" to 7= "to an extreme extent". The study also measured transportation decisions using five items among firms across three dimensions adapted from [39]; time of transit, defect on delivery and cost aggregate efficiency; using a 7-point scale, ranging from 1= "least effective" through to 4= "moderately effective" to 7= "most effective". Finally, warehousing efficiency was measured using five items with scales which ranged from 1= "very low" through to 4= "average" to 7= "very high". The first item was adapted from [109]. The fourth and fifth items were adapted from [5] and [56]. The remaining two items were newly developed.

3.2 Data Analysis Method

Both descriptive and inferential statistics were used in the analysis of the data. Descriptive statistics of respondents and firm profile as well as initial reliability tests was performed in SPSS. During confirmatory factor analysis (CFA), a SEM model was used to specify the indicators for each construct. The measurement model was run using LISREL 8.8. According to [104], the key benefits of SEM is that it provides estimates of measurement error, has a better chance of validating multiple measures at once and parameter estimates are closer to population values. Using the traditional notation of Linear Structural Relationship (LISREL) [110], items were subjected to CFA. The hypothesized paths were estimated using hierarchical multiple regression and [111] process MACRO in SPSS.

4. Results

4.1 Respondent and Firm Profile

Descriptive profile of firms and respondents are presented in table 1 below. It was prudent to assess informants' opinion on their level of comprehension of the questionnaires with two items (see Appendix A); "I am very informed about the issues the questionnaire is about" and "my answers to the questionnaire represent firm reality". Given respective means of 5.13 (SD =1.292) and 5.40 (SD =1.193) on a 7 point Likert scale with anchors 1= "strongly disagree" through to 4= "neither agree nor disagree" to 7= "strongly agree", it can be said that respondents somewhat agree to have been informed and therefore provided answers that depict realities in their firms.

Table 1. Respondents' status

	Categories	*F*	%	N
Education	Diploma/HND	64	29.6	216
	Degree holder	60	27.8	
	At least Masters	92	42.6	
Department/ work function	procurement	37	17.1	216
	Production	17	7.9	
	Warehousing	68	31.5	
	Finance	58	26.9	
Job role	Senior manager	23	10.6	216
	Middle manager	119	55.1	
	Junior manager	57	26.4	
	Others	17	7.9	
Employee work experience	Mean = 5.56 SD = 4.803			
Firm size	Mean = 43.09 SD = 28.056			
Firm business experience	Mean = 11.95 SD = 7.125			

29.6%, 27.8% and 42.6% of respondents were respectively diploma/HND holder, degree and at least master's degree holders. With regards to work function, majority of respondents had duties related to warehousing or storage. The study managed to assess 65.7% respondents' in both middle and senior management role. A firm had an average size of about 103 workers. Given an average employee work experience and firm business experience of 5.56 and 11.95 years respectively, it suggests responses were from respondents with quite vast experience and thus were suitable for the study's objectives.

4.2 Reliability Analysis of Constructs

Reliability of study constructs were assessed in order to determine the internal consistency among study items [100]. The Cronbach's alpha reliability coefficient was used to measure the reliability of scale items [104]. Alpha values of study constructs exceeded 0.7 supposing that relationship between constructs and its indicators are satisfactory [104]. Table 2 indicate reliability analysis of study constructs.

Table 2. Reliability analysis of study constructs

Construct	No. of Items	Cronbach's Alpha
Inventory Management (INV_MGT)	4	0.883
Transportation (TRANSPO)	5	0.760
Warehousing Efficiency (WH_EFFI)	5	0.765

4.2.1 Common Method Bias

Common method bias (CMB) poses threats to the validity and conclusions reached in empirical research, thus it was prudent to assess its potential presence in this study [112]. Prescribed measures were adopted in addressing this concern. First, different items were used to measure study constructs. The constructs and items were arranged in a way that could not easily allow respondents to process and identify patterns and reflect on the various scores provided. Aside these pre-measures, post measures were taken to examine CMB in the actual data collected. Using exploratory factor analysis (EFA) in SPSS, Harman single-factor model was used to assess CMB [112]. With unrotated factor solution, principal axis factoring was fixed to extract a single factor. Indeed with Eigenvalues above 1.0, the emergent single factor did not explain a significant proportion (i.e. at least 50%) of the total variance. It accounted for only 32.996%, which proved that CMB did not sufficiently describe the study data [112. Consequently, we reached a conclusion that CMB was not a major threat to our study's validity and thus its conclusions.

4.3 Confirmatory Factor Analysis (CFA)

4.3.1 Measurement Model Evaluation

A SEM model was used to confirm the items for the study constructs. The measurement model was run using LISREL 8.8. During CFA, a Maximum Likelihood method of Estimation and a covariance matrix of the measures were used as inputs for the analysis. An initial subjection of all fourteen items to CFA produced a model with a poor normed Chi-square i.e. χ^2/d.f. > 2.0 and standardized loadings for items; INV_MGT3, TRANSPO3, TRANSPO4, WH_EFFI1, WH_EFFI2 were less than 0.50, and were not deemed practically significant [104]. After further purifications i.e. removing poorly loading items and items cross loading on non-specified constructs, a satisfactory model fit to data was attained given a non-significant Chi-square with p-value > 0.05; χ^2(d.f.) = 17.86 (17). For SEM models, a good fit is obtained when the $\chi 2$ statistic is nonsignificant, which by convention is taken to happen for p-values ≥ .05. This supports the idea that our proposed theory fits reality [104]. Goodness of Fit indices were also satisfactory i.e. parsimony indices; standardized root mean square residual (SRMR) = 0.026 and root mean square error of approximation (RMSEA) = 0.015, comparative fit indices; comparative fit index (CFI) = 1.000 and non-normed fit index (NNFI) or Tucker-Lewis Index (TLI) = 1.000 in accordance to [113] recommendations. All standardized factor loadings (λ) were at least 0.5 and loaded significantly on their respective constructs with no cross loadings. It was further demonstrated that Average Variance Extracted (AVE) for all scales was above 0.50 cutoff threshold. Despite initial reliability analysis, the pitfalls of Cronbach's alpha is its inability to account for measurement error, and it tends to be optimistic with number of items in a scale [104]. So as a further proof of reliability, composite reliability for all measures ranged between 0.745 and 0.841, which are all above the recommended cutoff criteria of 0.70 [104]. Together, this was taken as evidence of convergent validity [113]. Additionally, all AVEs were higher than the highest inter-construct squared correlations between constructs, suggestive of distinctness of constructs and evidence of discriminant validity [114]. The final CFA output showing the retained items for each construct, the standardized factor loadings, composite reliability (CR), T-values and average variance extracted (AVE) values are shown in table 3. Table 4presents inter construct correlations.

Table 3. Validity and Reliability Results

Constructs and measures	Factor Loadings †	CR	T values	AVE
Inventory Management (INV_MGT)		.841		.639
Forecasting techniques ensure accurate demand estimation	.79		fixed	
Inventory optimization tools ensures consistent decision in time and quantity of ordering	.86		11.81	
Periodic review of inventory is done to prevent and stockouts	.74		10.81	
Transportation (TRANSPO)		.745		.600
Freight protection or claims free delivery is achieved	.64		7.48	
Total freight cost per unit shipped is efficient for truck loads	.89		fixed	
Warehousing Efficiency (WH_EFFI)		.835		.629
Maintenance of product quality	.70		10.69	
Reaching desired service levels	.83		12.68	
Total warehouse cost	.84		fixed	

Note: *CR = Construct reliability; AVE = Average variance extracted, t values significant at 1% (t values > 2.58)*

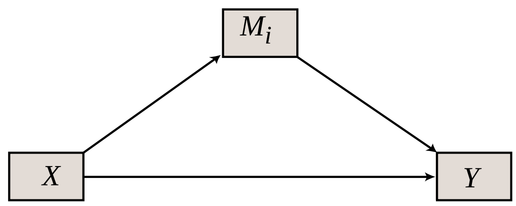
Table 4. Correlation matrix of constructs

Constructs	1	2	3
Inventory Management	1.00		
Transportation	0.45	1.00	
Warehousing Efficiency	0.50	**0.70***	1.00
Mean	4.48	5.01	5.13
Standard Deviation	1.50	1.38	1.28
Composite Reliability	0.841	0.745	0.835
Average Variance Extracted	0.639	0.600	0.629

Note: ** Highest r value among the constructs [$r^2 = 0.49$] < all the AVEs; demonstrating discriminant validity among the constructs]*

4.3.2 Model Estimation

In estimating the proposed framework, single indicant variables were created for each construct by averaging their respective items retained after CFA. The hypothesized paths were estimated using [111] process for SPSS and hierarchical multiple regression given the multiple dependence relationships in the framework. Two separate regression analysis i.e. hierarchical multiple for models one and two and Hayes process for models three, four & five were performed. The main outcome variable warehousing efficiency (WH_EFFI) was predicted by inventory management (INV_MGT) and transportation (TRANSPO) independently, however transportation mediates the relationship between inventory management and warehousing efficiency. Given the control variables, hierarchical regression was used to examine the relative contribution of transportation on warehousing efficiency. Hayes process was also used to predict (i) the effect of inventory management on transportation only, (ii) the effect of inventory management on warehousing efficiency and (iii) estimating the full mediation model. Hayes Process macro was used because it provides bootstrap confidence intervals for the indirect effect. In estimating these hypothesized paths, both effects of firm size and firm business experience on warehousing efficiency were controlled for in assessing the separate effects of inventory management and transportation on warehousing efficiency. Similarly, the effect of firm size and firm business experience on warehousing efficiency was controlled while assessing the mediating effect of transportation on warehousing efficiency. A depiction of the model by Hayes process is indicated in figure 2:



X: Inventory management; M_i: Transportation
Y: Warehousing Efficiency

Figure 2. Hayes single mediator model (Model4)

In all, five nested models were built and evaluated (see table 5). The model specifications and results obtained are as follows:

Model 1: For model 1, warehousing efficiency was predicted by control variables; business experience and firm size. Studies eg. see [115], [116], [117] have provided evidence that large firms with long business years' experience might have gone through the learning curve, achieve lower levels of risk about their operations and perform better in distinct business dimensions. Thus, there was the need to control for the potential effects of these variables. The model was statistically significant and explained 3.2% of the variance in warehousing efficiency.

Model 2: The effect of inventory management on warehousing efficiency was estimated. This model significantly accounted for 20.24% variations in warehousing efficiency.

Model 3: Transportation was predicted by inventory management. This model significantly explained 13.79% variations in transportation.

Model 4: The effect of transportation on warehousing efficiency was estimated. This model significantly explained 32.6% variations in warehousing efficiency.

Model 5: Here, all hypothesized paths were estimated. This model significantly accounted for 37.84% variance in warehousing efficiency. Accordingly model 5 was superior to all models.

Table 5. Study Results using Hayes Process Macro and Hierarchical Multiple Regression

	Dependent Variables				
	Warehousing Efficiency		**Transportation**	**Warehousing Efficiency**	
Independent variables	***Model 1***	***Model 2***	***Model 3***	***Model 4***	***Model 5***
Control paths					
Firm Size	.005 (.077)	.031 (.552)		.0004 (.168)	.0012 (.549)
Firm Business Experience	.177 (2.620)**	.156 (2.761)**		.0251 (2.628)**	.0234 (2.764)**
Hypothesised paths					
Inventory Management			.3492 (5.851)***	.3506 (6.737)***	.2087 (4.209)***
Transportation		.544 (9.626)***			.4078 (7.728)***
Goodness of fit indicators:					
R^2	3.2%	32.6%	13.79%	20.24%	†**37.84%**
F-Statistics	3.485	34.208	34.2349	17.9359	32.106

Note:
*T-values are reported in parentheses; * p<.05 (significant); ** p<.01 (significant); *** p<.001 (significant)*
†*-superior mediation model*

4.3.3 Hypothesis and Findings

The study argues in H_1 that inventory management is positively related to warehousing efficiency. The analysis provides statistical support for this hypothesis (β = .3506; t = 6.737, p < .001). This finding implies that the extent to which firms are efficient in their warehousing duties is significantly influenced by robust inventory management decisions.

In H_2, the study posits that inventory management is positively related to transportation. The results of the study yields empirical support for this hypothesis (β = .3492; t = 5.851, p < .001). This finding suggests that higher levels of inventory management leads to higher transportation tasks. Notwithstanding, more order of inventory comes with high transportation costs.

Hypothesis three, H_3 advances the argument that transportation is positively associated with warehousing efficiency. The results of the study (β = .544; t = 9.626, p < .001) statistically support this hypothesis. The implication from this finding is that firms that do well in their transport operations are more likely to improve their warehousing efficiency, which could manifest in their ability to maintain product quality in-house, reach desired service levels and eventually reduce total warehouse costs.

The study proposes in H_4 that the positive relationship between inventory management and warehousing efficiency is mediated by the role of transportation. Validating this assertion using Hayes's process, the study finds statistically significant support for this hypothesis given an indirect significant effect with bootstrap confidence intervals [*LLCI* = .0638; *ULC*I = .2538]. Given the non-zero significant indirect effect of .1424, this confirms mediation (partial mediation). The total direct effect of inventory management is weakened by the mediator; transportation, this implies that the indirect effect of inventory management on a firm's tendency to be efficient in their warehousing operations partially depends on their transportation decisions.

5. Conclusion and Discussion

Several theoretical and managerial implications are derived from these findings, and are the attention of the following discussions.

5.1 Theoretical Implications

The purpose of this study is to investigate the mediating role of transportation on the relationship between inventory management and warehousing efficiency. The study's theoretical model is tested on a sample of firms who operate a warehouse within the free zones enclave located at Tema, Ghana.

First, the study reveals that inventory management is a significant antecedent to warehousing efficiency. Firm practices that could advice on the best inventory management decisions; meeting customer service levels, decreasing lead time and cutting down inventories [118] would improve efficiency of warehousing operations. In a much broader sense, accurate forecasting techniques, use of optimization approaches that ensure consistency in time and order quantities as well as the periodic review of inventory that hedge against stockouts risks will significantly increase warehousing efficiency.

Second, the study's findings suggest that achieving transport objectives is reliant on inventory management. The study finds that logistic firms that want to serve their markets better by achieving "speed" dimension of their service propositions should have inventory techniques that is very responsive and elastic to market contingency. As noted by [96], the ultimate goal of supply chains is to enhance customer satisfaction and create superior value. In the particular case of firms in Ghana, it can be argued that robustness of inventory systems will stretch the competition by making their firms deliver on client's requisition anytime through reactive transportation.

Third, the study's findings indicate that greater transportation is associated with an improved warehousing performance. Through transportation, firms make optimal decisions that significantly reduce operational costs whilst satisfying the customer. Warehouses serve as zones that keep stocks in reaching desired customer level [119]. Inbound decisions expressed in the ability to protect goods en route to warehouses ensures value for money for goods in-transit while enhancing role warehouses play.

On a thoughtful note, despite achieving warehousing efficiency from robust inventory management and transportation decisions independently, drawing on the grander mediation model, findings suggest that achieving greater warehousing performance dwells on optimum inventory management practices which are driven through transportation decisions.

5.2 Managerial Implications

The findings uncovered in this study have important implications for managers of supply chains in institutionally underdeveloped societies. Though the study finds support that pursuing good inventory management initiatives and optimum transportation independently yields efficiency in warehousing. From the superior mediation model, we infer from the study that aptitude on firm's inventory management influences success in warehousing operations but driven through transportation initiatives. In particular, results indicate that achieving warehousing efficiency is driven by managers' ability to focus on both transportation and inventory management.

Inferred from the study, firms that seek the quest to ensure accurate forecasting techniques, use approaches that ensures consistency in time and ordering quantities, review inventory periodically as well as strive towards claims free delivery of full truck load per transit are likely to achieve efficiency in warehousing. With transportation, key decisions includes transportation mode selection and features of the item. Item features eg. Brittleness, fragility, and temperature conditions en route significantly affect its functional use through to the point of delivery. However, in as much as firms seek to indulge in these practices in the pursuit of warehousing efficiency in their business operations, they should be willing to build not erring inventory and transport tools by inculcating technology. For example, it can be argued that today's supply chains are greatly driven by sophisticated information technology (e.g. enterprise resource planning, vendor managed inventory) and that level-headedness in supply chains have to embrace the use of these systems. Further, this behooves on managers to invest resources in inventory and transport decision systems. As such, for firms that need to use these decisions in their logistic activities, it is important for firms to continuously train and educate staff in gaining skills and expertise, and must have such skills and competences thoroughly nurtured and transcended. By so doing small businesses in Ghana and in other developing economies operating a warehouse would minimize their operating cost while at the same time maximising value created for customers.

Warehouses need to be designed and operated in line with the specific requirements of the supply chain as a whole. They are therefore justified where they are part of the least-cost supply chain that can be designed to meet the service levels that need to be provided to the customers. Owing to the nature of the facilities, staff and equipment required, warehouses are often one of the most costly elements of the supply chain and therefore their efficiency is critical in terms of both cost and service.

5.3 Limitations and Directions for Future Research

Despite these theoretical and managerial insights for supply chain literature and practitioners, limitations were inherent. First, the study was contextualized in an industrialized local setting. Thus findings are reflective of this setting in a developing economy. We put forward for a further validation of the construct scales and that future research test this framework in a different setting to examine its consistency.

Second, the study did not hypothesize for the effect of firm business experience and firm size on warehousing efficiency. However the overall statistically significant result of this model (one) deem it necessary for future research to advance theoretical arguments on the impact of these firm related measures on warehousing efficiency.

Third, it is admitted that internal focus on improving inventory and transportation driven actions may not be without cause adequate to improve warehousing efficiency. However, it has been contended in this study that firms within supply chains could benefit from these, we also strongly believe that pursuing such efforts should be aligned with externalities eg. Supplier selection, and development as well as government mechanisms especially which could significantly affect warehousing efficiency. Given this, future studies should blend these measures in our model in addressing efficiency of warehousing.

Last, we suggest that future studies explore into the complementary/interaction effect of transportation decisions on the relationship between inventory management and warehousing efficiency. Transportation and inventory decisions are seldom modelled together in supply chain literature [69]. Therefore we conjecture that either extremely low or high levels of transportation may have undesirable consequences for firms. At high levels, firms may not obtain mastery or achieve strategic fit with regards to their inventory management approaches because of the high level of investments into transportation systems. At a low levels, transport as a glue to support inventory management to achieve the "speed" dimension of supply chain may be erring. Fairly, we believe pursuing transportation initiatives beyond certain thresholds may be costly. In line with these reasoning, we suggest that future research employ robust analytical techniques eg. SEM in teasing out these interactions in addressing warehousing efficiency.

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