Warehousification

Recommendations for the future of big box warehouses in the Netherlands

Tilburg University

Understanding Society

Colophon

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In the Netherlands, a public debate has grown around the big box warehouses built on new, greenfield locations in the countryside and suburban space. As the continued growth of e-commerce demand and ever-shorter expected delivery times have moved inventories closer to consumers, the visibility of such warehouses by urban and suburban residents has increased. While, historically, inventories are viewed primarily from the perspective of tying up working capital, increasingly, inventories also cause challenges in terms of tying up scarce public space, especially in areas with a high concentration of logistics activity. Globally, inventories have been increasing relative to sales. This is presumed to be caused by multiple developments. First, the globalization of supply chains has led to longer lead times and to increased uncertainty in supply, warranting larger inventories. Second, a global supply chain typically entails a larger number of manufacturing and transshipment locations, driving up inventory needs. The long period of historically low interest in the 2010s has also made it cheaper to tie up capital in inventory. Finally, at the tail end of the supply chain, online e-commerce with home delivery has grown considerably, creating a second retail channel in addition to traditional stores with associated inventory holdings. The drive toward faster home delivery has further exacerbated the number of e-commerce inventory locations.

Many Dutch residents are concerned that growing development of logistics spaces negatively impacts the natural scenery. This debate about the negative social effects of many big warehouses constructed in the Netherlands (a phenomenon sometimes referred to in Dutch as “verdozing” -- which we refer to as “warehousification”), often focuses on the negative effect of new warehouse building and usually much less on the potential logistical relevance of these locations. Both national regulators and local municipality representatives are calling for bans on new construction of distribution centers [1]. Those opposed to new construction want to preserve space for other purposes, such as housing, agriculture, and nature, and limit nitrogen emissions associated with construction, as well as limit the traffic that new warehouses may bring to the area [2]. Concerns that the presence of warehouses draws migrant workers, which strains an already stretched and tight housing market, add to locals’ protests. Moreover, there is concern that the Netherlands provides storage space for the rest of Europe with only marginal domestic economic benefit [3].

The need for storage space is a direct consequence of changes in global and local supply chains. However, both in the public debates and in the academic literature, these two phenomena seem to be disconnected. Whereas the need for space is primarily discussed from the perspective of spatial planning and economic geography, white papers and academic studies in these disciplines do not seem to consider the trade-offs between the need for storage on the one hand, and other externalities on the other. For instance, efficiently located storage generally reduces transportation movements and hence carbon emissions. Further, short delivery times to consumers can only be obtained if storage locations are close by. For instance, spatial planners in the Netherlands have argued for warehouses to be “exported” to Germany or Belgium, which would lead to more transport movement on the highways, or a lower service level, or higher costs experienced by consumers. Proper spatial planning should make an integrated trade-off between all of the associated costs and benefits rather than liming itself to the spatial consequences of the warehouse buildings.

As a contribution to the discussion, we have made efforts to understand the key barriers and concerns of warehouse managers, characterize current warehouse facilities, quantify the trends in storage facility fullness, and identify innovative ideas to increase the current total effective storage capacity. Moreover, many arguments have been made but largely without data to support these claims. Importantly, in the Netherlands there is a severe lack of data available regarding how much inventory is inside these very large warehouses and what markets the inventory actually serves (as compared to the United States, for example).

To help fill these gaps in critical information, our study is a first attempt to provide insight into the underlying mechanisms by collecting warehouse-level data. While definitely far from complete in terms of data, we are able to provide initial insights into the trade-offs, provide directions for policy advice, and indicate the necessity for more systematic and large-scale data collection. Our study provides options to policymakers on how to best utilize the existing warehouse space to serve demand and limit the negative

societal and environmental impacts of any new required construction. To do so, we collect data on inventory levels, markets served, and space usage from a sample of big warehouses in the Netherlands.

Our data represent about 11% of the big warehouses in the Netherlands (i.e., those that are at least 10,000 m2 in footprint) and we estimate it covers approximately 7% of the total warehouse space. We estimate how representative our sample in two ways. First, we obtain a list of all warehouses in the Tilburg region in the size categorization of interest (i.e., at least 10,000 m2). Our sample represents 11% of them. We have no reason to believe data collection is substantially different in the Tilburg region from any other region, thus we assume the Tilburg representation can be extrapolated to that of the whole of the Netherlands. Second, Buck Consulting International reports a total warehouse footprint in the Netherlands of 37.2 million m2 [4]. Our survey sample represents about 7% of the total footprint.

Hence, while our quantitative findings can only be considered indicative and caution needs to be exercised in interpreting the data in more quantitative terms, our data collection has enabled us to provide a number of clear considerations in the policy debate that may not have been addressed before. Above all, it indicates that a more systematic and potentially mandatory provision of inventory data in the Netherlands needs to be implemented such that policy advice does not just rely on the highly accurate and complete urban planning data but is complemented by comprehensive logistical data of the goods that are kept inside those warehouse spaces. Based on the findings, we provide a set of observations and recommendations for policymakers.

Survey of Dutch warehouse users

Data collection

Detailed warehouse-level inventory data in the Netherlands is not yet available. Therefore, we develop a survey approach targeting users (i.e., logistics service providers (LSPs) and shippers) of L (10,000-20,000 m2), XL (20,000-40,000 m2), and XXL (>40,000 m2) warehouses across the Netherlands. These size category definitions are based on those of Stec Group [3], Buck Consulting [4], and others [5]. To align with these reporting organizations, our sampling deliberately excludes warehouses smaller the 10,000 m2. However, these warehouses are usually positioned as part of mixed light industrial zones and, hence, typically not subject to the warehousification debate. We capture inventory levels and labor usage at two snapshots in time: 2022 and 2017.

We obtain responses for 30 L, 28 XL, and 23 XXL warehouses, with a total of 81 warehouses. We ask respondents to provide the following information for each of their largest warehouses: the footprint (m2) and height (m) of the warehouse, the municipality in which it is located, what percentage is dedicated to storage (rather than office space, inbound/outbound operations, etc.), how full the warehouse was in 2022 and five years prior in 2017 for on- and off-peak seasons, what percentage of the inventory is intended to be delivered to consumers (business-to-customer, B2C), which can either be direct to home or to retail store locations, versus the percentage of inventory that is intended for other businesses (business-to-business, B2B) such as unfinished goods. Furthermore, we ask what percentage of inventory is bound for specific geographic regions (Netherlands, Germany, Belgium, the rest of Europe, or Other), the number of workers (full-time employees, FTE) in the warehouse for on- and off-peak seasons in 2022 and 2017, and the percentage of workers that are Dutch versus foreign workers on- and off-peak in 2022 and 2017. In addition to these specific questions, we ask respondents to choose the top three challenges they are currently facing and top three potential solutions they see that may mitigate these challenges. Data collection took place between March and June 2023. We summarize the responses in **Table 1.**

Number of warehouses	
L (10,000-20,000 m2)	30
XL (20,000-40,000 m2)	28
XXL (>40,000 m2)	30
Total	**81**

Warehouse size (m2)	
Mean	33,397
St. dev	29,535
Min.	10,000
Max.	175,000

Number of respondents	
LSP	31
Shipper / retailer	16
Total	**47**

Table 1: *Summary of survey responses. Individual respondents can submit responses for multiple warehouses.*

Growth of retail inventory

Many see the rise in e-commerce demand during the COVID-19 pandemic as a striking sign we need more warehouse space. However, a small fraction of big warehouse retail inventory space is dedicated to this segment: 20-40% goes to to B2C, and the e-commerce segment that is characterized as direct-to-consumers' home deliveries (as opposed to shipments to stores) make up about 12% of that B2C space. Most (80%) of the direct-to-home inventory space is served by XXL warehouses, 14% is served by XL warehouses, and the remaining 6% is served by L warehouses. However, according to the survey, only L-sized warehouses saw an increase in fullness after the pandemic (XXL and XL warehouses were already at capacity even in 2017). This is all to say that e-commerce demand is not the only culprit for rising inventory levels.

Moreover, consumer buying patterns are expected to return to normal and e-commerce demand has leveled and is expected to slow to pre-pandemic levels. This could result in reduced fullness rates in XXL warehouses, or it may result in a shift in the mix of inventory within the warehouses: retail inventory intended for stores may increase and replace some of the diminishing e-commerce demand [6]. Even buying patterns revert to pre-COVID levels, inventory levels are growing, and the response has been additional warehouse construction [5].

Key challenges and solutions

Several key challenges have emerged as the national debate on big box warehouses has unfolded. To make a positive change for the industry and for society, it is important to understand which the most pressing challenges and promising solutions are from the perspective of the logistics community. The top current challenges and potential solutions the respondents face regarding warehousing and inventory space are shown in **Figure 1**. Respondents can select up to three options.

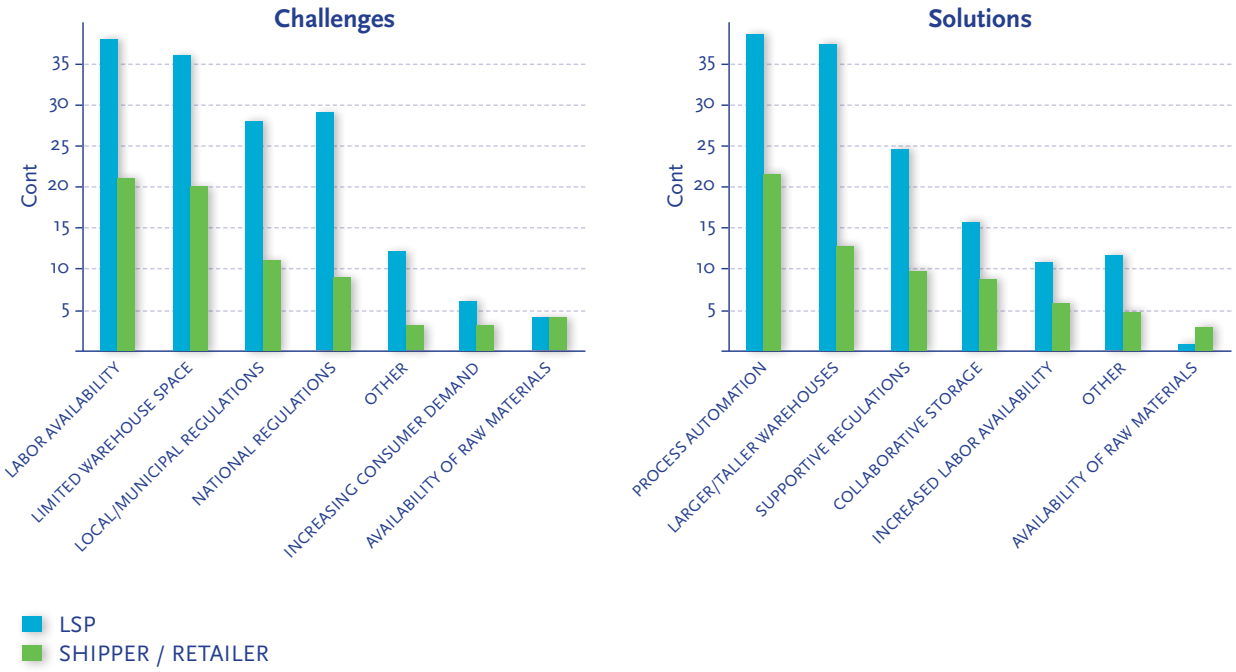


Figure 1

The top challenges for both LSPs and for shippers are labor availability and limited warehouse space closely followed by local and national regulations. The labor and warehouse space concerns are some of the main issues reported in the media, and our survey results further underscore their importance to logistics actors. The responses regarding regulation challenges suggest that regulators can have a major impact on the industry if they can come up with the necessary regulations that support the industry. Of course, these regulations must keep societal concerns in mind as well.

Accordingly, the top potential solutions to the respondents' current challenges indicated by their selections are process automation, larger/taller warehouses, and supportive regulations. The first two options can help increase the total inventory that can be stored within the same spatial footprint. Process automation can allow more efficient use of current storage space, increasing the inventory density. Automation may reduce the total labor force needed, however, most warehouse automation processes simply help workers do their jobs more quickly and safely. Supportive regulation of course will be important but only if the new policies can effectively address and mitigate concerns for both sides of the debate.

Collaborative storage (a solution ranking fourth by both LSPs and shippers/retailers) may increase the total space that can be used. For example, companies like Flexe find spare warehouse capacity and fill it with retailers' short-term inventory [7]. It is worth noting that the solutions suggested by warehouse operators consistently target a more efficient use of the existing warehouse footprint, rather than prioritizing growth of this footprint. Based on our research results, further in this document, we offer a set of four recommendations to help policymakers in these decisions.

The Netherlands as a storage facility for Europe?

Much of the national debate centers around the argument that the Netherlands is serving as a holding facility for the rest of Europe, incurring the drawbacks without considerable economic benefits. For example, it has been reported that between two-thirds [3, 8] and three-quarters [9, 10] of warehouses in the Netherlands cater to the Dutch market. However, these statistics include warehouses of all sizes. In other words, not all warehouses included in these statistics are relevant to the national debate about big box warehouses and their impacts on the country. We aim to understand what the share of inventory in big box warehouses in the Netherlands is that serve the Dutch market relative to other markets. Note that, distinct from prior studies, we survey the specific share of inventory, rather than a general question whether a warehouse (also) serves the Dutch market. We find that for the big warehouses of over 10,000 m2 in our sample, less than half (43%) of the inventory is intended for Dutch markets. Broken down by warehouse size, 40%, 51%, and 40% of the inventory in L, XL, and XXL warehouses, respectively is destined to stay within the Netherlands. Another 27% of the inventory is intended for areas of Europe other than the Netherlands, Germany, or Belgium (see **Figure 2**).

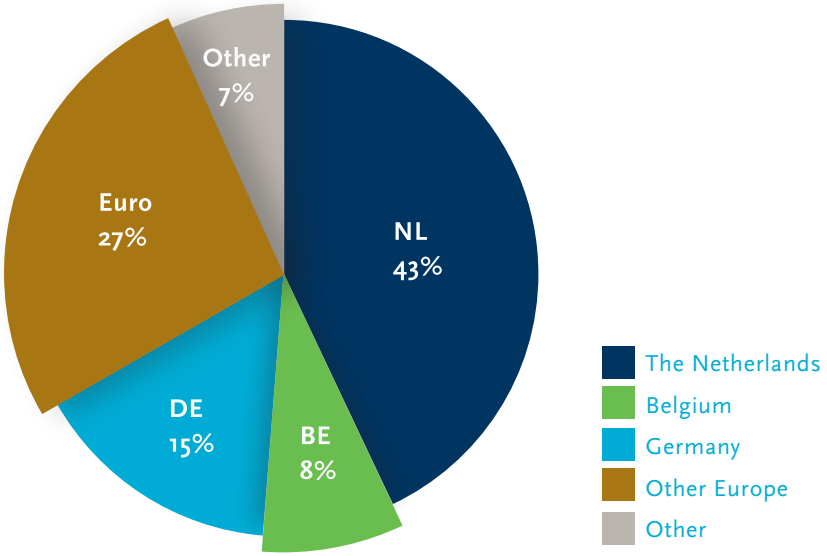


Figure 2

This result suggests that big warehouses use a larger part of their space serving non-Dutch markets compared to previous studies surveying the entire warehouse market. There are two likely explanations for this difference. First, as we limit our sampling to the big warehouses, it is likely that smaller warehouses may focus more on the Dutch market exclusively. Second, our question is different and more detailed—we ask the operators to specifically split the volume within the warehouse rather than assigning an entire warehouse to a market.

We expect there are regional differences regarding which markets local warehouses serve. To further explore this potential geographical heterogeneity with regard to export focus, we split our sample of warehouses into 9 geographic regions commonly identified by their logistics activities (see for example, [11]): Amsterdam, Arnhem-Nijmegen, Northeast Brabant, Rotterdam, Tilburg-Waalwijk, Venlo, West Brabant, Zwolle, and Other. The largest footprint of storage space in our sample is situated in Tilburg-Waalwijk with 26% of the 2.71M m2 of sampled storage capacity, followed by West-Brabant with 23% of the warehouse space, Northeast Brabant and Rotterdam with 10% each, and Venlo with 9% (see **Table 2**). In particular, Venlo seems to be underrepresented in our sample.

Cluster	Sampled warehouse space (m2)	Warehouse count
Tilburg-Waalwijk	703,500	17
West Brabant	631,500	18
Northeast Brabant	279,000	12
Rotterdam	275,000	11
Venlo	235,650	4
Arnhem-Nijmegen	117,500	7
Amsterdam	66,000	2
Zwolle	14,200	6
Other	255,000	4
Total	2,705,150	**81**

Table 2: *Summary of geographic clusters*

The popular corridor from Rotterdam to Tilburg-Waalwijk and on to Venlo is often noted as a route that likely serves non-Dutch markets as it runs from the Port of Rotterdam toward Central Europe. According to our survey, the picture is mixed: 63% of the inventory space in Tilburg-Waalwijk and 56% in Northeast Brabant is dedicated to Dutch customers. But in West Brabant and Venlo, only 23-25% of inventory is intended the for the Netherlands. This is depicted in **Figure 3**. Goods intended for Germany and the rest of Europe each account for almost 1/3 of the inventory space in these two regions.

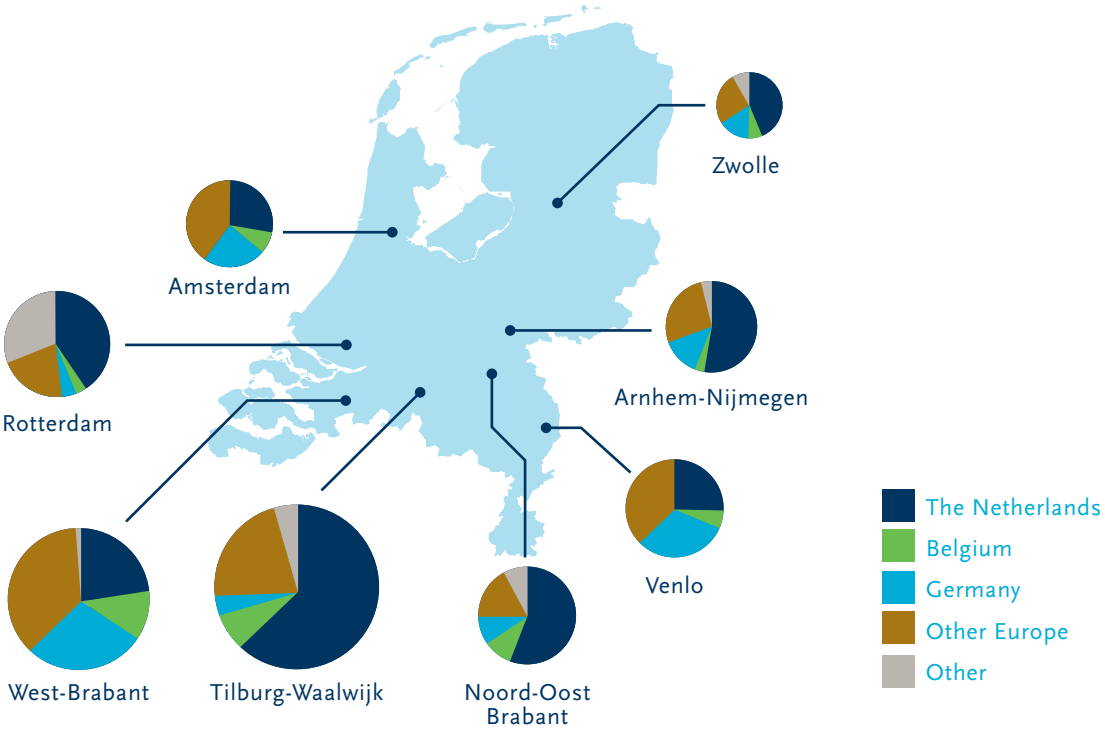


Figure 3: *Percentage of big warehouse space in the Netherlands intended for specific markets, by geographic region; Size of each bubble indicates relative big capacity (m2) in the geographic region.*

Based on these results, it appears a few geographic locations—i.e., Rotterdam, West Brabant, and Venlo—indeed have a greater share of inventory intended for markets other than the Netherlands. However, these areas do still serve Dutch markets. In addition, at least half of the inventory in most other regions is intended for Dutch markets. This level of detail regarding inventory levels and intended markets has not been made available previously. These results lead to our first recommendation.

Recommendation 1

Cluster all big warehouses into 20-25 logistics parks

We propose that the Netherlands Ministry of Spatial Planning explicitly designates a set of 20-25 logistics parks or clusters specifically for large-scale logistics activities (see for example, [5, 12]). These are groups of logistics-related businesses and organizations that are placed in a single park and work together to enhance logistics efficiency. Logistics companies at each cluster utilize shared freight yards, parking, security, and multi-modal logistics infrastructure. These parks would contain all necessary big warehouses in the country, densely spaced within the cluster. Location choice is such that transport needs are minimized to avoid overflow effects on the road infrastructure of ill-placed parks.

We suggest 20-25 clusters based on the following assessment. About 37.5M m2 of warehouse space has been available in the L, XL, and XXL warehouses in the Netherlands since 2020 [4]. Between 2000 and 2015, the Netherlands saw a growth in the total footprint of big warehouses at about 1 million m2/year. This increased to 2 million m2/year from 2015 to 2021 [13]. It is estimated that demand will be restored back to pre-pandemic levels [14]. Similar trends are observed in other regions of the world. For example, vacancy rates in the United States are already increasing and new construction leases are slowing [15]. Thus, assuming annual growth of 1 million m2, by 2030, the Netherlands will need approximately 50 million m2 of big warehouse space. If this space is split evenly into 20-25 clusters, it results in clusters of 2-2.5 million m2 per cluster. This is in line with the recent Moerdijk Logistics Park of about 150 hectares (1.5 million m2) [16], assuming double-story facilities.

With multi-story warehouses, the available capacity at each cluster will significantly increase. Larger and taller warehouses are cited as the second most popular potential solution to the warehouse space constraint issues by both shippers and LSPs due to economies of scale. This proposed scenario involves actively creating spatial planning policy rather than reactive restrictive measures in response to uncontrolled sprawl. The controlled planning should lead to the positive economic and social benefits suggested here. With taller, multi-story warehouses provisioned at these parks (only), more cubic meters of storage space can be offered without increasing the footprint [17].

Logistics clusters offer collaboration opportunities, value-added services, labor availability, and regional economic growth. Shared resources can reduce spatial needs within these parks. For example, a shared truck parking space reduces the total parking space needed. Security gates, fencing, and surveillance could be shared among all actors. Housing for (flexible) labor can be co-located near these parks. As the top challenge faced by warehouse users in our survey, labor availability is a serious concern; we find that in the XXL and XL warehouses, there are more migrant workers than there are in the L warehouses. Where to house these workers becomes even more challenging when we consider the existing local housing shortages across the country. Supportive regulation to enable dedicated housing near the logistics clusters could help alleviate some of these housing challenges, without further disrupting local residents' housing needs. Pooling of workers between facilities will also increase job security, which will make the work more attractive to residents.

Moreover, specific regulations should be in place to support and facilitate efficient logistics operations at these clusters. As noted by our survey respondents, such regulations would be crucial for alleviating current concerns. For example, there should be no or limited height restrictions, allowing for taller, multi-story warehouses. Moreover, regulations can require these logistics clusters to minimize negative societal impact. For example, the large surface areas of big warehouses are a prime contender for solar panels and could produce enough solar energy to power the entire fleet of box trucks and trailers in the Netherlands. We assume a total of 50Mm2 of warehouse footprint in the Netherlands by 2030, as outlined earlier. In ideal conditions, solar panels are rated at about 1,000 watts/m2 but in more realistic conditions closer to 200-300 watts/m2 [18]. This conservative power output suggests

an output of around 15 GW. The Netherlands sees about 1000 hours of sunlight per year [19], bringing the total solar potential of these big warehouses to about 15 TWh (terawatt-hours) per year. In a conservative assessment, researchers at the European Federation for Transport and Environment estimate battery electric trucks consume 1.44 kWh/km [20] and data from CBS suggest trucks and trailers combined traveled 6.5 billion km in 2019 [21]. Putting this together, a fully electrified Dutch trucking fleet would require 9.36 TWh – about 62% of the total solar potential from big warehouses in this cluster scenario.

Of course, there will be downsides to any potential solution that need to be addressed. While these clusters of warehouses can be located farther from populations to limit negative societal impact, some people may still be negatively affected. For example, one would expect an increase in truck, rail, and barge traffic in the areas of the logistics clusters. Additionally, with limited space in which logistics actors can place inventories, naturally, land prices will increase. This could lead to businesses shifting across borders to Germany or Belgium. It could also force greater efficiencies and more innovative solutions (we discuss this further in Recommendation #3). Such clusters have been successfully implemented in the chemical industry in the Netherlands and Germany (also referred to as the Sixth Cluster) [22].

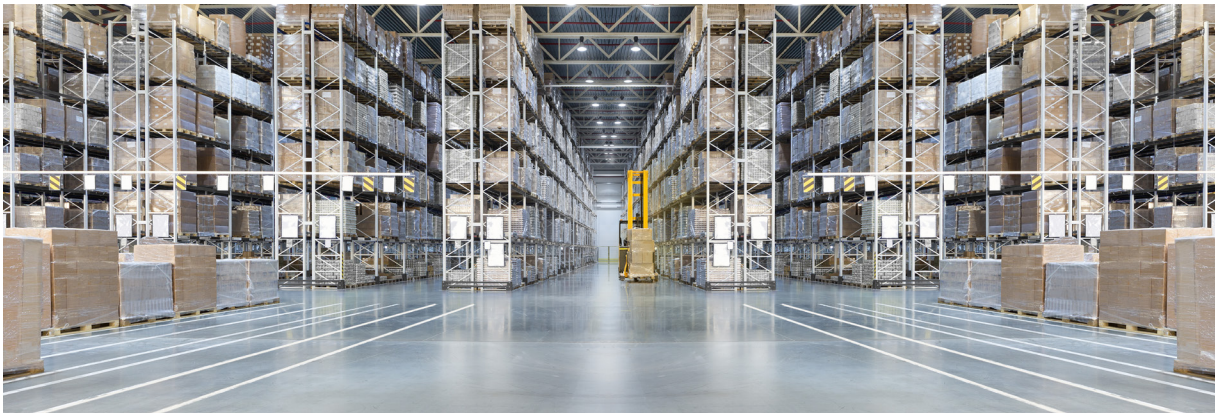
To explore this recommendation's full potential, additional discussions, data, and analysis are required. For example, it must be decided which geographic locations in the country are best suited for these clusters, which existing brownfield locations can be expanded upon or used as they stand for some clusters, how many greenfield locations are needed and what is the cost for development, and how the capacity should be spread across shippers and LSPs with big warehouse capacity needs. Moreover, data of each geographic region's demand for different industry product types should be analyzed to assess how to locate inventory closest to customers to avoid unnecessary transportation costs. Stakeholders, including shippers, LSPs, and local municipalities, should be engaged in these discussions. Solutions may also be drawn from other industries or countries.

Recommendation 2

Do more with existing warehouse space through densification and collaborative storage

As a second recommendation, we suggest substantially more effort, research, incentives, and attention for densification—that is, more efficient utilization of the existing logistics space. On average, big warehouses are reported to be at near-full capacity. However, even in warehouses at capacity, there is a lot of empty space, such as above. We make a distinction between two methods: densification and collaborative storage.

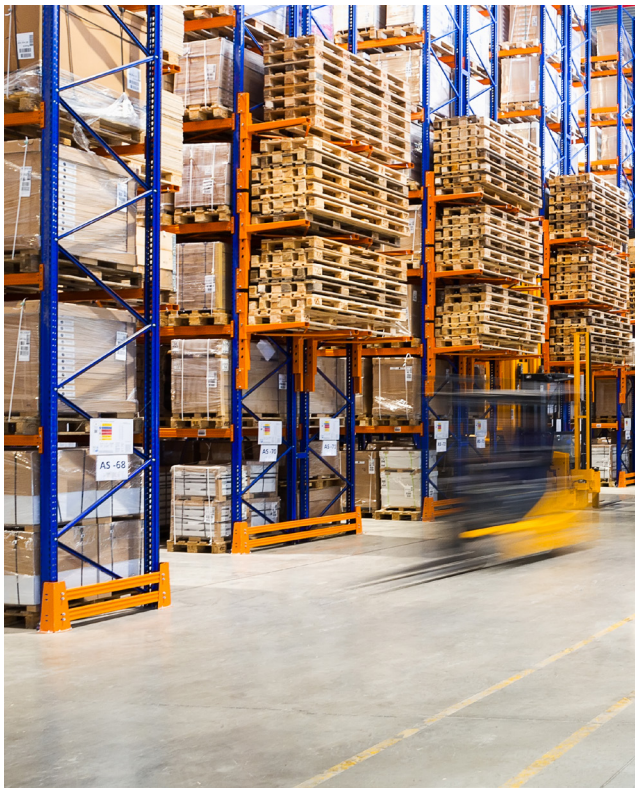
Densification involves better use of the space between, within, and above the existing storage racks and within the boxes that contain the products on the racks. Utilization of this space includes a design update by shifting storage racks and packages closer together, creating narrower passageways between them, and using empty overhead space for storage with the use of automation and advanced warehouse equipment. Proper estimates do not exist regarding overhead space, but it is not unlikely that a substantial part of warehouse space is filled with air rather than inventory. Apart from redesigning package and storage space, automation generally benefits densification. For example, while typical fullness rates may ideally be at 80-85% to allow for proper slotting and enough space to store inventory [23], the use of overhead cranes may enable fullness rates to increase to 90-95% by better utilizing higher storage space and placing incoming inventories in otherwise hard-to-reach areas, even without any physical changes. In more advanced solutions, robotics that bring inventory to warehouse pickers or helps pickers more easily and efficiently find inventory on shelves has become popular in warehouses serving e-commerce demand. By taking pickers out of the shelf space, shelves may be positioned more densely.



Collaborative storage involves greater utilization of the space on the existing racks, bins, and shelves themselves by allowing multiple users' goods to cohabitate in the same storage space. This capacity pooling would need to be coordinated by the shipper or LSP that operates the warehouse, or a third-party and would require detailed knowledge of the warehouse and near-real-time placement of inventory. Such collaborative storage, which received moderate support as a potential solution from survey respondents, particularly LSPs, may be one way to achieve more efficient use of storage space in areas where there is still capacity on individual shelves or in bins, for example. Similar solutions have already successfully demonstrated their potential to add value in smaller warehouses [24, 25]. This can be achieved by enabling short-term contracts and aligning inventories with complementary peak seasons to fill warehouse space continuously. With warehouse fullness currently decreasing, and the fact that there is strong seasonality in some of the warehouse utilization, empty space within the current warehouse infrastructure may be used if warehouse space were more pooled between different buildings. Such warehouse sharing is also offered by marketplaces such as Stockspots or Flexe and such pooling may be even easier if companies are located in the larger clusters discussed above.

To further convince users to adopt densification and collaborative storage, it will be important to measure their benefits. However, current warehouse metrics do not adequately do so. Therefore, we propose measuring the productivity of warehouse space as the added value of the stored products per square meter of land occupied. This is currently not a commonly deployed metric but will help to make it more insightful where inventory adds value in terms of public space usage.

With our survey, we attempt to address questions regarding how much new warehouse space is needed and how much demand the current Dutch infrastructure can support. However, limited responses make this challenging to fully answer. While the pressure from growing inventory is mounting in warehouses, many warehouses still have idle, usable space. This suggests that more efficient use of existing space is a plausible solution to be considered before having to decide if, or how much, new logistics warehouse construction is needed.



The main benefit of this recommendation touches on the social, economic, and ecological aspects of the warehousification issues in the Netherlands. Doing more with existing space does not require new warehouse construction. Therefore, this requires no additional big box buildings that negatively impact the natural view from roadways and residential areas. Focusing on greater usage of existing warehouse space utilizes the existing workforce rather than expanding an already constrained labor pool. Moreover, there should be limited additional freight traffic in the area in the case of collaborative storage because the extra inventory to be stored is likely from manufacturers and retailers with smaller volumes to fill in gaps. This recommendation requires no additional economic investment for construction or infrastructure. Finally, this solution avoids the environmental emissions such as CO_2, nitrogen, waste, and other pollution associated with new construction.

Any solution includes potential challenges. With densification, redesigning warehouses requires investments, typically in automation, while the warehouse may become less general-purpose, thus reducing usage flexibility. However, increased space productivity may justify these additional investments. Moreover, collaborative storage adds another level of coordination complexity within the warehouse. This starts with parking and dock slots as additional suppliers make use of the facilities as well as scheduling that must be coordinated. Variability in capacity needs of one user may disrupt the operations of others. Moreover, inventory loss, damage, or theft may lead to further challenges. A central coordinator will have to orchestrate these processes and potential liability concerns.

This recommendation requires more detailed data of what is inside big warehouses than our present study's survey. First, it is not currently evident how much space between individual shelves, bins, and slots exists for densification and collaborative storage, respectively. Detailed investigation of individual warehouses is needed. As warehouses become increasingly automated, more of this information can be digitized and made available. Coordination between warehouse operators such as the shippers and LSPs, as well as third-party space-matching providers that have recently emerged will be crucial to further developments. This includes discussions of additional risks that should be considered, how to design denser warehouses, and identifying the type of inventory that could be used for collaborative storage (e.g., demand patterns and seasonality that complements existing inventory, size of products, and order volumes).

Recommendation 3

Limit inventory growth by prioritizing industrial segments through pricing

New logistics space may continue to become scarcer—either naturally through continued demand or artificially by the cluster solution or by regulations that increase land prices. As land value increases, the market can naturally regulate which industry segments add the most value to the Dutch economy and society.

Of course, for the market to naturally determine which segments are most valuable taxation policies that do not interfere are required . The high-value segments will have the greatest demand and thus be prioritized for storage in the limited space. Regulators need not bear the burden of deciding which products to prioritize, consumer buying choices will make this clear. For example, it may become clear that the segments that fulfill a Strategic Autonomy initiative may be most valuable; efforts to retain inventory for industries that relieve Europe from over-reliance on the US and other global powers, such as healthcare, aerospace, and defense, and technology may become the most important inventory to store. However, regulators' responsibility is to be clear about what the limitations or restrictions are. Logistics actors will be forced to think in terms of inventory's "value added per cubic meter": how much value does the inventory create for the economy and society and is it worth the cost to store it?

Many industries have historically seen innovation driven by limitations. For example, pushes for reduced emissions have led to better electric vehicle battery technology. For the logistics industry, another outcome of increased land value is that logistics actors will be forced to implement more creative, efficient solutions to their capacity constraints. This includes double-story warehouses or warehouse spaces that can be aesthetically and functionally integrated into housing developments without large negative effects on local residents. Such plans have been developed in the United Kingdom, for example [26].

This recommendation addresses the criticism of the warehousification of the Netherlands as the storage facility for the rest of Europe. Therefore, the benefit of such a solution is that the Netherlands retains domestic inventory for industry segments that are vital to the nation. Critical to this solution is that the market determines which segments are prioritized; it is not a decision solely made by policymakers nor practitioners. In doing so, Dutch storage space can be used in a way that generates the greatest value for the Dutch economy.

Increasing land prices may have some downsides. Warehouse users in the prioritized industry segments may be forced to pay higher rents than their existing contracts. Users in other industries may be pushed to other nearby countries with lower storage costs but with increased transportation costs from port to warehouse and from warehouse to end customers in the Netherlands. These costs could be passed on to consumers. Moreover, market coordination challenges may emerge if consumer patterns evolve faster than inventory levels can respond, leaving previously high-value inventory tied up in high-value warehouse space without prospects of consumption. Therefore, industry segments that are prioritized may need to implement inventory policies that can respond quickly to demand.

Implementation of this recommendation will require buy-in from both regulators and industry players. The benefits we propose center on the premise that the Netherlands should not be a storage facility for the rest of Europe. However, as we noted earlier, our results suggest that currently about 50% of the inventory sitting in big warehouses in the Netherlands is intended for non-Dutch markets. However, a deeper investigation into a larger sample of big warehouses is necessary to further justify this statistic and recommendation. Moreover, metrics of success for such a policy will need to be considered. For example, even by implementing this recommendation, some portion of inventory intended for non-Dutch markets will remain. Therefore, a debate regarding what is an acceptable threshold may continue.

Recommendation 4

Collect and utilize detailed warehouse-level data for informed policymaking

National and local policy for the logistics sector should be based on a thorough analysis of the existing status of warehouse inventory. Therefore, a database of longitudinal data of inventory levels, intended markets, footprints, location, B2B vs. B2C inventory breakdown, etc. of all big warehouses (i.e., those >10,000 m2) in the Netherlands should be constructed. These data should be anonymized and available to inform researchers, policymakers, and practitioners regarding the current status and trends over time of the inventory of big warehouses.

Our survey can act as a guide for the set of questions that should be answered on an individual warehouse basis. We construct this survey with the help and feedback of Evofenedex, TLN, Bol.com, Midpoint Brabant, and others to be both comprehensive but manageable in duration for respondents.

To the best of our knowledge, our research is the first of its kind to make warehouse-level information available regarding how much inventory is actually inside big warehouses in the Netherlands, what the inventory is used for, and where it is going. Despite months of efforts to collect responses including direct communications and targeted conversations, our sample represents only about 11% of the total big warehouses in the country, estimated to be about 7% of total warehouse space. We base our recommendations on our findings and on interviews with experts in the industry. However, this is far from sufficient to conclusively answer whether enough warehouse space currently exists for the needs of the Netherlands—both for consumers and to support the logistics industry in the country. Even more, researchers, policymakers, and industry players cannot definitively answer whether new construction is even needed in the Netherlands because we do not have sufficient data.

Detailed warehouse-level inventory data can be used for a wide range of concerns related to the warehousification of the Netherlands. In addition to informing interested parties of the current warehouse-level inventory, consistent data collection can offer insights into logistics trends that can help project warehouse, transportation, and labor needs as well as technology investment patterns such as automation and sensing in the future. The data can be used for developers to determine where to find the best investment potential and how much capacity is needed, which can supplement their standard investigations.

Such data can be sensitive in nature. To manage and protect the data, the accepted General Data Protection Regulation (GDPR) in the European Union and approved Institutional Review Board (IRB) practices of Tilburg University [27] are applied. For this recommendation, a central, trusted authority such as the Dutch government or a neutral third party should be responsible for data management and protection. Moreover, there may be ownership and value capture concerns. For example, data collection requires time and resource investment. Whomever invests may require compensation for others to use the data. Some may argue that these data are a public good that the government should provide and make freely available. In either case, who owns and provides access–and how–are yet to become clear.

Such data are indeed possible to collect and store—and importantly, make openly available. Similar datasets are available for US warehouses because they are obliged to report inventory value [28]. Therefore, we urge the logistics community in the Netherlands to make such necessary information available to help encourage and inform regulations that can support rather than hinder its needs.

Conclusion

Warehouse operators are facing major challenges, including labor availability, limited space, and restrictive/unclear regulations. Process automation and new, larger, and taller warehouses are promising solutions to address these challenges. However, regulations vary by region, and public opinion continues to favor quick demand responses without the impact of the logistics industry's presence in their backyard. While acute and pressing for the Netherlands, the warehouse debate has gotten attention in other parts of the world as well, particularly loudly in the United States [2, 29]. Local residents are similarly pushing back on big warehouses being built in both urban and rural areas [30]. Addressing the national challenges will require collaboration between shippers, LSPs, and governments to find and implement effective solutions. In this report, we outline a set of recommendations based on our research to help influenced by potential policies regarding this national debate that is informed by the perspective of logistics operators themselves.

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