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# Improving distribution and business performance through lean warehousing

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**Abstract**

**Purpose** – Recent literature recognizes the role of warehouses in enhancing the overall logistics performance. Thus, lean thinking has recently found its way in supporting warehouse and distribution center operations. The purpose of this study is to examine the relationships among warehouse waste reduction practices, warehouse operational performance, distribution performance, and business performance.

**Design/methodology/approach** – A two-stage study was conducted. First, a Delphi technique was adopted to develop a relevant questionnaire. Second, this questionnaire was used to measure the degree of waste reduction in the different warehouse activities and to test the developed research hypotheses. We test our hypotheses with a sample of Middle Eastern warehouse operators.

**Findings** – There exists a positive relationship between warehouse waste reduction level and both warehouse operational performance and distribution performance. There was no direct relationship between warehouse waste reduction level and business performance. However, results revealed that the relationship between warehouse waste reduction level and business performance was mediated by warehouse operational performance and distribution performance.

**Practical implications** – The developed instrument provides a guide for logistics managers as to understand how to optimize waste in each warehousing activity. The results also inform logistics managers of how distribution performance can be improved through lean warehousing. The resulting performance improvements in the distribution operations will ultimately be reflected in the logistics performance of downstream retailers.

**Originality/value** – The study develops an original instrument for measuring waste reduction in warehouses, and provides insights on the evolving lean warehousing research area. This is the first scholarly work to uncover the relationships among warehouse waste reduction practices, warehouse operational performance, distribution performance and business performance.

**Keywords**: Lean, logistics, distribution, warehouse, performance, Delphi, Partial Least Squares (PLS)

## 1. Introduction

Organizations have long strived to adopt effective managerial tools and techniques that would improve the efficiency of their operations. This has largely been achieved building on lean thinking and tools. Lean has been one of the most powerful managerial philosophies in recent history (Womack and Jones, 1996; Womack and Jones, 2003; Holweg, 2007; Villarreal *et al.*, 2016; Shah and Khanzode, 2017). At the heart of successful lean implementation is the concept of 'waste', which refers to the non-value adding activities in a particular system. Waste can be defined as anything other than the minimum activities and materials necessary to perform a particular process (Womack and Jones, 1996). Although lean started as a production strategy, the Japanese philosophy is now widely implemented in a wide range of industries. Lean principles have been studied in production, operations, and business management literature (Womack and Jones, 2003; Villarreal *et al.*, 2009; Holweg, 2007; Shah and Khanzode, 2017). One research area in which waste reduction has been given a considerable attention is within the field of logistics and supply chain management. For example, within the particular area of logistics, scholars have carried out research on lean transport (Salhieh *et al.*, 2018), lean purchasing (Drake *et al.*, 2013), and lean supply chain (Drake *et al.*, 2013; Myerson, 2012). However, coordinating warehouse operations from a lean perspective have been given less attention than other logistics functions (Gu *et al.*, 2010; Bozer, 2012; Sharma and Shah, 2015; Shah and Khanzode, 2017). The importance of studying lean in warehousing and distribution operations is that any performance improvement in the distribution operations will ultimately be reflected in the logistics performance of downstream retailers (Pires *et al.*, 2017; Hübner *et al.*, 2016) and the whole distribution channel (Satyam *et al.*, 2017).

Warehouses can be viewed as a source of waste or non-value adding activities due to the intensive operations they undertake (Gu *et al.*, 2010; Battista *et al.*, 2014). The principles and managerial tools of lean philosophy have been "typically applied to improve the internal logistics of the company and not the warehouse" (Dotoli *et al.*, 2015, p57). Thus, there is an opportunity to minimize non-value adding activities of warehouses through identifying waste activities. We define warehouse waste reduction practices as the set of activities undertaken by an organization to increase the overall efficiency of the system. The few previous scholarly works on lean warehousing have mostly aimed at discussing the opportunities of applying lean tools and applications in the warehouse operations in order to reduce the time and cost of these operations. However, literature still lacks a model to assess the level of waste reduction practices in the warehouse environment. Therefore, developing an assessment tool is particularly necessary, as the implementation of any lean warehousing activities should start by evaluating the level of non-value adding activities in the current system (Sharma and Shah, 2016). This research addresses this gap in literature and provides a model to assess the level of waste reduction practices in warehouses. As such, the developed instrument is expected to provide a guide to warehouse and logistics managers for improving the level of waste reduction in the system. Achieving high efficiency levels upstream in the warehousing function will lead to improved distribution and delivery to retailers (Appelqvist *et al*., 2016; Pires *et al*., 2017; Hübner *et al*., 2016). Therefore, the purpose of this study is to empirically test a research model identifying the relationships among warehouse waste reduction practices, warehouse operational performance, distribution performance, and business performance. This effort is expected to advance existing research by investigating the links between these relationships and integrating lean warehousing with distribution performance.

The next section presents the literature review, the proposed model and hypotheses. The research methodology is described in the third section. The fourth section presents the results of the empirical study and discusses the hypotheses. Conclusions are discussed in Section 5. Finally, Section 6 presents the limitations and directions for future research.

## 2. Literature review and research hypotheses

### *2.1 Lean warehousing*

In recent years, there has been an increasing interest by supply chain management scholars in the warehousing function as a research area within the field of logistics and retail (Pires *et al*., 2017; Hübner *et al*., 2016). Warehouse management relates to optimizing warehouse resources including inventory, material handling equipment, loading/off-loading operations, staff, and ensuring innovative solutions are in place (Rexhausen *et al*., 2012; Pires *et al*., 2017; Battista *et al*., 2014). The increasing need to enhance supply chain performance has forced warehouses to focus on reducing non-value adding activities (de Leeuw and Wiers, 2015; Faber *et al*., 2017; Salhieh and

Abushaikha, 2016). The term 'lean warehousing' is relatively new in literature (Sharma and Shah, 2016). Analyzing the level of waste in the warehouse system is the first step towards understanding leanness implementation in the organization (Womack and Jones, 1996). Seeking perfection through reducing or eliminating waste is central to lean philosophy and implementing lean principles and techniques (Villarreal *et al*., 2016). Lean warehousing seeks to maximize the use of available warehouse resources and activities through reducing or eliminating wastes in the logistics system. As a result, this would lead to improve the quality of offered goods and services and optimize the use of resources (Villarreal *et al*., 2016). Because of the unique characteristics of service processes (Piercy and Rich, 2009), most service industries were reluctant to borrow lean principles from manufacturing literature (Swank, 2003; Piercy and Rich, 2009). However, since companies started to recognize that competitive advantage in service sectors can be attained through improved efficiencies, waste reduction practices were adopted in the service industry (Douglas *et al*., 2015; Salhieh *et al*., 2018) and distribution function (Villarreal *et al*., 2016). Because firms are seen as a collection of processes, waste reduction practices were successfully adapted to and applied in the service industry (Piercy and Rich, 2009).

Logistics and supply chain has been one of the areas in which waste reduction practices were implemented successfully. In particular, warehousing and transportation processes functions offer a good opportunity for reducing the wastes in the overall logistics system (Villarreal *et al*., 2016; Sharma and Shah, 2016; Shah and Khanzode, 2017). Therefore, if the elimination of waste can be relevant to the service environment, which differs significantly from a standard manufacturing environment, warehouse operations should also be able to adopt the elimination of waste in its operations. Several scholars (e.g. Hines *et al.,* 2004; Gu *et al*., 2010; Bozer and Britten, 2012; Gagliardi *et al*., 2012; Sharma and Shah, 2015; Sharma and Shah, 2016; Shah and Khanzode, 2017) have discussed the importance of lean principles and their role in eliminating waste for warehouse operations. Bozer and Britten (2012) stated that the most pertinent issues experienced by warehouses are known as the seven wastes, and have related these wastes to lean principles as described in Table 1.

| Original types of waste identified by lean manufacturing | Translation of waste in the warehouse environment |
|---|---|

| | |
|---|---|
| Inventory | Overproduction upstream in the supply chain may lead to pushing stock downstream from factories towards the warehouse, which results in accumulated inventory. Storing safety or buffer stock in the warehouse is also an indicator of waste. This leads to a lower storage space and workers' productivity due to accumulation of excess stocks. |
| Transportation | This can be seen in terms of the unnecessary movement of products, workers and forklift operators. This becomes a real problem when SKUs aren't stored in a logical sequence, which may result in longer searching time of orders. This can be also seen in terms of collecting of print outs or invoices from different offices as well as vehicles' parking lots being placed far from the unloading. |
| Waiting | This occurs when employees are ready to continue their work, but the process doesn't allow them to, due to unavailability of products, machines or the system. Further, it can be viewed in term of waiting in the parking lot as truck drivers queue up at the same time. Waiting may lead to underutilization of people and resource capacities. |
| Motion | In cases where inventory is not stored at the correct location level, employees need to reach or bend over to pick the items. The reverse is also true, when employees have to store items at ergonomically uncomfortable heights when it can be avoided. Unnecessary movements in trying to locate equipment (forklifts, hand pallet trucks, etc.) left by other people in non-designated areas. |
| Overproduction | Picking and preparing orders before being ordered downstream the supply chain by stores or customers can be viewed as overproduction in warehouses. This may lead to unnecessary congestion and work-in-progress in the dispatch area. |
| Over processing | This happens when warehouse workers need to re-enter certain information. It includes multiple scanning of barcodes or using equipment with additional capacity. Unnecessary inspection of picked orders and unnecessary packing. For example, conducting quality checks several times at the different stages. Moving products through more than one forklift could be also seen as over processing. |
| Defects | Picking the wrong item or quantity may lead to under or over supplying the customer, or maybe supplying them with the wrong order. It further leads to more returns that need to be processed (due to incorrect shipment of orders), which means more staff is required. Damage within warehousing affects a company's bottom line. |

Table 1: Translation of the seven waste in the warehousing context (adapted from previous literature (e.g. Bozer and Britten, 2012; Piercy and Rich, 2009; Myerson, 2012; Sharma and Shah, 2015; Salhieh *et al*., 2018).

*2.2 Lean, warehouse operational performance, and businesses performance*

Various studies have investigated the effect of lean production on performance (Swank 2003; Shah and Ward, 2007; Jaca *et al*. 2012). Lean contributes to significant cost reduction, staff productivity, and achieving higher quality (Holweg, 2007; Krafcik, 1988; Shah and Ward, 2007). Scholars have also suggested a positive link between lean production and business performance (Callen *et al*., 2000; Fullerton *et al*., 2003). Waste reduction practices are expected to increase an organization's market share and improve overall competitive position (Sharma and Shah, 2016; Shah and Ward, 2007; Salhieh *et al*., 2018). Although the studied firms in this research are warehousing firms, different pricing strategies and service levels offered to their customers, even if the warehouse is solely the firm's business, may improve business performance. Therefore, even if a warehouse as a business (e.g. warehouse operators) has a low level of waste reduction practices, it might still have a greater level of business performance than its rivalries who have high levels of waste practices in their warehouses. Hence, it hypothesized that:

*Hypothesis 1*: Warehouse waste reduction practices have a positive relationship with business performance

The effect of lean on performance has been traditionally studied with regard to lean production (Swank, 2003; Shah and Ward, 2007; Jaca *et al*. 2012). There is a predominant belief amongst scholars that lean contributes to improve operational performance (Cua *et al*., 2001). This is viewed in terms of achieving significant cost reduction, improved workforce productivity, quality and lead times (Holweg, 2007; Shah and Ward, 2007). The link between lean production and operational performance has been intensively researched and confirmed in literature (Crawford *et al*., 1988; Cua *et al*., 2001; Laugen *et al*., 2005). Lean provides the warehousing operations with a competitive edge by ensuring better stock control, improved picking accuracy, and lower storage costs (Garcia, 2003; Sharma and Shah, 2016). Eliminating waste from the warehouse activities may constitute a resource that enhances warehouse operational performance. The assessment of warehouse waste reduction practices level will be investigated in this study based on the flow of activities along the value stream in the warehouse. In warehousing, the flow of activities can typically follow these steps:

- Receiving – Offloading and inspection of goods to ensure correct quality and quantity of delivered orders. (Frazelle, 2002; Garcia, 2003)
- Put-away – Moving goods from the receiving area and storing them in the suitable location for future picking orders. (Frazelle, 2002; Faber *et al*., 2013)
- Picking – Once a customer has placed an order, the relevant goods are picked and prepared for dispatch in an efficient and effective manner ((Frazelle, 2002; Faber *et al*., 2013).
- Despatch – As orders fulfilled, they are packed and made ready for delivery to the customer. (Frazelle, 2002; Shah and Khanzode, 2017).

Capitalizing on the previous discussion, the second hypothesis has emerged:

*Hypothesis 2*: Warehouse waste reduction practices have a positive relationship with warehouse operational performance

High levels of warehouse operational performance generally suggest that an organization can have an efficient operation comparing to its competitors (Sharma and Shah, 2016; Frazelle, 2002; Shah and Khanzode, 2017). This efficiency will in turn enhance the organization's overall performance (Nawanir *et al*., 2013; Battista *et al*., 2014; Salhieh *et al*., 2018; Shah and Khanzode, 2017; Appelqvist *et al*., 2016). Warehouse operational performance can lead to high levels of economic performance, thereby increasing profitability and market share (Garcia, 2003; Rexhausen *et al*., 2012; Yang, 2016). The resource-based view (RBV) theory suggests that the ability of the firm to coordinate internal resources efficiently can be a source of business competitive advantage (Grant, 1991; Eng, 2016). Therefore, a positive relationship between warehouse operational performance and business performance is proposed.

*Hypothesis 3*: Warehouse operational performance has a positive relationship with business performance

*2.3 The role of distribution function*

Distribution is the logistics function, which is responsible for the physical movement of goods and services downstream the supply chain towards retailers and end users (Eng, 2016; Rexhausen *et al*., 2012; Satyam *et al*., 2017). Warehousing and distribution functions have long been studied jointly due to their major role in the outbound logistics operations and delivering goods to retail stores (Hübner *et al*., 2016; Rexhausen *et al*., 2012; Von der Gracht and Darkow, 2010;). Firms can improve their distribution performance through optimizing its warehouse design and operations (Rexhausen *et al*., 2012; Shah and Khanzode, 2017; Hübner *et al*., 2016). Since companies started to recognize that competitive advantage in logistics can be attained through improved efficiencies, waste reduction practices were adopted in the field of logistics (Douglas *et al*., 2015; Salhieh *et al*., 2018) and distribution function (Villarreal *et al*., 2016). The importance of adopting lean principles for warehousing is that any performance improvements in the warehouse operations will ultimately be reflected in the performance of distributors, and retailers (Pires *et al*., 2017; Hübner *et al*., 2016). Achieving efficiency in the coordination of internal resources (Grant, 1991), and streamlining the different warehouse processes can contribute to improve the performance in the customer-facing operations (Rexhausen *et al*., 2012; Shah and Khanzode, 2017). Lean practices in the warehouse could improve the overall warehouse performance in the context of distribution and retail (Shah and Khanzode, 2017). Hence, the following two hypotheses are developed:

*Hypothesis 4*: Warehouse waste reduction practices have a positive relationship with distribution performance

*Hypothesis 5*: Warehouse operational performance has a positive relationship with distribution performance

Literature acknowledges the role of distribution in supporting other functions in the organization and achieving higher customer satisfaction (Jaca *et al*. 2012; Rexhausen *et al*., 2012; Towers and Xu, 2016; Villarreal *et al*., 2009; Pires *et al*., 2017; Shah and Khanzode, 2017). A well-coordinated distribution channel enables firms to deliver goods and services to end customers in a timely, efficient and effective way (Jaca *et al*. 2012; Towers and Xu, 2016; Appelqvist *et al*., 2016; Hübner *et al*., 2016; Satyam *et al*., 2017). This largely relates to the efficient and effective management of transport scheduling, deliveries, achieving a perfect order while maintaining an acceptable level of service (Rexhausen *et al*., 2012; Villarreal *et al*., 2009). In addition, literature has mounted an enormous effort to understand how capabilities may lead to improved business performance. In line with the RBV, such capabilities are viewed in logistics and supply chain management literature as a source of performance improvement (Grant, 1991; Rexhausen *et al*., 2012, Eng, 2016). Leveraging distribution capabilities may produce an improved performance for the organization (Eng, 2016; Yang, 2016) by enabling timely and responsive deliveries. Building on this rationale and reviewing the relevant literature, we formulate our sixth and last hypothesis:

*Hypothesis 6*: Distribution performance has a positive relationship with business performance

Figure 1 presents the proposed research framework. It proposes that warehouse waste reduction practices will have an impact on business performance both directly and indirectly through warehouse operational performance and distribution performance. The warehouse waste reduction practices construct is conceptualized as a four-dimensional measure in the stated warehouse activities. Understanding the connection between waste reduction in a warehouse and the distribution function may produce an internal resource that has the potential of improving the overall firm's performance (Rexhausen *et al.*, 2012). The next section presents the research methodology.

## 3. Methodology

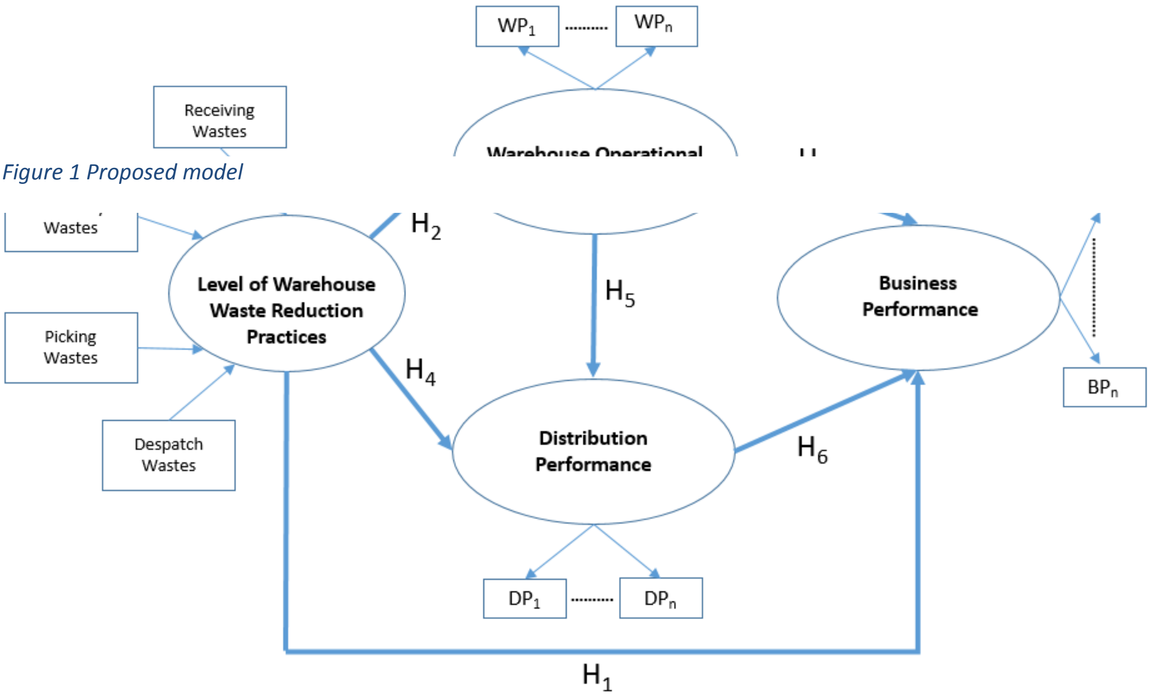


*Figure 1 Proposed model*

### *3.1 Waste reduction level construct*

Since there is little information in existing literature on warehouse waste reduction practices, we developed our questionnaire using a Delphi technique. In such cases, warehousing experts' opinions contribute to develop appropriate measurement tools (Dalkey and Helmer, 1963). Business management scholars have long used the Delphi technique. In particular, logistics literature has extensively used a Delphi technique to deal with lack of appropriate literature (Okoli and Pawlowski, 2004; Melnyk *et al.* 2009; Piecyk and McKinnon, 2010; Von der Gracht and Darkow, 2010). This is important as to make advancement in the evolving logistics and supply chain discipline through adopting new methods (Kembro *et al.*, 2017). A Delphi technique is also appropriate to develop the waste reduction construct due to the complexity of the subject (Kembro *et al*., 2017), which requires the knowledge of the experts who understand the different practices and activities that may generate waste within warehouses. A Delphi technique is well suited as a method for consensus building by using a series of questionnaires to gather qualitative data from experts (Dalkey and Helmer, 1963; Kembro *et al*., 2017) in the field of warehousing and distribution. Okoli and Pawlowski (2004) recommend adopting rigorous guidelines for selecting experts to include in the study. In contrast, other researchers prefer to interpret the phrase "expert panel" broadly as the individuals involved in the work. This study included practitioners who had a minimum of five-year experience in managerial positions related to warehouse and distribution management. For academicians, the panelists were chosen for their experience in teaching warehousing and/or, their scholarly publication history in lean thinking and logistics. The use of experienced and knowledgeable participants in the subject area (i.e. warehousing and distribution management) may help to improve content validity of the Delphi study (Dalkey and Helmer, 1963; Okoli and Pawlowski (2004). In deciding whom to invite to join the expert panel from the academic community, we utilized our network of German and Jordanian lecturers in the logistics academic programs as well as German consultants in the field of warehousing. In addition, two of the investigators of this paper had previously worked in the logistics industry in Jordan and the Gulf Cooperation Countries (GCC); thus, they were able to gain a good access to logistics experts and major companies. The first investigator focused on collecting evidence from international experts from Germany and GCC. He was also responsible for maintaining a database of all necessary communication with participants. The second investigator was able to collect evidence from the Jordanian panel members involved in the study. He was also responsible for revising the updated experts' questionnaire and calculating the Kendall's coefficient of concordance shown below.

Okoli and Pawlowski (2004) recommended 10-18 participants on a Delphi panel. In this current study, the expert panel size was 12 participants, of whom 6 practitioners and 6 academicians. Although the number of participants is relatively small, the purpose was only to gather qualitative information from the experts. Data was collected from panel experts over 18-month period between 2016 and 2017. The Delphi process was conducted repeatedly until consensus was determined to have been achieved

(Kembro *et al*., 2017). The first round was a brainstorming stage, in which participants suggested a list of items of warehouse waste reduction practices. In the second round, experts reviewed and rated the developed items as to their relevancy to the construct. Although there was some comments concerned with the priorities of the factors, depending on the warehouse types, the responses from this round suggested a strong agreement on the constructs. In the final round, experts revised their input according to the ratings produced in the previous stage, which resulted in the final instrument. Table 2 below details the data collection iterations of the Delphi study.

| Round | Purpose | Description | Output |
|---|---|---|---|
| Round 1 | This is a brainstorming stage in which panelists were asked to respond to open-ended questions | Questions were targeted to identify as many as waste reduction practices in receiving, put-away, picking, and dispatch activities. | This data collection stage resulted in developing a structured questionnaire based on the panelists opinions. |
| Round 2 | The developed structured questionnaire was sent to panelists during this stage of data collection. | Panelists were asked to review the questionnaire items, which were developed after first stage. This is to rate items as to their relevancy and applicability in capturing waste reduction practices in the investigated warehouse activities on a four-point Likert-type scale. | At this stage, areas of disagreement and agreement are identified and consensus started to emerge. |
| Round 3 | Each expert received a questionnaire that included the items and ratings summarized by the authors in the second round and were asked to revise their judgments. | Kendall's coefficient of concordance was used to estimate the level of consensus between among panelists. | The final items constitute the waste-reduction construct. These are used as our instrument to measure the statistical significant relationships among waste-reduction practices in the warehouse. |

Table 2: A summary of Delphi technique used (following recommendations by Ludwig (1997) and Schmidt (1997))

Table 3 below shows the result of Kendall's coefficient of concordance. Kendall's W of 0.7 or higher is considered as strong agreement (Schmidt, 1997). This is important as to estimate the level of consensus among the panel's members.

| | Statistics | Receiving | Put-away | Picking | Despatch/Shipping |
|---|---|---|---|---|---|
| Panel | N | 12 | 12 | 12 | 12 |
| | Kendall's W | 0.889 | 0.764 | 0.712 | 0.709 |
| | $\chi 2$ | 36.587 | 34.380 | 33.126 | 32.403 |
| | df | 10 | 5 | 8 | 6 |
| | p | 0.001 | 0.04 | 0.03 | 0.001 |

Table 3: Kendall's W for waste reduction practices

The final items that constitute the waste reduction construct were used as an instrument to measure the level of waste reduction in the warehouse environment as shown in Table 4 below.

| Warehouse Activity Items | Item Description |
|---|---|
| Receiving (R) | |
| R1 | As a warehouse manager, you are involved with your purchasing department in specifying and agreeing the packaging, items per carton, carton per pallet, and labeling requirement. |
| R2 | You ask your suppliers to send deliveries with the most suitable packaging for you. |
| R3 | You specify a time schedule for the suppliers to make the delivery. |
| R4 | You receive a notification from the suppliers/shipper before a delivery arrives at your warehouse. (ASN: advanced shipping notification) |
| R5 | You are able to plan the correct equipment (forklift, trollies, powered trucks, and pallets jacks) to use in unloading before the delivery arrives. |
| R6 | You are able to plan enough labor to unload the delivery before it arrives. |
| R7 | You are able to plan sufficient space to unload the delivery before it arrives. You always have stock-keeping units (SKU) master data available, e.g. for new products, that you are able to store and handle these products appropriately? |
| R8 | You perform cross-docking operations when possible or needed. |
| R9 | It is easy to identify deliveries from suppliers (product, description, pack quantity) |
| R10 | You do carry out inspections and quality checks on most of the goods received. In other words, you do count and identify 100% of the received products. |

| | |
|---|---|
| R11 | You usually breakdown deliveries into smaller or lager increments (pallets to cartons or vice versa) for storage based on data collected from customer orders. In other words, you do not require deliveries from your supplier in the normal selling quantity in order to increase the speed of throughput and simplify picking. (You do not order in logistics units) |
| Put-away (PA) | |
| PA1 | We have a system (computerized or warehouse manager) which allocate product locations prior to offloading and instruct the operator as to where to place the goods. |
| PA2 | You notice any delays in put-away because of labor or equipment being occupied or missing. |
| PA3 | The rack configuration is flexible enough to accommodate size of pallet received from suppliers. |
| PA4 | The put-away team work adjacently with the picking team. |
| PA5 | You create a time schedule to separate the operations of the put-away and picking team. |
| PA6 | The put-away process follows an ABC-structure of the warehouse (A-articles close to good-in/good-out area; C-articles very far away within an aisle? |
| Picking (P) | |
| P1 | You slot the heaviest SKUs in weight at the locations nearest to the start points of the pick. |
| P2 | You slot items which are usually sold together next to each other. |
| P3 | You use technologies in picking operations such as pick-to-light, voice picking, etc. |
| P4 | You use ABC categorization for volume and velocity of inventory in order to slot SKUs |
| P5 | Fastest-moving SKUs are placed in the middle row so that the picking process can be achieved faster. |
| P6 | The picker sort the order while picking. |
| P7 | The picker pick the exact quantity required. |
| P8 | You use a warehouse management system to create an efficient route within the warehouse in the picking process. |
| P9 | A worker can use “interleaving” method by putting away received SKUs and retrieving others required for a pick list in the same trip. |
| Despatch/shipping (D) | |
| D1 | There is sufficient space at the loading bay to stage the loads. |
| D2 | Truck arrivals are subject to a system in the shipping area |

| | |
|---|---|
| D3 | The picked orders arrive at the loading bay in the sequence in which they will be delivered. |
| D4 | We have grids marked out on the warehouse floor at the despatch area to replicate the floor area of the largest vehicle. |
| D5 | Vehicles at the despatch bay do not wait a long time until the despatch team is ready. |
| D6 | At our warehouse, the checking of vehicle papers at the despatch bay ensures the match of the SKUs to the right vehicles. |
| D7 | Despatch operator checks and inspects that picked SKUs and quantities are correct. |

Table 4: Waste reduction construct

### *3.2 Performance measurements*

Performance measurement has been one of the most frequently mentioned concepts in business management literature. However, although practitioners argued some areas in which performance measurement might be useful, literature still lacks a well-defined set of appropriate measures of how businesses should be managed (Nawanir *et al*., 2013). As lean practices have been implemented in several contexts such as production and service contexts (Piercy and Rich, 2009; Nawanir *et al*., 2013), the use of non-financial measures seems to be relevant in lean-based research (Hines *et al*., 2004; Neely *et al*., 2005; Nawanir *et al*., 2013; Salhieh *et al*., 2018). Thus, this study will use subjective measures (Wall *et al*., 2004) to assess the constructs of warehouse operational performance, distribution performance, and business performance.

#### *3.2.1 Warehouse operational performance construct*

Today's warehouses perform a wide range of functions such as storage, assembling customer orders, and value-adding services including customization, packaging, unitizing, and organizing dispatch and distribution activities (Faber *et al*., 2017; de Koster, 2012; Hackman *et al*., 2001). Thus, warehouse operational performance embraces multiple dimensions (Faber *et al*., 2017). Several authors (Stank *et al*., 1994; Hackman *et al*., 2001; Collins *et al*., 2006; de Koster and Balk, 2008) have measured warehouse operational performance through developing benchmarking tools (de Koster, 2012). Drawbacks of these approaches are manifested in the difficulty to capture accurate data. In addition, for every factor that is included in the benchmarking analysis, more cases needed in order to generate statistically meaningful results (de Koster and Balk, 2008). In addition, another difficulty that may stem from using benchmarking tools to provide is that the studied warehouses should be comparable (de Koster and Balk, 2008). Thus, this study will adopt a tool developed by de Koster (2012) to assess warehouse operations on a qualitative basis as shown in Table 5.

| Item # | Item Description |
|---|---|
| WP1 | The facility is clean and has a good work atmosphere. |
| WP2 | The work processes are ergonomically well-thought over. |
| WP3 | The layout prevents major cross flows. |
| WP4 | Material is moved over the shortest/best possible distances. |
| WP5 | Double handling is prevented and appropriate product carriers are used. |
| WP6 | SKUs are stored on their right locations. |
| WP7 | Appropriate (non-)splitting inventory is in bulk and forward pick stock applied. |
| WP8 | There is an effective process management for introducing new SKUs, getting rid of non-movers, and internal relocations. |
| WP9 | The organization of the picking process is well-designed without obvious improvement possibilities. |
| WP10 | Storage and receiving processes are monitored and controlled on-line. |
| WP11 | The response to mistakes and errors is immediate. |
| WP12 | Ratings are for customer satisfaction and shipping errors are displayed. |
| WP13 | The material handling systems are used, the racks and the product carriers in good operating condition and are well-maintained. |
| WP14 | A right balance has been struck between order customization, process flexibility and efficiency. |
| WP15 | Receiving and shipping processes, and inventory levels are tuned with suppliers and customers. |
| WP16 | This is a warehouse you would like to work in. |
| WP17 | The air quality is good and noise level is low in warehouse. |
| WP18 | The environment is attractive to work in. |

Table 5: Warehouse performance construct

### *3.2.2 Distribution performance construct*

Distribution performance measurements are not new to logistics and supply chain literature. Recent scholars have measured this construct based on the firm's capability to deliver timely and complete orders to customers. Transaction cost of delivering wrong items to customers can be very costly (Eng, 2016; Hübner *et al*., 2016). Leveraging distribution capabilities may produce an improved performance for the organization (Eng, 2016; Yang, 2016; Villarreal *et al*., 2009) by enabling timely and responsive deliveries. Furthermore, firms can improve their distribution performance through optimizing its warehouse operations (Rexhausen *et al*., 2012; Shah and Khanzode, 2017; Hübner *et al*., 2016). Hence, we will evaluate distribution performance in this study based on a set of measures derived from Eng (2016), Rexhausen *et al*. (2012), and Larson *et al*. (2007), as shown in Table 6.

| **Item #** | **Item description** |
|---|---|
| DP1 | Low number of product rejects and customer complaints |
| DP2 | Our customers are usually satisfied about our distribution capabilities |
| DP3 | Our products are usually delivered on time |
| DP4 | We rarely deliver wrong items to our customers |
| DP5 | Our products are always delivered damage-free |
| DP6 | We have rarely returned items from our customers because of distribution problems |

Table 6: Distribution performance construct

### *3.2.3 Business performance construct*

Building appropriate and measurable business performance constructs has been one of the most challenging tasks confronting academic researchers (Nawanir *et al*., 2013; Venkatraman and Ramanujam, 1986; Miller *et al*., 2013; Wall *et al*., 2004). Literature provides varying dimensions on the measurements of business performance (March and Sutton, 1997; Richard *et al*., 2009; Silvestro, 2014), including both subjective and objective measures. However, subjective measures of business performance are more accepted by business management scholars (Wall *et al*., 2004; March and Sutton, 1997). Therefore, we will measure business performance in this study based on a set of subjective measures (Wall *et al*., 2004) as shown in Table 7 below.

| Item # | Item description |
|---|---|
| BP1 | We have superior quality of service compared to our competitors. |
| BP2 | Our profitability has exceeded our competitors. |
| BP3 | Our revenue growth rate has exceeded our competitors. |
| BP4 | Our market share growth has exceeded our competitors. |
| BP5 | Our customers are satisfied with our company's delivery lead-time compared to our competitors. |
| BP6 | Our overall competitive position is better than that of our competitors. |

Table 7: Business performance construct

### *3.3 Research sample, measures and validation methods*

The population of this study comprised warehouse operators, who owned and operated at least one warehouse with distribution activities, from Jordan, Saudi Arabia, United Arab Emirates (UAE), Oman, and Kuwait. Despite the various classifications of warehouses (Pires *et al*., 2017), the essential difference between them is related to the perspectives of the sources, management and users of the warehouses (Van den Berg and Zijm, 1999; Frazelle, 2002). However, these warehouses are similar in terms of the nature of operations and activities they carry out (Pires *et al*., 2017). This includes receiving, storing, picking and despatching activities. The sampling frame consisted of 90 firms operating in the mentioned countries. Participants were purposively chosen from a population of logistics, warehouse/distribution, and general managers. The purposive sampling technique used was a homogeneous sampling. A homogeneous sample is chosen when the research question answered is particular to the characteristics of a certain group. In the case of this research, it is a group of warehouse and distribution employees. Furthermore, purposive sampling also enables other researchers to determine the generalization possibility of the research to other settings. The developed survey tool is administered in three mailings following a modified version of Dillman's (1978) "Total design for survey research". In the first e-mail, a covering letter explaining the purpose of the study together with the survey questionnaire was sent. Emails were sent four weeks later to remind and encourage non-respondents to participate in the research. Follow ups were made through phone calls, as two investigators had business with, or had some contacts at a number of the surveyed companies. Seven weeks after the initial e-mailing, a second survey was emailed to the rest of non-respondents. The resulting sample is made up of 270 usable responses (related questionnaires were sent to logistics, warehouse/distribution, and general managers), which constituted 90 firms. Therefore, responses on every measured construct were aggregated for each firm. Early versus late respondents were compared (Armstrong and Overton, 1997) and no statistically significant differences were found on any of the study variables. As two of the investigators of this paper had previously worked in the logistics industry in several countries in the Middle East, the research team was able to gain high accessibility to warehouse operators from the studied countries. A survey instrument was developed to statistically measure the structural portions of the model presented in Figure 1. The survey instrument used in this study measured 63 items: 33 items referred to waste reduction level, 18 items referred to warehouse performance, 6 items referred to distribution performance and 6 items referred to business performance. The respondents were asked to indicate their degree of agreement or disagreement with the statements using five-point Likert scales, where "1" represented "strongly disagree" and "5" represented "strongly agree". Researchers have to ensure whether or not the test measures do actually measure what is to be measured (validity) and maintain consistency of measurement results (reliability).

The partial least squares structural equation modelling (PLS-SEM) technique is used to evaluate the proposed model shown in Figure 1. This is a variance-based PLS path modelling technique that is similar to multiple regression analysis in operation (Oyewobi *et al*., 2017), which makes it useful for exploratory research purposes (Hair *et al*., 2014; Oyewobi *et al*., 2017). We opted to use this technique because of its relaxed distributional assumption, ability to use smaller sample size, and to formatively measure constructs (Hair *et al*., 2014; Oyewobi *et al*., 2017). Data analysis was performed using SmartPLS (version 2.0). A PLS path model consists two groups of linear equations: an outer model (or measurement model) and an inner model (or structural model) as recommended by Hair *et al*. (2014) and Ma (2014). In addition, the outer model distinguishes between a reflective measurement model and a formative one (Henseler *et al*., 2009; Ma, 2014). Based on the literature review, the PLS model was accordingly developed as shown in Figure1, in which the ellipses refer to the latent variables, the rectangular boxes refer to all the relevant indicators, and the straight arrows between ellipses indicate causal relationships in the same direction. More specifically, all ellipses and the arrows linking them constitute the inner model, whereas the ellipses, the rectangular boxes and the arrows between them constitute the measurement models. As such, the type of reflective measurement model employed for latent variables of Warehouse Operational Performance, Distribution Performance and Business Performance. Their reflective indicators measure the values of these unobservable constructs, whereas the type of formative measurement model was used to depict the relationships between latent variables (Level of Warehouse Waste Reduction Practices) and related indicators (Ma, 2014; Hair *et al*., 2014). Hence, the formative indicators will form the values of the latent variables. Therefore, the direction of the arrows between the ellipses and relevant rectangular boxes expresses the type of measurement model.

## 4. Results and discussions

The literature review in this paper suggested that warehouses are similar in terms of the nature of operations and activities they perform regardless of their size. This includes receiving, put-way, picking and despatching activities (Frazelle, 2002; Faber *et al*., 2013; Faber *et al*., 2017). Thus, there was no control variables for the firm size. However, we included the country as a control variable. In total, 13 per cent of the sampled firms were from Jordan (12 firms), 32 per cent from Saudi Arabia (29 firms), 27 per cent from UAE (25 firms), 12 per cent from Oman (11 firms), and 14 per cent from Kuwait (13 firms). The results show that country had no significant effect on business performance (−0.00 at $p > 0.05$). Most Middle Eastern countries, in particular Gulf Cooperation Countries (GCC), such as Oman, Saudi Arabia, Kuwait and UAE, are similar in the way they run their operations and the overall business environment (Belwal and Belwal, 2017). This applies also to most distribution channels in emerging markets (Satyam *et al*., 2017). Moreover, recent research (e.g. Faber *et al*., 2017) suggested that companies based in Western Europe are similar in terms of the nature of warehousing and distribution activities they perform.

To evaluate the results of the PLS path model, a two-step process has been followed as suggested by Chin (2010) and Ma (2014). The first step focuses on the assessment of the measurement model by estimating reliability and validity of item measures used in the conceptual model. The path coefficients are then assessed in the second step. In the outer model, the reflective measurement model and formative measurement model should be assessed. Reflective measurement models should be assessed in terms of reliability, which includes internal consistency of latent variables and reliability of all indicators, and validity, which includes convergent validity and discriminant validity

(Ma, 2014). The reliability assessment should meet the composite reliability (ρc) of at least 0.7 (Chin, 2010; Oyewobi *et al*., 2017), and a latent variable should explain a substantial part (at least 50%) of each indicator's variance. Thus, the absolute correlations, that is the absolute standardized outer loadings, between a construct and each of its indicators must be greater than 0.7 so that all the indicators are reliable (Chin, 2010; Henseler *et al*., 2009). As for validity assessment, an average variance extracted (AVE) value should be higher than 0.5, which means that a latent variable will be able to explain at least 50% of the variance of the relative indicators on average (Henseler *et al*., 2009; Ma, 2014). The AVE index is suggested to measure a reflective model's convergent validity. For discriminant validity, Fornell-Larcker criterion suggests that a latent variable shares more variance with its assigned indicators than with any other latent variable. The AVE of each latent variable must be greater than the latent variable's highest squared correlation with any other latent variable (Fornell and Larcker, 1981; Hair *et al*., 2014; Henseler *et al*., 2009).

In line with Oyewobi *et al*. (2017), confirmatory factor analysis was conducted to examine convergent validity, reliability and discriminant validity of the reflective indicators. Item loadings below 0.5 threshold at non-significant levels were taken out as shown in Table 8, as they did not make any useful or significant contribution to the construct. We ran again PLS algorithm and the results provide a high degree of reliability and validity, according to Table 8. The composite reliability scores for all reflectively identified variables were above the recommended threshold of 0.7, indicating high internal consistency. In addition, all constructs show sufficient levels of internal consistency, as the minimal standardized indicator loading of each reflective construct is higher than 0.7 (Chin, 2010; Ma, 2014; Oyewobi *et al*., 2017). Furthermore, all AVE values are above the recommended value of 0.50, which suggests that all our constructs are unidimensional, thus confirming convergent validity (see the results of Cronbach's alpha and the AVE in Table 8). In addition, comparing the value of AVE with the maximum squared correlation suggests that the Fornell-Larcker criterion has been achieved. Therefore, discriminant validity is confirmed (Ma, 2014; Oyewobi *et al*., 2017).

| Latent variable | Deleted Items | Composite reliability score | Min. standardized indicator loading | AVE | Cronbach's alpha | Max. squared correlation with latent variables | Mean of retained items |
|---|---|---|---|---|---|---|---|
| WP | (2,10,14,17) | 0.885 | 0.717 | 0.671 | 0.783 | 0.391 | 3.47 |
| DP | (1) | 0.871 | 0.746 | 0.701 | 0.799 | 0.212 | 3.12 |
| BP | (1) | 0.901 | 0.8765 | 0.823 | 0.831 | 0.521 | 3.31 |

Table 8: Assessment of the reflective measurement model

Concerning the formative measurement model, reliability is an irrelevant criterion for assessing measurement quality (Diamantopoulos, 2006). Conventional procedures used to assess the validity and reliability of reflective indicators are not appropriate for indexes with formative indicators (Diamantopoulos, 2006; Henseler *et al.*, 2009). This study used different steps and criteria to establish validity such as nomological validity (Rossiter, 2002), and statistical analyses (Henseler *et al*., 2009). The Nomological validity was considered using the Delphi method (Rossiter, 2002) presented in the previous section. The results of the various statistical analysis is presented in Table 9 below. The non-parametric bootstrapping procedure (500 samples) produced t-values indicating significance of the latent variable, and of most of the formative indicators (Ma, 2014). Moreover, the variance inflation factors (VIF), calculated using the SPSS linear regression function, do not indicate redundancy of any of the indicators (Diamantopoulos, 2006). Moreover, researchers should not discard formative indicators simply because of statistical outcomes, as this might lead to change the content of the formative index (Henseler *et al.*, 2009; Ma, 2014). Thus, as long as they are conceptually justified, both significant and insignificant formative indicators should remain in the measurement model.

| Latent variable/indicator | Bootstrap t-values | VIF | Mean of retained items |
|---|---|---|---|
| Level of Warehouse Waste Reduction Practices | 5.441 | N/A | 3.14 |
| Receiving | 6.131 | 1.021 | 3.54 |
| Put-away | 3.131 | 1.407 | 3.85 |
| Picking | 1.718 | 1.011 | 3.01 |
| Despatch | 4.767 | 1.435 | 2.15 |

Table 9: Assessment of the formative measurement model

In evaluating the structural model, $R^2$ of endogenous latent variables, estimates for path coefficients, effect size $f^2$ and prediction relevance ($Q^2$) were used to evaluate the quality of the model (Henseler *et al.*, 2009; Hair *et al.*, 2014; Oyewobi *et al.*, 2017). In PLS path models, the goodness of the path coefficients is usually tested by means of asymptotic t-statistics. If the t-value is greater than 1.96 based on a two-tailed test, then significance is accepted. The results are summarized in Table 10, which gives satisfactory indications. The values of $R^2$ are as follows: 0.23 for distribution performance, 0.45 for warehouse operational performance, and 0.55 for business performance. Although the values of $R^2$ for warehouse operational performance and business performance are substantial, the distribution performance value at 0.23 is weak. However, given specific context of this study, the $R^2$ of 0.23 considered substantial because there are other practices that might affect distribution performance, but are not covered in the proposed model (Rexhausen *et al.*, 2012).

The $R^2$ value for business performance suggests a substantial inner path structure, whereas warehouse operational performance and distribution performance suggest a moderate one. Furthermore, the $f^2$ effect size, indicate that business performance, warehouse operational performance and distribution performance have a large, moderate and weak effect at the structural model, respectively. In addition, the cross-validated redundancy measure $Q^2$ is above zero for all inner model variables. Thus, this indicates that the model has predictive relevance (Hair *et al.*, 2014; Oyewobi *et al.*, 2017).

| latent variable | $R^2$ for endogenous variable | Effect size $f^2$ | Cross-validated redundancy Measures $Q^2$ |
|---|---|---|---|
| Level of Warehouse Reduction Practices | N/A | N/A | N/A |
| Warehouse Operational Performance | 0.45 | 0.07 | 0.23 |
| Distribution Performance | 0.23 | 0.03 | 0.21 |
| Business Performance | 0.55 | 0.30 | 0.51 |

Table 10: Assessment of the structural model

Furthermore, t-values show that the path coefficients of all latent variables are statistically significant. The values of all path coefficients are shown in Table 11 and Figure 2. The direct effect of level of warehouse waste reduction practices on business performance was not statistically significant (0.01 at $p > 0.05$); thus, H1 is not supported. However, the level of warehouse waste reduction practices was found to have a positive relationship with both warehouse operational performance (0.41 at $p < 0.01$) and distribution performance (0.38 at $p < 0.01$). This result supports both H2 and H4. Figure 2 also indicates that warehouse operational performance has a positive relationship with both distribution performance (0.67 at $p < 0.01$) and business performance (0.39 at $p < 0.05$). This result suggests that H5 and H3 are supported. Our last hypothesis (H6), which states that distribution performance has a positive relationship with business performance, was also supported (0.56 at $p < 0.01$).

| Hypotheses | Path coefficient | *t*-statistics | p-value | Support for hypothesis |
|---|---|---|---|---|
| H1 | 0.135 | 0.874 | 0.01 | No |
| H2 | 0.482 | 2.563 | 0.41 | Yes |
| H3 | 0.372 | 2.931 | 0.39 | Yes |
| H4 | 0.529 | 3.145 | 0.38 | Yes |
| H5 | 0.398 | 2.876 | 0.67 | Yes |
| H6 | 0.566 | 3.289 | 0.56 | Yes |

Table 11: Path coefficient and testing of hypothesis

The direct effect of the level of warehouse waste reduction practices was not significantly related to business performance. However, the effect was directly related to warehouse operational performance and distribution performance. This means that both warehouse operational performance and distribution performance are significantly related to business performance. More specifically, there is an indirect effect of level of warehouse waste reduction practices on business performance through both warehouse operational performance and distribution performance.

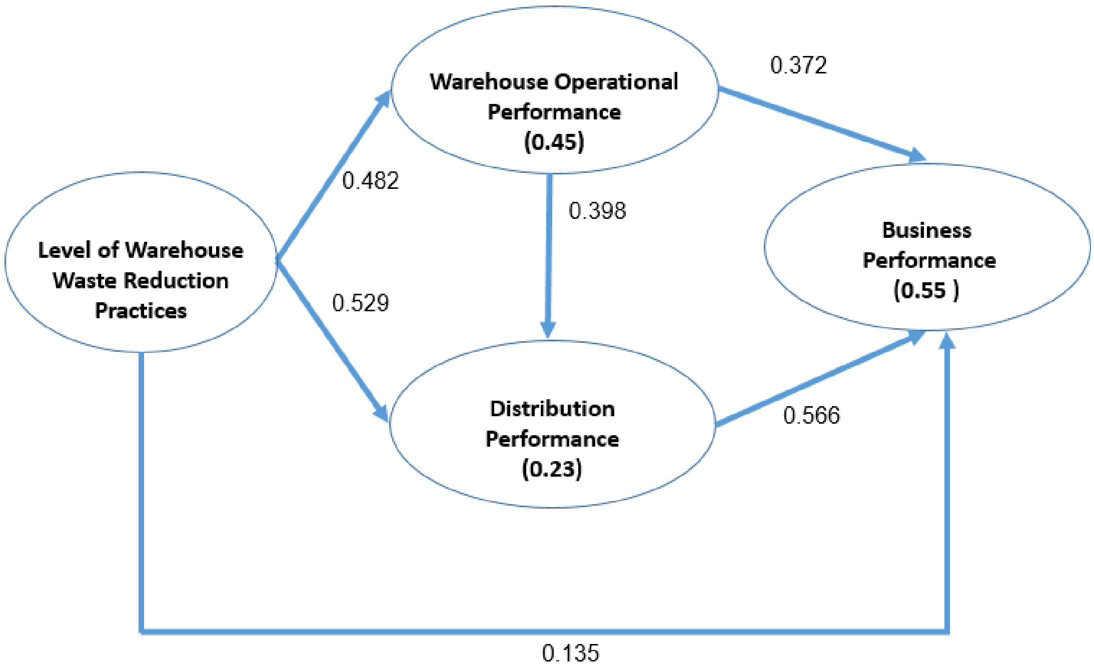


*Figure 2 PLS-SEM results*

The mediation in the model was investigated using the widely used test of Michael Sobel (Hayes, 2017). The results indicated that the indirect effect of the level of warehouse waste reduction practices on business performance via warehouse operational performance and distribution performance was 0.41 ($t = 3.67$ or $p < 0.01$) confirming the mediating roles of warehouse operational performance and distribution performance. This result was further checked by testing a competing model, where the direct path between levels of warehouse waste reduction practices and business performance was taken out. There was a slight change in the $R^2$-value from the original value of 0.55 to 0.54. This was important to ensure that taking out the level of warehouse waste reduction practices – business performance path will not weaken the model's fit. Thus, the direct effect of distribution performance on business performance and warehouse operational performance, and, the subsequent direct effect of the latter on business performance suggest that warehouse operational performance partially mediates the relationship between distribution performance and business performance. In addition, the effect of the level of warehouse waste reduction practices on business performance is fully mediated by both warehouse operational performance and distribution performance. The findings are congruent with the previous findings of (Garcia, 2003; Sharma and Shah, 2016; Shah and Khanzode, 2017), who found a significant link between lean practices and improving warehouse operational performance. The study findings are also consistent with previous research who suggested that improvement in the efficiency of warehouse operations would improve the overall distribution performance (Rexhausen *et al*., 2012; Appelqvist *et al*., 2016). Our study findings also corroborates with recent literature on waste reduction practices and its link to logistics activities. In particular, our results align with recent studies on waste reduction in transportation such as those of Salhieh *et al*. (2018), and (Villarreal *et al*., 2016), who found that waste reduction practices improve the efficiency of road haulage efficiency.

The general assumption in literature is that waste and lean practices directly affect business performance (Shah and Ward, 2007; Nawanir *et al*., 2013). However, this current study improves our understanding of how waste reduction practices in a warehousing context could be translated into improved business performance. Thus, the finding that the effect of the level of warehouse waste reduction practices on business performance is fully mediated by both warehouse operational performance and distribution performance is an important contribution to the logistics and distribution literature. Next section introduces conclusions, including theoretical and managerial implications.

## 5. Conclusions

### *5.1 Theoretical implications*

Although recent literature recognizes the role of warehouses in enhancing the overall efficiency of logistics operations, there is still a dearth of research of how waste reduction practices relate to the warehouse environment. This study contributes to the application of lean thinking to reduce waste levels in the warehouse operations. This has been achieved through translating the original types of wastes to the warehouse environment, but also through developing an instrument for measuring warehouse waste reduction practices, based on a Delphi study. This is the first scholarly work to empirically test the relationships among warehouse waste reduction practices, warehouse operational performance, distribution performance, and business performance. The importance of studying lean in warehousing and distribution operations is that any performance improvement in the distribution operations will ultimately be reflected in the logistics performance of downstream retailers (Pires *et al*., 2017; Hübner *et al*., 2016) and the whole distribution channel (Satyam *et al*., 2017). Thus, this study has contributed to existing literature by investigating the links between the various performance relationships and integrating lean warehousing with distribution performance.

The study showed that warehouse waste reduction level has a significant positive impact on warehouse operational performance and distribution performance. The findings also suggested that firms with high levels of warehouse operational performance achieved high levels of distribution and business performance. In line with the RBV, understanding the connection between waste reduction in a warehouse and the distribution function may produce an internal resource that has the potential to improve the overall firm's performance (Grant, 1991; Rexhausen *et al*., 2012; Eng, 2016). In addition, by eliminating waste from the warehouse activities, firms may enhance their distribution capabilities significantly (Rexhausen *et al*., 2012). Achieving high efficiency levels upstream in the warehousing function will lead to improved delivery performance to retailers (Appelqvist *et al*., 2016; Pires *et al*., 2017; Hübner *et al*., 2016).

Our study is different from previous studies (e.g. Shah and Ward, 2007; Dotoli *et al*., 2015; Faber *et al*., 2017) in that it provides a full exploration of the underlying mechanisms between warehouse waste reduction practices and business performance through understanding the mediating role of warehouse operational performance and distribution performance in this relationship. Furthermore, the majority of previous literature on lean warehousing was based on a qualitative case study methodology employing lean tools and investigating benchmarking improvements before and after the implementation (Sharma and Shah; 2016; Dotoli *et al*., 2015). This current study differs from previous research in that it investigated performance relationships empirically by developing an assessment tool of warehouse waste reduction practices. Since there are several classifications of warehouses (Frazelle, 2002; Bozer and Britten, 2012; de Leeuw and Wiers, 2015; Pires *et al*., 2017), and the principles of lean warehousing do not change by the type of warehouse (Bozer and Britten, 2012), the results of this study should be applicable to most types of warehouses.

### *5.2 Managerial implications*

This research provides practical implications for logistics and distribution managers. The developed instrument provides a guide for managers as to understand waste reduction practices that could be adopted to improve warehouse operational performance. This guide is seen in the instrument of warehouse waste reduction practices developed based on the input of academic and professional experts. For example, it helps them understand the sources of wastes in their warehouses but also how to optimize any non-value adding activities in the receiving, put-away, picking, and despatch operations. Efforts to reduce or eliminate waste in the warehouse activities should lead to improved warehouse operational performance and in turn (directly and indirectly) improved distribution performance and consequently, higher business performance. Thus, this suggests that distribution channel members including distributors and retailers can enhance the performance of their distribution operations through implementing lean principles upstream in the warehousing function. Such improvement in the "distribution channel is crucial to succeed in the retail sector across the globe, especially in the case of emerging economies due to their complex distribution structure" (Satyam *et al*., 2017, p1061). As a result, this may lead to improved logistics performance for retailers (Appelqvist *et al*., 2016; Pires *et al*., 2017; Hübner *et al*., 2016; Satyam *et al*., 2017).

## 6. Limitations and future research

This study has a number of limitations, which makes avenues for future studies in the warehousing field. Although most previous studies on lean warehousing have been largely based on an in-depth analysis through lean tools, by conducting a survey-based research, our study provided findings that are more generalizable. However, our results derived from only a sample of Middle Eastern companies; thus, future researchers could carry out a wider international investigation of warehouse waste reduction practices.

A more stringent test of the relationships among waste reduction level construct, warehouse operational performance, distribution performance, and business performance requires a longitudinal study, or field experiment, which could involve gathering data over a longer time span. Then, the association between the variation of independent factors and the variation of performance could be further investigated. Future researchers also invited to use the developed theoretical model and its instrument to test its validity, and consequently raise the state of knowledge of lean practices within the warehousing research area.

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