MAKERERE  **UNIVERSITY**

COLLEGE OF BUSINESS AND MANAGEMENT SCIENCES

(CoBAMS)

SCHOOL OF STATISTICS AND PLANNING

A PRICE AND PROFIT TESTING MODEL FOR A MICROINSURANCE ENDOWEMENT PLAN FOR THE BAYLIBI(HUSTLERS)

BY

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DECLARATION

DECLARATION

I, Katushabe Agrace, hereby declare that this project report is my original work and has been prepared in partial fulfilment of the requirements for the award of a Bachelor of Science in Actuarial Science at Makerere University. The work presented in this report has not been submitted for any other academic award, and all sources of information used have been duly acknowledged.

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APPROVAL

APPROVAL

This research project entitled Bayili Plan has been submitted by me as the university student`s supervisor

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DEDICATION

I dedicate this project to God Almighty for His guidance and blessings. I also dedicate it to my family, friends, and lecturers for their support, encouragement, and contribution to my academic journey.

ACKNOWLEDGEMENT

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LIST OF ACRONYMS

B/O	Bid-Offer (Spread)
CoBAMS	College of Business and Management Sciences
EPV	Expected Present Value
FSD	Financial Sector Deepening (Uganda)
GDP	Gross Domestic Product
IRA	Insurance Regulatory Authority of Uganda
M/C	Management Charge
NPV	Net Present Value
UGX	Uganda Shillings
UF	Unit Fund

ABSTRACT

Uganda's insurance penetration remains below 1% of GDP, leaving a majority of informal sector workers without adequate financial protection. This study designs, prices, and evaluates the financial viability of a unit-linked endowment microinsurance product -the Bayilibi Plan - targeting low-income individuals in Uganda's informal sector.

The product offers a sum assured of UGX 1,800,000, a funeral benefit of UGX 200,000, and a savings component payable at maturity. Premiums were priced using the equation of equivalence under a multiple decrement framework, with mortality based on Kenyan Life Tables (2007–2010) adjusted by a 131% loading factor and surrender rates of 10% applicable from Year 4 onwards. Profit testing was conducted across entry ages 20 to 45 for both genders under 5-, 10-, and 15-year terms using unit and non-unit fund projections, implemented in Microsoft Excel and Python.

Break-even premiums were approximately UGX 259,609 (female) and UGX 259,528 (male) at entry age 20 under a 5-year term. The product is profitable across most ages and terms, with the 10-year term generating the highest margins, peaking at 6.14% for females. Profitability declines with age, and male lives under the 15-year term yield negative margins from age 42. Sensitivity analysis identifies expenses as the most significant driver of profitability.

The Bayilibi Plan is financially viable and has potential to bridge the insurance protection gap for Uganda's informal sector workers

CHAPTER ONE

INTRODUCTION

1.0 Introduction

This section introduces the study by providing the background, problem statement and objectives of the research. it provides an over view of the key issues surrounding microinsurance, particularly its low penetration and limited accessibility among the informal sector workers in Uganda.

1.1 Overview of Microinsurance

Microinsurance has in the past few years developed as a financial innovation aimed at extending insurance services to the low-income populations who are largely excluded from conventional insurance systems. It is designed to provide affordable and easily accessible financial protection against risks such as mortality, morbidity, disability and income loss particularly for individuals in the informal sector (market vendors, boda boda riders, hair dressers etc). In developing economies like Uganda where a significant proportion of the population lacks access to formal financial services, microinsurance plays a crucial role in promoting financial inclusion and economic resilience.

Globally. insurance remains uneven, with developing regions experiencing significantly lower coverage compared to developed economies. In Africa particularly, insurance penetration averages at approximately 2.8%, which is considerably still lower than the global average of about 7%. This display reflects persistent challenges such as low-income levels, limited awareness and inadequate product design tailored to low-income populations.

In Uganda the insurance sector has experienced steady growth over the years; however, the overall penetration remains very low. According to the insurance regulatory authority of Uganda, insurance penetration stands at approximately 0.86% which is significantly lower than regional peers such as Kenya (2.4%) and Tanzania (2.01%) (IRA Uganda). Although gross written premiums increased from UGX 1.6 trillion in 2023 TO UGX 1.76 trillion in 2024 indicating a 10% growth in the industry, the level of insurance coverage across the population remains limited (IRA Uganda).

Microinsurance, which is specifically designed to cater to low-income individuals, contributes only a very small portion to the overall insurance market. In 2023, microinsurance accounted for approximately 0.04% of total insurance premiums, equivalent to about UGX 707 million.

Although the segment has shown rapid growth-reaching about UGX 1.64 billion in 2024, this growth is from a very low base. Additionally, the number of policyholders under microinsurance remains relatively small, increasing from 62,220 to 111,856 between 2024 and 2025.

The low uptake of microinsurance in Uganda is largely attributed to the dominance of the informal sector, where individuals earn irregular incomes and have limited access to financial services. Many informal workers face high exposure to risks such as accidents, illness, and death, yet lack adequate financial protection. Furthermore, low levels of awareness, mistrust of insurance providers, and the lack of tailored insurance products continue to hinder the growth of microinsurance in the country.

1.2 Problem Statement

Despite the growth of insurance industry in Uganda, insurance penetration remains significantly low, with levels below 1 % of the Gross Domestic Product (GDP). Microinsurance which is intended to extend coverage for low-income populations, contributes only a negligible share to the overall insurance market, accounting approximately 0.04% of total premiums (Atlas Magazine, 2023). This indicates a substantial protection gap, particularly informal sector workers who constitute the majority of Uganda's workforce

The low penetration of microinsurance in Uganda is largely due to the mismatch between existing insurance products and the needs of the target population. Most traditional products are characterised by high premiums, costs rigid payment structures and complex policy conditions making them mostly accessible to individuals with regular incomes and inaccessible for the irregular income earners. Additionally, low levels of financial literacy, limited awareness and mistrust of insurance of insurance providers further hinder the adoption of insurance services (Insurance Regulatory Authority of Uganda, 2024).

As a result, most of the individuals in the informal sector remain uninsured and rely on informal coping mechanisms such as borrowing, selling assets or depending on community or government support when faced with financial shocks. these mechanisms are often inadequate, exposing households to increased financial vulnerability and economic instability and economic instability ((FSD Uganda, 2024).

Although recent developments indicate some progress in microinsurance uptake, the level of coverage remains very low relative to the population size. For instance, microinsurance premiums increased to approximately UGX 1.64 billion and the number of policyholders rose

to about 111,856 in recent years (Insurance Regulatory Authority of Uganda, 2024). However, this growth is from a very small base and does not sufficiently address the existing protection gap.

This is why there is a need to design innovative and inclusive microinsurance products that are tailored to income patterns, risk exposures, and preferences of informal sector workers. Such products should offer affordable premiums, flexible payments mechanisms, and relevant benefits inn order to improve accessibility, increase uptake and enhance financial protection (Atlas Magazine, 2023; FSD Uganda, 2024; Insurance Regulatory Authority of Uganda, 2024).

1.3 Study objectives

The main aim of this study is to design an innovative unit-linked endowment microinsurance product for the informal sector workers, offering benefits upon death or policy maturity as well as funeral assistance.

The specific objectives of this study are;

- To design a low premium and low-cost unit-linked endowment microinsurance product that is easily accessible and affordable to informal sectors.
- To assess the profitability and financial viability of the proposed microinsurance product for insurance companies using profit testing and sensitivity analysis.

1.4 Significance of the study.

The effective design of this product is considerably significant to both the informal and insurance sectors. To the insurance sector, it demonstrates how well structured microinsurance products can enhance market penetration, reach underserved populations, and remain financially viable through appropriate pricing and risk management techniques. For the informal sector, the product provides and affordable and flexible insurance solution tailored to irregular income patterns and high exposure to risks such as illness, accidents and death thereby improving financial protection and promoting economic resilience.

CHAPTER TWO

MODEL ASSUMPTIONS

2.1 Introduction

In this chapter, the basis and the exact figures used in the development and design of the Hustlers Microinsurance (Bayilibi Plan) are presented and their interpretations.

Table 0.1 Model Assumptions

Assumptions	**Value**
Sum assured	1,800,000
Initial Expenses	15% of the premium
Renewal Expenses	2.25% of the premium
Initial Commission	15% of the premium
Renewal commission	None
Inflation rate	3.3%
Bid offer Spread	6%
Allocation in the 1st year	70%
Allocation in the other years	105%
Interest Rate	14.25%
Unit fund growth rate	15.5%
Non-unit fund rate	14.25%
Risk discount	18%
Management fund	1.5%
Funeral Benefit	200,000
Death benefit	Sum assured or Fund value
Surrender Benefit	70% of the fund value at policy end
Maturity benefit	100% of the fund at policy end
Surrender rates	10% for every year except the 1st 3 years
Mortality	131% of Kenyan rates

2.2. Explanation of the Assumptions

- **Mortality rates**: Due to the absence of a credible Ugandan insured-life mortality table, the Kenyan mortality table was adopted and adjusted by a 131% mortality loading to reflect expected higher mortality within the Ugandan microinsurance market.
- **Surrender rates:** Since microinsurance policies often experience higher lapse and surrender rates than traditional life policies, a surrender rate of 10% was adopted because policyholders tend to have irregular incomes and may stop paying premiums when faced with other financial priorities.
- **Unit fund and Non-Unit Fund growth rates**: The unit fund and non-unit fund interest rate assumptions were derived from an analysis of Uganda Government Treasury Bond yields over the past 10 years. The average yield over the period was used as a long-term estimate of future investment returns, reflecting the insurer's expected investment environment.
- **Inflation rate**: Consistent with the Bank of Uganda's medium-term inflation target and prudent for long-term insurance projections.
- **Discount rate**: Based on the average yield of Uganda Government Treasury Bonds over the last 10 years, representing the long-term risk-free rate available in the Ugandan market.
- **Expenses and Commission**. These were assumed as fixed percentages of premium income, reflecting the direct relationship between premium volume and the associated acquisition, administration, and distribution costs. No renewal commission was assumed because the microinsurance product requires minimal ongoing sales effort after inception and the absence of renewal commissions helps maintain affordability and control operating costs.
- **Funeral Benefit**: An additional funeral benefit was included alongside the death benefit to provide immediate financial support for funeral-related expenses, which are typically urgent and significant in the target low-income market.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter includes the techniques, formulae and software used to design the product in pricing and profit testing.

3.2 Software

For a single life aged 20 with a policy term of 5 years, Microsoft Excel was used for pricing and profit testing and then Python incorporating the same procedure was used for policy terms for the pricing and profit testing for other ages and policy terms

3.3 The General Model

This model is a microinsurance model called "BAYILIBI PLAN", a local name for HUSTLERS PLAN. It is a Unit-Linked Endowment model with an additional funeral benefit.

The plan consists of the Pricing Model which uses the equation of value to calculate the premium and the Profit Testing Model which contains the Unit-Linked model that calculates the profit margin for the premium calculated in the Pricing Model

Table 0.1 Multiple Decrement Table

Output	**Formula**
$(aq)_x^d$	q_x^d
$(aq)_x^w$	$q_x^w(1-(aq)_x^d$
$(ap)_x$	$(1-((aq)_x^d)-(aq)_x^w))$
${}_{t-1}(ap)_x$	$(ap)_x * {}_{t-1}(ap)_x$

Table 0.2 Pricing Formulae

Output	**Formula**
Discount Factor(v)	(1/ (1+discount rate)) ^year
Death benefit	Sum assured +funeral benefit
EPV death benefit	Death Benefit $*(aq)_x^d * v$
Surrender Benefit	80% of fund at policy end
EPV surrender benefit	Surrender benefit $*(aq)_x^w * v$

Maturity Benefit	100% of the fund Value at year end
EPV maturity benefit	Maturity benefit $*_{t-1}(ap)_x*v$
EPV benefits	EPV death benefit +EPV surrender benefit + EPV Maturity benefits
Initial expense renewal expenses	15% *premium 2.25% * premium
EPV expenses	(Initial expense$*(ap)_x$ *v) + (renewal expenses$*(ap)_x$ *v)
Initial Commission	15% * premium
EPV commission	Initial commission $*(ap)_x$ *v
EPV Total Expenses	EPV expenses + EPV commission
Premiums	Assumed premium (Before Goal seek)
EPV premiums	Premium* $(ap)_x$ *v
Equation of Value	EPV premium – (EPV Benefits +EPV Expenses)

Table 0.3 Unit Fund Formulae

Output	**Formula**
Value of units at start of year	Value at year start
Premium Allocation	7o% in the first year 105% in other years
Bid-offer spread	6% of premium allocated
Interest	Unit fund interest rate *(value at start +allocated premium– bid-offer amount)
Management Charge	1.5% *(value at year start+ allocated premium -bid-offer amount + interest)
Value at year end	(value at start +allocated premium – bid-offer amount +interest -management charge)

Table 0.4 Non-Unit Fund Formulae

Output	**Formula**
Premium Allocation	30% in the first year -5% in the other years
Bid-offer spread	6% of the allocated premium in unit fund amount
expenses	15% * premium +(2.25% *(1+inflation rate) ^year) *premium
interest	Non-unit fund interest*(allocated premium +bid-offer spread -expenses)
Management Charge	Value from the Unit fund
Expected surrender penalty	10% *fund value *$(aq)_x^w$
Extra death cost	(sum assured +funeral benefit – fund value) *$(aq)_x^d$
Profit Vector	Allocated premium +bid-offer spread -expenses +interest +management charge +expected surrender penalty -extra death cost

Table 0.5 Profit Margin Formulae

Output	**Formula**
Discount Factor profit	(1/ (1+discount rate)) ^ (year)
Discount factor premiums	(1/ (1+discount rate) ^ (year -1)
Profit signature	Profit vector* $_{t-1}(ap)_x$
Discounted profits	Profit signature * discount factor
Discounted premiums	Premiums*discount factor *$_{t-1}$ $(ap)_x$
NPV profits	Sum of discounted profits
NPV premiums	Sum of discounted premiums
Profit margin	NPV profits/NPV premiums

3.4 Description of the formulae symbols

$\mathbf{q_x^d}$: independent probability of death

$\mathbf{q_x^w}$: independent probability of surrender

$\mathbf{(aq)_x^d}$: dependent probability of death

$\mathbf{(aq)_x^w}$: dependent probability of surrender

$\mathbf{(ap)_x}$: dependent probability of survival

$\mathbf{_{t-1}(ap)_x}$: dependent cumulative probability in force at year start

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the results from the pricing and profit testing models for both genders. It also presents how different factors affect the profit margin in the sensitivity analysis.

The results presented are based on a 20 year old female and male with a sum assured of UGX 1,800,000, a death benefit of UGX 200,000 and a five year term

4.2 Multiple decrements

The multiple decrement tables for both males and females showing the independent and dependent are presented.

Table 0.1 Multiple decrements for the female life

Age	q_x^d	q_x^w	$(aq)_x^d$	$(aq)_x^w$	$(ap)_x$	$_{t-1}(ap)_x$
20	0.0019388	0.00000	0.00198388	0.0000000	0.9980612	1
21	0.0020829	0.00000	0.0020829	0.0000000	0.9979171	0.99806120
22	0.0022008	0.0000	0.0022008	0.0000000	0.9977992	0.99791710
23	0.0022449	0.1000	0.0022449	0.0997720	0.8979485	0.99779920
24	0.0023580	0.1000	0.0023580	0.09976551	0.8978896	0.89794854

Table 0.2 Multiple decrements for the male life

Age	q_x^d	q_x^w	$(aq)_x^d$	$(aq)_x^w$	$(ap)_x$	$_{t-1}(ap)_x$
20	0.00171610	0	0.00171610	0.99828390	0.99828390	1
21	0.00195190	0	0.00195190	0.99828390	0.99828390	0.9982839
22	0.00217460	0	0.00217460	0.99782540	0.99782540	0.99633535
23	0.00234490	0.1	0.00234490	0.89788959	0.89788959	0.994168719
24	0.00247590	0.0	0.00247590	0.89777169	0.89777169	0.892653743

4.3 Pricing Model

This model uses the equation of equivalence which is EPV Premiums = EPV Benefits + EPV (expenses + commissions). The premiums are paid by the policy holder and the benefits and the expenses are catered for by the insurer.

The pricing models results below are for a 20 year old male and a 20 year old female for a term of 10 years.

4.3.1 Pricing results for a 20 year old female.

Table 0.3 EPV Death and survival benefits

	Year	Amount	Discount	Probability	EPV
DEATH	0	2000000	0.875273523	0.0019388	3393.960613
	1	2000000	0.76610374	0.0020829	3185.247406
	2	2000000	0.670550319	0.0022008	2939.636181
	3	2000000	0.58691494	0.0022794	2659.013200
	4	2000000	0.513711108	0.0023449	2149.906218
SURVIVAL	5	1800000	0.5137111076	0.8902801	823224.194144
					837551.957761

Table 0.4 EPV Surrender Benefits

Kx	Amount	Discount	Probability	EPV
0	155,472.47	0.875273523	0	0
1	410,085.84	0.76610374	0	0
2	699,753.11	0.670550319	0	0
3	1,029,300.32	0.58691494	0.099152513	59899.19682
4	1,404,217.94	0.513711108	0	0
Total				**59899.19682**

Table 0.5 EPV Expenses

Kx	Amount	discount	Probability	EPV
0	38941.318596	1	1	38941.318596
1	6033.957317	0.875273523	0.9979171	5270.362527
2	6233.077908	0.76610374	0.9977992	4764.675072
3	6438.769479	0.670550319	0.89794854	3876.909821
4	6651.248872	0.58691494	0.9976551	3894.563509
				56747.829524

Table 0.6 EPV Commission

Kx	Amount	Discount	Probability	EPV
0	38941.3186	1	1	38941.3186
1	0	0.875273523	0.9979171	0
2	0	0.76610374	0.9977992	0
3	0	0.670550319	0.89794854	0
4	0	0.58691494	0.9976551	0
Total				38941.3186

Table 0.7 EPV Premium

Kx	Amount	Discount	Probability	EPV
0	259608.7906	1	1	259608.7906
1	259608.7906	0.875273523	0.9979171	226755.4061
2	259608.7906	0.76610374	0.9977992	198449.5544
3	259608.7906	0.670550319	0.8979485	156315.562
4	259608.7906	0.58691494	0.9976551	152010.9895
				993140.3027

4.3.2 Pricing results of a 20 year old male

Table 0.8 EPV Death and Survival Benefits

	Kx	Amount	discount	Probability	EPV
DEATH	0	2000000	0.875273523	0.0017161	3004.113786
	1	2000000	0.76610374	0.00194855	2985.583413
	2	2000000	0.670550319	0.002166631	2905.670019
	3	2000000	0.58691494	0.002331226	2736.463007
	4	2000000	0.513711108	0.002210121	2270.727828
SURVIVAL	5	1800000	0.513711108	0.890443622	823375.4027
					837551.9577

Table 0.9 EPV Surrender Benefits

Kx	Amount	discount	Probability	EPV
0	155424.2342	0.875273523	0	0
1	409958.617	0.76610374	0	0
2	699536.0208	0.670550319	0	0
3	1028980.994	0.58691494	0.099183749	59899.4782
4	1403782.303	0.513711108	0	0
5				**59899.4782**

Table 0.10 EPV Expenses

Kx	Amount	Discount	Probability	EPV
0	38929.237732	1	1	38929.23773
1	6032.0853865	0.875273523	0.99804810	5269.419133
2	6231.1442043	0.76610374	0.99782540	4763.321985
3	6436.7719630	0.670550319	0.89788959	3875.452638
4	6649.1854378	0.58691494	0.99752410	3892.84406
Total				**56730.27555**

Table 0.11 EPV Commission

KX	Amount	Discount	Probability	EPV
0	38929.23773	1	1	38929.23773
1	0	0.875273523	0.875273523	0
2	0	0.76610374	0.76610374	0
3	0	0.670550319	0.670550319	0
4	0	0.58691494	0.58691494	0
				38929.23773

Table 0.12 EPV Premiums

Kx	Amount	Discount	Probability	EPV
0	259528.2515	1	1	259528.2515
1	259528.2515	0.875273523	0.99804810	226714.8169
2	259528.2515	0.76610374	0.99782540	198393.1981
3	259528.2515	0.670550319	0.89788959	156256.809
4	259528.2515	0.58691494	0.99752410	151943.8767
Total				**992836.9523**

The equation of value balances for both males and females with **UGX992836.9523** for males and **UGX 993140.302706** for females. The premium from this equation is approximately **UGX 259528.2515** for males and **UGX 259608.7906** for females after goal seek.

The Goal seek function is used to get the actual approximated premium because an assumed premium was used.

4.4 Profit Testing Model results

This model is used for checking whether the whole product design is profitable and viable for the insure**r.**

4.4.1 Profit testing results for females.

Table 0.13 Unit Fund Values

Year	UF at Start	Allocation	B/O	Interest	M/C	UF at end
1	0	181,726	10,904	26,478	2,960	194,341
2	194,341	272,589	16,355	69,839	7,806	512,607
3	512,607	272,589	16,355	119,170	13,320	874,691
4	874,691	272,589	16,355	175,293	19,593	1,286,625
5	1,286,625	272,589	16,355	239,143	26,730	1,755,272

Table 0.14 Non-Unit Fund Values

Year	Allocation	B/O	Expenses	Interest	M/C	Death Cost	Surrender income	Profit Vector
1	77,883	10,904	77,883	1,554	2,960	3,501	0	11,916
2	-12,980	16,355	6,034	-379	7,806	3,092	0	1,676
3	-12,980	16,355	6,233	-407	13,320	2,471	0	7,583
4	-12,980	16,355	6,439	-437	19,593	1,622	25,617	40,088
5	-12,980	16,355	6,651	-467	26,730	515	0	22,472

Table 0.15 NPV Profits

Year	Profit	Discount	T-1(ap)x	NPV profits
1	11,916.0166144	0.8474576	1.0000000	10,098.3191647
2	1,676.1621663	0.7181844	0.9980612	1,201.4596546
3	7,583.3006748	0.6086309	0.9979171	4,605.8174264
4	40,087.6883504	0.5157889	0.9977992	20,631.2782162
5	22,471.5263359	0.4371092	0.8979485	8,820.1096488
				45,356.9841108

Table 0.16 NPV Premiums

Year	Premium	Discount	T-1(ap)x	NPV premiums
0	259,608.79064	1.00000	1.00000	259,608.79064
1	259,608.79064	0.84746	0.99806	219,580.89925
2	259,608.79064	0.71818	0.99792	186,058.64083
3	259,608.79064	0.60863	0.99780	157,658.18537
4	259,608.79064	0.51579	0.89795	120,238.29618
				943,144.81227

Table 0.17 Profit margin for females

PROFIT MARGIN	**4.75%**

4.4.2 Profit testing results for males

Table 0.18 Unit Fund Values

Year	Uf at start	Allocation	B/O	Interest	M/C	Uf at end
1	0	181,669.78	10,900.19	26,469.29	2,958.58	194,280.29
2	194,280.29	272,504.66	16,350.28	69,817.37	7,803.78	512,448.27
3	512,448.27	272,504.66	16,350.28	119,133.41	13,316.04	874,420.03
4	874,420.03	272,504.66	16,350.28	175,239.03	19,587.20	1,286,226.24
5	1,286,226.24	272,504.66	16,350.28	239,069.00	26,721.74	1,754,727.88

Table 0.19 Non-Unit Fund Values

Year	Allocation	B/O	Expenses	Interest	M/C	Death Cost	Surrender income	Profit Vector
1	77,858.47	10,900.19	77,858.475	1,553.2766	2,958.5	3,098.7956	0	12,313.2507
2	-12,976.41	16,350.28	6,032.085	-378.7961	7,803.8	2,898.5694	0	1,868.1971
3	-12,976.41	16,350.28	6,231.144	-407.1620	13,316.0	2,438.7163	0	7,612.8858
4	-12,976.41	16,350.28	6,436.772	-436.4639	19,587.2	1,663.9681	25,514.5482	39,938.4132
5	-12,976.41	16,350.28	6,649.185	-466.7328	26,721.7	542.0812	0	22,437.6122

Table 0.20 NPV Profits

Year	Profit	Discount	t-1(ap)x	NPV Profits
1	12,313.2507	0.8474576	1.000000000	10434.9582
2	1,868.1971	0.7181844	0.998283900	1339.40759
3	7,612.8858	0.6086309	0.996335350	4616.45741
4	39,938.4132	0.5157889	0.994168719	20479.666
5	22,437.6122	0.4371092	0.892653743	8754.86858
				45625.3578

Table 0.21 NPV Premiums

YEAR	PREMIUM	DISCOUNT	t-1(ap)x	NPV premiums
0	259528	1.00000	1.000000000	259,528.25
1	259528	0.84746	0.998283900	219,561.76
2	259528	0.71818	0.996335350	185,706.10
3	259528	0.60863	0.994168719	157,035.82
4	259528	0.51579	0.892653743	119,492.22
				941,324.15

Table 0.22 Profit Margin for males

PROFIT MARGIN	**4.79%**

The profit testing model was developed using a unit-linked product framework. Under this structure, each premium received is allocated among several components. A portion of the premium is used to provide insurance protection through the death and funeral benefits, while another portion is invested in units on behalf of the policyholder by the insurers to accumulate investment value. The remaining portion of the premium is used to meet policy acquisition costs, commissions, administration expenses, and other operational costs associated with managing both the insurance and investment components of the product.

The model projects the cash flows arising from these components over the policy term, taking into account mortality, withdrawals, expenses, commissions, investment returns, and management charges. Separate projections are made for the unit fund and non-unit fund to assess the overall financial performance of the product. Annual profits generated from these cash flows are discounted at the risk discount rate of 18% to determine the Net Present Value (NPV) of profits. The profitability of the product is then measured using the profit margin, defined as the ratio of the NPV of profits to the NPV of premiums, expressed as a percentage.

A positive profit margin indicates that the discounted value of future profits exceeds the discounted cost of providing benefits and servicing the policy, while a higher profit margin reflects greater profitability and financial sustainability of the product.

From the above tables, we have a profit margin of 4.75% for females and 4.79% for males indicating that the product is profitable for the insurers for a term of just 5 years.

Table 0.23 Profit margin across all ages for females

	TERM		
AGE	**5**	**10**	**15**
20	13.55%	18.04%	17.24%
21	13.49%	17.89%	16.98%
22	13.45%	17.80%	16.88%
23	13.42%	17.78%	16.90%
24	13.41%	17.83%	17.03%
25	13.42%	17.93%	17.28%
26	13.45%	18.08%	17.59%
27	13.49%	18.26%	17.96%
28	13.54%	18.44%	18.32%
29	13.59%	18.61%	18.64%
30	13.64%	18.76%	18.89%
31	13.68%	18.88%	19.02%
32	13.72%	18.94%	19.02%
33	13.74%	18.96%	18.87%
34	13.75%	18.91%	18.54%
35	13.74%	18.80%	18.02%
36	13.71%	18.62%	17.35%
37	13.68%	18.41%	16.56%
38	13.63%	18.14%	15.63%
39	13.58%	17.82%	14.58%
40	13.52%	17.45%	13.42%
41	13.46%	17.02%	12.14%
42	13.38%	16.54%	10.75%
43	13.29%	15.98%	9.26%
44	13.16%	15.32%	7.60%
45	13.00%	14.54%	5.80%

The female profit testing results indicate that the product remains profitable across all entry ages and policy terms. Profit margins range from 13.55% to 13.00% for the 5-year term and are highest under the 10-year term, peaking at 13.74% at age 33. Although profitability declines at older ages, all profit margins remain positive, including under the 15-year term. This reflects the lower mortality rates of females, which result in lower claim costs and higher profitability. Overall, the 10-year term is the most profitable option, while the product remains financially sustainable across all ages considered.

Table 0.24 Profit Margin across all ages for males

	TERM		
AGE	**5**	**10**	**15**
20	13.60%	14.07%	6.63%
21	13.49%	13.66%	5.64%
22	13.39%	13.34%	4.87%
23	13.32%	13.12%	4.34%
24	13.28%	12.98%	4.01%
25	13.25%	12.92%	3.87%
26	13.25%	12.93%	3.89%
27	13.26%	12.99%	4.03%
28	13.28%	13.08%	4.22%
29	13.31%	13.17%	4.44%
30	13.34%	13.25%	4.62%
31	13.36%	13.30%	4.72%
32	13.38%	13.30%	4.70%
33	13.37%	13.22%	4.51%
34	13.35%	13.08%	4.16%
35	13.31%	12.87%	3.67%
36	13.25%	12.60%	3.06%
37	13.18%	12.30%	2.36%
38	13.10%	11.96%	1.62%
39	13.01%	11.61%	0.85%
40	12.92%	11.26%	0.10%
41	12.83%	10.92%	-0.62%
42	12.74%	10.59%	-1.30%
43	12.66%	10.28%	-1.93%
44	12.58%	10.00%	-2.50%
45	12.51%	9.74%	-3.01%

The male profit testing results show that the product is profitable across most entry ages and policy terms. Profit margins are relatively stable for the 5-year term, ranging from 13.60% to 12.51%. The 10-year term generates the highest profit margins, reaching 14.07% at age 20 and remaining above 9% for all ages. Profitability under the 15-year term declines steadily with age and becomes negative from age 41 onwards, indicating that higher mortality costs reduce profitability for older entrants. Overall, profitability decreases with increasing age, and the 10-year term appears to be the most profitable option.

4.5 Discussion of results

The graphs below the variation of the profit margin versus the entry age of either females or males by the policy term

Graph for males

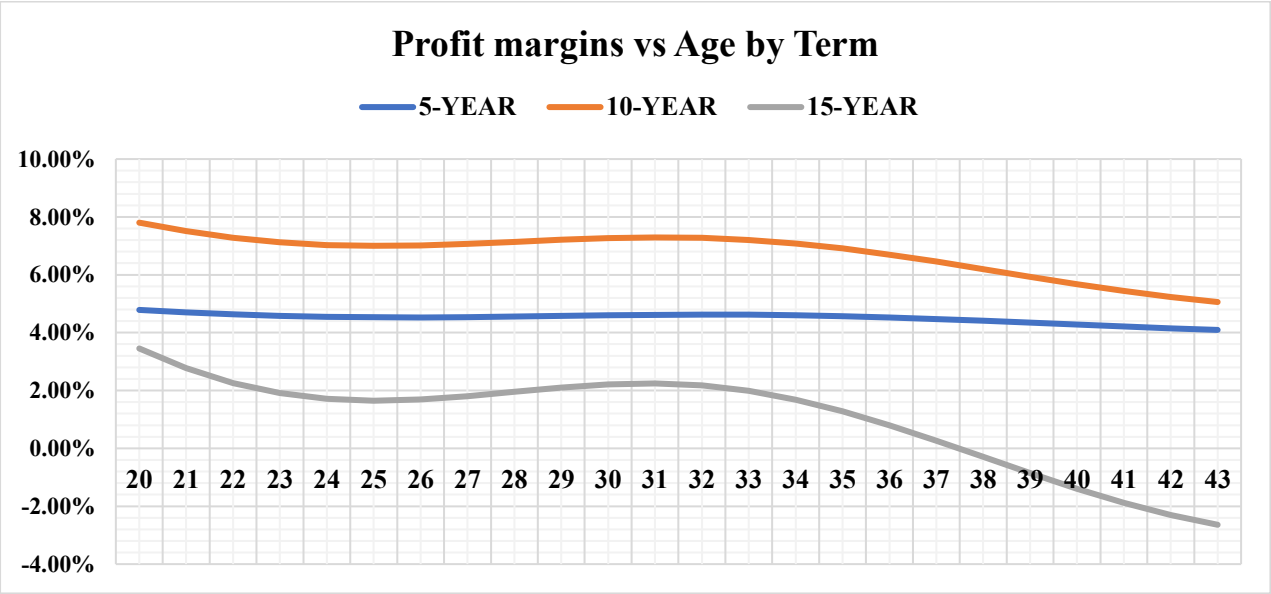


Figure 0:1 Profit Margin VS age by term for males

Graph for females

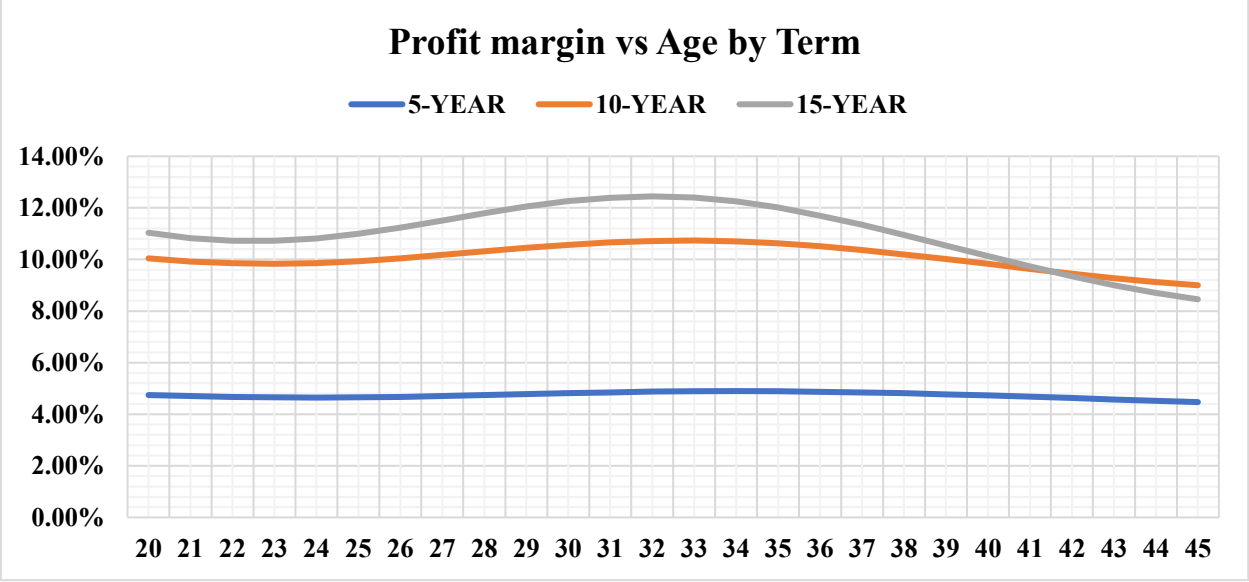


Figure 0:2 Profit Margin Vs age by term for females

The graphs show that profit margins generally decline as entry age increases for both males and females. This is expected because mortality risk increases with age, leading to higher expected death benefit costs and reducing the profit generated by the policy.

For males, the decline in profitability is more pronounced, particularly under the 10-year and 15-year terms. The 15-year term experiences the sharpest decline, with profit margins becoming negative at older ages. This occurs because the higher mortality rates of males increase expected claim costs over the longer policy duration, eventually outweighing the income generated from premiums, charges, and investment returns.

For females, profit margins are consistently higher across all terms and ages. Although profitability also declines at older ages, the reduction is less severe and all profit margins remain positive. This reflects the lower mortality rates of females, resulting in lower expected death benefit payments and allowing a greater proportion of premium income and investment earnings to contribute to profit.

For both genders, the 10-year term generates the highest profit margins across most ages. This suggests that the product benefits from a balance between sufficient premium and charge income, investment growth, and manageable claim costs. In contrast, the 5-year term provides less time for investment growth and charge accumulation, while the 15-year term exposes the insurer to higher mortality and withdrawal risks over a longer period.

Overall, the results demonstrate that profitability is strongly influenced by entry age, policy term, and mortality experience. Younger policyholders and female lives generate higher profit margins, while longer policy durations become less profitable at older ages due to increasing mortality costs.

4.6 Sensitivity Analysis

Table 0.25 Sensitivity Analysis

Assumptions		**%change**	**Profit margin**
Interest rate	Increase	15%	4.11%
	Standard	0%	4.75%
	Decrease	15%	5.35%
Mortality	Increase	15%	4.64%
	Standard	0	4.75%
	Decrease	15%	4.86%
Expenses	Increase	15%	3.49%
	Standard	0%	4.75%
	Decrease	15%	6.05%

Interest Rate: Increasing the interest rate by 15% reduces the profit margin from 4.75% to 4.11%, while decreasing it by 15% increases the profit margin to 5.35%. This indicates that higher interest assumptions increase the present value of future benefits and fund-related obligations, thereby reducing profitability. Conversely, lower interest rates reduce these obligations and improve profit margins.

Mortality Rate: A 15% increase in mortality reduces the profit margin from 4.75% to 4.64%, while a 15% decrease increases it to 4.86%. The relatively small change suggests that the product is not highly sensitive to mortality assumptions, although higher mortality leads to increased death benefit payments and lower profitability.

Expenses: The profit margin decreases significantly from 4.75% to 3.49% when expenses increase by 15% and rises to 6.05% when expenses decrease by 15%. This demonstrates that profitability is highly sensitive to expense levels, as expenses directly reduce the insurer's earnings throughout the policy term.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

In this chapter we see the conclusions, short comings and recommendations for the Hustlers plan microinsurance product

5.1 Conclusion

This study developed and evaluated a unit-linked microinsurance product designed to provide both life insurance protection and investment benefits. The product was priced using actuarial techniques and assessed through profit testing to determine its financial viability across different entry ages and policy terms.

The results showed that the product is generally profitable, with profit margins varying by age, gender, and policy term. Profitability was higher for younger policyholders and female lives due to lower mortality rates and lower expected claim costs. The 10-year policy term consistently generated the highest profit margins, indicating an optimal balance between premium income, investment growth, and benefit outgo. In contrast, profitability declined with increasing entry age, particularly for longer policy terms where mortality costs become more significant.

The sensitivity analysis revealed that the product is most sensitive to changes in expenses, moderately sensitive to interest rate assumptions, and less sensitive to mortality assumptions. This highlights the importance of effective expense management in maintaining the profitability and sustainability of the product.

Overall, the findings demonstrate that the proposed unit-linked microinsurance product is financially viable and has the potential to enhance access to affordable insurance and savings solutions while generating acceptable returns for the insurer.

5.2 Recommendations

To optimize profitability and long-term sustainability, the insurer should target younger demographics and emphasize 10-year policy terms while adopting age-based pricing to accurately reflect mortality risks across groups. Additionally, maintaining strict expense control and periodically reviewing key operational and financial assumptions will safeguard profit margins against market shifts.

However, a major shortcoming of unit-linked microinsurance is its inherent complexity; low-income policyholders may find market-driven returns difficult to understand, leading to distrust, misaligned expectations, and high policy cancellation rates if investment yields fluctuate but investing in financial literacy and awareness campaigns will be essential to expanding the reach and uptake of unit-linked microinsurance products among low-income populations**.**

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APPENDICES

APPENDIX A: Python program used for the pricing and profit testing.

```
22
23  PRODUCT_NAME = "BAYILIBI PLAN"
24
25  # ── KENYAN MORTALITY TABLE (2007-2010) with 1.31% loading ──────────────
26  # Base Kenyan qx (female, male).  Applied loading: qx_loaded = qx_base × 1.0131
27  # Kenya A67/70 graduated table values (ages 20-45):
28  _KENYA_BASE = {
29      20: (0.001913, 0.001695),
30      21: (0.002058, 0.001929),
31      22: (0.002174, 0.002148),
32      23: (0.002253, 0.002317),
33      24: (0.002316, 0.002450),
34      25: (0.002330, 0.002538),
35      26: (0.002316, 0.002580),
36      27: (0.002253, 0.002580),
37      28: (0.002174, 0.002552),
38      29: (0.002085, 0.002499),
39      30: (0.001980, 0.002450),
40      31: (0.001890, 0.002382),
41      32: (0.001800, 0.002330),
42      33: (0.001721, 0.002304),
43      34: (0.001670, 0.002317),
44      35: (0.001657, 0.002356),
45      36: (0.001683, 0.002435),
46      37: (0.001721, 0.002552),
47      38: (0.001786, 0.002679),
48      39: (0.001877, 0.002835),
49      40: (0.001967, 0.003004),
```

```
LOADING = 1.0131   # 1.31% loading factor

MORTALITY = {
    age: (round(v[0] * LOADING, 10), round(v[1] * LOADING, 10))
    for age, v in _KENYA_BASE.items()
}

# ── FIXED ASSUMPTIONS ──────────────────────────────────────────────────────
PRODUCT     = "BAYILIBI PLAN"
SA          = 1_800_000
FUNERAL     = 200_000
DEATH_BEN   = SA + FUNERAL          # 2,000,000
INTEREST    = 0.1425                # pricing / valuation interest rate
V_PRICE     = 1.0 / (1.0 + INTEREST)
INFLATION   = 0.033
WD_RATE     = 0.10                  # withdrawal rate (Year 4 onwards, not last year)
SURR_PCT    = 0.80
INIT_EXP    = 0.15
RENEW_EXP   = 0.0225
INIT_COMM   = 0.15
RISK_DISC   = 0.18
BO_SPREAD   = 0.06
ALLOC_YR1   = 0.70
ALLOC_OTHER= 1.05
MC_RATE     = 0.015
```

```python
UF_INT  = {5: 0.1500, 10: 0.1550, 15: 0.1575}   # unit fund interest by term
NU_INT  = {5: 0.1425, 10: 0.1450, 15: 0.1465}   # non-unit fund interest by term


# ── CORE ACTUARIAL FUNCTIONS ──────────────────────────────────────────

def get_qd(age, gender):
    """Loaded Kenyan mortality rate q^d."""
    return MORTALITY[min(age, 45)][0 if gender.upper() == 'F' else 1]


def is_withdrawal_year(k, term):
    """
    Withdrawal applies from Year 4 (k=3) onwards,
    but NOT in the last year (maturity).
    k=3,4,...,term-2  →  True
    """
    return k >= 3 and k < term - 1


def build_decrements(entry_age, term, gender):
    """
    Multiple decrement table.
    t1ap[k] = ap[k-1]  (k≥1),  t1ap[0] = 1.
    Withdrawal: q^w = WD_RATE for k in [3, term-2], else 0.
    """
    rows = []
```

```python
    rows = []
    for k in range(term):
        qd   = get_qd(entry_age + k, gender)
        qw   = WD_RATE if is_withdrawal_year(k, term) else 0.0
        aqd  = qd
        aqw  = qw * (1.0 - aqd)
        ap   = 1.0 - aqd - aqw
        t1ap = 1.0 if k == 0 else rows[k-1]['ap']
        rows.append(dict(k=k, age=entry_age+k,
                         qd=qd, qw=qw, aqd=aqd, aqw=aqw, ap=ap, t1ap=t1ap))
    return rows


def cum_prob(dec):
    """
    True cumulative in-force probability.
    cum[0]=1, cum[k] = ap[0]xap[1]x...xap[k-1].
    Used for EPV death, survival, and withdrawal.
    """
    c = [1.0]
    for row in dec[:-1]:
        c.append(c[-1] * row['ap'])
    return c
```

```
368
369     # Decrement table
370     wd_yrs = [k for k in range(term) if is_withdrawal_year(k, term)]
371     section(f"MULTIPLE DECREMENT TABLE  |  Mortality: Kenyan x {LOADING}  |  "
372             f"Withdrawal Years: {[k+1 for k in wd_yrs]}  |  "
373             f"t-1(ap)_x = ap[k-1]")
374     print(f"  {'k':>4}  {'Age':>5}  {'q^d (loaded)':>14}  {'q^w':>8}  "
375           f"{'(aq)^d':>12}  {'(aq)^w':>12}  {'(ap)_x':>12}  {'t-1(ap)_x':>14}")
376     print("  " + "-"*(W-4))
377     for r in R['dec']:
378         print(f"  {r['k']:>4}  {r['age']:>5}  {r['qd']:>14.8f}  {r['qw']:>8.4f}"
379               f"  {r['aqd']:>12.8f}  {r['aqw']:>12.8f}  {r['ap']:>12.8f}"
380               f"  {r['t1ap']:>14.8f}")
381     sep()
382
383     # EPV tables
384     epv_block(f"EPV  -  DEATH & SURVIVAL BENEFIT",
385               R['death_rows'],
386               f"Death: Σ {DEATH_BEN:,}×v^(k+1)×cum[k]×(aq)^d  |  "
387               f"Survival: {SA:,}×v^{term}×cum[{term-1}]×ap[{term-1}]")
388     epv_block("EPV  -  WITHDRAWAL (SURRENDER) BENEFIT",
389               R['wd_rows'],
390               f"WB = {SURR_PCT*100:.0f}%×UF_end  |  "
391               f"EPV = WB×v^(k+1)×cum[k]×(aq)^w  "
392               f"(Years {wd_yrs[0]+1}–{wd_yrs[-1]+1} only)" if wd_yrs else "No withdrawal years")
393     epv_block("EPV  -  PREMIUM INCOME",
```

```
396     epv_block("EPV  -  EXPENSES",
397               R['exp_rows'],
398               f"Year 0: {INIT_EXP*100:.0f}%×P  |  "
399               f"Year k: {RENEW_EXP*100:.2f}%×P×(1+{INFLATION*100:.1f}%)^k")
400     epv_block("EPV  -  COMMISSION",
401               R['comm_rows'],
402               f"Initial commission {INIT_COMM*100:.0f}%×P at Year 0 only")
403
404     # Equation of equivalence
405     section("EQUATION OF EQUIVALENCE CHECK")
406     tot_out = R['epv_death'] + R['epv_wd'] + R['epv_exp'] + R['epv_comm']
407     for lbl, val in [
408         ("EPV Death & Survival Benefit", R['epv_death']),
409         ("EPV Withdrawal Benefit",       R['epv_wd']),
410         ("EPV Expenses",                 R['epv_exp']),
411         ("EPV Commission",               R['epv_comm']),
412     ]:
413         print(f"  {lbl:<44} {val:>20,.5f}")
414     print("  " + "-"*66)
415     print(f"  {'TOTAL EPV OUTGO':<44} {tot_out:>20,.5f}")
416     print(f"  {'TOTAL EPV INCOME (Premium)':<44} {R['epv_prem']:>20,.5f}")
417     print(f"  {'BALANCE (should be ~0)':<44} {R['epv_prem']-tot_out:>20,.5f}")
418     sep()
```

```
    # Unit fund
    section(f"UNIT FUND PROJECTION  |  UF Interest={uf_int*100:.2f}%  |  "
            f"Alloc Yr1={ALLOC_YR1*100:.0f}%  Other={ALLOC_OTHER*100:.0f}%  "
            f"B/O={BO_SPREAD*100:.0f}%  MC={MC_RATE*100:.1f}%×pre-MC")
    print(f"  {'Yr':>4}  {'UF Start':>16}  {'Allocation':>14}  "
          f"{'B/O Spread':>12}  {'Interest':>14}  {'Mgmt Charge':>14}  {'UF End':>16}")
    print("  " + "─"*(W-4))
    for k, u in enumerate(R['uf']):
        print(f"  {k+1:>4}  {u['uf_start']:>16,.4f}  {u['alloc']:>14,.4f}"
              f"  {u['bo']:>12,.4f}  {u['interest']:>14,.4f}"
              f"  {u['mc']:>14,.4f}  {u['uf_end']:>16,.4f}")
    sep()

    # Non-unit fund
    section(f"NON-UNIT FUND PROFIT TEST  |  NU Interest={nu_int*100:.2f}%")
    t1ap_lbl = 'ap[k-1]' if g == 'F' else 'cumulative'
    print(f"  Extra Death = MAX({DEATH_BEN:,}−UF_end,0)×(aq)^d×t1ap_n[k]")
    print(f"  Surr Income = (1−{SURR_PCT})×UF_end×(aq)^w×t1ap_n[k]  "
          f"(Years {wd_yrs[0]+1}–{wd_yrs[-1]+1})" if wd_yrs else "")
    print(f"  t1ap_n ({glbl}): {t1ap_lbl}\n")
    print(f"  {'Yr':>3}  {'NU Alloc':>14}  {'B/O':>10}  {'Expenses':>12}"
          f"  {'Interest':>12}  {'MC':>12}  {'Extra Death':>13}"
          f"  {'Surr Inc':>11}  {'PROFIT':>14}")
    print("  " + "─"*(W-4))
    for k in range(term):
```

```
        u        = R['uf'][k]
        alloc_nu = P - u['alloc']
        bo       = u['bo']
        exp      = ((INIT_EXP+INIT_COMM)*P if k==0
                    else RENEW_EXP*P*(1+INFLATION)**k)
        interest = (alloc_nu + bo - exp) * nu_int
        mc       = u['mc']
        ed       = (max(DEATH_BEN - u['uf_end'], 0)
                    * R['dec'][k]['aqd'] * R['t1ap_n'][k])
        si       = (0.0 if not is_withdrawal_year(k, term)
                    else (1-SURR_PCT)*u['uf_end']*R['dec'][k]['aqw']*R['t1ap_n'][k])
        print(f"  {k+1:>3}  {alloc_nu:>14,.4f}  {bo:>10,.4f}  {exp:>12,.4f}"
              f"  {interest:>12,.4f}  {mc:>12,.4f}  {ed:>13,.4f}"
              f"  {si:>11,.4f}  {R['profits'][k]:>14,.4f}")
    sep()

    # EPV profit & margin
    vr = 1.0 / (1.0 + RISK_DISC)
    section("EPV OF PROFIT  &  PROFIT MARGIN")
    print(f"  Risk Discount Rate = {RISK_DISC*100:.0f}%  |  "
          f"Profit Margin = EPV(Profit) / EPV(Premium @ risk discount rate)\n")
    print(f"  {'Yr':>4}  {'Profit (UGX)':>16}  {'v_r^(k+1)':>14}"
          f"  {'t1ap_n[k]':>12}  {'NPV Profit':>16}")
    print("  " + "─"*(W-4))
    for k in range(term):
        disc = vr**(k+1)
```

```
          f"  {'':>12}  {R['epv_profit']:>16,.4f}\n")
    print(f"  {'Yr':>4}  {'Premium (UGX)':>16}  {'v_r^k':>14}"
          f"  {'t1ap_n[k]':>12}  {'NPV Premium':>16}")
    print("  " + "─"*(W-4))
    for k in range(term):
        disc = vr**k
        npv  = P * disc * R['t1ap_n'][k]
        print(f"  {k+1:>4}  {P:>16,.4f}  {disc:>14.8f}"
              f"  {R['t1ap_n'][k]:>12.8f}  {npv:>16,.4f}")
    print("  " + "─"*(W-4))
    print(f"  {'':>4}  {'TOTAL EPV PREMIUM':>16}  {'':>14}"
          f"  {'':>12}  {R['epv_prem_r']:>16,.4f}\n")
    sep('=')
    print(f"  ▶  PROFIT MARGIN  =  {R['epv_profit']:>14,.4f}  ÷  "
          f"{R['epv_prem_r']:>14,.4f}  =  {R['margin']*100:>10.6f}%")
    sep('=')

```

```
494  # ── PROFIT MARGIN SUMMARY TABLE ──────────────────────────────────────
495
496  def margin_table(ages=range(20, 46), terms=(5, 10, 15)):
497      title(f"{PRODUCT_NAME}  —  PROFIT MARGIN SUMMARY  |  Ages 20–45  |  "
498            f"5 / 10 / 15-Year Terms")
499      for t in terms:
500          print(f"\n  ── {t}-YEAR TERM  "
501                f"[UF={UF_INT[t]*100:.2f}%  NU={NU_INT[t]*100:.2f}%]"
502                f"  {'─'*70}")
503          print(f"  {'Age':>4}  {'Female Premium (UGX)':>22}  {'F Margin':>10}"
504                f"  {'Male Premium (UGX)':>22}  {'M Margin':>10}")
505          print("  " + "─"*(W-4))
506          for age in ages:
507              Rf = compute_all(age, t, 'F')
508              Rm = compute_all(age, t, 'M')
509              print(f"  {age:>4}  {Rf['P']:>22,.2f}  {Rf['margin']*100:>10.4f}%"
510                    f"  {Rm['P']:>22,.2f}  {Rm['margin']*100:>10.4f}%")
511          print("  " + "─"*(W-4))
512
```

```
514  # ── INTERACTIVE ENTRY POINT ──────────────────────────────────────────
515
516  def run():
517      sep('=')
518      print(f"  {PRODUCT_NAME}  —  PRICING & PROFIT TESTING")
519      print(f"  Kenyan Life Table 2007–2010 ✗ {LOADING} loading  |  "
520            f"Ages 20–45  |  Interest {INTEREST*100:.2f}%  |  Risk Discount {RISK_DISC*100:.0f}%")
521      print(f"  Withdrawal: Year 4 onwards (not last year)  |  "
522            f"UF Int: 15.00%(5yr) 15.50%(10yr) 15.75%(15yr)  |  "
523            f"NU Int: 14.25%(5yr) 14.50%(10yr) 14.65%(15yr)")
524      sep('=')
525      print("\n  1  —  Single age / gender / term  (full tables)")
526      print("  2  —  Profit margin summary  (all ages, all terms)")
527      print("  Q  —  Quit\n")
528
529      while True:
530          ch = input("  Choice (1 / 2 / Q): ").strip().upper()
531          if ch == 'Q':
532              print(f"\n  Thank you for using {PRODUCT_NAME}. Goodbye.\n"); break
533          elif ch == '1':
534              try:
535                  age    = int(input("  Entry age  (20–45)  : ").strip())
536                  gender = input("  Gender     (M / F)  : ").strip().upper()
537                  term   = int(input("  Term (5 / 10 / 15)  : ").strip())
538              except ValueError:
539                  print("  ✗  Invalid input.\n"); continue
540              if not (20 <= age <= 45):
541                  print("  ✗  Age must be 20–45.\n"); continue
```

```
539                  print("  ✗  Invalid input.\n"); continue
540              if not (20 <= age <= 45):
541                  print("  ✗  Age must be 20–45.\n"); continue
542              if gender not in ('M', 'F'):
543                  print("  ✗  Gender must be M or F.\n"); continue
544              if term not in (5, 10, 15):
545                  print("  ✗  Term must be 5, 10 or 15.\n"); continue
546              display(compute_all(age, term, gender))
547          elif ch == '2':
548              margin_table()
549          else:
550              print("  ✗  Enter 1, 2 or Q.\n")
551
```

APPENDIX B: Python out put for the pricing and profit testing

```
================================================================================
  BAYILIBI PLAN  –  PRICING & PROFIT TESTING
  Kenyan Life Table 2007–2010 x 1.0131 loading  |  Ages 20–45  |  Interest 14.25%  |  Risk Discount 18%
  Withdrawal: Year 4 onwards (not last year)  |  UF Int: 15.00%(5yr) 15.50%(10yr) 15.75%(15yr)  |  NU Int: 14.25%(5yr) 14.50%(10yr) 14.65%(15y
r)
================================================================================

  1  –  Single age / gender / term  (full tables)
  2  –  Profit margin summary  (all ages, all terms)
  Q  –  Quit

  Choice (1 / 2 / Q):
```

```
  Choice (1 / 2 / Q): 1
  Entry age  (20–45)  : 34
  Gender     (M / F)  : M
  Term (5 / 10 / 15)  : 10

================================================================================
  BAYILIBI PLAN  |  MALE  |  ENTRY AGE 34  |  10-YEAR TERM  |  ANNUAL PREMIUM: UGX 72,473.53
================================================================================

  ASSUMPTIONS & BASIS
    Product Name                    BAYILIBI PLAN
    Mortality Basis                 Kenyan Life Table 2007–2010 x 1.0131 loading
    Sum Assured (UGX)               UGX 1,800,000
    Funeral Benefit (UGX)           UGX 200,000
    Total Death Benefit (UGX)       UGX 2,000,000
    Valuation Interest Rate         14.25%
    Pricing Discount Factor v       0.87527352
    Inflation Rate                  3.3%
    Withdrawal  (Year 4 onwards)    10%  (k≥3, not last year)
    Surrender Benefit               80% of Unit Fund
    Initial Expenses                15% of Premium
    Renewal Expenses                2.25% x P x (1+3.3%)^k
    Initial Commission              15% of Premium
    Risk Discount Rate              18%
    Unit Fund Interest              15.50%  (10-year term)
    Non-Unit Fund Interest          14.50%  (10-year term)
    Alloc Yr1 / Other               70% / 105%
    Management Charge               1.5% x pre-MC unit fund
```

```
  Choice (1 / 2 / Q): 1
  Entry age  (20–45)  : 34
  Gender     (M / F)  : M
  Term (5 / 10 / 15)  : 10

================================================================================
  BAYILIBI PLAN  |  MALE  |  ENTRY AGE 34  |  10-YEAR TERM  |  ANNUAL PREMIUM: UGX 72,473.53
================================================================================

  ASSUMPTIONS & BASIS
    Product Name                    BAYILIBI PLAN
    Mortality Basis                 Kenyan Life Table 2007–2010 x 1.0131 loading
    Sum Assured (UGX)               UGX 1,800,000
    Funeral Benefit (UGX)           UGX 200,000
    Total Death Benefit (UGX)       UGX 2,000,000
    Valuation Interest Rate         14.25%
    Pricing Discount Factor v       0.87527352
    Inflation Rate                  3.3%
    Withdrawal  (Year 4 onwards)    10%  (k≥3, not last year)
    Surrender Benefit               80% of Unit Fund
    Initial Expenses                15% of Premium
    Renewal Expenses                2.25% x P x (1+3.3%)^k
    Initial Commission              15% of Premium
    Risk Discount Rate              18%
    Unit Fund Interest              15.50%  (10-year term)
    Non-Unit Fund Interest          14.50%  (10-year term)
    Alloc Yr1 / Other               70% / 105%
    Management Charge               1.5% x pre-MC unit fund
```

EPV – DEATH & SURVIVAL BENEFIT

Death: Σ 2,000,000×v^(k+1)×cum[k]×(aq)^d | Survival: 1,800,000×v^10×cum[9]×ap[9]

k	Amount (UGX)	Discount	Probability	EPV (UGX)	
0	2,000,000.0000	0.87527352	0.00234735	4,109.1513	
1	2,000,000.0000	0.76610374	0.00238126	3,648.5856	
2	2,000,000.0000	0.67055032	0.00245523	3,292.7152	
3	2,000,000.0000	0.58691494	0.00256686	3,013.0545	
4	2,000,000.0000	0.51371111	0.00241887	2,485.1982	
5	2,000,000.0000	0.44963773	0.00229750	2,066.0811	
6	2,000,000.0000	0.39355600	0.00218472	1,719.6156	
7	2,000,000.0000	0.34446915	0.00206989	1,426.0252	
8	2,000,000.0000	0.30150472	0.00195526	1,179.0410	
9	2,000,000.0000	0.26389910	0.00184199	972.2015	
SURV	1,800,000.0000	0.26389910	0.51645238	245,324.3726	← SURVIVAL
TOTAL				269,236.0419	

EPV – WITHDRAWAL (SURRENDER) BENEFIT

WB = 80%×UF_end | EPV = WB×v^(k+1)×cum[k]×(aq)^w (Years 4–9 only)

k	Amount (UGX)	Discount	Probability	EPV (UGX)
0	0.0000	0.87527352	0.00000000	0.0000
1	0.0000	0.76610374	0.00000000	0.0000
2	0.0000	0.67055032	0.00000000	0.0000
3	287,344.0027	0.58691494	0.09902493	16,700.2066
4	392,007.6546	0.51371111	0.08888055	17,898.6484
5	511,080.8747	0.44963773	0.07976275	18,329.5782
6	646,547.5004	0.39355600	0.07156800	18,210.6670
7	800,664.4939	0.34446915	0.06420421	17,707.7919
8	975,999.5444	0.30150472	0.05758826	16,946.4103
9	0.0000	0.26389910	0.00000000	0.0000
TOTAL				105,793.3024

EPV – EXPENSES

Year 0: 15%×P | Year k: 2.25%×P×(1+3.3%)^k

k	Amount (UGX)	Discount	Probability	EPV (UGX)
0	10,871.0297	1.00000000	1.00000000	10,871.0297
1	1,684.4661	0.87527352	0.99761314	1,470.8494
2	1,740.0534	0.76610374	0.99753310	1,329.7729
3	1,797.4752	0.67055032	0.89767311	1,081.9632
4	1,856.7919	0.58691494	0.89755731	978.1390
5	1,918.0660	0.51371111	0.89741508	884.2516
6	1,981.3622	0.44963773	0.89726098	799.3655
7	2,046.7471	0.39355600	0.89710780	722.6290
8	2,114.2898	0.34446915	0.89695462	653.2589
9	2,184.0614	0.30150472	0.99644605	656.1645
TOTAL				19,447.4238

EPV – PREMIUM INCOME

EPV = Pxv^kxt1ap_p[k] where t1ap_p[k]=ap[k] (k≥1), 1 (k=0)

k	Amount (UGX)	Discount	Probability	EPV (UGX)
0	72,473.5316	1.00000000	1.00000000	72,473.5316
1	72,473.5316	0.87527352	0.99761314	63,282.7547
2	72,473.5316	0.76610374	0.99753310	55,385.2759
3	72,473.5316	0.67055032	0.89767311	43,624.3547
4	72,473.5316	0.58691494	0.89755731	38,178.3171
5	72,473.5316	0.51371111	0.89741508	33,411.1745
6	72,473.5316	0.44963773	0.89726098	29,238.8950
7	72,473.5316	0.39355600	0.89710780	25,587.6615
8	72,473.5316	0.34446915	0.89695462	22,392.3785
9	72,473.5316	0.30150472	0.99644605	21,773.4543
TOTAL				405,347.7978

EPV – COMMISSION

Initial commission 15%×P at Year 0 only

k	Amount (UGX)	Discount	Probability	EPV (UGX)
0	10,871.0297	1.00000000	1.00000000	10,871.0297
1	0.0000	0.00000000	0.00000000	0.0000
2	0.0000	0.00000000	0.00000000	0.0000
3	0.0000	0.00000000	0.00000000	0.0000
4	0.0000	0.00000000	0.00000000	0.0000
5	0.0000	0.00000000	0.00000000	0.0000
6	0.0000	0.00000000	0.00000000	0.0000
7	0.0000	0.00000000	0.00000000	0.0000
8	0.0000	0.00000000	0.00000000	0.0000
9	0.0000	0.00000000	0.00000000	0.0000
TOTAL				10,871.0297

EQUATION OF EQUIVALENCE CHECK

EPV Death & Survival Benefit	269,236.04186
EPV Withdrawal Benefit	105,793.30236
EPV Expenses	19,447.42383
EPV Commission	10,871.02975
TOTAL EPV OUTGO	405,347.79780
TOTAL EPV INCOME (Premium)	405,347.79780
BALANCE (should be ~0)	0.00000

UNIT FUND PROJECTION | UF Interest=15.50% | Alloc Yr1=70% Other=105% B/O=6% MC=1.5%×pre-MC

Yr	UF Start	Allocation	B/O Spread	Interest	Mgmt Charge	UF End
1	0.0000	50,731.4721	3,043.8883	7,391.5755	826.1874	54,252.9719
2	54,252.9719	76,097.2082	4,565.8325	19,496.5739	2,179.2138	143,101.7077
3	143,101.7077	76,097.2082	4,565.8325	33,268.1279	3,718.5182	244,182.6932
4	244,182.6932	76,097.2082	4,565.8325	48,935.6807	5,469.7462	359,180.0034
5	359,180.0034	76,097.2082	4,565.8325	66,760.2638	7,462.0746	490,009.5682
6	490,009.5682	76,097.2082	4,565.8325	87,038.8463	9,728.6969	638,851.0934
7	638,851.0934	76,097.2082	4,565.8325	110,109.2827	12,307.3763	808,184.3756
8	808,184.3756	76,097.2082	4,565.8325	136,355.9414	15,241.0754	1,000,830.6173
9	1,000,830.6173	76,097.2082	4,565.8325	166,216.1089	18,578.6715	1,219,999.4305
10	1,219,999.4305	76,097.2082	4,565.8325	200,187.2750	22,375.7712	1,469,342.3099

NON-UNIT FUND PROFIT TEST | NU Interest=14.50%

Extra Death = MAX(2,000,000−UF_end,0)×(aq)^d×t1ap_n[k]
Surr Income = (1−0.8)×UF_end×(aq)^w×t1ap_n[k] (Years 4–9)
t1ap_n (MALE): cumulative

Yr	NU Alloc	B/O	Expenses	Interest	MC	Extra Death	Surr Inc	PROFIT
1	21,742.0595	3,043.8883	21,742.0595	441.3638	826.1874	4,567.3545	0.0000	-255.9150
2	-3,623.6766	4,565.8325	1,684.4661	-107.6350	2,179.2138	4,421.7591	0.0000	-3,092.4904
3	-3,623.6766	4,565.8325	1,740.0534	-115.6951	3,718.5182	4,310.9415	0.0000	-1,506.0160
4	-3,623.6766	4,565.8325	1,797.4752	-124.0213	5,469.7462	4,211.7517	7,113.5549	7,392.2089
5	-3,623.6766	4,565.8325	1,856.7919	-132.6222	7,462.0746	3,652.4668	8,710.4640	11,472.8136
6	-3,623.6766	4,565.8325	1,918.0660	-141.5070	9,728.6969	3,127.2331	10,191.3034	15,675.3501
7	-3,623.6766	4,565.8325	1,981.3622	-150.6849	12,307.3763	2,603.7778	11,568.0278	20,081.7350
8	-3,623.6766	4,565.8325	2,046.7471	-160.1657	15,241.0754	2,068.1689	12,851.5079	24,759.6575
9	-3,623.6766	4,565.8325	2,114.2898	-169.9594	18,578.6715	1,525.1049	14,051.5297	29,763.0030
10	-3,623.6766	4,565.8325	2,184.0614	-180.0763	22,375.7712	977.4687	0.0000	19,976.3208

EPV OF PROFIT & PROFIT MARGIN

Risk Discount Rate = 18% | Profit Margin = EPV(Profit) / EPV(Premium @ risk discount rate)

Yr	Profit (UGX)	v_r^(k+1)	t1ap_n[k]	NPV Profit
1	-255.9150	0.84745763	1.00000000	-216.8771
2	-3,092.4904	0.71818443	0.99765265	-2,215.7650
3	-1,506.0160	0.60863087	0.99527139	-912.2735
4	7,392.2089	0.51578888	0.99281615	3,785.4284
5	11,472.8136	0.43710922	0.89122437	4,469.3766
6	15,675.3501	0.37043154	0.79992495	4,644.8794
7	20,081.7350	0.31392503	0.71786471	4,525.5335
8	24,759.6575	0.26603816	0.64411199	4,242.7746
9	29,763.0030	0.22545607	0.57783789	3,877.4366
10	19,976.3208	0.19106447	0.51829437	1,978.2079
	TOTAL EPV PROFIT			24,178.7213

Yr	Premium (UGX)	v_r^k	t1ap_n[k]	NPV Premium
1	72,473.5316	1.00000000	1.00000000	72,473.5316
2	72,473.5316	0.84745763	0.99765265	61,274.0769
3	72,473.5316	0.71818443	0.99527139	51,803.2407
4	72,473.5316	0.60863087	0.99281615	43,792.7520
5	72,473.5316	0.51578888	0.89122437	33,314.8949
6	72,473.5316	0.43710922	0.79992495	25,340.7013
7	72,473.5316	0.37043154	0.71786471	19,272.1419
8	72,473.5316	0.31392503	0.64411199	14,654.3567
9	72,473.5316	0.26603816	0.57783789	11,141.1337
10	72,473.5316	0.22545607	0.51829437	8,468.7215
	TOTAL EPV PREMIUM			341,535.5512

► PROFIT MARGIN = 24,178.7213 ÷ 341,535.5512 = 7.079416%