

Risk Mapping for Social Security Pension Systems

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Introduction

In our days risk management has become an integral part of the governance and operations of the organisations. Even more so for organisations with responsibility for safeguarding the financial stability and long-term sustainability in their sectors. While the principles of Enterprise Risk Management (ERM) have become a standard practice, certain institutions have unique features that require specialized risk management frameworks. In the financial sector institutions such as banks adhere to the Basel Accords and insurers operate under the guiding principles of Solvency Rules, to effectively manage risks inherent to their specific operations.

However, among the financial institutions pension funds are usually in the also-ran category despite of their intricacies and crucial societal role. These organizations, entrusted with safeguarding the financial security of many individuals in their retirement years. Moreover, social security pension schemes, designed to provide a safety net for entire populations, introduce an additional layer of complexity to risk management practices. While the importance of risk management in the area of pensions is widely acknowledged, a universally applicable, comprehensive risk management framework tailored specifically for social security pension systems remains an underdeveloped area of study.

Thus, objective of this paper is, accordingly, to address the following questions:

This paper seeks to address the critical gap in risk management by trying to formulate a generalized risk management framework for social security systems.

In this endeavour we identify the general principles of ERM applicable to pensions and set social security pension schemes apart from other financial institutions. Our aim is to provide social security actuaries with a coherent and adaptable approach to managing the risks that pension systems inherently entail.

In the pursuit of this objective, we hope to empower social security actuaries and professionals with a robust toolset that is helping to identify, measure and monitor risks.

By doing so, we also intend to contribute to further discussions about this topic. The broader goal would be establishing the contribution of actuaries to risk reporting in the area of social security systems.

Setting Context

The European Commission's triennial Pension Adequacy Reports and the Ageing Reports offer the most comprehensive mapping of the European pension systems. These reports analyse European pension systems using projections of future states of the systems and apply a wide range of metrics to assess them. Then the conclusions are used to advise national governments to avoid adverse scenarios. Formulating the process like this makes it similar to risk management. Indeed, contingent future events pose risks to pension provision and regular monitoring, assessment and advice provide risk controls.

Enterprise risk management or ERM has developed widely used methods which can be used for general purposes. Enterprise risk management is dealing with organisations and institutions which have explicitly defined objectives. In our case the objective is providing pensions. A common understanding is that risks are measured in financial terms, again easily applicable to our case. In ERM it corresponds to the enterprise framework where business objectives are easily expressed in monetary terms. We can interpret pension as a financial transaction for this purpose. It is consistent with the definitions of pension as insurance, deferred income or consumption smoothing.

The general context to social security pension institution's risk management is similar to financial institutions' enterprise risk management. Here the best practice is relying on the ISO31000 and COSO standards. These standards defining the risks relative to the objectives of the organisation. This approach is positioning RM together with strategic and business planning. The risk management framework has strategic and operational level feedback cycles. The first one is aligning the RM to the objectives and monitoring and revising the RM framework. The second cycle is implementing and giving feedback to the RM framework. This one is built around risk assessment and risk treatment processes. The main point of reference is the risk appetite of the organisation. The risk appetite is defined in relation to the performance objectives of the organisation and based on the assessment of all relevant risks (the risk universe).

Enterprise risk management has another applicable concept. ERM is focusing on business objectives and business planning. This can be expressed in financial terms. The business of financial institutions is trading in risks and money. From this perspective pensions is a financial transaction in relation with the risks of old age and retirement. The ERM of financial institutions confirmed that the main categories of risks are governance and organisational relations, own business, and operational. All three have financial risks. For own business it can be best described as investment. For the other categories it is expenses and costs.

The objective of pensions is providing old age benefit. In social security the pension should be adequate, sustainable, affordable and robust.

According to our definition, social security pensions is deferred income earned during active career. The risk events occur during active life and retirement at individual and economy levels. The events form a multi-state model of active, inactive/ unemployed, disabled, retired, deceased states. Risk indicators can be identified in the cross-section of the risk events and the decomposition of the main risks. The completeness of the event space and the systematic decomposition of the objective may secure that all relevant risks are included in the risk universe.

In our examples we identify which variables change in transitions to a state during the career and retirement and identified the indicators which the variables are

used in. Not surprisingly we arrived to the well-known indicators of the Ageing Report and the Pension Adequacy Report, like the replacement rate or the dependency ratio. Other risk management tasks of a proper RM cycle include risk evaluation, prioritization, treatment as well as monitoring and review. The simplest risk treatments change the rules of the pension system according to the prioritized objective components. However, changing regulations of pension systems means changing Laws. In this process the role of actuaries can only be expert advisors', but an RM framework can be used for devising provident risk mitigation tools, like Automatic Adjustment/Balancing Mechanisms.

In the following we discuss ERM in general to establish a common terminology, then risk management of financial institutions as the broader context for pensions and the articles which have already dealt risk management topics for insurers, with some outlook to pensions. The closest to our area of interest is the ISSA-ILO Actuarial guideline. Then we point out the distinctive features of pensions before, finally, focusing on social security pension provision by public sector financial institutions. This approach may make use of the already established methodologies and still take into account the differences between the pension sector and other financial institutions. The main section of the paper is devising the pension risk universe ending with an example of using a risk heatmap for assessing social security pensions sustainability as an illustration the above considerations. The Annex includes further examples and general information on risk management for reference.

ERM Risk and Risk assessment

Risk concepts

The most widely used standards in this area are developed by the COSO and the ISO for business enterprises in support of business planning and achieving business objectives.¹ But still the concepts and methodology is formulated in a way which makes it possible to adapt for all kind of organisations with defined objectives.

An organisation may fail to achieve the objectives or may gain from assuming risks for several reasons. The ever-changing risk universe can be derived from the objectives and *operational environment* of the organisations. They give the general risk categories. In this approach Risk is the possibility that an **event** will occur and (*adversely*) affect the achievement of **objectives**.² **The objectives must be set consistently with the** Risk appetite and tolerances of the organisation as measured against performance, providing the risk profile of the organisation. It requires the assessment of all risks of the risk universe. In a risk management system the risk universe is systematically described by a risk register or inventory, which is using similar methods as the business performance measurement. The links with objectives and performance establishes the relationship with strategic and business planning. The risk register identifies the risk with several descriptor, among others Key Risk Indicators.³

¹ The ISO standard has a more general approach starting from objective and more layered definitions the elements of the risk assessment. It better distinguishes the strategic and operational levels and use the traditional risk management feedback cycles.

² Still the methodology includes upside risk, the risk responses are „reduce, accept, transfer or avoid”

³ See Appendix

1 Name or title of risk	Unique identifier or risk index
2 Scope of risk	Scope of risk and details of possible events, including description of the events, their size, type and number
3 Nature of risk	Classification of risk, timescale of potential impact and description as hazard, opportunity or uncertainty
4 Stakeholders	Stakeholders, both internal and external, and their expectations
5 Risk evaluation	Likelihood and magnitude of event and possible impact or consequences should the risk materialise at current level
6 Loss experience Indicators and Monitoring	Previous incidents and prior loss experience of events related to the risk
7 Risk tolerance, appetite	Loss potential and anticipated financial impact of the risk or attitude Target for control of risk and desired level of performance Risk attitude, appetite, tolerance or limits for the risk
8 Risk response, treatment and controls	Existing control mechanisms and activities; Level of confidence in existing controls Procedures for monitoring and review of risk performance

Establishing and reviewing a risk register is supposing to have all relevant risks once and only once with minimal overlap between them as the best coverage. Similarly, finding the best set of risk indicators might also present a challenge. For that purpose we start with breaking down the objective into components and mapping all events which will occur during the course of achieving the objective. Risks can be identified at the cross-section of the components of the objective and the events. Having the components of the objective and the risk events defined, the potential impact of the events to performance and losses can help defining risks and risk indicators.

Most risk management frameworks analyse risks considering impact and likelihood and distinguish inherent and residual risk after applying risk controls or mitigants. In the COSO approach the underlying concept is the Value at Risk or Capital at Risk, and the Cost of Risk = Expected Loss + Cost of Capital (or other risk controls). In practice, risks are assessed in the Likelihood x Impact coordinates.⁴ The methodology is capable to comprise both quantitative and qualitative indicators and downside as well upside risks.

Risk assessment

Risk assessment is processing all relevant risks in relation to the objective. Not only by coincidence, both the risk management framework and the process are usually defined as feedback cycles. The first one setting the strategic context to the second implementing the strategy and providing information to the first one.⁵ Setting objectives and decisions on risk appetite and risk profile regarded as framework at governance and strategy level, while risk-by-risk

⁴ Note that the Risk=Impact(\$) \times Probability(%) is an overly simplified expected value formula, which needs careful interpretation if used.

⁵ Both ISO and COSO defines principles, framework and process. See Appendix

assessment is in the focus of the operational level risk management implementation process.⁶ Again, the risk management cycles are aligned to the strategic and business planning.

The COSO risk management implementation process consists of

- Identifying risk
- Risk assessment, performing: Developing assessment criteria and Assessing risks and risk interactions by qualitative and quantitative risk metrics, indicators
- Prioritizing and Responding to risks and establishing Residual risk assessment
- Monitoring Performance in portfolio view. Regular own risk reporting is part of the monitoring process

The process is preceded by objective setting in relation with the risk appetite (given profile, tolerance and performance) and supported by control activities, information and communication.⁷

Enterprise risk categories

Enterprises and/or institutions has common characteristics. All of them has a mission and must have governance and organisational structures. Their staff performs daily operations to achieve their goals.

What makes them distinct is their individual mission and how they decide to fulfil it. That is, in ERM terms their own objective and business. Their area of operations and performance make them different from the others even if they may use the same or similar governance and organisational structures, processes, IT systems during their daily operations.

This duality can also be seen in finances: financing the core business is investment, while financing organisation and daily operations might be regarded as general expenses.⁸ In this paper we narrow financing to the core business, that is investment. This distinction is to avoid all uncertainties in case of financial institutions, where investment will mean investing assets for funding liabilities to investors/policyholders/fund members and statutory capital (if required).

Using this we may define the main risk categories as governance and organisational structures, own business, and operations of the organisation.

Objective: the funding document and mission statement define the objective of the institution. The business strategy and plans specify the objective taking into account the risk appetite.

⁶ The terms of framework and risk management are sometimes also used to refer to the methodology or one element of the process, depending on the standard in question.

⁷ In the ISO standard Risk assessment includes risk (i) identification, (ii) analysis, and (iii) evaluation in a narrow sense. Risk assessment preceded by defining the scope, context and criteria and followed by Risk treatment and Monitoring and review. The process is completed by recording and reporting, communications. Here the term of Risk assessment describes different elements of the process. Analysis and evaluation might better specify elements assessment, but interactions, prioritization and portfolio view better highlighted in the COSO methodology.

⁸ It becomes a delicate distinction in case of Human Capital.

1. Governance and organisation risks

- a. Governance and Strategy risks, Reputational risk, Compliance risk
Decisions on Risk appetite/tolerance belongs here
- b. Organisational, responsibilities, reporting, and structures, HR and organisational culture and processes

2. Business risks: specific to own business activities

- a. Risks of achieving the objectives of the organisation
- b. Including Financial risks of financing own business: financing development projects, investment, financial asset risks like: Market risks (market: to which the business is exposed to), Credit risk (lender or borrower), Solvency/Liquidity risks

3. Operational risks: operating as an organisation (the “infrastructure” of the organisation and the business)

BIS definition: the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events

E.g. IT/cyber risks are here, financing risks of the operations and organisation (expenses, costs)

In this approach financial institutions differ from others in their business risks. Their own business is transforming risks and durations of financial transactions, so financing own business, investment is in itself their core activity. Therefore for example their risk appetite/tolerance is special in financial risk taking.

Financial sector context

Historically the Basel Accords in banking and the solvency criteria for insurers preceded the general purpose ERM standards. The business of banks and insurers is trading in money and risks. These financial sector regulations start from business risks and look at operational and other risks from the perspective of secondary reasons endangering business objectives. The regulations prescribe regulatory/solvency capital requirements, proportional to risks, as mandatory risk control tool. The most recent versions of the Basle and Solvency regulations also require comprehensive risk management systems, so as to take into account risk other mitigations.

The COSO and ISO ERM standards also have predecessors. Both organisations first developed compliance and internal control standards. Their guidelines are more principle based and procedural without assigning specific mitigant tools like capital requirements on business portfolio risks assessment.

Banking and even more insurance are examples for pensions, and their advanced methods can be applied in pensions, taking into account the differences. Banks and insurers are enterprises using ERM in their operations. In a survey of central banks 91% rely on ISO31000 and 75% takes into consideration COSO in their organisational ERM framework.⁹

For that reason the general ERM approach might be helpful as the common starting point in finding the similarities and the differences.

One step further, Social Security Systems are also pension funds, but with

⁹ [ISO 31000 remains top framework for risk managers - Central Banking](#)

significantly different policy objectives and

- governance,
- funding,
- administration and
- statutory regulations.

Still, our objective is to attempt to outline an own Social Security Risk Assessment.

Overview of insurance ERM articles

ERM is a general framework for managing risks. Actuaries are managing a special set of quantifiable risks, so actuarial methods and skills are readily applicable to RM. From a different perspective, actuarial tasks arise in the context of an organisation, that is an enterprise. So there is a two-way road between the topics of interest of the two areas.

The IAA have produced several papers discovering ERM from actuarial perspectives.¹⁰ Two of them is dealing with the development an ERM system for insurers. The first one is a general guideline from 2009 establishing ERM for insurers, and the other is more focused on actuarial methods, but still embedded in the ERM context (2016). Another IAA paper is added to the 2009 IAA Note on ERM to establish the relation between the insurers' case and pensions. An AAE paper discusses operational risk management of insurers and IORPs with a certain outlook the general case and the ORSA and ORA reports. Here the main purpose is to establish the role of actuaries in risk management.

The two IAA papers dedicate specific sections to definitions and explaining the basics of ERM. The AAE paper clarifies the difference between operations in general and the operations which is common to every organisation. It points out that in the financial sector operations related to credit and investment and risks are different from running the organisation. For this narrow-sense operational risk concept they rely on the BIS and the EIOPA definitions.

The IAA papers follow top-down approach to the description of the system starting from risk governance to risk culture of the organisation and description of the risk management processes. At this stage they distinguish the governance, management and daily operations levels. But they discuss the strategic level risk appetite/tolerance issues among the processes rather than a governance topic. It is interesting that the 2009 IAA Note and AAE paper identify the upside risk as integral part of the financial sector business. The Note Addendum on pensions points out that operating an occupational pension scheme is a downside risk for the employer.

Discussion of the ERM processes is starting with a broad list of risks and the usual disclaimer about the examples and interpretations. All lists are similar, but still different. Only the IAA Actuarial Aspects paper proposes a layered approach to market risk. The IAA Note Addendum on Pensions discusses the difference between insurers and pension funds but fails to elaborate set of risks for pension schemes. It also claims that the case of DB pension schemes can be extended to public pension schemes where the employer's covenant falls on the taxpayers.¹¹

In relation with the risk management process these papers introduce the concept of the risk management cycle of risk identification, analysis, evaluation and treatment, followed by monitoring and reporting. Risk metrics and/or KRIs are

¹⁰ We discuss the ISSA-ILO Guidelines to Actuarial Work in a later chapter.

¹¹ While the situation far from this simple, the idea is certainly establishing a chain of thoughts between ERM and the risk management framework of social security pension schemes.

discussed under different headings in multiple sections. The IAA papers explicitly consider risks on an inherent – residual basis. The Economic Capital Models and ORSA is also examined in details. The IAA Note Addendum on pensions propose to have a kind of ORSA to pension schemes, and of course, the AAE paper covers the ORA of the EU IORP Directive as well.

ISSA ILO Actuarial Guidelines on Risk Management

The closest source to our topic is the ISSA ILO Actuarial Guidelines, having a chapter on actuarial contribution to risk management. However, without having another dedicated ISSA Guideline on RM – This Guideline is discussing risk management and actuarial contribution side-by-side. First setting out the objective of risk management and social security systems, then discussing an RM Framework and process, and the requirement for a dedicated RM function. After discussing the elements of a basic RM cycle the Guidelines provides for a risk inventory¹² and establishment of the risk appetite (as risk budget) and a risk management plan. The Guideline describes the risk management process as the project of the risk function unit. The risks are delineated under the categories of Scheme risks and Operational Risks. Without going into details here, the ISSA Guidelines risks are:

- **Scheme risks**
 - Benefit expenditure risk
 - Financing risk
 - Investment risk
 - Interest rate risk
 - Currency risk
 - Third-party provider risk
 - Scheme objectives risk
- **Operational risks**
 - Human resources risk
 - Governance risk
 - Regulatory risk
 - Reputational risk
 - Operational risk

While it is mentioned that some risks may overlap, other grouping could be applied. For the sake of our discussion in the following sections, we draw the attention to Governance and organisational risks (responsibilities and reporting lines) as strategic issues which could be separate from operations. Third party risk is also a strategic decision, while the operational consequences may appear under the function which has been outsourced. Investment risks might also be positioned and discussed differently.

The primary definition sets out the objective well: Risk management enables the social security institutions to increase the likelihood of achieving its objectives, in responding to life-cycle risks of the population. For our purposes all the life-cycle risks and benefits – including monetary and in kind – are too broad topics, and indeed, in some cases leading too general or irrelevant guidance for us, for example in risk mitigation.

The risk management framework seems to follow other standards than the COSO or ISO. The focus is on the processes of the risk function unit and could be best described as a project management risk management. The ways modalities of actuarial contribution are well elaborated.

Definition of the inventory of elementary risks and mitigations is a critical element of the process. It should be derived from the objectives. In this sense, while all branches of social security can best described by multi-state models, their risk events and financing models are significantly different. So it would worth to define the objectives and the corresponding risk inventories of the branches of the social security branches one-by-one.

¹² Also called risk universe, risk register.

In most cases the governance and administration (institution and organisation) is not the same anyway.

Pensions as financial systems

Looking at pensions as a financial instrument, we may regard it as transfer of income to after retirement (consumption smoothing) and insurance against old age poverty. Pension funds are financial institutions, collecting contributions and paying out pension benefits. In this section we describe social security pension institutions highlighting their special features.

Pension systems are defined by long-term contracts covering the widest group of people because of the mandatory nature in pillar 1. For most of them this is the largest financial transaction of their life in which the benefits are paid for in advance the service is provided. In social security the governance and organisation are also special, usually a public body and state administrator.¹³

Social security pension is the first pillar of the pension system. Multi-pillar pension systems have evolved either historically or developed by structural reforms, but nowadays exist in all EU Member States. The pillars are usually defined by their adequacy objectives and risk appetite of the targeted socio-economic group. Including affordability in the definition we arrive to the core concept of the COSO risk appetite/tolerance and performance/target space.

The pillars define the governance, organisation and finances as

- Public or private
- PAYG or funded
- DB or DC
- Mandatory or voluntary
- Intergenerational by arrangement or not

Different pension arrangements share risks differently.¹⁴ In ascending order of risk sharing:

- In a pure DC scheme, risk of varying returns to a pension accumulation falls entirely in the individual. In extreme an individual account scheme may use securities accounts as funding mechanism
- In a pure DB scheme, the risk of varying returns falls on the plan sponsor, e.g. in a firm or industry scheme on workers, shareholders and/or customers
- In a pure public PAYG DB scheme, the risk of rising pension costs falls on current workers
- In a scheme which includes at least some tax finance, risk falls on taxpayers and hence, via government borrowing, can be shared with past and future taxpayers

¹³ Richard Hinz: Supervision of Pension Funds: Theory and Practice in Supervising Private Pensions: Institutions and Methods, OECD 2005

¹⁴ Source: prof. Nicholas Barr

The World Bank¹⁵ defines the objective of pension systems to provide

- Protection against the risk of poverty in old age
 - Consumption smoothing from work to retirement,
- and the evaluation criteria of achieving the objective are
- Adequate and equitable
 - Sustainable
 - Affordable and
 - Robust and predictable retirement income.

Adequacy and sustainability are discussed in the EC Ageing and Adequacy reports. Affordability takes into account the financing capacity of both the individual and the economy. An equitable system may provide for income redistribution from the lifetime rich to the lifetime poor consistently with agreed social preferences, but otherwise provides the same benefit for the same contribution. Predictability assumes unforeseen changes in the rules and value of the benefits and robustness the capacity to withstand major shocks, including those coming from economic, demographic and political volatility.

For the purposes of this discussion we take the example of 1st pillar mandatory PAYG social security pension systems. Under this arrangement contributions deducted from present income, the rights to future pension benefits accrue by contribution payment during active working career. The government is guarantor of the benefits and administrator of a public sector pension institution.¹⁶

We summarise the social security pension system risks as the following:

Objective

- Provide Adequate, Sustainable, Affordable and Robust retirement income.
- In this paper we focus on improving Adequacy and Sustainability by managing the risks of

Governance and organisational relations

- *the social security institution: public pensions*
- *with the involvement of ministers and politicians*
- *formal interface with Ministry of Finance and Labour/Social Ministry*
- *public accountability*

Business and Finances

- PAYG DB
- *business risk driven by demographic factors, including dependency ratio*
- *impact of changing earnings structures and working patterns*
- *evolving attitudes to ill-health and disability*
- *economic situation and exogenous factors such as pandemics*

Operations (of the organisation)

- Public sector administrator
- *government department or independent agency*
- *challenges of running such a large agency efficiently and economically*
- *database and information challenges: life-long employment, family status and benefit records¹⁷*

¹⁵ Robert Holzmann, Richard Paul Hinz and Mark Dorfman: Pension Systems and Reform Conceptual Framework, SP Discussion Paper No. 0824, The World Bank 2008

¹⁶ In some European countries the main public scheme is a tax financed basic and/or minimum pension arrangement, and main source of old age income comes from a funded occupational scheme. For them only the basic concepts described here are applicable. Other papers discuss funded pensions with more emphases on investment issues.

¹⁷ Socio-economic status

In social security pension systems the risk management framework may contribute to more adequate, sustainable, affordable and robust pension systems by risk-based monitoring and risk assessment by adopting new risk controls. They can just improve monitoring methods, help systematically devise control mechanisms, or prioritising and schedule other risk controls. For example automatic balancing mechanisms, as described in the AR¹⁸ fit into this framework. They use risk indicators as triggers to parametric changes.

Social security institutions should have dedicated risk management units, reporting to the governing body, closely working together with budgeting and planning. Even if there is a difference in approach: budgeting focus on a feasible financing, risk management on potential threats to financing. Actuaries can and should be involved in risk management and budgeting. Even if using similar actuarial assumptions and methods the objective and interpretation should be adapted to the function.

Devising the pensions risk universe

In case of pensions, the objective is to provide pensions in old age. In more details, we are aiming adequate and sustainable pensions after accruing pension rights during a working career. Career events shaping the pension are changing the employment, the employer and/or the pension system. Adequacy is an individual level concept, while sustainability is a macroeconomic issue. But for example, in case of an economic crisis an employer will have to make workers redundant to reduce its contribution costs and so pension benefits of the employees concerned. This is influencing both adequacy and sustainability, even if lagging in time. The usual method of analysing pension systems is aggregating pension rights of the covered population. It is readily applicable for sustainability issues and average adequacy measures. The Ageing Report is further breaking down the pension expenditure indicator (PE/GDP) into demographic, labour and adequacy components of dependency, coverage, labour market and benefit level. For adequacy, more granular measures can be found analysing the socio-economic groups. Having the components of the objective of a pension system and the risk events defined, the potential impact of the events to costs (sustainability) and benefit level (adequacy) can help defining risks and risk indicators.¹⁹

Events	Impact	Indicators
<i>What can change pensions? To whom? When?</i> Events influencing pensions in multi-state events space occur <ul style="list-style-type: none">at individual level and system level	<i>Events may change outcomes vis-à-vis the objectives</i> Risks with effect on <ul style="list-style-type: none">AdequacySustainabilityAffordability and	<i>Key Risk Indicators</i> Examples PAR: Adequacy indicators: Replacement rates AR: Pension expenditure measures: PE/GDP and its component factors Affordability: Required contribution rate

¹⁸ See also the SSSC discussion paper on this topic.

¹⁹ We focus only on risks endangering benefits and do not deal with governance, organisational and operational risks.

Events	Impact	Indicators
<ul style="list-style-type: none"> with different effects on socio-economic groups <p>Also taking into account demographic cohorts: age 18, ..., 100 in year 2016, ..., 2070</p>	<ul style="list-style-type: none"> Robustness (vs volatility) of the retirement income 	<p>Contribution density</p> <p>Robustness: Benefit „volatility“</p>

We have defined the objective and the main risk categories of a pension system in the previous chapter. For now, of the main risks we focus on the potential impact of the events to costs (sustainability) and benefit level (adequacy) to help in defining risk indicators. Here we catalogue the events of an individual life with effect on pensions as the risk event space.

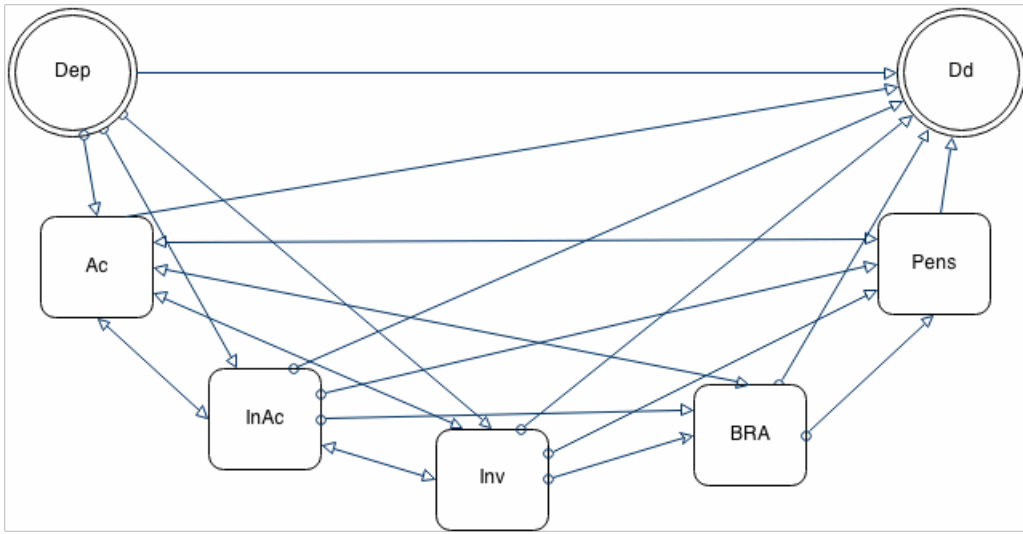
The objective of all pension systems can be measured by the benefits and by the variables defining the benefits and benefit financing at individual and system levels. The events influencing the pension benefit occur at individual level during the active career of the individual. Society or system level changes influence the working careers of people according to their socio-economic groups.²⁰ Different events influence the careers of different socio-economic groups differently. Usually we analyse the demographics of the system by adding the age dimension (demographic cohort) and calendar year (as cross section) to the event space. The events influence the outcome vis-à-vis the objectives, that is the occurred risks have effect on adequacy and sustainability. A pension system has an explicit or implicit retirement benefit objective relative to an assumed career.

There are events at society and economy level which may, in the end, influence the individual pensions. The rules of the pension scheme, employment regulation may change and economic and demographic changes also influence the pension outcome. These occurrences obviously influence individual life paths. We only make this distinction because some events are easier to formulate at individual level, others will be better done on aggregate. The impact at economy/society level depends on demography and actuarial neutrality or level generosity of the benefits. For example split career patterns, gig economy, minimum wage declaration, ageing society and increased longevity, systemic generosity, distortive redistribution, ad hoc systemic changes might be easily assigned to the main event categories. Events and indicators can be further detailed and finetuned to establish the monitoring and risk assessment of a specific pension scheme.

Pension systems can be best described by a multistate model.²¹ Transitions are between the Dependant, Active, Inactive, Invalid, Below retirement age beneficiary, Pensioner, Dead states as represented by the arrows. Transitions occur at individual level and can be aggregated to society level for a period, like for example the population of an age cohort in a calendar year.

²⁰ Define socio economic groups: Socio-economic status and socio-economic groups might be defined on employment, income and education scores. In our discussion gender, career (active, disabled, retired) status and family (married, widowed, dependent) status also relevant.

²¹ Acronyms mean Dependant, Active, Inactive, Invalid, Below retirement age beneficiary, Pensioner, Dead. For simplicity of discussion we'll deal with transitions between Active, Inactive/Unemployed, Pensioner, Dead.



It might be confusing that an event is also a risk covered by social insurance, like unemployment or disability, but managed separately. On the risk response spectrum of *accept - avoid - reduce - share - pursue* social insurance systems accept pension, death and disability risks while making some preventive measures of downside consequences. Here we focus only on the impact on pension benefits, that is in most cases shorter service/contribution period and early access to benefit. This approach assumes that the benefit formula is not actuarially neutral, but generous. Another presumption is that the finances of the scheme is in balance or at least sustainable by the time of the assessment.

Events have impact on the benefits and so may pose risks. Indicators measure risks by their impact. The key risk indicators measure the effect of the events on the outcomes throughout monitoring of the system. The next step is defining risks according to the events vis-à-vis the main component categories of the pension objective. A systematic review table can be used to define the descriptions, the changing variables of the risk indicators, and in the end the items of a risk register/inventory. The first step is to examine the impact of the event space transitions to the variables describing the objectives. We attach a simplified example in Appendix C.

At individual level the career events during active life (unemployment, disability) change the level of pensionable earnings and the length of the service period. The timing of the retirement determines the level of pension benefit and, supposing the life expectancy at retirement, the period of the annuity. At system level the aggregate number of contributors and their contribution capacity provide the source funding the pension benefits of the retired population.²² The variables effected by the events include the number of contributors and pensioners, level of pensionable income, service period, benefit and length of retirement. This description might be adequate for the analysis of the macro sustainability a PAYG system. But to obtain more detailed assessment the transitions should be observed at and take into account the socio-economic group of the individual.

In the simplest cases individual risk indicators best applicable to adequacy risks and economy or society level indicators to sustainability. Indeed, risk events decreasing pensionable earnings and/or service period impact clearly negatively adequacy and PAYG financing. We are aiming more sophisticated than the evident results to find better risk mitigation tools. We have adequacy indicators from the Pension Adequacy Report

²² On the pensioners' side of the pay-as-you-go equation the number and level of new benefits may significantly different from that of the deceasing pensioners.

and other papers analysing the adequacy.²³ The Ageing Report provides pension sustainability measures, e.g. the expenditure projected. ILO and the World Bank reports use required contribution rate and contribution density as usual measure pointing to affordability, or rather “unaffordability”. Benefit volatility maybe a measure of robustness at economy and society level.

Most pension modelling exercise face the uncertainty of long-term modelling. For the purposes of risk modelling the starting point is that all pension schemes/systems are operational and paying the benefits by the time of the assessment. The risks must be formulated supposing a possible scenario different from the expected and assign likelihood to that scenario.

Measuring risks in terms of benefits helped define the impact. The other axis of risk measurement is probability. In case of pension modelling it will need careful considerations.²⁴ The best way is to look at it as rough qualitative scaling and using comparing past modelling and statistics as starting point.

Going beyond the general considerations, similar scenarios might take place with different effect and probability in different pension systems, depending on their specific scheme rules and micro- and macro-operational environment. We may just think about the different definitions of the multi-pillar systems and even in the pillars the rights and benefits can be different country-by-country. Consequently, even starting with the same key risk category the definition of the component risks must be specific to the scheme. *So to start with a rough model it might be advisable to examine and compare the results of past models and statistics only to establish a simple qualitative scaling of each and every individual risk.*

Next steps of the RM cycle

A proper risk management cycle also includes the Risk evaluation, treatment and the monitoring and review steps. Having the results of the assessment the risk response is to avoid, accept, reduce, or share, transfer risks, taking into account the total risk portfolio in the risk appetite/tolerance and performance coordinates.

In case of competing or even contradicting objectives prioritization may help finding an answer. In pensions adequacy and sustainability objectives can be easily interpreted as contradicting. Further decomposing objectives, considering other risk criteria (coverage, timing, etc) may further explaining the significance of a risk.

Risk treatment/mitigation means selecting the most appropriate risk treatment option(s); and designing risk treatment plans specifying how the treatment options will be implemented. For the pension administrator these are the usual policies, control activities and procedures implemented and carried out to help ensure the risk responses. Finally Monitoring and review – again, this is something what actuaries are already doing, even if for other purposes.

Pension systems accept risks basically according to service period, pensionable earnings, contribution payment, retirement age and benefit rules. The simplest risk treatments change these rules according to the prioritized objective components. Changing regulations of pension systems means changing Laws, and the role of actuaries can only be expert advisors’. Monitoring can be used for

²³ See SSSC discussion papers on adequacy

²⁴ In fact it is the case in other professions, too. It is difficult to explain the necessity of involving risk management into financial planning to a successful businessman.

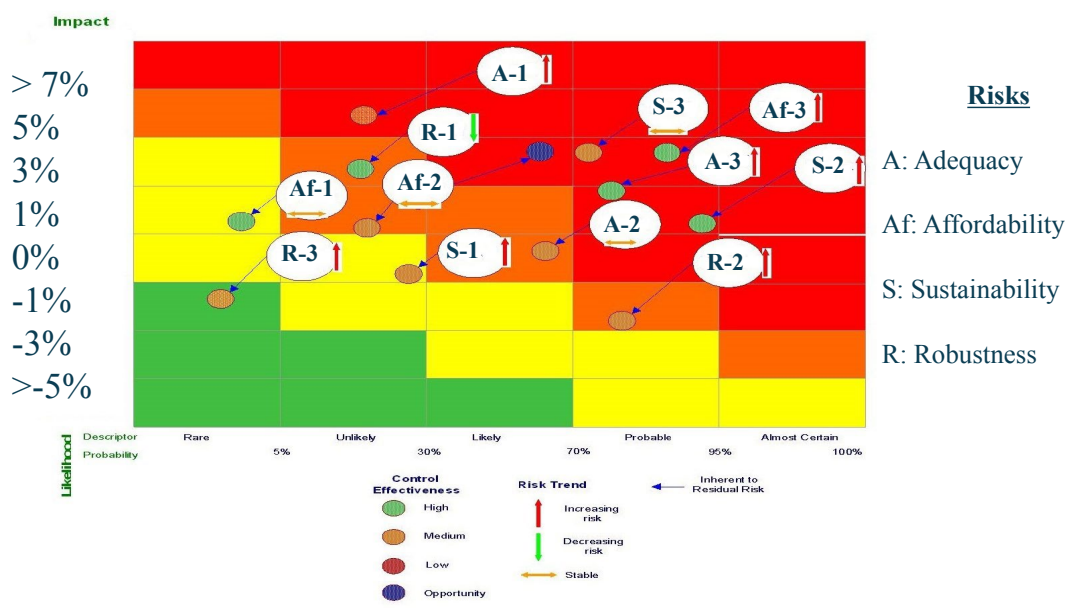
devising provident risk mitigation tools, like Automatic Adjustment/Balancing Mechanisms.

Example: Social Security Risk mapping of one country

1. Example Social Security risk mapping

Risk maps serve as standard tools in risk management dashboards. They interpret an Impact-Probability domain of all relevant risks of the risk universe. The scales of the axes can be both quantitative or qualitative. When showing multiple risks or entities on the same map the values must be congruent for comparability. The impact on the y axis can be loss expressed in monetary terms or in percentages, for comparisons like pension expenditure/GDP of the EU Member States. The probability on the x axis in qualitative terms can be (Very) Low, medium, (Very) High. Heatmaps can show inherent and residual risks and trends as well, depending on the purpose of the discussion, for example prioritisation.

Take the example of a pension system, where the risk universe identified twelve risks, three in the main categories of Adequacy, Sustainability, Affordability and Robustness. The aim of the own risk assessment was to examine the effectiveness of the risk controls in place. The result can be summarised in a heatmap. ²⁵



In the Appendix we illustrate the above heatmap on the Pension Expenditure/GDP indicator of Ageing Report. The indicator can be used for country contributions to assess the EU, and the breakdown to Replacement Rate, Dependency Ratio, Coverage Ratio, and Labour Market effect is applied to the assessment of one country.

²⁵ Example graph derived from Note on Enterprise Risk Management for Capital and Solvency Purposes in the Insurance Industry, IAA 2009

Conclusions

At this stage the above discussion has only rephrased the analytical works of the AR and PAR and other traditional social security sources, this paper using an ISO/COSO ERM framework and terms. Another convenient assumption was looking at pensions as financial transaction and applying results of financial institutions RM, while taking into account specific features of social security pension systems. This way a *Risk management framework can be systematically built up for SSPSs.*

The Reports use projections, that is generating relevant future events for the purpose of analysis. The method is similar to risk assessment, only the discussion and interpretation of the results is different. The conclusions of the Reports are policy advice, which can be regarded as risk controls, again underlining the similarities. Furthermore, with respect to the EU Pension adequacy and Ageing Reports: Risk assessment can result in as good analysis as the Reports. But because of the systemic approach and *more consistent and **comprehensive** analysis and by definition forward-looking risk mitigation methods, the RM can deal with a wide range of objectives on a comparative basis, under the umbrella of an integrated framework.*

Pension systems accept risks basically according to service period, pensionable earnings, contribution payment, retirement age and benefit rules. The simplest risk treatments change these rules according to the prioritized objective components. Changing regulations of pension systems means changing Laws, and the role of actuaries can only be expert advisors’.

Actuarial contribution – just as to SSPS administration – is certainly applicable to building up and operating a SSPS Risk Management framework. As pointed out in other papers for pensions, an *RM Function, ORA is advisable for SSAs. The regular actuarial reviews of the financing of a social security scheme can be a key risk mitigation measure and may lead to specific design features like the Automatic Balancing Mechanisms.*

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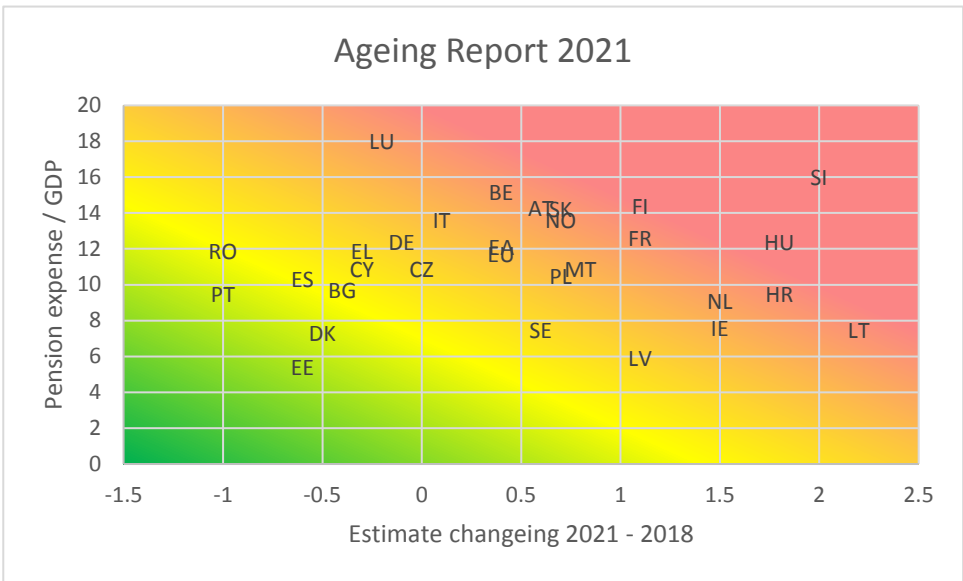
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APPENDIX

Appendix A: Example: Risk mapping – Sustainability in the Ageing Report

As for illustration of risk assessment and interpretation on a heatmap we use data from the 2021 Ageing Report. The central metrics of Ageing Report is expenditure/GDP, that is a sustainability measure. This is used in cross-country comparisons. The breakdown of this measure apply benefit ratio, coverage ratio, dependency ratio and the employment or labour ratio as component factors. The decomposition may be used for conclusions also at individual country level.²⁶

The first graph intends to show the risk of the Member States contribution to the Pension expenditure/GDP risk at EU level. The higher the percentage the higher the impact is. A proxy of the probability is derived from the measure (pp) and direction (up or down) of the change since the last assessment in 2018.

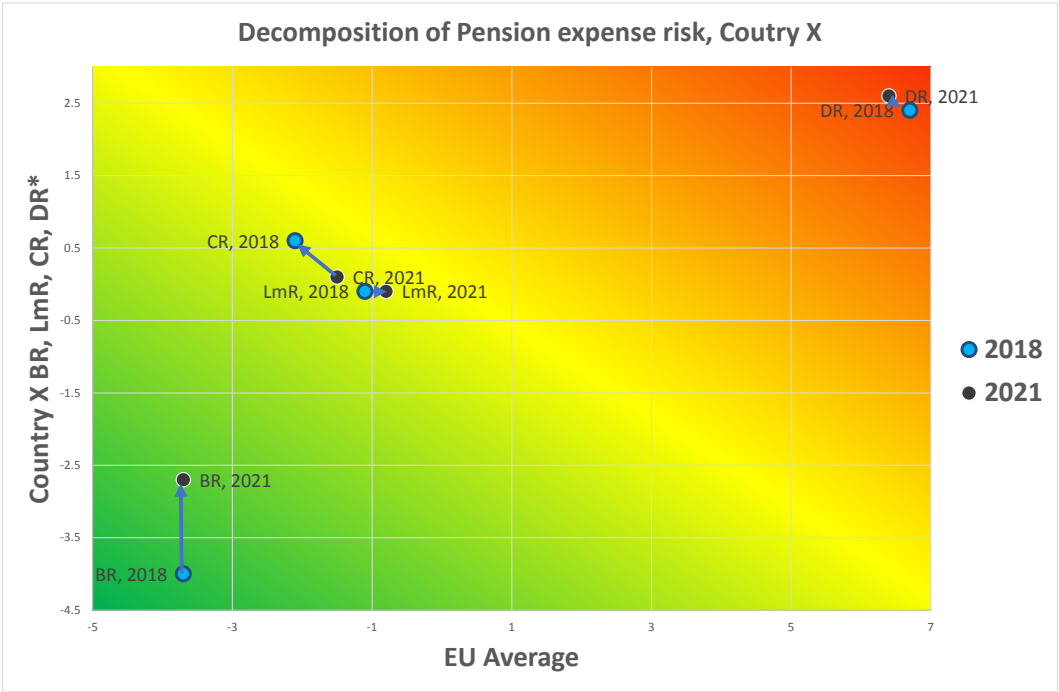


The second graph describes the changes of the decomposition of the PE/GDP risk index of a selected country in the two assessment periods. The idea is to expect that the policy advice in the Reports and the following European Semester exercise is a risk control mechanism and contributes to changing the risks. So, had we drawn the picture ex ante, it would have illustrated an inherent – residual risk graph. The y axis shows the contribution of the risk components to the total risk, and the x axis is a proxy scaling of probability by deviation from the EU average.²⁷

²⁶ The Ageing Report was prepared by Commission and the Member States with immeasurable thorough work and analysis.

²⁷ As for an average measure in the EU practice see the inflation and interest rates definitions in the conditions of the introduction of the euro currency.

* BR: Benefit ratio contribution, CR: Coverage ratio contribution, LmR: Labour market ratio contribution, DR: Dependency ratio contribution



Appendix B: Risk management standards

International standards apply a three-step top-down approach to defining ERM. First they state the definition and objective of risk management in line with the objectives of the organisation. The second level embed ERM into the governance and organisation and defines the strategic risk governance actions. The last layer is the daily operations of risk management.

In the following we show this in the cases of the ISO and the COSO Standards. In our interpretation we are highlighting the similarities to establish a general approach.

Components of ISO 31000:2018

The ISO model differentiates the strategic or governance and executive/operational level elements of the framework, even if sometimes risk management becoming redundant.

1. Principles

The purpose of risk management is the creation and protection of value. It improves performance, encourages innovation and supports the achievement of objectives. Principles include the requirement for the risk management initiative to be (1) customised; (2) inclusive; (3) structured and comprehensive; (4) integrated; and (5) dynamic.

2. Risk management architecture/Framework²⁸

The purpose of the risk management framework is to assist with integrating risk management into all activities and functions. The effectiveness of risk management will depend on integration into governance and all other activities of the organisation, including decision-making.

Leadership and commitment, including: Risk management strategy

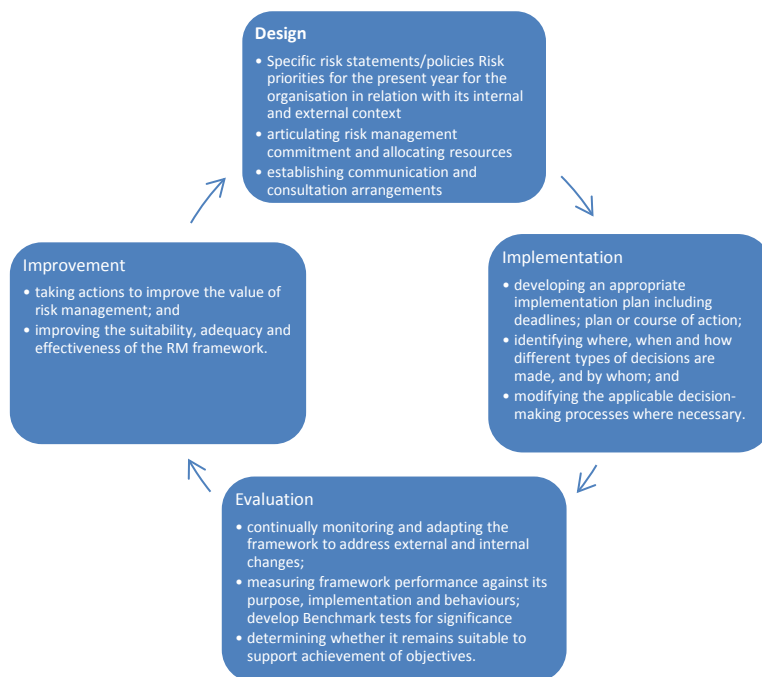
- aligning risk management with the strategy, objectives and culture of the organisation;
- Risk management philosophy issuing a statement or policy that establishes a RM approach,
- making necessary resources available for managing risk; and
- Risk appetite and attitude to risk: establishing the amount and type of risk that may or may not be taken.²⁹

²⁸ Note that in some terminology Framework refers to the whole RM system

²⁹ When establishing risk appetite, we mean the whole process from defining risk universe, then

Arrangements for embedding risk management: **Integration**

- determining management accountability and oversight roles and responsibilities; and
- ensuring risk management is part of, and not separate from, all aspects of the organisation.
- Roles and responsibilities, structures and terms of reference
- Internal reporting requirements and external reporting controls



3. Risk management Process

The risk management process involves the systematic application of policies [using] procedures and practices [or protocols³⁰ in general] to the activities of communicating and consulting, establishing the context and assessing, treating, monitoring, reviewing, recording and reporting risk.



COSO Definition of Enterprise Risk Management

1. Principles

³⁰ Risk management protocols include • RM Tools and techniques • Risk classification system • Risk assessment procedures • Risk control rules and procedures • Responding to incidents, issues and events • Documentation and record keeping • Training and communications • Audit procedures and protocols • Reporting/disclosures/certification



The COSO ERM Standard focuses on a concise ordered list of RM activities which has to be adapted and implemented consistently at all functional and hierarchy level of the organisation.

Definitions and objective: Enterprise risk management is [dealing with risks and opportunities affecting value creation or preservation of the entity], and is

- **a process**, ongoing and flowing through an entity
- able to provide **reasonable assurance** regarding the achievement of entity **objectives**;
- effected by an entity's board of directors [**governing body**], management and other personnel: i.e. **by people at every level of an organization**
- applied to **strategy** setting, and
- applied across the enterprise: at every level and unit, and
- ERM includes taking **an entity-level portfolio view of risks** (all of them separately and in interrelations),
- designed to identify **potential events** that may affect the entity and to manage risk within its **risk appetite**.



2. Risk management architecture/Framework

The COSO RM framework is integrated into the organisation's business planning and implementation model. This way better supporting value creation but only implicitly following the Performance, Design, Implementation, Evaluation, Improvement risk governance feedback cycle. In COSO terms it looks like:



3. The COSO implementation model is a three-dimensional cube.

We define the RM governance dimensions by decomposing the objectives according to functional and organisational hierarchy: The value creation is defined as an outcome of the implementation of the objectives set by the strategic management (governing body). The objectives are converted to the levels of

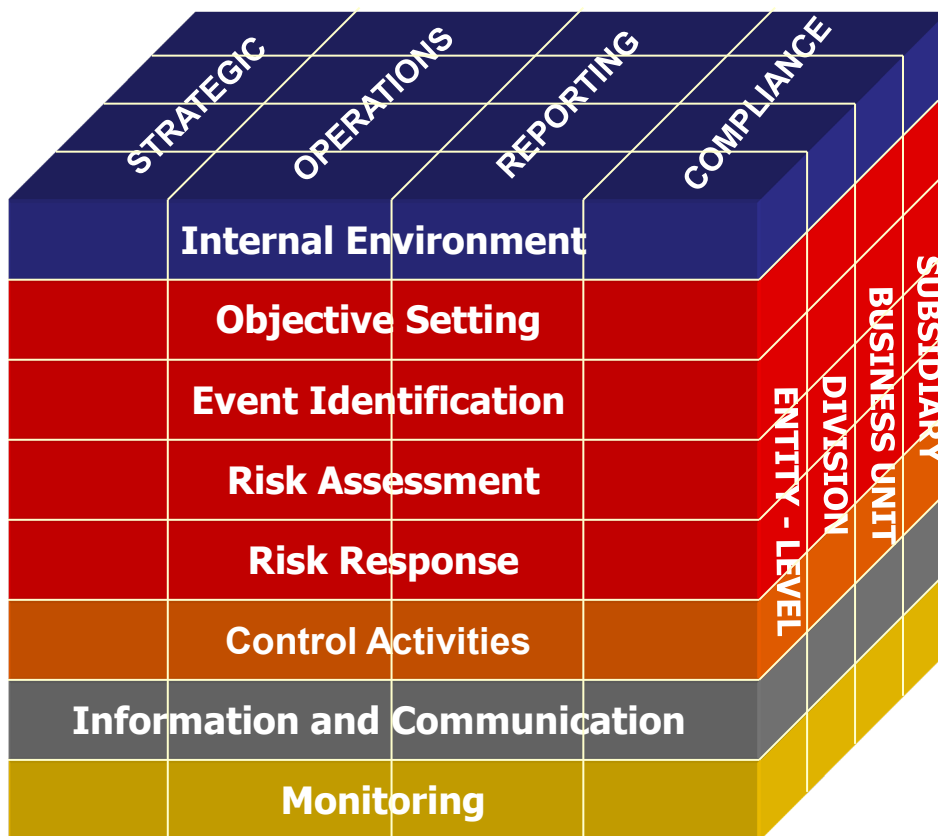
- Strategic – high-level goals, aligned with and supporting its mission
- Operations – effective and efficient use of its resources
- Reporting – reliability of reporting
- Compliance – compliance with applicable laws and regulations.

On another axis, according to the organisational hierarchy:

- Entity, Division, ..., Unit

At the process level the COSO Enterprise risk management consists of eight interrelated components integrated in the management processes:

- Setting Internal Environment – Organisational culture to risk culture, including risk management philosophy and risk appetite³¹
- Objective Setting – Consistent with its risk appetite and risk tolerance
- Event Identification – Risk profile: risks and opportunities
- Risk Assessment – likelihood and impact, inherent-and-residual basis
- Risk Response – on portfolio and priority basis execute actions to: avoid, accept, reduce, or share, transfer risks
- Control Activities – Policies and procedures are established and implemented to help ensure the risk responses are effectively carried out
- Information and Communication
- Monitoring [and review]



³¹ Again, when establishing risk appetite, we mean the whole process from defining risk universe, then appetite, tolerance, etc. vs performance

Appendix C: Devising risk indicators

Appendix C-1: Adequacy and Sustainability risk indicators: Events' impact on objectives

Event, transition (Status)	Adequacy Individual level	Sustainability Society/Economy level
Baseline: Working (Active)	<i>Increase in pension rights according the scheme rules</i> Still, Employer risks: Contribution payment and/or reporting issues	<i>Contributes to the finances of the scheme</i> Still, Systemic risks: Changing career patterns, gig economy, risks of the state pension administrator
Active Becomes Unemployed (Inactive)	Lower pensionable earnings, assessment base Lower pension RR down	Working population, Contributions: Decrease in contribution base DepRatio, LM_Int CR up, FR up
Active Deceases (Dead) Covered risk	Spouses benefit usually limited, Risk of poverty AROP	Demographic stability, actuarial neutrality Working population, Contributions: Decrease contribution base DepRatio, LM_Int CR up, FR up
Active Retires (Pensioner) early	Lower Pension Risk of poverty AROP RR down	Contributions, Working population, Pensions, Pensioners More pensioner, lower pensions for longer period DepRatio, LM_Int worsen CR up, FR up
Active Retires (Pensioner) after NRA Contributions, Working population, Pensions, Pensioners	Higher pension RR depends	Contributions, Working population, Pensions, Pensioners Higher pensions for shorter period DepRatio, LM_Int Improve CR imp? FR?
Unemployed Retires (Pensioner) early	Much lower Pension Risk of poverty AROP	Contributions, Working population, Pensions Pensioners More pensioner, for longer period DepRatio, LM_Int worsen

Event, transition (Status)	Adequacy Individual level	Sustainability Society/Economy level
	RR down	CR up FR up
Unemployed Retires (Pensioner) at NRA Covered risk	Lower pension AROP RR down	Pensions, Pensioners DepRatio, LM_Int worsen CR up FR up
Unemployed Deceases (Dead) Covered risk	Spouses benefit limited Risk of poverty AROP	Demographic stability, actuarial neutrality Contributions, Working population Demographic stability, actuarial neutrality DepRatio, LM_Int worsen CR up FR up
Retired Deceases (Dead) “early”	Pensions TRR	Pensioners, Pensions Demographic stability, actuarial neutrality DepRatio impr CR imp FR
Retired Deceases (Dead) “late” Pensioners, Pensions	Pensions TRR	Pensioners, Pensions Demographic stability, actuarial neutrality DepRatio worse CR up FR

Appendix C-2: Affordability and Robustness risk indicators: Events' impact on objectives

Event, transition (Status)	Affordability		Robustness	
	Individual level	Society-Economy level	Individual level	Society-Economy level
Working (Active)	Chance for higher income	More contribution to economic development (added value/GDP)	Better predictability	Less exposure of economic or political volatility
Active Becomes Unemployed (Inactive)	Limited, indirect effect	Narrows contribution base	Lower than expected pension	May lead to crisis, increase volatility
Active Retires (Pensioner) early	Risks of poverty	More pensioner, but higher poverty	Lower than expected pension	More pensioner, but higher poverty
Active Retires (Pensioner) after NRA	Higher pension If one cannot afford retiring at NRA	Higher pensions for shorter period	Higher pensions	Higher pensions for shorter period
Unemployed Retires (Pensioner) early	Risks of poverty	More pension for longer period	Increasing unpredictability	Increasing volatility
Unemployed Retires (Pensioner) at NRA	Covered Risk but still lower pension	Covered Risk	Covered Risk, but lower than expected pension	Covered Risk with political risk
Active Deceases (Dead)	N/A	Depends on Souses' benefits generosity	N/A	Demographic stability
Unemployed Deceases (Dead)	N/A	Depends on Souses' benefits generosity	N/A	Demographic stability, actuarial neutrality
Retired Deceases (Dead) "early"	N/A	Souses' benefits generosity	N/A	Demographic stability, actuarial neutrality
Retired Deceases (Dead) "late"	N/A	Souses' benefits generosity	N/A	Demographic stability, actuarial neutrality

