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# Improving Warehousing process with Lean Management

Case: Kuehne+Nagel Vietnam

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The purpose of this thesis was to conduct a case study on the implementation of Lean thinking in warehouse management. The result was how operations could be improved with help of lean management tools. Lean is commonly linked to manufacturing or non-manufacturing. However, the scope of this thesis was narrowed to warehousing only, which is one of the main logistics activities.

In this research, lean tools and techniques were studied and applied in a case study carried out in a warehouse of a Third Party Logistics company Kuehne+Nagel Vietnam. After the literature review on warehousing process and lean thinking, some tools of lean management were utilized, namely the 5S and value stream mapping. Besides, problems related to layout design, storage location, picking method are addressed in order to optimize the performance of the system. The final results suggest ways to eliminate wastes, reduce time and cost in warehouse management of the case company.

Drawing from interviews of warehouse personnel, a plan was developed to implement practical solutions. Lean is a powerful management approach which might be applied effectively in warehouse management in Vietnam. However, there are conditions and limitations of its applicability. The effectiveness of applying Lean depends largely on many factors. Such factors are e.g. the human factor and the nature of the products which have certain influences on the working procedures. The implementation is varied from one warehouse to another but in general there are few core areas where Lean can be seen as effective improvement approach. These areas are the layout planning, personnel training and continuous improvement.

Keywords	Warehouse Management, Warehouse Operations, Lean Thinking, Lean, Management, Order Picking, Storage Location
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## 1 Introduction

During my internship in Contract Logistics department of Kuehne+Nagel Vietnam, my main responsibility was related to the operation in the warehouse. I joined one of their continuous improvement project in the warehouse through which I have learned about the reality of logistics in Vietnam. The fact is that many logistics activities are still in their infancy and the ideology and tools of Lean Management are not well-known and utilized yet in Vietnam. Therefore I decided to look further into Lean Management tools and make research whether they could be applied in the case company in order to improve its warehousing process.

Since 1990s the logistics services in Vietnam have begun to develop. These services are were mainly freight forwarding and warehousing. After Vietnam became officially a member of the World Trade Organization (WTO) in 2007 there has been many changes in the economic position of Vietnam. This membership has attracted increased amount of foreign direct investments and many domestic enterprises have been founded. As a result, the rapid growth of international trade has led to an increase in the demand for transportation and warehousing. Currently there are approximately 1,200 businesses providing logistics services like freight forwarding services, warehousing, handling, shipping agents, in Vietnam. They are concentrated mainly in the area of the Ho Chi Minh City and Hanoi (SCSC, 2014).

Logistics services in Vietnam are classified by Investment Promotion Centre South Vietnam as:

1. The transport operating businesses: transport services (road, sea, air)
2. The infrastructure operators in the nodes (ports, airports, gas)
3. The warehousing enterprise, offering handling and logistics services
4. The freight forwarding business , 3PL enterprises and other businesses including logistics software solutions, consulting, assessment, inspection, finance.

Besides, Vietnam is facing many challenges due to poor infrastructure and underdeveloped operations, which explain why the logistics costs in Vietnam are much higher than in many other countries. Most of the enterprises in the logistics area are small in size and have fragmented activities and lack logistics expertise. Other downsides of logistics in Vietnam are the shortage of trained manpower and qualified managers and that the legal environment is not unanimous. There are differences in legal systems, customs clearance and in other administrative procedures (IPC, 2013).

Systems used in warehousing, ports and harbors in particular are dispersed due to the fact that the enterprises are focusing rather on quantity than quality. Special logistics areas including cargo handling sector, light industry and transport and other logistics activities are in high demand but still a new field in Vietnam (Ngo and Trinh, 2014).

### 1.1 Kuehne+Nagel in Vietnam

Founded in 1890 in Germany, Kuehne+Nagel is an international freight forwarder with more than 1000 locations in over 100 countries. It has more than 63,000 employees and is no.1 in sea freight and amongst the top 2 global airfreight in the world (Kuehne+Nagel, 2015).

Kuehne+Nagel Vietnam belongs to the South Asia Pacific business division and has been operating in Vietnam since 1990. Nowadays, it ranks as number one in sea freight in the country. With more than 150 experienced staff members in four locations, the company provides international forwarding by sea and air, contract logistics and project management services. Kuehne+Nagel Vietnam has three warehouse facilities throughout Vietnam with the total capacity of 25 000 sqm. It provides transport models, covers nationwide distribution and supports customers in integrating domestic local network into the global supply chains (Kuehne+Nagel Vietnam, 2015)

Kuehne+Nagel's services can be classified into three categories as described in figure 1:

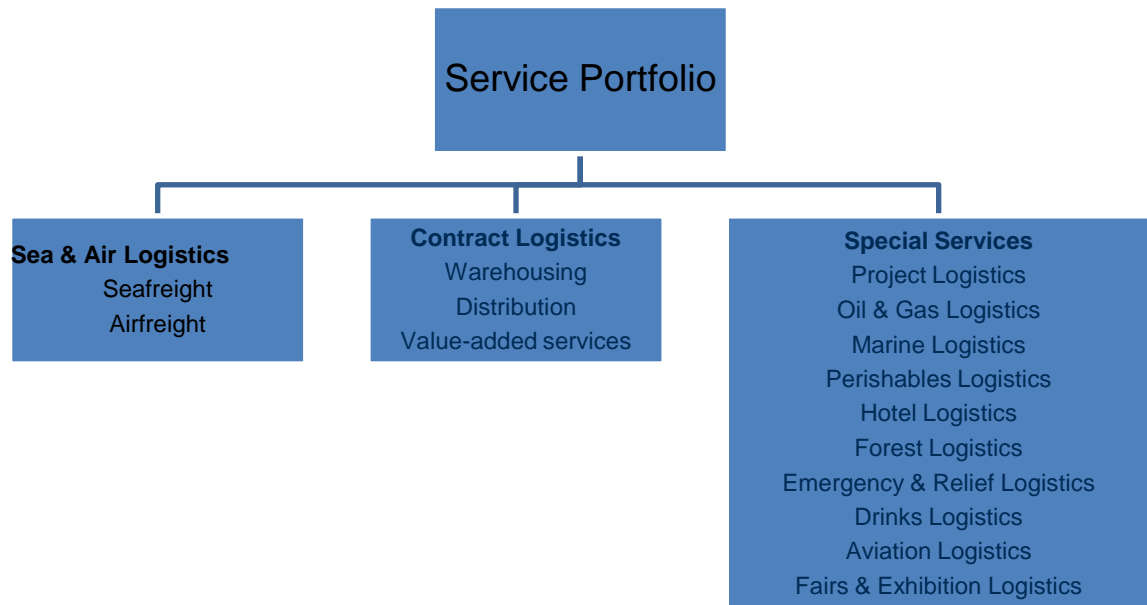


Figure 1. Kuehne+Nagel Vietnam 's Service portfolio (Kuehne+Nagel Vietnam, 2015)

Kuehne+Nagel Vietnam offers tailor-made services for warehousing ranging from inbound receipts, storage, put-away, pick & pack operations, inventory management to national distribution. Furthermore, Kuehne+Nagel Vietnam offers value-added services such as labeling and price-tagging. (Kuehne+Nagel Vietnam, 2015)

## 1.2 Objectives, scope, methodology and limitations

The main objective of this thesis is to conduct a case study on how warehouse operations could be improved with help of lean management tools in a logistics company in Vietnam. Lean is commonly linked to manufacturing and to non-manufacturing only in a large scale such as supply chain or logistics services (Goldsby and Martichenko, 2005). However, the scope of this thesis is narrowed to warehousing only, which is one of the main logistics activities.

The research questions that this thesis intends to answer are:

1. What are the tools and methods of Lean used in warehousing process in general?
2. What tools and methods of lean management could be implemented in a project of improving warehousing effectively?



3. What are the possible challenges in the implementation of lean management in a warehouse environment?
4. How to measure the development and improvement achieved with lean management process in a warehouse?
5. Could Lean Management be used in order to develop warehousing activities in Vietnam?

Secondary research was conducted by studying books, journals and internet websites about Lean management project implementations which had showed results especially in improving warehousing process.

A case study was conducted to test how Lean management philosophy could be applied in a warehousing process in Vietnam. Kuehne+Nagel warehouse provided a good ground for a pilot project since the Lean management philosophy is employed there only by the management level of the company at the moment and not implemented in the operations level in the warehouse. The research methods used in this case study were qualitative meaning that primary data was collected from some archival documents of the company, by conducting interviews to workers in the warehouse and by author's own observation while visiting the warehouse. In the analysis of the data collected from the warehouse operations some analytical tools like fishbone and value stream mapping were used.

The research was conducted at Kuehne+Nagel warehouse in Binh Duong province focusing on warehouse management, transportation operations and management of the warehouse workers daily work. The limitation of this research is that it might not present the warehousing process as a whole because the author's internship at the company was only three months long and the research was conducted only in one warehouse. It was much harder to get an access and to collect data and information as expected as the warehouse is quite large in size. The data collected may not grasp all the facts. Moreover, the methodology used and the number of people interviewed was not so big and in such a detail that the results would reflect the problems as a whole.

## 2 Lean Management

### 2.1 History of lean management

The Lean production was originated in Japan when the mass production was popular in many industries in America. Taiichi Ohno, who was an engineer of Toyota firm, wanted to deviate from the popular style of mass production and create value for the customer with higher level of efficiency and less waste (Dehdari, 2013). Eventually, he developed the Toyota Production System to enable his organization to meet customer demand in a more efficient way. The changes were that Toyota produced in small batches which reduced inventories and capital needed to produce the same product. Alongside, Toyota started to invest in people with the belief, that it was more important than investing in bigger production size. Regular training motivates employees so that they become more open to changes like that improvement of processes requires and are more willing to give their input to the company (Dehdari, 2013).

Lean production sprung from Toyota was deemed to convey more benefits due to its ability to respond to changes in demand by switching quickly production model from one to another (Drew et al., 2004). Toyota production did not reply to the economies of scale like the production of car manufacturers in America. It developed an organization and culture that pursued the elimination of waste, inflexibility and variability by focusing on operating system which was able to respond to demand quickly. This in turn required that the workforce was more skilled and flexible than those in mass production systems. Eventually, these factors contributed to operations that follow the basis of lean or Toyota Production System (Drew et al., 2004).

Womack (2010) advocates the applicability of lean thinking stating that it can "work in every company and industry where it is seriously tried". It is a fact that use of lean management ideology and tools has continuously gained more popularity. According to Lean Enterprise Research Centre, it has moved from just being management philosophy in manufacturing to other fields like public sector, healthcare, administration and business planning of start-ups

## 2.2 Main principles of Lean management

By Womack and Jones (2010) there are five lean principles which are explored in Lean thinking:

**Specify value:** Value is described as what the customer is willing to pay for. One example could be the process of transforming the product such as machining and assembly. It is defined by the customer. However sometimes it could be formed by pre-existing organizations, especially engineers and experts. They could add other values of no interest to the customer.

**Identify the Value Stream:** The Value Stream comprises all the necessary actions and processes to bring a product or deliver value to the customer. The complete value stream flows through the complete supply chain, from raw materials to finished goods.

**Flow:** The value-creating steps or processes should be made to flow without delay or interruption. It is said that one should try to avoid the execution of a single-task process on large batches.

**Pull:** The production should be make-to-order. The production processes should be activated once the customer wants to receive, not when the supplier wants to provide.

**Pursue perfection:** The thinking is that there is no end to the process of reducing space time, cost and errors. One should strive for perfection by continually reducing waste.

## 2.3 Waste in lean management (Muda)

As stated by Womack et al (1990) "Leanness calls for the elimination of all wastes". In lean terminology waste is called "muda" (Ben Naylor et al., 1999). Seven wastes were identified as part of the Toyota Production System (Hines and Taylor, 2000a). These wastes are described next in more detail.

1. Overproduction: producing too much or too soon, resulting in poor flow of information or goods and excess inventory (Hines and Taylor, 2000b).
2. Defects: frequent errors in paperwork, product quality problems, or poor delivery performance. Defects in the supply chain can do harm to the supply chain since they do not only result in increased labour costs but they also require time to figure out the roots, to repair, and to get back to work like Mangan et al (2008) are stating. These kind of unexpected incidents cannot be avoided completely. However, they can be minimized by monitoring the process well and regularly.
3. Unnecessary inventory: excessive storage and delay of information or products, resulting in excessive cost and poor customer service. As mentioned by (Jacoby, 2010) in lean operation any inventory is unacceptable. (Bowersox et al., 2002) refer to inventory as any kind of raw material, work-in-process or finished goods that has not yet produced income, hence, not adding any value and therefore regarded as waste.
4. Inappropriate processing, as defined by Jacoby (2010), takes place when any stage of the process is done twice instead of one if that would have been possible. In addition, Mangan et al (2008) define this waste as a situation where all products are treated as on the same level even when though this would be needed only for particular products or market.
5. Excessive transportation can be understood as excessive movement of people, information or goods resulting in wasted time, effort and cost. Almost every products need this from the stage of raw materials to the end customers. The idle time when the products are in the truck, train or ship for example, adds costs to the firm without adding any value to the chain (Mangan et al., 2008).
6. Waiting: long periods of inactivity for people, information or goods, resulting in poor flow and long lead times (Jacoby, 2009). As a result, man power, money, machine, material could be wasted if they have to wait until another stage of process begins (Mangan et al., 2008).

7. Motion: any motion that is caused by poor workplace organization, resulting in poor ergonomics (Jacoby, 2009). One obvious form of unnecessary motion includes back and forth movement in a workplace and searching for parts or tools.

## 2.4 Lean tools and techniques

### 2.4.1 Value stream mapping (VSM)

The value stream is defined as a set of all the “specific activities required to design, order, and provide a specific product, from concept to launch, from order to delivery, and from raw materials into the hands of the customer” (Faulkner and Badurdeen, 2014). What happens to a product at each stage in its production is described in the value stream, from designing the product to ordering raw material and finally delivering the ready product. Activities in the value stream are divided into three one adds value and the other two are “muda” meaning waste (Faulkner and Badurdeen, 2014):

- Value-Added: activities that indisputably create value.
- Type One Muda: activities that add no value but are inevitable due to current technologies or production assets.
- Type Two Muda: activities that add no value and are immediately avoidable.

When constructing a VSM, the flow of information and materials is outlined in different part of the map. The points at which products stay waiting for the next process with its time are also drawn. Consequently, we can easily determine the lead time and processing time of product identifying which is value added time and which is not. This is demonstrated in an example of VSM in figure 2.

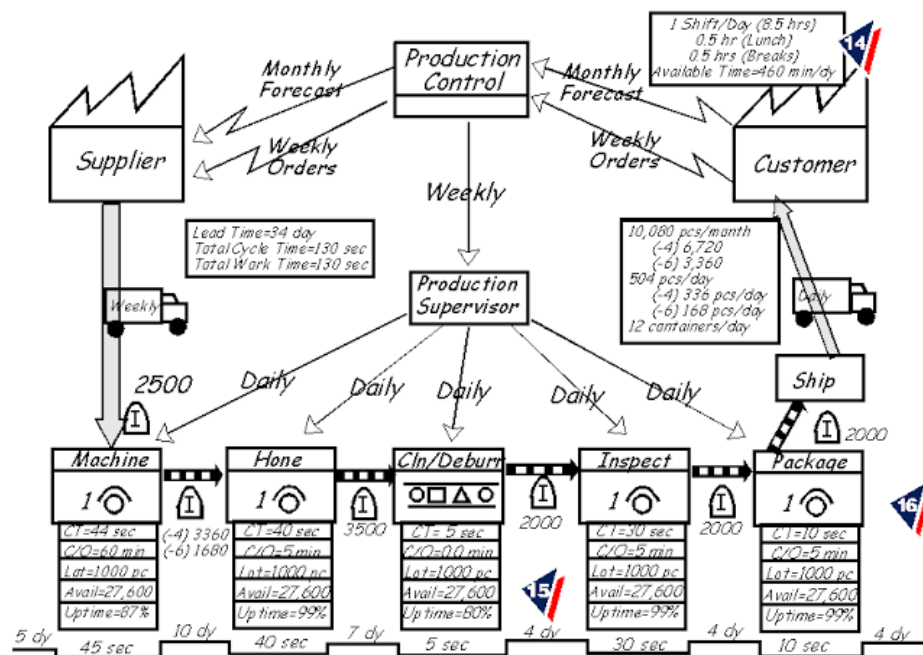


Figure 2. Value stream mapping (Boersema, 2008)

#### 2.4.2 5s technique

One of the most well-known and popularly applied tools of Lean is 5s which has its origins in Japan in the early 70s. It is of great important to the visual management in an organization. The main purpose of 5S practice is to provide a safe, organized and efficient workstation, resulting in a reduction of waste and improvement of performances of workers and in processes (Shivanand, 2006). The name of this 5s technique is composed of the initial letters of five Japanese words – *Seiri*, *Seiton*, *Seiso*, *Seiketsu* and *Shitsuke* (2015c)

**Seiri (sort)** Separate the useful from the useless. That is to sort through items and keep only what is needed to perform value-added-activities and dispose of what is not. A method to do this is the red-tagging. This consists of marking the rarely used items with a red tag identifying them as an item to be removed from the workplace. Figure 3 shows an example of a worksheet and tags used for this purpose.

Red tag	Usage Frequency	Where to place
	Daily	Workstation
	Once a week	Work area
✓	Once a month	Storage place
✓	Once a year	Warehouse
✓	Obsolete	Sell/Eliminate

Figure 3. Red tag classification example (2015a)

***Seiton (orderliness):*** the phrase "*A place for everything and everything in its place*" can be used to describe this step. There must be well-defined place for everything and it needs to be checked that everything is in its place. The most frequently used gear needs to be placed at hand to avoid unnecessary movement for the worker, and visual label should be on the gear and at the place where they must be placed (Wilson, 2009).

***Seiso (cleanliness):*** cleaning the workstation anticipates failure conditions which could do harm to the product's quality or induce machine failure (Wilson, 2009)

***Seiketsu (standardize):*** defining a standard regulation for order and cleanliness in the workplace (Wilson, 2009). In other words, develop systems and procedures, with visual controls for example, to maintain and monitor the previous S.

***Shitsuke (self-discipline):*** maintaining a stabilized workplace in an ongoing process of continuous improvement. It must be noted that 5S is not just to organize and label material and tools and to create a shiny environment. It is a support system to lean management in order to enable smooth flow of materials and people (Shivanand, 2006).

### 3 Warehouse Management

#### 3.1 Role of a warehouse in supply chain

Warehouse is defined as holding goods until they are required. In the past, warehouse is known as a cost center but now organizations use warehouse as a place to add value by doing many related jobs such as labeling and packaging. The fact that there are many different activities inside a warehouse leads to the need for different kind of facilities, staff and technical equipment. The issues put forward for warehouse management are to increase productivity and accuracy, reduce and control cost of inventory and shipping while providing good customer service (Richards, 2011). Role of a warehouse in the supply chain network is essential because it provides temporary storage before the products reach the customers. Various roles of warehouse in the supply chain are illustrated in the figure 4.

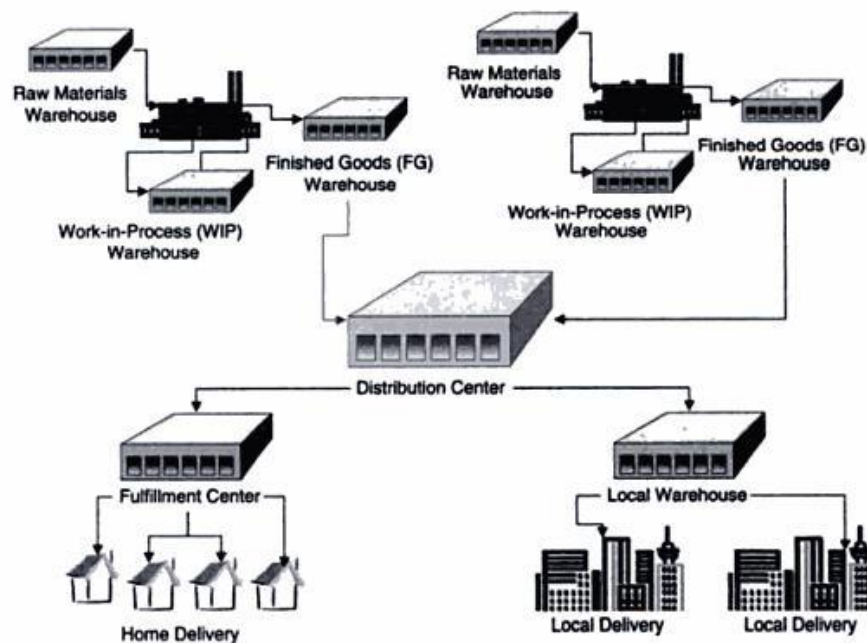


Figure 4. A Warehouse's Role (Hackman et al., 2001)

Ackerman (2012) mentions three types of warehouse ownership. A private warehouse is owned or leased by the company itself to support its main operations. This will give greater control over broader logistics activities. This kind of ownership offers the company the possibility to choose location, size of the warehouse to fit the customer service supporting the company with lower cost and possible tax advantages and



development grants. A public warehouse is managed by an independent contractor, who provides services for many companies at the same time. This kind of warehouse gives companies the flexibility to deal with changing demand and the possibility to avoid large capital investment and to use the economies of scale in order to reduce cost. Contract or dedicated warehouse: uses a combination of private and public warehouses. In particular, an independent contractors warehousing service is bought for a period of time according to a contract.

The author also states that the aim of a warehouse is to support logistics activities by combining quality of customer service and low costs. These main targets include the following issues:

- Providing necessary storage in supply chain
- Giving secure storage
- Keeping stock in good condition and minimizing damage
- Offering good customer services
- Controlling the flow of materials effectively
- Sorting materials quickly and accurately
- Picking materials departing quickly
- Being flexible to cope with variations in stocks
- Giving safe working conditions

The mission of good warehousing process is to move products in any configuration to the next step in supply chain with high concern about product damages and serves quality. Hence, also in this thesis the main target was to explore the influences of Lean management in order to guarantee better warehousing process in the case company.

### 3.2 Classifying warehouses

Rushton (2010) has classified warehouses based on the nature and purpose of a warehouse within the supply chain as follows:

- By product type: there are different kind of products which require their own shipping and storage conditions, such as frozen food, fragile items and high value

items.

- By the stage in the supply chain: the warehouse is assigned to store raw materials, work-in-process or finished goods.
- By geographic location: this warehouse is constructed just to serve the specific areas and to meet strictly local demands.
- By function: the warehouse is used for the purpose of holding inventory or sorting.
- By company usage: the warehouse is used by one company or shared by various users.

On the other hand Hackman et. al. (2001) suggest that dependent on customer, warehouses can be categorized to several types such as retail center which supplies retail stores, service part center for expensive equipment storage, 3PL warehouse which is outsourced by the company to serve other organizations and perishable warehouses, which carry short-shelf-life products.

### 3.3 Planning of warehouse layout

The layout of a warehouse is described by Walters (2003) as “the physical arrangement of storage racks, loading and unloading areas, equipment, offices, rooms, and all other facilities.” Wasson (2005) defines it as “an integrated elements of interoperable elements, each with explicitly specified and bounded capabilities, working synergistically to perform value-added processing to enable a user to satisfy mission oriented operational needs in a prescribed operating environment with a specified outcome and probability of success.”

According to Salvendy (2001) warehouse layout should meet the following standards:

- Give the smooth flow of materials to move in, move out and move through the warehouse.

- Simplify, combine separate movements to reduce the total distance traveled
- Locate high storage requirements to high-bay space and labor intensive processes in low-bay space.
- Give appropriate space for aisles so that they are large enough for equipment movement

The layout can be classified into four categories by Van Den Barg and Zijm (1999) based on the level of activities and size of storage area as shown in table 1:

Table 1. Layout classifications

		Storage	
		high	low
Activities	high	Large distribution center. Automated order picking systems materials handling, sorting system and high density storage	Condensed forward picking area coming with simple overstocks storage
	low	High bay, high density storage multi-level, random location strategy, manual or semi-manual order picking	Small warehouse, floor storage, simple pallet, rack, conventional shelves are used

The main purpose of warehouse layout is to control the balance between handling cost and costs generated from warehouse space. The objective is to fulfill the warehouse capacity while keeping the handling costs at low level (Roodbergen and Vis, 2006)

The layout planning can be understood as the optimum arrangement of facilities including personnel, equipments, storage space, materials handlings and other services. Since the warehouse layout is very important due to its long-term commitment to provide optimal relationship among storage and processes, it should be analyzed carefully in order to set up a good plan for layout. Important principles for warehouse layout planning mentioned by Roodbergen and Vis (2006) are:

- Integration of all factors: the plant should integrate and combine all the resources such as personnel, machine, services, etc. to make use of the utilization of such

resources.

- Minimum movement: if the total distance of travelling can be reduced, the cost will be reduced while the productivity increases sharply.
- Unidirectional flow: materials should move towards the same direction and it is essential to avoid any back-tracking.
- Efficient space handling: the materials should be well-organized and allocated in such a way that it is easy to find and pick them as well as to make use of the space of the warehouse and thus either reduce cost of floor rent or maximize the capacity.
- Inherent safety: the company must set up safe working environment for employees as well as machine and warehouse strategy in which everything works smoothly and safely.
- Maximum observation capacity: the observation and supervisor can be conducted at any time during the working day to find out the problems and make adjustment in time to ensure the efficiency.
- Maximum accessibility: it must ensure the accessibility to any items and machines at any time and in any circumstances in order to prevent the operating flows to get stuck.
- Minimum Handling: The inefficient handling of materials leads to an increase in cost generating. Therefore materials should be transferred into one direction.
- Maximum protection: the protection of employees, materials, items and machine must be put forward too. The security system should be checked regularly and carefully.
- Maximum flexibility: the plans should be able to be changed due to the changes in demand for storage or change in storage conditions.

### 3.4 Warehouse activities

The main function of a warehouse is to store goods. But as mentioned in the previous chapters, there are many activities associated with warehouse operations and value added that exist in every warehousing process. Tompkins et al (2010) find following stages in the warehousing process as in figure 5:

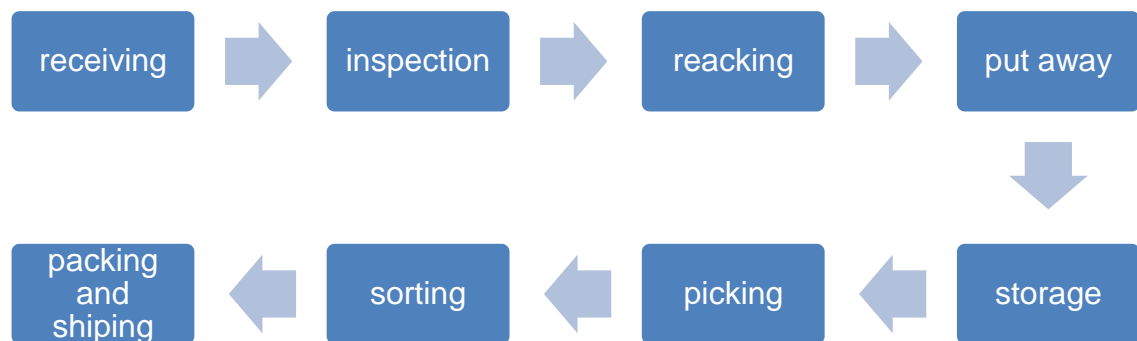


Figure 5. warehouse process (adapted from Tompkins et al., 2010)

- *Receiving* is the activity associated with order receipt of the material moving to the warehouse. At this stage, employees check the quantity and quality of items to make sure that they are as ordered, and then disburse them to be ready to storage.
- *Inspection and quality control* belongs to the receiving stage when the suppliers are not consistent in product quality or the items required special inspections at all steps.
- *Repackaging* is conducted when the products received increase the storage cube requirement or the item is received without markings that can be recognized by systems or humans.
- *Put-away* is the stage where products are moved from unloading docks to storage bays. This stage includes materials handling and placement.

- *Storage* is an activity that is influenced by products. The form of needed storage depends on the quantity, size and the characteristics of the products.
- *Order picking* is conducted when the company receives customers' orders. It is the procedure of picking the pallet from the bulk area storage or smaller quantities from the pick area storage.
- *Sortation* is the arrangement of batch picks into customer's orders. For orders which have more than one item, this step is to accumulate picks into orders.
- *Packing and shipping* are to check the completed order and pack products into shipping containers. The shipping documents are prepared and the products loaded into the trucks.
- *Cross-docking* occurs when the storage is not needed. In this case, products from receiving dock will be moved directly to the shipping dock.
- *Replenishing* is picking inventory from reserve storage locations to primary location to ensure the efficient inventory flow.

### 3.5 Storage strategies

Tompkins et al (2010) classify material storage into dedicated and randomized storages.

In the dedicated storage each Stock-Keeping-Unit (SKU) is assigned into a fixed specific location and at that location, no other SKU is stored. Barthodi and Hackman (2010) have proved that dedicated storage strategy utilized only 50% of the warehouse in those warehouses where it was followed. This can be explained by the fact that when the "out of stock" occurs there are many empty slots which are not used because SKU is fixed at their own location or the decrease in inventory leads to the development of empty slots as well.

In randomized storage SKUs are assigned to available storage location regardless of fixed storage bay. Bartholdi and Hackman (2010) have proved that in randomized storage strategy, space utilization is higher than that of dedicated storage strategy because the all SKUs will not reach the maximum inventory level simultaneously. Therefore randomized storage requires fewer opening of slots compared to the need for this in dedicated storage strategy.

Lee and Elsayed (2005) developed the optimal capacity using dedicated storage. Following their findings, SKUs should be assigned to locations based on the ratio of their activities to the number of slots assigned. So, the highest rate SKU should be placed at the preferred openings and ones at lowest rate should be located at the least-preferred openings.

Due to some disadvantages of dedicated and randomized storage strategy, the other form of storage strategy has been introduced. Class-based-storage strategy is the strategy in which SKUs are divided into classes due to the activities ratio and stored in a fixed zone. However, in this model in each class SKUs are stored randomly. This strategy can enhance the throughput advantage of dedicated storage while it at the same time maximizes the space benefits of randomized storage (Chan and Chan, 2011).

The storage in class-based strategy is divided into three areas: A, B, and C. A is the storage area of the highest level of input/output (I/O) activity items. Therefore it is often assigned near the dock. Class B items have lower level of I/O activities. B storage area is located a little bit further from the dock. Finally, class C items are items which have the lowest level of I/O activities and hence, storage C is located furthest from the dock to make sure that the materials flows smoothly inside the warehouse (de Koster et al., 2007). Figure 6 gives an example of a warehouse where products are divided into A, B and C storage areas.

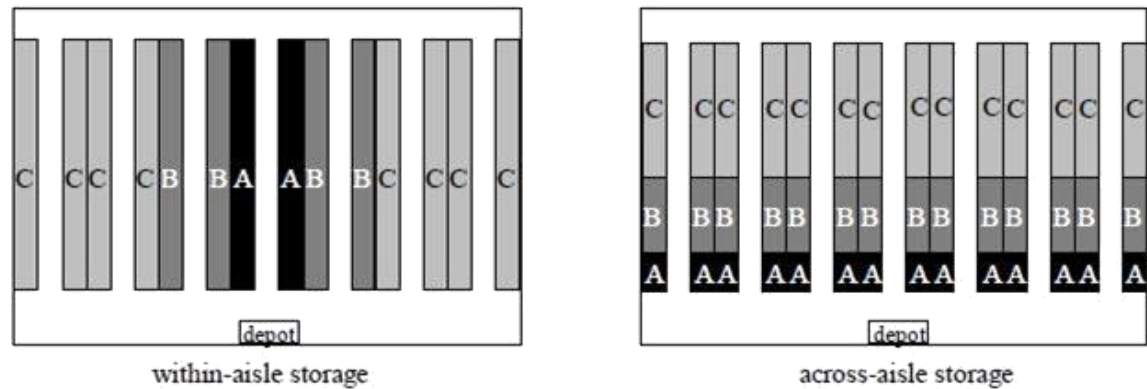


Figure 6. Class-Based Storage Strategy (de Koster et al., 2007)

The ABC analysis is a mechanism for identifying different categories of stock that requires different management and control, hence placing significant impact on overall inventory management cost (Lysons and Farrington, 2006). Similar to Pareto principle which states that "roughly 80% of the effects spring from 20% of the causes" (Bunkley, 2008), ABC approach states that A-items whose 80% of the annual consumption accounts for only 20% of total inventory items. B-items owns a medium consumption value 15% and typically accounts for 30% of total inventory items. On the contrary, C-items with the lowest 5% of the annual consumption value accounts for 50% of total inventory (Lysons and Farrington, 2006). Figure 6 visualizes ABC inventory analysis as adopted from Lysons and Farrington (2006)

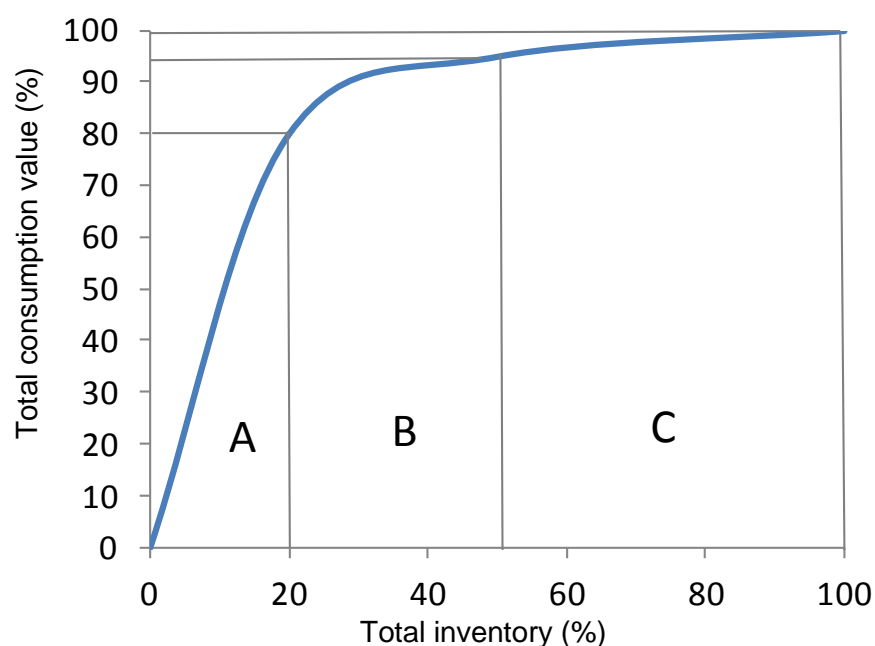




Figure 6. ABC analysis inventory (adopted from Lysons and Farrington, 2006)

Another strategy is forward and reserve, warehouse layout is divided into two different areas: forward and reserve. The forward area is the primary or fast-pick area in which the dedicated strategy serve products that are picked in less than pallet quantity. This is also known as bin pick (Bartholdi and Hackman, 2010). SKUs in this case are allocated into smaller cases so that they are easy to access and replenish from the reserve area (Rouwenhorst et al., 2000). The reserve area is the secondary, bulk storage, or replenishment area in which products are stored in pallets or in large quantity bays. The reserve area supplies the forward area and functions also as supplies for bulk pick (Bartholdi and Hackman, 2010).

### 3.6 Order picking process

Order picking is “the process of retrieving products from storage (or buffer areas) in response to a specific customer request”. It is known as one of the most labor-intensive activity that requires the highest capital investment; as mentioned by Frazelle (2004) order picking accounts for more than 50% of the operating costs in the warehouse function. Nowadays, the order picking activities play a critical role because of the development of the markets. The changes in logistics trends such as the introduction of JIT (just-in-time) deliveries, cycle time reduction and quick response to customer orders, require more efficient order picking in order to meet the customer’s satisfaction in terms of frequent and accurate delivery. Order picking activities have a key role in developing logistics processes so that product damages are minimized and cycle time reduced (Walters, 2003).

The characteristics of products to cope with and the number of orders and order picking lines necessitate the best methods suitable to complete each order regardless to the level of difficulty of the activities and the kind of operation the company is conducting. Hence, many methods of order picking which aim at maximizing the productivity, are introduced as follows based on various sources.

- Single Order method: The most popular order picking type is the single order picking policy or discrete picking policy in which the pickers make a complete tour

around the warehouse to pick all items of a single order. This kind of policy is used mostly because it is simple, easy to conduct and proves the reliability regardless to its characteristics. But to some people this policy is quite costly and inefficient since the pickers deal with just single orders per travel (Petersen and Aase, 2004).

- **Batch Order method:** Different orders are grouped together and then picked at the same time. This reduces the number of trips travelled because the pickers do not have to return to pick other items. Hence, it has more advantages than the former method of single order. This policy is an efficient way to reduce trip travels, consequently reducing the time and cost. But this method has some disadvantages. Although batch picking can minimize traveling time, if there are many items picked in the same carts, it may take time from the picker to sort the items picked (Petersen and Aase, 2004).
- **Zone Picking method:** In zone picking, the warehouse is divided into many different zones and employees are assigned to conduct their work in a specific zone. By changing the warehouse layout, the productivity can be developed. Moreover, by studying the configuration of each warehouse zone using class-based-storage strategy, it was stated that analyzing the storage capacity, number of picking orders and the storage strategy helps to choose the right zone configuration to decrease the travel distance, hence reducing the operating time. Overall, zone picking is commonly used and it is said to be very effective to response quickly to the customers' orders (Petersen and Aase, 2004).
- **Wave Picking method:** Orders are received, grouped, and combined into a list so that pickers can estimate the routine travel to pick items in the order on the picking list (Taljanovic and Salihbegovic, 2009). To do this, the warehouse manager uses modern technology such as Warehouse Management System and Radio Frequency technology to sort the order list and to conduct the replenishment schedule and support the picker by handheld equipment which displays the next order.
- The opposite of wave picking is Wave-less Picking. Wave less-picking, or continuous flow picking, is used when the orders are ranked based on the shipping day. In this case, each picker receives a pick list which is updated as they will travel through the

fixed routine (Gallien and Weber, 2008). After all, wave-less picking is said to outshine wave picking by estimating the picker's idle time among waves and letting the priority orders to be conducted as soon as possible without delay (Gallien and Weber, 2008).

### 3.7 Key Performance Indicators in storage

Storage functions utilize the resources such as space, equipment, and personnel while trying to meet the customers' satisfaction. Customers are looking for a warehouse that is able to deal with the logistics activities quickly and keep products in good condition. Hence, the issues of storage are how to maximize the use of those resources and at the same time in the most efficient way. The performance measurement of storages is based on storage capacity in terms of the total volumetric space and the total number of stored components, storage density which represents available volumetric space for storage, the accessibility which is the ability to access items in storage location. Utilization and availability are used as indicators to measure the performance as well.

The companies conduct the performance measurements to identify whether the operation was performed according to the stated objectives and to find out reasons for poor performance in order to be able to make adjustments in time. There are many reasons for conducting the performance measurements, "for improving performance, for avoiding inconveniences before it's too late, for monitoring customer relations, for process and cost control and for maintaining quality" (Ackerman, 2003). Performance measurement is conducted by using chosen indicators that affect the operations as a whole. They are called key performance indicators. In each stage of the production chain, there are some main activities which are used to determine the key performance indicators. The company managers use indicators to compare process with standard values. If there are many results that are lower than the expected standard values, then the inspection is needed to find out the problems and make adjustments. They are the control system of the operating process.

The performance indicator or key performance indicator (KPI) is a measure of performance of the business. The reasons why companies to construct these indicators are that they want to benchmark their performance against the competitors and

develop a standard for production. In warehouse management, KPIs are set up with some factors that occur in each stage of the warehousing process. In table 2 are listed different KPIs in warehousing. The KPIs circulated are discussed later in the analysis and suggestions for improvements in the case company.

Table 2. Key Performance Indicators of Warehouse Management (Warehouse KPIs (2011))

	Financial	Productivity	Utilization	Quality	Cycle Time
<b>Receiving</b>	Receiving cost per line	Receipts per man-hour	% Dock door utilization	% Receipts processed accurately	Receipt processing time per receipts
<b>Putaway</b>	Putaway cost per line	Putaways per man-hour	% Utilization of putaway labor and equipment	% Perfect putaways	Putaways cycle time (per putaway)
<b>Storage</b>	Storage space cost per item	Inventory per square foot	% Locations and cube occupied	% Locations without inventory discrepancies	Inventory days on hand
<b>Order picking</b>	Picking cost per order line	Order lines picked per man-hour	% Utilization of picking labor and equipment	% Perfect picking lines	Order picking cycle time (per order)
<b>Shipping</b>	Shipping cost per customer order	Orders prepared for shipment per man-hour	% Utilization of shipping docks	% Perfect shipments	Warehouse order cycle time

## 4 Methodology

In this research, I am applying theory to analyse and give suggestions for improvement in a specific case of Kuehne+Nagel Warehouse operations:

During my internship, I experienced the working load in warehouse operations and wrote them down carefully. Such primary data is valuable because it illustrates the real-life situations, issues and problems that occur daily in a warehouse. On the other hand, I talked often to the employees in the warehouse in order to absorb more knowledge of their work. By talking to them, I had also chances to get more information and data which is not documented officially but was very useful for conducting my thesis.

Observation is a common method of collecting qualitative data. This method is also very demanding. "It requires that the researcher becomes a participant in the culture or context being observed" (Mahoney & Goertz, 2006). Participant observation requires a long period of time of intensive work so that the researcher becomes accepted as a natural part of the culture. Eventually, he is able of ensuring the observations are of the natural phenomenon. Through observation at the warehouse, I eventually got familiar with the processes, different work streams; hence getting an overview of both operation floor and on the warehouse management system.

During the internship period, I had chances to observe the operation of Kuehne+Nagel Vietnam warehouse and this research method gave me the very first and direct image about what is happening in the warehouse. These preliminary observations were then supported by conducting interviews which provided deeper insight into the warehouse activities. (see appendix 1 for interview questions)

Merriam (1998) mentions that another common mean of collecting qualitative data is interviewing. There are three ways to conduct interviews distinguished by Ghauri and Gronhaug (2005); email interview, phone interview and face-to-face interview.

Due to the tight working schedule, I didn't have enough possibilities to conduct face-to-face interviews with all workers in the warehouse. However, I collected data with

help of daily conversations with some workers. These interviews had an important role in my research since I wanted to examine Lean implementation in the warehouse.

Information collected from any sources that have already been published is treated as secondary data. In my case, I considered using secondary data as the books, journals or contents of website which can be easily accessed to get information about the thesis topic. Other sources used were the company's internal information system in form of reports, statistics, company's presentation materials and newsletters.

#### 4.1 Reliability and Validity

Kumar (1999) described that reliability is when an instrument is able to produce consistent measurement. The instrument is deemed reliable if it produces the same or similar set of information under the same or similar conditions.

The validity concerns the interpretation of observation. It is defined by Cooper & Schindler (2000) as "the extent to which a test measure what we actually wish to measure" which concerns more about the accuracy of the measurement procedure compared to reliability. Two major forms of validity are internal and external. As stated by Cooper & Schindler (2000) external validity is the ability to generalize data across persons, settings and time. On the other hand, internal validity is about how research findings fit into the reality which is assumed to be assumed to be holistic, multidimensional and changing (Merriam, 1998).

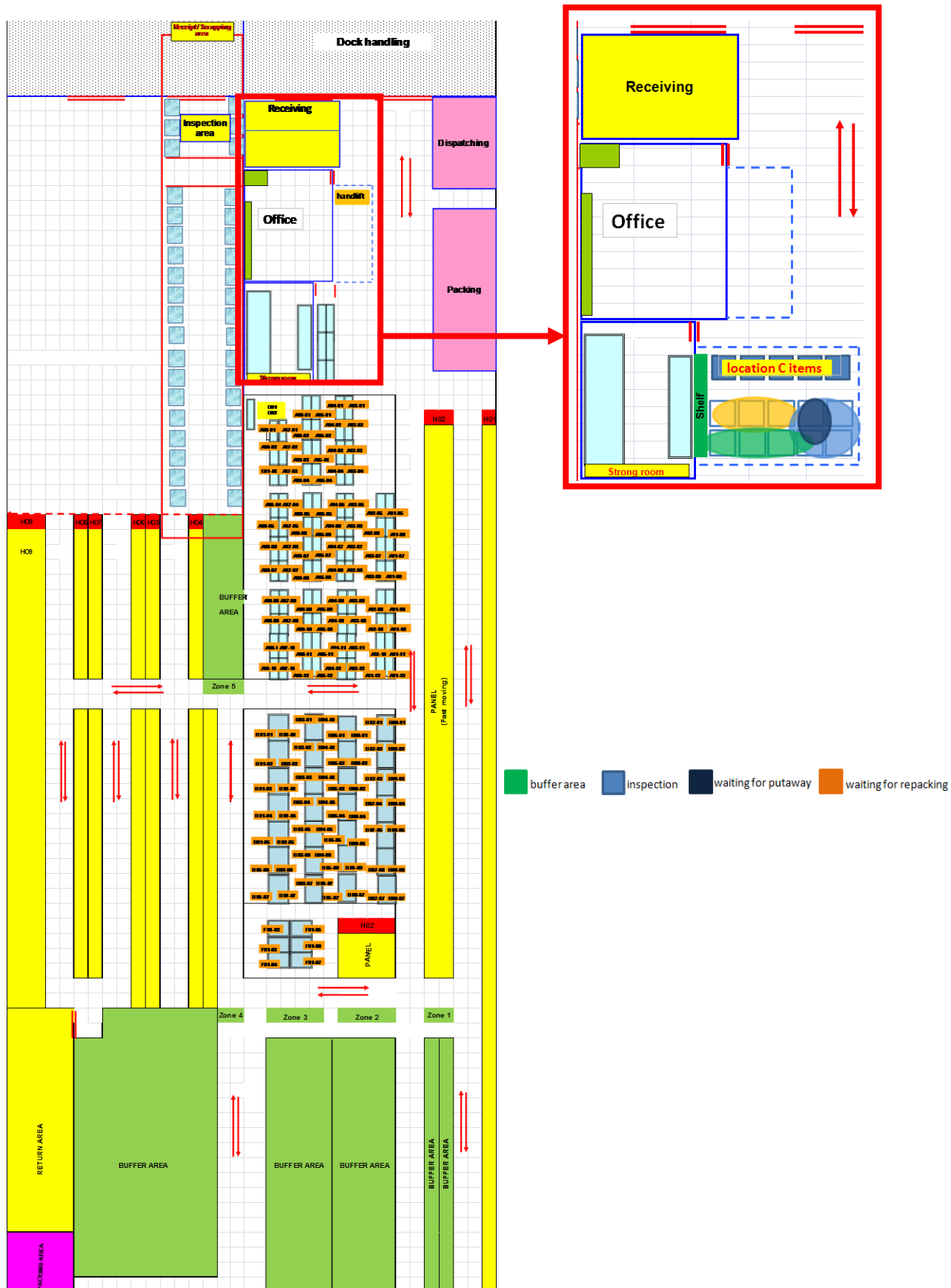
In order to ensure internal validity of the information, I tried to study the literature and gather information about the operations in the warehouse in the correct way in order to capture the meaning and substance of the research topic. Regarding the external validity of the data, the ability to draw conclusions from other places in the world or other periods of time is dependent on the differences of warehouses in different countries and the development of the business.

## 5 Data analysis and results

The main object of this thesis was to understand how warehouse operations could be improved with help of lean management tools. Firstly, I gathered information and data about the operations aiming at to identify the existing problems. Each storage location in the warehouse was examined to understand the stock and quantity. I collected data to calculate the number of the prospective amount of outbound volume in June 2015. Then, I conducted an ABC-analysis for each group of product in the warehouse. Class A is the products with fastest moving rate compared to the others, class B accounts for 15% volume and the remaining of the stock. The storage in the warehouse is based on bin locations in 5 levels shelves, and in bulk on pallet. Each bin or pallets stores the same SKU. I designed a new storage layout and I rearranged the locations of the SKUs in the warehouse—so that the new layout is corresponding to the priority of the fast moving goods.

### 5.1 Needs for layout change

As can be seen from figure 7, the current layout of the warehouse consists of six main areas: the office block, receiving area, valued added services (packing) area, damage and trade return (deformed, damage, expired) area, dispatching and storage. In figure 7 a smaller area next to the office block is highlighted and will be discussed in more detail.





The smaller area highlighted in figure 7 next the office block comprises of items which belong to buffer area, inspection, waiting to be put away or waiting for repacking. Classification of these items will be analysed later in this chapter. The area next to the office block is highlighted because items in this area are now mixed together and there is hardly any clear physical separation between them like can be seen in figure 8 which is a picture from the warehouse.



Figure 8. Items mixed together in the area next to the office block

Based on the size of boxes or their space utility, we can divide the products in this area into three categories. These are the main reasons why they are put there. Figure 9 shows the share of these three categories based on their volume of space utility. Approximately 58% of the items are in this buffer area because their normal storage location in the warehouse is full. Items which belong to inspection area and waiting to be put away account for 23% of the space utility volume and 20% of the items are waiting for repacking before being put away. Those items which belong to the category "location is full" are critical. For "inspection-waiting for putaway" and "waiting for repacking before putaway" items the time needed to be put away is maximum from two to three days. But those items whose normal storage location is full will stay there for around one or two months according to Ms Tinh, the inbound officer at the warehouse.

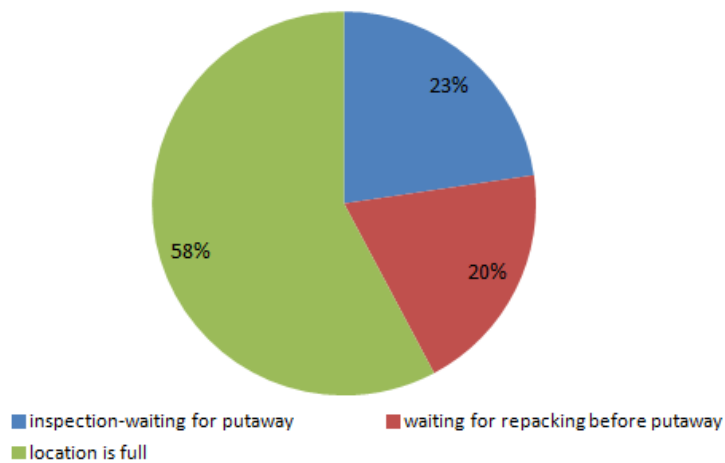


Figure 9. Volume utility of items in the buffer area

The so called location C items in figure 7 are of high value but because of the lack of space in the actual storage there has been need to put them into this buffer area with other products which can be categorised as batteries, main parts, cameras and covers and others. The rate of goods moving or stock turn can be calculated according to the formula in figure 10. The amount of products outbound each month is compared to the inventory at a specific time.

$$\text{Rate of goods moving} = \frac{\text{No of product outbound per month}}{\text{inventory}}$$

Figure 10. Formula used for calculating rate of goods moving (adapted from Rao and Rao (2009))

Table 3. Products categories in the buffer area (Kuehne+Nagel inventory statistics, 2015)

No	Type	Code	Rate of goods moving	Volume utility
1	Battery	GH43	19.5%	17.1%
2	Main part	GH82	16.8%	5.5%
3	Camera	GH96	41.4%	13.7%
4	Cover	GH98	0.9%	3.5%
5	Others		21.4%	35.7%
6	Location C			24.5%
	Total		100%	100%

The products whose normal storage location is full should be classified using the ABC-analysis in order to facilitate their picking and refilling to the main storage. (I am not sure if I have understood your full correctly and hopefully have not written text which is not correct, please try to clarify this following my example trying to write out in more detail what you mean) As can be seen from the figure 9 and table 3, product group called cameras has the highest goods moving rate of 41.4% and it accounts for 13.7% of volume utility in the area. Such products with high moving rate should be placed near the outside door and on top of shelf- stacking area and on the other hand products with lower moving rate should be placed lower in the stacking area.

## 5.2 Value stream mapping of the picking process

According to my observations of the outbound process, there are cases in which pickers do not follow the process as it is described and instructed in the Standard Operation Process (see appendix 2). In order to analyse the problem of order picking, a value stream mapping tool was employed and is presented in figure 11.

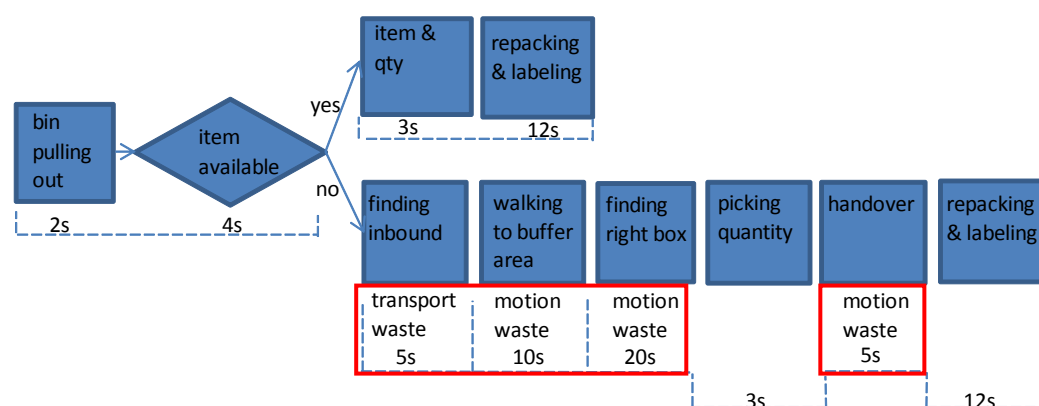


Figure 11. Value stream mapping of the order picking process

After pulling out the bin to pick the items as given in the picking order, the picker has to make the decision based on the availability of the item. If the product is available in the bin, he picks it as per picking order. If the product is not available, he has to go to the buffer area next to the office block to find the product. Based on the value stream map in figure 11, there are two type of wastes that can be identified in the picking process, namely transport waste and motion waste which are highlighted in red boxes.

The nonvalue adding time which is waste time accounts for nearly 65.5% of the total picking time.

As mentioned earlier, the items in the buffer area are mixed and unlabelled, which causes problems to the picking process. It is confusing and difficult to find the right items to pick and increased walking and finding time and handover time will decrease the possibilities to increase the productivity in the warehouse. These problems that take place every day in the picking process is caused by unreasonable layout. Workers have to move a lot between storage and buffer area in order to pick the right products. My suggestion is to change the current layout of buffer area into a better layout which could decrease the total length and time of travelling. Therefore in order to be able to remove the problems mentioned applying tools of lean methodology is essential.

### 5.3 Attempts to implement 5S Technique

The company is already applying 5S technique, but overall production has not been successful because workers are unaware of the benefits of implementing 5S and method has not been consistent with the actual situation at the company.

"I refilled the products from buffer area to their main location weekly. So that the buffer area is not overload", said Mr Tuan, who is a worker at the warehouse. However, he also said that he did it on his own and at his disposal. There was no official standardised schedule or instructions regarding this like 5S suggests.

Ms. Thu, who is a warehouse supervisor, mentioned one practical situation of keeping the workplace in order.

It is hard to get all the workers to keep the workplace in good order due to the large amount of incoming goods every day and fast working pace. Even when I attached the stock card for clarifying the goods, someone had eventually took it off when he picked the product.

Overall, the workers are not familiar and aware of the benefits of 5S while applying 5S in the company which will significantly improves the quality of products as well as

meets the orders. Some suggestions are made later in the conclusions in order to apply 5S technique at the case company warehouse.

## 6 Conclusions and recommendations

### 6.1 Improvement of the productivity through layout change

The size of the warehouse will be the same as it was before. It means the total buffer area consists of an area for 15 pallets. To conduct the new layout design, the first thing to do is to rearrange the buffer area to be suitable for inside activities. There are three ways to arrange the storage area, which are; randomized, dedicated and hybrid storage as introduced in the theoretical framework. Randomized storage means that each unit from any SKU can be stored in any available location. This method results in less storage space than that required for dedicated storage. Dedicated storage method means that every SKU gets a number of storage locations exclusively allocated to it. And the number of storage locations reflects its maximum storage needs. For the hybrid storage, SKU's are grouped into classes and located in specific dedicated storage area, but items within a class are stored randomly.

It is suggested that the hybrid storage model should be used. There are thousands of codes of products stored. Hence it is difficult to assign the location by code but by the type of product. Class A should include cameras and others, class B batteries and main parts and class C covers and items in location C since they have very low rate of goods moving or near to zero rate. This is due to the fact that these items usually are stores there for six months while the inventory turnover of the other product groups is maximum a month.

Because no investments have been made into having shelf storage for the items in the buffer area the items are stored only on pallets on the floor. I would like to suggest to build a shelf storage where class A products are put on the lower shelves for easy access and the highest stack would be for class C products. To solve the problem of confusing storage in the buffer area, products are to be put into boxes by types and on shelves according to the ABC-analysis discussed earlier.

Due to the increasing demand of the storage space for the location C items, the company has decided to extend the storeroom for them. The rest of the products in the area next to the office block, should be transferred to the receiving area and on dedicated pallets for each product groups as shown in figure 12.

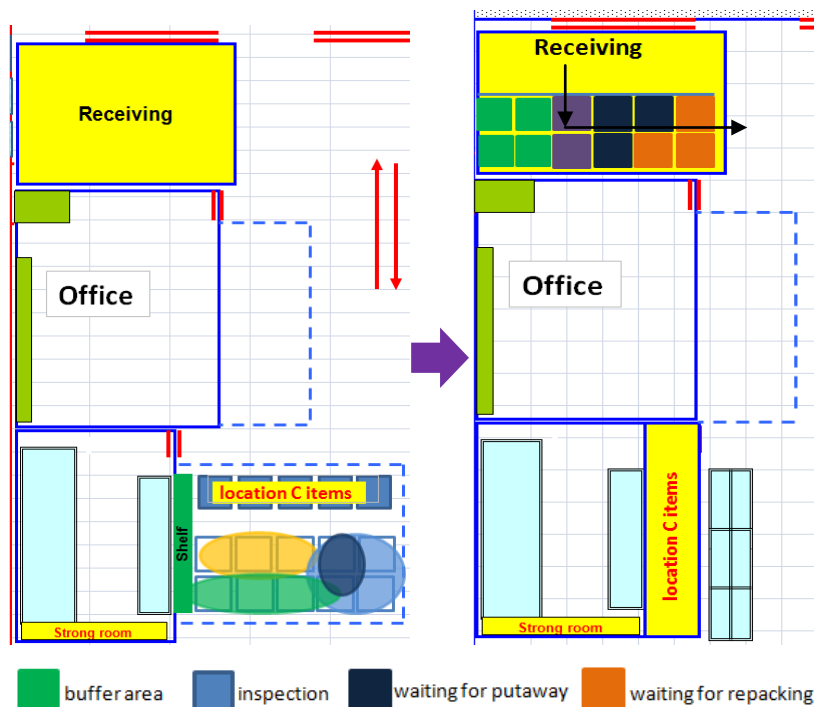


Figure 12. Suggested new layout which would increase the productivity of the warehouse

The new receiving area has a capacity to store 12 pallets which can be dedicated to the products from the old area. The new layout would also facilitate the product flow of the inbound. The new buffer area would account for four pallets and two pallets for products that are after receiving put into inspection. The rest of the pallet area is reserves for waiting-to-be-put-away products that have not been put to their main location due to the large amount of inbound and the final area is for the waiting-for-repacking products which need repacking before being put to their main location.

## 6.2 Assessments of the layout change

The changes to the layout and product storage will facilitate the picking order process and consequently enhance the warehouse performance. Regarding the productivity, as there is no unnecessary motion, there will be no wasted time as before. The productivity before and after layout change measured by seconds saved to complete the order picking process is compared in table 4. The order picking time will be reduced by 33%. The company pays now 375 € per month for two workers doing the picking process. If the productivity increases, company will be able to save on order picking 123.75 € per month, which means 1 485 € per year.

Table 4. Storage productivity before and after layout change measured in seconds needed to complete the picking process

Picking step	Time (s)	
	Before	After
bin pulling out	2	2
checking bin	4	4
finding inbound	5	0
walking to buffer area	10	0
finding right box	20	20
picking quantity	3	3
handing over	5	0
repacking and labeling	12	12
total	61	41
Reduce 33%		

Kuhne+Nagel warehouse uses some criteria for KPIs as can be seen in figure 13. All of these criteria are measured daily to produce a monthly performance report.

KEY PERFORMANCE INDICATOR							
KPI	Definition			Frequency		Calculation formula	
On-time goods issue	From the time DO created to confirm shipment			Monthly		No of on-time orders/Total orders	
On-time billing after GI	Billing completed within the same day after GI			Monthly		No of on-time billing/Total orders	
Outbound in full	Ratio of no of orders delivered in full to total orders			Monthly		No of orders delivered in full/Total orders	
Cycle count inventory consistency	Match between no of physical goods and SAP			Daily		No of items counted/Total SAP qty	
System inventory accuracy	Match between no of physical goods and SAP			Twice a year		No of items counted/Total SAP qty	

Cut-off time/DO creation	7:30	9:00	10:00	11:15	13:15	14:45	16:00
Confirm shipment/Billing	9:00	12:00		13:30	14:30	15:15	17:15

Figure 13. KPIs of the warehouse (Kuehne+Nagel inventory report, 2016)

The reduction in the order picking time will affect positively both on goods delivered on-time and on-time billing after picking. At Kuehne+Nagel warehouse, the order picking routine is seven order lines per day and each line picked is measured against these KPIs given in figure 13. In order to measure the performance in detail, I would like to suggest to add few new criteria adapted from Ackerman (2003) and explained and highlighted in table 2 in the theoretical framework and in table 5.

Table 5. Suggestions for additional KPIs to measure order picking process

KPIs/month	Before	After
Picking cost per line	53.57 €	35.89 €
Order line pick per man-hour	0.88 lines/ h	1.3 lines/ h

It is indicated in table 5 that the picking cost per line would decrease from 53.57 € to 35.89 € and the order line pick per man hour would increase by . Overall, the changes are significant but the cost saved is of little value. This is due to the size and scale of operations of Kuehne+Nagel warehouse in general and particularly in Vietnam. Providing a larger scale of warehouse operations as might be in more developed countries than Vietnam, these improvements would be more significant.



### 6.3 Suggestion for a 5S Implementation plan

I would like to suggest that a 5S plan is revised in order to utilize this approach better among the workers in the warehouse. 5S implementation period is estimated to be within 12 months and to include three stages:

**Stage 1:** During the first three months 5S will be implemented in one function of inbound

**Stage 2:** The next stage will be implemented only if stage 1 was successful, extending 5S to the other outbound, buffering, and defect areas.

**Stage 3:** 5S applied to the entire warehouse. This stage is expected to be completed and stabilized in the period of 12 months after applying 5S for inbound

Factors which are essential for successful implementation of 5S are e.g. the following:

- The 5S plan is submitted to the head department as well what benefits the implementation of 5S would bring to the company if successfully applied.
- The head department is committed to implement 5S as well as to give financial support and other resources required in the implementation process.
- Need to establish a committee for the translation of 5S. This committee should include team leaders from each function and the supervisor.

Next I am describing the more detailed 5S implementation plan according to each S.

**Seria – Sort:** Separate the useful from the useless. That is to sort through items and keep only what is needed to perform value-added-activities and dispose of what is not adding value. Steps to implement this are:

- The supervisors and the workers conduct the workplace observations. Detecting and identifying which material, WIP or anything else not needed and then remove it and never store such things again
- Note with symbols and dates products that need to be get rid of and keep track daily.

- After three months supervisors should check whether any worker uses the marked tool. If not, then it should be removed immediately.
- The types of cartons, cardboard used in packaging that have not been used for a long time are also removed after the team leader has conducted observations.

The supervisors must frequently monitor and mark things which are not used. Mark the card as following:

Mark the WIPs with yellow card if it has not been used for a week and with red card if not for a month.

Mark the tools with yellow card if it has not been used for three months and with red card if not for a year.

**Seiton - Set in order:** There must be well-defined place for everything and regular checks that everything is in its place. The most frequently used gear need to be placed at hand (avoiding unnecessary movement for the worker), and visual help (identifying labels) should be on the gear and at the place where they must be placed. There is also need to make a clear boundary among workstations, WIP areas and aisles and exit ways in order to help the products flow fluently. Arrange and classify rationally among WIP areas and container areas in order to allow the workers to move to their next task easily.

**Seison - Shine :** Cleaning the workstation prevents failure conditions that could hurt the product's quality. This can be secured if the following rules and instructions are followed.

- Worker at each station has a responsibility to clean up the workplace, tools, machines Particularly before lunch time and after finishing the afternoon shift, each worker has to clean up his/her workstation area in about 5 to 10 minutes.
- At each processing station a small tank should be allocated for waste disposal to avoid littering the floor.
- Managers and team leaders are responsible for reminding workers to clean their working area frequently.

**Seiketchu – Standardize:** Define a standard regulation for order and cleanliness in the workplace. In other words, develop systems and procedures with visual controls to maintain and monitor the 5S.

- Propose to manager and team leader of the program to clean and tidy the working area:
- Each worker has the right and responsibility to keep his working area clean and tidy.
- Propose to the head department to offer a reward or recognition for workers who perform better on the first three S. This helps to create better awareness among all workers.

**Shitsuke – Sustain:** Maintain a stabilized workplace in an ongoing process of continuous improvement. It must be noted that 5S is not just to organize and label materials, tools and to create a shiny environment but that it is a tool of lean management which aims at smooth flow. Hence, it is of great importance to maintain the culture among workers:

- Perform all the tasks voluntarily without being reminded by team leader or manager, which seems to be unrealistic. However, the company can provide personal assessment yearly based on 5S performing, which could greatly motivate workers to maintain 5S
- The team leaders should take a lead in implementing 5S and create 5S culture among all workers.

#### 6.4 Summary of suggested improvements

Based on the findings after careful analysis of the problems, some conclusions were made. Although Kuehne+Nagel Vietnam is a foreign investment company which is guided by a leading provider of innovation, integration and logistics solutions, the company in Vietnam still needs more improvements.

First of all, the warehouse layout design is inefficient. The buffering area is not efficiently organized. Most SKUs are arranged by their own location, but in rush time, they can be placed everywhere, even on the aisle or near the emergency door, which

makes it really hard for the put-away and order picking employees to work. Moreover, this warehouse is functioned by low-updating technology and the equipment works ineffectively.

The picking process is consequently affected by the poor layout of buffering area. The untidy arrangement within the warehouse together with the current storage policies, which is randomized storage, is not suitable to the efficient function of the area. It takes too much time for employees to search for the products and then pick them and remove them. Moreover, due to the current layout arrangement, pickers have to travel a long distance to fulfill the picking order and they waste time in searching for the right product. If the layout is rearranged based on class-based storage policy, the worker can reduce his walking distance and this way reduce the cycle time and increase productivity of the warehouse.

Lean thinking is known at the moment only by the management level of the case company. The workers at the warehouse should be also included. Regular training and a long-term-plan is needed to instill the lean methodology into the working environment properly.

Lean is a powerful methodology which can be applied effectively in warehouse management in Vietnam too. However, there are conditions and limitations of its applicability. The effectiveness of applying Lean depends on many factors. One of them is the human factor and the other the nature of the products. Both have certain influences on the working procedures. The application is varied from one warehouse to another but in general there are core areas where Lean can be seen effective. These are the layout design and continuous improvement.

## 6.5 Limitations and suggestion for Further Studies

The research contributes both theoretically and practically to the continuing understanding of how Lean could be employed in a warehouse in Vietnam. Although some practical findings were attained in the present study, they should be taken as suggestive rather than definitive because of limitations which might be addressed in future researches.

Due to lack of time and money this research focused just on warehouse process. Therefore, further research about applying Lean on other aspects of warehousing for example optimal order picking, optimal storage could be conducted. Also applying more quantitative methods would give a nice ground for comparison with the results of this study.

Key Performance Indicators (KPI) are also constructed manually and they are not detailed. This thesis merely introduces the indicators and makes basic calculation to measure the performance of the company. There is a need to computerize these indicators so that the results are more efficient and make the exact benchmarking against the competitors more reliable.

As a final remark, the study of lean tools and techniques in a warehouse was both challenging and rewarding. Further efforts should be made to deepen the understanding of the lean concept and to advance the measurements and improve the understanding of lean thinking in warehouse operations.

## References

2007. What is Lean Thinking? Available: <http://www.leanenterprise.org.uk/what-is-lean-thinking/what-is-lean-thinking-and-key-lean-thinking-principles.html>.
2011. Warehouse KPIs. Available: <http://www.keyperformanceindicators.info/2011/02/warehouse-kpi.html>.
- 2015a. *Implement 5 S* [Online]. The Global Competitive Enterprise. Available: <http://toolbox.vetonline.swin.edu.au/1004/toolbox/resources/res3090/res3090.htm>.
- 2015b. Kuehne+Nagel Vietnam Ho Chi Minh.
- 2015c. What Is 5S. Available: <https://www.graphicproducts.com/articles/what-is-5s/>.
- ACKERMAN, K. B. 2012. *Practical handbook of warehousing*, Springer Science & Business Media.
- BARTHODI, J. & HACKMAN, S. T. 2010. *Distribution Science Atlanta*.
- BEN NAYLOR, J., NAIM, M. M. & BERRY, D. 1999. Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain. *International Journal of Production Economics*, 62, 107-118.
- BOERSEMA, M. 2008. Value Stream Map Examples for review and comparison. *leansimulations* [Online]. Available from: <http://www.leansimulations.org/2011/09/value-stream-map-examples.html>.
- BOWERSOX, D. J., CLOSS, D. J. & COOPER, M. B. 2002. *Supply chain logistics management*, McGraw-Hill New York, NY.
- BUNKLEY, N. 2008. Joseph Juran, 103, Pioneer in Quality Control, Dies.
- CHAN, F. T. & CHAN, H. K. 2011. Improving the productivity of order picking of a manual-pick and multi-level rack distribution warehouse through the implementation of class-based storage. *Expert Systems with Applications*, 38.
- DE KOSTER, R., LE-DUC, T. & ROODBERGEN, K. J. 2007. Design and control of warehouse order picking: A literature review. *European Journal of Operational Research*, 182, 481-501.
- DEHDARI, P. 2013. *Measuring the Impact of Lean Techniques on Performance Indicators in Logistics Operations*. The Karlsruhe Institute of Technology.
- DREW, J., MCCALLUM, B. & ROGGENHOFER, S. 2004. *Journey to lean: making operational change stick*, Palgrave Macmillan.
- FAULKNER, W. & BADURDEEN, F. 2014. Sustainable Value Stream Mapping (Sus-VSM): methodology to visualize and assess manufacturing sustainability performance. *Journal of Cleaner Production*, 85.
- FRAZELLE, E. & FRAZELLE, E. 2002. *World-class warehousing and material handling*, McGraw-Hill New York.
- GOLDSBY, T. J. & MARTICHENKO, R. 2005. *Lean Six Sigma Logistics*, Boca Raton, FL, USA, J. Ross Publishing, Incorporated.
- HACKMAN, S. T., FRAZELLE, E. H., GRIFFIN, P. M., GRIFFIN, S. O. & VLASTA, D. A. 2001. Benchmarking warehousing and distribution operations: an input-output approach. *Journal of Productivity Analysis*, 16, 79-100.
- HINES, P. & TAYLOR, D. 2000a. Going lean. *Cardiff, UK: Lean Enterprise Research Centre Cardiff Business School*, 3-43.
- HINES, P. & TAYLOR, D. 2000b. Going lean. *Cardiff, UK: Lean Enterprise Research Centre Cardiff Business School*.
- IPC. 2013. Logistics situations and solutions in Vietnam. Available: <http://www.ipcs.vn/vn/doanh-nghiep-logistics-viet-nam-thuc-trang-va-giai-phap-W473.htm>.
- JACOBY, D. 2009. *Guide to supply chain management*, London, Profile Books Ltd.

- JACOBY, D. 2010. *The Economist Guide To Supply Chain Management*, Profile Books.
- KUEHNE+NAGEL. 2015. Available: <http://www.kn-portal.com/>.
- LEE, M.-K. & ELSAYED, E. 2005. Optimization of warehouse storage capacity under a dedicated storage policy. *International Journal of Production Research*, 43.
- LYSONS, K. & FARRINGTON, B. 2006. *Purchasing and supply chain management*, Pearson Education.
- MANGAN, J., LALWANI, C. & BUTCHER, T. 2008. *Global logistics and supply chain management*, John Wiley & Sons.
- NGO, H. & TRINH, C. 2014. Logistics services: facts and solutions. Available: <http://hoinguoidibien.vn/>.
- PETERSEN, C. G. & AASE, G. 2004. A comparison of picking, storage, and routing policies in manual order picking. *International Journal of Production Economics*, 92, 11-19.
- RAO, M. C. & RAO, K. 2009. Inventory turnover ratio as a supply chain performance measure. *Serbian Journal of Management*, 4, 41-50.
- RICHARDS, G. 2011. Warehouse management. *The Chartered Institute of Logistics and Transport (UK) and Kogan Page, London*.
- ROODBERGEN, K. J. & VIS, I. F. 2006. A model for warehouse layout. *IIE transactions*, 38, 799-811.
- ROUWENHORST, B., REUTER, B., STOCKRAHM, V., VAN HOUTUM, G., MANTEL, R. & ZIJM, W. 2000. Warehouse design and control: Framework and literature review. *European Journal of Operational Research*, 122, 515-533.
- SCSC. 2014. Vietnam logistics' professionalism on the increase. Available: [http://scsc.vn/info\\_news\\_detail.aspx?ID=390](http://scsc.vn/info_news_detail.aspx?ID=390) [Accessed 20 Dec 2015].
- SHIVANAND, H. 2006. *Flexible manufacturing system*, New Age International.
- TOMPKINS, J. A., WHITE, J. A., BOZER, Y. A. & TANCHOCO, J. M. A. 2010. *Facilities planning*, John Wiley & Sons.
- VAN DEN BERG, J. P. & ZIJM, W. 1999. Models for warehouse management: Classification and examples. *International Journal of Production Economics*, 59, 519-528.
- WILSON, L. 2009. *How to implement lean manufacturing*, New York.

## Appendix 1. Interview template

Date: July, 2015

Location: Kuehne+Nagel warehouse, Binh Duong, Vietnam

Interviewees: Ms Thu (warehouse supervisor), Mr An (warehouse manager)

### Questionnaire outline

<b>1.0</b>	<b>General</b>				
1.1	Please provide an overview of the warehouse.	The warehouse is to store spare part of Samsung			
1.2	What activities are there at the warehouse?	Handling inbound shipment, outbound shipment, conduct cycle count			
1.3	Does the product require special handling or storage for each SKU or product group?	goods are of different sizes (small, medium and large), packed in carton, stored in pallets, shelves and bins			
1.5	Are there any hazardous products / dangerous goods?	No, but there is high value goods which are stored in locked rooms			
1.7	What is the operating time of the warehouse?	7:30-17:30/weekdays, 7:30-12:00/Saturday			
<b>2.0</b>	<b>Inventory</b>				
2.1	Total number of SKUs ?	approximately 15,000 SKUs			
2.2	What is the package type, size of the goods by each SKUs?	Product group	Package type	L x W x H	Weight
		There are thousands of SKUs stored in bin, pallets			
2.5	What kind of pallets are used? What is the dimension of pallets?	1.0m x 1.2m			
2.9	How often do you perform stock-take?	Everyday. It takes a month to cycle count all the stock in warehouse			
2.11	Approximate warehouse area?	2500 m2			
<b>3.0</b>	<b>Inbound Handling</b>				
3.1	Number of inbound shipments?	4 inbound shipments/day			
3.2	Number of inbound lines (SKUs) per shipment?	not specific, varies from 3-20 or more			
3.3	What is unit for receiving (Kg, CBM, PO, carton, Case, PCS)?	LCD screen (PCS), the rest (carton)			
3.4	How often and how much per month will be delivered to warehouse for storage?	Everyday, the working pace here is very high due to a large number of inbound, each inbound shipment contains hundreds of items			
3.5	How much notice will KN get on what is expected to be delivered to the warehouse?	there is a fix time schedule of 4 inbound shipments perday agreed by KN and Samsung			
3.6	Expected warehouse receiving time?	8:50am, 11:10am, 2:10pm, 4:30pm			
3.7	What kind of check point for receiving?	All goods needs checking right number of pieces, LCD screens needs checking if they are in good condition			
3.8	Is the cargo received sorted? Will they be palletized or in carton?	yes, each SKUs are stored in separate cartons. One cargo includes many cartons			
3.9	How many suppliers are there?	Incoming goods are from Samsung factory in Binh Duong city and overseas			
3.10	Is there more than one SKU in one pallet?	There are more than one SKUs in one pallet.			
<b>4.0</b>	<b>Outbound Handling</b>				
4.1	Number of Outbound shipments?	7 outbound shipments/day			
4.2	Number of outbound lines (SKUs) per shipment?	not specific, there are many SKUs per outbound shipments			
4.3	What is unit for delivering (Kg, CBM, PO, carton, Case, PCS)?	goods are delivered in cartons to retailers			
4.4	How often and how much volume per month will be shipped?	not specific, hundreds of items per months			
4.5	Please outline order processing lead-time?	KN prinout the delivery order from SAP at fixed time as agreed with Samsung (7:30am, 9am, 10am, 11:15am, 01:15pm, 02:45pm, 4pm).			
<b>5.0</b>	<b>Value Added Service</b>				
5.1	Does KN provide any other added services value (example labeling, kitting)....	KN repacking and labeling the outbound goods shipped to retailers			
<b>6.0</b>	<b>Systems</b>				
6.1	What order/inventory management/ERP system(s) KN and Samsung use?	Samsung requires KN to use SAP for inbound, outbound, inventory management			
6.2	Is barcode/Scanpack/EAN Labeling used &/or required?	RF scanner are used for inbound and outbound process			
6.3	Describe type of documents printing required for outbound?	Picking list, shipping labels, invoices to send with goods			



## Appendix 2. Standard operation process in Kuehne+ Nagel Vietnam warehouse

