RISK PREDICTION AND REDUCTION IN PASSENGER TRANSPORT SERVICE DELIVERY

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ABSTRACT
Risk is a phenomenon that has become part of human activities. Risk is in everything and is defined according to the circumstance of the activity or event under contention. Transportation business in Nigeria is a highly risky one especially as it affects passenger transport services. The abundance of bad roads and reckless driving habits coupled with poor highway and vehicle maintenance culture tends to multiply the risk for both operators and their human cargoes. The need to effectively determine operational risk with a view to finding ways of reducing same gave rise to the research and presentation of this paper. In the course of study, records were obtained and analyzed from the offices of the Federal Road Safety Corps (FRSC) and a prominent luxury bus transport company at Onitsha. The analysis gave informed insight into the causes of road accidents and their risk factors from which a modest risk prediction model was formulated whilst offering useful suggestions on risk reduction strategies. The study also revealed that passenger transportation business operational risk is of two folds – accidental and financial risk and it is the combination of these two that determines the overall systematic risk of the business.

Keywords: Operational Risk, Passenger, Manifest, Route, Trip, Accidental Risk, Fatality, Mortality, Highway, Insurance, Systematic Risk.

Jel Classification: R40, M41, C13, M21

Introduction

The business terrain is full of risks. This in accordance with an Igbo adage is because the pathway to wealth is strewn with thorns. In the opinion of Brockington (1987), many potential very profitable enterprises carry a high risk of expensive failure. For instance, prospecting for oil could be very rewarding if a rich strike is made but ruinous if the exploration proves abortive. Therefore, the high point in doing business lies in risk taking, however, eventual success or failure depends on the ability of the risk taker to predict and reduce the risks.

What is risk and how does it affect entrepreneurship? Horngren (1997) defines risk as the probability that business profit projections will not come true. In the same manner Van Horne (1982) stated that risk is the possibility that the actual return will deviate from that which was expected. The *American Heritage Dictionary* in http://www.answers.com defines risk thus:

1. The possibility of suffering harm or loss.
2. A factor, thing, element, or course involving uncertain danger; a hazard.
3. The danger or probability of loss to an insurer; or the amount that an insurance company stands to lose.
4. The variability of returns from an investment; or the chance of nonpayment of a debt.

In other words, risk is the probability or likelihood of failure. These definitions with the exception of number 2 above, relate to business/economic aspects of risk. What about other risks that are not business or economic. For instance, how do you define the risk of war or the risk of accident? Naturally and inferring from the above definitions, risk should be seen as the chance that a negative event might occur during a normal event procedure. It then follows that the chance of war is a risk taken when dealing with matters that, though may be beneficial to the decision maker, but may cause disaffection in the neighborhood of those adversely affected by that decision. In the same vein, the chance of accident during journeys may be as a result of risk taken by the tour operators through their inability to do what is expected, for instance engaging a reckless driver or failing to take their vehicle for routine maintenance.

Business/Economic Risk

Projecting into the future normally presents problems of uncertainty. The future is definitely uncertain for several reasons and some of these reasons are unforeseeable. Natural disasters such as earthquakes, droughts etc, technological advancements and general change in taste and fashion are some of the reasons why the future cannot be accurately predicted. Uncertainty of the future, therefore, gave rise to risks in business.

To be able to estimate the inherent or systematic risk of a business, you need to have good information on the past performances of the business or similar businesses. The distinction among various degrees of uncertainties depends on how probabilities are assigned to past events.

To start your estimate of risk, you need to make some underlying assumptions for instance:

1. that previous periods trends will continue in the up coming period.
2. that there will be even-distribution of activities within the projection period
3. that the projection will cover only one period as extensions into unforeseeable future may become unattainable, and lastly
4. that there will be no unexpected or unforeseen occurrence within the projection period.

Of course, most of these assumptions are not always tenable but we must have something to hold on to, especially as the economist would say “an escape route”. It is not always true that trends will continue to remain the same; likewise activities cannot be evenly distributed in a year for obvious reasons; and it is seasons that determine sales and public consumption patterns, not paper projections.

Next analyze your previous performance data which must be in the form of a cash flow statement, to get:

(a) the probability assignments to event occurrence

(b) the expected value of the cash flow

(c) the standard deviation of the cash flow; and

(d) the coefficient of variation of the cash flow which is the measure of risk for the project or business.

Illustration:

Mega star Express a passenger bus company has been analyzing its passenger traffic for each of the last 3 months for the past ten years. It estimates that it expects a 20% increase in passenger volume over the average for the past 10 years due to the introduction of additional fleet of new buses. Net cash flow from each passenger fare is averaged at =N=550. The following passenger data have been compiled from the loading manifest:

Year	**No. of Passengers**
1996	126,000
1997	111,500
1998	126,000
1999	118,000
2000	130,600
2001	130,600
2002	141,800
2003	130,600
2004	118,000
2005	126,000

Analysis

First we group and assign probabilities to the given data as below

No of Passengers	Occurrence	Probability
111,500	1	0.1
118,000	2	0.2
126,000	3	0.3
130,600	3	0.3
141,800	1	0.1

Next we find the expected value:

No of Passengers	Probability	Expected Value
111,500	0.1	11,150
118,000	0.2	23,600
126,000	0.3	37,800
130,600	0.3	39,180
141,800	01	14,180
		125,910

From our computations above, the number of passengers expected during the last 3 months of 2006 for *Mega Star Express* is estimated at 125,910. This when adjusted for 20% increase expected will come to 151,092 passengers and when translated into cash flow will amount to =N=83,100,600. However, whether this figure is realizable will depend on the risk inherent in the projections. This we shall now estimate, first by calculating the dispersion of the entire distribution from the

expected value, then by calculating the coefficient of variation to have knowledge of our risk expectation for the period.

Passengers	Pr	(x-mean)	(x-mean)2
111,500	0.1	-14,410	207,648,100
118,000	0.2	- 7,910	62,568,100
126,000	0.3	90	8,100
130,600	0.3	4,690	21,996,100
141,800	0.1	15,890	252,492,100
627,900	1.0		544,712,500

Mean = expected value = 125,910

$\sigma = \sqrt{}$ (544,712,500 / 1) = 23,339.08

The coefficient of variation = 23,339.08 / 125,910 = 0.185

This means that there is 18.5% chance that the projected passenger volume will be less than 125,910. This is the business risk (or more appropriately the *financial risk)* for the period. However, since the firm is projecting an increase of 20% which amounted to 151,092, then the true *financial risk* of the company for the period must be based on the projected volume and not the expected value. Thus:

Passengers	Pr	(x-mean)	(x-mean)2
111,500	0.1	-39,592	1,567,526,464
118,000	0.2	-33,092	1,095,080,464
126,000	0.3	-25,092	629,608,464
130,600	0.3	-20,492	419,922,064
141,800	0.1	- 9,292	86,341,264
627,900	1.0		3,798,478,720

Mean = projected value = 151,092

$\sigma = \sqrt{}$ (3,798,478,720 / 1) = 61,631.8

Hence, the risk or coefficient of variation = 61,631.8 / 151,092 = 0.4079

This means that there is a 40.79% chance that the projected passenger volume will be less than 151,092, which is the existing projection plus the expected 20% increase. This is the real *financial risk* for *Mega Star Express* for the projected period.

Accidental Risk

In passenger transport service delivery, it is not enough to consider only the business or economic risk involved. There are equally other types of risks that must be considered as well. These other risks include accidental as well as mortality risks. Accidental risk is defined as the probability that a mishap might occur during a normal journal while mortality risk is the probability that lives might be lost in the event of an accident. Mortality risk in this sense differs from the mortality risk as defined for insurance purposes. Estimating either of these two is not as easy as defining them. This is because accidental and mortality risks are psychologically within the control of humans and can therefore be avoided when laid down rules are observed. Though the sources of data for accidental and mortality risk estimations are different, the procedure for the estimate follows the same pattern of using previous period's observation data.

To get data for a proper estimate of accidental risk the author visited the Onitsha office of the Federal Road Safety Corps (FRSC) where the data used for analyzing the information on table 1 was obtained; the author equally visited and made a thorough analysis of the operating records of a prominent transport company with head office in the same city.

Table 1: Analysis Enugu – Onitsha – Lagos Route
Accidents 1999-2004 (Passenger Valuations)

				CAUSE OF ACCIDENT		
Vehicle Type	Total	Fatal	Non-fatal	Bad Road	Reckless driving	Poor Maintenance
Luxury Buses	115	36	79	29	51	35
Small Buses	167	70	97	61	64	42
Commuter Cabs	120	32	88	51	30	39
	402	138	264	141	145	116
Distribution:	100%	34.3%	65.7%	35%	36%	29%

Source: *E.P. Enyi from FRSC Figures*

Note: Those categorized as fatal, involved the loss of at least one life.

Figures in table 1 as can be seen already reveal that there are three (3) elements or causes of road accidents. These are bad roads which accounts for 35%, reckless driving, which accounts for 36% and poor vehicle maintenance culture which accounts for 29% of road accidents in that route.

Driving Habit and Experience

The analyses of the records of the prominent transport company earlier mentioned show that one out of ten newly engaged/trained drivers with less than 3 months experience get involved in accident at least one time. 3 out of every 10 of those with less than 3 months experience, who previously got involved in an accident, get involved the second time while 5 out of 10 of those who get involved previously in 2 accidents get involved the third time.

It also showed that the experience of those with up to 6 months or less follow the same pattern but with lower probabilities. So also are those with 12 months, 2 years and 5 years experiences.

To make for a better understanding and use, a complete analysis of the different work behaviors of the different categories of drivers are tabulated in table2 and

form the basis for estimating risks associated with reckless driving. To interpret the table, a driver with 3 months or less experience who is involved in accidents up to 3 times is a high-risk driver. In the same vein, a driver with 6 months experience with up 6 accidents cases is also a high-risk driver. So also is 12 months with 8 cases or 2 years with 10 cases.

Table 2: RECKLESS DRIVING RISK VALUE TABLE

Experience	0	1	2	3	4	5	6	7	8	9	10	>10
≤ 3months	0	0.10	0.30	0.50	0.07	0.90	0.99	0.99	0.99	0.99	0.99	0.99
≤ 6months	0	0.09	0.18	0.27	0.36	0.45	0.54	0.63	0.72	0.81	0.90	0.99
≤ 12mnths	0	0.07	0.14	0.21	0.28	0.35	0.42	0.49	0.56	0.63	0.70	0.99
≤ 2 Years	0	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.80
≤ 5 Years	0	0.035	0.07	0.105	0.14	0.175	0.21	0.245	0.28	0.315	0.35	0.60
≤ 10 Years	0	0.02	0.04	0.06	0.08	0.10	0.12	0.14	0.16	0.18	0.20	0.40
≤ 20 Years	0	0.015	0.03	0.045	0.06	0.075	0.09	0.105	0.12	0.135	0.15	0.25
> 20 Years	0	0.005	0.01	0.015	0.02	0.025	0.03	0.035	0.04	0.045	0.05	0.10

Source: E. P. Enyi

Putting it together

Having obtained information on how to get the data for one of the three vital elements of accidental risk, we shall not proceed to discuss the remaining two and attempt to fit them into a risk prediction model.

- ***Bad Roads*** – though, there are no official figures for this, nearly all the roads in Nigeria are bad or substandard. Most of the newly constructed ones lack the basic attachments and decorations recommended for normal highways using international highway construction standards. Bad roads naturally induce accidents and roads can be assigned to probabilities in accordance with the capability to induce accidents with reference to its state of disrepair. A very bad road can take between 0.75 to 1.0 risk value, while a good and standard road will naturally have a probability of zero. Table 3 suggests a risk pattern for roads.

- ***Poor Vehicle Maintenance Culture*** – In countries with more amenable behavior towards the strict observance of maintenance culture, passenger vehicles are

usually placed on strict periodic maintenance routines, which must be observed to ensure continuous unbroken service and preservation of human life. This unfortunately is not the ideal in Nigeria and many other developing countries of the world. The emphasis and general idea is to squeeze out as much profit as possible while avoiding "unnecessary costs" at all times. It is indeed regrettable that most transport business owners in Nigeria regard routine maintenance and proper vehicle insurance as "unnecessary costs". This inadvertently has resulted in the increase in accidental and financial risk for both passengers and transport operators alike. Assigning risk values to vehicle maintenance will normally follow the age and physical mechanical condition of the vehicle. Table 4 is hereby suggested as a guide towards assigning vehicle conditional risk values:

Table 3: Suggested Road Conditional Risk Values

Age of Road	Good condition. Standard	Good Condition Non-Standard	Slightly Damaged	Moderately Damaged	Heavily Damaged	Bumpy &Pot	Untarred Road
0	0	0.05	0.15	0.20	0.35	0.40	0.30
1	0	0.05	0.18	0.23	0.38	0.43	0.44
2	0	0.08	0.21	0.26	0.41	0.46	0.58
3	0	0.11	0.24	0.29	0.44	0.49	0.72
4	0	0.14	0.27	0.32	0.47	0.52	0.86
5	0	0.17	0.30	0.35	0.50	0.55	0.99
6	0	0.20	0.33	0.38	0.53	0.58	0.99
7	0	0.23	0.36	0.41	0.56	0.61	0.99
8	0	0.27	0.39	0.44	0.59	0.64	0.99
9	0	0.30	0.42	0.47	0.62	0.67	0.99
10	0	0.33	0.45	0.50	0.65	0.70	0.99
11	0.1	0.43	0.48	0.53	0.68	0.73	0.99
12	0.12	0.45	0.51	0.56	0.71	0.76	0.99
13	0.14	0.47	0.54	0.59	0.74	0.79	0.99
14	0.16	0.49	0.55	0.62	0.77	0.82	0.99
15	0.18	0.51	0.58	0.65	0.80	0.85	0.99
16	0.20	0.53	0.61	0.68	0.83	0.88	0.99
17	0.22	0.55	0.64	0.71	0.86	0.91	0.99
18	0.24	0.57	0.67	0.74	0.89	0.94	0.99
19	0.27	0.60	0.70	0.77	0.92	0.97	0.99
20	0.30	0.63	0.73	0.80	0.95	0.99	0.99
>20	0.40	0.70	0.77	0.85	0.99	0.99	0.99

Accidental risk prediction takes two steps. First, we determine the individual risk values for each of the three elements for a particular route taking into cognizance the vehicle maintenance condition as well as the applicable highway condition. Then we aggregate these values by summing them and dividing by three. This will give us the accidental risk for that trip. To get the accidental risk for a period, we simply sum up all the estimated accidental risks for the trips and divide by the number of trips projected for that period. To get the total risk for the transport firm for the projected period we multiply the projected financial risk with the accidental risk and find the square root. That will give us the total systematic risk of the transport firm for the projected period.

To find the mortality risk, we simply multiply the accidental risk by 0.343 (i.e. the fatality rate of 34.3% obtained from table 1).

Table 4: Vehicle Maintenance Risk Values (suggested)

Age of Vehicle	Good With Mtce	Good Without Mtce	Body Problem	Engine Problem	Tyre Problem	Transmission Problem	Beak Problem
1 year	0.00	0.00	0.10	0.30	0.35	0.20	0.50
2 years	0.00	0.10	0.20	0.40	0.45	0.30	0.60
3 years	0.00	0.15	0.25	0.45	0.50	0.35	0.65
4 years	0.00	0.20	0.30	0.50	0.55	0.40	0.70
5 years	0.00	0.22	0.32	0.52	0.52	0.42	0.72
6 years	0.00	0.24	0.34	0.54	0.59	0.44	0.74
7 years	0.10	0.26	0.36	0.56	0.61	0.46	0.75
8 years	0.15	0.30	0.40	0.60	0.65	0.50	0.80
9 years	0.20	0.35	0.45	0.65	0.70	0.55	0.85
10 years	0.22	0.38	0.48	0.68	0.73	0.58	0.88
>10	0.24	0.4	0.50	0.70	0.75	0.60	0.90

Overview

Suppose our *Mega Star Express* wants to know its total risk for the last 3 months of the year given that its previously computed financial risk still subsists. Its management was able to provide the following additional information:

1. No of buses in its fleet = 36
2. Route to be plied = Onitsha to Lagos;
3. Condition of highway = Moderately damaged;
4. Age of highway = 8 years;
5. All the 36 drivers have 5 years experience with maximum of 6 recorded accidents each;
6. All the vehicles were bought seven years ago with slight body damages. No other maintenance problem is noted.
7. Each vehicle is to make at least 75 trips within the period.

Solution

First we calculate the *accidental risk* per trip (since all trips have the same similarity).

Driving Risk value	=	0.21	(Table 2)
Vehicle Maintenance Risk	=	0.36	(Table 3)
Road Conditional Risk	=	0.44	
Total	=	1.01	

Accidental Risk Value = 1.01 / 3 = ***0.34*** per trip

Secondly, we estimate the number of trips thus: 75 x 36 = 2700

Then, we estimate the ***total accidental risk*** for the entire trip (this is usually added up when there are differences in accidental risk values for different trips)

i.e. 2700 x 0.34 = 918

Next, we divide the total accidental risk value by the number of trips projected:

918 / 2700 = 0.34

(This was the same for the above because we have used uniform conditions for all drivers, road and vehicles for the period).

To estimate the ***mortality risk*** for the firm we multiply the accidental risk of 0.34 by the fatality probability in table 1. This will give 0.34 x 0.343 = 0.117

i.e. the mortality risk for the company for the period = 0.1166 or 0.12

The ***systematic*** (i.e. total) ***risk*** for the firm for the period is then estimated thus:

Accidental Risk (as above) = 0.34

Financial Risk (previously) = 0.4079

Therefore, ***Systematic Risk*** = $\sqrt{}$ ***(0.34 x 0.4079)***

= ***0.372***

Here the accidental risk represents the business's ***operational risk***. The operational risk is used to multiply the financial risk because operational activities determine the success of financial projections. The systematic risk value of 0.372 calculated above suggests that road transport business in Nigeria is a highly risky one, using the *Mega Star Express* example as a guide. In other words, the business has only 62.8% chance of attaining its objectives for the period.

Risk Reduction

The ability to predict risk is one thing but avoiding or reducing the incidence of risk is entirely a different ball game. We have seen that operational risk is not only determined by a firm's internal operating conditions but also by factors well out side the control of the firm. For instance, the probability of an accident occurring is heightened by bad road maintenance culture, which is dependent solely on the state. Hence, the ability of an individual company to reduce the occurrence of

accident is seriously hampered by the government's slow response to road maintenance and rehabilitation necessities. Thus, accidental risk would be greatly reduced if the government lives up to its responsibility in the area of road maintenance, rehabilitation and construction. In addition, newly constructed roads should be made to have all the features of a standard international highway like correct road demarcation markings, traffic control signs and good side walks.

On the part of the individual transport company a lot has to be done in order to meet acceptable international transportation standards. The following points should guide each firm on the best possible way towards reducing operational risk:

1. Transport firms should embrace periodically based routine maintenance culture. This will ensure that vehicles are in good and serviceable conditions at all times. The use of maintenance logbooks should be introduced to constantly remind the operators of vehicles due for routine service or maintenance in order to reduce the risk of road accidents associated with poor vehicle maintenance. Though, this may sound economically wasteful at first but the benefits will very much outweigh the so-called associated costs for instance there is no cost greater than human life no matter the magnitude.
2. Adequate and well-articulated vehicle movement schedule is another innovation that can help to reduce operational risk. When departures and arrivals are put on schedule and properly monitored for compliance it will help to check the excesses of drivers and such vices as over-speeding - which has been known to increase the likelihood of accidents as well as incessant stops on the way to pick up unregistered passengers otherwise known as "attachments" in local parlance.

3. Implementation of proper and comprehensive vehicle and passenger insurance scheme which will ensure that transport operators adhere strictly to safety rules and initiate adequate vehicle maintenance and replacement programme before contract acceptance.
4. Transport companies should equally articulate a robust vehicle replacement policy that will ensure that aged vehicles in their fleet are promptly replaced at the most cost effective period. Doing this will reduce accidental risk associated with sudden malfunctioning of over-aged vehicle.
5. Engagement of drivers should follow adequate staff recruitment procedure, which will ensure that only low-risk drivers of proven experience or good vehicle handling performance would be engaged. This will check the propensity of drivers towards recklessness.
6. In a country where the conditions of the highways cannot be guaranteed, it would be suicidal to embark on night travels especially with the absence of streetlights on the highways in addition to incessant armed robbery attacks. This is the reason why it is speculated that most fatal highway accidents happen at night. A total ban on night journeys in Nigeria will help to reduce accidental risks drastically.
7. The probable reason why reckless driving has the greatest percentage of road accident occurrence as can be seen from table 1 is because of the tendency of most drivers towards disregarding highway codes and road signs. Zebra crossing and other speed limiting signs are generally un-regarded in most cases by speeding drivers. Strict observance of highway codes should be embedded as part of the training programmes

and morning briefings for drivers by all transport companies to enforce observance and reduce associated risks.

Conclusion and Recommendations

Risk is a phenomenon that has become part of human existence. There is risk in everything; in eating, in working, in movement, in employment, in business and even in living, to mention just a few. Everyone must take and manage one form of risk or the other but the ability to predict and reduce the magnitude of risk situations becomes the most important aspect of an enterprise's operational management. The business of passenger transport is entwined with two types of risks – *accidental risk* and *financial risk*, which combines together to form the business's *systematic risk*. The ability to predict and reduce this risk, determines to a large extent the success and continued existence of the business. Determination of the business's operational and systematic risk factors requires careful and meticulous analysis of past records of operations as well as external factors such as the provision and maintenance of public amenities.

The model and suggestions presented within this paper is not intended to be foolproof or exhaustive, as they have been based on operational conditions obtainable in Nigeria. Those in other parts of the world with differing conditions may, however, find them as useful reference points for further studies in risk prediction and reduction in road transportation system of their country or region.

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