Continuous Machine Learning

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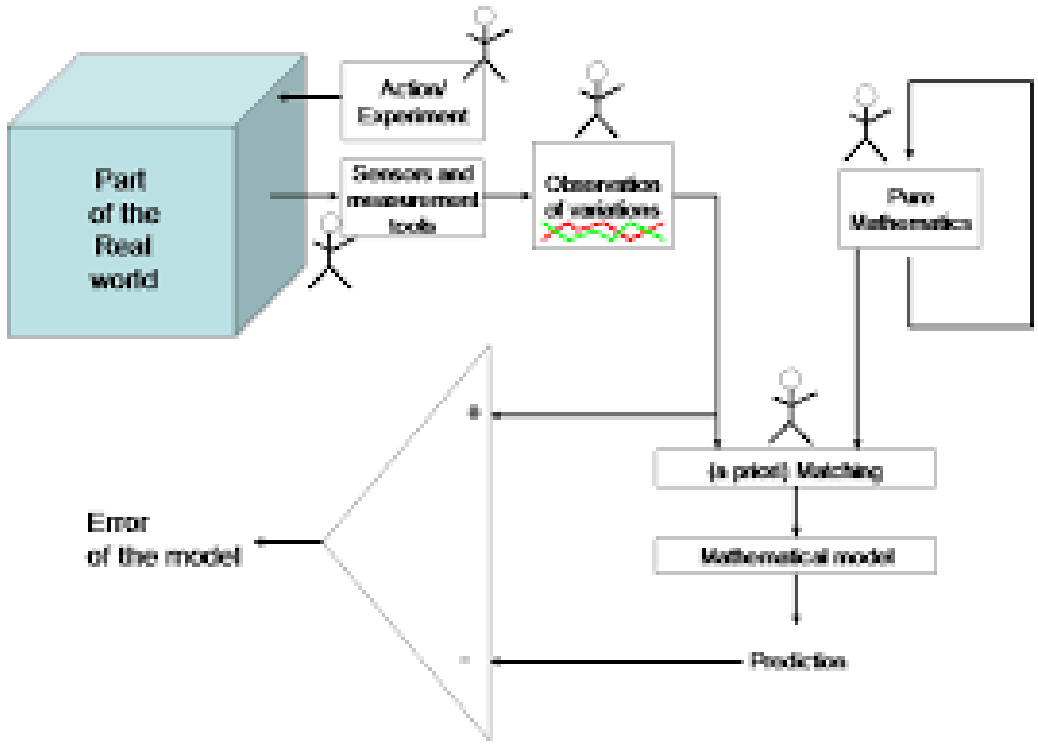


Model definition, uses, examples, decisions, lifecycle

What is a model?

- A quantitative method, system, or approach that applies statistical, economic, financial, or mathematical theories, techniques, and assumptions to process input data into quantitative estimates or output. (SR 11-7)
- Also covers quantitative approaches whose inputs are partially or wholly qualitative or based on expert judgment, provided that the output is quantitative in nature. (SR 11-7)
- Not all models involve complex mathematical techniques or require detailed computer programming code.
- Financial models describe business activity, predicting future or otherwise unknown aspects of that activity.

Uses of models in the banking industry

- setting the business strategy,
- informing decision making,
- measuring risk,
- managing risk,
- monitoring and setting internal limits,
- calculating exposures,
- pricing different instruments,
- performing stress testing,
- calculating regulatory capital,
- estimating asset values, etc.

Examples of models in the banking industry

- Credit scoring models
- Interest rate risk models
- Derivatives pricing models

Decisions that can be influenced through the use of models

- Setting the appropriate level of reserves a company should hold to fulfill its obligations;
- Setting the rates to charge for new business;
- Targeting specific products to sell;
- Exiting the market for certain products;
- Management of the in-force business, including the current premiums, cost of insurance (COIs), credited rates, dividend scales, and replacement programs;
- Incorporating risk mitigation such as reinsurance agreements;
- Management of capital resources.

Model life cycle

Model risk may pop up at any stage during the life cycle of a specific model.

1. Start
The future model user initiates a model origination process.

2. Model Design and Development
Model developers start the development. All results are recorded in the technical model document.

3. Implementation
Following development, the model is implemented, tested and rolled out to the users.

4. Periodical Model review
During the use phase, the model Is regularly tested to ensure adequate results. Model monitoring may be considered.

Figure 2: model life cycle

Model development life cycle

- Define and develop specifications for the model;
- Develop or modify code/program the model;
- Test/validate the model;
- Approve the model for implementation; and
- Validate that controls are in place and documentation is complete.

Regulatory expectations: of models, of institution senior management

Regulatory expectations of models

- Since the last financial crisis, there has been ever increasing regulatory pressure over the appropriateness of models.
- Regulations question the appropriateness of models wrt:
  - assumptions and limitations of models,
  - quality of data used for calibration,
  - thoroughness and independence of the validation process,
  - robustness of policies, processes and controls,
  - use tests,
  - quality of model documentation.
- Banks should closely look at their models to protect their business and its reputation.

Regulatory expectations of institution senior management

- Understand the limitations of models, regardless of where the limitations come from, e.g.
  - Methodological underpinnings
  - Quality and availability of data used for calibration
  - Limitations linked to the models' implementation (numerical inaccuracies, technological issues, source code bugs, etc.)
  - Limitations imposed by the context in which the model will be used
- Challenge the assumptions made by model developers.
- Question whether or not the models would be adequate in real-life situations.
- It should be clear under what circumstances the assumptions would no longer hold.

Model risk, components, sources, ranking, teams

Model risk

- Although the use of models as a management tool is a significant advance for the industry, the models themselves represent a new source of risk - the potential for model output to incorrectly inform management decisions.
- The application of models for decision making also exposes the institutions to a new form of risk, i.e. model risk.
- This is the risk of financial loss or reputational damage resulting from weaknesses in the use of models.
- Unlike other types of risk, model risk is a secondary type of risk in the sense that it is not rewarded.

Key risk components

- Financial impact;
- Regulatory, reputational, and operational impacts;
- Complexity of data and assumptions utilized;
- Complexity of the calculation engine;
- Complexity of the overall process, intuitiveness/transparency;
- Level of expertise/experience of the model developer and user.

Sources of model risk

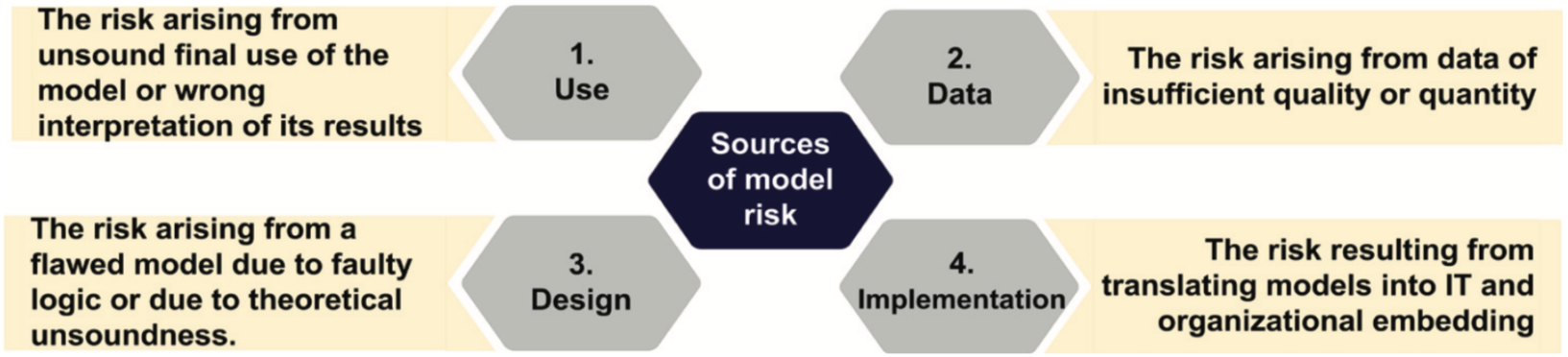


Figure 1: four types of model risk

Model risk ranking

- The appropriateness of model use - “fit for purpose”;
- The frequency and depth of model reviews;
- The level of approval for new model development or when an old model is (substantially) revised;
- The composition of a model review team.

Model risk teams

- Ideally, model risk teams, together with model validation teams, are independent of model development teams to avoid a conflict of interest.
- Their mandate should cover all aspects of the development, calibration, validation, and implementation of the models, as well as the quality of the model results and reporting.
- Challenge the effectiveness of the policies that affect the use of these models, review the robustness of the process used in data management, model calibration, and implementation, as well as the thoroughness of the controls.
- Determine the required level of automation, which minimizes human error while allowing for reasonable judgment overrides.

Model risk teams

- Model risk teams should establish a process for approvals, including key stakeholders and sign off levels required before the model can be used (i.e., whether department/regional committee approval is enough or whether business line or even group level approvals are required).
- Once the firm has accepted that the use of models carries a specific type of risk, this risk should be included in the firm's risk appetite statement. In particular, budget approvals for modeling teams and critical investments on model, data, and reporting technology should be part of these discussions.

Model governance: uses, lifecycle, framework, key roles, key elements, best practices

Model governance uses

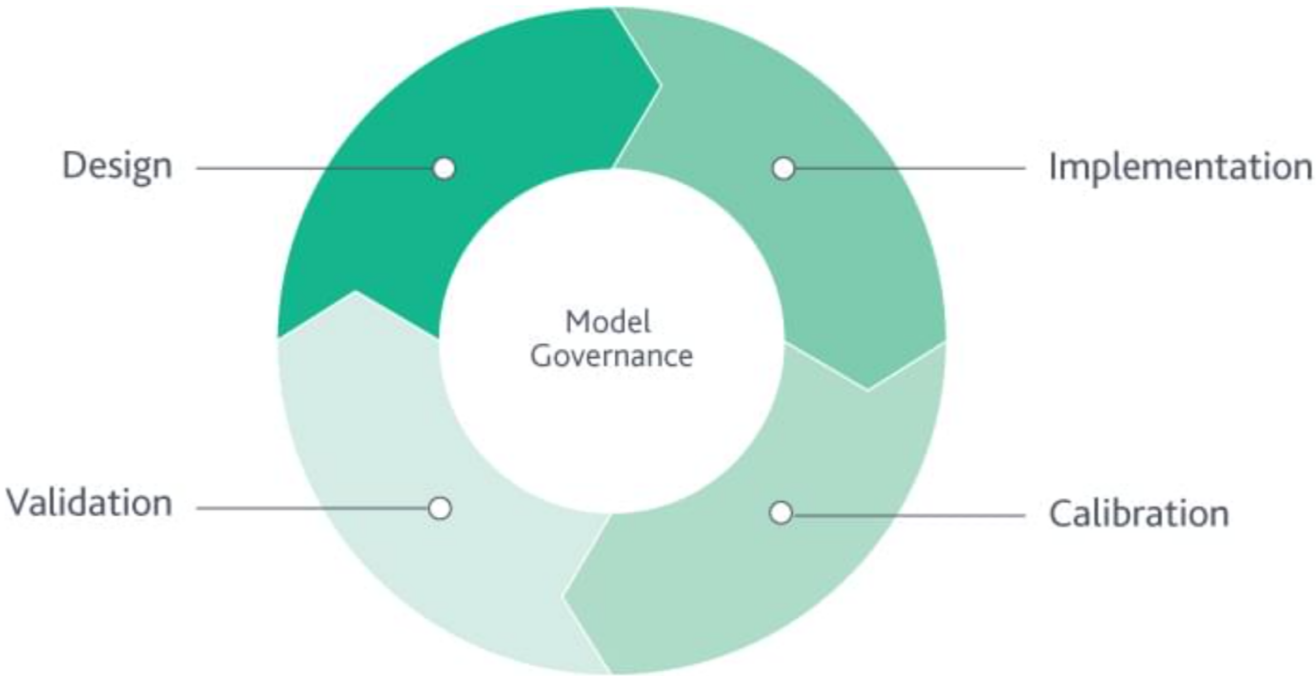
Although modeling necessarily involves the opportunity for error, strong governance procedures can help minimize model risk by

- Providing reasonable assurance the model is operating as intended;
- Contributing to ongoing model improvement to maintain effectiveness;
- Promoting better management understanding of the limitations and potential weaknesses of a model.

Key purpose of model governance is to manage the set of models in such way as to reduce model risk.

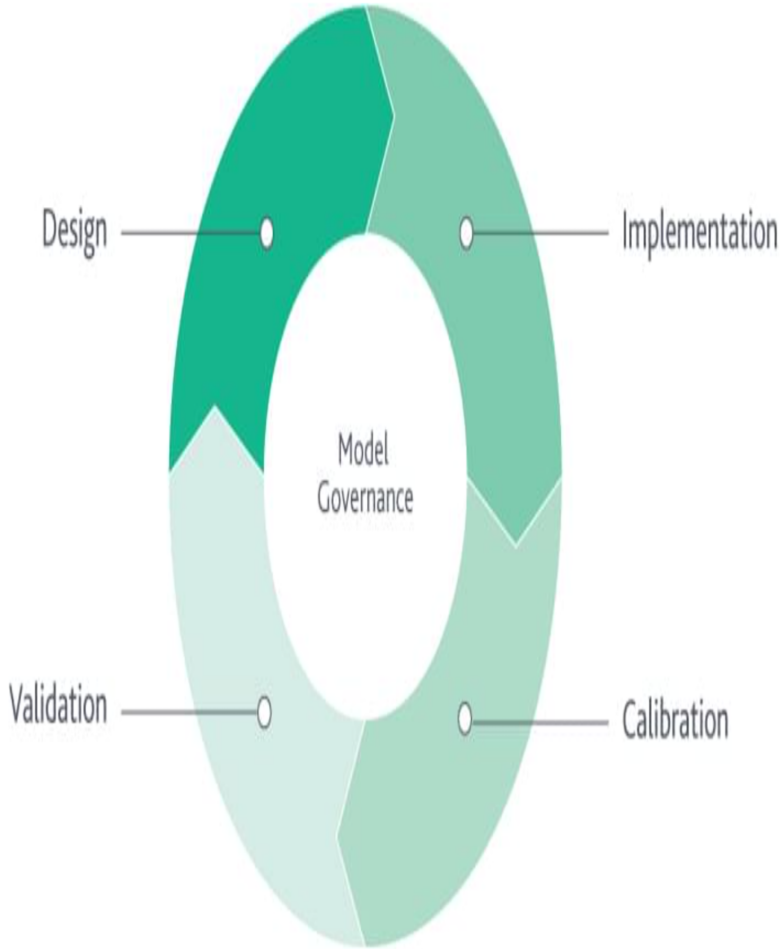
Model governance lifecycle

FIGURE 1. MODEL GOVERNANCE LIFECYCLE



SOURCE: MOODY'S ANALYTICS

Model governance lifecycle vs model development lifecycle



(a) Governance

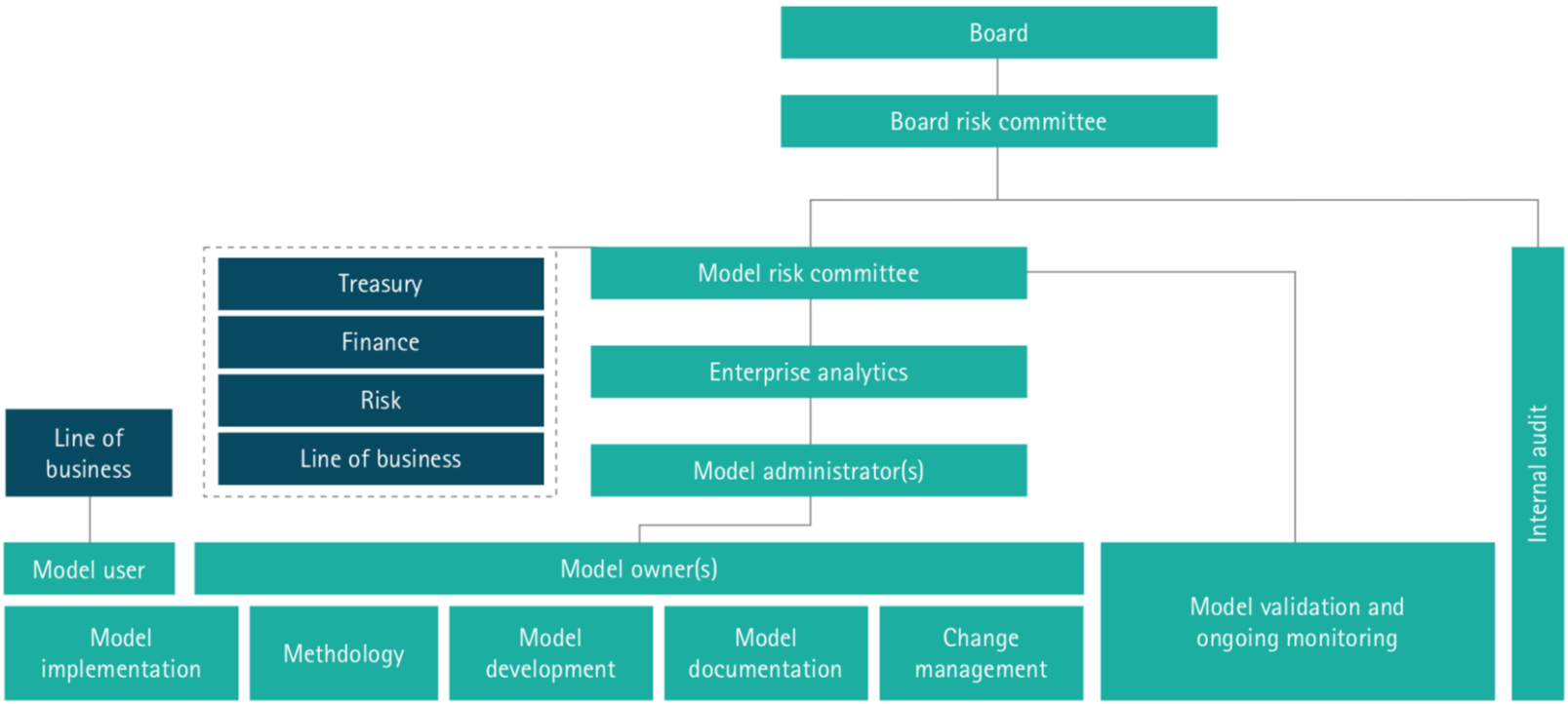
Model governance lifecycle

Overall governance set around a model's lifecycle

- model development (design)
- model implementation
- model calibration
- model validation

Model risk governance framework

Figure 1. Model Risk and Governance Framework



Source: Accenture, August 2015

Model governance: 3 lines of defense

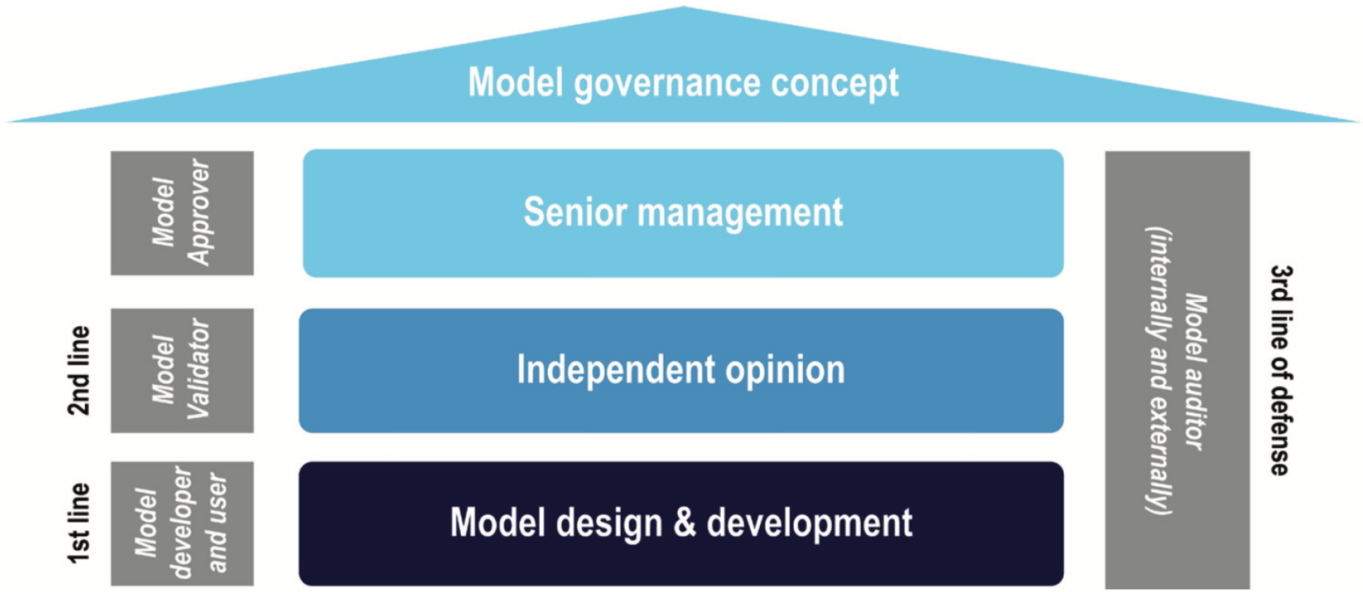
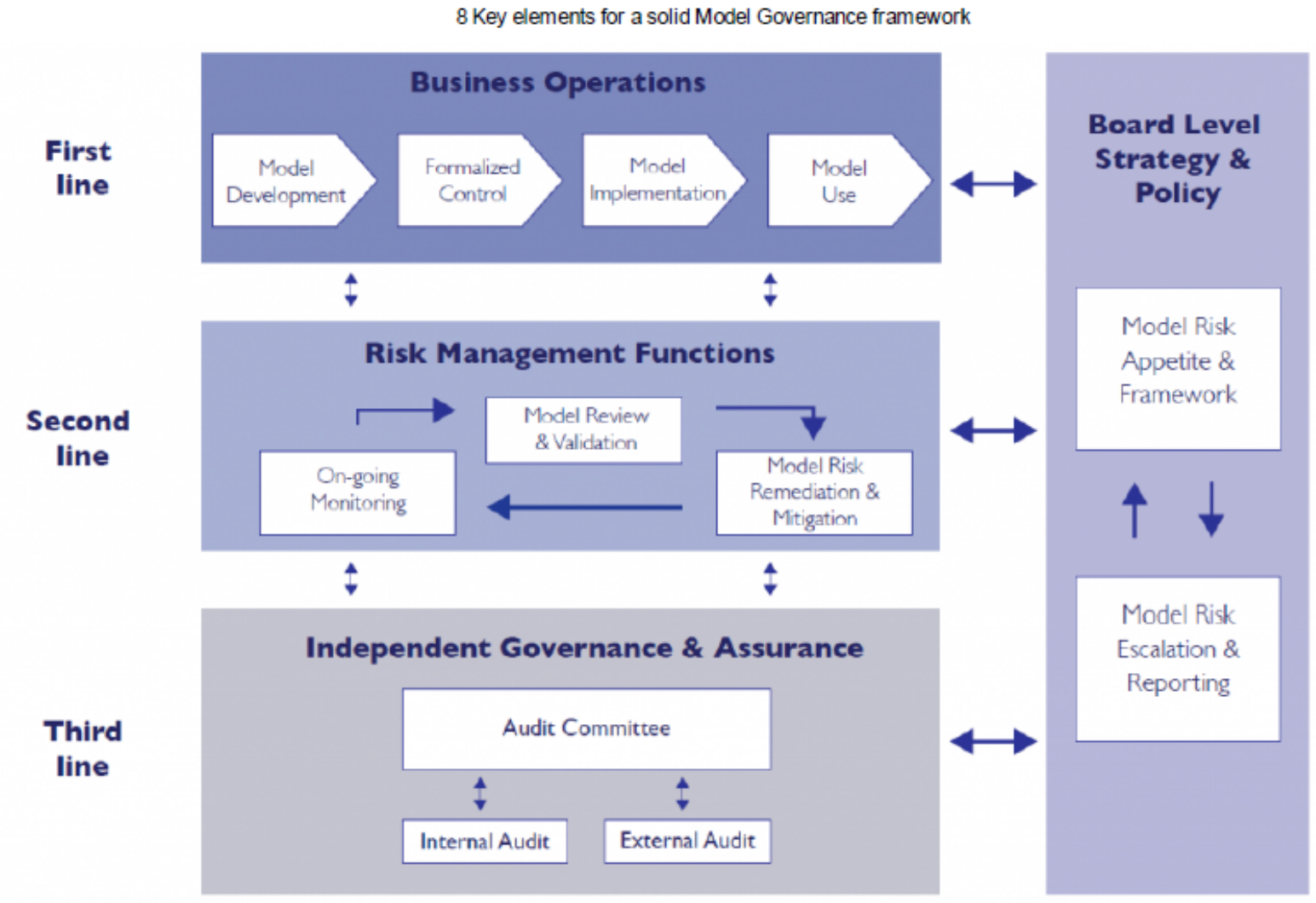


Figure 3: model governance concept

8 key elements for a solid model governance framework



8 key elements for a solid model governance framework

- Development
- Validation
- Approval
- Modification
- Implementation
- Retirement
- Inventory
- Information sharing

Model governance best practices

- model definitions
- model inventory
- model categorization
- model risk teams

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