Demand for Warehouse and Distribution Center Space

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INTRODUCTION

The market for warehouse and distribution center (W/DC) space is the least discussed property type in the academic and professional literature. Yet the demand for W/DC space is important for developers and investors to understand. The underlying determinants of W/DC demand are complex, have changed over time and show signs of continued change in the future.

Both the theory of and the investigation into the determinants of W/DC space demand evolved from office and retail space demand models that focus on employment and population. Prior to 1990, W/DC demand was the poor cousin to the other commercial property market studies. From 1990–1995, W/DC analysis came into its own. This article presents a brief review of this "industrial" space literature that, heretofore, included W/DC space as an undifferentiated property type. It also expresses current thinking, hints at potential new developments that may cause the current models to come into question, and concludes with suggestions for further research into W/DC demand.

To set the stage for a discussion of the demand for W/DC space, it is important to realize that W/DC space consists of different forms of warehousing. The general definition of a warehouse is "a structure or room for storage for merchandise or commodities."[1] Also, "Warehouse applies to unrefrigerated or refrigerated buildings that are used to store goods, manufactured products, merchandise or raw materials."[2]

However, within the real estate industry, storage space is used for different purposes:

- **Bulk:** Containers or pallets enter the structure in one truck and are routed to two or more trucks for distribution to users of the products (cross docking of pallet loads);
- **Fulfillment:** Containers or pallets enter the structure, the pallets are disassembled and routed by individual parcel to other trucks for distribution to users of the product (cross docking of disassembled parcels from incoming pallets);
- **Distribution:** Individual items enter the structure and are routed by individual parcel to other trucks for distribution to users of the product;

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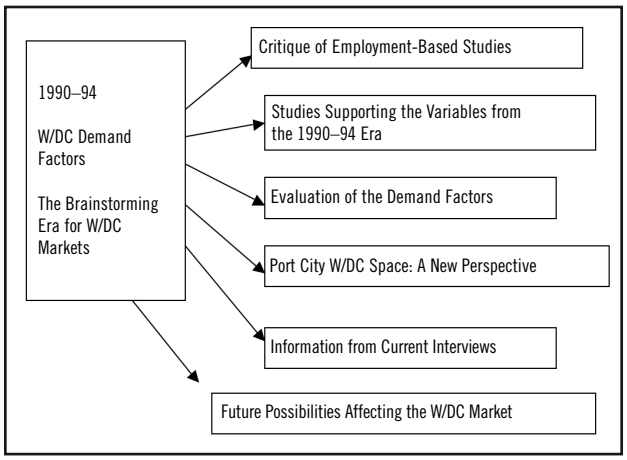
- **Intermodal:** Shipments come to the facility by one transportation mode and depart via another. The transfer of containers from ship to truck or rail is an example of this activity. The transfer from rail to truck is another example.

A schematic of this article appears below:



W/DC DEMAND FACTORS

The foundation of the W/DC demand determinant literature was laid from 1990–1994. During this time, most of the academic studies took a broad perspective, researching "industrial" demand that includes W/DC but also other property types such as manufacturing (both heavy and light), R&D and general flex space. The important demand factors we extracted from these studies are as follows:[3]

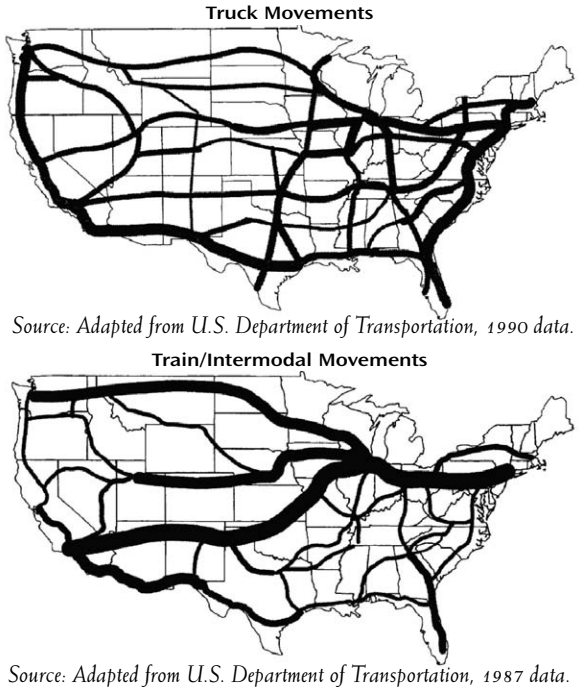
- Physical factors such as structural attributes are important determinants of demand. Age, condition, ceiling heights, structure size, column span, number of dock doors, number of drive-in doors, sprinklers, building age, parking area, truck service area, presence of a railroad siding and presence of office space in the structure are important factors.[4, 5]
- Location variables such as access to thoroughfares and location in a city or metro area are important considerations in determining warehouse demand.[6]
- Factors that extend the scope beyond the physical characteristics of the structure include the revenue potential of the property, the per capita income of the market area, change in the population of the market area and access to major highways. [7]
- Demand for warehouse space is a function of physical features (size, percent of office space, ceiling height, dock doors, and age but not rail siding); financial factors (industrial cap rate and prime rate but not an index of local economic activity); location (county and distance to airport); and type of tenant (single or multi-tenant).[8]
- Demand for warehouse space is a function of the labor force and the population of the economy, public infrastructure and services, and international issues such as currency exchange rates and trade barriers/restrictions. Transportation is of particular note since it is the one factor most aligned with the demand for warehouse space. The author contends this to be the case when transportation access including highways, rail and deep water are advantages of a region.[9]
- Demand for W/DC space increases as firms relocate their operations from cheap office space (Class B and C space) to W/DC space in business and industrial parks typically in the suburbs.[10]
- Demand decreases as firms get better at managing inventories with modern computer systems and inventory handling equipment.[11]
- Increased warehouse technology (in the form of racking systems and forklifts) reduce demand for warehouse space property.[12]
- Industrial property demand (like other asset classes) is affected by lags related to the desire of organizations to purchase and deploy new capital and also in the risk mitigation approach of taking up only a portion of new capital in each of several successive years or investment periods.
- Warehouse employment is a cleaner proxy for warehouse demand as this figure tracks inventory levels very closely.[13]
- Changes in output (or employment) and movements in the after-tax cost of corporate capital are associated with industry property completions.[14]
- Increases in manufacturing output that result primarily from technological improvements and capital intensification rather than increased employment affect industrial space demand.[15]
- Considering employment as the major driver of commercial real estate demand, the author introduces economic development factors into the analysis. These additional factors are the employment growth rate, the instability of employment, the industry mix (the industrial structure of the local economy as revealed in one-digit SIC codes), a measure of industrial diversity (as measured by the Theil Entropy Index), educational attainment, percentage of young firms (five years old or less) and the percent of locally owned firms.[16]
- Location, even small geographic differences in location, can affect demand for warehouse facilities. Also, the land-to-building ratio can affect demand.[17]
- Replacement demand due to functional and locational (external) obsolescence of existing facilities affects total

demand for new W/DC space.[18] Properties suffering from obsolescence face a declining demand.

- Focusing on the price per square foot of industrial properties as the dependent variable, price per square foot in earlier periods, recent construction, a "monetary base" (undefined in the article) and a variable created as the difference between the long-term Treasury bond and the Moody's Baa corporate bond rate.[19]
- The "path of goods movement" (POGM) theory proposes that land for warehouses gravitates to transportation corridors and hubs with favorable access to seaports, rail, air and truck transportation between major import sites and consumption centers throughout the nation. Figure 1 displays a map of the U.S. with the major highway transport routes. Rather than locating warehouses near the large manufacturing centers as had been the custom in past development cycles, warehouse space demand will more closely follow population centers where manufacturers and importers can position their product for quick consolidation, packing and distribution to the key retail and consumption markets in large population centers. Markets on this path of goods movement will see more warehouse space than other markets controlling for industrial and manufacturing activity.[20]

Figure 1

Path of Goods Movement



Source: Adapted from U.S. Department of Transportation, 1990 data.

Source: Adapted from U.S. Department of Transportation, 1987 data.

Summarizing the 1990–94 literature research into W/DC demand identified a wide array of substantive variables. They included physical attributes of the site and the structure; locational characteristics; inventory management techniques such as Just-in-Time inventory (JIT); technological improvements in W/DC equipment; the price of capital goods (W/DC space and equipment); the cost of capital; replacement demand due to functional and locational obsolescence; economies of scale; path of goods movement; and industrial employment level changes.

CRITICISM OF INDUSTRIAL EMPLOYMENT-BASED MODELS

Starting in 1997 the "industrial space" demand literature branched in two directions from the 1990–94 literature. The first was the criticism of industrial employment-based demand models. The basic element of this criticism contends that the industrial space demand model and the analysis of the industrial space market are not variants of the office demand model and market analysis.[21] The determining factor in office demand models is employment with a more specific definition of office-based employment across SIC codes (NAICS codes today).[22] Some office studies used total employment in SIC codes that had a high percentage of office-based employment such as the finance, insurance and real estate SIC code (FIRE) and the services code.

The task of estimating office-based employment is difficult, but estimating "warehouse-based employment" is even more difficult. Manufacturing, wholesale and transportation sector employment are not easily segmented into employment in W/DC facilities. The manufacturing sector includes employment in both production and warehousing facilities, very often without specific distinction. Many workers in wholesale and transportation do not work in W/DC facilities. Many workers in the retail industry are W/DC employees but counted as retail workers; consider the big box retailers that use W/DC type facilities with high ceilings for their retail stores and use the upper racks for storage.[23]

"The demand for warehouse space originates more from the volume of inventories stored, rather than from the workers used to move this material around."[24] The volume of freight shipments was used as a proxy for warehouse inventory. [25]

SUPPORT FOR THE ORIGINAL DISCOVERIES

As stated above, starting in 1997 the "industrial space" demand literature took one of two branches from the

1990–94 literature. The second branch presents empirical support for the original discoveries made in the 1990–94 literature. The empirical results generated the following conclusions:

- Focusing on W/DC properties, ceiling height, age of the structure, number of ground level doors (not dock high doors), the change in net employment, and location in a metropolitan area (e.g., Dallas/Fort Worth) are statistically significant.[26]
- Focusing on W/DC properties and using a survey, a majority of respondents (62 percent) indicate that they expect their square footage needs to increase in five years; they are satisfied with the current number of doors and believe their future need for dock doors will remain unchanged (60 percent); their need for ceiling height will not change in five years (79 percent).[27] The survey was performed in 1998 and may not have current relevance.
- Focusing on "industrial" property, the demand for industrial space is a function of employment, investment and technology.[28]

NEW DETERMINANTS

Focusing attention on the determinants of NOI in W/DC properties in three metropolitan markets, significant relationships for several different variables were discovered. In Chicago, the change in exports, the change in gross domestic product (GDP) and the W/DC vacancy rate were found to be significant. In Dallas, the change in exports and inventories as well as building "starts" (a ratio of new construction to the stock of W/DC space in the metro area) were found to be significant. In Los Angeles, the change in imports and manufacturing productivity were found to be significant. Previous period NOI was also found to be significant in each metro area.[29]

Focusing on the "industrial" property market, previous period rent, current period vacancy, current period GDP and the latest period change in GDP are statistically significant determinants of W/DC demand.[30]

EVALUATION OF SUPPORTING VARIABLES

The previous sections of this article chronicle the W/DC market determinants discussed in the literature specifically starting with 1990. However, there are market factors not fully discussed in the literature.

Gross Domestic Product

The role of GDP in W/DC models focused on the U.S. needs examination. First, GDP numbers do not exist for small geographic areas such as local market areas defined as counties or metropolitan areas. So, GDP-based models use national values in local market models; these GDP values are a proxy for local market vitality. The accuracy of this proxy relationship is questionable.

GDP is the total dollar value of all new goods and services produced in the U.S. in a specific year. Relating GDP to W/DC, consider the following ideas:

1. The newly produced goods may require W/DC space but the services do not. So, GDP measures more value than what goes into W/DC space.
2. Imports, which are not produced in the U.S., are a big factor in W/DC demand.[31]

Population or Employment

Population or employment: Which is the conceptually correct W/DC demand side variable? Population and employment numbers in a geographic area are related in the "labor force participation" rate. The rate is stated as the civilian labor force (employed plus unemployed workers) divided by the population in that area. For the majority of geographic areas, the labor force participation rate is typically in the 55–70 percent range. To develop the demand for W/DC space either of these concepts can be used. But which is most conceptually correct? It is population because retail expenditures are related to population more directly than to employment. Employment by NAICS codes in the study area is conceptually less appropriate because employment data does not include children or senior citizens who are retired. These are two large population groups.

Consumer Disposable Income

An author made the following statement: "… high levels of disposable income in the region… draw warehouse developers there."[32] W/DC space holds inventories of retail goods distributed to retail stores for purchase by people who have disposable income. Two geographic areas with the same population but with different incomes will exhibit different demand levels for retail goods. The appropriate income measure to use with population figures is the per capita income of the population in the market area. If households are the measure of people in the area, the mean household income is the appropriate measure. However, many data sources provide only the median income figure of households in the market area.[33]

Levels of Location

W/DC space is located on specific sites in the local economic area and this W/DC space serves at least two related but distinct geographic market areas. The local market area consists of the counties that comprise a metropolitan area. Some portion of the local W/DC space serves the needs of the local residents in the metro area, and it serves the needs of manufacturers that provide goods to both the local residents and to those residing outside of the local market area.

The regional market area that surrounds the metro area is the other geographic area. The other portion of the local W/DC space serves the needs of the consumers, manufacturers and the importers in this regional geographic area.

The geographic extent of these exurban areas reflects federal government regulation that sets restrictions on the truck transport industry. These restrictions are the topic of the next subsection.

Drive Time Regulation

On the demand side, the important linkage for W/DC facilities is population. A key to the demand for W/DC space is "the percentage of population within one day's drive of the port."[34] A W/DC facility can serve at least two different population bases. It can serve the needs of the population in the local economic area, and it can serve the needs of a population external to the local economic area—the regional market area. The ability to serve these populations depends in large part on the regulations governing the truck drivers' hours of service. The regulations are below:

Commercial truckers transporting property (the rules for passenger trucks are a bit different) *are subject to daily and weekly limits on the number of hours they are permitted to work. Generally, drivers are permitted to work no more than 14 consecutive hours. Of that time, only 11 hours may be devoted to driving.* (The remaining time may be devoted to paperwork, loading and unloading, etc.). *After exhausting these limits, drivers are required to spend a minimum of 10 consecutive hours off duty.* (At this time a secondary source states that the 11 hours of driving time is being reduced to 10 hours but we have been unable to confirm this point.)

Drivers are subject to weekly limits as well. Federal regulations prohibit driving after the driver has been on duty 60 hours in seven consecutive days, or 70 hours in eight consecutive days. Drivers may restart the 60- or 70-hour clock by taking no less than 34 consecutive hours off duty.

The local population can be served by "short haul" truckers who leave a trucking facility, deliver the products and return to the facility within the 11-hour driving time and 14-hour maximum limits and generally confine the trips to the local economic market area—the metro area.

The population in the regional market can be served by "long haul trucking" which is also determined by these regulations. These long haul day trips involve a departure and return within the 11-hour driving time and 14-hour maximum limitation. On the condition that the truck can average 55 miles per hour, the total driving time sets out a total distance of 550 miles and a one-way distance of 275 miles.

Points of Entry/Egress

The points of entry are the facilities along the three coasts of the U.S. (the East, West and the Gulf coasts) and the border crossings with Canada and Mexico. Figure 1 displays the 10 major ports and the 10 top border crossings with Canada and Mexico.

Path of Goods Movement Theory

The POGM model is still theory; it suggests a strong association between truck traffic, W/DC locations and population. An inspection of the POGM routes reveals a strong relationship to the Interstate Highway System. Larger W/DC nodes tend to occur at major intersections in this system along routes to and near large population bases. A port is the end point of the POGM system. Over time, the container volume has grown at these major ports and the square footage of warehouse space per person in the major nodes of the POGM system has grown.[35]

Logistics and Supply Chain Management

Logistics has many definitions that may be of interest to the reader. We provide the following from a Google search of the term. Notice that both of these definitions link a process to a warehouse.

- *The detailed **coordination** of a complex operation involving many people, **facilities** or supplies;*
- *The **management and control** of the flow of goods and services from the source of production to the market. It involves knowledge, communication, transport and **warehousing**.*

Supply chain management (SCM) is also defined as a process that is linked to a warehouse. Here is an appropriate definition taken from a Google search:

- *SCM is the organization of the overall business processes to enable the profitable transformation of raw materials or products (inputs) into finished goods and their timely distribution to meet customer demand.*

As logistics and SCM improve the efficiency of business operations within a company and between/among companies, the demand for W/DC space will decline. Here the efficiencies created would be quicker processing of products through a distribution center and the minimization of storage time in the facility. A point to remember is that technological change is not always technological improvement; resources could be reorganized in such a way that productivity declines. Logistical processes could also lead to a decrease in efficiency.

PORT CITY W/DC: A NEW PERSPECTIVE

"Freight movements are an increasingly important determinant of warehousing/distribution space demand. In particular, the rising use of marine container terminals in the global movement of goods is a major contributor to demand (for W/DC space) in the United States."[36] The growth of global trade volume and the demand for additional W/DC space will be determined by many factors, chief among them being the following factors that involve the accommodation of container ships of increasing size.[37]

Panamax and Post-Panamax Ships

The size of oceangoing container ships is limited by the capacity of the Panama Canal. A Panamax ship can pass through the Panama Canal but it is at the upper limit for size. The Panamax ship cannot exceed 951 feet in length, 106 feet in width and a "draft" not exceeding 39.4 feet. The ship can carry a maximum of 4,500 containers known as TEUs (twenty-foot equivalent units). Each TEU is 20 feet long by eight feet wide and eight feet high. This limitation affects shipping between Southeast Asia (China, Japan, Taiwan, Korea, etc.) and the ports on the East Coast of the U.S.

These limitations do not affect shipping through the Suez Canal, which can handle larger ships (Post-Panamax) because it is wider. This extra width affects the shipping routes from Southeast Asia to the East Coast ports of the U.S. for the Post-Panamax ships. However, the transit time for ships taking the Suez Canal route instead of the Pacific Ocean route grows from 11 days to 30 days. The Panama Canal Authority announced plans in 2006 to expand its facilities to handle larger ships. According to their plan,[38] the new facilities will be open in 2014 or 2015. As of 2003, ocean freight carriers were ordering ships of larger size—the Post-Panamax ships. These ships are longer (approximately 1,100 feet), wider (140 feet) and have a greater draft (48 feet); they also carry 8,000 to 12,000 TEUs.

"A Post-Panamax container ship of 366 meters (1,200′) length, 49 meters (160′) width and maximum 15 meters (50′) draft was used as the reference for establishing the ideal lock chamber sizes. This vessel has been identified as the largest type of vessel that carriers in the routes with the greatest frequency, volume and intensity would regularly deploy in transiting the Canal. It accommodates up to 19 container rows through its width and has a nominal cargo capacity of up to 12,000 TEU. The proposed lock dimensions will also allow handling of *Capesize* dry-bulk vessels and *Suezmax* tankers displacing 150,000 to 170,000 tons."[39]

The obvious conclusion is the port cities that will experience an increase in demand for W/DC space will be the ports that can handle the Post-Panamax ships.

Port Infrastructure

In order to accommodate the Post-Panamax ships, port cities must:

- Complete and maintain necessary dredging;
- Lengthen the dock facilities;
- Invest in new overhead cranes that can span up to 22 containers (existing cranes can span 18 containers);
- Provide land to expand the size of dock space;
- Provide land to expand the W/DC facilities;
- Provide skilled labor to expand the docks and build the new space;
- Redesign the dock facilities to efficiently handle the expanded volume of containers;
- Change time of operation of the docks. Many current docks operate only from 8 A.M.–5 P.M. In order to handle the expanded volume of containers, these hours will need to be expanded. 24/7 might be the ultimate time schedule for these expanded ports.

Local Infrastructure

Even if the port facility significantly upgrades its infrastructure in order to handle the expanded container volume, it will not be successful if the containers cannot

be efficiently transported away from the docks. The local economy's infrastructure must facilitate this next leg of transportation. The local economy must:

- Provide streets and highways to facilitate the expanded shipments (expanding the number of lanes, dedicating truck lanes, etc.);
- Provide intermodal facilities to handle the expanded shipments;
- Eliminate impediments to traffic flows such as at grade rail crossings and street intersections that cause traffic backups.

Transit Times

Both producers and retailers want to minimize transit time between the factory and the W/DC that ultimately serves the retailer and its consumers. Transit time has three components—ocean transport, transshipment and land transport. Transshipment involves the removal of the cargo from the ocean carrier and placing it on a land carrier, a process often requiring two to three days. Transshipment may also include the time it takes to cross dock the cargo in a port city W/DC to get the shipments on the road to the ultimate destinations. "The shorter the transit time, the more inventory turns can be accomplished and the greater the flexibility to meet changes in consumer demand or respond to other special circumstances."[40]

INFORMATION FROM CURRENT INTERVIEWS

As a point of interest for the authors, a convenience sample was generated and 10 designees from the Society of Industrial and Office Realtors® were asked several questions. One question was: "Please list as many warehouse space requirements as possible from the point of view of a W/DC space tenant." The items topping their lists largely coincided with the determinants identified in the 1990–94 studies. The rank order of their responses was: location, access to interstates, building size, access to good labor, and building characteristics. When building characteristics were listed, the respondents took the time to identify a series of the physical attributes studied in the academic literature. They also identified several characteristics that have not appeared in the literature. These include: floor flatness and load bearing capacity; insulation rating; electrical power capacity; air circulation; sprinkler system rating; and dock equipment.

In addition, the respondents identified several non-physical determinants not mentioned in the literature. These include: the ability of the facility to expand; the nature and extent of publicly provided infrastructure; the provision of locational incentives; image of the facility; the nature and quality of neighborhood and the general area; and the safety/security aspects for the facility.

WHAT THE FUTURE MAY HOLD

Future events and trends will have either a positive or a negative effect on W/DC space in the U.S. These "favorable" or "unfavorable" effects on W/DC space may emerge slowly over time or may not become evident until an unpredictable, critical threshold is reached.

Energy Costs

A reasonable expectation is increasing energy costs. This increase in fuel cost will raise transportation costs on land, sea and air. Focusing on ocean transport and international air transit, as transport costs increase to a high enough level, they will reduce the advantage of overseas production that uses lower wage labor. This will reduce demand for W/DC in port cities and increase the need for W/DC space near inland metro areas as production of previously imported items shifts to lower wage areas in Mexico, Canada and the U.S.

Foreign Wage Structure and Standard of Living

As the Asian and Indonesian economies grow, the result will be a rising wage structure and standard of living in that area of the world. To the extent these economies outpace the U.S., this will narrow the current wage gap between the U.S. and the Asian and Indonesian economies. Their costs of production will rise, reducing the current advantage of offshore production. Offshore wages will also increase as labor productivity in these countries increases.

Terrorist Attacks

Terrorist attacks on the Panama Canal and Suez Canal facilities would result in canal closures. Such disruptions to shipping routes would greatly lengthen shipping days and increase transportation costs. Terrorist attacks on the major port facilities in China, India and Indonesia would stop a high percentage of ocean cargo, raise transport costs and create an environment of uncertainty regarding the economics of offshore production.

Relative Wage Rates

A decline in the U.S. real wage structure relative to world wages will reduce our relative production costs and thereby increase our exports. At the same time, imports in general, and higher priced imports in particular, will become more expensive. The exact impact on the demand for W/DC space depends on the relative change in imports versus exports.

Value of the Dollar

A decline in the value of the dollar, relative to other key currencies, will reduce our imports and increase our exports. Even if our exports increase, the combined effect of these two changes will be a reduction in the volume of traffic through U.S. ports.

U.S. Government Regulation

Unproductive regulation that unduly limits transport options for the trucking industry will negatively affect procurement and distribution costs. Limiting driving time for drivers shrinks the travel zones and increases the need for overnight delivery patterns.

Currency Exchange Rates

As the exchange rate of the U.S. dollar changes relative to foreign currencies, export and import levels in the U.S. will change. If the U.S. dollar falls relative to those foreign currencies, imports become more expensive and exports become cheaper. This situation will narrow the balance of trade deficit but more than likely will not turn it positive. The major effect could be a differential effect on the volume of traffic through specific ports. The ports nearest the export firms may experience an increase in the demand for W/DC space while most firms should experience a decrease in demand from a reduction in imports.

Ship Size

The size of the fleet of transoceanic ships will continue to increase with more and bigger ships. This trend will not affect deep water ports but will affect the shallow harbor ports that will have to forgo servicing the big ships or incur greatly expanded costs of operation because of the need to dredge. Also, the Post-Panamax ships are wider, so the cranes will have to be upgraded as existing, narrower crane operations become functionally obsolete.

INTERESTING STATISTICS

The demand for and regional structure of the W/DC space market are largely driven by the top ocean ports, border crossings and airports along the path of goods movement. Analysis of these factors presented in Figure 2 reveals several points of interest about export/import truck traffic. First, the top border crossing is U.S./Mexico but the next three top crossing points are along the U.S./Canada border. Second, these border crossings are not in major metro areas but may require an extra amount of W/DC space—more than needed by their local population. Figure 3 reveals similar information about the top ten railroad crossings: Seven of the ten crossings are located at the U.S./Canada border.

Figure 2

Top 10 Border Crossings By Truck

State	Crossing	# Containers
Texas	Laredo	1,382,319
Michigan	Detroit	1,197,967
New York	Buffalo/Niagara Falls	846,114
Califonia	Otay Mesa/San Ysidro	684,425
Texas	El Paso	644,272
Michigan	Port Huron	625,642
Texas	Hidalgo	419,426
Washington	Blaine	310,075
New York	Champlain/Rouses Point	294,970
Arizona	Nogales	276,877

Source: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics

Figure 3

Top 10 Border Crossings By Train

State	Crossing	# Trains
Minnesota	International Falls	3286
Michigan	Port Huron	2846
Texas	Laredo	2479
New York	Buffalo/Niagara Falls	2120
Minnesota	Warroad	2097
Michigan	Detroit	1895
North Dakota	Portal	1739
Texas	Eagle Pass	1555
Texas	El Paso	1424
Washington	Blaine	1219

Source: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics

Figure 4

Top 15 Ports by Total Value in 2008

Port	Value ($ millions)
Los Angeles, CA	$243,910
New York/New Jersey	$185,385
Houston, TX	$147,695
Long Beach, CA	$91,537
Charleston, SC	$62,332
Savannah, GA	$58,987
Norfolk, VA	$53,950
New Orleans, LA	$49,765
Baltimore, MD	$45,312
Philadelphia, PA	$43,176
Seattle, WA	$39,989
Oakland, CA	$38,698
Morgan City, LA	$38,503
Tacoma, WA	$35,322
Corpus Christi, TX	$29,685

Source: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics

Figure 5

Top 10 Airports by Total Value in 2008

Airport	Value ($ millions)
J. F. Kennedy, NY	$167,966
Chicago, IL	$97,180
Los Angeles, CA	$78,292
San Francisco, CA	$52,756
New Orleans, LA	$49,585
Anchorage, AL	$41,443
Miami, FL	$40,036
Dallas/Ft. Worth, TX	$39,488
Atlanta, GA	$32,335
Cleveland, OH	$30,812

Source: U.S. Department of Commerce, U.S. Census Bureau, Foreign Trade Division, 2009

Figure 4 displays the top fifteen ocean ports and Figure 5 displays the top ten U.S. airports for shipping products. Figure 6 shows a different data set for volume of cargo in the top 30 international airports. Notice that Memphis, the FedEx hub, shows up as number one in cargo followed by the airport in Louisville (UPS hub), number two in the U.S. These airport facilities have a significant impact on the W/DC space demand in their local market areas and on specific locations in those local market areas.

Figure 6

Cargo Traffic 2009

Last update: August 5 2010

Rank	City (Airport)	Total Cargo	% Change
1	MEMPHIS TN, US (MEM)	3,697,054	0.0
2	HONG KONG, HK (HKG)	3,385,313	(7.5)
3	SHANGHAI, CN (PVG)	2,543,394	(2.3)
4	INCHEON, KR (ICN)	2,313,001	(4.6)
5	PARIS, FR (CDG)	2,054,515	(9.9)
6	ANCHORAGE AK, US (ANC)*	1,994,629	(15.0)
7	LOUISVILLE KY, US (SDF)	1,949,528	(1.3)
8	DUBAI, AE (DXB)	1,927,520	5.6
9	FRANKFURT, DE (FRA)	1,887,686	(10.6)
10	TOKYO, JP (NRT)	1,851,972	(11.8)
11	SINGAPORE, SG (SIN)	1,660,724	(11.9)
12	MIAMI FL, US (MIA)	1,557,401	(13.8)
13	LOS ANGELES CA, US (LAX)	1,509,236	(7.4)
14	BEIJING, CN (PEK)	1,475,649	8.1
15	TAIPEI, TW (TPE)	1,358,304	(9.0)
16	LONDON, GB (LHR)	1,349 571	(9.2)
17	AMSTERDAM, NL (AMS)	1,317,120	(17.8)
18	NEW YORK NY, US (JFK)	1,144,894	(21.2)
19	CHICAGO IL, US (ORD)	1,047,917	(17.1)
20	BANGKOK, TH (BKK)	1,045,194	(10.9)
21	GUANGZHOU, CN (CAN)	955,270	39.3
22	INDIANAPOLIS IN, US (IND)	944,805	(9.2)
23	NEWARK NJ, US (EWR)	779,642	(12.1)
24	TOKYO, JP (HND)	779,118	(8.3)
25	LUXEMBOURG, LU (LUX)	628,667	(20.2)
26	OSAKA, JP (KIX)	608,876	(28.0)
27	SHENZHEN, CN (SZX)	605,469	1.2
28	KUALA LUMPUR, MY (KUL)	601,620	(9.9)
29	DALLAS/FT WORTH TX, US (DFW)	578,906	(11.3)
30	MUMBAI, IN (BOM)	566,368	1.3

Airports participating in the ACI Annual Traffic Statistics Collection.
Total Cargo: loaded and unloaded freight and mail in metric tonnes.
**ANC data includes transit freight.*
Source: Airports Council International (ACI) at www.airports.org

SUMMARY AND CONCLUSION

Today, research into the demand for W/DC space must investigate the flow of goods and technological factors for answers to the pressing questions concerning both industry and academia. Early research focusing on the flow or path of goods transport began when U.S. manufacturing shifted first to Mexico and later to Asia, and increasingly to China. In the years since the introduction of the path of goods model, China has emerged as the dominant source for consumer goods shipped via larger and larger container ships to ports on both the East and West coasts of the U.S.

As the need for W/DC space grew in port cities, the demand for W/DC space in general was reduced by concurrent shifts in retail distribution activity in the U.S. As large retailers such as Walmart, Target, Costco, etc. grew, they sought to reduce costs and improve the speed and flexibility with which they move product to their stores. This motivation led to the creation of large W/DC structures placed along the pathways—interstate highways—to key markets. This trend reduced the demand for W/DC space in many older geographic markets. So demand grew in port cities and key inland sites along major truck transport routes while demand fell in other market areas. In more recent years, the W/DC space placed in the key markets, port cities and metro areas with major interstate interchanges was large square footage under a single roof—750,000 or more square feet.

Real estate developers building W/DC space should now consider the projections of port growth, import/export activity, and the transport pathways to major markets rather than the traditional industrial or manufacturing employment projections when making decisions on the amount of space and the best locations for new construction of speculative W/DC projects.

W/DC demand literature presents an orderly progression from employment and population demand models to current analytical methods tailored to the dynamics in the W/DC economic activity and spatial markets. ■

ENDNOTES

1. *Webster's New Collegiate Dictionary*.
2. Space Type Definitions – Warehouse at *http://www.energystar.gov/ia/business/tools_resources/target_finder/help/Space_Type_Definitions_-_Warehouse.htm.*
3. Many of the studies referenced in this article focus on "industrial" properties. W/DC space is combined with manufacturing (usually light manufacturing). Also, some of the studies focus on a single set of factors such as structural items while other studies combine sets of factors such as structural and locational. For this reason the categories presented are the authors' choice; for other authors the categories could be specified differently. Finally, this literature search focused on concepts and ideas affecting the demand for W/DC space so statistical results appearing in the articles were ignored.
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22. For a more detailed discussion of the office demand model see Joseph Rabianski and Karen Gibler, "Office Demand Analysis Analytical Techniques," *Journal of Real Estate Literature*, Vol. 15, No.1, 2007.

23. Rabianski and Black, op. cit.

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31. In macroeconomic theory, Gross Domestic Product (GDP) = C + I + G + X – M.

    C = Consumption (a measure of all retail goods and many services bought by consumers)

    I = Investment in new capital goods such as industrial building, fixed equipment, inventories and capital goods (manufactured goods that are used in the production process but not directly sold to consumers)

    G = Government spending on goods and services

    X= Exports

    M = Imports (a negative entity in the GDP calculation but a positive entity in the use of W/DC space)

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33. The mean and median are the same value only in a normal distribution—the bell shaped curve. When the mean is greater than the median the income distribution is skewed to the higher income categories. Using the median income in this situation underestimates the consumer purchasing power in the market.

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37. The following discussion is based on information taken from McGowan. Parts of that discussion are supplemented by the authors.

38. Available at *http://www.pancanal.com/eng/plan/documentos/propuesta/acp-expansion-proposal.pdf.*

39. See endnote 31.

40. McGowan, op. cit.