Cost Reduction Considerations for Peddle-Run Distribution Systems

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Emphasizes the importance of the awareness of visit frequency savings potential.

Maintaining cost effectiveness where nonhomogeneous products are being supplied to a number of locations from one-carrier routes is among the most difficult problems in distribution management (2,3,4).[1] For example, attempts to enhance truck capacity utilization are frustrated by concurrent needs to maintain order integrity, to meet delivery schedules, and to provide an adequate level of services.[2] For a given time interval, demands may range from multiples of one truck's capacity to very small fractions thereof, New employees find that learning the art of carrier loading is difficult if not impossible. Products are damaged and individual orders must be resorted at the delivery point due to improper loading practices. In essence, any thought of implementing potential cost reduction techniques are tempered by the possibility that they might fail and are further tempered because costs may even be increased (1, p. 51).

Typically, in a situation where many retailers are served by one warehouse the routes are determined according to carrier capacity, road miles, and retailer demand for a week (or other regular interval) (3). The weekly route structure is then followed religously until demands on any one route increase beyond truck capacity, until new retailers enter, or until old retailers leave the system. Once route restructuring is required the initial process is repeated with all or more than likely a small part of the affected retailers (5).

The objectives of this study are: 1) provide insight into safe cost reduction techniques; 2) the load-size/loading-time trade-off is presented to demonstrate how it is that greater capacity utilization is not always desirable and 3) determine potential cost savings from determining visit frequency within a distribution routing analysis rather than accepting it as given.

Capacity Utilization Considerations

Carrier capacity utilization is crucial to peddle-run management once a particular sized carrier is assumed. In situations where a choice of carrier capacities exist the following suggestions can be utilized iteratively to estimate peddle-run distribution costs for each size carrier being considered. Estimates for each capacity are essential because implications from considering the interactions between loading productivity, capacity utilization, and visit frequency cannot be generalized across capacities. In fact, it is conceivable that two firms utilizing equal capacity tractor trailers could easily exhibit different average load size because of different product densities, bulk, shape or combinations.

The need to understand the relationship between average and maximum capacity presented itself in a recent research (5). Apparently, dispatchers regularly underutilized their cubic truck capacity. Curiousity as to the motivation behind such capacity utilization revealed the importance of the load-size/loading-time trade-off.

Consequently, capacity utilization was studied in a sensitivity analysis to evaluate the trade-off between loading time and average load-size. Loading times and therefore costs increase more than proportionately as load-size (LS) increases for a given carrier capacity (CC). More and more time and expense was incurred in the loading effort as larger and larger proportions of the total capacity were utilized (Figure 1).[3]

In other words, as the LS/CC ratio increases, the loading time and therefore the loading cost (LC) increases more than proportionately. The cost in time spent loading carriers must be offset by the number of visits that can be made with each carrier per trip. The more available capacity utilized the more visits each carrier can make per trip, the lower the total system's delivery cost (DC). Total system's distribution costs (TC) where TC = LC + DC, might be reduced by increasing the number of trucks (routes) if the subsequent decrease in LC is greater than the increase in DC.

The study firm's management was adding a route to a weekly distribution system despite an average carrier utilization of less than 50 percent in cubic measure. The transportation manager justified the added route in terms of loading times. Given that managers may tend to turn first attention to what currently seems to be their most troublesome areas, it is likely that the firm's distribution situation had proceeded to the right of point b. in Figure 1 before the need for change was realized. Further firm-level research on this aspect of the problem would likely pay high premiums to decision makers. Iterative capacity manipulation allowed for load-size/loading-time trade-off analysis.

The question of what should be done with dealer demands that are greater than carrier capacities is usually solved by forcing round trips to the applicable dealers. However, forcing round trips to dealers with demands greater than the carriers capacity may not be ideal as only the residual demand is treated by the actual route structuring portion of the exercise. Total costs may be minimized if the large dealer's demand is parceled out to two or more nearby routes.

Visit Frequency

Implicitly, most distribution routing schemes, including computerized routing models, assume a given visit frequency. Demand expressed as daily, weekly, or monthly dealer requirements forces daily, weekly, or monthly delivery. Manipulating visit frequency is likely to reduce cost over a solution that requires uniform regular delivery.

Frequency manipulation is at least a potential for savings through distribution-routing. A sample problem is presented in Figure 2. The shortest route (OACBO) covers 180 miles for each time period, one week, for example. If however, point C could accept less frequent visits, say once every four or eight weeks, adding C to the weekly route would be suboptimal.[4] In this particular example, up to two round trip deliveries to C would be less expensive than including C in the total route every week. (Table 1 and Figure 3). In an actual situation, less frequent visits to C might allow less frequent visits to the remaining points in the main route and therefore reduce costs. Replacing less frequent

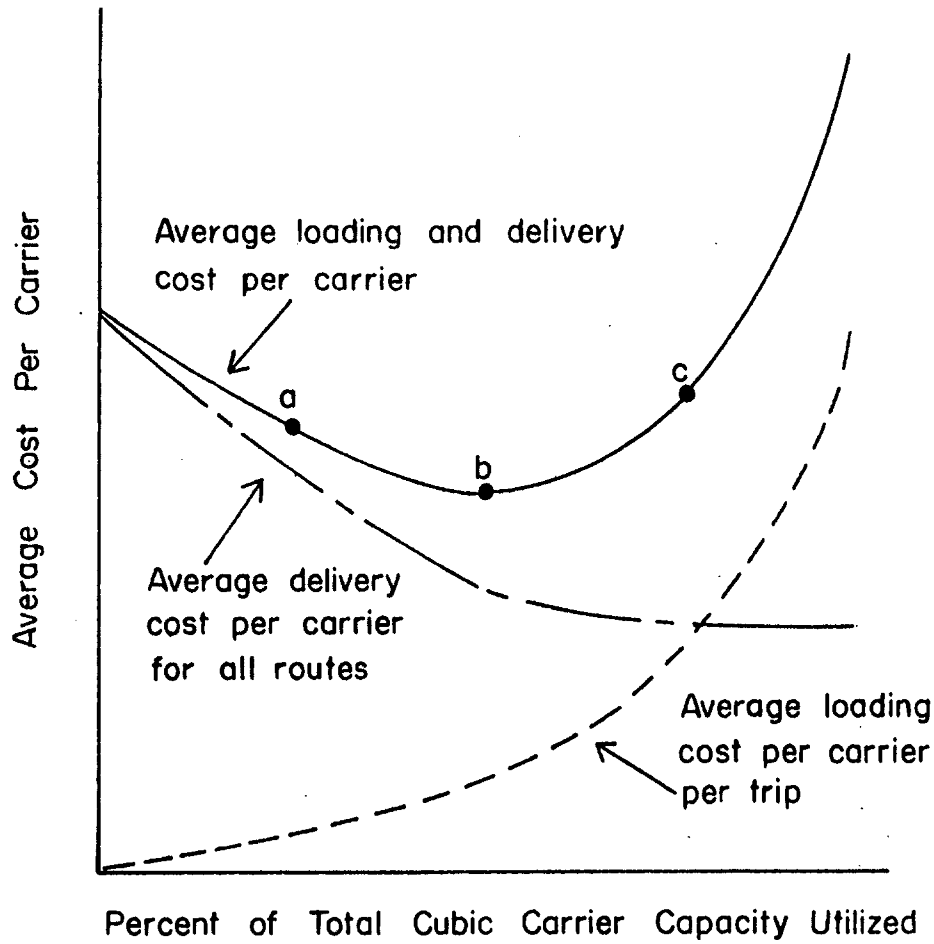

Figure 1. Hypothetical relationships between loading and delivery cost per carrier trip as they relate to degree of total cubic carrier capacity utilization.

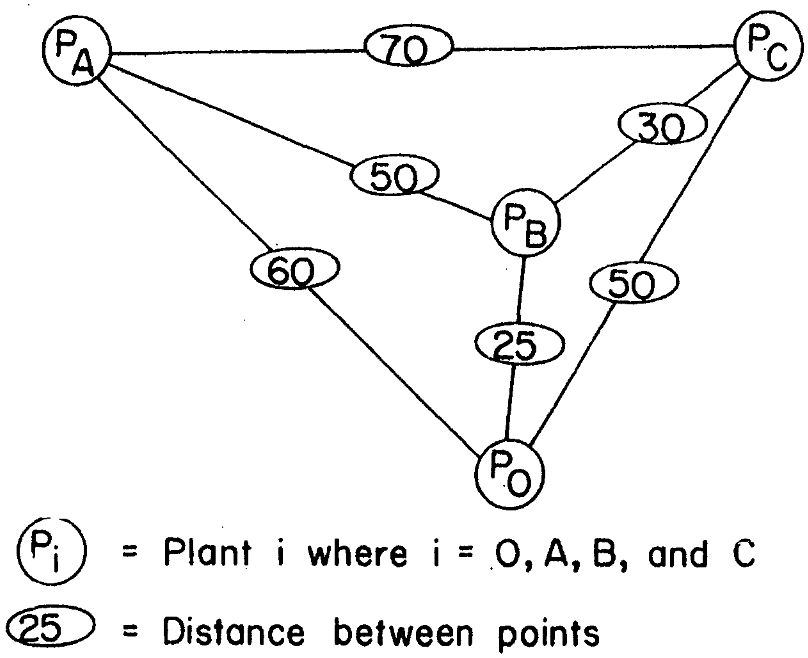

Figure 2. Location of points for sample problem.

Table 1. Sample problem's trade-off between separate round trips, less frequent visits, and equal visit frequency to C in miles traveled per month.

Routing Plan	Visit Frequency Per Month: to C	Route Stop Sequence*: OACBO** (185 miles)	OABO (135 miles)	OCO (100 miles)	Total Travel per Month (miles)
1	4	4	0	0	740
2	3	3	1	0	690
3	2	2	2	0	640
4	1	1	3	0	590
5	0	0	4	0	540
6	4	0	4	4	940
7	3	0	4	3	840
8	2	0	4	2	740
9	1	0	4	1	640

*Route mileage given in parentheses.

**OACBO is the route made up of P_A, P_C, P_B, in that order, originating and ending at P_O. Similarly OCO just includes P_C and OABO includes P_AP_B.

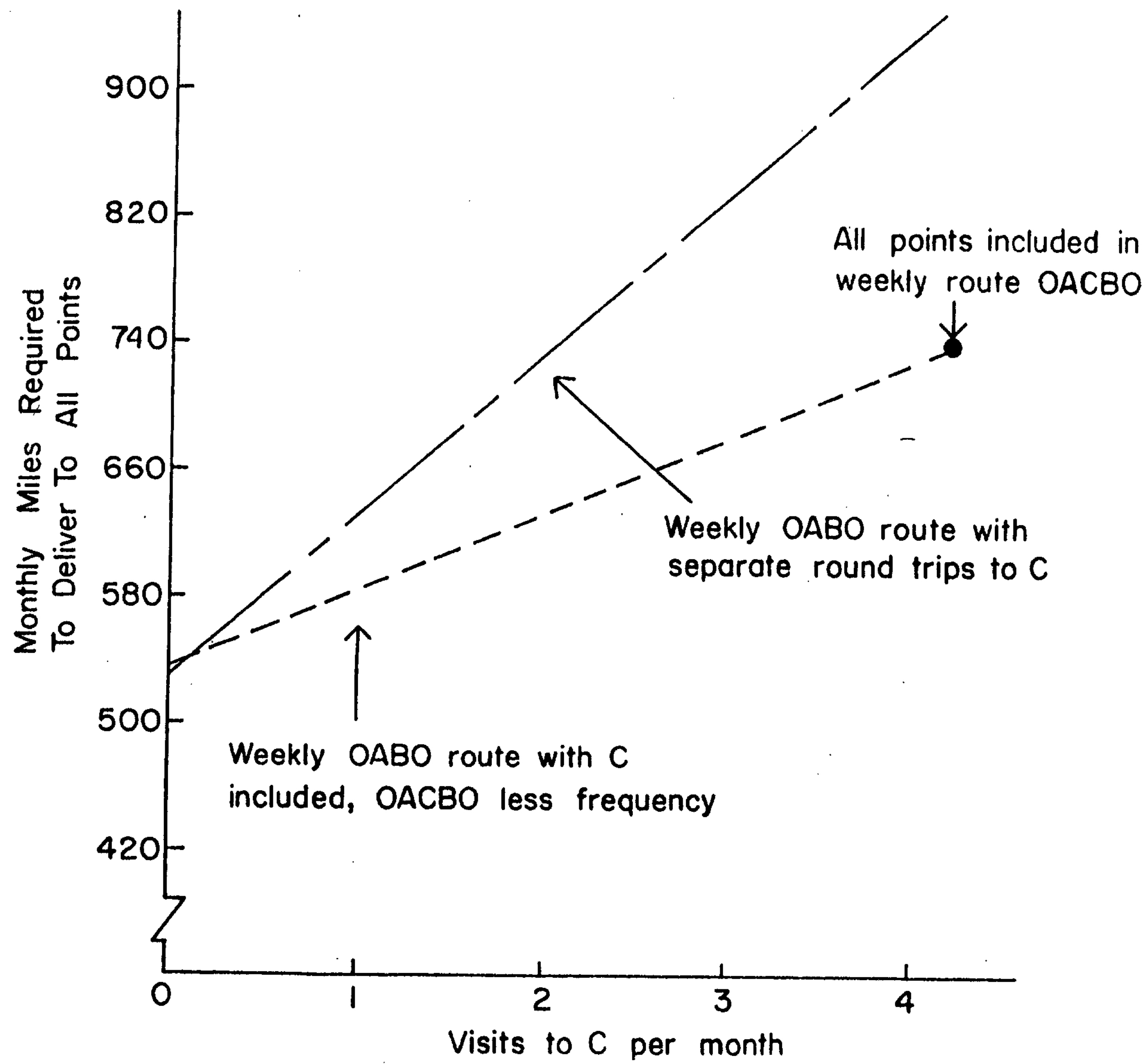

Figure 3. Sample problem's trade-off between separate round trips, less frequent visits, and equal visit frequency to C in miles traveled per month.

round trips to C with occasional full route trips whenever possible, e.g. OABO three times per month and OACBO once per month, saves even more travel (Table 1 and Figure 3).

An immediate solution to the visit frequency opportunity area is not apparent. For small problems or even large problems where only a small portion of the dealers exhibit irregular demands, frequencies might be established easily by inspection. The difficulty is in conceptualizing large problems.

One possible solution would require a three-stage approach. The first stage would aggregate dealers with similarly sized demands, geographically. The second would assign visit frequencies and the third would establish routes for each frequency. For example, if twenty dealers were to be visited once, thirty dealers twice, and fifty dealers four times per month, three routings would be required. One sequencing would be established for the two weeks that only fifty dealers were to be visited. Another sequencing would be required for the one or two weeks that eighty or more dealers were to be visited. The final routing would be for the one week that carriers visit ninety or one-hundred dealers.

Conclusions and Recommendations

An aware peddle-run management team should analyze the trade-off between load size and loading time. Average carrier capacity parameters should be iteratively searched until the most efficient load size, in total systems' terms, is discovered. This approach avoids the pitfalls of the usual assumption that more complete carrier capacity utilization is better by directly evaluating the load-size/loading-time trade-off.

Research into additional possibilities is necessary to establish guidelines for parceling out a dealer's demand to two or more multiple-dealer routes when that demand is greater than the carrier's capacity. The general practice in such cases may be too restrictive in that round trips to reduce the demand to less than one carrier's capacity are usually forced into the solution.

Similarly, the entire notion of visit frequency has been essentially ignored by practitioners. The assumption that all dealers will be visited on a regular interval basis is often injected into routing analyses without inspecting the implications. The sample problem demonstrated potential savings if regular time interval visits are not required and assumed.

The central issue is not determining what aspect of the frequency question is most important to routing research. The central issue is to provide an awareness of visit frequency's savings potential. More researchers and decision makers are likely to explore whether sufficient returns exist from frequency considerations if they are generally more aware of the possibility.

Until a computer routing scheme becomes readily available that will determine visit-frequency internally, visit-frequency allocation decisions must be made externally. Because current computer algorithms that exclude frequency considerations do as well or better than manual routing schemes, (5) it must be assumed that either apparent conceptual advantages of frequency allocation do not exist, or else managers have overlooked a large potential source of transportation cost saving. More investigation is needed. More awareness should motivate more investigation.

Footnotes

[1]A peddle-run refers to a series of small orders that are delivered to a number of locations by one truck. The distribution system is therefore made up of a number of these one-truck routes.

[2]Here level of service refers to the speed with which back orders are filled. Normally, level of service includes the number of unfilled orders as well as the speed with which they are filled. The more restrictive definition is required here because carrier capacity utilization conflicts only with the need to fill back orders promptly.

[3]The cost relationships shown in Figure 1 are general and are presented for ease of conceptualization. The functions continuity and inflection point locations are not intended to reflect one specific situation, only general relationships.

[4]The weekly frequency is simply assumed as a starting point for this discussion. Any other interval and its multiples would yield the same relative results.

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