Supply-chain system costs of alternative grocery industry pallet systems

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Abstract

This paper reports results from a study of the financial components and relative advantages of two alternative pallet load systems: rental and purchased pallets. Through personal on-site and telephone interviews of 13 large pallet-using grocery companies in various regions of the United States, cost variable categories were established and cost ranges were assigned to each category for each system. Simulation modeling of each pallet system was performed, using data randomly generated from the defined ranges of costs. Results of the simulations indicate a statistically significant finding that rental pallet systems are, on average, more costly to the customers through the supply chain than purchased pallet systems, by at least $1.00 per pallet trip.

Each year, the wood pallet industry provides over 400 million new wood pallets into a total pallet pool of over 4 billion pallets. Users of these wood pallets face two distinctly different options for acquiring the use of these pallets: they can purchase them, or they can rent them for a cycle through the supply chain, what is commonly termed a "pallet-trip." Since the rise of the rental pallet systems in the United States in the early 1990s, conflicting claims of the cost effectiveness, and especially the true total cost of a pallet in each type of system, have become a source of much contention in the industry.

Claims in support of as well as against the cost effectiveness of rental pallets have circulated among major end-users (The Pallet Foundation 2003). This discrepancy is due to several factors: the perceptual importance of initial cost, the fact that platform managers have different "value" systems, little accurate research on pallet life and quality as related to different customer groups, the impact of pallets that "leak" from given supply chains, and the unquantified costs of asset management. Industry trends in the 1990s and on into this decade have seen most large pallet-consuming organizations trying to "get out of the pallet business" as they seek to focus on core competencies. In this business climate, the attraction of rental pallet systems that take the ownership of pallets and their associated management costs out of the customers' hands found a welcoming corporate constituency.

In the early 1990s, as the rental pallet companies struggled to build a critical mass in their pallet pools and market share, the costs associated with the inefficiencies of existing purchased pallet delivery systems were noted by the industry but little progress was made to reduce these inefficiencies. Most notably, the pallet exchange system that thrust logistics firms in the middle of the pallet ownership cycle imposed a special source of inefficiency that encouraged unnecessary middleman costs and profits, and inconvenient service standards. Also, product damage due to poor pallet quality resulting from lack of industry standards drove many pallet customers to seek alternative shipping platforms.

For many companies, the rental pallet companies provided a solid alternative solution. Utilizing a high-quality, low maintenance strategy, the rental pallet providers made significant gains in market share as corporate purchasing agents sought ways to simplify their life. Although this higher quality and service certainly had a cost associated with it, the rental companies spread the cost over the distribution system with

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innovative pricing systems aimed to reduce the front-end charge to the product manufacturers. The net result for many pallet customers in the supply chain was decreased pallet cost with improved service and pallet quality. As the rental systems reached critical mass and landed large corporate customers, many other companies changed ships and signed contracts with rental pallet providers, and began divesting themselves of their supporting overhead for management of pallets. However, the special requirements of participating in rental pallet pools related to pallet asset tracking and accounting carried their own administrative burden.

At issue, then, is at what price the additional level of pallet quality and service offered by pallet rental agencies comes to the users. Vertically integrated corporations, in particular, which realize the entire cost of the pallet through the supply chain, have begun taking hard looks at the total "system cost" of their pallet usage. In order to provide an objective analysis of the product/service options to these large, important industry customers, this study seeks to quantify and compare "total system costs" of rental and purchased pallet systems.

The primary objective of this study was therefore to provide a current, accurate, and objective analysis and comparison of the relative system costs of purchased pallets and rental pallets as they were marketed in 2004. A secondary objective was to establish a standard methodology and user-friendly tool by which future pallet system cost analyses can be conducted.

Review of pallet costing research and tools

Most of the available literature on pallet cost is focused on estimating the manufactured cost of pallets. The most extensive work has been done by Palmer et al. (2001) who developed the Pallet Costing System (PCS). This software product "computes the total and per-unit cost of manufacturing an order of wood pallets." PCS allows the user to consider typical manufacturing costs (i.e., raw materials, labor, fixed machine costs, and overhead) in the light of current market demand to establish a selling price for the manufactured pallet product. PCS also allows sensitivity analysis to be run on alternative raw materials, labor costs, and manufacturing configurations.

Various pallet equipment manufacturers also offer pallet manufacturers tools to estimate manufactured cost. For example, Automated Machine Systems (2005) offers pallet manufacturers computerized tools to calculate and control pallet manufacturing costs, and Forestry Systems, Inc. (2005) with its Yardmaster Premier Pallet System offers the addition of pallet inventory control as well as interface to a barcode-based pallet tracking system.

Anderson and Wisdom (1991) developed a methodology to estimate total usage of grocery system (GMA) pallets in the industry. Using the following assumptions, they were able to estimate that the grocery industry carried a total pallet inventory cost of over $700 million: 1) 75 million grocery pallets manufactured per year; 2) an average pallet life of 1.5 years and 12 trips; and 3) an average turnover period of product in a warehouse of 3 weeks. Also, they estimated that first-use pallets accounted for roughly 15 percent of the grocery pallets in the system.

As alternative rental pallet systems have become established, the difference in pricing schemes as compared to the traditional purchased pallet systems has gradually created considerable confusion in the marketplace over the true total cost of the alternative pallet systems. Our project sought to update previous pallet costing studies and provide a meaningful comparison of the two competing pallet systems.

Methodology

The methodology for this project was determined after consultation with industry experts and extensive study of the pallet systems in question. The research team determined that study participation and data collection from a broad-based industry survey would not be comprehensive or robust enough to develop meaningful and statistically significant models. Therefore, the decision was made to base an analysis on cost estimate ranges and simulated data sets.

Data collection

The methodology chosen was to conduct sufficient industry interviews to establish realistic ranges of the various costs of the pallet delivery systems, and use computer simulation to sample from those expert-derived ranges, model the alternate systems, and perform analyses accordingly. Six grocery-industry companies (three in Texas, one in Ohio, and two in Pennsylvania) contributed significant time with the research team in personal on-site interviews, discussing pallet system cost ranges, based both on their own realized costs and their knowledge of costs across their industries. Seven other companies (one in Texas, three in North Carolina, one in New Jersey, one in New York, and one in Pennsylvania) were interviewed by telephone and helped fill in some holes from our on-site interviews of the six primary companies. These companies were carefully selected to ensure representation of the entire supply chain of a typical grocery pallet trip.

It must be understood that all references to pallet costs in this study refer specifically to *system costs*, or the cost of a pallet in usage to the customers through a complete cycle of the supply chain, or as is more commonly known in the industry, through a "pallet trip." It was not within the scope of this study to determine actual total costs per different type of pallet, including manufacturing costs, etc. In the context of this study, pallet costs are simply what the pallet users realize as actual costs to them. In effect, it is assumed that total comprehensive costs of the pallets (including raw material, manufacturing, carrying costs, etc.) are reflected in the system cost as charged to the users. In actual practice, this may not be the case; however, it has no bearing on the research objectives or results of this particular study.

Process modeling

Simplification and variable aggregation. — One modeling issue that evolved during the study was that of "simplification." The numbers, complexity, and apparent interaction of all the variable components of pallet system costs through the supply chain can easily begin to bewilder anyone who attempts to define the systems. One study participant had identified over 50 different variables in his attempts to quantify the pallet-costing problem. Therefore, based on prior modeling success the authors have had with multivariate evaluation and factor analysis (Zhang and Ray, 1995; Ray et al. (2006), the team began to attempt simplification of the modeling problem by clustering the variables into categories. However, in the absence of "real" data, these variable categories were determined through intuitive process relationships, rather than strict data relationships. Detailed variable costs that appeared to be wholly included in larger, more general cost categories were dropped from the list of variables to be modeled. The

Table 1. —*Alternative pallet system cost categories and data ranges, per pallet-trip.*

Variable	Variable ID	Purchased system	Rental system
Acquisition/issue fee	*A*	4.00 to 6.00 (used) 9.00 to 11.00 (new)	1.00 to 5.00
Retention ratio	*RR*	80% to 100%	80% to 100%
Daily rental charges	*DR*		0.00 to 0.03
Pallet rental basis	*b*		10 to 60
Transfer fee	*T*		0.00 to 1.50
NPD surcharge	*NPD*		0.00 to 0.50
Pallet racking, etc.	*Ra*	0.05 to 0.20	0.0
Pallet sortation	*So*	0.02 to 0.10	0.02 to 1.00
Pallet administration	*Ad*	0.01 to 0.10	0.10 to 1.00
Product damage	*Da*	0.03 to 0.30	0.005 to 0.02
Return (credit)/cost	*Re*	(1.50 to (2.50)	0.15 to 0.35

resulting list of cost categories, while not capturing every single cost incurred in pallet usage, does include each of the major costs identified by the project sponsors (The Pallet Foundation 2003). These cost categories, with the data ranges as determined through the project interviews, are listed in **Table 1** and demonstrated graphically in **Figure 1**.

Based on translation of the developed graphical model (**Fig. 1**), the system cost (C_i) for any individual pallet trip in the purchased pallet system was determined to be:

$$C_i = A_i + Ra_i + So_i + Ad_i + Da_i - (Re_i * RR_i) \qquad [1]$$

where: i = simulated iteration, and all other variables are as shown in **Table 1**.

In comparison, the system cost (C_i) for any individual pallet trip in the rental pallet system was determined to be:

$$C_i = A_i + (DR_i * b_i) + T_i + NPD_i * (1 - RR_i) + So_i + Ad_i + Da_i + Re_i \qquad [2]$$

where i = simulated iteration, and all other variables are as shown in **Table 1**. Justification for the determined Equations [**1**] and [**2**] is developed in the following discussions of the individual variable categories.

System cost variables in the study. — **Table 1** shows the range of all cost variable categories as they were assigned and utilized to randomly generate the simulated cost scenarios in the study. These ranges were determined through the participant interviews, and validated through follow-up calls both to the participant companies and other industry experts. Each variable category is explained briefly in the following paragraphs.

Acquisition/ issue fee (A): This is a best estimate of the range of pallet acquisition costs to the product manufacturer. One important issue in modeling the total system of purchased pallets was how to accurately represent the relative proportions of new and recycled pallets used by customers. The solution settled on was to generate one new pallet cost scenario for each nine recycled pallet acquisition cost scenarios. This yielded a simulated pallet system where 10 percent of all pallets beginning a pallet trip were new pallets, that is, 1 out of 10 entered the system at the cost of a new pallet.

We put forward two logical justifications for this approach. The first justification is related to pallet pool size. The National Wooden Pallet and Container Association estimates

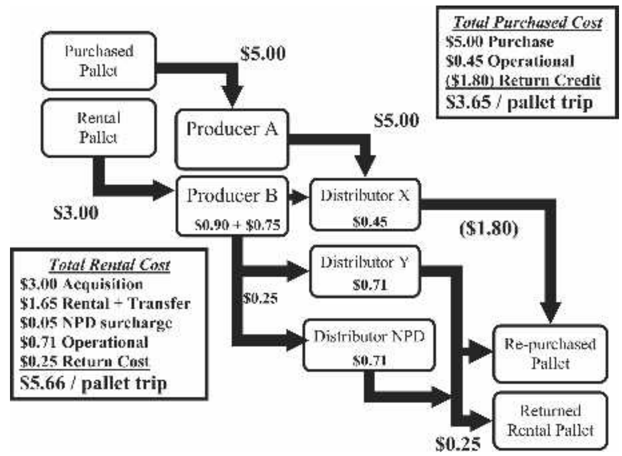

*Figure 1. — Graphical comparison of typical generalized pallet system cost models, with one possible set of costs included for demonstration of cost model (Equation [**1**]). This figure illustrates one of the 228 simulated scenarios used for analysis in the study, with a realized $5.66 total rental system cost vs. a $3.65 total purchased system cost in this one scenario. NPD stands for "non-participating distributor" in industry terminology.*

that 420 million new pallets enter the national purchased pallet pool each year. In addition, they estimate that 275 million pallets are repaired and recycled yearly, for a total of nearly 700 million pallets entering the purchased pallet system each year. Furthermore, they estimate that the number of pallets held in storage somewhere in the system to be five times that number, equaling approximately 3.5 billion pallets. This would represent a total of 4.2 billion pallets total in the entire wood purchased pallet system. Since 420 million of those are newly introduced each year, 10 percent of the annual total purchased pallet system would be flowing through the system at new pallet cost.

As a second logical justification, Anderson and Wisdom (1991) had estimated that 15 percent of the pallets in the grocery system at any one time were new (first-trip) pallets. Based on improvements in pallet design since, and the huge increase in the pallet recycling business, it is logical to assume that a smaller percentage of new pallets is now needed in the system.

Based on these logical justifications, 10 percent was settled on as a good rule of thumb, and that number was selected as the percentage of new pallets generated in the simulation.

Finally, the issue fee associated with rental pallets was assigned a range determined by prices quoted in the study. The simulated range of rental acquisition fees as shown in **Table 1** is probably biased low; the first of several variable costs to be biased low for rental system cost estimates.

This choice to bias the estimates favorably toward the rental pallet option was done to improve the statistical power of the analysis. Preliminary cost calculations of the two systems hinted that the rental system appeared to be the higher cost alternative. If statistical measures of significance supported a difference in average prices, even with the assumed higher cost rental system biased low, confidence in the strength of the simulated statistical results could be supported.

Retention ratio (RR): One of the challenges of this study was to estimate total system cost under different assumptions of "leakage" from each system. All of the participants agreed that their actual leakage number was hard to pinpoint . . . several had gone through a leakage calculation exercise with their rental pallet provider to settle inventory reconciliation disputes. In this study, an average loss to each system of 10 percent (90% retention) was simulated, with individual scenarios randomly generated between 0 and 20 percent (100% to 80% retention).

Daily rental charges (DR) and rental basis (b): This is an interesting cost in that some companies appear to be paying daily rental fees, and others claim that they do not. Those that don't are either turning their pallets very quickly, or generally paying a higher issue fee on the front end. The rental basis is used to simulate the length of time the rental fee is charged, and ranges from 10 to 60 days. As shown in Equation [**2**], the product of daily rental charges (*DR*) and the rental basis (*b*) is a component of the rental system cost; these costs do not appear in the calculation of purchased system costs (Eq. [**1**]), for they are not part of the purchased pallet system cost structure.

Transfer fee (T) and NPD surcharge (NPD): These are two costs specific to typical rental pallet systems at the time of the study. A transfer fee may be charged by the pallet rental company to the customer as it "transfers" the pallet to the next point in the supply chain; this fee was found to fall between no fee and $1.50 per pallet. An NPD surcharge is an additional fee assessed to the customer if the pallet is shipped to a "non-participating distributor," that is, a distributor who has not signed contracts of participation in the rental company's pallet pool. Neither of these costs is incurred in purchased pallet systems.

Pallet racking (Ra): This cost is associated with downtime and other miscellaneous costs related to pallets causing a disruption in the warehouse flow, usually in automated handling systems. Several warehouse managers commented that one of the biggest advantages of the rental pallets is that their construction specifications result in smooth flow through their system. In fact, no company interviewed could assign any pallet racking costs to the rental pallets. This study reflects that opinion, with $0 being assigned for pallet racking costs in every simulated instance of rental pallet usage; therefore, variable *Ra* does not appear as a cost component in Equation [**2**].The companies in the study unanimously associated this cost with the variable quality and specifications of the purchased pallets. Variable *Ra* is therefore included as a cost component in Equation [**1**].

Pallet sortation (So): This variable reflects the yard/warehouse handling costs of pallets once their loads have been removed and the pallets are being sorted for return. The pallet sortation cost range for the purchased pallets reflects, on the low end, simple forklift/fuel/storage costs for an all-purchased pallet operation, where on-site sortation is not necessary. On the high end, certain distribution centers run their own pallet sortation operations in which damaged pallets are set aside for disposal or shipment to pallet recyclers.

The pallet sortation cost range for the rental pallets reflects the following: 1) on the low end, an operation with all rental pallets, where sortation is not necessary and simple stacking for return is all that is necessary; and 2) on the high end, large distribution centers that have such a large volume of mixed rental/purchased pallets that they have built special sortation facilities on site, manned by up to four employees. Therefore, the cost variable *So* was shown to be a real cost in both systems and was thus used as a cost component of both Equations [**1**] and [**2**].

Pallet administration (Ad): This variable reflects one of the most greatest advantages to the purchased pallet system. Purchased pallet systems that do not require tracking of the pallet asset require a considerably smaller investment in administration resources than do rental pallet systems where the customer is responsible for tracking and accounting for the asset.

Many of the companies indicated that this administration cost is coming down as the rental pallet systems mature. This cost area is one that seems ripe for improvement, possibly through the use of technology to eliminate manual tracking counts and reports. However, the cost of the technology may necessarily increase the issue cost of the pallet. A sensitivity analysis on the administration cost range in this study indicates that any technology that increases the rental system issue fee less than $0.50 a pallet will be a net cost improvement for the customer.

For purchased pallet systems, a lower *Ad* cost range reflects the nature of the purchased pallet systems, with costs and credits being passed through on normal invoices, thereby requiring no unique administrative or clerical resources.

Therefore, since it was shown as relevant in both systems the cost variable *Ad* becomes a cost component of both Equations [**1**] and [**2**].

Product damage (Da): This variable is one that is a significant source of advantage for the rental pallet systems, which provide standardized pallets for customers that are over-engineered for most applications. Various industry estimates of over $2.00 per pallet product damage, or 20 to 25 percent of the total cost of the pallet, seem to be taken from extrapolations of worst-case scenarios from a previous non-cited study and allocation of these estimates over an estimate of a total pallet pool that is several times too low. It could also be that the general improvement in pallet quality in the 1990s due to Pallet Design System (PDS) education and competition from the rental pallet designs has considerably decreased product damage costs.

Shown to be a real cost in both systems, the cost variable *Da* becomes a cost component of both Equations [**1**] and [**2**]. The ranges of *Da* reflected in **Table 1** were settled on by first determining the type of products most frequently damaged, how many times a month a product damage incident was likely to occur, the cost of that damage, and then allocating that across the total pallet volume for that customer.

Results and discussion

Simulation of total system cost

In order to increase the strength of the system cost findings, the research team modeled the alternative supply chains according to the variable ranges as discussed in the Methodology section. For ease of use in the industry, the model was formulated in a spreadsheet environment, using Microsoft Excel. A sample set of scenarios is shown in **Table 2**. Scenario 1 represents a purchased/recycled system; scenario 2 represents a purchased/new scenario; and scenario 3 represents a rented pallet system. This set of scenarios represents 3 of 228 scenarios used to calculate the statistical tests of significance, and 3 of the thousands used for graph generation during sensitivity analysis.

Table 2.—A sample set of three scenarios, representative of simulated total cost generation in this study.

Variable	Scenario 1: Recycled	Scenario 2: New	Scenario 3: Rental
Acquisition/issue fee	4.00	9.40	3.20
Retention ratio	0.90	0.88	0.91
Daily rental charge			0.023
Pallet rental basis			45
Transfer fee			0.88
NPD surcharge			0.40
Racking/operational cost	0.094	0.097	
Sortation cost	0.06	0.02	0.387
Administration cost	0.099	0.017	0.64
Product damage cost	0.038	0.072	0.012
Return (credit)/cost	1.575	1.716	0.31
Total system cost	2.72	7.89	6.50

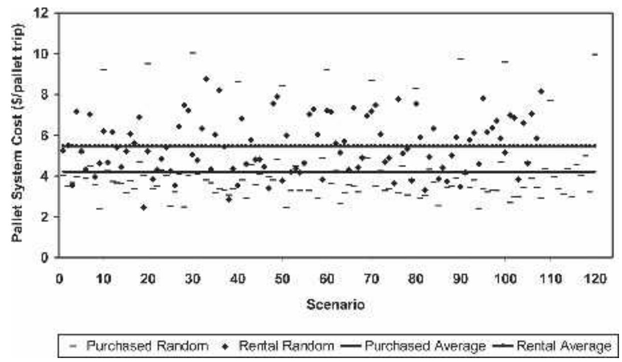

Figure 2. — Graphical representation of 228 realizations of randomly generated sample scenarios. Rental system realizations are plotted as solid diamonds; purchased pallet systems realizations are plotted as dashes. Dashes near top of graph represent new purchased pallet scenarios as generated.

A graphical representation of 228 realizations of the simulated scenarios is shown in **Figure 2**, which illustrates the conclusions that summary statistics in **Table 3** support. The pattern of solid diamonds represents different realizations of simulated rental pallet system costs. The pattern of dashes represents different realizations of simulated purchased pallet system costs. While individual realizations sometimes overlap, the general tendency of the rental data points is to be higher (more costly) than the purchased data points, with the exception of the new pallet scenarios, which are the line of dashes near the top of the graph. The solid lines represent the respective averages of the scenarios; for these data points, the average system cost of the purchased pallets is near $4.00 (new pallet scenarios included); the average system cost for the rental scenarios approaches $6.00.

A two-sample t-test assuming equal variances was conducted on the first 228 simulated scenarios, consisting of 108 purchased-recycled scenarios, 12 purchased-new scenarios, and 108 rental scenarios. The 12 purchased-new scenarios were included in the purchased data set as noted in the Methodology section. The test statistics are given in **Table 3**. and can be summarized as follows:

- The average cost of the first 120 randomly-generated purchased pallet system scenarios (including 12 new pallet scenarios) is $4.07; the average cost of the first 108 randomly generated rental pallet scenarios is $5.56.
- The variance and SD of the purchased scenarios are higher than those of the rental scenarios. This indicates the higher variability of purchased pallet cost systems, but this effect is due to the inclusion of the new pallet scenarios. Without the new pallet inclusions, the rental pallet cost outcomes are actually slightly more variable, as will be noted in the Sensitivity Analysis section of this paper.
- The pooled variance of all scenarios is nearly half as large again as the mean cost of the pallet systems. This indicates that relative to cost, there are significant cost differentials across different scenarios, another way of saying that pallet system cost scenarios are not very consistent from one scenario to another.
- Hypothesizing a zero difference in the true mean cost of the two systems, we find that the probability of this hypothesis is extremely low (0.0000000000109). Thus we conclude that there is, in fact, a significant difference in the means of the two systems.

Table 3.—A two-sample t-test (alpha = .05) assuming equal variances on the first 228 randomly generated scenarios. Purchased values include 108 recycled and 12 new scenarios.

Statistic	Purchased scenarios	Rental scenarios
Mean	4.07	5.56
Variance	2.80	1.71
Sample standard deviation	1.67	1.31
Observations	120	108
Pooled variance	2.28	
Hypothesized mean difference	0	
Degrees of freedom	226	
t statistic	−7.432	
P(T<=t) one tail	1.09 E-12	
t critical one tail	1.65	
P(T<=t) two tail	2.19 E-12	
t critical two tail	1.97	

- Based on a 95 percent confidence calculation of the mean system costs, we estimate the true mean of the purchased pallet systems to lie between $3.78 and $4.37, while the true mean of the rental pallet system to lie between $5.38 and $5.89. Comparing the smallest and largest differences of these two ranges, we can estimate that the actual cost differential of the two systems is between $1.01 and $2.11.

Sensitivity analysis

The simulation model makes certain leverage points apparent. For both systems, initial acquisition/issue costs are the key driver. Any reduction of the front-end cost to the customer considerably impacts the whole system cost of that option. For the rental pallet systems, the typical transfer fee and administrative costs incurred by the customer are both considerable from a cost standpoint. Elimination of the transfer fee and any system improvement that reduces or eliminates the need for customers to track pallets through physical inventories and paperwork will greatly improve the competitiveness of the system.

And finally, for the purchased pallet systems, the real cost leverage lies with the return credit, or pallet repurchase price.

Any system partnerships or accommodations that would increase "purchasing power" of the pallet recyclers on the backend, yielding an increased credit to the pallet customer, would greatly increase the competitiveness of these systems.

Limitations of the study

The objective of the study as specified by the project sponsors was to focus specifically on standard grocery-industry pallets, the main business in which the rental systems compete. System costs of non-grocery-industry pallets have not been examined here, and do not seem relevant to the topic at issue.

Cost variable ranges from which the simulated data were generated were developed by applying an estimated 2-standard deviation buffer around the cost numbers suggested by the project participants. For example, when product manufacturers typically gave us recycled pallet purchase costs of $4.50 to $5.25 on average, we selected $4.00 to $6.00 as a range that would have a solid chance of capturing recycled pallet purchase costs in at least 95 percent of the cases around the country. We attempted to be conservative in our estimations; that is, we tried to give a wider range than we suspected we might find through exhaustive data collection. And to double the conservative nature of our analysis, we sampled from a uniform distribution of randomly generated numbers within that range. This would eliminate any bias from an over-specified exponential or normal distribution, and give us estimates that allow for an equal chance of generation anywhere within the range. For our example above, then, the simulation model randomly generated recycled pallet purchase costs between $4 and $6, with any cost in that range having an equal chance of being generated.

In a simulation where we might have stronger data to guide our cost simulations, we would attempt to increase the precision of the simulated instances by sampling from a more specific distribution, such as a normal (bell-shaped) distribution. This would drive the randomly generated cost scenarios toward the center of the specified range, implying that we have confidence that the actual true average cost would be near the center of the range. However, lacking a large sample size for direction, we opted to generate and sample the variables from uniform (equal-chance) distributions, which decreases the precision of the estimates of average cost, but increases our chances at accuracy in conclusion.

Finally, it does make logical sense that certain of the variables used in the cost models have some degree of correlation. In some cases, these variables may be inversely correlated, with the result that a high cost of one variable in a system may necessarily generate a lower cost of the inversely-correlated variable. In a simulation-based analysis of this type, variable correlation is impossible to ascertain. If real data ever become available for study, correlation analysis, along with more precise generation of variable distributions as noted above, will certainly improve the quality of the analysis.

Conclusions

Our simulation of the relative costs for pallet rental systems vs. pallet purchase yielded a number of important findings. First is that the average system cost, to all pallet users in a typical grocery pallet supply chain, of a rental pallet is from $1.01 to $2.11 higher than the average system cost of a purchased pallet. However, pallet system costs at the product producer (e.g., a food manufacturer) stage of the supply chain can be lower for rental systems, depending on pallet turns.

Pallet system costs roughly equalize once the pallets enter the distribution system. Daily rental fees, transfer fees, and NPD surcharges begin to offset the higher acquisition costs of the purchased pallets. Higher initial cost and product damage costs in the purchased pallet systems are offset by the higher administrative costs of the rental pallet systems.

It appears that final disposition of the pallets determines the ultimate cost differential of the two systems. The return credit or sell price of purchased pallets yields the cost advantage for the purchased pallet system, and it is increased by the rental pallet return costs. Since the system price differential is not realized until this final step in the supply chain, only distribution centers or vertically integrated corporations realize the impact of this differential.

Verification of the data ranges in this study, and generation of a large number of simulated scenarios stemming from those data ranges, lead us to have a high level of confidence in the *accuracy* of the conclusions of this study. We would expect actual pallet system costs to fall within the predicted ranges anywhere in the United States where the variable costs fall within the stated ranges.

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