

INSTITUTE OF ACTUARIES OF INDIA

Subject SP9 - Enterprise Risk Management

May 2026 Examination

INDICATIVE SOLUTION

Introduction:

The indicative solution has been written by the Examiners with the aim of helping candidates. The solutions given are only indicative. It is realized that there could be other points as valid answers and examiners have given credit for any alternative approach or interpretation which they consider to be reasonable.

Solution 1:

- i) Key Risk Indicators (KRIs) are a set of risk metrics that form a key part of an organisation's risk management framework.

Risk metrics are indicators of the level of risk in a specific part of the organisation.

They may be quantitative or qualitative,

and designed to give a quick and early indication of changes in risk profile that may lead to a breach of risk tolerance.

Some desirable traits of a KRI are:

- Being quantifiable
- Based on consistent methodologies and standards
- Incorporating key risk drivers
- Tracked over time
- Tied to objectives
- Linked to an accountable individual
- Useful in decision making
- Able to be benchmarked externally
- Timely
- Cost effective to measure
- Simple (but not simplistic)

Some relevant KRIs for the banking subsidiary:

- Credit risk: non-performing loans, high-risk sector concentration, etc.
- Operational risk: system down-time / outages, number of fraud incidents, etc.

Some relevant KRIs for the insurance subsidiaries:

- Underwriting and claims risk: fraud claims ratio, claims processing time, etc.
- Operational risk: employee turnover rate, etc.
- Reputational risk: Number of regulatory fines, etc.
- Catastrophe risk: Maximum exposure to a single (high risk) geography, etc.

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- ii) An emerging risk can represent

- either a change in nature of (or in the underlying effectiveness of risk management approaches to) an existing or known risk,
- or the development of a new risk, i.e. a risk for which there has been no explicit allowance already made within the existing risk management framework.

Emerging risks are typically characterised by:

- Greater uncertainty compared to existing risks due to insufficient data and a lack of knowledge
- A time horizon that is difficult to predict and may be subject to significant change
- Difficulties in quantification due to greater uncertainty over the incidence and impact of the risks
- Generally external to an organisation and therefore more difficult to control and manage
- Often significant in size and scale, covering a number of industries and territories
- Often arising as the result of global trends

Some relevant examples of emerging risks are:

- Significant shifts in power between world economies (impacting business in some regions)
Impact: Significant movement in the foreign exchange rates, and hence finances on the group.
Potential mitigation: Ensuring each country's operation is self-sustaining, and immune to such a foreign exchange rate change.
- Investments being affected by increased contagion in asset markets (e.g. uncorrelated asset classes moving together in same direction)
Impact: This may impair continued operations of a subsidiary, potentially even rendering it insolvent.
Potential mitigation: Conducting stress tests on correlation and ensuring ability to sustain such shocks
- Insurance claims from new or unexpected sources, e.g. due to:
 - Driverless vehicles and advent of drones
 - Genetically modified foods
 - High mobile phone usage
 - Unexpected changes in mortality / longevity (e.g. cure for cancer being found)
 - Climate change
 - New and emerging diseases (including infections / pandemics)
 Impact: This may lead to adverse financial outcomes, up to and including insolvency.
Potential mitigation: Margins for adverse deviations, water-tight drafting of policy terms so as not to cover any unforeseen risks, etc.
- Operational risks due to increased reliance on technology, i.e. cyber risks (hacking, security breaches, espionage, data theft, extortion, cyber terrorism, etc.)
Impact: Business disruptions, loss of reputation, financial loss, etc.
Potential mitigation: A competent cyber security team, purchasing a cyber risk policy
- Climate change risks
 - Physical risks (e.g. to properties held as collateral by banks)
 - Transition risks (e.g. financial markets being in a flux due to a major climate change event)
 - Liability risks (e.g. insured parties covered by insurance subsidiaries being sued for climate related negligence)
 Impact: Financial losses, disruption of operations, reputational loss, etc.
Potential mitigation: Avoiding geographical concentration, having adequate buffers, etc.
- Political upheavals (e.g. leading to currency devaluation)
Impact: Significant movement in the foreign exchange rates, and hence finances on the group.
Potential mitigation: Ensuring each country's operation is self-sustaining, and immune to such a foreign exchange rate change.
- Massive legislative / regulatory changes (e.g. nationalisation of an entire sector)
Impact: Existential threat to the specific subsidiary in the country.
Potential mitigation: Diversified operations across countries.

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iii) The key risk is the agency risk arising from the interests of the agents (management) being misaligned with those of the principals (stakeholders), presumably causing them to take undue risks due to poor remuneration structures that fail to align their interests appropriately.

Other examples of misalignment of interests are:

- Differing objectives of lenders / debtholders (seeking stability) and equity-holders (seeking upside / high returns)
- Managers / employees seeking to protect their job security and therefore making low-risk decisions, penalising the company's long-term profitability and shareholders' return
- A dominant CEO / executive causing echo chambers (troupe of yes-men) leading to risky and inferior decision-making from shareholders' perspective
- Interests of regulators / government being misaligned with those of the general public as regulators tend to be more in demand in terms of crises (which are not great for the broader population) and politicians may tend to support policies that upset the least number of people in the short term rather than those that are the best long-term solutions in view of their inherent interest in getting re-elected (line of least resistance rather than line of greatest advantage).

iv) Effectively, the total potential compensation equals 2.5X, implying the split as:

- 40% in terms of base salary, which is fixed and paid monthly in cash
- 40% in terms of bonuses linked to quarterly revenue targets, paid quarterly in cash
- 20% in terms of stock options, awarded annually but exercisable two years after the award

Overall comments:

- The fact that all executives have an identical structure may help in aligning their interests.
- However, such an arrangement fails to acknowledge or account for their individual zone of influence and their performance therein.
- At its maximum, 80% of the compensation is in cash, which might be on the higher side for senior executives. To address agency risk, there is some scope to increase the restricted stock / stock options component.

Monthly base salary:

- The CXOs will receive a base salary of X regardless of outcomes and company performance. As such, choosing a reasonable and moderate value of X is essential.
- If X is very high, it may cause some complacency and agency risk.
- On the other hand, if X is very low, the CXOs may resort to undue risk taking to maximize their compensation from the other components which are contingent on outcomes.

Quarterly revenue-linked cash bonus:

- This is a relatively unusual structure where the performance is evaluated quarterly rather than annually. This allows the executives to receive some compensation even if the annual revenue target wasn't met provided some quarterly targets were met.
- On the other hand, the binary nature of the pay-out means that even if the revenue is slightly below target in each quarter, the bonus will be zero despite the revenue being close to the target.
- Since the bonus is linked solely to revenue, this might lead to a singular focus on revenue to the detriment of other important metrics such as combined ratio or profitability.
- This might also lead to perverse incentives to strategically book sales in advance (in order to meet target when close) or delayed (when targets have already been met or are very unlikely to be met)...
...although the extent to which this can be done in general insurance may be limited.

Annual stock options:

- These align with shareholders' interests on the upside potential, which is healthy.
- But the misalignment on the downside may lead to undue risk-taking.
- Share price movements are often caused due to movements in equity market as a whole, which are beyond the control of the executives and may be a source of demotivation.

Suggestions for change:

- A structure that varies slightly by executive, e.g, CFO's compensation should be more aligned towards profitability
- The cash bonus being based on a balanced scorecard instead of just the revenue
- The cash bonus being more granular (e.g. rating on a scale of 10 based on some objective factors) or even continuous (function of various metrics) in terms of pay-out possibilities rather than being binary.
- A higher component of stock relative to cash

v) Asset utilisation ratio

- Definition: Ratio of revenue to (share capital + reserves + long-term debt)
- This is a profitability ratio, which measures how effectively they turn capital into revenue (say, net written premium).
- A higher value indicates efficient asset utilisation (equity and debt combined) to generate business (premium).

Return on capital employed

- Definition: Ratio of (profit before tax and interest) to (share capital + reserves + long-term debt)
- This is a profitability ratio, which measures how effectively they turn capital into profit.
- A higher value indicates better overall performance (underwriting, claims and investment) for a given level of capital (equity and debt combined).

Gross profit margin

- Definition: Ratio of gross profit to revenue
- This is a profitability ratio, which measures its underwriting and claims performance.
- A higher value indicates better underwriting and claims performance but may also depend on the state of the market (hard vs soft).

Current ratio

- Definition: Ratio of current assets to current liabilities
- This is a liquidity ratio, which measures its ability to meet current (short-term) liabilities using current assets.
- While a value greater than 1 is desirable for other industries, this ratio is often less than 1 for insurers given their ability to manage liquidity through premium cash flows.

Asset cover

- Definition: Ratio of (total assets less current liabilities less intangible assets) to (loan capital plus prior ranking debt)
- This is a debt-related ratio, which measures its ability to meet its financial obligations and debt repayments.
- This ratio needs to be sufficiently greater than 1 (say, 1.25 or more) to give lenders comfort of the insurer's ability to repay their debt.

Income gearing

- Definition: Ratio of (interest on borrowings) to (profit on ordinary activities before interest and tax)
- This is a debt-related ratio, which measures what proportion of its profit from its usual business activities (i.e. underwriting and investments) will be spent on interest payments on its borrowings.
- A very high value (closer to 1) threatens an insurer's solvency while a low value may be symptomatic of excessive caution and thus scope for growth.

Dividend yield

- Definition: Ratio of dividend per share to market price of an ordinary share
- This is a share-related ratio, which measures the cashflow from the shareholders' perspective per dollar invested
- Younger, high-growth companies tend to have a lower dividend yield than more mature, stable companies (as the former would be valued higher relative to earnings on account of growth potential and would prefer to retain earnings rather than paying them as dividends).

Payout ratio

- Definition: Ratio of dividend per share to earnings per share
- This is a share-related ratio, which measures what proportion of its earnings will be redistributed to shareholders by way of dividends.
- Younger, high-growth companies tend to have a lower payout ratio than more mature, stable companies (as the former would prefer retaining earnings as capital to fund their growth rather than distributing as dividends).

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- vi) Solvency II applies to insurers operating in EU member states and is similar in many ways to Basel II for banks.

Both Basel II and Solvency II are mandatory frameworks designed to be suitable for multi-national firms.

Further, both are based on three pillars.

For Solvency II, Pillar 1 contains the quantitative requirements.

The crux is a risk-based approach to calculating the Solvency Capital Requirement (SCR) and Minimum Capital Requirement (MCR).

These are designed to capture underwriting, credit, market and operational risks.

These can be assessed using a standardised approach or a company's own internal model (if approved).

Pillar 2 contains qualitative requirements.

The insurers must carry out their Own Risk and Solvency Assessment (ORSA).

ORSA requires each insurer:

- To identify the risks to which it is exposed
- To identify the risk management processes and controls in place
- To quantify its ongoing ability to continue to meet its solvency capital requirements (both MCR and SCR), given their identified risks and associated risk management processes and controls.

Pillar 3 covers supervisory reporting and disclosure.

Differences in Basel and Solvency II:

- While Basel II significantly concerns itself with contagion risk in banking sector, this is considered unlikely in insurance so Solvency II is not designed from that perspective.
- Overall, Basel is more prescriptive, while Solvency is relatively more principles-based, leaving details to regulators of individual countries.
- In pillar 1, unlike Basel II, Solvency II requires calculation of both MCR (minimum capital requirement) and SCR (solvency capital requirement).
 - Also Solvency II includes underwriting risk.

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- vii) For a life insurance company, risks can be transferred to another party in several ways such as:

- Insurance (e.g. risk associated with fire on its office property can be transferred to a general insurance company)

- Reinsurance (e.g. risk associated with excess mortality due to a pandemic can be transferred to a reinsurer)
- Coinsurance (e.g. while entering a new region / segment, co-insurance can be used to limit the risk)
- Sharing the risk with a policyholder via policy design (e.g. Exclusions in policy terms and conditions, or having a co-payment where payout is not fixed)
- Securitisation (e.g. using mortality bonds to offload mortality risks to securities market)
- Purchasing derivatives (e.g. use of interest rate derivatives to hedge interest rate risk)
- Alternative risk transfer (ART) (e.g. customised multi-trigger policies for an extended period of time)

Some key considerations while making a risk transfer decision are as follows:

- Cost effectiveness: Since risk transfer has a cost (e.g. reinsurance premium) over and above the expected loss, it should be weighed against the benefit arising out of the transfer.
- Loss of upside potential: Some risk transfer strategies also lead to transfer of the upside (e.g. proportional reinsurance or interest rate swaps), while the ones that don't usually come at a higher cost (e.g. interest rate swaps).
- Market capacity: The effectiveness of risk transfer may be constrained by the capacity (or appetite) of the market to absorb it (e.g. a hardened reinsurance market may constrain the use of other alternatives).
- Counterparty risk: This is a residual risk arising out of risk transfer (e.g. reinsurer default risk)
- Liquidity risk: This is also a similar residual risk (e.g. risk of delayed settlement from reinsurer)
- Operational constraints: The ability of the systems and/or personnel may restrict the possibility of some risk transfer mechanisms, e.g. ART may require expertise which may not be present.
- Regulatory restrictions: There may be regulatory capital rules which may impact the efficacy of some risk transfer mechanisms, e.g. only partial credit for some forms.

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viii) A life insurer can have exposure to interest rate risk of two types:

- Direct: Changes in interest rates have a direct effect on size of cashflows (e.g. investment income from a floating rate bond)
- Indirect: Changes in interest rate affect the value of future cashflows (e.g. the value of the present value of future payments due on an annuity portfolio changing)

Direct exposure to interest rate risk can be hedged using an over-the-counter (OTC) derivative contract called a forward rate agreement (FRA).

An FRA contract commits two parties to exchange payments dependent on some interest rates at a future date (or over a future period).

In practice, the terms are sought to be arranged such that one leg of the FRA exactly (or closely) offsets the interest rate exposure.

- A practical example where this can be used it to convert a floating rate bond investment to a fixed rate one, or vice versa.

Alternatively, the risk from direct exposure can be limited (in one direction) using interest rate caps and floors.

- Caps are useful to protect against the risk of rising interest rates, while floors do the same for falling interest rates.
- A practical example where these can be used is where life insurer has sold products with guaranteed returns. To hedge against the risk of the guarantee biting, floors can be used.

Hedges to direct exposure should lead to the capital component associated with interest rate risk. Albeit it would also increase the capital component associated with counterparty defaults (credit risk).

Indirect exposure (interest rate risk to future cashflows) can be managed by:

- Cashflow matching: Investing in assets with cashflows that exactly match the known cashflow liabilities in size and timing
- Immunisation: When pure matching is not possible, immunisation can be achieved against small changes in interest rates by following Redington's immunisation criteria
- Hedging using model points: Rather than full immunisation, hedging cashflows at key reference points in the future may be pragmatically acceptable]

A standard capital model may fail to adequately capture management techniques for indirect exposure, while a bespoke internal capital model may be better equipped to do so.

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ix) Sensitivity analysis

- This involves varying each assumption one at a time (holding everything else constant) to understand how each affects the NPV of the portfolio.
- This is often performed only for key inputs.
- There is no consideration of the probability of occurrence of such a change.
- This can help us understand the risk faced and may also provide insight into the dependence of the output on subjective assumptions (i.e. how material they are).
- Examples include change in NPV due to
 - A $\pm 1\%$ change in risk-free interest rate curve across maturities
 - A $\pm 5\%$ change in foreign exchange rates
 - A one-notch credit rating downgrade for corporate issuers, leading to increased default probability and risk premium

Scenario analysis

- This entails varying the inputs simultaneously to produce the portfolio NPV under various sets of plausible future scenarios.
- Choice of scenarios is typically driven by historical events.
- Alternatively, ideas can also be generated by brainstorming with relevant stakeholders and experts (e.g. economists).
- This might be particularly useful for emerging risks, for example.
- Most scenarios are negative, although positive ones can and should be considered too.
- There is no consideration of the probability of occurrence of such a change.
- Examples of scenarios
 - Assumptions from the time of inception of the portfolio, or n years ago
 - A scenario involving twisting (flattening or steepening) of interest rate curves and other associated assumptions
 - A scenario of a couple of defaults and some adverse credit migrations (affecting default probabilities and hence risk discount rates for individual bonds) and associated illiquidity

Stress testing

- This is like scenario or sensitivity analysis but focused on extreme scenarios or very large changes in input assumptions.
- This can be top-down (scenario tests) or bottom-up (individual variable tests).
- These are often helpful to supervisors / regulators to compare the impact of same / similar stresses on different companies within the industry.
- Its use can also aid in assessing the efficacy / appropriateness of a risk response strategy.
- Examples include:
 - Assumptions from the 2008-09 Global Financial Crisis
 - A 25% domestic currency depreciation

- A default contagion

Deterministic modelling

- All the three approaches are deterministic models, under which sets of assumptions are pre-determined.
- These can be used to help answer “What if?” questions. They provide useful insight into the impact of changing assumptions but not their probability.
- Compared to stochastic modelling approaches, they are more pragmatic and cost-efficient.
- As such, they are often a key part of regulatory / supervisory requirements.
- However, given the lack of probabilities and occasional subjectivities, their use should be in conjunction with and not in lieu of other approaches (stochastic models, for example).
- A key use for these analyses is as part of ORSA, which is a qualitative requirement under Pillar 2 of Solvency II requirements.
- ORSA requires insurers to quantify their ability to continue to meet SCR and MCR requirements in the near future, given their identified risks and associated risk management processes and controls. As such, scenario analysis and stress testing can be specifically very helpful.
- Scenario analysis can also be used for strategic decision-making where quantification is challenging (e.g. operational risks).
- Sensitivity analysis can be used for more incremental or tactical decision-making.
- Stress testing can give comfort to stakeholders that the company can withstand extreme circumstances with its risk management practices.

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- x) VaR (value at risk) is the maximum potential loss, with a given (high) probability, α , over a given time period.

Mathematically, this can be stated as $\text{VaR}(\alpha) = \inf\{l \in R: P(L > l) > 1 - \alpha\}$.

TVaR (tail value at risk) is the expected loss given a loss over the specified VaR has occurred.

Mathematically, this can be stated as $\text{TVaR}(\alpha) = E[L|L > \text{VaR}(\alpha)]$.

Both VaR and TVaR can be computed using various approaches - empirical, parametric and stochastic.

For some of these (e.g. parametric), TVaR can be challenging (depending on the distributions assumed).

In general, VaR is simpler, easier to explain and more easily interpretable.

Also TVaR is likely more sensitive to subjective distribution choices, parameters and assumptions, which can be a concern when data in the tail (to inform or validate those) is scant.

However, a major drawback of VaR is that it is not a coherent risk measure (owing to not being sub-additive), which TVaR is. This makes aggregation across subsidiaries / geographies tricky with VaR.

Another challenge is that VaR does not use information about loss distribution beyond the threshold, while TVaR does. As such, when VaR is used regulatorily, it may even encourage herding of risks beyond the threshold.

[6]

- xi) Different levels of capital may be computed using differing approaches to meet different aims. The regulatory capital requirement is just one such measure of appropriate level of capital for a company.

The internal model is more tailored to the circumstances of the company and should more accurately describe its capital needs. Examples of such circumstances / needs could be:

- Writing new business
- Developing a new product

The internal model is the one that is specifically geared towards the aims and objectives of the company. Examples of the company-specific aims could be:

- Providing shareholders a specific level of return
- Stability in published company accounts from year to year
- Achieving / maintain a certain credit rating from a particular agency
- A risk tolerance level or time horizon different from the regulator

The internal model may differ from the regulatory model by way of:

- having a more detailed model for certain risk types (e.g. operational risk)
- allowing for correlations between risk types differently
- allowing for volatility of separate business lines differently
- tax treatment or other asset-related aspects

The implication of the differences would be that the company would be required to hold the higher of the capital computed by regulatory model as well as the internal model.

Also, there would be a need for a broad explanation for the difference in the outputs, in terms of the break-down of the contributions from some of the above-mentioned reasons.

[5]

xii) Capital allocation using pro rata (proportional to standalone capital requirement) approach:

- Divide the total capital of 96 among P, Q and R in the ratio 42:30:56.
- Capital allocated to P = $96 \times 42 / 128 = 31.5$
- Capital allocated to Q = $96 \times 30 / 128 = 22.5$
- Capital allocated to R = $96 \times 56 / 128 = 42$

Advantages:

- Simple to compute
- All capital allocated

Limitations:

- Fails to account for diversification between regions meaningfully

Capital allocation using pro rata (proportional to revenue) approach:

- Divide the total capital of 96 among P, Q and R in the ratio 40:30:50.
- Capital allocated to P = $96 \times 40 / 120 = 32$
- Capital allocated to Q = $96 \times 30 / 120 = 24$
- Capital allocated to R = $96 \times 50 / 120 = 40$

Advantages:

- Simple to compute
- All capital allocated

Limitations:

- Not risk sensitive

- Fails to account for diversification between regions meaningfully

Capital allocation using marginal approach:

- Capital allocated to P = Group capital required – Capital required for (Q+R) = $96 - 70 = 26$
- Capital allocated to Q = Group capital required – Capital required for (P+R) = $96 - 82 = 14$
- Capital allocated to R = Group capital required – Capital required for (P+Q) = $96 - 56 = 40$

Advantages:

- Corresponds to financial principle of marginal pricing

Limitations:

- Complicated to calculate (required simulations)
- Not all capital is allocated (sum was 80, not 96)

From a performance measurement perspective, the pro rata (proportional to standalone capital requirement) approach seems the most appropriate because:

- This approach is risk-sensitive, unlike the pro rate (proportional to revenue) approach (which is not risk-sensitive).
- Also it arrives at a good relativity of independent performance of regions (without accounting for diversification *between* regions, unlike the marginal approach (which is better suited for investment / divestment decisions)).

[10]

[100 Marks]
