VALUES FOR SELECTED PARAMETERS IN PHYSICAL DISTRIBUTION SIMULATIONS AND GAMES

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ABSTRACT

Specifying parameters for a model is often a problem confronted by the developer of a game or simulation. *It* is often something which comes up after the basic relationships have been defined and coded.

This paper presents the results of a survey which sought to establish some of the important parameters of a physical distribution system.

INTRODUCTION

One of the primary requirements for successful gaming and simulation, particularly in business education, is the ability to mirror reality. It is felt that the student or analyst should be confronted with situations which are as close to those found in the "real world" as possible. One important aspect of accomplishing the objective of a realistic simulation is in specifying the parameters of the simulated world.

The developer of a simulation will quite often concentrate on developing the algorithm. That is, specifying the variables to be included in the model, and their relationships. However, once the model is developed and ready to run, the analyst often feels much less confident about specifying the parameters of the important variables which will be similar to those likely to be encountered in the real world. For example, those familiar with physical distribution systems are aware of the many variables found in those systems such as warehouses and customer orders and they are aware of the basic relationships between these variables. However, they may not know how many warehouses or how many customer orders per day would be reasonable or realistic to expect.

Those games and simulations currently reported in the literature, unless modeling a specific organization for which all of the parameters are known, arbitrarily choose parameters which the analyst feels are appropriate and generalizeable. However, there is no substantive reason or rationale offered for the particular choices. This paper reports the findings of a survey of the physical distribution systems of 53 firms and provides guidelines or benchmarks for a number of variables which can be used in setting up physical distribution simulations and games.

The data collection method and respondent characteristics will be described first, then the findings and finally some conclusions will be offered.

METHODOLOGY

A questionnaire was mailed to a sample of firms belonging to the National Council of Physical Distribution Management. A total of 53 responses was received. Table I presents a breakdown of the responding firms by industry and sales volume. While the sample size does not permit the development of a precise characterization of physical distribution in American industry it does provide valuable insights across several industries and firms of varying size.

Table I Distribution of Responses by Industry Classification and Sales

Industry	% Less than $100 Million	% $100-500 Million	% $500 Million - 1 Billion	% Over $1 Billion	Total*
1 Pharmaceuticals	0.0	2.4	0.0	2.4	4.8
2 Retail (non food)	2.4	4.8	0.0	4.8	11.9
6 Consumer Non Durable	0.0	0.0	9.5	4.8	14.1
7 Paper	0.0	2.4	0.0	2.4	4.8
8 Food Manufacturing	0.0	4.8	9.5	7.1	21.4
12 Data Processing	0.0	0.0	0.0	4.8	4.8
60 Manufacturing	9.5	0.0	0.0	4.8	14.3
70 Electronics	4.8	2.4	0.0	0.0	7.1
80 Chemicals	0.0	0.0	0.0	2.4	2.4
90 Textiles	0.0	0.0	0.0	2.4	2.4
50 Miscellaneous	0.0	9.5	2.4	0.0	11.9
Total*	16.6	26.2	21.4	35.7	100

N = 53

* Totals may not add correctly due to rounding

FINDINGS

The findings of this study fall into three general categories; 1) customer order characteristics 2) the network or channel structure of the physical distribution system and 3) the transportation system. Each of these areas will be presented and discussed below.

Customer Order Characteristics

It is common for industrial simulation models such as FRTCON and games such as BOY GEORGE and LOGSIMX which deal with physical distribution to begin operation with the generation of customer orders based on some predetermined frequency distribution. Playing the game subsequently involves making decisions to deliver those orders to customers and to insure that future orders can be delivered as well. The game or simulation developer must specify such things as the average size of customer orders, minimum order size, percentage of orders with requested shipping dates, if any, and other values. This study provides guidelines for estimating values such as these.

The average size in pounds of customer orders received by firms responding to this survey was 10,160 ranging from 30 for a retailer to 60,000 pounds for a food manufacturer. Table II presents the frequency of responses in various weight categories along with several types of industries represented in each weight category.

Table II
Average Order Weight and Type of Industry

Average Order Weight	Number of Firms	Type of Industry
<100 lbs	2	Retailing Electronics Manufacturing
100 to 500 lbs	5	Packaged Consumer Goods Retailing Electronics Manufacturing
500 to 1,000 lbs	6	Automobile Accessories Electronics Manufacturing Paper Distribution
1,000 to 2,000 lbs	8	Food Manufacturer Health Care/Pharmaceuticals Textiles Data Processing Equipment
2,000 to 5,000 lbs	7	Arc Welding Supplies Rubber Manufacturing Food Manufacturing Glass Manufacturing
5,000 to 10,000 lbs	2	Lawn Fertilizer Manufacturing
10,000 to 20,000 lbs	6	Retailing Food Manufacturing
20,000 to 30,000 lbs	3	Fibers Chemicals Food Manufacturing
> 30,000 lbs	4	Retailing Food Manufacturing

The average order weight responses are generally what would be expected. Retailers and electronics firms reported handling lower weight orders than do food manufacturers and chemicals producers. However, it also appears that there can be a lot of variation within an industry. For example food manufacturers are represented in several weight categories. Certainly, type of industry is not the only variable which might help explain order sizes.

Twenty-six of the responding firms reported having minimum acceptable order sizes expressed either in dollars or pounds reflecting a concern for the profitability of handling very small orders. Nineteen firms used an average minimum order size of 1616 1b8. ranging from 50 pounds for a chemical producer to 5,000 lbs. for a food manufacturer. Seven respondents reported using either $50, $100 or $500 as their minimum acceptable order quantity. The types of firms using a dollar minimum order size included a health care products firm and an arc welding supplies producer.

Another factor which may be important in determining physical distribution decisions is the percent of orders with requested shipping or delivery dates specified by customers. According to respondents 68% of their orders have requested shipping or receiving dates and 15% even specified the transportation company they wanted their orders to be delivered by. Companies in the electronics, food, health care and motor vehicles reported that all of their orders specified shipping or receiving dates while respondents in the glass and some consumer goods industries reported very few or no requested dates.

Channel Structure

Another important part of a physical distribution game or simulation is the channel structure employed. For instance, the number of plants, warehouses and middlemen used and the flow of orders through each is a critical aspect of any physical distribution system.

The fifty manufacturing firms which responded to this question reported having from one to 120 plants with an average of 14 and a median of five. The distribution of responses is presented in Table III.

Table III
Number of Manufacturing Plants

Number of Plants	Firms Responding
1- 5	24
6-10	12
11-15	4
16-20	0
21-30	3
31-40	2
41-50	2
51-60	0
61-70	1
>70	2

Interestingly, the firms reporting the least number of plants, zero, and the most, 120, identified themselves as retailers. A number of large retailers, such as Sears are vertically integrated and therefore have manufacturing plants even though we would not tend to think of most retailers being involved in manufacturing.

The number of warehouses reported by responding firms ranged from zero to 130 with an average of 17 and a median of 5. Table IV presents the distribution of responses.

Table IV
Number of Warehouses

Number of Warehouses	Firms Responding
0	7
1- 5	14
6-10	6
11-15	4
16-20	2
21-30	4
31-40	0
41-50	1
51-60	2
61-70	0
71-80	0
81-90	0
91-100	1
>100	1

The firm reporting the largest number of warehouses was in the pharmaceutical industry and those reporting very few warehouses represented such industries as packaged consumer goods manufacturing, other manufacturing, retailing, electronics, and glass.

Shipments may move directly from the plant to customers rather than through warehouses or distribution centers. For the average firm responding to this questionnaire fifty percent of less than truckload (LTL) orders moved directly from the plant or plant warehouse to customers. Responses ranged from zero to 100% with a median of 42%. Responses were rather evenly distributed between zero and 100Z. Firms distributing 90 to 100% of their orders directly to customers or retail stores were in the food, fibers, manufacturing and retail industries. Industries distributing fewer than 10% of their shipments directly to customers were in the packaged consumer goods, data processing, textiles, food, tires and lawn fertilizer industries.

Respondents were also asked the percentage of orders shipped to wholesalers/distributors, industrial users, governments, retailers and households. The average responses to this question are presented in Table V. Responses ranged from zero to one hundred percent for wholesalers! distributors, industrial users and retailers, from zero to 20% for government and zero to 50% for households.

Table V
Percent of Orders Shipped to Type of Customer

Type of Customer	Average Percent
Wholesaler/Distributor	46%
Industrial Users	20%
Government	3%
Retailers	29%
Households	2%
	100%

Transportation Variables

For many firms the most important component of the physical distribution system is transportation. There are five basic modes of transportation which an be employed in a physical distribution system. These are railroad, truck, air, water and pipeline. Respondents were asked the percentage of their firm’s shipments which are transported by each mode. The average responses to this question are presented in Tables VI and VII. Truck was broken into for-hire and private or do-it-yourself. Nearly three quarters of all shipments moved by truck. Railroad was a distant second at 17% followed by water and air at 5% and 3.5% respectively. Table VI also presents the range of responses to the question concerning which mode shipments move by. As might be expected both for hire and private truck were the only modes which were used for all shipments at several of the responding firms to the exclusion of all other modes. The largest percentages reported for rail, water and air were 60, 80 and 30 respectively.

Table VI
Percentage of Shipments Moving by Each Mode

Transportation Mode	Average Response	Range of Responses
Railroad	17.0	0-60
Truck (for hire)	63.0	0-100
(private)	11.5	0-100
Air	3.5	0-30
Water	5.0	0-80
Pipeline	0.0	NA
	100.0	

Table VII
Percentage of Firms Using Each Mode

Transportation Mode	Percentage of Respondents Using
Railroad	71.4
For-Hire Truck	95.9
Private Truck	65.3
Air	58.0
Water	42.0
Pipeline	0.0

Table VII presents the percentage of respondents which used each mode at least somewhat. For example, although only 17% of the shipments were moved by rail fully 71.4% of the firms used rail at least for some shipments. Again, truck is the most commonly used mode. Judging from this data, a physical distribution game which only includes one mode would be somewhat realistic as long as that mode was truck. It is interesting that while only 3.5% of all shipments moved by air 58% of the responding firms do use air.

90% of the firms responding to this survey use stopoffs to some extent. Yet only one physical distribution game, Boy George, includes stop- offs. Stop-offs are when two or more orders are in a shipment and one or more of them is picked up or delivered at some intermediate point. For the average 21% of all shipments made by respondents had stop-offs. What’s more, 28% of those shipments with stop-offs had two intermediate stops, 17% had three and 7% had more than three intermediate stops.

CONCLUSIONS

This paper has presented a number of values which can be used as parameters for variables in physical distribution games and simulations. While the results of the study cannot be generalized to American industry as a whole they do provide some insight into what might be reasonable and relevant ranges for these variables.

The findings also provide insights into which aspects of the physical distribution system should be included in a game. For example, 20% of all shipments by responding firms involved at least one stop-off yet only one game includes stop-offs.

It is also apparent that there is a need for more work. First, the number or variety of firms studied should be increased to insure a more reliable base of information. Secondly, there are many variables not addressed in this study. For example, the number of distinct products and SKU's, the number of vehicles in the transportation fleet, the size of the warehouses and many, many more.

This study was meant to take some of the guesswork out of modeling physical distribution systems by providing averages and ranges of parameter values for a group of firms representing several industries.

NOTES

1. For example see Robert G. House, "LOGSIMX: Version 2.0" The Ohio State University College of Administrative Science Working Paper Series, Columbus, Ohio, or James Gentry, George C. Jackson and Fred Morgan, "Demonstration: A Computerized Logistics Game for Micros," Proceedings of the Association for Business Simulation and Experimental Learning, Orlando, Fla, Feb. 27-March 1, 1985, or "SIMCON I? A Computer Based Simulation Model for Evaluating Physical Distribution Strategies Involving Order Consolidating" Proceedings of the Association for Business Simulation and Experiential Learning," Feb. 24-27, 1982, Phoenix, Arizona.

2. See footnote 1 above.

3. Boy George is the name of the game presented in "Demonstration: A Computerized Logistics Game for Micros," Proceedings of the Association for Business Simulation and Experiential Learning, Orlando, Fla., Feb 27-March 1, by Gentry, Jackson and Morgan.