# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 HISTORICAL BACKGROUND

In the insurance industry, rate making have been considered by various authors and writers.

The International Financial Reporting Standard issued on May 2017 describes insurance as a contract under which one party (the insurer) accepts significant insurance risk from another party (the policyholder) by agreeing to compensate the policyholder if a specified uncertain future event (the insured event) adversely affects the policyholder.

Premium is the monetary consideration passing from the insured to the insurer. As such, it is a necessary element in the formation of the insurance contract. Hansel D.S (1980)

Following the definition J.Orukwu (2001) in his book - Accidental & Motor Insurance in West Africa defined premium as the financial consideration paid by the insured to the insurer in return for the promise of the insurer. It is the price paid for the purchase of an insurance cover.

Alex Akhigbe and Norman Lawrence (2005) gave their own definition of premium as the amount paid to the insurer in exchange for which the insurer agreed to provide an insurance protection. Various payment of the life insurance go into a pool from which claims will be met.

According to G.C.A Dukson (2002). The premium which an insured pays, represents the insured's contribution to the common pool. This contribution must be fair and must reflect the degree of risk which that insured brings to the pool

Mark Green and James Trieshmann (1990) stated the properties of premium I.e premiums must be sufficient to cover expected estimate of the level of claims of which is expected. It is not possible to say exactly how much is to be paid in claims but law of large numbers does allow the insurer to make a reasonable accurate assessment of the likely loss cost. At the minimum, the premium must be sufficient to meet these expected claims. Secondly, the premiums must be sufficient to create an estimate for outstanding claims because not all claims will be settled during the year for which the premium has been paid and hence the premium must take into account those claims still to be settled at the end of the year. Thirdly, it should be sufficient to provide a reserve. That is , the insurer must also take into account the fact that there can be contingencies beyond their control which may involve a liability to meet claims at sometime in the future.

Contributing to the essence of premium sufficiency G.C.A Dukson (2000) explained that premium meet all expenses. Since the insurer has alot of operational expenses to meet in the running of the business which include; salaries of staff, office costs of all forms, advertising, commission etc. these operating costs must be covered from the aggregate premium collected from the insured. Secondly, premium should be sufficient to provide for profit.

Writing on premium rating in life insurance, Mike and Cammack (2007) takes inflation into cognition. According to them the insurer must be aware of the changing value of money claims that will be met in future out of today's premium. These means that the cost of settling a claim may rise and fall accordingly to the value of money.

Oladele Olashore (2006) defines premium rating in terms of interest rate and exchange rate. He writes that insurers are major investors of funds. These funds generate substantial investment income upon which insurers depend. Variability in interest rates is to be taken into account in premium calculaion. In terms of exchange rate, the insurer has to take into account substantial volume of premium income which is derived from outside the country. Hence there is the added problem of exchange rate risk.

One of the major decisions an underwriter will have to take is the fixing of the price of insurance for a particular risk. In fixing the pricing for an insurance cover, an insurer will take into consideration what the future costs will be to ensure he does not undercharge. At the same time, consideration must be given to the forces of competition, otherwise an insurer will price itself out of business. Thus, both the insured and he insurer are interested in the rate that is fair so that each insured group is charged its proper share of the total loss and expenses. The insurance rate itself is the naira amount charged per unit of exposure. Insurance premium has two components, the pure premium and the loading factor (Albrait 2007)

The pure premium is that portion of the initial premium that is enough to cover expected claim cost unit of exposure. The loading factor on the other hand is the portion that will cover the sale expenses, management expenses, profit of the insurer and tax. The loading is usually expressed as a percentage of the final premium or gross premium. The loading factor may be as high as 40% of the gross or final premium. There have been arguments for and against the size of loading. To an average insured, the loading proportion may appear too high. This figure of course is not too high if one considers the other activities engaged in by the insurers apart from loss payment. First would be the expenses incurred in loss prevention efforts and in processing a claim. Second would be the value-adding efforts of the insurers in promoting their services to the public. All these involve substantial amounts.

As at **2018,** measured by premiums written, annuities are the largest life/health product line, followed by accident and health, and life insurance. Life insurance policies can be sold on an individual, or ordinary basis or to groups such as employees and associations.

### 2.1.1 ACTUARIES AND PREDICTIVE ANALYTICS

The insurance industry is data-dependent. A recent trend in the insurance industry is the use of Big Data in predicting insurance premium charges. Big Data is any large data set of facts or statistics that is collected. It can be structured or unstructured, self-provided information, published reports, or logs of all internet searches. In an insurance firm, it represents a large data set containing

information or data on past and existing policy holders, this information may includes their sex, age, policy type, medical history, premium charged etc.

Decisions can be made in a life office on the amount of premium to charge by Predictive Analytics which involves the use of modeling and data analysis techniques on large data sets (of informations gotten from past and existing policy holders ) to discover predictive patterns and relationships for use in fixing premium.

According to Actuarial Institute article - *'Impact Of Big Data On Future of Insurance*' Nov 2016 release: the availability of Big Data enhances the possibility of Insurers to rely on data and statistics to determine the cost of risk and to set prices for their insurance policies.

Over the years, life insurance companies have been attempting to sell their products efficiently, and it is known that before an application is accepted by the life insurance company, a series of tasks must be undertaken during the underwriting process. Mishr K (2016)

According to Wuppermann A (2016) underwriting involves gathering extensive information about the applicant, which can be a lengthy process. The applicants usually undergo several medical tests and need to submit all the relevant documents to the insurance agent. Then, the underwriter assesses the risk profile of the customer and evaluates if the application needs to be accepted. Subsequently, premiums are calculated. Prince A (2016)

Companies perform underwriting process to make decisions on applications and to price policies accordingly. On average, it takes at least 30 days for an application to be processed. However, nowadays, people are reluctant to buy services that are slow. Due to the underwriting process being lengthy and time-consuming, customers are more prone to switch to a competitor or prefer to avoid buying life insurance policies. Lack of proper underwriting practices can consequently lead to customers being unsatisfied and a decrease in policy sales.

With the increase in the amount of data and advances in data analytics, the underwriting process can be automated for faster processing of applications. This research also aims at providing solutions to enhance risk assessment among life insurance firms using Predictive Analytics.

## 2.2.0 THEORIES RELEVANT TO THE RESEARCH

### 2.2.1 OBJECTIVES OF RATEMAKING

Rating system in insurance should meet the following objectives (Aduloju, 2009)

- Adequacy: Whatever rating method employed must ensure that adequate rate is charged to cover all losses and expense. Inadequate rates may lead to financial deficiency. An insolvent insurer will be unable to pay claims and meet other obligations. If this should happen then the purpose of insurance is defeated.

- Not outrageous: While premium rates should not be too low, it must not be too high or this would go against public interest. When the policy holders pay more than the actual value of the protection granted, the principle of fairness is lost;
- Simple: The rating system should tend itself to simple calculation. In addition, the procedure involved in computing a rate should be replicable. Simplicity will afford the proposed an opportunity to estimate what the cost of insurance would be and could thus take actions to reduce the cost.
- Stability: Insurance rates should be relatively stable over a given period of time. When rates are stable the insured would not have much difficulty in planning for his insurance.
- Responsive: A relatively stable premium may still be responsive, or dynamic. Changes in loss exposure and economic conditions supported by necessary data should be reflected in the premium charged. Responsive rates should be amenable to changes.
- Stimulating loss prevention: The rating method used should encourage loss prevention activities. Because loss prevention efforts tend profitability. Insurers in some classes like fire normally give credits to the insured for measures which tend to reduce both the frequency and the severity of loss.

### 2.2.2 CRITERIA FOR FIXING INSURANCE PRICES

In arriving at an appropriate premium for a product, insurers are guilded by certain criteria some of which are statutory and most of which are business related. These criteria includes the following:

- Loss cost: The rate charged should be sufficient enough to cover all future contingencies arising from an insurance contract. However, the problem is that the insurance rate is set before all the costs are known. Thus a definite estimate of insurance price must be made in advance with no possibility of a later renegotiation if the estimate of loss was incorrect. Based on the statistics and experience, a fairly appropriate rate could be set that will cover the expected losses.
- Expenses: In addtion to the expected losses, rates charged should be able to cover management expenses. What is the proportion of the expenses to the gross premium? The industry-wide statistics can provide a guide.
- Profits: The insurers, just like other entrepreneurs, set up their business with the main objective of making profits. Therefore, profit must be factored in when computing the final premium.
- Reserves: The insurers usually build up reserves in order to meet future contingencies for especially losses of catastrophic proportions. In fact, the insurance Act requires an insurer to

maintain certain minimum levels of technical reserve which are necessary to ensure financial solvency. All these are put into consideration in fixing premium rates for insurance products.

- Taxation: One of the early reason for government regulation of insurance was to genetate revenue for the state in form of taxation. This also should be reflected in premium computation.
- Loss prevention: In some insurance classes, the insured are allowed discounts in premium payments to encourage them in their loss prevention efforts. For instance installation of fire extinguishing appliance and burglary alarm system entitles the insured to discounts in fire and burglary insurance policies respectively.
- Investments: The insurers have long realized that all the premiums will be used up in loss payments as soon as they come into the pool. A good portion of these will be invested which will yield further income. It is only reasonable that the insured be given benefits for this by way of rate reductions.
- Competition: Competition exerts great pressure on insurance pricing having rates too low is just as undesirable for long run solvency of insurance fund. Conversely, when rates are too high, an insurer will lose business to the competitors.
- Legislation: Some classes of insurance are statutorily required and thus, the interest of the state is often reflected in premium rates. In many countries, employer's liability insurance premium and motor insurance premium rates are fixed by statutes.

### 2.2.3 PRICING METHODS

A combination of the above mentioned criteria is expected to produce the final rate. However, one difficult problem is how to develop a rate making method that will meet all those criteria at the same time. Underwriters will have to rely on the underwriting judgment, experience and statistical evidence to be able to do this effectively. Again, the knowledge of mathematics will assits the underwriter in treating alike all members of an insured group that fall into predetermined categories, thereby ensuring a degree of consistency. The two major approaches to rate making are manual and individual, with the third method being a combination of the two. These approaches produce different premium methods.

1. MANUAL APPROACH:

This is known as pure or class rating approach. The procedure is to set rates that apply uniformly to each exposure unit falling within some predetermined group or class. Thus, everyone falling within a given class is charged the same rate. This approach is frequently used in life, workmen's compensation, liability, motor and fire. For instance, in motor insurance, the loss data are broken down according to the territory, vehicle type, value, age of driver and use of vehicle. One needs to go to the appropriate page in a manual to find what the insurance rate is hence the term 'manual

rating'. In the past, the Nigeria Insurance Association (NIA) developed such a manual for motor insurance based on the values and cubic capacity of the vehicle. The following premium methods are used in manual rate making:

(a) Pure premium: This is known as the central technique in manual rate making. In using this method, all loss data falling into each class which is to be rated are collected and divided by the number of exposure units to arrive at a pure premium.

(b) Loss rate method: Sometimes it may be difficult to use pure premium method to develop a rate due to the existence of too many classifications in the manual. There may be many risk categories involved that each category losses on only a small number of exposure occur in a given period, and this number may be deemed insufficient on which to based decisions from a statistical point of view. A way out of this logjam is to develop a rate by comparing the actual loss ratios of combined groups with the expected loss ratio.

2. INDIVIDUAL RATING METHOD

This is otherwise known as a merit rating method because recognition is given to individual features of a specific risk in order to arrive at an appropriate rate. A rate is normally assigned to a risk based on its peculiar hazards or good features that make it substantially different from the general class to which it belongs. A number of techniques are used under this method, some of which are discussed below:

(a) Special Rating Classes: As the name implies, the insurers set up special rating classes and give them discounts from the normal rates. In motor insurance for example, proposers with good loss and traffic violation records are rewarded with substantial discounts in rating. Similarly, in life insurance, special classes of insured groups are known as "preferred risk" and are charged substantially lower premiums than that assigned to the general public. Alternatively, those other groups are called "substandard risk" and are charged extra premiums in addition to the ones assigned to the general class to which they belong.

(b) Schedule rating: This is popular in fire and burglary insurance, where individual building being proposed for insurance is considered separately and a rate established for it.

(c) Experience rating: This is another form of merit rating. This applies to insured with a relatively large exposure where the hazards affecting their operations are sufficiently within their control. Expectedly, if through special efforts they were able to reduce losses, they would enjoy a lower insurance rate for the coming period.

(d) Restropective rating: Unlike experience rating method, retrospective rating is based on the insured's loss experience during the current insurance period.

3. COMBINATION METHOD:

This is the hybrid rating method – a combination of class rating method and individual rating method. Under this method, an underwriter may develop a manual rate and still decides to rate

some individuals in a group differently due to individual characteristics. An individual in a group may qualify for rate reduction if certain requirements are met or be subject to rates higher than the manual rate under certain conditions.

### 2.2.4 INSURANCE PAYABLE AT THE MOMENT OF DEATH

The amount and the time of payment of a life insurance benefit depends on the length of the interval from the issue of the insurance to the death of the insured. Our model (for the actuarial technique) will be developed with a **benefit function**, $\mathbf{b_t}$, and a **discount function**, $\mathbf{v_t}$. In our model, $\mathbf{v_t}$ is the interest discount factor from the time of claim payment back to the time of policy issue, and **t** is the length of the interval from issue to death. For the discount function we assume that the underlying force of interest is deterministic; that is, the model does not include a probability distribution for the force of interest. Moreover, we usually show the simple formulas resulting from the assumption of a constant, as well as a deterministic force of interest. (Bowers, 1977). We define the present-value function, $\mathbf{z_t}$ by :

$$z_t = b_t v_t$$

Thus, $\mathbf{z_t}$ is the present value at the policy issue of the payment.

### 2.2.5 LEVEL BENEFIT INSURANCE

**An n-year term insurance** provides for a payment only if the insured dies within the n-year term of an insurance commencing at issue. If a unit is payable at the moment of death of (x), then the **actuarial present value** for the n-year term insurance with a unit payable at the moment of death of (x), E[Z] is denoted by $\bar{A}^{i}_{x:\overline{n}|}$. This can be calculated by recoginzing Z as a function of T so that E[Z] = E[$Z_t$]. Then, we use the probability density function (p.d.f) of T to obtain :

$$\bar{A}^{i}_{x:\overline{n}|} = E[Z] = E[Z_t]. = \int_0^n b_t v^t {}_t p_x \mu_{x+t}\, dt$$

### 2.2.6 PREDICTIVE ANALYTICS AND THE INSURANCE INDUSTRY

Risk assessment is a crucial element in the life insurance business. Individual life insurance organizations still rely on the conventional actuarial formulas ( e.g **n-year term insurance** formula which have been discussed above ) to predict mortality rates and premiums of life policies. Life insurance companies have recently started carrying out Predictive Analytics to improve their business efficacy, but there is still a lack of extensive research on how predictive analytics can enrich the life insurance domain. Researchers have concentrated on data mining techniques to detect frauds among insurance firms, which is a crucial issue due to the companies facing great

losses. Goleiji L, Tarokh M (2015). Joudaki H, Rashidian A, Minaei-Bidgoli B, Mahmoodi M, Geraili B, Nasiri M, Arab M (2016). Nian K, Zhang H, Tayal A, Coleman T, Li Y (2016)

### 2.2.7 PREDICTING INSURANCE PREMIUM CHARGE USING PREDICTIVE ANALYTICS (MULTIPLE LINEAR REGRESSION)

In predicting insurance charges using predictive analytics, we make use of the Multiple Linear Regression tool contained in Computer Software Programming language – Python. Linear regression is the most basic and commonly used predictive analysis. Regression estimates are used to describe data and to explain the relationship between one dependent variable and one or more independent variables.

There are three major uses for Regression Analysis:

- Causal analysis
- Forecasting an effect
- Trend forecasting.

1. Causual Analysis

   It might be used to identify the strength of the effect that the independent variable(s) have on a dependent variable. Typical question particular to this study is what is the strength of relationship between premium charges and age, gender, health habits, body mass index..etc

2. Forcasting An Effect

   It can be used to forecast effects or impacts of changes. That is, regression analysis helps us to understand how much the dependent variable will change when we change one or more independent variables. Typical questions are, "*How much additional Premium charge will a policy holder get for an increase in age, change in health habits, increase in number of children etc*?"

3. Predict Trends / Trends Forcasting / Predictive Analytics

   Regression analysis predicts trends and future values.The regression analysis can be used to get point estimates. Typical questions are, " What premium will be charged to a policy holder given his age , gender, number of children, body mass index..etc ?

Other than correlation analysis, which focuses on the strength of the relationship between two or more variables, regression analysis assumes a dependence or causal relationship between one or more independent and one dependent variable.

### 2.2.8 INSURANCE AND DATA SCIENCE INDUSTRY

During John Taylor's presidential address at the Institute And Faculty Of Actuaries annual general meeting on the 26 of June **2019**, he stated that every industry sector is being fundamentally altered by the deluge of data and that institutions are struggling to create value from it. He explained that in Austrailia, actuaries are heavily involved in data science and are helping supermarkets use data to choose which products to stock. He affirmed that actuaries are also using data to become more involved in environmental issues through the creation of Climate Change Indices and also explained that the advertisement sector heavily relies on data science.

The need for formal data science education amongst qualified actuaries have been recognised hence, John Taylor, at his presidential address announced the lunch of the IfoA's online 'Certificate in Data Science'. This credential will be available to members of IfoA at all stages of their careers and wherever they are located across the globe. It will cover topics such as Data Visualisation, Machine Learning, AI and Ethics, and the application of these to actuarial work.

The combination of data science toolbox and the essential skills of an actuary, will help actuaries innovate and remain leaders in their traditional domains – insurance and pension.

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