Proceedings of the 3rd World Conference on Supply Chain Management, Vol. 2, 2017, pp. 111-122

ISSN: 2424-6697 online
DOI: https://doi.org/10.17501/wcosm.2017.2110

EVOLUTION OF UNITIZATION IN E-COMMERCE SUPPLY CHAIN

Rohit Sanjay Pitale[1], Paras Arora[1], Charumani Singh[1], Pankhuri[1] and Darpan Malkan[1]

[1]*Flipkart Internet Pvt. Ltd*

Abstract: Unitization as a way of moving bulk shipments is known to save on multiple fronts like time, space, costs, manpower and damages in any supply chain. This study talks about the need for evolution of unitization in e-commerce supply chains in emerging markets like India. We also highlight the challenges faced while designing a standardized unit for a wide range of shipments, with non-standard packaging being transported across various facilities and in non-standard vehicles. Secondary level unitization is identified as a key focus area for addressing the challenges and three variations of using roll containers as units are proposed for different scenarios of a versatile end-to-end e-commerce supply chain. A detailed view is given on interaction of unitization with various activities in the supply chain and the subsequent benefits derived in key performance metrics of the supply chain. To quantify this impact, estimated improvements are provided based on a theoretical study was conducted in a leading Indian e-commerce supply chain. As suggested earlier, roll containers bring improvements in areas like process throughput, manpower requirement, space efficiency, handling ergonomics and reduction of damages.

Keywords: Unitization; Material Handling; E-Commerce

Introduction

While sustainable competitive advantage in the e-commerce industry comes from an efficient supply chain design, the idea is to do more with less, and scrutinize every aspect of operations for efficiency and savings. An end-of-the-line function, like unitizing, is at the very core of creating the perfect load for handling, shipping and storing product. Truck utilization and turn-around time, staging area utilization, shipping damages, material handling manpower, operational productivity, transport center dock management, packaging costs, etc. are some of the key metrics that are directly affected by the unit used to transport goods.

Unitization is the process of consolidation of several smaller units into a single unit. It allows the combination of boxes, cartons, packages, etc., into one load (such as a pallet) for ease of handling, identification, and transportation. Factors like the types, materials and sizes of items, and transportation are key while designing the most suitable material handling unit. The finer design elements depend on the functional area, be it handling, transporting or storing the products. The process gets more complex when we try to unify these areas into a single unit design.

Most traditional industries have their own best suited methods for unitization which are integrated across the supply chain. Typically, large items are secured directly to a pallet while smaller boxes and other containers are secured to a pallet using shrink-wrap or steel strapping.[1] Industries involving products like bicycles or furniture, that are larger than an average pallet, tend to design customized units based on their requirement. Goods that are fragile, perishable or very expensive require added layers of protection. Nonetheless, each of these industries are fairly matured in terms of material handling standardization. On the contrary, e-commerce, in the emerging markets, is still in its initial phases of development.

The peculiar attributes of an e-commerce supply chain are

- Owning the end-to-end supply chain process
- High variability and range in shipment sizes and packaging design

- Loose shipment handling at source and destination
- Extremely short Service Level Agreements (SLA) time frames
- Managing high rate of returns due to damages

Some of these attributes are common to the Package Delivery and the Retail industries considering their shipment level treatment, varied range of products and extremely short SLA time frames. Hence, while designing the most appropriate form of unitization, the supply chains of global giants in these industries were studied, and learnings from these helped the base design take shape. The air cargo industry has designed large standardized secondary units or the ULD (Unit Load Device), which in turn carry primary units like bulk bags or large loose shipments.[2] The ULD forms the base of unitization for global leaders in the package delivery industry for their bulk transportation. Their counterparts in the emerging markets are less dependent on air cargo routes and thus, don't have any use for the secondary units. Retail industry, on the other hand, is largely local, and depends on surface transport, where apart from pallets, roll containers are used as secondary units.[3] In this study, roll containers are taken up as a starting point for the next step of evolution from bags as primary units.

E-Commerce in India

In a typical Indian e-commerce logistics, a shipment travels through the basic supply chain route i.e.

- Originating from a warehouse (Inventory Model) or a seller location (Marketplace Model)
- Sortation at source Consolidation Centers
- Transportation through Line Haul to the next / destination Consolidation Centers
- Transportation to the Delivery Centers from destination Consolidation Centers
- Customer level sortation at Delivery Centers
- Doorstep delivery to customer

Figure 1 shows the flow of shipment through a typical e-commerce supply chain.

In this supply chain, bulk bags are being used as a unit for bulk handling of shipments. Based to ergonomic considerations, typically such a filled bag, is restricted to weigh between 10-12 kg. These bags have been used for long enough to become the foundation around which all the systems, processes and metrics of the supply chain are defined.

Following are the observable benefits of using bags:

Flexibility

Being flexible in size and shape is one of the biggest benefits of a bag. While loading in trucks, bags allow utilization of the entire truck irrespective of the body dimensions. Additionally, a semi-filled bag takes no additional volume than what the aggregate of its shipments requires. This is a boon from space utilization point of view.

Easy Handling

The size of each bag is kept limited to allow an operator to lift, move and load a bag into the trucks. This eliminates the need for special equipment of infrastructure to handle the bags. Thus, every facility including the much smaller Last Mile and First Mile hubs can easily manage operations.

Cost-effective

The plastic bulk bags are inexpensive as compared to any rigid units made of plastic, wood or metal. Their durability is something which will be discussed further into the study.

Each of these benefits come with a flipside which could become limiting factors for a sustainable and scalable growth of the supply chain. Across the organization, people see the need to move towards a superior and more standardized unit.

Need for Evolution

This section briefly touches upon the existing pain points of the e-commerce supply chains in emerging markets which are looking for newer and superior methods of material handling as they head from a phase of rapid growth to maturity. Primary units like bulk bags carrying multiple shipments face multiple challenges as detailed below:

- **High variability and In-accurate Planning**

Owing to the non-standard and highly variable dimensions of a filled bag, making it un-stackable, it

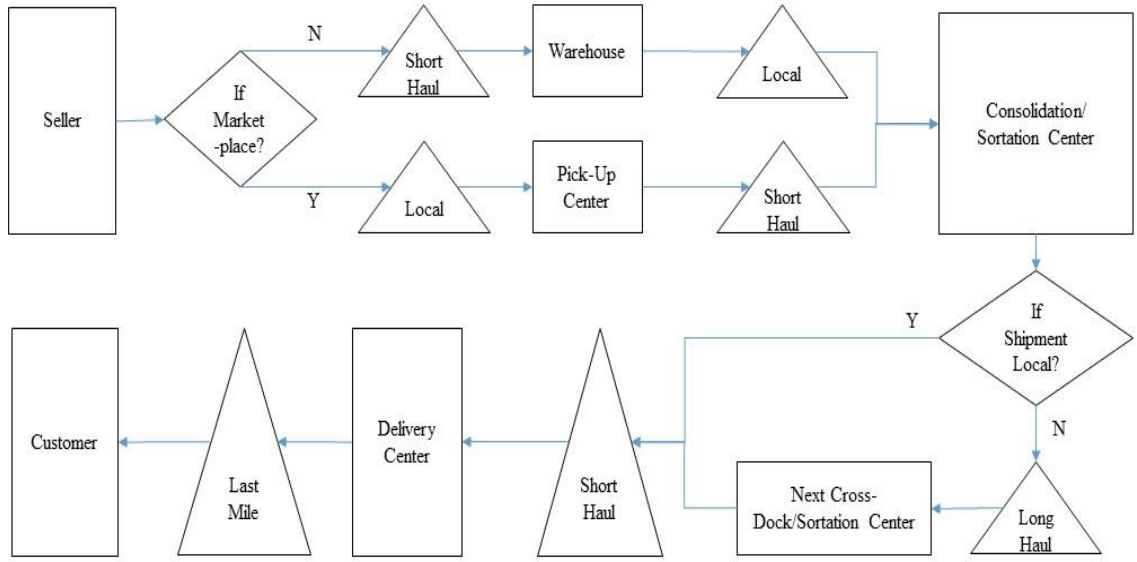

Figure 1: Forward Shipment flow through an E-Commerce Supply Chain

is difficult to compute the space and time required for the given number of shipments. The problem inflates When transportation through trucks is considered, since it prevents us from planning for the number of shipments that can be loaded onto the truck. This can lead to maintaining a buffer in the truck capacity, hence, underutilization of trucks. In monetary terms, a full truck must be rented even if only part of it is being utilized, which is often the case.

- **Time Consuming**

A typical long haul truck can be loaded with close to a thousand of these bags and can take up to four hours before it is completely filled. Even within the facilities, bags are generally moved around using trolleys. Each movement from one point to another involves loading, unloading, stacking and unstacking on and off trolleys respectively. These additional steps may seem insignificant, but they consume a good chunk of time and manpower at the facilities and lead to choking of the docks for long hours.

- **Space Consuming**

Storage and Sorting facilities dedicate up to 40% of their built-up area for staging the inbound as well as the outbound load before it moves to the next stage. Since bags don't allow for any special equipment for stacking, these are just piled up on each other in a pyramidal structure which is manually feasible. Space requirements increase with growing operations, shifting the focus on designing solutions involving secondary units which enable vertical staging.

- **Handling Ergonomics**

As mentioned earlier, bag operations are laborious with a typical bag going up to 12 kg. in weight and 6-8 cu. ft. in volume. Each bag must be handled twice while going on a trolley, being staged or being loaded into a truck. A single operator does this for more than 100 bags in a day. While loading trucks, these need to be lifted to a height of 7 feet. This slows down the process and requires additional manpower to handle the same no. of bags. Secondary units designed with respect to the truck dimensions can make these processes more ergonomic and efficient.

- **Scope for Damage**

Bulk bags are flexible which exposes the shipments to external forces when being stacked or loaded in trucks. Also, manual handling of bags increases the chances of lifting and dropping the bags on hard ground or inside trucks. This leads to measures taken on designing durable shipment packaging, to reduce the damage percentages, thus increasing packaging expenditure. Hence a need is seen in making rigid units to reduce damages, packaging costs and rate of returns.

- **Recurring costs of Consumables**

Plastic bulk bags also tend to get damaged with improper handling and multiple handshakes. Typical lifecycle of a bag is around 6 trips which leads to a consumption of lakhs of bags every month. This means that an average bag can cater to a little more than 100 shipments in its lifetime. Considering the recurring expenses on consumables and the larger impact on environment caused by these bags, a clear need is seen to move towards more durable units.

Existing Logistical Challenges in Emerging Markets

1. Non-Standard Trucks

For an e-commerce entity in its growth phase, one of the most fundamental challenges while running operations in a country like India, is dealing with a large number of vehicle service providers. There exists an 'unholy equilibrium' in the trucking sector in India wherein the regulations, financing, competition and corruption did not incentivise a trucking company to own a large fleet of trucks.[4] Roughly 75% of the fleet is with those who own up to 5 trucks. Only about 10% of the fleet is with those who own more than 20 trucks. At this scale, having a few standard players across all the regions is difficult. One must deal with more than 100 trucking companies at a Pan-India level just to run its Line Haul operations.

Another concern is the nature of the market. OEM's sell their trucks with just the cowl or a cabin. This comes with various benefits. Mainly they don't need to worry about the regulations around the body type and dimensions which are different for every state. Customers also prefer to get the bodies fabricated from external sources. Apart from getting the body made to suit the application, it also allows them to cheat the regulations and resort to bribes where necessary.

This leads to a condition where trucks provided differ with manufacturer, region and service provider. Designing secondary units which will be transported through a wide range of trucks becomes a challenge.

a) ***Truck Floors:*** Most trucks in India have corrugated metal flooring. This design allows extra rigidity and strength with thin metal sheets, and avoids contact of the load with any residual rain water if any. Any kind of unitization, be it based on wheeled containers or pallets moved using MHEs, require a standard flat flooring to allow movement within the truck. This poses a challenge from scalability point of view since only limited trucks have flat flooring and any additional installation in them like chequered plates to flatten the surface adds to a cost of around INR 20000 - 30000 per truck, and it is also a hassle with a high churn in existing fleets.

b) ***Truck Dimensions*****:** As mentioned earlier, the truck bodies are fabricated by external sources and thus the dimensions (length, breadth and height) of the truck vary substantially. Although, largely the big trucks are categorised based on their length in feet (17', 20', 22' and so on), their actual length can vary quite a bit from their claimed length. Their width also varies from 6' to 8' while their height varies from 7' to 10'. Truck utilization being a key performance indicator for the line haul operations, only flexible units like bags can ensure full utilization of trucks with such variations in dimensions. With secondary units, a single size that fits all is to be designed.

c) ***Truck Bed Height*****:** The dock height in facilities across India is kept at a standard 4'. Although majority of the trucks do match the dock height, the smaller length trucks and those which are modified by external fabricators do pose a problem. Since trucks with tail lifts is a rare sight in places like India, a dock leveller is a must while moving towards standard units. New installations at almost every facility across the supply chain accounts for a significant expenditure while moving towards secondary unitization.

One obvious solution to the above problems faced by an e-commerce supply chain could be to have its own fleet of trucks. However, there are plenty of hassles that come along with owning and administering a

fleet, making it a mammoth management task, and most players choose to leave this to the experienced vehicle service providers.

The logistics sector in India is on the brink of a major transformation. The pace of introduction of new reforms is changing now with added efforts from the Ministry of Road Transport and Highways (MoRTH) on infrastructure, regulations and telematics to boost the logistics sector for fuelling economic growth. Standardization is the need of the hour. Unitization is one of the many ways by which growing entities can embrace the forthcoming revolution in the logistics landscape.

2. Wide Range of Shipments

The second most fundamental challenge is the wide range of shipments to be dealt with using standard units. To simplify the processes, levels of separation based on shipment size are created within the supply chain, which is divided into Large and Non-Large segments. White goods, furniture, and other similar categories with a high weight or volume constitute the Large segment and require a different handling and storing procedure. Rest of the categories fall under the Non-Large segment which still has a huge variation in size, shape and weight. Following are the complexities that come along with designing a standard unit for a wide range of shipments.

a) Shipment Sizes: The same supply chain caters to shipments ranging anywhere between a pen drive to a teddy bear or a bean bag. This eliminates the use of standard cartons, boxes or pallets for unitization and narrows down the options to large collapsible boxes or roll containers as seen in the retail or package delivery industries.

b) Packaging Types: The secondary packaging also varies based on size and categories and mainly constitutes cardboard boxes, polybags or bubble wrap. Standardization exists on the box sizes and polybag types used for the inventoried shipments, but it is difficult to exercise a tight control on the packaging used by the innumerable sellers in the marketplace model.

c) Loading Efficiency: Like most cases in a supply chain, here too, there exists a trade-off between productivity and utilization. While proper stacking of the shipments in a unit ensures maximum space utilization, it comes a cost of productivity. Bags, being flexible, allow a good space utilization, even if stacking is not followed. So, time required per shipment to be filled in the bag is relatively low. Rigid units require proper stacking of shipments to ensure good space utilization and this comes with a compromise on filling throughput. This needs to be weighed against the time and manpower saved in closing, staging and moving these units.

3. Non-Standard Facilities

Every E-commerce supply chain consists of dedicated warehouses and sortation centers spread across the country with capacities to manage their usual load. In preparation for peak sale events of the year, additional facilities are rented and developed on a temporary basis, based on the specific needs arising out of the operations conducted at each facility.

a) ***Flooring:*** Warehouses with G+5 storage required specialized MHEs and with it comes the commercial grade heavy duty flooring. Sorting hubs which don't require any MHEs and can do with simple trolleys for bag movement have basic concrete flooring. Often even in the same facility, the type of flooring changes from docks to internal storage areas.

b) ***Docks***: The loading and unloading of bags at the docks requires a lot of time and manpower, but it does not require dock levellers. Operators are positioned at the docks and inside the trucks as the bags are handed over from one to another, one by one. Owing to this, very few facilities have dock levellers and even those are left un-utilized.

As new methods towards standardization are introduced, a need to define the norms across all facilities will arise.

4. Truck Space Utilisation

The limitations arising due to non-standard trucks, wide range of shipments and the compromise on loading efficiency with productivity lead to under-utilization of the trucks. Bags being smaller and flexible can use up every available space within the truck. When moving to rigid units of defined size, productivity is improved at the cost of truck utilization. Assuming roughly 40% of the trucks going completely full on any given day, truck space utilization becomes one of the crucial metrics in the overall economics of the supply chain. An average reduction of 8-10% in truck utilization comes by just moving from flexible to rigid units of the same volume. Additional under-utilization can creep in as the size of the primary unit goes on decreasing.

5. Size for Sorting

A typical life-cycle of a shipment involves multiple stages of sorting before it reaches the final leg of its journey. Units filled at the end of one stage of sorting go to the next stage based on the assigned destination (zone, city or postal code). Also with every successive stage of sorting, the no. of sorting stations rises and the no. of homogenous shipments per sorting station falls. At each sorting station, we need to ensure that the size of the unit is small enough to keep a healthy ratio of filled units to under-utilized ones. The initial stage where the no. of shipments per sorting station are high, they can be filled directly into the secondary units, while as they move to the next stage, primary units start coming into picture. Assuming every last unit per station is under-utilized, the effective under-utilization of assets (units, trucks and facilities) will be lesser in case of a well designed primary unit.

Design Study

The focus of the study is to propose units which can cater to most of the needs mentioned above. As a starting point, the designers started solving for making dock operations easier to save on damages, human effort and truck turnaround time by making loading and unloading of trucks faster and easier. The units have to allow a single person to swiftly move them into and out of the trucks. As the design thinking progressed, the remaining use cases were added like reducing the staging area requirement by using more vertical space, and improving the throughput at sorting stations by where sealing activity was a bottleneck.

Roll Containers

Roll containers are one of the widely used modes of material handling on shop floor and warehouses due to the ease of movement and protection of items stored inside. They also facilitate fast and smooth loading and unloading processes at the docks. Variations in no. of walls, wall dimensions, material and accessories are seen depending on the industry and the type of products associated with the roll containers. But the elegance of the solution lies in functionality and the multitude of use cases a simple design can solve for. Most importantly, the roll containers are collapsible and nestable to allow for space efficiency and easy movement when not in use. A critical factor in designing the right dimensions of the secondary units is truck utilization. An optimal design should minimize space wastage in trucks with a wide range of length and width. Underutilized truck width accentuates the space inefficiency as it spreads throughout the truck length. Taking learnings from the pallet design, units were designed with a rectangular cross section instead of square. Each unit is designed with length and breadth of 3 feet and 4 feet respectively. They can be arranged in a way to give a combined width of 6 feet, 7 feet or 8 feet, thus accommodating for the truck width variability. Considering majority of the trucks in use have a storage body height of more than 8 feet, the roll containers were designed with a height of 8 feet including wheels. Increasing the width of the roll container wheels will allow to overcome the corrugations of the truck bed. The design also needs to take care of locking the roll containers once inside the truck. Additional accessories like parking locks, detachable shelves, harnessing belts can be a part of the finer design of the roll containers. The main advantage, though, comes from the fact that, once these roll containers are filled and sealed after sorting, they are opened directly at the next destination for finer level of sorting. This reduces the number of handshakes or direct handling of shipments or primary units which means reduced

time, manpower and damages and consumable costs. Roll containers are versatile, as they can be designed to accommodate shipments as well as primary units like bags or totes. This is a useful property as depending on the stage of sorting, they can serve as primary or secondary units.

Figure 2 shows the interaction of roll containers with various activities and the key metrics which are improved in each of these activities. As mentioned earlier, truck space utilization is the only area which takes a hit while moving from bags to rigid units, although with standardization, this impact can be

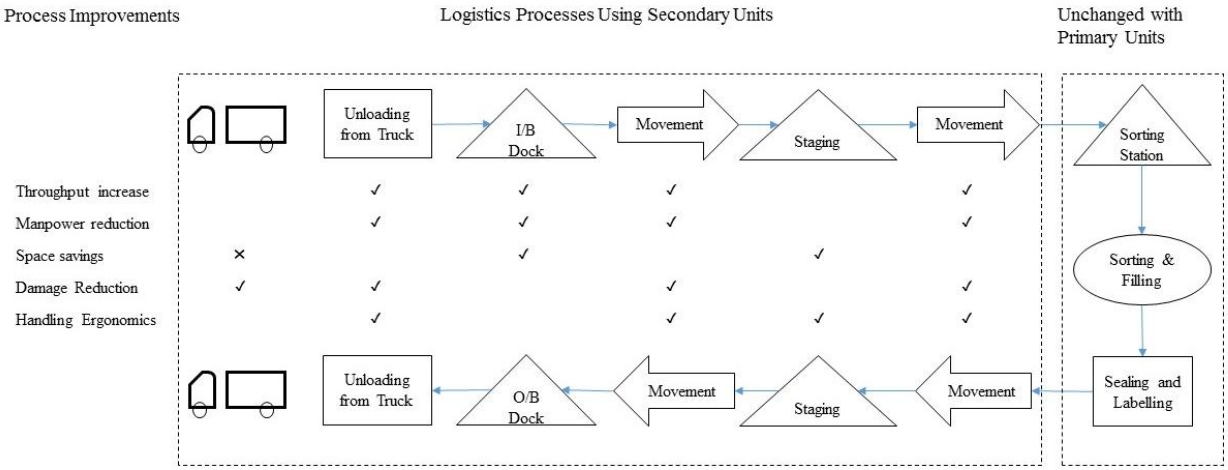

Figure 2: Secondary Unit interaction with Logistics Process at the Sortation Center

minimized. While playing role of secondary units in most logistics processes, roll containers bring improvements in areas like process throughput, manpower requirement, space efficiency, handling ergonomics and reduction of damages. Proposed below are three variations showing different ways in which roll containers can be used for unitization.

Figure 3. Nestable Roll Container with Split Door

Elaboration of Several Design Alternatives:

As part of the study, three variations of roll containers were designed based on requirements of different legs of the supply chain at Flipkart, a leading E-commerce player in India. The supply chain network and processes resembled that of a standard e-commerce entity. A benchmarking study was conducted at selected warehouse and sortation centers and metrics like throughput, manpower, space requirement etc. were extracted from the value stream mapping data and layout design in the existing condition. Further, theoretical studies conducted at these facilities with each of the above-mentioned proposals gave us reasonable estimates of the revised metrics. Specifically, Proposal A is a roll container used as a Primary load unit, best suited for use between the primary and the secondary stage of sorting. Post fine level of sorting, roll containers prove beneficial as secondary load units as seen in Proposals B and C. Given below are the details on the designs and their potential benefits as estimated in the theoretical study.

Proposal A: Roll Containers as Primary Units

Initial legs of the e-commerce supply chain, like inventory transfers and primary sorting involve a high quantity of shipments per sort. A large primary unit works best in such situations where a larger bulk of shipments are to be dealt with. Factors like manual handling capability and efficient truck space utilization put an upper limit on the size of primary units. In the Figure 3 we can see one variation of roll container designed as a primary unit. At the manual sorting stations, shipments can be directly put into these roll containers. A split door allows filling in contents with a higher throughput without spillage. Detachable shelves allow separation within the container, if necessary. Considering their size equivalent to 20 times that of a bulk bag, no additional manpower is required for sealing them once they are full. This leads to a reduction of 33% in manpower requirement at sorting stations as compared to the traditional bagging process. At the staging area, a 12 sq. ft. floor space, which can typically accommodate 8 bags stacked in two layers, can now accommodate a unit equivalent of 20 bags, thus saving 60% of staging space. Moreover, movement to staging area and the docks and into the trucks requires significantly lesser manpower owing to the larger unit size. 5 operators can now achieve the same throughput which otherwise requires 14 operators. The same holds for operations at the destination facility where the trucks are bound. An effective manpower reduction of 52% can be achieved in the facility by introducing larger primary units. Furthermore, the loading activity at the docks is 3.5 times faster, thus increasing the productivity of the docks and improving the truck turnaround time. Approximately 30% of the shipment packaging damages in transit are attributed to erratic handling of the bags while getting them on and off the trolleys or in and out of the trucks. Roll containers, being rigid, should eliminate the occurrence of these damages. While considering the cost of consumables, the cost of replenishing damaged bags can be compared with the maintenance and repair costs of a roll container. It is often the wheels of the roll container which need to be replaced after frequent intervals while the rest of the body suffers little damage. Considering estimates on average life span of a bag and a wheel of a roll container, and using the 20:1 leverage, significant savings of 94% can be achieved by getting rid of bags and moving to roll containers as primary units. Truck space utilization is one area which takes hit while moving from bags to rigid walled units. A typical truck used in the initial legs of the supply chain has a storage body measuring 20 feet, 8 feet and 8 feet in length, width and height respectively. This volume, which usually accommodates 300 bags on average, can now accommodate 12 roll containers or an equivalent of 240 bags, thus reducing truck space utilization by 20%. Although this drawback can be weighed against the other benefits to understand the overall impact on the supply chain costs and improvements in other key metrics.

Proposal B: Roll Containers as Secondary Units containing Bags

Bulk level sorting builds large unit loads of shipments which then proceed to the sorting facilities where they are put through secondary sortation for finer level of sorting with a relatively low shipment count per sort. From here on, movement down the supply chain requires smaller primary unit loads. In the current scenario, this constraint is met by using bags which carry around 20 shipments each. This proposal aims to retain bags as a primary unit due to a

multitude of benefits that bags bring to the table as mentioned in this study. There are also a lot of limitations which come along with the use of bags as primary units. To solve for these issues, secondary units like roll containers are introduced into the system. The bags created at a sortation station can be directly stored in roll containers. Roll containers serve as a trolley as well, collecting bags from multiple stations serving the same route. The same unit can be further used in transportation.

Figure 4. Roll Containers for large and varied range of products. (Source: http://furnibox.com/index.html)

To improve stackability and space efficiency while using bulk bags as primary units, a larger roll container with twice the width and capacity of the standard roll container can also be explored. This unit, as shown in Figure 4, is 6 feet wide and 4 feet deep with a height of 7 to 8 feet. It normally caters to shipments in the large category and is a common sight in furniture or white goods warehouses. The main aim is to achieve space efficiency while dealing with primary units having a wide range of shapes and sizes. Since, in this proposal, 40 bags can be stored and moved together as compared to 20 bags in Proposal A, savings in manpower and time are slightly more pronounced.

Processes till the bag creation are retained as before, but once a bag is created it gets loaded into a roll container assigned to it based on the desired destination. Once these destination specific roll containers are filled, they can be moved to the staging area and the docks and into the trucks as in Proposal A. Although manpower required for sorting remains the same, the manpower for movement in the outbound area is reduced from 14 to 3 as compared to handling bags. Overall manpower reduction per facility is estimated to be 54%. The savings on floor space required for staging are the same as those in Proposal A since the dimensions and capacity of this unit are simply doubled in Proposal B. The loading activity at the docks is 5.6 times faster, thus increasing the productivity of the docks and improving the truck turnaround time. Since bags aren't eliminated in this proposal, shipment damages due to bag handling will still exist, although a lot lesser due to reduced handling. We estimate a 20% reduction in damages. While considering the cost of consumables, we must consider a fundamental assumption that a life of a bag is inversely proportional to the number of touches in a typical usage cycle from a sealed bag to the next time it is opened. A touch corresponds to each time a filled bag is lifted and dropped. The traditional bag handling process involves 26 touches per bag per cycle, whereas Proposal B reduces that number to 11. This implies a 2.3 times improvement in life of a bag which corresponds to savings of 57% on consumable costs. On adding a factor of unit maintenance and repair to the equation, the overall savings comes down to 45%. As seen in Proposal A, truck space utilization is reduced while moving to rigid secondary units carrying bags. A typical truck used at the sorting facilities of the supply chain has a storage body measuring 32 feet, 8 feet and 8 feet in length, width and height respectively. This volume, which usually accommodates 500 bags on average, can now accommodate 10 roll containers or an equivalent of 400 bags, thus reducing truck space utilization by 20%. Since the distances traveled by trucks in this leg

are at a zonal and national level, under-utilization of truck-space could turn out to be very expensive as compared to initial legs of the supply chain. Trucks costs are measured in terms of capacity measured in tonne-kilometer (TKM) and every under-utilized TKM adds to wastage in the Line Haul of the supply chain. This metric has to be carefully weighed against the benefits achieved from introducing secondary units.

Proposal C: Roll Containers as Secondary Units containing Totes

Figure 5. Totes in Roll Container

A typical roll container as seen in Proposal A, but with only two walls can also be used for carrying totes instead of bags as primary units. Totes are preferred over bags in cases where the shipments are small-sized, are fragile or have a standard size allowing stackability within the totes. Typical areas of application are specific supply chains involving mobile phones, apparels, shoes, grocery, etc. Since space efficiency is not a challenge while stacking totes, a normal size roll container as that used in Proposal A serves the purpose of an ergonomic and convenient secondary unit. It stacks up 10 totes in a 2X5 matrix as shown in Figure 5. Since, primary units are retained, manpower requirement in sorting remains unchanged, while manpower savings in movement are like that seen in Proposal A. This allows an overall reduction in manpower of 44% as compared to traditional bagging process. Savings in consumable costs are negligible while moving from totes to bags since a 10-15 times improvement in life per unit is compensated by a 10 times increase in cost per unit along repair and maintenance of the primary units. To allow optimal use of volume, the dimensions of the totes should allow compact stacking of the shipments and the totes in-turn should be compactly stacked in the roll container. This will minimize truck space wastage and may even bring it lower than that seen in Proposals A and B. Although this number is heavily dependent on the type of shipment in consideration.

Comparison of alternatives

Table 1 quantifies the improvements in various metrics of a typical e-commerce supply chain for each of the proposals as compared with the existing processes. The huge difference in performance of each alternative highlights that each of them have a unique set of merits and demerits. Process design professionals can match these attributes with their specific supply chains depending upon the type of shipments and network design to choose the most suitable alternative for achieving maximum benefits.

Metrics	**Proposal A**	**Proposal B**	**Proposal C**
Sortation Productivity Improvement	43%	-	-
Manpower Reduction	52%	54%	44%
Staging Space Reduction	60%	60%	60%
Transport Capacity Utilization	-20%	-20%	-20%
Docking Time Reduction	71%	82%	71%
Damage Reduction	30%	20%	30%
Consumable Cost Reduction	94%	45%	-

Table 1 Estimated Improvements based on Theoretical Study

Managing Logistics of Units

As methods of secondary unitization are introduced, roll containers are no more kept captive within a single facility. They move vertically across the network from pick-up points and warehouses to delivery centers and back. This calls for attention to managing the logistics of these units ensuring replenishment of units at each facility as needed. Additionally, the procurement, maintenance, repair and lifecycle of the roll containers also needs to be considered. Depending on the load going through a single facility, it requires a couple of hundred of units at any point. The entire network, then, would require thousands of units, empty or filled, to be circulated between its facilities every day. Logistics at this scale also needs technology backed management by dedicated teams of professionals positioned centrally and at each of the sites. The movement of the units in and out of the facilities can be tracked using RFID solutions and a central logistics management portal, which can be integrated with the central ERP system of the organization for end-to-end mapping and visibility. Internal teams for managing the supply chain of roll containers and dealing with suppliers for fresh batches as and when required. Assuming most routes of the network have a two-way traffic with balanced load, transporting empty units to a facility for replenishment will be rare. Nonetheless, the roll containers, being nestable, minimize the additional costs of transporting for replenishment. Alternatively, organisations can outsource the management of the unit logistics to external partners with expertise in the field and provide solutions at lucrative costs. Similar models exist in the pallet industry where players like CHEP® cater to a range of clients with pallet pooling solutions. A caveat for unit pooling is that pallets are standard across industries while roll containers aren't as popular and standardized. But large e-commerce players have the onus of taking the initial steps before their practices become an industry standard and are widely adopted.

Conclusion

Unitization is a fundamental function deeply woven into the fabric of the supply chain and its influence spans vertically across all teams, processes and facilities. Hence there is a lot of inertia attached to it and bringing about a change in unitization requires bringing together various internal functions and external partners. This study provides a bird's-eye view of the interactions, benefits, challenges and possible solutions associated with evolving to roll containers for secondary unitization. Multiple benefits can be seen in terms of reduction in costs, time, space, manpower and damages which form the key metrics for any supply chain. These benefits will only be enhanced with standardisation across various functions like transportation, facilities and logistics processes. As the emerging markets throw one challenge after another at the e-commerce entities, their supply chains struggle to strike a balance

between growth and profitability. It is important for them to recognize the importance of solving fundamental problems like unitization to step into the next phase of sustainable growth. E-commerce entities in emerging markets have roughly 80% of their shipments are transported by surface. With terms like Same Day Delivery and Next Day Delivery becoming more common, it becomes necessary to remove inefficiencies and buffers built into the system and make way for just-in-time processes. This also calls for more automation and lesser handshakes to build predictability into the system. Robust material handling and movement is the foundation for building a highly sophisticated supply chain.

References

Dennis, William T. Parcel and Small Package Delivery Industry. Creatspace, 2011.

LIAO, Zhi Yong. IATA ULD Regulations. World Cargo Symposium, March 2015

Daniel Hellström, Mazen Saghir. Packaging and Logistics Interactions in Retail Supply Chains. Packaging Technology and Science, May 2007.

G. Raghuram. An Overview of the Trucking Sector in India: Significance and Structure. Indian Institute of Management, Ahmedabad, December 2015.