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Minimum Chargeable Weight Estimation in Less-Than-Truckload Freight using Monte Carlo Simulation

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Abstract— Through the years there has been an increasing demand of the customer for high quality road freight at the most competitive prices. These trends have increased the competition between businesses to deliver supreme quality at the best price in the market. The Less-Than-Truckload (LTL) service offering can be a lucrative business in the freight industry. However, there is a lot of uncertainty present when it comes to the selection of the minimum chargeable weight slab for a new project with no prior record of demand. This minimum chargeable weight slab can be a crucial key for increasing your revenue gains by chosing an appealing costing structure for the customer. In this paper, we will use Montecarlo simulation to estimate the various revenue gains against multiple minimum price slab considerations to estimate the best slab to choose from. The simulation is done on a new two stage consolidation trucking route project using Excel.

Index Terms— Road freight, Less-Than-Truckload, Monte Carlo simulation, Minimum chargeable weight

1 Introduction

The paper will use Montecarlo simulation to project the estimated project revenue across a variety of minimum chargeable weight slab considerations. The trucking will be a two stage freight consolidation project. Here goods will be consolidated at four metro cities followed by transportation to a final consolidation hub. The last mile transportation will include consolidated freight from all four metros. This type of two stage consolidation can be used in cases when a particular destination has demand across multiple metro cities for a more cost effective transport model.

In this project road is considered as the medium for transportation as it is comparatively cheaper than air mode but faster than ocean mode in the case of our transport route.

A minimum chargeable weight is levied in Less-Than-Truckload movement. The minimum chargeable weight cost structure can be a key factor in driving higher revenue. Here, Monte Carlo simulation is used for generating multiple trials to simulate the possible outcomes of various scenarios to determine an estimate of the revenue generated through this project. The use of such type of simulation in a new road freight project can be advantageous as there is no historic data and the demand is uncertain.

2 Literature Review

Monte Carlo methods for evaluating the mathematical expectation of a random variable often involve generating many independent samples of the random variable and then taking the empirical average of the sample as a point estimate of the expectation. The accuracy of this method is proportional to $\sigma/\sqrt{n}$ where σ2 denotes the variance of each sample, and n denotes the number of samples generated. The key advantage of the MonteCarlo methods is that given the value of σ, the computational effort (roughly proportional to the number of samples) needed to achieve desired accuracy is independent of the dimension of the problem, i.e., if one thinks of the expectation as an integral, then this is independent of the dimension of the space where the integrand is defined. In this respect, it differs from other numerical techniques for evaluating integrals whose performance typically deteriorates as this dimensions increases. For complex options based on multi-dimensional underlying assets, the Monte-Carlo method provides a promising pricing approach.

3 Truck Schedule and Planning

In this project, there is a single vehicle scheduled per metro to the final consolidation hub followed a single vehicle journey for the last mile transport in consol mode. Freight is transported in LTL mode from various locations across the respective metro to a common hub for consolidation. Once consolidated the goods are transported to a final consolidation hub outside of the metro. This case is repeated across all metros. We are considering that only one truck is assigned per metro to the final consolidation hub and we have taken only four metros for this project.

In Fig. 1 we can see the transport route explained in brief. A, B, C, D represents the four metro cities where consolidation happens. The trucking within the metros is displayed in the figure from the various nodes. All four metros transport their consolidated freight to the final consolidation centre K. After all goods have arrived at centre K, consolidation takes place and it is delivered to the final destination X in consol mode.

We use this simulation with only one vehicle for the transport of consolidated freight at each stage. The problem can further be used for multiple vehicles at each stage of operation. The selected vehicle will be a 2.5 TEU truck for transport from local hub to final consolidation centre K. The final mile will be carried out in a 12 TEU truck in consol mode.

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We have calculated the price of operation from customer to final consolidation centre and from final consolidation centre to final destination.

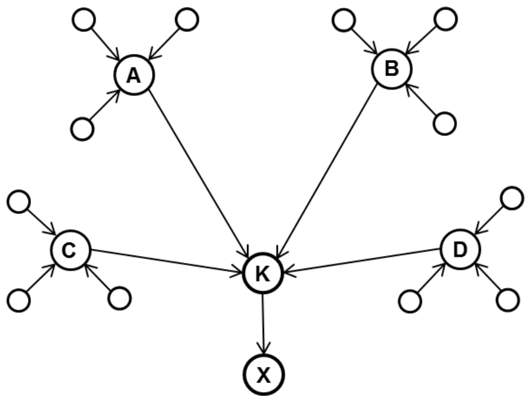

Fig. 1 shows the first stage consolidation at various metros A, B, C, D followed by transport to consolidation centre K. The last mile transport is in consol mode to destination W

4 Monte Carlo simulation

The Montecarlo simulation creates multiple trials of particular activities to determine an expected final value. We have five activities A, B, C, D, K. Each activity has an associated per kg cost attached with it. The total cost of the project will be the sum of all the individual costs. The cost of each individual entity in LTL is dependent on the weight slab the freight lies within.

In this simulation we will generate random cases on the number of freight packages consolidated per truck rather than generating the profit directly as with traditional sales simulations. The maximum number of packages that can be consolidate per truck is the calculated as per equation (1). The associated profit will be found out by multiplying the number of packages with the cost per kg and the minimum chargeable weight. Each package received is an order from the customer. For similicity we will assume that each package falls within or equal to the minimum chargeable weight of the project and hence will be charged as per the minimum chargeable weight. Cost of freight exceeding the minimum chargeable weight is calculated on a case by case basis and has not been considered here.

Since we have contracted a 2.5 TEU truck the maximum number of packages that can be held within it is the total capacity divided by the minimum chargeable weight as calculated by equation (2). The cases have been listed down in table 1.

In the simulation we have considered the minimum chargeable weight slabs in increments of 50 kg upto 500 kg. The area of study can be increased by taking further number of increments. The minimum number of freight pacakges are considered to be 1 for the respective metro to be considered in the final trip. The minimum and maximum packages for the last mile transport is the addition of each individual metro.

TABLE 1
MINIMUM CHARGEABLE WEIGHT CONSIDERATIONS

Minimum Chargeable Wt. (kg)	A, B, C, D		K	
	Min	Max	Min	Max
50	1	50	4	200
100	1	25	4	100
150	1	16	4	64
200	1	12	4	48
250	1	10	4	40
300	1	8	4	32
350	1	7	4	28
400	1	6	4	24
450	1	5	4	20
500	1	5	4	20

Table. 2 Represent the various weight slab considerations across which monet-carlo simulation has been taken.

5 Equations

The following equations have been used during the Monte Carlo simulation.

$$n = \left[\frac{100 \times z_c s_x}{xE} \right]^2 \tag{1}$$

Where n= number of iterations, $z_{c=}$ Level of confidence taken as 2.33 for 98% confidence level.

$$N = \frac{W}{Z} \tag{2}$$

Where N= number of freight packages per truck, W= maximum weight capacity of truck, Z= minimum chargeable weight

6 Simulation results

In the simulation the average of all iterations have been taken per case. The summary result of all cases are showed in Table 2. After simulating the estimated revenue across 10 different minimum weight slabs we can observe that weight slab 50 kg and 100 kg yield the highest revenue while selecting a higher minimum weight slab the revenue is considerably less. Based on this imulation the transport manager can evaluate the value to be considered for the project.

It can be also be observed that the % error for all weight slabs is below 2% as we considered the level of confidence as 2.33 for 98 % confidence level.

The transport manager can now use the simulation results to fix a minimum chargeable weight slab for the project. These simulated values give us the best indication about the estimated future outcomes of the project.

TABLE 2
SIMULATION RESULTS

Minimum Chargeable Wt. (kgs)	Average	% Error
50	1,817	0.76%
100	1,744	0.80%
150	1,592	0.86%
200	1,523	0.93%
250	1,516	0.98%
300	1,370	1.05%
350	1,333	1.11%
400	1,214	1.21%
450	1,023	1.38%
500	1,139	1.40%

Table. 2 provides us with the estimated average revenue across the 10 cases of minimum chargeable weight we have considered.
Revenue is indicated in dollars.($)

7 Conclusion

The study has equipped the transport manager with a good indication of the estimated revenue the project can produce across multiple minimum weight slab considerations. The can help him evaluate multiple scenarios and make data driven decisions to drive the company bottom line. The study can be further extended by considering more locations for stage 1 consolidation with a higher number of vehicles. The study can also been further evaluated with more weight slab considerations.

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References

[1] E. Bukaçi, Th. Korini, E. Periku, S. Allkja, P. Sheperi, "Number of iterations needed in Monte Carlo Simulation using reliability analysis fortunnelsupports."(http://ijera.com/papers/Vol6_issue6/Part%20-%203/J0606036064.pdf)

[2] Morris R. Driels, Young S. Shin, Determining the number of iterations for Monte Carlo simulations of weapon Effectiveness, Naval Postgraduate School, Monterey, CA, April 2004.

[3] Hoek, E., Carranza-Torres C., Corkum B.: Hoek-Brown failure criterion – 2002 Edition,Proc. NARMS-TAC Conference, Toronto, 2002, (1),pp. 267-273

[4] N.Bolia,S.Juneja,MonteCarlomethodsforpricingfinancialoptions (http://web.iitd.ac.in/~nomesh/pubs/survey_MC_methods_options.pdf)

[5] Ritter, F. E., Schoelles, M. J., Quigley, K. S., & Klein, L. C. , Determining the number of simulation runs:Treating simulations as theories by not sampling their behavior. In S. Narayanan & L. Rothrock (Eds.), Human-in-the-loop simulations: Methods and Practice 2011 (pp. 97–116). London: Spring-Verlag.