Abstract—At present, 70% of shipments which served by logistics services are e-commerce goods weighing 0-4 kg. The speed of delivery and package security become important factors for both couriers and consumers. It is undeniable that vehicles become the key to successful delivery activities. But the challenge so far, the shipments is too large to be sent by a motorbike, but also too small to be sent by car and feared will be damaged or tucked away. The only solution is by implementing a storage management system so that the courier can load, arrange and unload the package from the vehicle easily. This article proposes a design of implementable storage management system for delivery vehicles so that delivery activities done by couriers become more effective and efficient. By analyzing storage requirements, the ideal cargo criteria will be known. After that, storage accessibility study will be conducted to find out more about storage operations on vehicle and its critical dimensions that will become the storage specifications. Through applying gravity principle, a simple shelving system is expected to be a solution for storage management of delivery vehicle.

Keywords—Storage System, Storage Management, Delivery Vehicle, PT Pos Indonesia.

I. INTRODUCTION

The rapid growth of online sales (e-commerce) has resulted in high goods movement activity, especially on urban area (urban goods movement) [1]. At present, 70% of shipments served by logistics services are e-commerce goods [2] where the items weigh 0-4 kg and are package types (not letter or document types). Speed and safety are now an important factor for both couriers and consumers. Therefore, it becomes a challenge for logistics services to carry and arrange packages in vehicles so that the package is not damaged or tucked away.

PT Pos Indonesia (Persero), a State-Owned Enterprise (BUMN) engaged in logistics and courier, and as a national logistics backbone, determines the criteria for packages weighing 0-2 kg for motorcycle. The rest of the criteria are transported by car. The weight of an e-commerce package that ranges from 0 - 4 kg is too large to send using a motorbike, so the remaining option is by car even though it is too small to send using a car. The only solution is by implementing a storage management system so that the courier can load, arrange and unload the package from the vehicle easily. Therefore, the objective of this research is to design and develop an implementable storage management for delivery vehicles so that delivery activities done by couriers become more effective and efficient.

II. METHODS

A. Data Collecting

Data collecting in this research used several sources, they are: stakeholders, existing studies and literature studies. Data collecting is intended to find problems, needs, and opportunities that exist. The problems, needs, and opportunities obtained are then concluded and used as reference in design. The methods used include: interviews with Head of Delivery Center (DC) of Letter and Packages PT Pos Indonesia Regional Surabaya and user observation (courier).

B. Study and Analysis

Stage of study and analysis consist of study and analysis of storage requirements, which will describe the various types of packages handled by the courier, their dimensions and volume to determine the ideal cargo volume requirements of a vehicle. After the results are known, storage accessibility study will be conducted to find out more about storage operations on vehicle and its critical dimensions that will become the storage specifications.

III. RESULTS AND DISCUSSIONS

A. Storage Requirements
PT Pos Indonesia courier handles shipments where 70% of all shipments are e-commerce goods, 20% are non-e-commerce goods (in the form of personal/public goods and corporate goods), and 10% are letters and documents (Table 1).

After knowing the types of goods delivered, the following analyzes the dimensions and volume of goods to find out storage requirements (Table 2, 3 and 4).

### Table 2. Volume analysis for letters and documents

<table>
<thead>
<tr>
<th>Goods</th>
<th>Detail</th>
<th>Dimension (cm)</th>
<th>Delivery Target Assumption</th>
<th>Total Volume (cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letters &amp; Documents (in Envelope)</td>
<td>32 x 46 x 1 (A3)</td>
<td>50</td>
<td></td>
<td>73,680</td>
</tr>
<tr>
<td>Postcard</td>
<td>15 x 10.5 x 0.02</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Volume (cm³)</td>
<td></td>
<td></td>
<td></td>
<td>36,840</td>
</tr>
</tbody>
</table>

Letters and documents will be separated from the e-commerce and non-e-commerce packages, because it is feared that they will be tucked and crushed, making them fold or not intact. So, the average volume for the whole package is (e-commerce package and non-e-commerce package):

\[ \frac{(6,000 \text{ cm}^3 + 15,000 \text{ cm}^3)}{2} = 10,500 \text{ cm}^3 \]

With assumptions:
- Courier Working Duration = 9 hours
- Weight limits per package = 4 kg
- The total of package that can be transported = 100 packages
- Maximum weight of cargo = 400 kg

The minimum volume of vehicle storage needed is:

\[ \frac{10,500 \text{ cm}^3/\text{package} \times 100 \text{ packages} + \text{tolerance} \pm 20\%}{1,050,000 \text{ cm}^3 + \text{tolerance} \pm 20\%} = 1,260 \text{ cm}^3 \]

\[ = 1,260 \text{ L} \]

From the storage volume obtained, the vehicle storage size is obtained, namely (l x w x h): 1,200 mm x 1,050 mm x 1,000 mm. Here is the visualization of the minimum size of the vehicle storage:

![Visualization of the minimum size of the vehicle storage (l x w x h) 1,200 mm x 1,050 mm x 1,000 mm.](image)

### Table 3. Volume analysis for e-commerce packages

<table>
<thead>
<tr>
<th>Goods</th>
<th>Goods Detail</th>
<th>Dimension (cm)</th>
<th>Total Volume (cm³)</th>
<th>Average Volume (cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clothes</td>
<td>Scarf and</td>
<td>20 x 5 x 3</td>
<td>20,590</td>
<td>4,120</td>
</tr>
</tbody>
</table>

### B. Gravity Flow Tube Shelving

The system used gravity principle, where an item will fall towards a lower altitude area. Shelves are fixed, they cannot be adjusted in height, but the rack components consist of modular parts that can be removed and added as needed. The components in this storage system include: long pipe (as the main construction), base (as the base of the pipe which is then connected to the floor and to the vehicle ceiling), various joints/connectors, connecting track modules, modules track adapter (as a connecting roller track module to the pipe), side guide, stopper + label module (for package stop boundaries), and bolts and nuts.
Figure 2. Gravity flow tube shelving system.

Figure 3. Several modules of storage system, consist of: base module, track adaptor modules, flow track module, joint modules.

C. Storage Accessibility

After the shelving is designed, the following are illustrations of the dimension and accessibility of the courier when loading or unloading the packages. Note that the dimensions are adjusted to the vehicle dimension.

<table>
<thead>
<tr>
<th>Goods</th>
<th>Goods Detail</th>
<th>Dimension (cm)</th>
<th>Total Volume (cm³)</th>
<th>Average Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-e-commerce</td>
<td>Personal</td>
<td>40 x 25 x 30*</td>
<td>60,000</td>
<td>30,000</td>
</tr>
<tr>
<td></td>
<td>Corporate</td>
<td>40 x 25 x 30*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Goods</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Volume (cm³)</td>
<td></td>
<td>30,000</td>
<td>15,000</td>
</tr>
<tr>
<td></td>
<td>Average Volume (cm³)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Because the vehicle will replace the motorcycle, the package dimensions are taken from the maximum package size that can be carried by a motorcycle.

Courier loads the packages from the shelf which has higher altitude, so that the packages will fall toward the lower altitude. Courier loads the packages from the first order of delivery, so when courier received (unloading) the package, he does not need to look up for the package anymore.
D. Storage Implementation on Vehicle

Figure 6. Implementation of gravity flow tube storage system on a delivery vehicle design. There are two storage systems: front and rear storage. Front storage system can be accessed through two side doors of the vehicle (right or left door), while rear storage can only be accessed through the rear door.

The storage system then implemented into a delivery vehicle specifically designed for PT Pos Indonesia (Persero). Vehicle storage dimensions also already meet the minimum storage dimension criteria that have been obtained in previous results. Storage system can be placed in the front and rear area of delivery vehicle that has been designed. The front area is an area that starts from behind the driver and can be accessed through two side doors (left and right sliding door) of the vehicle, while rear area can only be accessed through rear door (Figure 6).

IV. CONCLUSION

Storage management system in this delivery vehicle design used the principle of gravity. This system consists of modules so that they can be disassembled according to the needs of the vehicle and/or the packages. By applying the system into the delivery vehicle, it provides convenience for couriers in loading, arranging, and retrieving (unloading) packages from vehicle to provide efficiency and effectiveness. The shelving system also provides separators between packages so that the package is not stacked and damaged.

REFERENCES
