SuperLife
Saving Lives

PTCST Consulting

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1. Objectives

As one of Lumaria's major life insurance carriers, SuperLife is seeking methods to improve its policyholders' expected mortality following the purchase of a life insurance policy. The introduction of a health program that can be bundled with SuperLife's longer-term life insurance offerings is being considered, with the two key objectives of the program to:

- Reduce the frequency and severity of life insurance claim payouts for the company
- Incentivise healthier behaviours of policyholders

These two objectives work together to increase the profitability of SuperLife and will be measured by the following key metrics:

Key Metric	Frequency
Mortality Rates of Policyholders	Annually for first 5 years, then once every 5 years
Expected Death Payouts	Annually
Number of New Business Signups	Annually
Expected Policy Profits & Costs	Annually
Satisfaction Rate (Net Promoter Score)	Annually for first 5 years, then once every 5 years

Given these metrics, the program will be reviewed every 5 years to assess whether it is still achieving its main objectives, and modify the program's features and/or pricing if necessary.

2. Program Design

PTCST Consulting developed a comprehensive health incentive program for SuperLife that incentivises participation by offering profit-sharing opportunities.

2.1 Intervention Programs

PTCST Consulting's wellness plan uses a tailored approach whereby each new SuperLife policyholder over the age of 25 will undergo an initial, compulsory health check-up which forms the basis of their personalised health plan. This personalised health plan will include some or all of the listed program features and will be revised each year, based on the results of the policyholder's Compulsory Annual Health Check-Up and Heart Screening:

Compulsory Annual Health Check-Ups:

- Initial comprehensive health checkup occurring at policy signup, and annually thereafter, that provides fully subsidised health screenings for various conditions, including blood pressure, cholesterol and diabetes.
- Used to determine recommendations of programs and health goals for the year.

Annual Heart Health Screenings:

- Annual screenings for all policyholders (and immediately upon new policy signup) to gauge risk of a heart attack or stroke in the short-term (next 5 years).
- Use to develop other features of personalised health plan, e.g., following a heart-healthy eating plan, increasing exercise and reducing tobacco use.

Cancer Prevention Initiatives:

- Personalised based on policyholder's lifestyle factors i.e. diet, tobacco use.

- Access to genetic testing for policyholders with a family history of cancer.
- Offer personalised educational resources on lifestyle improvements and its effect on reducing cancer risk.

Discounted Gym Memberships:
- Partner with large franchise gyms to offer discounted local gym memberships.
- Provide access to virtual fitness classes and online workout programs for policyholders who elect to exercise at home.

Weight Management Programs:
- Develop personalised weight management program, with potential aspects of:
  - Dietitian appointments, healthy eating and cooking classes.

Safety Campaigns:
- Provide both general and personalised safety workshops, based on policyholders' profiles, that aim to promote safe living and injury prevention.
- Create personalised workplace safety campaigns that advise on work stress management, ergonomic practices and safety techniques, e.g., proper lifting techniques for policyholders with manual labour jobs.

2.2 Incentive Schemes

SuperLife's incentive scheme is underpinned by a multi-level reward system, where policyholders progress by completing goals in their personalised health plan, e.g. participating in safety workshops. This system is split into five levels, each with different proportions of profit share allocated to policyholders, who start on Level 1 upon sign-up (see *Table 2.2*).

Each year, in the annual check-up and Heart Screening, the policyholder will receive certain health goals from the medical practitioner, such as BMI requirements, target heart-rate or ideal cholesterol levels. At the policyholder's next annual check-up and Heart Screening:

- If the policyholder has met (not met) the previous policy year's goals, they move up (down) a level in the incentive scheme structure for the next year.

	Level 1	Level 2	Level 3	Level 4	Level 5
Profit Share Allocation	10%	25%	35%	45%	60%

Table 2.2: Profit Share Allocation Structure

Other Key Program Requirements

- Policyholders must agree to participate in initial and annual health and heart check-ups to track personal progress and improvements.
- Policyholders must be committed to making lifestyle changes and implementing healthy habits to improve overall wellness.
- Policyholders must be willing to honestly share their progress to qualify for incentives.
- Policyholders must agree to participate in NPS[1] feedback surveys.

[1] Net Promoter Score (NPS) is a customer loyalty and satisfaction measurement taken from asking customers how likely they are to recommend your product or service to others on a scale of 0-10

Justification of Program Features

QUALITATIVE

Lower frequency and severity of life insurance claim payouts by…

- **Decreasing Expected Mortality**: through the overall development of healthy behaviours, the program aims to reduce policyholders' mortality likelihood.

Incentivises Healthy Behaviour through…

- **Participation in the Program**: material rewards system uses gamification of progression to higher levels to motivate policyholders (Garaialde et al. 2021).
- Social support aspect of program features, such as group healthy cooking or exercise classes, encourages engagement and makes it easily accessible.

Increases SuperLife's overall profitability by…

- **Increasing Life Insurance Sales**: rewards and discounts offered through the program will incentivise individuals to purchase SuperLife's products, thereby increasing sales and revenue.
- **Improving Product Marketability and Competitiveness**: this holistic health plan will differentiate SuperLife's offerings in the market, making them more attractive to potential policyholders.
- **Adding Economic Value to SuperLife**: by promoting healthier lifestyles and reducing mortality rates, the program ultimately increases sales, customer loyalty and long-term customer relations.

QUANTITATIVE

Intervention Program Selection Methodology:
Sorting methodologies were conducted to determine the most optimal intervention programs to include (see *Appendix 7.1* for visuals):

1. Sorted intervention program descriptions to maximise impact on mortality rates whilst simultaneously minimising per capita cost
2. Plotted and identified leading causes of death and mapped these to the associated intervention schemes
3. Determined top schemes with maximal impact on mortality rates and minimum per capita cost that can be directly linked to mitigating leading causes of death.

2.3 Program Evaluation

Justification of Short-and-Long-term Timeframes

- *Short-term timeframe* is the **5-year period** from 2023 (2023–2028): Evaluating the wellness program within the next 5 years is a sufficient amount of time for SuperLife to see the impact on mortality rates, but not too extensive so as to allow them to adjust the program if needed, based on feedback and results, to ensure it achieves the project goals.
- *Long-term timeframe* of the **30-year period** from 2023 (2023-2053): SuperLife offers products such as whole life and 20-year term insurance that therefore have long-term implications for policyholders. Hence, this timeframe allows Superlife to recognise the long-term benefits in terms of lower mortality rates and higher customer retention.

3. Pricing/Costs

3.1 Method

Summarised below is an overview of PTCST Consulting's pricing methodology, with further detail in *Appendix 7.6*.

Costs	Costs were priced according to four main categories: **expected payout costs**, **intervention program costs**, **incentive costs** and **operating expenses**. Program costs were determined by sampling participation booleans for each policyholder and intervention program according to the signup rates for each intervention program (see *Appendix 7.2.1*). The actual costs per year of providing each program to each policyholder were then determined by sampling from a uniform distribution bounded by the lower and upper limits of costs given in the provided data.
	Annual expected payout costs were determined by multiplying survival probability to that year by death probability in that year and the policy face amount. The key difference was in the death probability reductions from the intervention programs which were determined by sampling from a multivariate normal distribution with parameters provided in *Appendix 7.2.1*. These values were incrementally applied according to the program time horizons listed in the assumptions.
	To determine the incentive scheme costs, we first had to simulate which levels policyholders were likely to be at throughout their policies. This was modelled by sampling booleans for whether someone was likely to regularly meet their health goals that were set in their Annual Check-Up or not. If they were, they received the Level 5 benefits, and if they weren't, they received the Level 1 benefits. In addition to this, as people who are unlikely to meet their health goals are unlikely to be actively taking part in their intervention programs, some of their mortality reductions were removed, such as mortality reductions received from discounted gym memberships (see *Appendix 7.2.2*).
	Operating expenses were derived by considering data provided by APRA on life insurers and their breakdown of costs in Australian insurers. While this data is not completely reliable in estimating costs for Lumaria, using the proportion of operating expenses to policy revenue still provides a workable estimate for understanding our operational costs.
Premiums	Rather than determining premiums and then evaluating policy revenue based on a given premium, each policy was priced by "risk units". The base number of risk units for a given policyholder was determined using their gender, age, policy type, underwriting class and smoking status. The total number of risk units was found by multiplying their base risk units by the sum insured divided by 1000. This allowed for the price per Č1000 of sum insured for each policyholder to be determined.
	By using this method, the total number of risk units in the cohort of policyholders can be determined, with the premium per risk unit later decided to generate a specific profit margin. The tables to determine the total number of risk units per policyholder are in *Appendix 7.2.3* with some examples of possible policyholders and their pricing for a given premium per risk unit.

3.2 Assumptions

Assumptions for this proposed wellness program were split into more generalised cases, as well as those with greater impact on analyses, with full details of both in *Appendix 7.3.1*.

General definitions used in this proposed program and evaluation include:

- Short-term timeframe is defined as the 5-year period from 2023 (i.e., 2023–2028)
- Long-term timeframe is defined as the 30-year period from 2023 (i.e., 2023-2053)
- Claims inflation is assumed to be negligible
- Population is assumed to be closed as of 2023
- Assume linear trend of mortality improvement across the time horizons

Key assumptions with the most significant impact on the proposed program's costs include:

- Economic inflation rate from 2023 onwards is a constant 2% p.a. (see *Appendix 7.3.2*)
- Interest rate used for discounting from 2023 onwards is a constant 5% p.a.
- Correlations between different intervention programs (see *Appendix 7.3.3*)
- Mortality reduction time-horizons for each intervention programs (see *Appendix 7.3.4*)

3.3 Results

Total Economic Costs for Short Term (5 Years) & Long Term (30 Years)

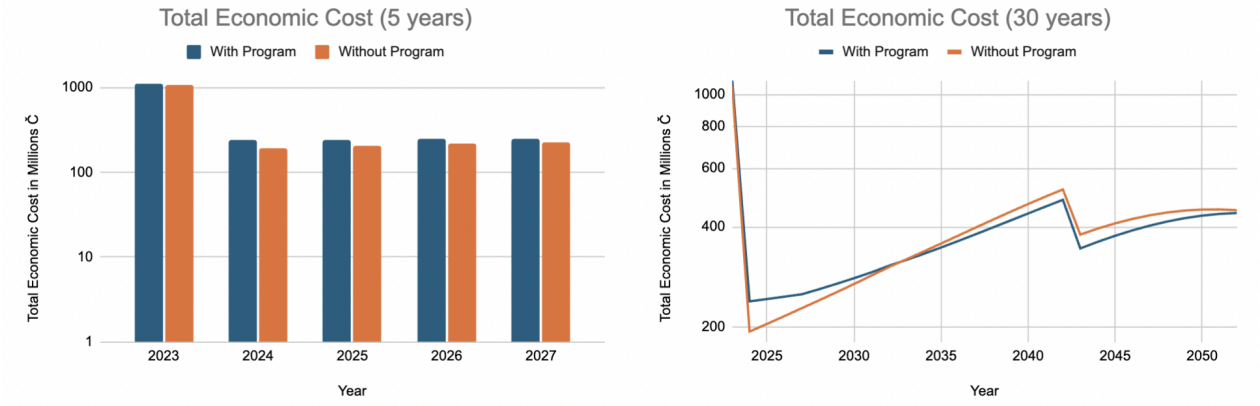


Figure 3.3.1: Total Economic Costs for Short Term (5 Years) & Long Term (30 Years)

From *Figure 3.3.1* it can be seen that the total economic costs incurred per year with the wellness program are higher in the first 10 years than the total economic costs incurred without the program. This is expected since there will be initial costs associated with the implementation of the program and the benefits to mortality rates will not be fully realised in the short term. After the 10 year mark we can see that the total economic costs incurred with the program are lower than without the program reflective of the realised decrease in mortality rates.

With Program Cost Formula	Without Program Cost Formula
Total Economic Costs (With Program) = Policy and Other Expenses + Program Expenses + Expected Death Costs	Total Economic Costs (Without Program) = Policy and Other Expenses + Expected Death Costs

Expected Death Costs for Short Term (5 Years) & Long Term (30 Years)

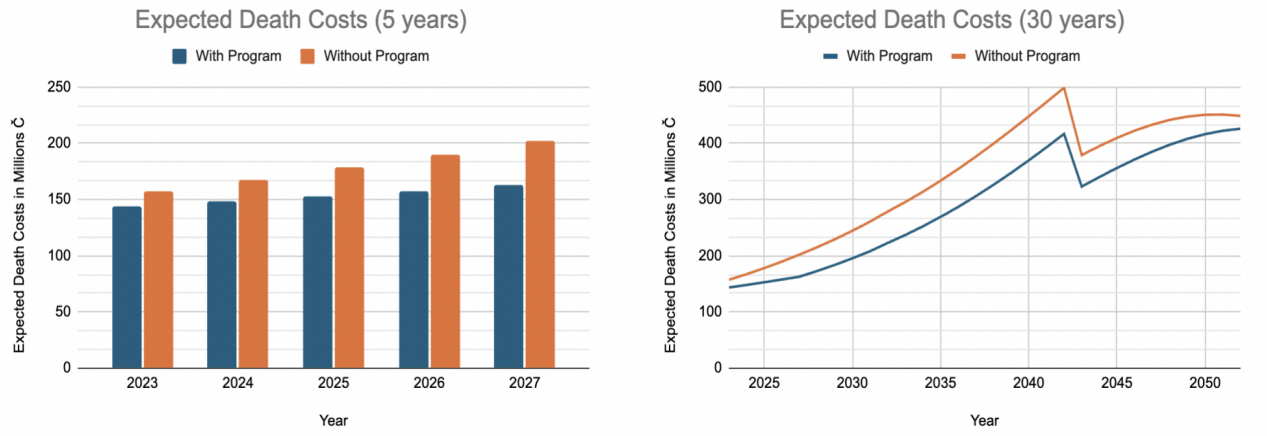


Figure 3.3.2: Expected Death Costs for Short Term (5 Years) & Long Term (30 Years)

From *Figure 3.3.2* it can be seen that the expected annual death costs with the program are consistently lower than that without the program. This difference becomes larger for the first 20 years before we see that the with-program costs slowly approach the without-program costs. This can be explained by the reduction in mortality, hence postponement of the death of policyholders.

With regards to possible savings if the program had been implemented 20 years ago, by accumulating all savings to the start of 2024, approximately Č6.46 billion in savings could have been accumulated (see *Appendix 7.4.1* for visualisation). It should also be noted that a large proportion of these savings would have been offset by program expenses, but regardless, it demonstrates a high level of possible savings in benefit payouts.

Revenue for Short Term (5 Years) & Long Term (30 Years)

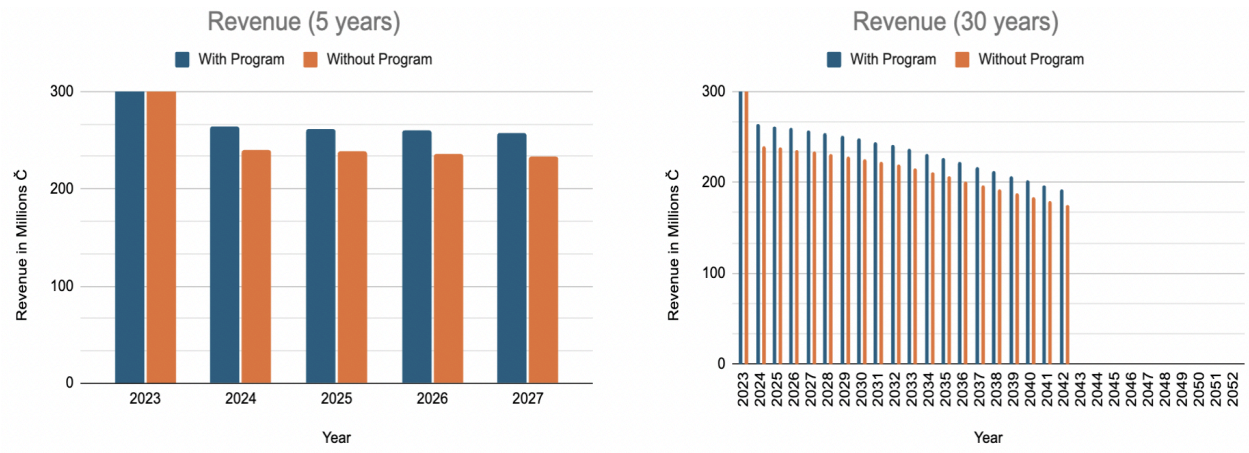


Figure 3.3.3: Revenue for Short Term (5 Years) & Long Term (30 Years)
Note: The 2023 revenue values have been hidden out of bounds to better display the rest of the data
(2023 With Program: Č 9036.38 M, 2023 Without Program: Č 8214.89 M)

From *Figure 3.3.3*, it can be seen that the revenue is very high in the first year due to a proportion of policyholders being modelled to hold Single Premium Whole Life insurance

(SPWL). The revenue generated per year for the next 19 years is much lower since they are from T20 policies and due to mortality these values have a decreasing trend before they drop to 0 after the 20-year period. Comparatively, more revenue is generated with the program than without, as charging a higher premium is reflective of the benefits the program provides to the policyholder.

Finally, a comparison of the profit margins obtained with and without the program is detailed in *Table 3.3.1*, demonstrating that a higher profit margin is obtained with the program.

Profit Margin With Program	Profit Margin Without Program	Relative Diff in Profit Margin
17.47%	**15.40%**	**13.41%**

Table 3.3.1: Profit Margins With and Without Program

Sales Optimization
Premiums were set generously for policyholders without the program and hiked by only 10% with the program. When monitoring the program over the next few years, if sales are below expectations, SuperLife can consider reducing premiums to optimise sales. However, it is vital to note that premiums should only be reduced to a minimum of $1.07037 \times (Premiums_{without\ program})$ to ensure profit margin remains at par or greater than without the program.

4. Risk & Risk Mitigation Considerations

4.1 Risks & Risk Mitigation

A summary of the potential risks and possible risk mitigation techniques is provided below. The complete matrix and table with risk scores is provided in *Appendix 7.5*.

4.1.1 Risk Assessment Matrix

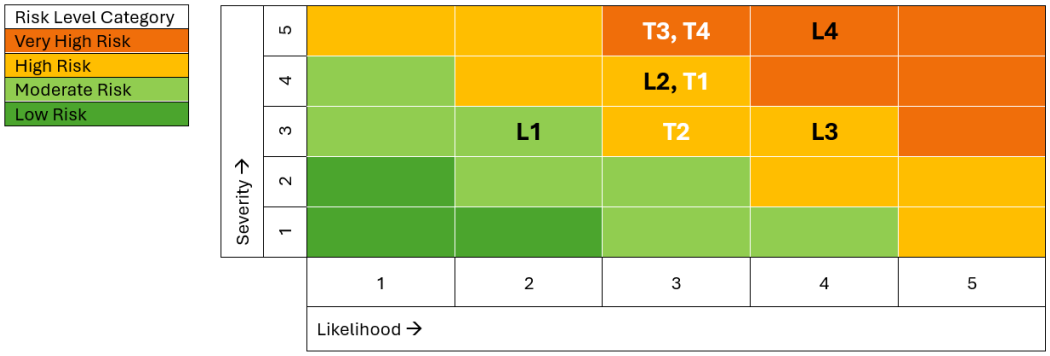


Figure 4.1.1: Risk Assessment Matrix

4.1.2 Qualitative Risks & Mitigation

L1	**Exploitation of loopholes**: Policyholders may fabricate adherence to the program.
	Mitigation: Define clear rules, carefully develop the program, monitor engagement and identify suspicious activity.
L2	**Policyholders not adopting healthy behaviours**: Program hence ineffective in decreasing mortality.

	Mitigation: Provide adequate incentives, tailored programs to suit individual needs and emphasise benefits for the policyholder.
L3	**Program may be perceived as intrusive**: Potential customers may be deterred by the level of monitoring within the program.
	Mitigation: Provide opt-out options, collect minimal data required, provide transparency about data collection and emphasise benefits for the policyholder.
L4	**Regulatory Compliance**: The level of monitoring and access to health data may be violating Lumarian regulations.
	Mitigation: Seek advice from legal advisors, conduct frequent audits and ensure ongoing compliance by monitoring and updating.

4.1.3 Quantitative Risks & Mitigation

T1	**Underestimation of program costs**: Underestimation may lead to unforeseen expenses and challenges to maintain the program.
	Mitigation: Conduct thorough cost analysis, monitoring and ensure there are sufficient reserves to buffer unexpected costs.
T2	**Model Selection Risk**: Inadequate model can lead to inaccurate predictions/biases.
	Mitigation: Exploratory data analysis, compare models and evaluate performance using performance metrics (AIC/BIC, R-square) and update as data evolves.
T3	**Liquidity Risk**: Inadequate funds to meet obligations, especially at program launch.
	Mitigation: Conduct stress testing, arrange contingency funding arrangements and regularly monitor liquidity metrics.
T4	**Inappropriate correlation assumptions between intervention programs**: This can lead to over or under-estimation of the effectiveness of combined intervention programs at reducing mortality.
	Mitigation: Research and utilise studies, seek expert advice from intervention program providers and adjust correlation coefficients with incoming data once program is launched.

4.2 Sensitivity Analysis

A sensitivity analysis was performed on the key variables (see *Appendix 7.7.1* for tested values) to assess the financial impact of changes in key assumptions. Ranges of values were determined for each of the above variables, with the theoretical experience assumptions lying within this range. A comparison of the absolute impacts on SuperLife's net present value and the relative impacts on profit margin for the best and worst case scenarios for each variable was conducted. The profit margin comparison is illustrated in *Figure 4.3.1* below. See *Appendix 7.7.2* for the NPV comparison and an in-depth analysis of the sensitivity results.

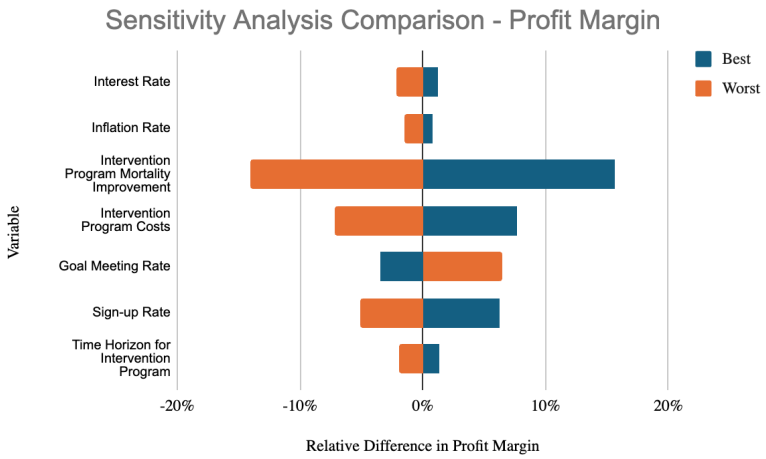


Figure 4.3.1: Sensitivity Analysis - Profit Margin

Evidently, the effect of the intervention programs on mortality rates will have the largest impact on SuperLife's profit margin. The outer bounds of each intervention program's approximate impact on mortality rates was used, where the upper bound generates the best case scenario and the lower bound generates the worst case scenario. Given the results, it is important for SuperLife to closely monitor and update the mortality rate improvement assumptions regularly, as the worst case scenario results in a 14% decrease in the profit margin. Additionally, the evaluation of a specific scenario can be found in *Appendix 7.7.3.*

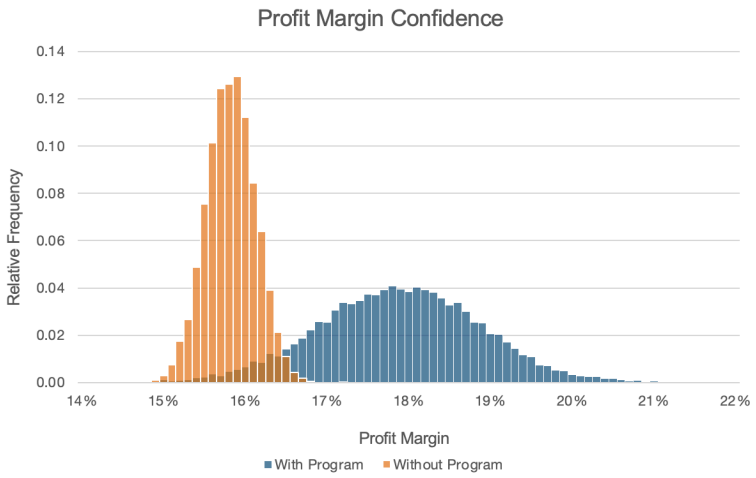


Figure 4.3.2: Profit Margin Confidence Distribution

Figure 3.3.4 illustrates a comparison of the distribution of profit margins, where 97.48% of the observations for 'With Program' have a higher profit margin than those for 'Without Program'. This implies that there is a **97.48%** degree of certainty that the value of the benefits derived from the program will exceed the value of the benefits derived without the program. Additionally, extending upon the results in Section 3.3 regarding the possible past mortality savings from the program, it can be deduced that there is a high degree of certainty for mortality improvements if the program had been implemented for the past 20 years.

5. Data & Data Limitations

5.1 Data Sources

No external data sources were used in the analysis.

5.2 Data Limitations

Table 5.2 discusses the data limitations and their impact on the analysis (See *Appendix 7.8*).

Limitation	Explanation
No homogeneity between insured & general populations	Selection effects of differences between insured vs. general population (*Appendix 7.9*) may compromise accuracy of analysis.
No gender differentiation in mortality table data	The provided mortality table does not distinguish between the two genders and thus required approximations for male and female mortality rates.
Limited past policy data	Truncation of data blocks insight into possible longitudinal and cross-sectional trends, reducing precision of future projections.
Limited data on Lumaria's population trend	The lack of population-trend data has led to the assumptions of a closed population and a linear trend in mortality improvement.
No data on policy premiums or expenses	Use of Principle of Equivalence for premium calculations compromised accuracy of estimated cash inflows. Lack of expense data required approximation based on other companies
Historical economic data	Use of historical inflation/interest/spot rates to project future rates compromised the accuracy of projected revenue and costs.

Table 5.2: Data Limitations

6. Further Recommendations & Considerations

SuperLife must ensure that the wellness program does not unfairly discriminate against policyholders by factors disallowed under their regulatory requirements. This also ensures compliance with any regulations or consumer protection laws.

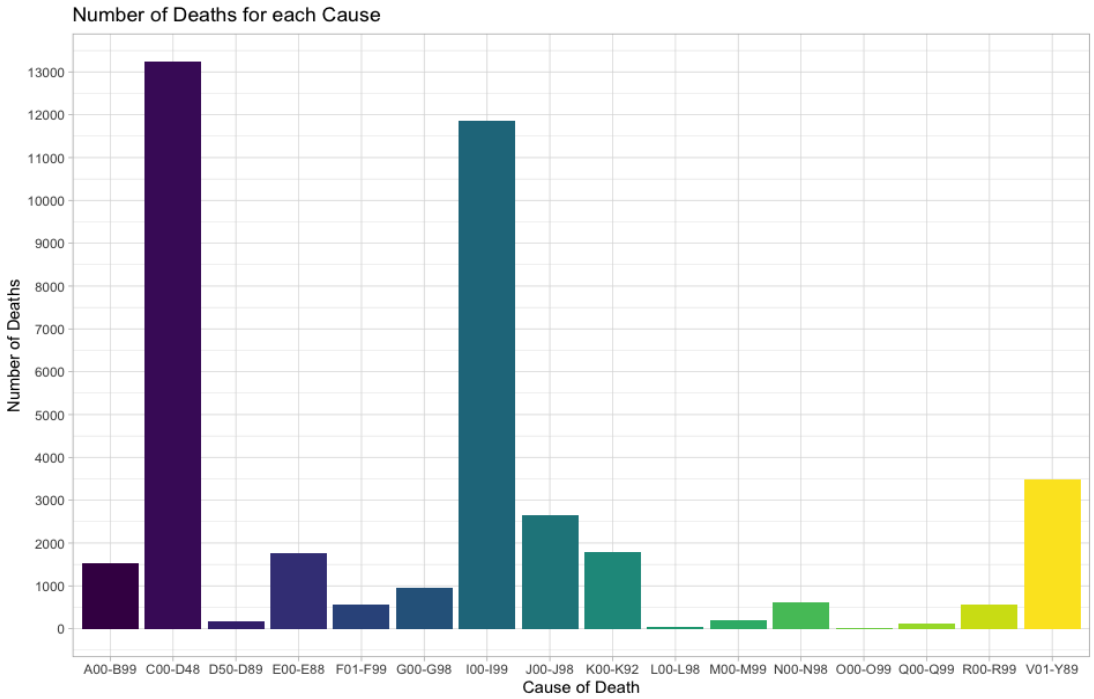
The use of policyholder data to evaluate the impact of the wellness program is essential for measuring effectiveness and making informed decisions for future improvements. However, for ethical purposes, SuperLife may consider implementing transparent data collecting and analysis processes, with data only being used to measure the effectiveness of the program and make improvements for the future benefit of policyholders.

Conclusion

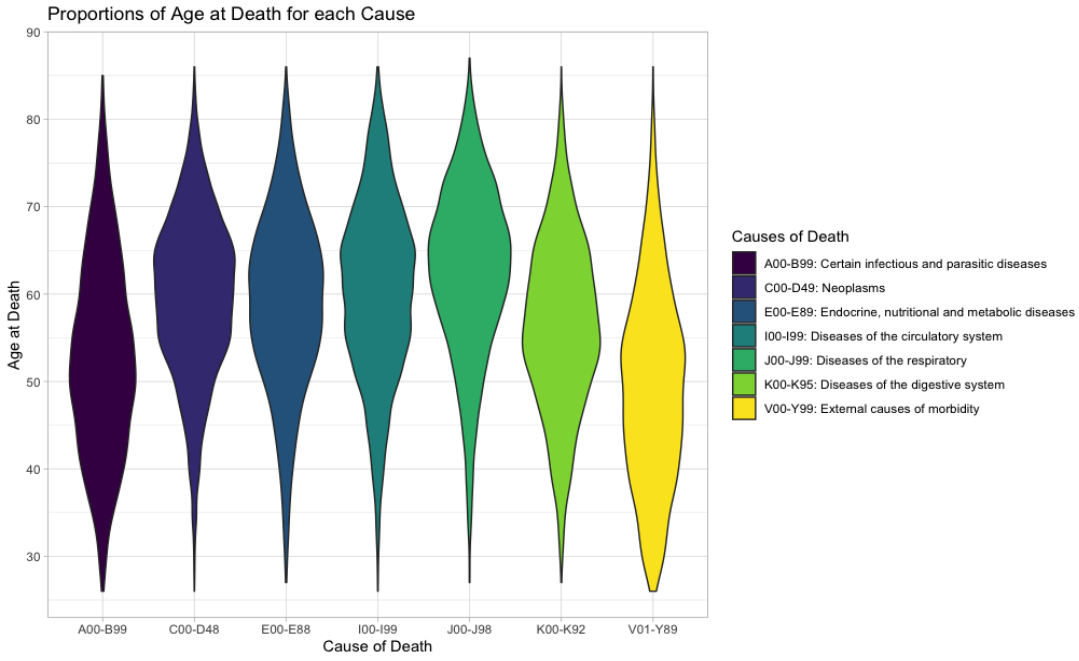
The proposed wellness intervention program can help SuperLife improve its policyholders' expected mortality whilst also achieving increased profitability (with a 97.48% degree of certainty). The expected increase in the profit margin is 13.41% relative to the profit margin without the program. After thorough qualitative and quantitative analyses on its impact over short and long-term timeframes, the associated financial and social benefits provide substantial evidence that the project should be undertaken. However, it is crucial to perform ongoing monitoring of risks, costs and progress on initial objectives.

Appendix

7.1 Intervention Program Selection Methodology



Column Graph 7.1: Count of deaths associated with listed causes



Plot 7.1: Proportion of ages at death of each cause

7.2 Cost Calculations

7.2.1 Intervention Program Parameters

Program	Sign-Up Rate	Effect	Cost (Č)
Safety Campaigns	0.6	• Upper = 0.04 • Lower = 0.03	• Upper = 35 • Lower = 30
Annual Check-Ups	1	• Upper = 0.07 • Lower = 0.05	• Upper = 870 • Lower = 300
Discounted Gym Membership	0.2	• Upper = 0.05 • Lower = 0.03	• Upper = 870 • Lower = 600
Weight Management program	0.4	• Upper = 0.065 • Lower = 0.05	• Upper = 870 • Lower = 500
Cancer Prevention Initiatives	0.5	• Upper = 0.08 • Lower = 0.05	• Upper = 85 • Lower = 50
Heart Health Screenings	0.5	• Upper = 0.08 • Lower = 0.05	• Upper = 345 • Lower = 150

7.2.2 Mortality Reduction Removals

Based on the chosen intervention programs, it was determined that some of the intervention programs would require “active” participation in order for the policyholder to receive the mortality improvements. Using the same boolean that determined whether people would sit in Level 5 or Level 1 of the rewards program, we would determine whether each policyholder was likely to have “active” participation or not, and if not, they would receive a mortality improvement of 0 for those intervention programs. The choices of which intervention programs suffered from this effect can be seen and is justified below.

Program	Decision and Justification
Safety Campaigns	Safety campaigns require active participation, because without this, it is unlikely that the policyholder would learn anything from the campaigns or apply it in their day to day life
Annual Check-Ups	Annual check-ups do not require active participation because no effort is required from the policyholder (bar attending the appointment)

Discounted Gym Membership	Gym memberships require active participation because without regular attendance to the gym, the mortality reductions would be non-existent
Weight Management program	The weight management programs require active participation because without it, policyholders would be unlikely to apply any of the weight management techniques that are taught
Cancer Prevention Initiatives	Cancer Prevention schemes require active participation because it requires the policyholder to actively implement the ideas taught in the initiatives
Heart Health Screenings	Heart health screenings do not require active participation because no effort is required from the policyholder (bar attending the appointment)

7.2.3 Risk Unit Tables

Age	Male Term	Female Term	Male WL	Female WL
25-29	1.05	0.43	14.07	5.82
30-34	1.23	0.61	16.56	8.27
35-39	1.58	0.94	21.06	12.70
40-44	2.14	1.48	28.35	19.89
45-49	3.04	2.35	39.71	31.10
50-54	4.46	3.72	56.96	48.16
55-59	6.77	5.95	83.61	74.60
60-65	10.68	9.74	124.70	115.61

	Very Low	Low	Medium	High
Factor	1.00	1.15	1.40	1.60

In addition to the above, a multiplicative factor of 1.74 was applied for smokers.

For calculations, the relevant value from the first table, is multiplied with that of the second, which is multiplied by the smoking factor for smokers.

To see how these values work in practise, using the premium per risk unit used throughout the paper of 4.76, some example cases for price per Č1000 of sum insured

Age	Gender	Term or Whole Life	Underwriting Class	Smoker Status	Price per Č1000 sum insured
30	M	Term	Low	Non-smoker	Č5.43
34	F	Whole Life	Medium	Smoker	Č95.92
50	M	Term	High	Smoker	Č59.12
43	F	Term	Low	Non-Smoker	Č8.09

As an addendum to this table, while the prices look remarkably low, this is primarily driven by the incredibly high average sum insured of Č665,573.

Values were checked for reasonableness using existing pricing data from AustralianSuper[2].

7.3 Assumptions

7.3.1 Assumptions Table

Variable	Assumption
Inflation	Economic inflation rate from 2023 onwards is a constant 2% p.a., with negligible claims inflation assumed
Timeframes	Short-Term timeframe is defined as the 5-year period from 2023 (i.e., 2023–2028) ● Evaluating the wellness program within the next 5 years was decided as a sufficient amount of time for SuperLife to start seeing the impact on mortality rates, but not too extensive so as to allow them to adjust the program if needed, based on feedback and results, to ensure it achieves the project goals.
	Long-Term timeframe is defined as the 30-year period from 2023 (i.e., 2023-2053) ● SuperLife offers products such as whole life, 20- and 30-year term insurance, and universal life products, which have long-term implications for policyholders. Hence, this timeframe allows Superlife to recognise the long-term

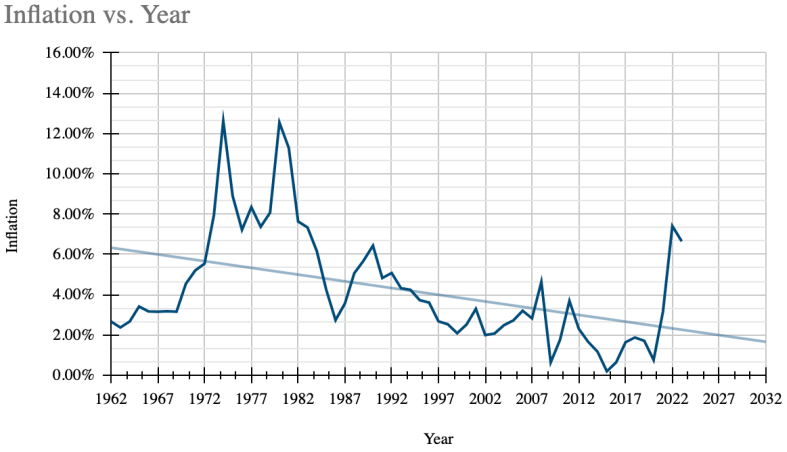
[2] Money when it matters most - Insurance in your super, November 2023

	benefits in terms of lower mortality rates and higher customer retention.
Population	Closed population based on 2023 figures
Premium	Premiums are determined by using Principle of Equivalence, where: $EPV\ of\ benefit\ outgo\ =\ EPV\ of\ net\ premium\ income$
Interpolation	Assume linear trend of mortality improvement across years
Interest/Discount Rates	Assumed a **constant 5%** for analyses, as the average of Lumaria's 1-yr and 10-yr Risk-Free Annual Spot Rates were 5.68% and 6.74%, respectively, with significant declines of each rate in recent 10 years, trending at ~ 0-2%.
Interval Dates	Annual date of Health Check-Up and Heart Screening is based on yearly anniversary of policy inception date
Program Time-Horizons	Time-horizons for mortality reductions to occur in each intervention program: ○ Safety Campaigns: 6 months (Newnam & Muir 2015) ○ Annual Health-Checkups: 5 years (Maindal, Støvring & Sandbaek 2014) ○ Discounted Gym-Memberships: 10 months (Homonoff, Willage & Willén 2020) ○ Weight Management Programs: 3 months (Ahern et al. 2017) ○ Cancer Prevention Initiatives: 9 years (Valle, Tramalloni & Bragazzi 2015) ○ Heart-Health Screenings: 5 years (Alageel & Gulliford 2019)
Subsidies	Costs of initial and Annual Health Check-Ups and Heart Screenings are fully incorporated into all SuperLife policyholder premiums
Correlation	● Correlations were determined through research, predominantly based on experimental results yielded under similar conditions to Lumaria's population ● Correlations between programs found to be less than 0.10 were assumed negligible ● Annual Health Check-Ups and Heart Health Screenings assumed to be independent since they are both compulsory for policyholders on an annual basis ● Non-zero correlation values include:

	○ Annual Health Check-Ups & Safety Campaigns: 0.45 Burioni, et al (2015) ○ Annual Health Check-Ups & Discounted Gym Memberships: 0.35 M Rand (2020) ○ Annual Health Check-Ups & Weight Management Programs: 0.40 Madigan et al. (2022) ○ Annual Health Check-Ups & Cancer Prevention Initiatives: 0.50 Kuwabara et al. (2022) ○ Heart Health Screenings & Discounted Gym Membership: 0.25 Norton and Norton (2011) ○ Heart Health Screenings & Weight Management Programs: 0.30 Zhao (2018) ○ Heart Health Screenings & Cancer Prevention Initiatives: 0.30 Rikke et al. (2023) ○ Safety Campaigns & Cancer Prevention Initiatives: 0.30 Shankar et al. (2017) ○ Discounted Gym Memberships & Weight Management Programs: 0.40 Riseth et al. (2019) ○ Discounted Gym Memberships & Cancer Prevention Initiatives: 0.25 McTiernan et al. (2018) ○ Weight Management Programs & Cancer Prevention Initiatives: 0.30 Anderson et al. (2020)
Mortality & Lapse Rates	Mortality rates and lapse rates are calculated as dependent as they were drawn from a dataset where people could both lapse and die
Expense and Expected Death Cost Calculations	● Expenses assumed to be paid in advance ● Expected death costs assumed to be paid in arrears

7.3.2 Inflation Assumption

Plot shows that the economic inflation rate from 2023 onwards approaches 2% in the short-term, hence set to this constant 2% for all analyses.



7.3.3 Intervention Program Correlation Matrix

The correlations between different intervention programs were deduced using research.

	Annual Health Check-Ups	*Heart Health Screenings*	*Safety Campaigns*	*Discounted Gym Memberships*	*Weight Management Programs*	*Cancer Prevention Initiatives*
Annual Health Check-Ups	1	0	0.35[3]	0.35	0	0.25
Heart Health Screenings	0	1	0	0.25[4]	0.10[5]	0.10
Safety Campaigns	0.35	0	1	0	0	0.35[6]
Discounted Gym Memberships	0.35[7]	0.25	0	1	0.375[8]	0.25[9]
Weight Management Programs	0[10]	0.10	0	0.375	1	0.30[11]
Cancer Prevention Initiatives	0.25[12]	0.10[13]	0.35	0.25	0.30	1

7.3.4 Intervention Program Time Horizons

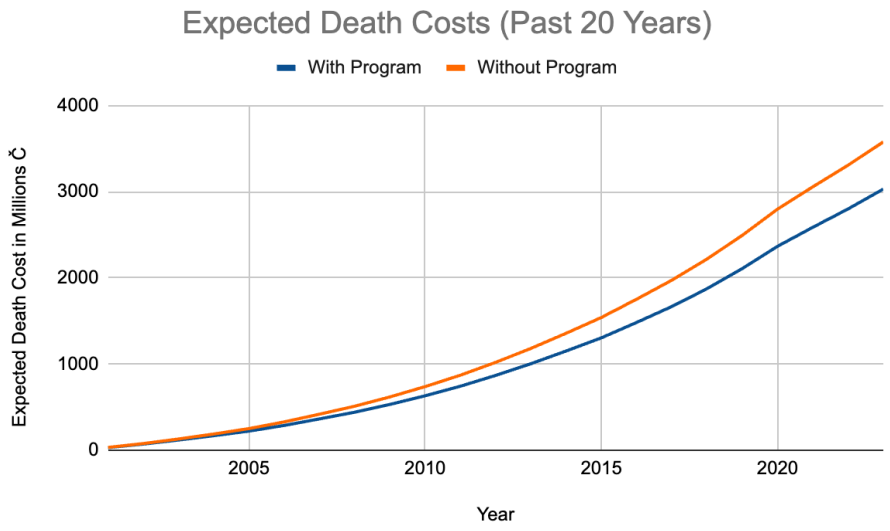
The time horizons for mortality reductions to occur in each intervention program were deduced using research.

- Safety Campaigns: 1 year (Newnam & Muir 2015)
- Annual Health-Checkups: 5 years (Maindal, Støvring & Sandbaek 2014)
- Discounted Gym-Memberships: 1 year (Homonoff, Willage & Willén 2020)
- Weight Management Programs: 1 year (Ahern et al. 2017)
- Cancer Prevention Initiatives: 9 years (Valle, Tramalloni & Bragazzi 2015)
- Heart-Health Screenings: 5 years (Alageel & Gulliford 2019)

[3] Burioni, et al (2015)
[4] Norton and Norton (2011)
[5] Zhao (2018)
[6] Shankar et al. (2017)
[7] M Rand (2020)
[8] Riseth et al. (2019)
[9] McTiernan et al. (2018)
[10] Madigan et al. (2022)
[11] Anderson et al. (2020)
[12] Kuwabara et al. (2022)
[13] Rikke et al. (2023)

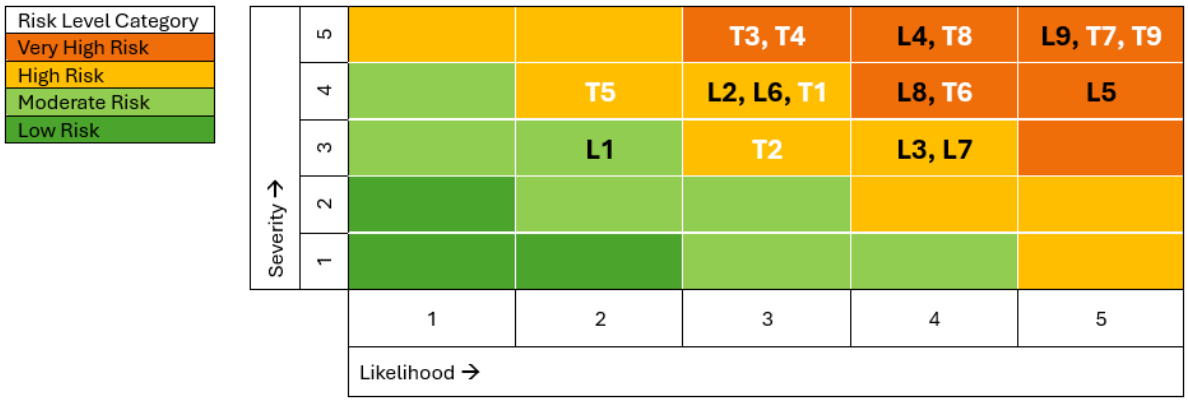
7.4 Results

7.4.1 Mortality Savings for Past 20 Years



7.5 Risks & Risk Mitigation Table

7.5.1 Risk Assessment Matrix



7.5.2 Qualitative Risks (L)

Risk	Explanation	Risk Score	Mitigation
L1. Exploitation of loopholes	Policyholders may exploit loopholes in the health program if monitoring is not stringent enough or if the	6 (Moderate)	• Define clear rules and criteria regarding what constitutes the completion/progression of the health program. • Carefully consider possible

	completion of the program activities are easy to forge. E.g., if there is a daily requirement of 1000 steps, the policyholder could just attach their step counter device to their dog.		loopholes when developing the healthcare plan. ● Monitor policyholder engagement patterns and investigate any suspicious activity.
L2. Policyholders not adopting healthy behaviours	The policyholders may not adopt healthy behaviours in which case the program wouldn't be that effective and the high initial costs to implement the program may not be compensated by decreased mortality in the future.	12 (High)	● Ensure participation incentives are sufficient to motivate participation. This could be done by conducting surveys and exploring existing data from other health care plans. ● Providing tailored programs taking into account barriers to change and mitigating those accordingly. ● Ensure that the policyholder understands the short and long term benefits of adherence.
L3. Program may be perceived as intrusive	Policyholders may feel that SuperLife's access to their health data and the level of monitoring is intrusive leading to potential customers hesitating to purchase a life insurance policy with them.	12 (High)	● Ensuring there is transparency surrounding which health data will be used and how individuals will be monitored. ● Ensuring that only the minimum required data is collected to complete the required work. ● Providing options for policyholders to refrain from sharing certain data if they would like to keep it private. ● Emphasising the benefits of participating so that they know their data is being used in their best interests
L4. Regulatory Compliance	Using policyholder health data and constant health monitoring to determine e.g., premium reductions may be violating Lumarian regulations.	20 (High)	● Utilise regulatory and legal advisors whilst developing the program to ensure there is compliance to all relevant laws. ● Conduct frequent audits to ensure ongoing compliance especially when there are

			changes to regulations.
L5. Dependence on Technology	It is likely that there will be a lot of technology used for monitoring purposes throughout the program. Some policyholders (e.g., the elderly population) may not have sufficient digital literacy leading to accessibility issues amongst different age groups.	20 (Very High)	● Provide good customer service and technology support. ● Ensure a user friendly interface and clear instructions.
L6. Employee Resistance	Implementing a health program like this would require more work from employees since there would be more inquiries from policyholders and more information would need to be provided to customers. This concept is new so it would take quite a bit of work on the employees' part to help customers understand and feel secure.	12 (High)	● Since more employees will need to be hired, make sure to hire individuals who are supportive of the program and its objectives. ● Provide comprehensive training, guidance and resources so that they understand the program and its benefits. ● Incentivise frontline workers to promote the new products.
L7. Competitive Rivalry	Other insurance companies may implement similar health programs creating competition for SuperLife.	12 (High)	● Ensure that the program being provided by SuperLife has some differentiating aspect that isn't easy to replicate, e.g., SuperLife could have an exclusive supply partnership with some other companies to provide unique incentives to policyholders. ● Monitor the competition landscape continuously and ensure the program continues to have a differentiating factor and is reasonably priced.
L8. Privacy Concerns	There is a risk of customer privacy being breached.	16 (Very High)	● Ensure compliance with the relevant regulators. ● Conduct frequent audits.

			• Create appropriate access controls and encryption. • Only collect the minimum data necessary to complete the required work.
L9. Pandemic Risk	Pandemics can have a significant and unforeseen impact on mortality rates, economic conditions, healthcare costs, etc. This can result in a reality that is far from the projected mortality and cash flows.	25 (Very High)	• Incorporate pandemic scenarios into stress testing to assess the potential impact on mortality and cash flow projections. • Make reinsurance arrangements to transfer some of the risk associated with pandemics. • Work with epidemiologists and other health authorities to stay informed about emerging pandemic risks and taking measures to mitigate their impacts. • Diversify the premium investment portfolio to mitigate any sudden losses.

7.5.3 Quantitative Risks (T)

Risk	Explanation	Risk Score	Mitigation
T1. Under-estimation of Program Costs	The total initial and ongoing costs of the program may be underestimated leading to unforeseen expenses and challenges to maintain the program.	12 (High)	• Conduct thorough analysis of all potential costs including admin, incentive payouts, marketing, new employee salaries, training, etc. • Regularly update cost projections depending on inflation. • Ensure there are reserves to buffer unexpected costs. • Conduct sensitivity analysis to determine what would be an appropriate amount of reserves.
T2. Model Selection Risk	Potentially selecting an inadequate modelling for projecting the program outcomes leading to inaccurate predictions or biases.	9 (High)	• Understand the data (conduct exploratory data analysis) and use suitable assumptions. • Compare models. • Evaluate model performance using metrics such as AIC/BIC and R-squared.

			• Update assumptions and model as the program evolves.
T3. Liquidity Risk	There may be inadequate liquidity to fund payouts and meet other financial obligations especially during the first few years of implementing the program.	15 (Very High)	• Conduct stress testing and cash-flow analysis. • Organise contingency funding arrangements e.g., reinsurance. • Monitor liquidity metrics regularly.
T4. Inappropriate correlation assumptions between intervention programs	Inaccurate correlation assumptions between intervention programs can lead to combinations of intervention programs being either under or overestimated in their effectiveness at reducing mortality.	15 (Very High)	• Conduct research to identify commonalities in the outcomes of intervention programs. • Utilise existing studies and other data driven approaches to determine correlations between programs. • Seek advice from experts in the field and providers of the intervention programs. • Upon implementation, make sure to adjust correlation coefficients such that they are reflective of the mortality outcomes seen from running the program.
T5. Inaccurate Health Assessments (Counterparty Risk)	There is a possibility that third-party vendors and healthcare providers conduct inaccurate health assessments leading to mispricing of premiums or not providing the most effective incentives.	8 (High)	• Conduct due diligence on selected counterparty's experience and expertise. • Define clear performance metrics. • Monitor and audit the performance of the counterparty.
T6. Adverse Selection	Individuals with higher health risks may be more likely to sign up to the program leading to higher claims and increased losses to SuperLife.	16 (Very High)	• Ensure high risk individuals are filtered out during the health assessment process using well defined underwriting guidelines. • Monitor the risk profile of individuals and make sure to adjust their premiums and incentives accordingly.

T7. Economic Assumptions Risk	Economic factors such as inflation and interest rates can be highly volatile. Hence, any assumptions about these rates are likely to be incorrect leading to false projections and revenue forecasts.	25 (Very High)	● Assume constant inflation and interest rate since the high volatility of these factors means there is no added benefit or projecting these. ● Conduct sensitivity analysis to assess economic scenario impact. ● Regularly update economic assumptions.
T8. Inaccurate mortality and lapse rate assumptions	Inaccurate mortality and lapse rate assumptions could significantly impact long term cash flow projections and overly optimistic assumptions can lead to financial instability and misallocation of resources.	20 (Very High)	● Utilise historical data and actuarial analysis to determine reasonable assumptions. ● Conduct sensitivity analysis to evaluate the sensitivity of projections to changes in mortality and lapse rates. (make sure the model is robust and small changes in assumptions don't lead to major changes in projection) ● Regularly review and update assumptions based on incoming data and changing demographics.
T9. Sum insured shift risk	The sum insured desired by the population may be different from that assumed to design the pricing model. E.g., If the pricing model is designed based on policyholders having a very high average sum insured but upon implementation majority of people want a smaller sum insured, the pricing model would fail and premiums would have to be increased significantly to fund the program expenses and other obligations.	25 (Very High)	● Conduct scenario testing to assess the impact of significant shift in sum insured preferences, and develop contingency plans accordingly. ● Conduct market research on customer preferences and how these have changed over time. Use this to make evidence based assumptions regarding the desired average sum insured. ● Conduct regular data analysis monitoring trends in the sum insured preferences among policyholders. Proactively adjust the pricing strategies accordingly.

7.6 Pricing Method

7.6.1 Simulated Variables

To generate the model parameters, the uniform distribution was used to generate a vector of TRUE/FALSE entries that represent whether each policyholder meets their annual health goals or not[14], with policyholders generating TRUE, being referred to as "Goal Meet-ers". The uniform distribution was then used to generate the cost of each policyholder's personalised program, with the full value of the individual programs added to SuperLife's expenses. Then, using the multivariate normal distribution, mortality benefits were generated for each policyholder, based on their individual set of intervention programs. For policyholders not classified as "Goal Meet-ers", effects derived from their intervention programs were excluded.

7.6.2 Calculations for Decrements

A lapse table and mortality table were created by considering policyholders' lapse rate and mortality rate, respectively, as the duration of the policy increased. For mortality tables, graduation was then applied using standard life tables by fitting a linear regression. This approximation was sufficient for the male population (pop.), although further approximation was required for more realistic female mortality (mort.) values, using the formula:

$$Standard\ Mort. \times Total\ Pop. = Male\ Mort. \times Male\ Pop. + Female\ Mort. \times Female\ Pop.$$

7.6.3 Expenses and Expected Death Cost Calculations

Expenses and expected death costs were calculated for each policyholder, for each policy year:

1. Calculate mortality reductions for policy year, according to:
$$New\ Mortality\ Rate = Old\ Mortality\ Rate \times (1 - Mortality\ Reduction)$$
2. Calculate cumulative survival probability to that point from age at date of issue
$$Survival\ Probability = 1 - Lapse\ Probability - Death\ Probability$$
3. Multiply the expenses associated with policyholders' individualised health programs by the cumulative survival up to that point
4. Multiply policyholders' cumulative survival by death probability and face amount to find expected death costs

7.6.4 Basis for Premium Pricing

Pricing methodology is centred on first determining total expenses and expected death costs, then determining the required premiums to cover those costs and generate a specified profit margin. To determine the amount of the total required premium each policyholder should undertake, the concept of "risk units" is applied, whereby the annual premium for a single risk unit is determined, then depending on each policyholder's individual characteristics, the quantity of risk units they must purchase for each Č1000 of sum insured is determined. This is used to find equitable proportions of total premiums paid by each policyholder, and price estimations. See *Appendix 7.6.6* for the risk unit determination methodology.

After obtaining these risk units, standard valuation calculations were made, replacing premium values with $Total\ Risk\ Units \times P$, where P represents the price of a single risk unit. Finally, P was solved based on specified profit margins (see *Results* section).

[14] This could be more accurately modelled using discrete-time Markov Chains, although the implemented method is more viable and, on average, yields similar accuracy

7.6.5 Valuation and Zeroisation

The amount of required reserves each year to make the wellness program self-financing was determined by the equation below:

$$Reserves_t = Premiums_t - Expenses_t - Expected\ Death\ Costs_t$$

Final cash flows were then discounted by 5% (see *Assumptions*) to determine the NPV.

7.6.6 Determination of Risk Units

1. Calculate premiums for a unit of insurance using the Principle of Equivalence for all ages and both males and females
2. Find the ratio of each age and gender's premium relative to a baseline 30 year old male
    - i.e., a ratio of 1.34 for a 41 year old Female for term insurance indicates that this policyholder incurs approximately 1.34 times of the cost of a 30 year old male
3. Ratios (see *Appendix 7.2* for tabulated values) are then grouped into 5 year age brackets to increase interpretability and usability.
4. To consider the underwriting class risk, death probability ratios between the four risk classes were examined, using "Very Low risk" as a baseline
    - yielded factors: L = 1.15, M = 1.4, and H = 1.6
5. Smoker factor was deduced by similar methodologies to Step 4, but was scaled down for reasonableness, as it would be "double counting" risk from their underwriting class.
    - Resulted in a final factor of 1.74
6. Determined the number risk units each of the 2023 policyholders are worth

7.7 Sensitivity & Scenario Testing

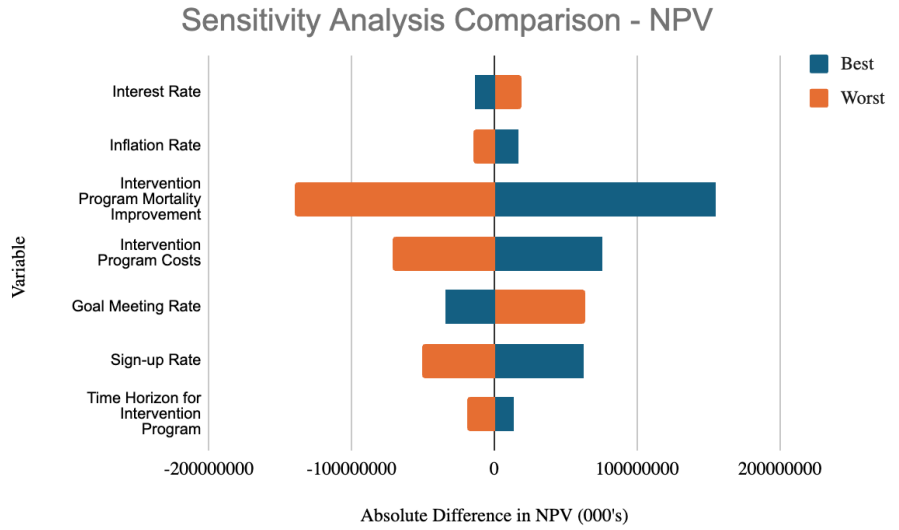
7.7.1 Sensitivity Analysis

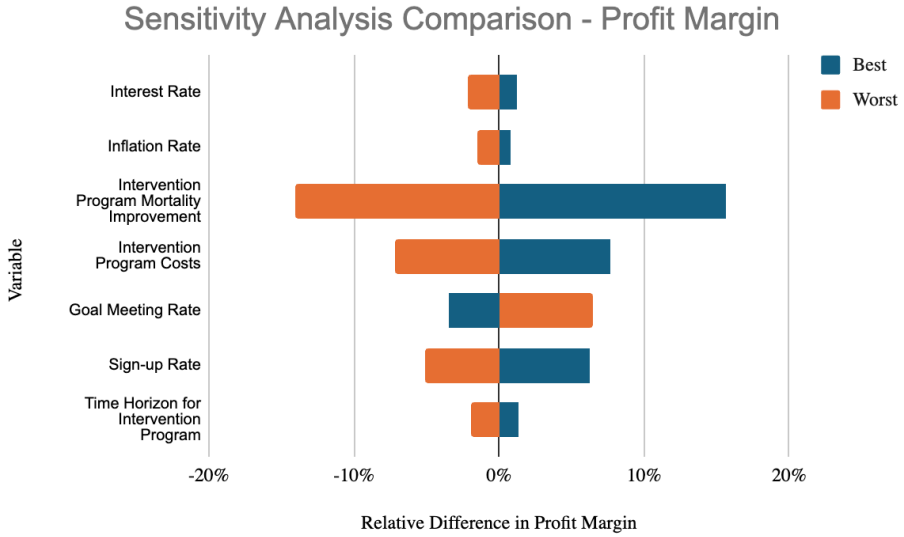
Range of values used for each variable that was tested in the sensitivity analysis.

Variable	Range
Interest rate	3% - 6.5%
Intervention program mortality rate improvements	Used outer bounds ● Safety campaign: 3-5% ● Annual Check-Up: 5-10% ● Discounted Gym Membership: 3-6% ● Weight Management: 5-10% ● Cancer Prevention: 5-10% ● Heart Screening: 5-10%
Intervention program costs	Used outer bounds ● Safety campaign: Č10-35 ● Annual Check-Up: Č175-870 ● Discounted Gym Membership: Č175-870

	● Weight Management: Č175-870 ● Cancer Prevention: Č20-85 ● Heart Screening: Č90-345
Goal meeting rate	30% - 80%
Sign up rate	Plus/minus 20% ● Safety campaign: 50-90% ● Annual Check-Up: Mandatory ● Discounted Gym Membership: 10-50% ● Weight Management: 40-80% ● Cancer Prevention: 40-80% ● Heart Screening: 40-80%
Time horizon for mortality reductions in each intervention program	30% increase/decrease ● Safety campaign: 0.7-1.3 years ● Annual Check-Up: 3.5-6.5 years ● Discounted Gym Membership: 0.7-1.3 years ● Weight Management: 0.7-1.3 years ● Cancer Prevention: 6.3-11.7 years ● Heart Screening: 3.5-6.5 years

7.7.2 Sensitivity Analysis Results





The results illustrate a comparison of the varied effects of changes in assumptions on SuperLife's net present value and profit margin. By comparing the magnitudes of impact, we can rank the variables based on their relative impact on SuperLife's financials. From greatest to least impact:

1. Intervention program mortality improvements
2. Intervention program costs
3. Sign-up rate
4. Goal meeting rate
5. Interest rate
6. Time horizon for intervention program
7. Inflation rate

It is important to note that a 1.5% increase in the interest rate assumption forms the 'best case scenario' and leads to a 1.18% increase in SuperLife's profit margin whilst leading to a ~14m decrease in the NPV. The discrepancy in movement is explained by the greater level of discounting and hence, the smaller NPV. However, the EPV of premiums also decreased which led to an overall increase in the profit margin.

Another discrepancy in the results is the movement in the NPV and profit margin when the 'goal meeting' rate was adjusted. The 'best case scenario' was defined to be an 80% 'goal meeting' rate whilst the 'worst case scenario' was defined to be 30%. The results indicate that the 'best case scenario' actually led to downward movements in SuperLife's financials and vice versa. This can be explained through the understanding that if a greater proportion of policyholders meet their goal, SuperLife will have to payout a greater amount as a result of the profit allocation structure of the program.

7.7.3 Scenario Testing

To showcase the interplay of changing assumptions, the evaluation of a specific scenario was conducted:

- *Natural Disaster* (scenario): A decrease in supply of agricultural products due to major droughts which reduces crop yields and production, causing a significant decline in exports and income for individuals in Lumaria working in the agriculture sector.
- *Lower Mortality Improvements*: export volume decreases could lead to a decrease in revenue, hence limiting resources to invest in healthcare. This could result in lower quality of healthcare services, leading to higher mortality rates.
- *Lower Goal-Meeting Rate*: Lower mortality improvements and correlation may correspond to less policyholders meeting goals.
- *Increased Program Costs*: economic decline causes higher prices for programs, especially non-essential ones
- *Lower Interest-Rate*: due to lower economic activity.
- *Lower Sign-Up Rate*: lower income and possible layoffs in the agricultural sector may result in lower spending, hence less likely to take out insurance.

The specific values tested in the scenario are found below:

Variable	Range
Interest rate	4% (lower)
Intervention mortality rate improvements	Reduce bounds to • Safety campaign: 3-4% • Annual Check-Up: 5-7% • Discounted Gym Membership: 3-5% • Weight Management: 5-6.5% • Cancer Prevention: 5-8% • Heart Screening: 5-8%
Goal meeting rate	60%

Sign up rate	Reduce values to • Safety campaign: 60% • Annual Check-Up: Mandatory • Discounted Gym Membership: 20% • Weight Management: 40% • Cancer Prevention: 50% • Heart Screening: 50%
Intervention Program Costs	Increase bounds to • Safety campaign: Č30-35 • Annual Check-Up: Č300-870 • Discounted Gym Membership: Č600-870 • Weight Management: Č500-870 • Cancer Prevention: Č50-85 • Heart Screening: Č150-345

7.8 Data Limitations

Limitation	Explanation
Lack of homogeneity between insured population vs. general population	The SuperLife Inforce data set is used as a representative sample of the Lumaria population. However, the selection effects of the differences between the insured population versus the general population may compromise accuracy of analysis.
No differentiation of gender in mortality table data	Discrepancies between female and male life expectancies in reality should be reflected in differences in their mortality rates. However, the mortality table provided does not distinguish between the two genders and thus required approximations.
Limited past policy data	Truncation of the SuperLife Inforce dataset to 2001 blocks insight into possible longitudinal and cross-sectional trends, thus reducing the precision of future projections by introducing unaccounted variance.
Limited data on Lumaria's population trend	The lack of data on Lumaria's population trend has made it difficult to extrapolate calculations. This had led to the assumptions of a closed population and a linear trend in mortality improvement.
No data on policy premiums	Exact policy premiums were not provided. Our premiums were estimated based on the Principle of Equivalence, which compromises the accuracy of the estimated cash inflows.

Historical economic data	Historical inflation/interest/spot rates were used to project future rates, thus compromising the accuracy of projected future revenue and costs.
Inability to connect external data	Due to the nature of the task with Lumaria being an imaginary country, there was minimal opportunity to connect external data sources reliably to gain more insight.

7.9 Age Distribution Comparison

To justify the assumed homogeneity between the SuperLife Inforce sample and the general Lumaria population, a comparison of the age distribution was performed, as per the table below. The discrepancy in the age distributions can be attributed to the SuperLife data only covering persons aged 25+.

Age	Insured Data	Population Data
0-14	0%	20%
15-24	0%	18%
25-54	84.5%	46%
55-64	14.3%	12%
65+	1.2%	4%

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