FERMA PERSPECTIVES 03

FERMA™
Federation of European
Risk Management Associations

ARTIFICIAL INTELLIGENCE APPLIED TO RISK MANAGEMENT

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1. INTRODUCTION & EXECUTIVE SUMMARY

INTRODUCTION

Artificial Intelligence or AI is portrayed as the next super-power. It is the only technology that we treat as human. We credit it with the skills that people have. Every day we hear how AI is at the forefront of innovation and is on its way to change fundamentally our everyday lives, both in the private and professional spheres. The extent of opportunities, affected industries and possible uses seem unlimited. The development of this technology combined with the ever-increasing amount of data available – which plays a key role – seems to be driving a new AI era. Risk management will not be excluded.

As with every new technology, there are emerging risks and challenges related to AI. Questions on ethics, equality, biases, trustworthiness and reliability of decisions made or suggested by AI, are just some of the topics that need attention. Transparency of algorithms and increasing cyber risks are also issues for the risk manager to address.

Some strategic questions that organisations need to address include:

- How and why is our company using and applying AI?
- What new liability or cyber challenges arise?
- What are the challenges for our workforce on decision, on ethics and biases?

In the AI race, not only companies and scientists are competing with each other, but also countries and governments, because the related impact goes beyond companies and individuals; today's research and decisions will affect societies. Europe has the opportunity to define its own way on how to apply AI and handle the related risks and fears in what the European Parliament described once as a "human-centric" approach to AI.

With this document, FERMA aims to kick off a broader discussion on AI and risk management.

Enjoy the reading and please join in.

EXECUTIVE SUMMARY

To write this paper, FERMA brought together a group of experts from within and beyond the risk management community. The ambition was to develop the first thought paper about AI applied to risk management.

The goal was first, to perform an initial assessment of the potential value of AI to improve enterprise risk management (ERM), and second, to understand how risk managers can be key actors in highlighting to the organisation leadership the opportunities and challenges of AI technologies.

This paper aims to guide risk managers on applying AI. It goes from basic learning to identifying new risks and developing their own strategy on how to take the next steps regarding the implementation of AI. The basics of AI are explained with an emphasis on its requirements and its limits.

To perform well, AI needs data of a certain quantity and of a certain quality. The very first question to consider is therefore about the organisation's strategy for managing its corporate data. As such, solving the data issue and implementing AI in business is a challenging project that impacts many corporate functions, including the risk manager.

In terms of ERM, risk managers will want to consider how AI can be best used:

- How can risk management frameworks integrate AI, especially as a source of new risks across the organisations?
- Can we process more data to mitigate losses?
- How can we use AI in the claims process?
- What processes will we create and what will be provided by brokers, insurers and re-insurance companies?

We expect corporate risk management to benefit from AI in several areas. From its ability to process large amounts of data to the automation of certain repetitive and burdensome risk management steps, AI could allow risk managers to respond faster to new and emerging exposures.

By acting in real time and with some predictive capabilities, risk management could reach a new level in supporting better decision-making for senior management.

2. LET'S TALK ABOUT AI

2.1. WHAT IS AI?

Artificial Intelligence (AI) is a term describing computers performing human tasks. It can simply be defined as: "Human intelligence performed by a machine".

The I of AI refers to the implementation of the algorithms by the machines. It is Artificial since it is a branch of computer science. It employs statistical, mathematical methods through software scripts and techniques to automate decision making.

The independent high-level expert group on artificial intelligence set up by the European Commission in 2018 produced the first EU-wide definition of AI in April 2019

"Artificial intelligence (AI) systems are software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can either use symbolic rules or learn a numeric model, and they can also adapt their behaviour by analysing how the environment is affected by their previous actions.

As a scientific discipline, AI includes several approaches and techniques, such as machine learning (of which deep learning and reinforcement learning are specific examples), machine reasoning (which includes planning, scheduling, knowledge representation and reasoning, search, and optimization), and robotics (which includes control, perception, sensors and actuators, as well as the integration of all other techniques into cyber-physical systems)."

Briefly speaking,

- **Machine learning (ML)**, as a part of AI, is mostly considered as the methodology for implementing algorithms and statistical models that computer systems use to effectively perform a specific human task without explicit instructions to the machine.
- **Deep learning (DL)** is a subset of machine learning that imitates the workings of the human brain (like artificial neural networks) in processing data and creating patterns for use in recognition and in decision making.

[1] High-Level Expert Group on Artificial Intelligence - A DEFINITION OF AI: MAIN CAPABILITIES AND DISCIPLINES, 8 April 2019. Available at https://ec.europa.eu/futurium/en/ai-alliance-consultation/guidelines#Top

Tabular data

x_1	x_2	...	x_p	y
0	1	...	4	3
3	2	...	1	1

Computer vision

Natural language processing

"Project Brainwave is a hardware architecture designed to accelerate real-time. AI calculations. The Project Brainwave

Machine Learning

Deep Learning

The main difference between machine learning and deep learning is the implementation of the algorithmic solutions that suit the given type and quantity of the data:

- **Computer vision** is an interdisciplinary scientific field that deals with how computers can see, identify and process images in the same way that human vision does from digital images or videos.
- **Natural language processing (NLP)** is the technology used to aid computers to read, decipher and understand human languages from speech or text.

2.2. WHY IS NOW THE TIME TO FOCUS ON AI?

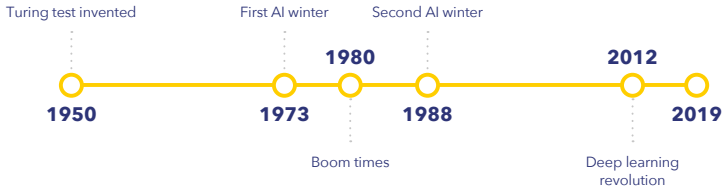
You might have heard that the first development of machine intelligence started in the 1950s. The famous British mathematician Alan Turing devised the "Turing Test" as a measure of a machine's ability to exhibit intelligent behaviour equivalent to, or indistinguishable from a human.

Early results were disappointing, however, because of over-optimism and under-estimation of the technical challenges. Two periods known as "AI winters" followed in the 1970s and the 1990s. Scientific interest diminished and funding from governments and industry fell. So why is everyone now focusing on AI?

From the early 2010s, a new era for AI became possible for two main reasons:

1. A huge **increase of data** (Big Data), with billions of interconnected devices (computers, phones, tablets, cameras, television, sensors, etc.) and online interactions generating vast amounts of **real-time** electronic data. Companies realised, however, that they also had a lot of unproductive complex data capital.

2. **A large increase in computational power** and storage capacities with a sharp decrease in costs from the 1990s.



Source: Schuchmann, Sebastian. (2019). Analyzing the Prospect of an Approaching AI Winter.

Today

Companies in many industries are now using AI techniques to exploit data and optimise business and production processes. They process information in more productive ways and create value, with faster and more accurate decisions, reduced operational costs and personalised customer experiences. Increasing capacity for data storage and new software for data-driven AI solutions are yielding paradigm changes in the analytic environment.

As a result, both companies and governments have heavily increased their investments, which are driving today's boom and achievements in AI.

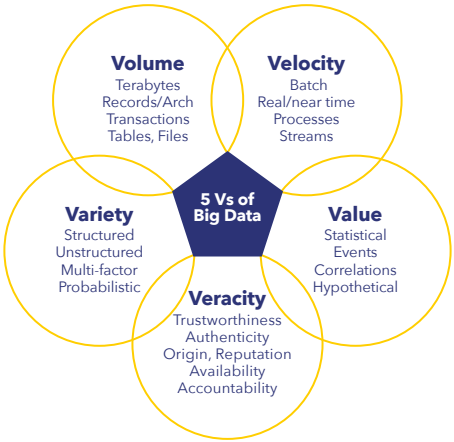
2.3. DATA IS KEY

No data, no AI! The very first requirement for a successful AI solution is a sufficient amount and quality of data. Data can be a text, number, image, audio or video.

Generally speaking, a three-fold data capacity problem arises for companies: they have too much data, too little data or they have not yet collected data.

The following chart summarises the complexity of dealing with "big" data in business solutions:

Any data can be qualified in terms of 5V items.

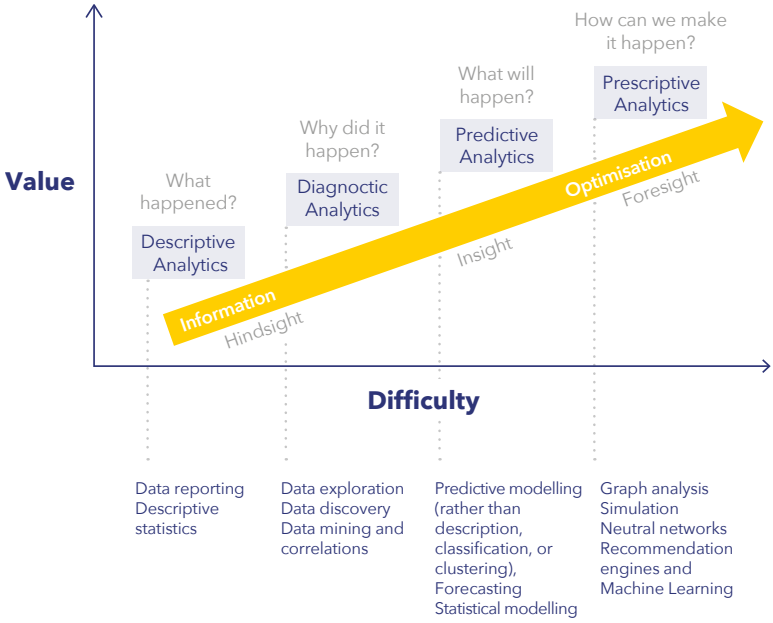


- **Variety and veracity** mostly inform about the quality of the existing data.
- **Volume and velocity** determine which data ecosystem must be used in the AI solution. The ecosystem is the set of infrastructure, analytics and applications used to capture and analyse data.
- **Velocity and value** have role in the determination of algorithmic components of the solution.

Source: Ramadan, Rabie. (2017). Big Data Tools-An Overview. International Journal of Computer Science and Software Engineering. 2. 10.15344/2456-4451/2017/125.

When the organisation has the data, it must adapt its infrastructure to better explore the quantity and quality of information available.

As the organisation increases its use of data and provides more products and services, the result is still more data. The organisation has to be careful about its use of these data and the methods to exploit them during the production process.



The Gartner's analytic value escalator describes the different types of business analytics (descriptive, diagnostic, predictive and prescriptive) as well as their impact on corporate value.

Each type of business analytic has the capacity to respond to a specific question from "what happened?" or "why did it happen?", to "what will happen?" or "how we can make it happen?".

Source: Gartner's analytic value escalator. https://www.flickr.com/photos/27772229@N07/8267855748

3. AI IN RISK MANAGEMENT IMPACTS OF AI IN THE ERM FRAMEWORK

3.1. INTEGRATING RISKS GENERATED BY AI IN THE ERM FRAMEWORK

In order to manage AI risks in a secure, vigilant and resilient manner, organisations need to analyse their risk profile through the components of their risk management framework. The COSO 2017 ERM Framework gives the foundations for such an analysis.

The diagram below of the five components of the COSO ERM 2017 Framework illustrates specifically how to use a risk management framework to better capture and follow the new risks created by AI.

GOVERNANCE & CULTURE
Exercises Board Risk Oversight - Establishes Operating Structures - Defines Desired Culture - Demonstrates Commitment to Core Values - Attracts, Develops, and Retains Capable Individuals.

STRATEGY & OBJECTIVE-SETTING
Analyzes Business Context - Defines Risk Appetite - Evaluates Alternative Strategies - Formulates Business - Objectives.

PERFORMANCE
Identifies Risk - Assesses Severity of Risk - Prioritizes Risks - Implements Risk Responses - Develops Portfolio View.

REVIEW & REVISION
Assesses Substantial Change - Reviews Risk and Performance - Pursues Improvement in Enterprise Risk Management.

INFORMATION COMMUNICATION & REPORTING
Leverages Information and Technology - Communicates Risk Information - Reports on Risk, Culture, and Performance.

Source: COSO ERM 2017 - Integrating with Strategy and Performance Executive Summary, April 2017. Page 6.
Available at: https://www.coso.org/Documents/2017-COSO-ERM-Integrating-with-Strategy-and-Performance-Executive-Summary.pdf

1. GOVERNANCE AND CULTURE FOR AI-RELATED RISKS

- Map or define the organisation's mandatory or voluntary AI-related requirements.
- Consider opportunities for embedding AI in the organisation's culture and processes.
- Look for ways to increase board awareness of AI-related risks.
- Map the operating structures, risk owners for AI-related risks, reporting lines and ERM and strategic planning process to identify areas for improved oversight and collaboration.
- Create opportunities for collaboration throughout the organisation.
- Embed AI-related skills, capabilities and knowledge in hiring and talent management to promote integration.

2. STRATEGY AND OBJECTIVE-SETTING FOR AI-RELATED RISKS

- Examine the value creation process and business model to understand impacts and dependencies on all capital resources in short, medium and long term. To assist this process, conduct:
  - Megatrend analysis to understand the impact of disruptive new technologies and the linked emerging issues in the external environment
  - Strengths, weaknesses, opportunities and threats (SWOT) analysis
  - Impact and dependency mapping for all types of capital
  - An AI materiality assessment to describe significant AI usage issues
  - Engagement with internal and external stakeholders to understand AI emerging usage trends
  - Analysis of the impact of AI implementation on specific resources
- Throughout the risk management process, align with the organisation strategy, objectives and risk appetite.
- Consider the AI-related risks that will impact the organisation's strategy or objectives.

3. PERFORMANCE FOR AI-RELATED RISKS

3.A. IDENTIFY RISK

- Examine the organisation's risk inventory to determine which AI-related risks have or have not been identified.
- Involve AI risk owners and IT teams in the risk identification process to leverage subject-matter expertise.
- Convene meetings across the organisation with risk management, data scientists, AI users and IT teams to understand AI-related risks.
- Identify the AI-related risks that may impact the organisation's strategic and operational plans.
- Define the impact of AI-related risks on the organisation precisely.
- Use root cause analysis to understand drivers of the risks.

3.B. ASSESS AND PRIORITISE RISK

- Understand the required output of the risk assessment – what is the likely impact in terms of the strategy and business objectives.
- Understand the organisation's criteria for prioritising risks.
- Understand the metrics used by the organisation for expressing risk, qualitative and quantitative.
- Select appropriate assessment approaches to measure risk severity.
- Select and document data, parameters, assumptions, algorithms and open source library usage.
- Leverage subject-matter expertise to prioritise AI-related risks.
- Identify and challenge organisational bias against AI issues.

3.C. IMPLEMENT RISK RESPONSES

- Select an appropriate risk response based on organisation-specific factors such as costs, benefits and risk appetite.
- Develop the business case for the response and obtain buy-in.
- Implement the risk response to manage the risk.
- Evaluate risk responses at organisation level to understand the overall impacts to the risk profile.

4. REVIEW AND REVISION FOR AI-RELATED RISKS

- Identify and assess internal and external changes that could substantively affect the strategy or business objectives.
- Review ERM activities to identify changes to ERM processes and capabilities.
- Pursue improvements in how AI-related risks are managed by ERM.

5. INFORMATION, COMMUNICATION AND REPORTING FOR AI-RELATED RISKS

- Identify relevant channels for internal and external communication and reporting.
- Communicate and report relevant AI-related risk information internally for decision-making.
- Communicate and report relevant AI-related risk information externally to meet regulatory obligations and support stakeholder decision-making.
- Continuously identify opportunities for improving the quality of AI-related data reported internally and externally.
- Provide stakeholders with a communication channel to report any anomaly linked to the use of AI.

3.2. SCOPE OF AI-RELATED RISKS

AI-related risks will vary with the organisation, which may apply its own definitions. However, applying ERM processes to AI-related risks will support the whole organisation in reviewing and identifying extensively where such risks are present.

We have identified 14 themes and 26 key issues:

MACRO RISK CATEGORIES	THEMES AND PROCESSES	AI-RELATED RISK KEY ISSUES
STRATEGIC AND ENVIRONMENTAL RISKS	Governance	AI strategy execution and follow up.
		Organisation and responsibility for AI projects.
		Impacts on stakeholders/ data ecosystem.
		Do employees have the right qualifications and training?
	Data and infrastructure governance	Data quality management.
		Data acquisition: reliability and availability of external data in the long term.
		Infrastructure and security.
	Liability	Automated decision processes are likely to raise new situations where the final responsibility needs to be clarified.
	Environmental impact	High energy consumption.
	Data property/ sovereignty breach	Foreign legislation enabling governments to access cloud suppliers data in contradiction with the GDPR.

BUSINESS RISKS	Product conception	Ethical by design.
	Product production	Human-centric production processes.
	Product distribution	Client information/ freedom of decision/ access to a market open to competition (no monopoly).
	Market disruption	Systemic risk from the same decision processes/ unintended consequences for society.
OPERATIONAL RISK	IT risks: data and Information	Risk of data quality / data governance.
		Risk of unavailability data/ data ownership.
		Risk of data hacking / security.
		Risk of untraceable data/ compliance with the EU General Data Protection Regulation (GDPR).
		Algorithm divergence.
		Maintenance of open source algorithm, dependency on external providers, intellectual property interpretability, transparency and "explicability".
		Storage: cloud or local data lake.
	Organisation and project management	Line of reporting/ common rules.
	Human resources	Risk of losing human expertise.
		Risk for certain roles to become obsolete.
		Risk of lack of competencies.
	Externalisation	Dependency on external providers or specific skills. An alternative plan should always be ready.
	Continuity of activity / recovery plan	Contracts with external partners, especially new players, should ensure continuity of activity by enabling the organisation to run the algorithms and access the codes and data in case the partner stops its activity.

4. BENEFITS AND OPPORTUNITIES FOR RISK MANAGERS APPLYING AI

4.1. GENERAL BENEFITS FOR RISK MANAGEMENT

Across industries, AI is ever more recognised for its potential. It will change people's day-to-day activities, including in risk and insurance management. Insights, that now become visible only when losses occur, can in future emerge before then through learning from large volumes of historical data.

For risk management, key benefits will relate to:

- **Data processing**: Usage of not only structured but also unstructured data in massive amounts; combinations of datasets and updating patterns.
- **Improving efficiency**: Reducing cost by automating day-to-day assistance and guidance in the risk management processes.
- **Real-time and predictive**: Awareness of new exposures, increasing preventative risk advices, faster response time in critical situations.
- **Business decisions**: Better decision-making through greater (predictive) insights and visibility of risk (also for top management).

Current limitations of risk management by functions and silos, and of data sets, research, modelling and monitoring can be overcome. Decisions that have previously been made mainly "from the gut" or by benchmarking will become data-driven and systematic.

It is clear that we are only just beginning to understand the full benefits of AI. It's an evolution. We need to keep thinking about what the outcome should be and where we have come from. Today's AI algorithms are trained to do one clearly defined operation really well. Although for that specific operation, AI far exceeds human capabilities, it is still far from a general all-purpose superpower.

Nevertheless, companies should start their journey of AI if they want to be at the forefront of risk leadership. In that way, they will build the foundation for a technology that soon will reshape the way we deal with risks.

4.2. AI ACTION GUIDE FOR RISK MANAGERS

This "AI Action Guide for Risk Managers" has been developed to support the risk manager in identifying key areas to apply AI methods. Risk managers can use this matrix according to their organisation's specific requirements and areas of benefit, especially according to the available data, the risk management steps to be improved (identification, analysis…), claims occurring, lines of business and total cost of risk (TCOR). While in some cases, own implementation of AI applications makes sense, in others, risk managers may choose to partner with insurers, brokers or third-party vendors for greater benefit and cost-effectiveness.

The table below can inspire your thought process. The template in the appendix of the document can help you to develop your own approach and take leadership in your company.

	RISK MANAGEMENT STEP	PROBLEM(S) TO BE SOLVED	AI USE CASE	WHAT KIND OF DATA NEEDED?	AI FOCUS	MARKET EVOLUTION STAGE	RISK MANAGER TOUCHPOINTS
RISK MANAGEMENT PROCESS	RISK IDENTIFICATION	• Reduce manual data collection • Simplify assessment to better understand the risk • Real-time visibility	Gathering and filtering relevant internal risk information and mapping to existing assets. Risk identification transforms from a static process (pre-defined intervals) to continuous and real-time.	Internal risk information, e.g. location data, values, financials, technical insights	• Mathematical / logical Intelligence • Computer vision (only if handwriting recognition is needed)	• Experimentation	Review current view and frequency of risk assessments and challenge existing ways of risk information collection.
		• Increase transparency • Reduce manual work	Scanning and filtering of relevant external 3rd party information and mapping to existing assets. The risk inventory is enriched.	External information, e.g. news, natural catastrophe reporting, credit scores	• Mathematical / logical Intelligence	• In production	Identify your areas of greatest benefit using (real-time) 3rd party data, e.g. supply chain. Evaluate external software filtering data based on your requirements.
	ANALYSE AND ASSESS	• Increase transparency • Assess risk on a wider data set	A recommendation system suggests the probability and impact of single risks by taking all current relevant data into account and connecting them with historic patterns.	All data collected in risk identification, historical loss data indicating probability and impact	• Mathematical / logical Intelligence	• In production	• Ethical and auditable by design • Check the output.

	RISK MANAGEMENT STEP	PROBLEM(S) TO BE SOLVED	AI USE CASE	WHAT KIND OF DATA NEEDED?	AI FOCUS	MARKET EVOLUTION STAGE	RISK MANAGER TOUCHPOINTS
RISK MANAGEMENT PROCESS	AGGREGATE	• Automate a very difficult manual task • Increase transparency on how certain risks are correlated and the overall risk exposure	Risk dependency identification: Correlations between certain risks can be evaluated by machine learning models, identifying connections that are not easily observable.	All data collected in the risk identification	• Mathematical / logical Intelligence	• Experimentation	• Ethical and auditable by design • Check the output.
		• Real-time visibility of a company's changing overall risk exposure	Feed new data continuously into the aggregation model and use machine learning for model validation, e.g. detecting anomalies in data points and correlations.		• Mathematical / logical Intelligence	• Experimentation	• Identify your most relevant data points (risks-related) that have the greatest impact on probability and risk exposure. Once identified connect them to the machine learning aggregation model.
	MONITOR	• Improve risk protection	Video surveillance of property facilities and automatic detection of risks. Send alert if a hazard level rises, e.g. somebody smoking in a dangerous area.		• Computer vision • Mathematical / logical Intelligence	• Experimentation	• Challenge traditional ways of risk engineering especially in property, static / dynamic assets etc.

RISK MANAGEMENT PROCESS	MONITOR	• Avoid accidents, increase workforce health	Enhance workplace safety by using smart device data and reinforcement learning models to give employees direct feedback on their behavior.	• Raw sensor data or aggregated data if provided, e.g. by vendor / 3rd party	• Mathematical / logical Intelligence	• In production	• Evaluate workers' compensation/ employee liability impact and safety to decide on further actions and investments in smart devices and adjusted software.
		• Faster reaction time on relevant risks / events • Overall greater resiliency • Preventive instead of reactive • Better protection of assets / workforce	An alert system based on machine learning models extracting the relevant information for their risk profile will notify risk managers in case of an event.	• Various internal / external data depending on specific alert / risk	• Mathematical / logical Intelligence	• Experimentation	• Challenge traditional ways of responding to risk, moving "from insured to protected". • Identify high risk areas and discuss what immediate alerts would help protection.

	RISK MANAGEMENT STEP	PROBLEM(S) TO BE SOLVED	AI USE CASE	WHAT KIND OF DATA NEEDED?	AI FOCUS	MARKET EVOLUTION STAGE	RISK MANAGER TOUCHPOINTS
RISK MANAGEMENT PROCESS	RESPOND AND IMPROVE	• Faster reaction time for risk mitigation measures	Scan historic risk mitigation measures for the present risk type and recommended actions based on the real-time situation, e. g. proposal of free capacity in another building after a fire.	• Claims management data	• Mathematical / logical Intelligence	• Early stage	
INSURANCE & CLAIMS MANAGEMENT PROCESS	RISK TRANSFER	• Better price modeling thanks to the high volume of available data and the machine learning algorithm	Combine data sets (relevant for pricing) and pricing models and apply machine learning techniques (cross-company) to produce pricing alternatives.	• Internal, external and related data sets	• Mathematical / logical Intelligence	• Experimentation	• Start specific dialogues with brokers and underwriters on those products.
		• Insurance cover only for the time of usage • Better pricing according to actual behavior	Dynamic insurance products based on the machine usage or the behavior of individuals. The integrated machine learning technique identifies the covered period.	• Raw sensor data or aggregated data if provided, e.g. by vendor / 3rd party	• Mathematical / logical Intelligence	• Experimentation	• Review your current insurance products regarding dynamics, e.g. logistics, leasing, motor. • Start specific dialogues with brokers and underwriters on these products.

INSURANCE & CLAIMS MANAGEMENT PROCESS	RISK TRANSFER	• Faster underwriting • Inconsistency or fraud spotted faster	Handwriting recognition in questionnaires and text mining in required documents, such as historic insurance contracts and risk reports, to automatically compile all relevant information.	• Policy documents	• Mathematical / logical Intelligence • Computer vision	• In production	• Discuss with insurer or broker.
	CLAIMS	• Increased speed and accuracy in the notification process	First notice of loss is performed by machines, sensors or drones that in combination with algorithms can directly identify losses and details of the event.	• Raw sensor data or aggregated data if provided, e.g. by vendor / 3rd party • Historical claims data	• Mathematical / logical Intelligence • Computer vision	• Experimentation	• Check if data-capture technologies / data streams are already available. • Discuss with insurer(s) if they can use such data streams and would rely on them.
		• Efficiency in claims process • Improvement in safety	Incident optimization. Receive quantitative and qualitative information such as visual data or text. The claim can be automatically classified and processed.	• Pictures from personal devices, drones, satellites • Claims forms, e-mails, documents	• Mathematical / logical Intelligence • Computer vision	• Experimentation	• Increase efforts to produce and transfer imagery data • Identify relevant 3rd party imagery provider • Evaluate external software.

	RISK MANAGEMENT STEP	PROBLEM(S) TO BE SOLVED	AI USE CASE	WHAT KIND OF DATA NEEDED?	AI FOCUS	MARKET EVOLUTION STAGE	RISK MANAGER TOUCHPOINTS
INSURANCE & CLAIMS MANAGEMENT PROCESS	CLAIMS	• Faster or automated settlement • 24/7 assistance	Chatbot-based claims triage	• Internal, external and related data sets	• Mathematical / logical Intelligence • Linguistics • Interpersonal Intelligence	• In production	• Screen market for chatbot-solutions and integrate in internal claims process.
		• Balance sheet benefit • Faster loss ratio adjustment	Improve prediction of reserves	• Internal, external and related data sets	• Mathematical / logical intelligence	• Experimentation	• Review impact of reserves for the company / risk transfer.
		• Fair claims handling	Fraud detection	• Historical claims data	• Mathematical / logical intelligence	• In production	• Pre-analysis could be relevant in-house or focus area for insurers.
	RESTITUTION MANAGEMENT	• Cost optimisation • Increased speed and quality of service	Choice and control of 3rd parties	• External data sets	• Mathematical / logical Intelligence	• In production	• Challenge 3rd party administrator or insurer • Buy-in of comparison software.

- Early stage - Early market development, still in research, development phase
- Experimentation - Proof of Concept (POC) or Minimum Viable Product (MVP) stage, first pilots taking place in the market
- In production - "In production" phase, solution starts scaling, companies have implemented it in their service offerings

4.3. DEVELOPING AN AI ROADMAP

Companies implementing AI commonly use eight steps that risk managers can also apply when they are considering using AI technologies for ERM. The roadmap below should be seen as a dynamic process, which must be constantly reviewed and adjusted according to the environment of the organisation.

Eight key steps to consider when developing an AI Roadmap (suggested order):

1. Define Use Cases – identify problems you want AI to solve

Familiarise yourself with the basic concepts of AI and take the time to get a good understanding of what AI can do. Begin to explore different ideas and think about how you can integrate AI capabilities in your existing processes and services. Have a definite use case in mind before you start to implement AI.

The key questions are: What business problems or challenges do you want to solve or provide significant value? A clear definition of the desired business achievements is extremely important for a good return on investment. What model shall we use? Are there industry-wide commonly approved models?

2. Think Big Start Small – proof of concept for feasibility and viability

It is good to have lofty goals when aiming for a transformation with AI but start with a proof of concept. A small test or a pilot project can demonstrate the feasibility and viability of your idea. Remember that today's AI algorithms are trained to do precise operations with a limited scope, such as visual recognition, text analysis, speech recognition…

Tie your initiative(s) directly to business value and look at potential and feasibility. This will help to prioritise visibility and financial value.

Choose one particular initiative to test AI for this endeavour. This exercise might disclose problems which can occur during digital transformation. And at the same time, you will identify the challenges lying within the data ecosystem that may have to be addressed for a seamless transformation.

3. Creation of a Knowledge Repository

The success of an AI implementation depends on how robust the underlying knowledge repository and data base are. The AI will learn as it goes along - but even at the stage of training the AI, vast amounts of data are needed. The idea is to have the AI system define how a problem can be solved and be driven by the relevant insights the AI provides itself. By having a highly mature algorithm driven by a robust database, you can improve the quality of the insights available. The primary difference between a normal knowledge repository and a knowledge repository for AI is in the structure and the content. For AI, an interface and highly structured data which can be queried are necessary.

Key questions around data to consider:

- What data will we use?
- Do we have the right data?
- Do we combine your data with external data?
- If using vendors, do they need our data?

4. Build or Buy – choosing the correct partners for a seamless integration

AI may be necessary for every organisation, but not every organisation will have the resources to implement it on their own. Alternatively, they may be able to implement AI in specific areas of business in which they want to build a strategic asset, but not throughout the organisation. You should be aware what your organisation is capable of from a technology and business process perspective before starting an AI implementation. Addressing any internal capability gap means identifying what you need to acquire and what processes need to be developed internally before you get going. You can build the expertise or work with a partner. Picking the right partner is a crucial decision. Selection considerations include the availability of skilled human resources, successful past implementation, understanding of your business challenges and the partner's future business model.

Key question: Do you buy a finished product from a vendor trained on external data?

5. Data Quality

For AI, data quantity is not enough; data quality is paramount. AI is driven by data science and statistical algorithms. These algorithms become trustworthy if the quality of the data set on which the system is being trained and implemented is accurate and consistent. You may have to fix data duplication issues and remove corrupt and broken data.

Corporate data is typically spread out across multiple silos of different legacy systems and may even be in the hands of different business groups with different priorities. Hence, a very important step toward obtaining high-quality data is to talk about data governance, so you can integrate different data sets and deal with inconsistencies to produce data which are accurate and rich.

This phase to prepare your data is complex and requires specific skills in feature engineering. This data cleaning will ensure their usability by the chosen algorithms.

6. Cloud or On-Premise

As you scale up from a small sample of data, you will need to consider the storage requirements for an AI solution. Once in place, the knowledge repository will increase in size at an exponential rate. A tsunami of streaming data will fill up the storage fast. Hence, many organisations use the cloud for storing data. Factors like the security and compliance requirements, apart from the cost and storage volume needed, will determine whether to go for cloud or stay on site.

7. Right Resource Pool

Irrespective of the decision to build or buy, trained and experienced human resources are scarce. You do not want to alienate employees who may be wary of technology that can affect their jobs. Introducing the AI solution as a way to enhance their daily tasks is important. It is common to underestimate the demands AI will make on the business. This is not just about the technical resources needed to implement the systems. AI strategies sometimes fall apart because the organisation did not train or develop its functional resources to cater to the new ways of working. Business processes will change, agility will increase and responsibilities will shift - your people will have to be ready.

8. C-level – top management buy-in

Like any other strategic initiative, the involvement of the top management is a key factor for the success of any AI implementation. With top management puts its weight behind a project, the probability of its success increases significantly. The organisation starts treating the implementation with the required seriousness. Resources get allocated and results get tracked.

5. RELEVANT COMPETENCES FOR THE RISK MANAGER OF TOMORROW

Faced with the progress of AI, risk managers need to position themselves as value drivers within the organisation and as AI risk advisers to senior management and the board. The risk manager will not usually be a technical subject expert. He or she will add value from a combination of risk management skills, knowledge of the organisation and a level of broad digital understanding.

The current risk management skills – a thorough understanding of a wide range of risk management techniques, people management and communication skills – remain essential. The risk manager will also need a minimum level of digital knowledge, which will require continuing updating.

In this way, the risk manager will have the knowledge and skills to work with the subject experts in a multi-disciplinary team, understand the enterprise risk implications and communicate with senior management. He or she will also be able to explore the value of AI for risk management tasks notably for governance, risk and compliance applications.

Three main areas for risk managers to apply their skills address the following issues:

1. Change Management/ AI Readiness

Ensuring AI readiness while dealing with the risks of change management will be important for risk managers.

In terms of **strategic leadership,** their actions should lead to a better decision-making process for the leadership of the organisation. Top management needs to be aware of potential growth opportunities and the risk implications of digital technologies in general, including AI. If they are seen as a source of strategic advantage, priorities and budgets will be set accordingly.

In terms of **governance, compliance and risk**, techniques such as risk and control self-assessment already provide an ideal platform to set up guidelines, rules and processes for transparency, acceptance and analysis of the impact of AI.

2. Digital expertise within risk management

Regardless of the internationality or size of an organisation company, risk managers will need to work with data scientists to play a role in areas such as automated data collection and exchange, data quality, data governance and the quantification of qualitative data for AI.

Choosing the technical solution that will provide the best insights for risk management will require digital understanding and an ability to compare the costs and benefits of traditional quantitative modelling versus AI.

3. Building a cross functional risk management environment

Acquiring and retaining people with the right digital expertise represent a frequent challenge for organisations on their AI journey.
Based on the potential of AI, risk assessments, risk consulting and risk monitoring can be more closely integrated with other specialist areas such as IT/ AI development, data science and data analysis.

Bringing together different skills, such as analytical thinking, the translation of technology into business processes, programming, data collection/cleaning/processing and risk consulting can create an interdisciplinary team that combines innovation and efficiency, structured analysis and pragmatic implementation.

6. APPENDIX

6.1. DEFINITIONS

- **Algorithms** are a set of rules or instructions which a computer can use to help solve a problem or decide what to do next.

- **Machine learning** means that the computer systems perform a specific task without using explicit programming instructions but implement different classes of algorithms and statistical models to learn iteratively, i.e. identifying patterns from different types of current and past data and using them to make predictions to solve different types of problems.

- **Deep learning** is a subset of machine learning. Deep learning algorithms are a class of learning algorithms that are becoming popular because of their effectiveness in tasks related to speech and computer vision. They are also described as a technique that teaches computers to do what comes naturally to humans. Algorithms of probabilistic predictive methods use deep learning methodology. This consists of a neural network composed of different layers performing AI functions that imitates the workings of the human brain in processing data and creating patterns for use in decision making.

- **Natural language processing (NLP)** usually abbreviated as NLP, is a branch of artificial intelligence that deals with the interaction between computers and humans using natural language. The goal of NLP is to read, decipher, understand and give meaning to human languages in a valuable way. Most NLP techniques depend on machine learning to extract meaning from human languages. *Real-world applications: personal assistants (e.g. Alexa, Siri), chatbots…*

- **Speech recognition** is an AI process that can map audio data to text data. With more voice usage data and computer efficiency, speech recognition accuracy rates have improved a lot over the last ten years. *Real-world applications: security (surveillance), home automation, automatic translation and transcription speech-to-text (real time speech writing).*

- **Computer vision techniques** are used for data composed of images. They can identify, classify and react to visual data. They are mostly used within neural network structure and deep learning models.
  Real-world applications: autonomous driving, medical imaging and diagnostics to identify cancer cells, astronomy to build the first direct image of a black hole.

- **Recommendation systems** are data filtering tools that make use of algorithms and data to recommend the most relevant items to a particular user.
  Real-world applications: video/audio streaming platform (Netflix, Spotify, YouTube…)

- **Text mining** describes when the computer systems extract and format text to better understand the syntax, context, sentiments etc.

6.2. SELECTED HISTORIC STEPS OF AI

1950	Alan Turing proposes the "Turing Test" as a measure of machine intelligence.
1970s	AI winter starts; funding and interest in AI reduces.
1990s	All areas of AI see major advances, with significant demonstrations of machine learning, intelligent tutoring, case-based reasoning, multi-agent planning, scheduling, uncertain reasoning, data mining, natural language understanding and translation, vision, virtual reality, games and other topics.
1997	The Deep Blue chess machine (IBM) defeats the (then) world chess champion, Garry Kasparov.
Late 1990s	Web crawlers and other AI-based information extraction programs become essential in widespread use of the World Wide Web.
2009	Google builds autonomous car.
2011	IBM's Watson computer eventually defeated in television game show Jeopardy.
2011-2014	Apple's Siri (2011), Google's Google Now (2012) and Microsoft's Cortana (2014) smartphone apps use natural language to answer questions, make recommendations and perform actions.
2014	Amazon launches Alexa, an intelligent virtual assistant with a voice interface that can complete shopping and other tasks.
2016	Natural language processing applied to software testing and test automation.
2017	AI used for anomaly-based intrusion detection/ prevention systems following WannaCry and Petya/ Non-Petya ransomware attacks.
2018	Alibaba language processing AI outscores top humans at a Stanford University reading and comprehension test, scoring 82.44 against 82.30 on a set of 100,000 questions. **Autonomous and semi-autonomous driving** • Embark and Starsky Robotics pursue semi-autonomous truck driving. Daimler invests heavily in autonomous technology for cars and trucks. **Drone delivery** • Amazon Prime Air expects to ship 86 percent of items ordered on Amazon weighing five pounds (about 2.3 kg) or less using drones. UPS deploys drones from trucks for residential delivery tests. The drone delivers the package autonomously, while the driver continues to the next delivery. The drone then redocks with the truck.
2019	**Voice assistants** • Siri, Alexa, Google Assistant and Cortana are more powerful than ever. Powered by natural language processing, voice assistants are now handling 40 percent of all searches. **Facial recognition** • Facial recognition is becoming common and unexceptional, particularly in public and retail spaces. Businesses combine wider resolution, web tracking and biometrics to rapidly understand how customers interact with a brand and what content is most relevant them as individuals. **Business** • Financial services, supply chains, retailers and manufacturers are moving from pilot initiatives to production. Data is the new "crown jewel", replacing oil.

6.3. TEMPLATE: YOUR AI RISK MANAGEMENT ROADMAP

To develop your own roadmap on AI, get your team up to speed on AI basics. Then organise a workshop and invite a diverse set of colleagues from within and outside your department. Consider different backgrounds and focus areas such as risk engineers, claims handlers, data scientists and data analysts to work on your company's roadmap.

WHAT PROBLEM DO WE AIM TO SOLVE?	RISK MANAGEMENT STEP	OUR USE CASE	OUR COMPANY'S / CLIENT'S BENEFITS	WHAT DATA AND HOW TO GET IT? BE SPECIFIC!	DEPENDENCIES	SCOPE OF PROOF-OF-CONCEPT

6.4. TOP READS

Here are some selected sources of information and training for risk managers and their teams to further develop their understanding of AI.

Learning

- An Executive Guide to AI
  by McKinsey
  https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/an-executives-guide-to-ai

- Machine Learning for Humans - Simple, plain-English explanations accompanied by math, code, and real-world examples.
  by Vishal Maini and Samer Sabri
  https://everythingcomputerscience.com/books/Machine%20Learning%20for%20Humans.pdf

- Machine Learning: Implementation in Business
  by MIT Sloan School of Management, online short course

- We Need to Talk, AI - A Comic Essay on Artificial Intelligence
  by Dr. Julia Schneider, Lena Kadriye Ziyal
  https://weneedtotalkai.files.wordpress.com/2019/06/weneedtotalkai_cc.pdf

Ethics

- Ethics Guidelines for Trustworthy Artificial Intelligence (AI)
  by High-Level Expert Group on Artificial Intelligence (AI HLEG) - European Commission
  https://ec.europa.eu/futurium/en/ai-alliance-consultation/guidelines

- Recommendation of the Council on Artificial Intelligence, OECD/LEGAL/0449
  By Organisation for Economic Co-operation & Development (OECD)
  https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449

Risk management

- AI and Risk Management – Deloitte
  https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Financial-Services/deloitte-gx-ai-and-risk-management.pdf

Reading references are shown with author first, while learning has title first. Suggest make consistent.

- J. Hurwitz and D. Kirsch (2018), Machine Learning for Dummies, IBM Limited Edition

- R. Schutt and C. O'Neil (2014) Doing Data Science: Straight talk from the frontline, O'Reilly Media

- V. Kale (2016) Big Data Computing: a Guide for Business and Technology Managers, CRC Press

6.5. FERMA EXPERT GROUP

FERMA is grateful to our subject-matter experts for their hard work and valuable insights without which this report would not be possible.

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About FERMA

FERMA brings together 21 risk management associations in 20 European countries. They represent nearly 5000 professional risk managers active in a wide range of business sectors. FERMA acts on their behalf at European level and promotes the risk management profession.

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