



# Emerging Technologies and their Impact on Actuarial Science





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## CONTENTS

<b>Introduction.....</b>	<b>5</b>
<b>Use of this Report .....</b>	<b>6</b>
Limitations of this Research .....	6
<b>Executive Summary .....</b>	<b>7</b>
Summary of Key Findings Across Technologies.....	7
Technology Outlook .....	7
Technology Journey Positioning of Insurance Participants.....	10
Other Characteristics.....	11
Key Calls to Action for Profession and Actuarial Organizations .....	12
Future Topics of Exploration .....	13
<b>Section 1: Scope and Definitions .....</b>	<b>15</b>
1.1 Other Key Terms Used throughout this Report .....	16
<b>Section 2: Methodology .....</b>	<b>17</b>
2.1 Phase 1 – Technology Identification.....	17
2.2 Phase 2 – Technology Lead User Interviewers.....	18
2.3 Phase 3 – The Art of the Possible: Actuarial Discussion .....	18
<b>Section 3: Analysis – Deep Dive into Technologies, Case Studies, and Actuarial Implications.....</b>	<b>20</b>
3.0 Overall Findings Across Technologies.....	20
3.0.1 Technology Familiarity.....	20
3.0.2 Implementation Maturity .....	22
3.0.3 Technology Familiarity – Life vs. P&C .....	23
3.0.4 Implementation Maturity – Life vs. P&C.....	25
3.0.5 Technology Value vs. Ease of Implementation.....	26
3.0.6 Other Key Findings .....	28
3.1 Machine Learning and Artificial Intelligence.....	29
3.1.1 Definition and Terminology .....	29
3.1.2 Value Proposition .....	30
3.1.3 Case Studies.....	32
3.1.4 Implementation Considerations.....	38
3.1.5 Actuarial Current State and Future Outlook.....	42
3.2 Business Intelligence Tools and Report Generators .....	49
3.2.1 Definition and Terminology .....	49
3.2.2 Value Proposition .....	50
3.2.3 Case Studies.....	52
3.2.4 Implementation Considerations.....	59
3.2.5 Actuarial Current State and Future Outlook.....	61
3.3 Extract-Transform-Load (ETL) / Data Integration and Low-Code Automation Platforms.....	64
3.3.1 Definition and Terminology .....	64
3.3.2 Value Proposition .....	65
3.3.3 Case Studies.....	68
3.3.4 Implementation Considerations.....	74
3.3.5 Actuarial Current State and Future Outlook.....	77
3.4 Collaboration and Connected Data.....	81
3.4.1 Definition and Terminology .....	81
3.4.2 Case Studies.....	82
3.4.3 Value Proposition .....	84
3.4.4 Implementation Considerations.....	86

3.4.5 Actuarial Current State and Future Outlook.....	87
3.5. Data Governance and Sharing.....	91
3.5.1 Definition and Terminology.....	91
3.5.2 Value Proposition.....	92
3.5.3 Case Studies.....	94
3.5.4 Implementation Considerations.....	96
3.5.5 Actuarial Current State and Future Outlook.....	98
3.6 Digital Process Discovery (Process Mining and Task Mining).....	100
3.6.1 Definition and Terminology.....	100
3.6.2 Value Proposition.....	101
3.6.3 Case Studies.....	101
3.6.4 Implementation Considerations.....	102
3.6.5 Actuarial Current State and Future Outlook.....	103
<b>Section 4: Conclusions and Other Implications.....</b>	<b>104</b>
4.1 Outlook of the Technologies for the Actuarial Profession and Current Company Positioning.....	104
4.1.1 Technology Outlook.....	104
4.1.2 Technology Journey Positioning of Insurance Participants.....	106
4.1.3 Other Characteristics.....	108
4.2 Other Implications for the Actuarial Profession.....	109
4.3 Recommendations.....	110
4.4 Future Topics for Exploration.....	112
<b>Section 5: Acknowledgments.....</b>	<b>114</b>
<b>Section 6: List of Participating Companies.....</b>	<b>115</b>
<b>Appendix A: Scope and Definitions.....</b>	<b>116</b>
Emerging technology.....	116
What do we define as emerging?.....	116
What is defined as technology?.....	117
Significantly affecting the actuarial profession.....	117
What does it mean to “affect” the profession?.....	117
What is defined as work performed by actuaries today?.....	118
How do we define “significant” impact over the specified time horizon?.....	119
What markets are we examining when measuring tech adoption by actuaries?.....	119
Other terms and definitions.....	119
General terms.....	119
<b>Appendix B: Research Methodology.....</b>	<b>122</b>
Phase 1 – Technology Identification.....	122
Phase 2 – Technology Lead User Interviews.....	123
Phase 3 – The Art of the Possible: Actuarial Use Cases.....	123
<b>Appendix C: Mapping of Technologies to Technology Groups.....</b>	<b>125</b>
<b>References.....</b>	<b>126</b>
<b>About The Society of Actuaries Research Institute.....</b>	<b>130</b>

# Emerging Technologies and their Impact on Actuarial Science

## Introduction

The increasing availability of technologies is changing the way many industries have traditionally operated. The Society of Actuaries (SOA) commissioned this study to highlight the leading emerging technologies that may significantly affect the actuarial profession over a three-year horizon. This study focuses on:

1. The identification of emerging technologies currently utilized in other sectors that may significantly impact the actuarial profession in the coming three-year horizon, i.e., by 2024;
2. Analysis of emerging technologies, including their functionality, their value proposition, and several implementation considerations;
3. Case studies of how these technologies are being used today or will be used in the near future; and
4. Commentary on the current state and future outlook of these technologies for the actuarial profession sourced from a combination of interviews with actuarial professionals and the authors' observations at various insurance companies.

This study also acts as a guide and a resource for actuaries or potential employers to identify the prospective tools to enhance or expand actuarial work, for people collaborating with actuaries who may be affected by these technologies, and for leaders looking to enable teams employing actuaries through the introduction of these tools.

## Use of this Report

While this report offers commentary on a number of technologies that may potentially impact the actuarial profession, this report does not contain a prescriptive view on how the actuarial profession will unfold and does not contain an exhaustive list of all the tools and technologies that will impact the profession, particularly given the scope of the research. The report does not cover a full listing of all possible use cases for each technology, but rather provides examples of how they are being used by actuaries, as well as in other fields and professions.

This report is intended to inform and provide insights and, as a result, the authors (both individually and Deloitte as an organization) and the SOA are not responsible for the consequences of using this report. No part of this report may be used or presented without reference to it.

Of note about this report:

- This report covers emerging tools and technologies rather than specific vendor implementations. While some vendors may be referenced for ease of understanding or to present examples in case studies, these references are not endorsements for specific vendors.
- The preparer has assumed that the responses provided during the interviews were an accurate representation of the organizations' practices or understanding of their corresponding industry. The information presented in this study is based on what participants willingly shared and, in some instances, on what the participants estimated when they did not have an exact answer to a question.
- The research is subject to the below limitations; therefore, conclusions regarding actuarial applications should be drawn with caution.

## LIMITATIONS OF THIS RESEARCH

- The scope was limited to prospective tools used by actuaries. This excludes technologies that are adjacent to actuarial work that will likely have significant impacts on the actuarial profession (e.g., cloud data platforms, enterprise level tools actuaries do not directly use, Blockchain, etc.)
- The scope was limited to analyzing the impact on assessing insurance risk and longevity risk associated with pension plans. This excludes impacts on areas relating to investments (unless they relate to Asset-Liability Management).
- The actuarial interviews were done for a limited sample of companies. While a broad representation was targeted, the number of companies does not represent a statistically significant sample size. In addition, interviews did not explicitly cover actuaries who work outside of insurance and pension industries (e.g., those who work at technology companies, marketing companies, etc.). The sample also skewed toward larger companies and, therefore, may not represent the experience of those working at smaller companies.
- Interviews of health actuaries did not cover those who work at health plans. Health actuarial concepts were instead covered by multiple practitioners across two health consulting firms. Similarly, pension-related interviews did not cover actuaries working at companies' in-house pension plan areas. Pension-related concepts were covered by multiple practitioners at one consulting firm.
- The content coverage during actuarial interviews was limited by time constraints of the interviewees, so gaps were covered with follow-up emails.
- Interviewees may have been identified as the correct representatives of their company to cover these technologies, but they may not have had the full view of their organization.
- The self-rating responses provided during the interviews were subjective and represented that of the actuarial teams within their companies. They can also be influenced by the interviewees' personal experiences and understanding of the technology in question.

## Executive Summary

This research evaluates the current state and future outlook of emerging technologies on the actuarial profession over a three-year horizon. For the purpose of this report, a technology is considered to be a practical application of knowledge (as opposed to a specific vendor) and is considered emerging when the use of the particular technology is not already widespread across the actuarial profession. This report looks to evaluate prospective tools that actuaries can use across all aspects and domains of work spanning Life and Annuities, Health, P&C, and Pensions in relation to insurance risk.

We researched and grouped similar technologies together for ease of reading and understanding. As a result, we identified the six following technology groups:

1. Machine Learning and Artificial Intelligence
2. Business Intelligence Tools and Report Generators
3. Extract-Transform-Load (ETL) / Data Integration and Low-Code Automation Platforms
4. Collaboration and Connected Data
5. Data Governance and Sharing
6. Digital Process Discovery (Process Mining / Task Mining)

Each of these six broad groups of tools/technologies contain several types of tools discussed throughout this report and should be viewed as guidelines rather than as strict delineations since there can be technologies that fall into multiple groups and vendor implementations that combine multiple technologies.

## SUMMARY OF KEY FINDINGS ACROSS TECHNOLOGIES

### TECHNOLOGY OUTLOOK

Based on our analysis of actuaries' current usage and the future outlook of the technologies reviewed, we have grouped those technologies into four segments based on their potential readiness for actuaries in the future: in use today, ready in the next three years, potential opportunity in the future, and likely no actuarial usage. Figure 1 below summarizes the first three of these segments. The segments are described as:

- Technologies **“used today”** are those used by at least an early majority of participants and appear to be imminently used across the majority of actuaries.
- Technologies **“ready in the next few years”** are those still evolving in usage, with only a small number implementing or piloting, but also have a positive future outlook for use by actuaries. As a result, we suspect that those technologies will have the potential to reach an early majority usage in three years' time.
- Technologies listed under **“potential opportunity in the future”** either do not have enough traction with actuaries due to a lack of familiarity or have been noted to not have a positive future outlook for usage by actuaries without being completely written off. Therefore, those technologies will likely not see much usage by actuaries directly in the next three years, but might have some niche opportunities for actuaries, regardless, and may warrant potential exploration.
- The remaining technologies under **“likely no actuarial usage”** have no positive future outlook for actuarial use and do not have any niche actuarial uses foreseen in the next three years.

**Figure 1**  
**TECHNOLOGY OUTLOOK FOR ACTUARIAL USAGE**

Technology Outlook for Actuarial Usage					
In use today / imminent		Will be ready in next 3 years		Potential opportunity in the future	
ML/AI – structured data	BI Tools (Data Viz)	ML/AI – unstructured data	Data Governance	Digital Process Discovery (Process/Task Mining)	Connected Data & Reporting
Low-Code ETL & Low-Code Programming	Documentation Generators (Markdown)	Application Programming Interfaces (APIs)	Privacy Enhancement Techniques (PETs)	Robotic Process Automation (RPA)	
Dynamic Collaboration	Source/Version Control Management	DevOps Tools			

Note - ML/AI: Machine Learning/Artificial Intelligence, BI: Business Intelligence, ETL: Extract-Transform-Load

In the figure above, we also added DevOps tools in blue as we did not explicitly cover this in our initial scoping of technologies but have identified such tools as having potential for use by actuaries in the next three years. Please also note that these technologies do not include ones that will affect actuaries but are anticipated to not have direct usage by actuaries (e.g., cloud data storage platforms, Blockchain, etc.). Such technologies will be important and potentially even enablers of many of the technologies in our scoped list. However, such technologies were evaluated to not be used directly by actuaries, hence the exclusion of these tools.

The technologies, along with example vendor implementations (which are not meant to be endorsements of specific vendors), are summarized in further detail in the following list split by level of adoption by participating companies in our study and by future outlook:

- **Technologies that have reached widespread adoption today:**
  - **Dynamic Collaboration Tools** – e.g., Microsoft Teams, Slack, Miro – Most companies are now using this type of technology. Some are using the different functionalities (e.g., digital whiteboarding, project management tools, etc.) more fully than others at this time.
- **Technologies that are reaching early majority adoption today:**
  - **Business Intelligence Tools (Data Visualization component)** – e.g., Tableau, Power BI -- Most respondents have started their journey in using these tools, with many having implemented solutions. While a few respondents are lagging in its adoption, some companies have scaled applications of this technology to all actuaries. BI tools will change and accelerate the way actuaries diagnose results, understand results, and communicate insights to stakeholders.
  - **ML/AI on structured data** – e.g., R, Python – Most respondents have started their journey in using these techniques, but the level of maturity varies widely. The average maturity is beyond the piloting phase amongst our respondents. These are used for a wide range of applications in actuarial functions, including pricing business, modeling demand, performing experience studies, predicting lapses to support sales and marketing, producing individual claims reserves in P&C, supporting accelerated underwriting and portfolio scoring on inforce blocks.
  - **Documentation Generators (Markdown)** – e.g., R Markdown, Sphinx – Many respondents have started using these tools, but maturity level varies widely. The average maturity for those who have started amongst our respondents is beyond the piloting phase. As the use of R/Python becomes more prolific amongst actuaries, the ability to simultaneously generate documentation and reports for developed applications and processes will increase in importance.
  - **Low-Code ETL and Low-Code Programming** -- e.g., Alteryx, Azure Data Factory – Amongst respondents who provided responses, most have started their journey in using these tools, but the level of maturity



- varies widely. The average maturity is beyond the piloting phase with our respondents. Low-code ETL tools will be useful where traditional ETL tools requiring IT support are not sufficient for business needs (e.g., too difficult to learn quickly for users or reviewers, ad-hoc processes) or where IT is not able to provision views of data quickly enough.
- **Source Control Management** – e.g., Git, SVN - A sizeable proportion of the respondents are currently using these technologies. Amongst these respondents, solutions have already been implemented. These technologies will become more important in the context of maintaining code quality for programming-based models and tools such as those developed in R/Python. The value of the technology will be further enhanced with the adoption of DevOps practices and tools, which blur the lines between Development and Operations teams to accelerate the deployment of applications/programs.
  - **Technologies not yet adopted by the majority but moving closer to that adoption level in the next three years:**
    - **ML/AI on unstructured data** – e.g., R, Python – For the respondents who provided answers, a sizeable portion have started their journey in using this technology, but the level of maturity varies between piloting / implementing and beyond. The average maturity amongst those who have at least started planning is beyond the piloting phase. These techniques are utilized for a wide range of uses across actuarial functions; however, the use cases are more concentrated in Research & Development / Analytics and Pricing / Underwriting / Product Development in comparison to the use cases on structured data.
    - **Data Governance** – e.g., Collibra – There was a low level of adoption and familiarity of these tools by respondents since data governance has been seen by actuaries as an IT responsibility. However, front-running companies see this technology as providing high value to actuaries and are beginning to pilot such tools. Increased reliance on data, particularly in ML/AI applications, will require the companies to be more involved in preventing and managing risks associated with the misuse of data and changing data dimensions over time, which will be better managed with the use of governance tools.
    - **Application Programming Interfaces (APIs)** – e.g., Swagger, R's Plumber – Respondents had a very low level of familiarity and adoption of APIs. However, some companies have identified opportunities for APIs to be deployed in future actuarial applications. For example, as ML/AI models need to be deployed in real-time to downstream applications, usage of APIs will likely increase in importance.
    - **Privacy Enhancement Techniques (PETs)** – e.g., Privitar, CryptoNumerics - Respondents also had a very low level of familiarity and adoption of PETs. However, companies that do use them or are looking into them identified these tools as having high value. As privacy regulations around the use of data evolve, these tools could potentially become more useful for actuaries indirectly in terms of helping them share data and join datasets in a manner that is compliant with those regulations.
  - **Potential opportunity in the future:**
    - **Robotics Process Automation (RPA)** – e.g., Automation Anywhere, UiPath - The direct usage of RPA by actuaries is very limited due to other types of automations that are already in place or because implementations have been IT-led with minimal actuarial involvement. Many companies that are using RPA at the enterprise level are not doing so for actuarial processes. It should also be noted that most of the respondents indicated no plans to adopt RPA over the next three years. However, if several different applications are being used in one process, RPA could be useful to streamline across applications. That being said, it's not clear whether such processes would be better served by a combination of other automation tools (i.e., R/Python, low-code ETL, and automation built into actuarial software).
    - **Connected Data & Reporting** – e.g., Workiva, BlackLine - Respondents also had a very low level of familiarity and adoption of Connected Data & Reporting tools. Respondents who are using this are only doing so in a very limited fashion, generally as inputs for accounting. It appears that actuaries aren't fully aware of how these tools will help them over alternative tools. For example, one company is

trying to pilot collaborative editing elements using a Dynamic Collaboration tool instead. Further investigation would need to be performed to learn how these tools might benefit actuaries in combination with other departments.

- **Digital Process Discovery (process mining and task mining)** – e.g., Celonis, FortressIQ – There was no current application of this technology nor any stated implementation plans from the respondents; however, some participants noted that such tools could help with respect to process flow documentation and analysis of customer behavioral patterns.
- **Likely no actuarial usage:**
  - **Close Automation** – e.g., BlackLine – Most respondents were not familiar with these tools; however, those who were saw such tools as more accounting focused, so they do not appear to have much actuarial application.

### TECHNOLOGY JOURNEY POSITIONING OF INSURANCE PARTICIPANTS

Based on the responses from the actuarial interviews documented in Section 3: Analysis – Deep Dive into Technologies, Case Studies, and Actuarial Implications, we clustered companies together based on their demonstrated characteristics with respect to the technology stacks “used today” and “ready in the next few years.”

The technology journey positioning clusters are relative groupings across the respondents (only Life and P&C since the Health and Pension ones won’t be comparable due to being answered by consultants) for each technology in Figure 2A below that show differentiation in behaviors and characteristics across the participants, with participants falling into three buckets: “Behind,” “Middle of the Pack,” and “Front-Runners.” The figure also summarizes the separation in features among each of the clusters for each technology. It should be noted that being behind is not necessarily a bad position to be in. A company’s position is subject to its technology strategy and corresponding decisions regarding where and when to invest in such technologies.

**Figure 2A**  
TECHNOLOGY JOURNEY POSITIONING

		Technology Journey Positioning		
Characteristics		Behind	Middle of the Pack	Front-runners
Tech stack used today	<b>BI Tools</b>	<ul style="list-style-type: none"> <li>Only starting to be explored</li> </ul>	<ul style="list-style-type: none"> <li>Implemented for only a small number of actuarial functions</li> </ul>	<ul style="list-style-type: none"> <li>Dynamic reports are embedded across all actuarial teams/ functions</li> </ul>
	<b>ML/AI (structured data)</b>	<ul style="list-style-type: none"> <li>Used for only experience studies at most</li> </ul>	<ul style="list-style-type: none"> <li>Used for small number of actuarial specific functions only.</li> <li>No expansion of actuaries to other areas of org</li> </ul>	<ul style="list-style-type: none"> <li>Performed by actuaries across the business, not just within actuarial functions</li> </ul>
	<b>Documentation Generators (Markdown)</b>	<ul style="list-style-type: none"> <li>Not used</li> </ul>	<ul style="list-style-type: none"> <li>Used in by only a small number of individuals</li> </ul>	<ul style="list-style-type: none"> <li>Static documentation used across several actuarial teams / functions.</li> </ul>
	<b>SCM &amp; Modern Programming Languages</b>	<ul style="list-style-type: none"> <li>Modern programming languages (e.g. R and Python) are starting to be explored; SCM usage just starting or not started</li> </ul>	<ul style="list-style-type: none"> <li>Modern programming languages (e.g. R and Python) supported by SCM are used only for a small number of actuarial functions</li> </ul>	<ul style="list-style-type: none"> <li>Modern programming languages (e.g. R and Python) supported by SCM are used for several actuarial functions across the organizations</li> </ul>
Tech stack used in next few years	<b>Data Governance Tools</b>	<ul style="list-style-type: none"> <li>Treated as IT responsibility only or not discussed</li> </ul>	<ul style="list-style-type: none"> <li>Treated as IT only with some actuarial input. However, not considered for future use for actuarial</li> </ul>	<ul style="list-style-type: none"> <li>Identified as important and relevant for actuaries to use.</li> <li>Pilots have already started for actuaries to use in the future</li> </ul>
	<b>ML/AI (unstructured data)</b>	<ul style="list-style-type: none"> <li>Not started</li> </ul>	<ul style="list-style-type: none"> <li>Pilots started</li> </ul>	<ul style="list-style-type: none"> <li>Implementation has started or finished; ROI has not been fully realized yet for several cases as investment levels are high</li> </ul>
	<b>APIs and PETs</b>	<ul style="list-style-type: none"> <li>Not used nor considered</li> </ul>	<ul style="list-style-type: none"> <li>Actuaries may help developers with data-related requirements (e.g. APIs), but only by providing business requirements.</li> <li>PETs not thought as relevant for actuaries</li> </ul>	<ul style="list-style-type: none"> <li>Emerging usage for data sharing, access, and real-time deployment of models</li> </ul>

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Source: Deloitte analysis based on actuarial interviews for this research paper

Note - ML/AI: Machine Learning/Artificial Intelligence, BI : Business Intelligence, SCM: Source Control Management, APIs: Application Programming Interfaces, PETs : Privacy Enhancement Techniques

Please note that the figure above excludes both Dynamic Collaboration tools and Low-Code ETL tools. Dynamic collaboration tools are now being used by all companies, with slight differences in practices being the types of functionality used; however, the difference in companies is not very significant. Usage of low-Code ETL tools varies from company to company with no discernable pattern between participants that are behind and those that are ahead. While ETL tool usage will be minimal for actuaries, there will be some light ETL tool usage in small niches such as using ETL capabilities built into BI tools for dashboard creation, piloting solutions that are difficult to build in Excel, etc.

Based on the summarized criteria above, we reviewed each company's responses to assess their technology adoption position qualitatively and quantitatively for the technology stack used today and the one ready in the next few years. The aggregated results are outlined in Figure 2B below (to reiterate, Health and Pension responses were excluded as they came from consultants and were, thus, not directly comparable). Note that a company's positioning sits on a continuum rather than in discrete buckets, so a number of companies sitting on the boundaries of the buckets could be viewed differently, particularly if focusing on Life or P&C segments only.

**Figure 2B**

#### TECHNOLOGY JOURNEY POSITIONING - DISTRIBUTION OF INSURANCE PARTICIPANTS

	Behind	Middle of the pack	Front-runners
Tech stack used today	3	3	5
Tech stack used in next few years	5	3	3

Source: Deloitte analysis based on actuarial interviews for this research paper

**Tech stack used today:** Figure 2B above shows that, out of the 11 Life and P&C respondents, we observed five Front-runners, three Middle of the Pack, and three Behind. Within this group of technologies, a larger variation was observed in the usage of Source Control Management and Documentation Generators (Markdown). Respondents who are considered behind provided no response or no plan for consideration, whereas the front-runners identified several implemented use cases and across more than one actuarial function. For Business Intelligence and ML/AI on structured data, the differentiation mainly resided in the degree the tools had been scaled across the organizations: the middle of the pack and slightly behind respondents only identified applications within a limited number of actuarial functions, whereas the front-runners had wider adoption of such technologies.

**Tech stack used in next few years:** For this category, we received much fewer responses, indicating that companies are implementing these technologies today. Figure 2B above shows that out of the 11 Life and P&C respondents, we observed three Front-runners, three Middle of the Pack and five Behind. For APIs and PETs, many companies have not started any plans to use these tools amongst actuaries, whereas the front-runners provided at least one piloted use case. For ML/AI on unstructured data, front-runners have gone beyond the pilot stage for at least one use case, whereas the respondents who are behind had not begun plans to use such techniques amongst actuaries. For Data Governance, the front-runners identified the technology as important for actuaries and had at least planned for implementation with actuaries, whereas the behind respondents still considered the technology as solely driven by IT and had not considered it for their actuaries.

#### OTHER CHARACTERISTICS

In addition to the technologies listed in Figure 2A, a number of companies mentioned important characteristics that we noted were different between the more advanced companies and those that were behind. Such characteristics, i.e., data infrastructure and operating model, appear to have a correlation with the maturity of technology adoption amongst the actuarial teams of our participants. Since these topics were not explicitly covered, we did not have data from all companies to confirm whether this phenomenon was widespread. Companies that have been able to scale the emerging technologies for actuaries have shown distinguishing characteristics in their data infrastructure and operating model – see Figure 2C below.

Figure 2C  
TECHNOLOGY JOURNEY POSITIONING

Technology Journey Positioning			
Characteristics	Behind	Middle of the Pack	Front-runners
<b>Data infrastructure</b>	<ul style="list-style-type: none"> <li>Traditional data warehouses locked behind IT</li> </ul>	<ul style="list-style-type: none"> <li>Traditional data warehouses locked behind IT, perhaps discussing move to modern cloud data platform</li> </ul>	<ul style="list-style-type: none"> <li>Moving away <b>from traditional “ETL” into an “ELT” based approach</b>. That means that, where possible, raw data is loaded into the modern cloud data platforms from a variety of sources, and then transformed in the cloud. Idea is not new, but has been picking up traction due to powerful cloud data platforms</li> </ul>
<b>Operating model</b>	<ul style="list-style-type: none"> <li>Strict delineation between Actuaries and IT or Pure DS</li> <li>Actuaries at best provide requirements for analytics and any data requirements</li> </ul>	<ul style="list-style-type: none"> <li>Actuaries are only moderately involved or only doing analytics work for Experience Studies and Pricing</li> <li>Starting to explore self-service data processing / analytics</li> </ul>	<ul style="list-style-type: none"> <li><b>Using actuaries extensively for ML/AI</b> work rather than purely IT-type or pure DS</li> <li><b>Self-service analysis</b>, enabled by emerging tools towards this paradigm, allow for flexible implementation of data transformation and analysis to serve rapidly evolving business needed</li> <li>Implementation still <b>enabled, but not constrained</b>, by central IT team.</li> </ul>

Source: Deloitte analysis based on actuarial interviews for this research paper

Note – ML/AI: Machine Learning/Artificial Intelligence, DS: Data science, ETL: Extract-Transform-Load, ELT: Extract-Load-Transform

This correlation makes intuitive sense since data infrastructure and operating models allowing for self-service would result in actuaries doing more work and having more mature use cases when it comes to looking at actuarial work. However, this linkage does not just point to more work being done by actuaries; the front-runners have also noted a performance difference in terms of productivity when getting actuaries more involved with performing self-service analysis and ML/AI across the organization. Furthermore, investments in data infrastructure should naturally enable the use of and extraction of value from other data-related technologies.

### KEY CALLS TO ACTION FOR PROFESSION AND ACTUARIAL ORGANIZATIONS

As actuaries update the technologies they use and target more effective use of technologies, we recommend the following in light of this research, with detailed considerations by level and stakeholder outlined in Section 4.3 Recommendations:

1. Actuaries should *embrace technologies that enhance the remote working experience* within their internal teams and across departments by investigating functionalities beyond messaging and video calls. Such tools can be used to reimagine day-to-day communication, such as facilitating engagement within the actuarial community, co-authoring, and enhancing knowledge transfer.
2. Actuarial organizations and employers should *examine technologies where there is a wide range or gap in maturity and familiarity* and evaluate whether a knowledge gap exists and whether the gap is due to lack of education and training. Furthermore, they should investigate how these tools may impact their actuaries’ work, either directly or indirectly (e.g., data governance tools supporting ML/AI and financial reporting, PETs supporting the usage and sharing of data enabled by the additional safeguards of these advanced techniques, digital process discovery tools to uncover inefficiencies in actuarial processes, etc.). Furthermore, consideration given to certain tools might also add value at an enterprise-wide level even if the added value to actuaries in isolation is not as high.

3. Actuaries should *consider bolstering their communication methods amongst actuaries and with other stakeholders by using insight delivery tools* such as BI and Report Generation tools. Actuaries can drive change at all levels of their respective organizations.
4. Actuarial leaders, regulators, and auditors need to *become more familiar with ML/AI techniques in order to gain comfort over their results*. This comfort will unlock the ability for companies to extract further value from more complex ML/AI techniques. These concepts are further discussed in other SOA research papers such as those entitled [Interpretable Machine Learning for Insurance](#) and [Validating Algorithmic Underwriting Models - Expert Panel Report](#).
5. As the use of programming tools (e.g., R, Python) matures for ML/AI applications and other automation applications, companies will need to *investigate potential revisions in their processes and technology surrounding the deployment (i.e., SCM tools, DevOps, etc.) of models and applications* relying on these programming tools.
6. Actuaries should *become familiar with data governance tools tailored to business users and look into working with IT to drive change* in this area. Data governance principles will grow in importance with increased reliance on data for decision-making. This will likely be accelerated by the requirement to have access to detailed cash flow projections under the evolving accounting and regulatory standards. This will necessitate a higher need to monitor data drift, maintain data dictionaries, record data lineage, etc. to reduce the risk of misuse of data in downstream applications.
7. Actuarial organizations should continue to *evaluate and promote the potential expansion of areas where actuaries can work* (Data Science roles, Life Science and Pharmaceutical companies, etc.). Insurance companies using actuaries in Data Science roles have seen a marked improvement in productivity over pure statisticians and Data Science employees with the pre-requisite domain knowledge. Actuaries are well positioned with the advantage of strong domain knowledge and understanding of how non-technical users in their business need to consume insights and other outputs from the analytic work.

As actuarial teams and leaders evaluate emerging technologies, they will need to consider factors aside from the functionality of these tools, detailed further in Section 4.2 Other Implications for the Actuarial Profession, such as:

1. Their organization's current strategy, operating model, processes, technology landscape, and data infrastructure
2. Their organization's future state with respect to the previous point and the ease of enacting change to reach that future state
3. The ability to demonstrate a return on investment through the use of proofs of concept
4. Future legal and regulatory changes that may potentially impact the application and governance around these technologies

## **FUTURE TOPICS OF EXPLORATION**

Future topics and ideas beyond the scope of this paper for further research, if not done already, include:

- Expand the emerging technologies usage survey to a larger sample size to cover more actuaries at insurance companies, health plans, consulting firms, insurtech companies, and in other non-traditional roles;
- Perform a survey of top vendors for each technology used by actuaries and/or other areas of their organizations to obtain further insights into possible platforms;

- Investigate actuarial usage of DevOps tools and practices – including Continuous Integration/Continuous Deployment (CI/CD), containerization platforms, etc. – surrounding ML/AI and any other areas where programming tools are used by actuaries;
- Perform a deeper study of tools with which actuaries are less familiar to understand how they may impact actuaries, not only in terms of prospective tools for actuaries to use, but also how they might perform their work with existing tools;
- Assess the impacts of enabling technologies not directly used by actuaries – e.g., Cloud Data Platforms (Amazon AWS, Microsoft Azure, Snowflake), Blockchain (note that a relevant paper was recently [published by the SOA](#)), and the use of additional data sources;
- Perform a survey of the operating model – particularly around the split of responsibilities between actuaries and IT – used to implement/operate each technology in different contexts (e.g., projects, R&D, production, etc.);
- Conduct a survey of extent of use of R/Python and useful packages/libraries for actuaries;
- Research and assess the impact on future actuarial work of evolving regulations and guidance surrounding emerging technologies, such as the discussion paper, “Developing financial sector resilience in a digital world: Selected themes in technology and related risks,” by the Office of the Superintendent of Financial Institutions; and
- Perform a research study of the potential impact of technologies that would occur beyond a three-year time horizon (e.g., quantum computing).

## Section 1: Scope and Definitions

Key terminologies are defined to specify the scope of the research and achieve a common understanding for users of the research. The categorization aims to identify case studies used outside of the actuarial profession which can be applied to actuarial work; therefore, a rigorous and 100% accurate taxonomy is not the goal for this research.

The scoping exercise delves into various factors for the purposes of understanding what is in scope for this research – in particular, what is considered emerging, what is a tool/technology<sup>1</sup>, what does “significantly impacting the actuarial profession” entail, etc. We summarize this discussion below, with further details found in Appendix A: Scope and Definitions. For this study, we consider technologies that are:

- a) a practical application of knowledge, as opposed to a platform or vendor, that is not mature amongst the actuarial profession in mature markets as at the beginning of 2021;
- b) emerging within any one industry employing actuaries (i.e., Life insurance, P&C, etc.);
- c) practically used in any industry either currently (beginning of 2021) or within the next year, in order to separate technologies that have demonstrated practical impact vs. those that have only demonstrated theoretical potential.

In order for the technology to be considered, it must also have the potential to “significantly affect the actuarial profession.” Considering the criteria, only technologies that affect one of the multiple components of actuarial work listed below would be candidates for inclusion consideration.

- a) It must be a tool that can be used by an actuary. (i.e., additional sources or volumes of data do not count, even though it enables the use of specific emerging tools).
- b) It must be relevant to insurance risk, which covers all areas related to Life, Health, P&C, and Pensions with respect to longevity risk only. Note that while Asset-Liability Management (ALM) is included, asset management and investments are not. Pensions are specifically included from the perspective of analyzing risks related to mortality and longevity, as well as ALM.
- c) It needs to either directly change how actuaries perform their day-to-day work or increase/decrease the scope of work performed by the actuary, where actuarial work is defined as data analysis (excluding collecting, gathering, and storing of raw data), actuarial calculations, project/team communication, review of results, and presentation to relevant stakeholders.

Furthermore, such technologies would have to “significantly” affect the actuarial profession over a time horizon of three years from the beginning of 2021, where significant is defined as definitively moving past the early adopter phase and into the early majority phase as defined in the technology adoption framework discussed in Appendix A: Scope and Definitions.

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<sup>1</sup> Note that this paper uses the terms “tool” and “technology” interchangeably.

## 1.1 OTHER KEY TERMS USED THROUGHOUT THIS REPORT

Throughout this report, we will use the following terms and acronyms:

- *ALM* – Asset-Liability Management
- *API* – Application Programming Interface
- *BI* – Business Intelligence
- *ELT* – Extract, Load, Transform
- *ETL* – Extract, Transform, Load
- *GLM* – Generalized Linear Model
- *IFRS* – International Financial Reporting Standards
- *LDTI* – Long Duration Targeted Improvements
- *ML/AI* – Machine Learning / Artificial Intelligence
- *PET* – Privacy Enhancement Technique
- *Platform/Vendor* – This refers to a specific software that has been implemented by a vendor. It may include multiple tools/technologies bundled together.
- *RPA* – Robotic Process Automation
- *Tool/Technology* – As mentioned above, a Tool/Technology is meant to refer to a practical application of knowledge rather than a specific platform or vendor implementation. This can encompass a technique/algorithm such as stochastic modeling or machine learning.
- *UW* – Underwriting

Detailed definitions of many of the above terms will be provided in subsequent sections of this report where needed. Other less frequently used terms and acronyms will be defined in the Appendix.



## Section 2: Methodology

Our research is divided into three phases, with each phase dependent on the preceding ones:

1. Technology Identification
2. Technology Lead User Interviews
3. The Art of the Possible: Actuarial Use Cases

These phases are further outlined below, but also described in more detail in **Appendix B: Research Methodology**.

### 2.1 PHASE 1 – TECHNOLOGY IDENTIFICATION

In the initial research phase, we identified new technologies in use by teams outside of the actuarial profession and combed through numerous sources, including books, publications, websites, and journals. We also gathered information to further investigate potential case studies.

For the purpose of identifying a list of technologies to consider, we cataloged our findings into the below listed categories:

- Robotics Process Automation
- Data Analysis and Insights
- Machine Learning (ML) and Artificial Intelligence (AI)

This classification mainly serves as a simplified framework with respect to the grouping of technologies we expected to review further for the purpose of identifying technologies to include in the study. This was not meant to be a formal or rigorous taxonomy and some tools straddle the line between two or all of these categories.

The research team made the following notable exclusions:

- **New data sources** (e.g., sensor data, telematics data, biometrics, etc.) – These are not tools that actuaries would use themselves, but rather enablers for other emerging tools such as Machine Learning and Artificial Intelligence. Such alternate data sources are expected to alter product development and downstream actuarial analysis but are not tools on their own.
- **Blockchain / Distributed Ledger Technology (DLT)** – The technology by itself is not expected to be a tool that will be used directly by actuaries for actuarial work, at least in the next three years. Current implementations may require actuaries to be aware of the technologies, the data collected, and how that might influence actuarial work; however, usage of such tools will reside with IT and data teams in the near future.
- **Cloud computing and cloud data platforms** – This technology specifically deals with the infrastructure where work is performed or where data is sourced rather than affect how or what work is performed. Therefore, it is not considered to directly affect the actuarial day-to-day processes, except when paired with other tools, some of which come bundled with cloud vendors. Furthermore, use of cloud environments for actuarial model runs has become increasing common and is generally in use for companies that need the technology. The reduction of run-times, while important, was not considered to significantly affect actuarial work for the purpose of this study. It should be noted that the cost reduction in investment in robust data infrastructure enabled by cloud vendors indirectly impacts the value extracted from other technologies.
- **Quantum computing** – Increased computing power will indirectly enable new tools for the actuarial space but was not considered to significantly impact actuaries as it is not a prospective tool for them to directly use themselves. Further, the impacts of quantum computing will probably not be emerging in the next three years.

Note that if a technology was not immediately apparent to be “mature” amongst the actuarial profession, it was included for initial consideration, unless other factors discussed below excluded it. Further phases of research were then used to confirm the degree of usage via interviews with actuaries.

## **2.2 PHASE 2 – TECHNOLOGY LEAD USER INTERVIEWERS**

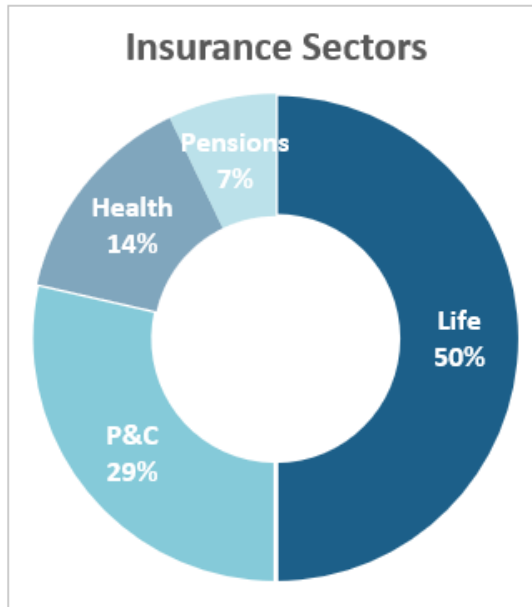
The authors identified and interviewed “lead experts” for each technology included in the study during the Technology Identification Phase (Phase 1). These lead experts are experienced in managing and delivering projects utilizing the specific emerging technologies covered in this report across all industries. Discussions included pros and cons of adopting the technology, strengths and limitations, implementation challenges and mitigating solutions, business processes that are most suited to the use of the technology, and detailed non-actuarial case studies. The case studies provided by the lead users come from different industries and are used to showcase the use of the technologies and educate the reader on how that technology might be applied in any industry. These use cases are supplemented by further research gathered from publicly available sources. In some cases, the full set of information (e.g., total implementation cost) for the case study was not available.

## **2.3 PHASE 3 – THE ART OF THE POSSIBLE: ACTUARIAL DISCUSSION**

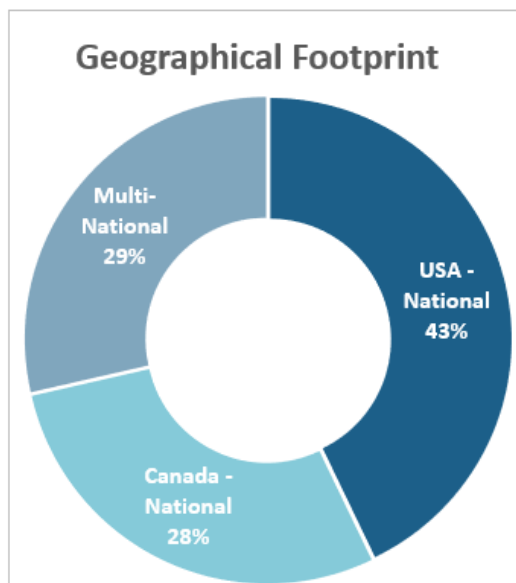
The authors identified and interviewed numerous actuaries across Life and Annuities, P&C, Health, and Pensions, with the goal of covering all actuarial functions to understand the current state and future outlook of these tools within the actuarial profession. Interviews were conducted with 14 companies where different lines of business (i.e., Life and Annuities, Health, P&C, and Pensions) were counted separately within the same company – seven Life and Annuity, four P&C, two Health, and one Pension. Companies with both Life and P&C business had separate interviews for each and are counted as separate companies for the purposes of this report. During those interviews, we collected explicit scoring of familiarity and implementation maturity levels from actuaries who worked at insurance companies, which totaled 11 companies across the Life and Annuity and P&C participants. It should be noted that the Health and Pension interviews were done with actuaries who worked at consulting firms; thus, we only collected qualitative answers on technology usage and future outlook since explicit scoring would not be as comparable to those coming from insurance companies because technology implementations are client specific. The findings from the Health and Pension interviews were, therefore, more qualitative in nature.

Figures 3 and 4 below show a demographic representation of the companies interviewed, with the full list of participants detailed in Section 6: List of Participating Companies:

**Figure 3**  
INSURANCE SECTORS



**Figure 4**  
GEOGRAPHICAL FOOTPRINT



These interviews were supplemented by the authors' own experiences and observations of actuaries using these emerging technologies. Additional research was performed as needed based on findings uncovered during this phase.

## Section 3: Analysis – Deep Dive into Technologies, Case Studies, and Actuarial Implications

As described earlier in Section 2.2 Phase 2 – Technology Lead User Interviewers, the research team contacted a few “lead experts” of each of the identified technologies to dive deeper into the technologies and their applications. These discussions included topics such as: strengths and limitations, benefits of technology adoption, business processes that are most suited to the use of this technology, and implementation challenges. The lead experts’ responses were supported, to the extent possible, by case studies of current day usage in a range of industries and professions. Answers were provided via a combination of interviews, supplementary documentation provided to support the answers, and follow-up emails. This was augmented by further research by the research team. Using this list of tools and supporting information, the research team interviewed the actuarial community to understand their familiarity with these tools, their current and planned use by actuarial professionals, their level of implementation, perceived value relative to implementation efforts, and future outlook for the actuarial profession.

When going through the results of the analysis, it is important to note that vendors often combine more than one technology into a combined package (e.g., a BI tool might combine data transformation, data visualization, and predictive analytics into one solution). Where possible, we tried to focus on the core functionality of the tools identified when gathering responses in relation to each technology. Moreover, many tools and technologies offer different solutions to achieve similar outcomes (e.g., a company may choose to use an ETL vendor to solve a similar problem that could have been solved with RPA) resulting in overlap in some of the listed technologies in our study, which may lead users to consider one technology as a substitute for another.

### 3.0 OVERALL FINDINGS ACROSS TECHNOLOGIES

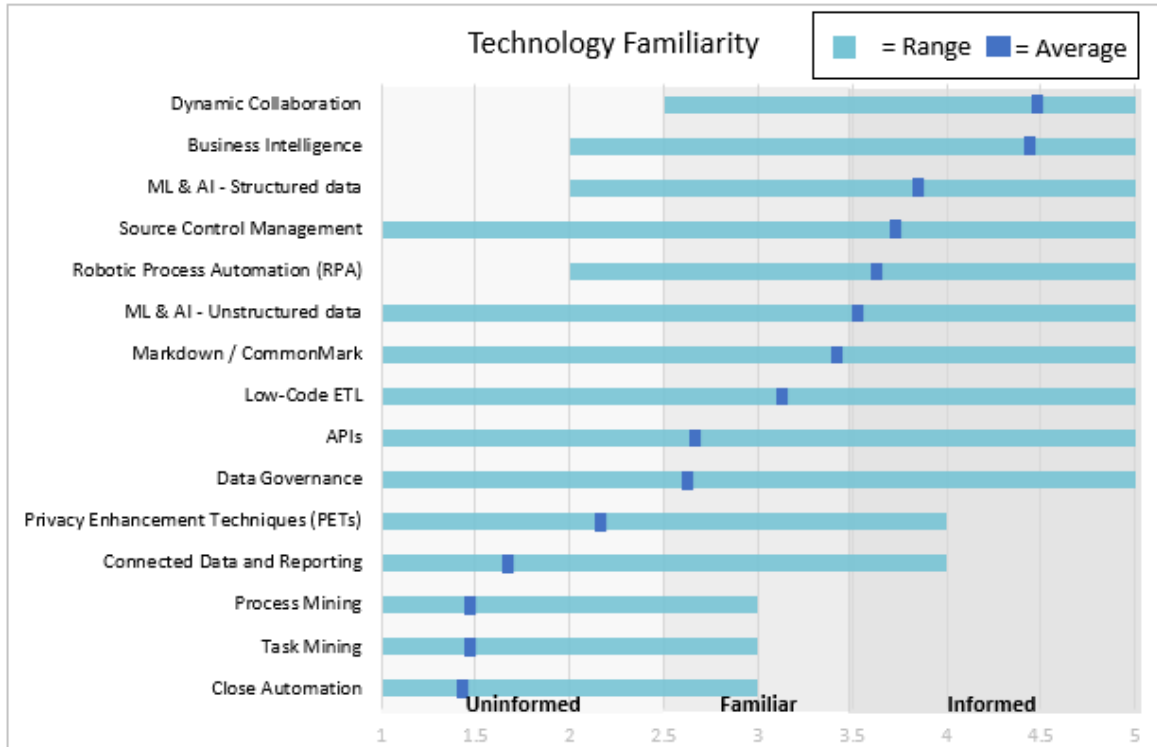
The interviews with actuaries covered their organizations’ relative familiarity of the technologies in scope for this study, their depth of implementing these technologies, their value and ease of implementation, and their future outlook. As discussed in Section 2.3 Phase 3 – The Art of the Possible: Actuarial, the research team surveyed actuaries on these aspects, but only captured explicit quantitative measurements for Life and Annuity and P&C actuaries working in insurance companies since those scores reflected views of their own organizations. Responses of this nature totaled 11 companies across Life and Annuity and P&C. However, the Health and Pension interviews only qualitatively measured these factors since those actuaries worked at consulting firms, whose scores would not be as comparable since the measures related to the technologies would be mostly specific to the clients they work with. Rather, we focused on use cases and outlook and captured familiarity at a high level. Therefore, figures below do not include Health and Pension data explicitly.

#### 3.0.1 TECHNOLOGY FAMILIARITY

Figure 5A below shows the results of a survey of the 11 companies’ Life and Annuity and P&C participants on their actuaries’ familiarity with each technology at an organization-wide level. The survey indicated that:

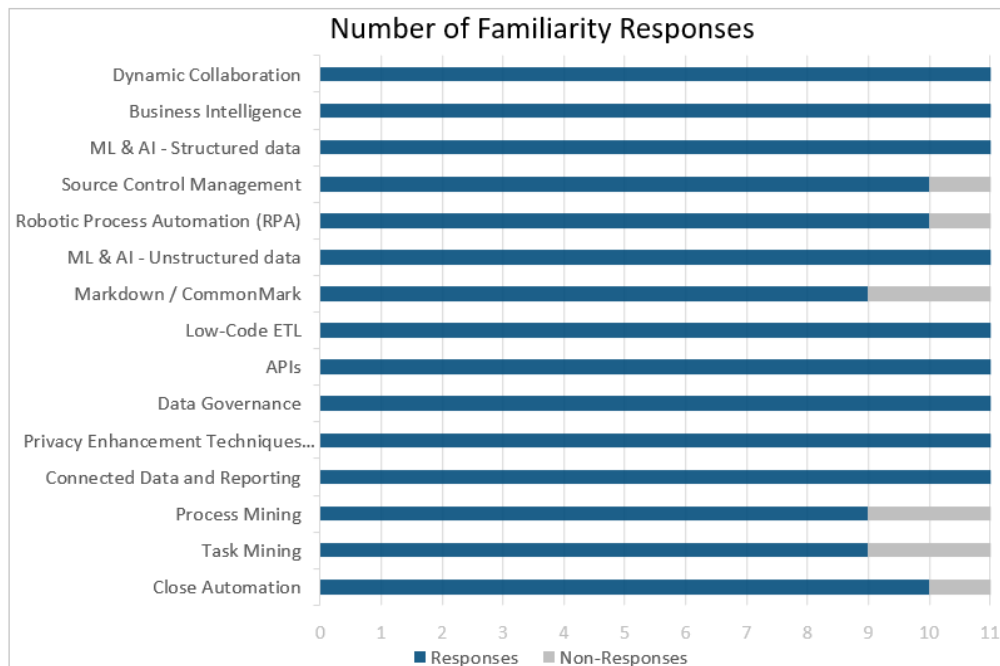
- Actuaries have the highest average familiarity with Dynamic Collaboration and BI tools.
- They have the lowest average knowledge of Process Mining, Task Mining, Connected Data & Reporting, and Close Automation tools. They are also relatively uninformed about PETs.
- On average, actuaries are informed about ML/AI, Source Control Management tools, and RPA, and are familiar with Documentation Generators (Markdown), Low-Code ETL, APIs, and Data Governance.
- Furthermore, actuaries have a wide range of familiarity with each technology identified. For example, some companies are still relatively uninformed on BI tools and ML/AI. Some technologies (i.e., Source Control Management tools, Markdown, ETL, APIs and Data Governance tools) range from no knowledge at all to very informed.

**Figure 5A**  
TECHNOLOGY FAMILIARITY



To complement the graph above, Figure 5B below shows the count of responses for each technology (in the same order as the above graph).

**Figure 5B**  
NUMBER OF RESPONSES FOR TECHNOLOGY FAMILIARITY

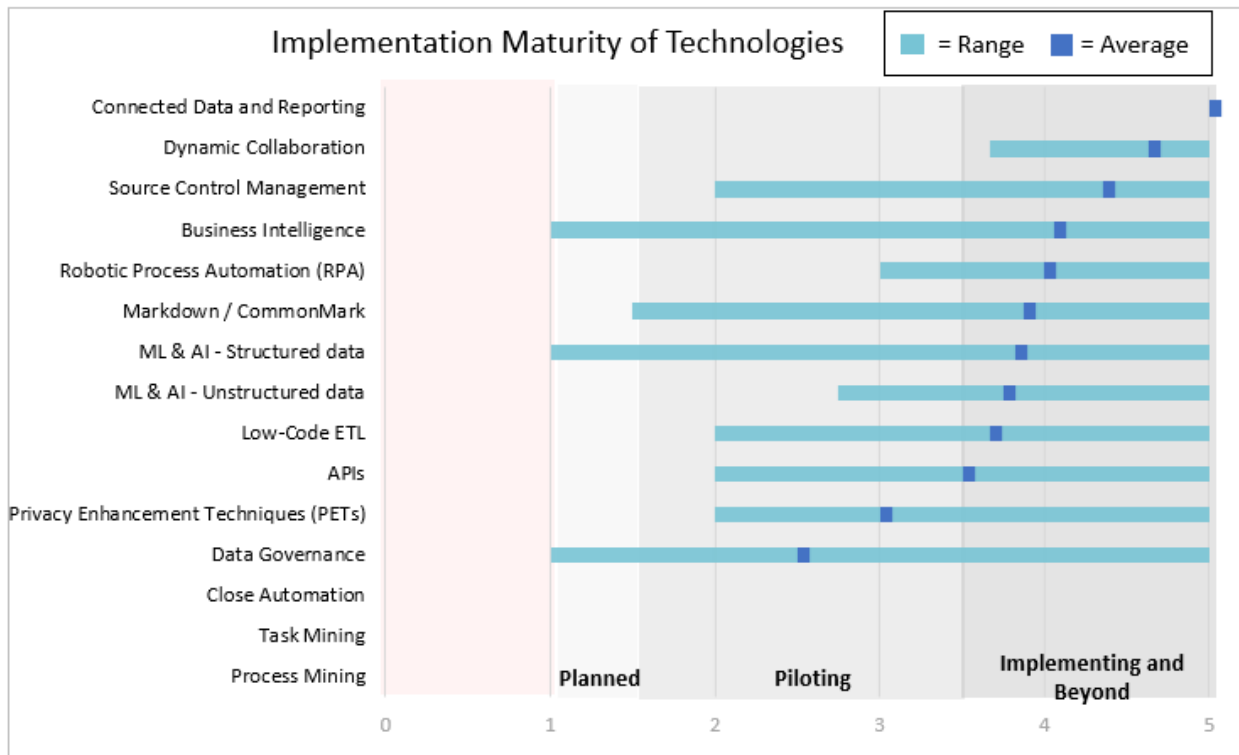


### 3.0.2 IMPLEMENTATION MATURITY

Figure 6A below shows the results of a survey of the 11 companies’ Life and Annuity and P&C participants on their companies’ implementation maturity within processes where actuaries are closely using the tool (either as a developer, user, or as a close reviewer requiring knowledge of how the tool works) amongst those who have at least planned to implement each of these technologies. Average and range of maturity scores exclude companies that have not responded or have no plans to implement the technology in the next three years to focus on the maturity of those that have started the journey of exploring or implementing these technologies. The survey indicated that:

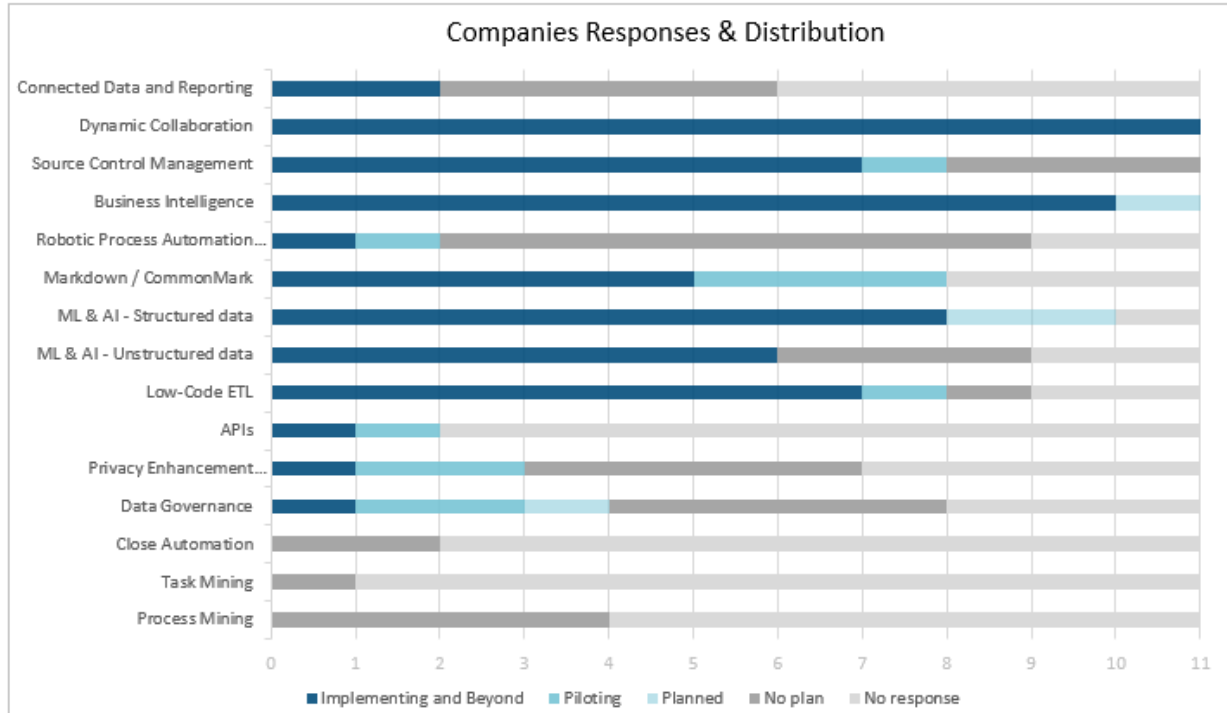
- Organizations have a wide range of implementation maturity in the adoption of these technologies -- particularly with BI tools, ML/AI on structured data, and Data Governance -- ranging from “not currently using but planned in the next three years” to “at least one use case fully implemented.”
- It is important to note that the responses below are reported at an organization level for the actuaries but may range in maturity when looking at the actuarial function level (e.g., Reserving is generally less mature in the use of ML/AI vs. Pricing).
- Highest average maturity was seen in Dynamic Collaboration and BI tools. Connected Data & Reporting platforms have a high average maturity, but are coupled with a very low sample size of responses to draw conclusions regarding its high average rating
- Dynamic Collaboration tools are not only at the top end of the technologies, but also have a narrow range of responses, with all respondents indicating the technology is past the piloting phase. Given the recent COVID-19 pandemic and the accelerated shift to remote working, this is not surprising.
- Lowest average maturity was observed in Process/Task Mining, Close Automation, where respondents have indicated no plans to implement in the next three years.

**Figure 6A**  
IMPLEMENTATION MATURITY OF TECHNOLOGIES



To complement the graph above, Figure 6B below shows the count of responses for each technology (in the same order as the above graph).

**Figure 6B**  
**COMPANY RESPONSE DISTRIBUTION FOR TECHNOLOGY IMPLEMENTATION MATURITY**



### 3.0.3 TECHNOLOGY FAMILIARITY – LIFE VS. P&C

Figure 7A below shows that average familiarity follows mostly the same trend between Life and P&C carriers, but with P&C carriers slightly more familiar with most tools, particularly those surrounding predictive analytics work and insights reporting (e.g., ML and AI, Markdown, Source Control Management). RPA familiarity is also higher for P&C respondents. However, the second graph below, which complements the prior one, shows a low sample size for some responses, particularly for P&C. Therefore, it is difficult to draw too many conclusions using this split of responses.

Figure 7A  
TECHNOLOGY FAMILIARITY

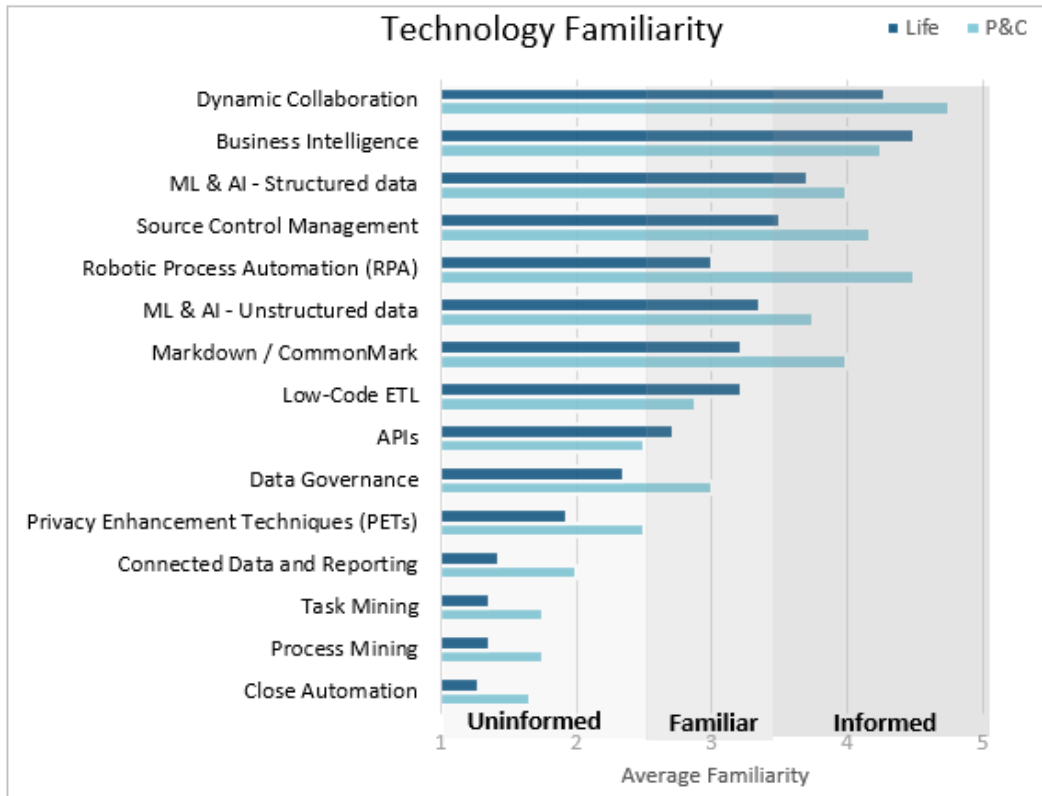
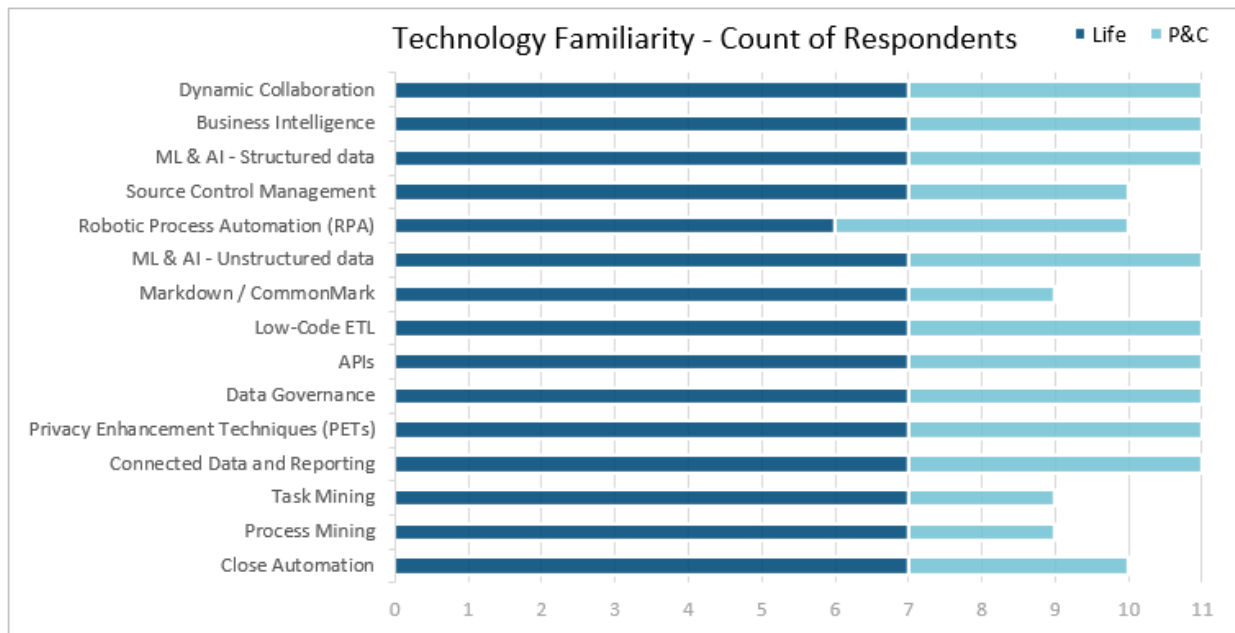


Figure 7B  
TECHNOLOGY FAMILIARITY – COUNT OF RESPONDENTS



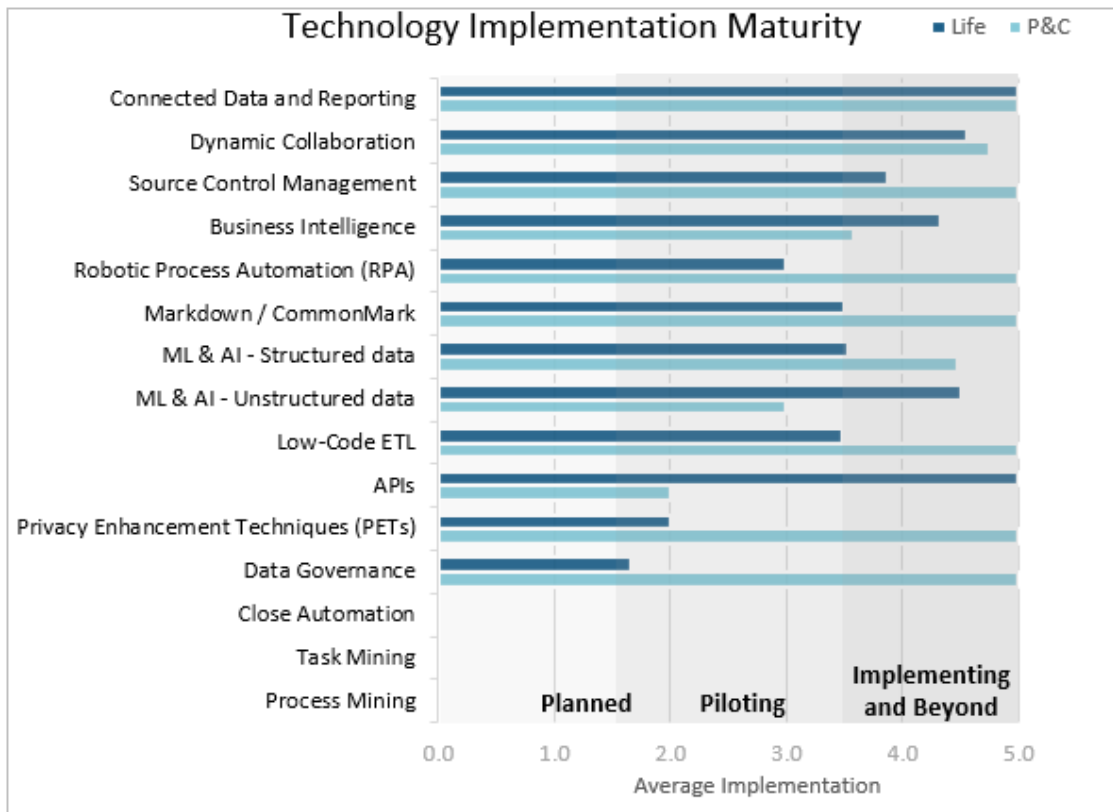


### 3.0.4 IMPLEMENTATION MATURITY – LIFE VS. P&C

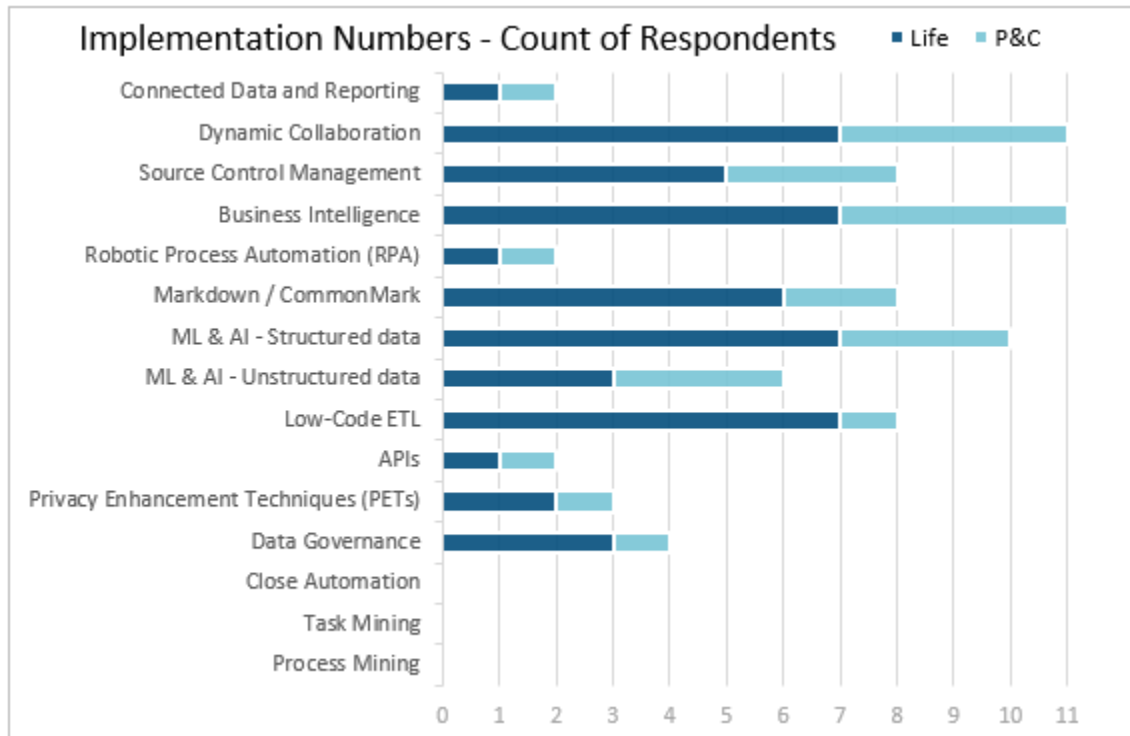
Figure 8A below shows the average implementation maturity excluding companies that have not responded or have no plans to implement these technologies in the next three years. Again, this applies to processes where actuaries are closely using the tool (either as a developer, user, or as a close reviewer requiring knowledge of how the tool works). Please note that Figure 8B below indicates a low sample size when splitting between Life and P&C, so caution must be drawn when coming to any conclusions. The results show:

- Life and P&C carriers exhibit very different results. P&C participants are showing a higher maturity with most tools, particularly those surrounding predictive analytics work (e.g., ML/AI on structured data, Markdown, and Source Control Management), Low-Code ETL, Data Governance and PETs.
- Life participants are ahead for a few tools, namely BI tools, APIs, and, surprisingly, ML/AI on unstructured data (discussed further in Section 3.1.5 Actuarial Current State and Future Outlook).
- For Connected Data and Reporting, and RPA, very limited use cases were identified for both Life and P&C participants, with relatively high implementation maturity.
- Dynamic Collaboration tools are equally mature between Life and P&C, indicating a universal trend toward remote work and collaboration, as expected.

**Figure 8A**  
TECHNOLOGY IMPLEMENTATION MATURITY



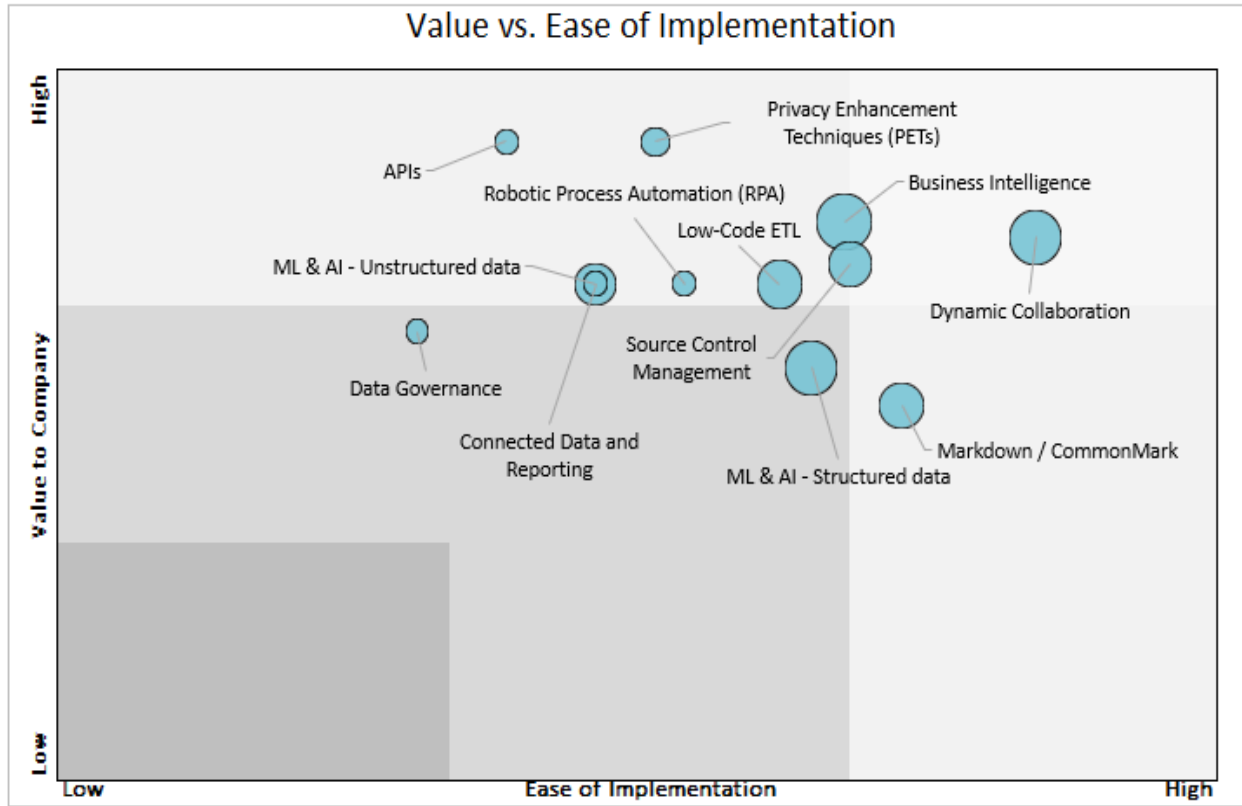
**Figure 8B**  
**TECHNOLOGY IMPLEMENTATION MATURITY – COUNT OF RESPONDENTS**



**3.0.5 TECHNOLOGY VALUE VS. EASE OF IMPLEMENTATION**

Figure 9 below shows the results of a survey of the 11 companies’ Life and Annuity and P&C participants on their perceptions of the value and ease of implementing each of these tools. The bubbles in the graph are sized by the count of respondents who provided both scores. The results exclude respondents who are missing responses or not planning to use the tool in the next three years in order to focus on the views of companies that have at least started their exploration or implementation of each technology. Note that value and ease of implementation often significantly varies by use case within each technology so the amounts below indicate average amounts reported for the use cases within each technology. Detailed discussions for each technology will be highlighted in subsequent sections.

Figure 9  
TECHNOLOGY VALUE VS EASE OF IMPLEMENTATION



For the purpose of seeing an approximate overall picture of which technologies hold the highest prioritization for future consideration, Figure 10 below illustrates a prioritization score that was assigned to each technology based on a combined sum of the technology’s value and ease of implementation, with higher weight given to the value over the ease of implementation. However, please note that company-level decisions on technology prioritization should be based on the individual company’s existing organizational objectives, structure, processes, and technology available.

Figure 10

Prioritization	Technology	Prioritization Score	# of Respondents
Highest Priority	Dynamic Collaboration	13.1	10
	Privacy Enhancement Techniques (PETs)	12.3	3
	Business Intelligence	12.3	11
	Source Control Management	11.7	7
	APIs	11.5	2
Medium Priority	Robotic Process Automation (RPA)	10.5	2
	Low-Code ETL	10.1	8
	ML & AI - Structured data	10.0	10
	Markdown / CommonMark	10.0	7
	Connected Data and Reporting	10.0	2
	ML & AI - Unstructured data	10.0	6
Lower Priority	Data Governance	8.3	2
	Process Mining	0.0	0
	Task Mining	0.0	0
	Close Automation	0.0	0

The findings below are split between slightly arbitrary (but qualitatively in line with expectations) priority buckets based on the priority scores:

- **Highest Priority Technologies**
  - The highest priority combined with the highest levels of adoption were Dynamic Collaboration tools, BI tools, and SCM tools – all which focus on enhancing collaboration efforts and deriving insights from data across the organization.
  - PETs and APIs made up niche high priority technologies based on a small sample, with high value and moderate ease of implementation noted by the respondents.
- **Medium Priority Technologies**
  - ML/AI on structured data had the largest number of respondents, indicating moderate value and moderate/high ease of implementation.
  - ML/AI on unstructured data was covered by a smaller number of respondents but showed higher perceived value with lower ease of implementation. This can be explained by the higher potential for value that can be extracted from unstructured data, which is much harder to analyze using traditional techniques.
  - Low-Code ETL and Markdown both had a decent number of respondents and appear to be candidates for further consideration for companies that may not have explored these tools yet.
  - RPA and Connected Data & Reporting had very small sample sizes, but both show high value and moderate ease of implementation in those niche responses.
- **Lower Priority Technologies**
  - Data Governance tools, despite being indicated by companies as important, were perceived to have moderate value, but also the hardest to implement. Companies that have started their journey with Data Governance tools expect them to emerge in the future. However, these tools become more important once some of the higher and medium priority technologies relating to data have been started, so it would make more sense to start the data governance tool journey with a longer view in mind if the other technologies have not yet been started.
  - Process/Task Mining and Close Automation did not have responses given the lack of companies planning to use such tools over the next three years.
  - Note that these technologies are not necessarily unimportant, but they either need further investigation/education or require more time and effort before value for actuaries can be potentially realized from the tools.

### 3.0.6 OTHER KEY FINDINGS

More complex ML/AI modeling methods (e.g., GLM, GAM, random forests) are used to achieve more accurate predictions and add sophistication. However, this adds challenges as companies need to interpret and communicate the results for their leadership teams and obtain regulatory approval when it is required. Adding sophistication also requires achieving a balance between investing in the process and the resulting value added. Looking forward, companies can explore more use cases given the advancement in unstructured data sources, automated modeling software, and new ML/AI methodologies. As ML/AI gains more traction, companies will need to proactively adopt additional safeguards and data governance to ensure that these techniques are being used appropriately.

Companies are generally looking to implement BI tools for senior management reporting, financial results, IFRS 17 projections and all actuarial functions. BI tool usage is expected to increase in the near future to enable self-service analysis. However, the value obtained from these tools is heavily reliant on having a strong data infrastructure. In addition, IFRS 17 is a key catalyst for modernized central data repositories, often located on cloud environments. The ability to easily access data is becoming a need and requirement for financial reporting in addition to enabling analytics work across the enterprise. Post-IFRS 17 implementation, additional ad-hoc analysis may be required,

which may not be covered by the implementation of traditional ETL tools and cloud data platforms initially built during the IFRS 17 implementation projects. Such scenarios can be supplemented by low-code ETL tools, which have gained some traction in small pockets of the actuarial community. In those small niches where these low-code tools are used, the usage is well regarded and very strong.

Furthermore, the increasing reliance of data outside of analytics correspondingly increases the need for strong data governance. Data governance tools today are seen as an IT responsibility with low impact for actuaries. However, actuaries will need to increasingly ensure auditability and traceability of their calculations. They will also need a good understanding of data lineage and data definitions underlying their work, particularly as they respond to questions from management and auditors. Furthermore, the continuous reliance on data for ML/AI applications requires the monitoring of data drift and data shift, exacerbating the need for data governance tools. It is worth noting that the most advanced companies in this area have identified this as a need in their organizations. Outside of the actuarial profession, the market has also seen increased need for these tools with the introduction of GDPR and related regulations surrounding the use of data around the world.

RPA is perceived to have limited usage in many actuarial functions due to other automations already in place (e.g., VBA macros, Python, mainframe extraction codes, etc.). Enterprise-wide RPA usage is usually driven by other dedicated teams such as IT or an RPA Center of Excellence focused on insurance operations. Actuarial involvement is generally limited with actuaries providing requirements and performing user acceptance testing. However, a few respondents noted the potential of RPA in certain reserving applications where a high volume of data needs to be processed on a regular basis and in a repetitive manner.

Remote working in the past one to two years has accelerated the usage of dynamic collaboration tools across companies. Actuaries should also look at other functionality aside from co-authoring, enhanced chat, and mobile applications. These tools also offer some lesser used functionalities such as Kanban boards, DevOps, digital whiteboarding, and wikis. Source Control Management tools (e.g., Git or equivalent), in particular, are at a growing stage of usage amongst actuaries. These tools will be increasingly more important as actuaries adopt programming tools such as R and Python.

## 3.1 MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

### 3.1.1 DEFINITION AND TERMINOLOGY

The terminology and understanding around Machine Learning and Artificial Intelligence have been misunderstood as hype around these concepts has increased. Often, definitions used by practitioners are inconsistent or even misleading. This report defines many of these terms to establish a common understanding.

***Artificial Intelligence (AI)*** uses a broad array of technologies to mimic or extend human functions, such as reasoning and interactions. AI applications generally fall into those two functions, where

- Reasoning refers to processes that generate insights, predict, recommend, optimize, and
- Interaction refers to interacting with text, images, video, and sound/voice

***Machine Learning (ML)***, a subset of AI, refers to instructions or rules that learn from past data. It should be noted that ML algorithms power most of today's AI applications.

Throughout this report, the term ML/AI will be used to collectively refer to these algorithms under the ML and AI umbrella. This section specifically focuses on the use of algorithms that make predictions and learn from past data, which includes Neural Networks, Decision Trees, Gradient Boosting Machines, and even Generalized Linear Models. Other portions of the analytics pipeline (e.g., data transformations, data visualization, report production, etc.) are

considered in other sections of this report. It is also important to note ML/AI has been increasingly embedded in other tools (e.g., RPA, low-code ETL, etc.) rather than used in isolation to train a model.

Throughout this report, we refer to the use of ML/AI on both structured and unstructured data given the separation in the type of skillsets required and implementation maturities. See Appendix section “Machine Learning and AI related terms” for the definition of these and other related terms.

### 3.1.2 VALUE PROPOSITION

Businesses today work in a fast-paced environment where decisions are required to be precise and quick.

When it comes to analyzing data, ML/AI can help a company:

- Analyze existing datasets more efficiently, improve on existing models, and derive better insights
- Derive insights from new, additional data not considered in the past (larger datasets across the entire organization, third-party datasets)
- Digest and analyze new data types that were not possible in the past (e.g., unstructured data)

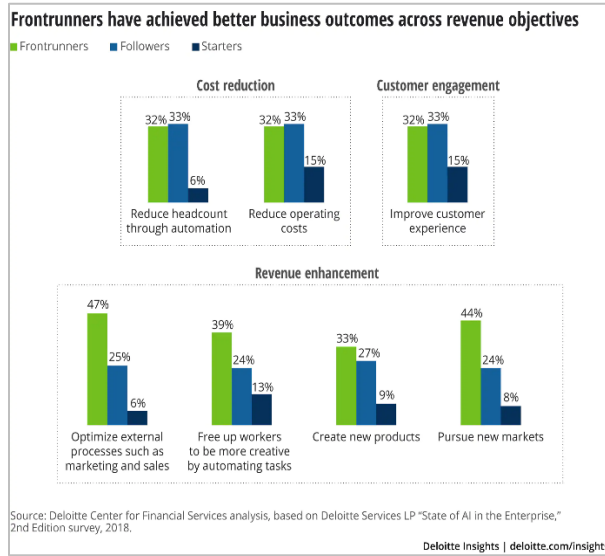
ML has enabled teams to have high productivity, enhancing existing products and services, faster use case development, and new use cases with alternative data.

While ML/AI has a reputation that it replaces humans in carrying out their jobs and tasks, the technology today still requires a great deal of human oversight in the creation and application of models. In addition, some ML/AI models are not transparent, which may be too restrictive for certain uses that require explainable models. In a sample from a 2018 Deloitte survey<sup>2</sup> covering US-based financial services companies, a sizeable proportion of those companies reported that they were generating a financial return on AI investments (see Figure 12 below). Companies deploying AI projects reported favorable outcomes over numerous metrics, including cost reduction, improved customer experience, freeing up FTEs for higher value activities, optimized processes, and new products and services (see Figure 11 below).

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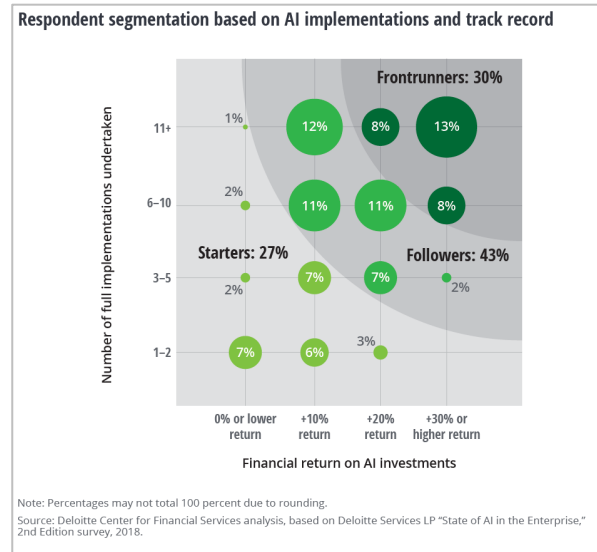
<sup>2</sup> <https://www2.deloitte.com/us/en/insights/industry/financial-services/artificial-intelligence-ai-financial-services-frontrunners.html> (Accessed 9/2/2021)

**Figure 11**  
**TECHNOLOGY FRONTRUNNERS**



Source: Deloitte Center for Financial Services analysis

**Figure 12**  
**AI IMPLEMENTATION TRACK RECORD**



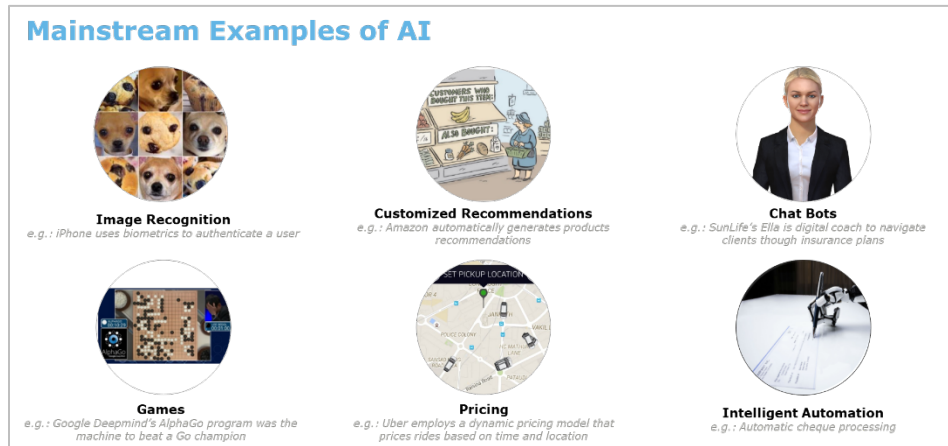
Source: Deloitte Center for Financial Services analysis

As described in Figure 12 above, this survey found that the distribution between Frontrunners, Followers, and Starters were 30%, 43%, and 27%, respectively, based on the number of full AI implementations undertaken and the financial return on AI investments. Looking at the clusters, the positive outcomes on AI deployments were reflected in overall company performance as well, with Frontrunners reporting a company-wide revenue growth of 19%, which was in stark contrast to the growth of 12% for Followers and a decline of 10% for Starters. However, the results above indicate that there are still many companies, particularly in the Starter cluster, that are not generating a positive return or are only realizing a muted return on their AI implementations. Given the performance of the companies that are more advanced in their AI journey, this split of results implies that there is plenty of room for improvement for those starting their AI implementations. This will be discussed in a subsequent section.

### 3.1.3 CASE STUDIES

There is a broad range of use cases in the application of ML/AI across industries and professions. Some mainstream consumer-facing examples are depicted in Figure 13 below:

**Figure 13**  
**COMMON AI IMPLEMENTATIONS**



As mentioned earlier, ML/AI can be applied to processes involving reasoning or interaction. This report discusses some case studies for each:

Reasoning (processes that generate insights, predict, recommend, and optimize)

- McDonald's – Predictive order recommendations<sup>3,4,5</sup>
- Coca-Cola – Product placement/inventory optimization and product development<sup>6,7</sup>

Interacting (interacting with text, images, video, and sound/voice)

- Ping An Financial OneConnect / Swiss Re – Smart Fast Claim<sup>8,9</sup>
- Bank of America – “Erica”, your chatbot financial assistant<sup>10,11,12,13,14</sup>
- Barclays – voice biometric verification<sup>15,16</sup>

<sup>3</sup> <https://www.nytimes.com/2019/10/22/business/mcdonalds-tech-artificial-intelligence-machine-learning-fast-food.html> (Accessed 9/2/2021)

<sup>4</sup> <https://www.fool.com/earnings/call-transcripts/2019/08/15/mcdonalds-corp-mcd-q2-2019-earnings-conference-cal.aspx> (Accessed 9/2/2021)

<sup>5</sup> <https://www.fool.com/earnings/call-transcripts/2020/01/29/mcdonalds-corp-mcd-q4-2019-earnings-call-transcrip.aspx> (Accessed 9/2/2021)

<sup>6</sup> <https://digital.hbs.edu/platform-digit/submission/coca-cola-leverages-data-analytics-to-drive-innovation> (Accessed 9/2/2021)

<sup>7</sup> <https://www.gwprime.geospatialworld.net/case-study/the-story-of-coca-cola-and-its-ai-powered-vending-machines/> (Accessed 9/2/2021)

<sup>8</sup> <https://www.prnewswire.com/news-releases/ping-an-financial-oneconnect-unveils-smart-insurance-cloud-to-over-100-insurance-companies-300514482.html> (Accessed 9/2/2021)

<sup>9</sup> <https://www.swissre.com/reinsurance/market-announcement-swiss-re-ping-an-oneconnect-partner-offer-ai-cloud-solutions-european-motor-claims.html> (Accessed 9/2/2021)

<sup>10</sup> <https://manychat.com/blog/chatbot-examples/#bank-of-america-chatbot-example> (Accessed 9/2/2021)

<sup>11</sup> <https://promo.bankofamerica.com/erica/> (Accessed 9/2/2021)

<sup>12</sup> <https://bankautomationnews.com/allposts/retail/bofas-ai-powered-assistant-erica-pulls-in-10-million-users/> (Accessed 9/2/2021)

<sup>13</sup> <https://thefinancialbrand.com/84350/bank-of-america-chatbot-erica-retail-banking-virtual-assistant/>

<sup>14</sup> <https://www.businesswire.com/news/home/20191211005345/en/Bank-of-America%E2%80%99s-Erica%C2%AE-Surpasses-10-Million-Users-Introduces-New-Capabilities> (Accessed 9/2/2021)

<sup>15</sup> [https://www.nuance.com/content/dam/nuance/en\\_au/collateral/enterprise/case-study/cs-barclays-en-us.pdf?ppi=Enterprise%20-%20Voice%20Biometrics&campaign=DEO-2017-WL-VB-FreeSpeech-Barclays-CS&campaignID=7010W000002S1VwQAK&formName=Enterprise-Web-Default](https://www.nuance.com/content/dam/nuance/en_au/collateral/enterprise/case-study/cs-barclays-en-us.pdf?ppi=Enterprise%20-%20Voice%20Biometrics&campaign=DEO-2017-WL-VB-FreeSpeech-Barclays-CS&campaignID=7010W000002S1VwQAK&formName=Enterprise-Web-Default) (Accessed 9/2/2021)

<sup>16</sup> <https://www.theguardian.com/money/2018/sep/22/voice-recognition-is-it-really-as-secure-as-it-sounds> (Accessed 9/2/2021)



### Reasoning Case Study 1: Predictive order recommendations – McDonald’s

**Problem Statement:** In recent years, fast-food sales have slowed across the United States as Americans turn to healthier alternatives. While it has performed better than many of its rivals, McDonald’s has lost customers, closed restaurants and seen its quarterly sales dip below analysts’ expectations.<sup>17</sup> McDonald’s was looking to transform its business by revamping their restaurant purchasing experience to one akin to shopping at Amazon in reaction to customers’ changing expectations.

**Solution and Outcome:** In March 2019, McDonald’s spent more than \$300 million to buy Dynamic Yield, the Tel Aviv-based company that developed the artificial intelligence tools now used at thousands of McDonald’s “drive-thru.” McDonald’s is now using digital boards programmed to market its food more strategically, taking into account such factors as the time of day, the weather, items already in the order<sup>18</sup>, the popularity of certain menu items, and the length of the wait. On a hot afternoon, for example, the board might promote soda rather than coffee. At the conclusion of every transaction, screens now display a list of recommendations, nudging customers to order more. The “drive-thru” experience with its digital screens and recommendation algorithms did indeed feel a bit like shopping online.

**During an earnings call in July 2019, Steve Easterbrook, then McDonald’s CEO, said the recommendation algorithms built into the drive-through menu boards have generated larger orders.**<sup>19</sup> By the first quarter of 2020, the digital “drive-thru” experience was deployed in all U.S. “drive-thrus” and in all of Australia<sup>20</sup>. McDonald’s also has plans “to take that similar decisioning engine-type logic and be able to use that further in kiosk and global mobile app ultimately [... to] continue getting further sales lifts in other digital mechanisms also.”<sup>21</sup>

### Reasoning Case Study 2: Product placement/inventory optimization and product development – Coca-Cola

**Problem Statement:** Coca-Cola aspired to better leverage the mountain of data it collects from customers all around the world in order to understand consumer trends and preferences. In addition, given Coca-Cola’s presence in 200+ countries with varying customer trends, it has become increasingly important for the beverage company to understand and track the evolving taste of its customers.<sup>22</sup>

**Solution and Outcome:** The company has been investing extensively in research and development, especially in AI. Coca-Cola used data collected from their vending machines to power ML/AI-based recommendations. These vending machines served as valuable sources of data to enable:

- Optimization of vending machine product placement/inventory based on consumer preferences
- Product development from collected consumer behavior insights

<sup>17</sup> <https://www.nytimes.com/2019/10/22/business/mcdonalds-tech-artificial-intelligence-machine-learning-fast-food.html> (Accessed 9/2/2021)

<sup>18</sup> <https://www.fool.com/earnings/call-transcripts/2019/08/15/mcdonalds-corp-mcd-q2-2019-earnings-conference-cal.aspx> (Accessed 9/2/2021)

<sup>19</sup> <https://www.fool.com/earnings/call-transcripts/2019/08/15/mcdonalds-corp-mcd-q2-2019-earnings-conference-cal.aspx> (Accessed 9/2/2021)

<sup>20</sup> <https://www.fool.com/earnings/call-transcripts/2020/01/29/mcdonalds-corp-mcd-q4-2019-earnings-call-transcrip.aspx> (Accessed 9/2/2021)

<sup>21</sup> <https://www.fool.com/earnings/call-transcripts/2020/01/29/mcdonalds-corp-mcd-q4-2019-earnings-call-transcrip.aspx> (Accessed 9/2/2021)

<sup>22</sup> <https://digital.hbs.edu/platform-digit/submission/coca-cola-leverages-data-analytics-to-drive-innovation> (Accessed 9/2/2021)

### *Vending Machine Product Inventory Optimization*<sup>23</sup>

Coca-Cola launched a big data open innovation challenge in 2014 through the Coca-Cola Founders Platform. Two entrepreneurs decided to input Coca-Cola's supply chain data from 60 vending machines in Newcastle, Australia, into their self-learning AI algorithm. The algorithm analyzed the transaction pattern of each machine and came up with recommendations that could help increase each machine's revenue. **By stocking the right products at the right location, Coca-Cola saw a 15% increase in transactions and the need for restocking visits dropped by 18% for the 60 selected machines.** The successful trial led to the founding of the AI firm HIVERY, and the vending analytics platform was deployed in Coca-Cola's vending machines across Australia, New Zealand, and the United States.

By integrating vending management software with an AI tool, a particular product's performance can be analyzed and predicted accurately. The AI tool identifies sales patterns based on specific location and consumer set. For example, the AI tool recognizes that consumers do not buy energy drinks when visiting hospital emergency rooms, so the company places less stock of its Monster energy drink in those particular vending machines. On the other hand, in a sports and entertainment stadium in Sacramento, visitors usually drink a lot of lemonade, so the AI tool allocated two rows of its Minute Maid lemonade beverages for the vending machine there.

The company also uses an AI tool to create a "what if" analysis. Instead of conducting a real test of placing a product onsite, the AI provides predictive analytics on how a product would perform at particular locations.

With the knowledge gathered from AI, restocking visits can be combined with maintenance service, improving the company's overall operational efficiency

### *Product Development*<sup>24</sup>

In 2008, Coca-Cola unveiled a new "Freestyle" fountain drink machine, which allowed customers to prepare drinks, mixing a variety of flavors, from their smartphone. People could order exact percentages of different mixtures and flavor additions and save them for the future. Based on monitoring data collected from the self-service soft drinks' fountains, Coca Cola launched Cherry Sprite as a new flavor.

**These Freestyle fountain machines, which generated invaluable insights into customer preferences, led to the launch of new brands and flavors.** "We discovered that there were a lot of people that really preferred Cherry Sprite. This channel has become a powerful outlet for the introduction of new brands or flavors." Thomas Stubbs, VP/Engineering and Innovation at Coca Cola.

### **Interacting Case Study 1: auto claims processing – Ping An Financial OneConnect / Swiss Re**

Problem Statement: The claims submission and processing process has historically experienced many friction points at a time when the consumers are at an emotional low point. During the process, the consumers often don't know what exactly is covered and what information is needed to make a claim, they often have to make one or more phone calls, and they often are dissatisfied with the speed of the process. With customers' expectations on the customer experience changing, insurers have been looking for ways to make the claims process easier for the insureds.

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<sup>23</sup> <https://www.gwprime.geospatialworld.net/case-study/the-story-of-coca-cola-and-its-ai-powered-vending-machines/> (Accessed 9/2/2021)

<sup>24</sup> [https://digital.hbs.edu/platform-digit/submission/coca-cola-leverages-data-analytics-to-drive-innovation/#\\_edn3](https://digital.hbs.edu/platform-digit/submission/coca-cola-leverages-data-analytics-to-drive-innovation/#_edn3) (Accessed 9/2/2021)

**Solution:** Ping An Financial Group’s OneConnect developed a digital claims processing solution to make auto insurance claims faster, easier, and more accurate to process.

In 2017, OneConnect announced their “Smart Fast Claim” solution to the public and highlighted several technical functionalities, including<sup>25</sup>:

- 1) **High-precision image recognition:** up to 90% recognition accuracy of car models, exterior parts, and 23 damage levels
- 2) **Immediate one-click damage identification:** automatic damage determination powered by ML algorithms using an uploaded image of the vehicle exterior. The repair cost is assessed in a few seconds.
- 3) **Accurate repair cost estimates:** repair costs are determined based on a sophisticated algorithm utilizing the cost of auto parts in various provinces and municipalities, among other factors
- 4) **Smart risk control:** risk library which will be used to effectively reduce the cost of claims

In 2020, OneConnect announced a partnership with Swiss Re to deploy “Swiss Re Smart Claims” to pilot the solution in Italy and Switzerland before a wider roll-out in 2021.<sup>26</sup> Swiss Re also described the solution as providing insurers with the possibility of offering direct cash payouts or direct the driver to a workshop of their choice within minutes of any accident.

**Value:** According to Swiss Re<sup>27</sup>, this saves time and claims processing costs. For policyholders, the process becomes easier, faster, and more transparent. At the same time, insurance companies benefit from process efficiency and services around the analysis of repairs for analytical insights.

Thanks to the “Smart Fast Claim,” Ping An Property & Casualty handled over 4.99 million automobile claims in the first half of 2017, with a Net Promotor Score (NPS) of 82% and intercepted approximately RMB 3 billion of leakage (the gap between optimal and actual claim settlements) risks<sup>28</sup>. When fully implemented in the industry, the platform is expected to substantially improve the overall claims efficiency and reduce the number of disputes and risk of leakage, bringing approximately RMB 20 billion revenue for risk leakage control and enhancing claims efficiency by over 40%<sup>29</sup>.

## Interacting Case Study 2: “Erica”, your chatbot financial assistant – Bank of America

**Problem Statement:** Consumers are now accustomed to the types of seamless mobile experiences provided by apps like Uber and Airbnb and want better banking experiences. Consumers know they can get great experiences elsewhere and they want it from their bank, too.<sup>30</sup>

In its consumer research leading up to the launch of the app, the bank heard three main wishes for a virtual agent, according to Christian Kitchell, AI Solutions and Erica Executive at Bank of America<sup>31</sup>:

- Help me avoid fees and stay out of trouble
- Help me reduce debt

<sup>25</sup> <https://www.prnewswire.com/news-releases/ping-an-financial-oneconnect-unveils-smart-insurance-cloud-to-over-100-insurance-companies-300514482.html> (Accessed 9/7/2021)

<sup>26</sup> <https://www.swissre.com/reinsurance/market-announcement-swiss-re-ping-an-oneconnect-partner-offer-ai-cloud-solutions-european-motor-claims.html> (Accessed 9/2/2021)

<sup>27</sup> <https://www.swissre.com/reinsurance/market-announcement-swiss-re-ping-an-oneconnect-partner-offer-ai-cloud-solutions-european-motor-claims.html> (Accessed 9/2/2021)

<sup>28</sup> <https://www.prnewswire.com/news-releases/ping-an-financial-oneconnect-unveils-smart-insurance-cloud-to-over-100-insurance-companies-300514482.html> (Accessed 9/2/2021)

<sup>29</sup> <https://www.prnewswire.com/news-releases/ping-an-financial-oneconnect-unveils-smart-insurance-cloud-to-over-100-insurance-companies-300514482.html> (Accessed 9/2/2021)

<sup>30</sup> <https://www.cnbc.com/2016/10/24/bank-of-america-launches-ai-chatbot-erica--heres-what-it-does.html> (Accessed 9/7/2021)

<sup>31</sup> <https://thefinancialbrand.com/84350/bank-of-america-chatbot-erica-retail-banking-virtual-assistant/> (Accessed 9/2/2021)

- Help me put together a plan to balance financial priorities<sup>32</sup>

Solution: In the initial rollout, Erica was capable of assisting with these functions:

- Search for past transactions across any of their BofA accounts
- Call up credit score information
- Get help navigating the app to find things such as routing numbers or ATM locations
- Schedule face-to-face meetings
- View bills and schedule payments
- Lock and unlock debit cards
- Transfer money using the Zelle person-to-person solution

A notable addition to Erica came in November 2018 with the launch of Insights, a series of proactive financial management tools, some powered by AI. The first group of insights included:

- **Spend Path:** weekly snapshot of month-to-month spending
- **FICO Score Tracker:** tracks month-to-month score changes
- **Subscription Monitor:** flags upcoming recurring charges
- **Bill Reminders:** alerts customers to upcoming BofA and third-party ebills coming due within five days of the due date

Six months after Bank of America's AI-powered digital assistant Erica reached seven million users, Erica surpassed ten million users, completing over 100 million client requests. Kitchell said the jump from seven to ten million users was caused by steady customer adoption after the bank launched proactive insights in November 2018.<sup>33</sup>

Initially, the transaction-searching function was overwhelmingly the most popular feature, according to Kitchell. Since the launch of Erica Insights, however, he says "we get a ton of engagement with bill reminders." Spend Path is also resonating, he says. "If you're running a little hot with your spending, two weeks into the month, Erica lets you see that so you can make adjustments to stay inside your budget before it's too late."<sup>34</sup>

A new insight that's coming, called Balance Watch, will notify consumers when typical spending patterns have the potential to take their balance below \$0 in the next seven days. In addition, a couple of new features were scheduled to be added to Erica in early 2020<sup>35</sup>:

- **New Card Merchant List Assistance:** After receiving a replacement debit or credit card, Erica will proactively provide clients a list of merchants and subscription services where their card information may be stored, making updates easier. Clients can also ask Erica for a list of companies that have their card on file at any time.
- **Duplicate Merchant Charges Insight:** Erica will alert clients when they may have been charged more than once for a purchase so they can take immediate action. Erica will then guide them through the process of filing a dispute when necessary.

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<sup>32</sup> <https://thefinancialbrand.com/84350/bank-of-america-chatbot-erica-retail-banking-virtual-assistant/> (Accessed 9/2/2021)

<sup>33</sup> <https://bankautomationnews.com/allposts/retail/bofas-ai-powered-assistant-erica-pulls-in-10-million-users/> (Accessed 9/2/2021)

<sup>34</sup> <https://thefinancialbrand.com/84350/bank-of-america-chatbot-erica-retail-banking-virtual-assistant/> (Accessed 9/2/2021)

<sup>35</sup> <https://www.businesswire.com/news/home/20191211005345/en/Bank-of-America%E2%80%99s-Erica%C2%AE-Surpasses-10-Million-Users-Introduces-New-Capabilities> (Accessed 9/2/2021)

**Value:** Erica is well on its way to making the banking customer experience more delightful for consumers. Consumers not only have an alternative channel to perform their banking, they also have Erica “looking at people’s situation and behaviors and offering proactive guidance and insight to help consumers stay more connected with their cash flow, to avoid surprises and identify savings opportunities.”<sup>36</sup> However, they can turn them off if they wish. Few customers do that, it would seem. After Insights was launched, daily engagement with Erica doubled. “On average 150,000 customers now tap on the insights proactively shared by Erica each week,” the bank said.

Peter Wannemacher, from the research company, Forrester, says their view of the Erica chatbot is “decidedly positive,” and that “Erica is the linchpin of Bank of America’s current digital banking experience for many of their customers.” However, it is too early to tell whether Erica will provide a sustained competitive advantage that flows through to Bank of America’s financial results. Early results are positive as Erica’s overall satisfaction tracking is at about 82-83%, “which compares very favorably to all of [the bank’s] other digital channels,” according to Kitchell. He also says early signals have been good with regard to Erica helping to facilitate deeper relationships.<sup>37</sup>

### **Interacting Case Study 3: voice biometric verification – Barclays**

**Problem Statement:** Results from Barclays’ client satisfaction research indicated that its clients wanted a better experience from the telephone channel security processes, reducing the time it takes to complete the authentication process for them to be authenticated before their query can be dealt with. Barclays’ client service center-based relationship managers also voiced concerns about the process, explaining they did not feel comfortable asking their clients a comprehensive set of security questions when they had already established a relationship.

**Solution:** Barclays implemented FreeSpeech from Nuance, a speaker verification solution. The technology authenticates the caller while ensuring the flow of the call is not interrupted. During the opening seconds of any call with an agent, Nuance’s FreeSpeech voice biometrics solution checks a client’s voice against a voiceprint they previously enrolled with Barclays, returning a verification result to the agent and, assuming it is positive, the Barclays CRM system loads the client’s account management information instantaneously.

The verification data is acquired passively in the background, eliminating cumbersome and intrusive authentication questions. The technology determines the closeness of a match to the stored voiceprint using subtle unique characteristics, such as vocal tract length and shape, pitch and speaking rate, which contribute to more than 100 evaluated characteristics. In addition, the authentication process is now more secure. By its very nature, the speaker’s voiceprint is unique and non-transferable, making the technique safer than any password-based or “challenge question” process.

**Value:** Being able to identify the client in the background seamlessly using FreeSpeech while the customer is speaking, makes the identification process easy for the agent and painless for the customer. Since the deployment went live in August 2012, an average of 65% of calls are now voice authenticated by the solution, allowing customers much easier access to check their balance or get updates on payments.

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<sup>36</sup> <https://thefinancialbrand.com/84350/bank-of-america-chatbot-erica-retail-banking-virtual-assistant/> (Accessed 9/2/2021)

<sup>37</sup> <https://thefinancialbrand.com/84350/bank-of-america-chatbot-erica-retail-banking-virtual-assistant/> (Accessed 9/2/2021)

As customers are automatically verified as they speak with a service center agent, authentication time has been cut significantly. In addition, the new approach enables agents and relationship managers to focus on clients' needs rather than the mechanics of authentication. Other benefits gained, noted from post-call customer service surveys, include:

- 71% of clients are more satisfied with voice authentication compared to the previous security process
- 90% reduction in complaints regarding the security service
- 15% reduction in average call handling time
- Reduction in time to authenticate, between two to seven minutes using the old process, down to 20 seconds using voice authentication, freeing up capacity in their global service centers
- Time freed up for bankers and relationship managers to focus on revenue generation resulting from clients calling the service centers far more frequently because of the improved service

### 3.1.4 IMPLEMENTATION CONSIDERATIONS

In the global "State of AI in the Enterprise survey" conducted by Deloitte<sup>38</sup> in the fourth quarter of 2019 of 2,737 IT and LOB executives, 26% were classified as "seasoned" adopters of AI, 47% were "skilled" and 27% were "starters." Twenty-six percent of all respondents said that AI technologies enable them to establish a significant lead over their competitors. For seasoned adopters, this rises to 45%. AI is becoming a core part of organizations' strategy and operations and lessons are being learned about the implementation as the market is now moving into the "early majority" chapter of this maturing set of technologies. Adoption maturity varies by industry, but is generally most advanced in Banking, followed by Retail, then Insurance. In discussions with Deloitte Canada's Chief Data Scientist, Ian Scott, he noted that banks were piloting five years ago and putting applications into production two years ago, although they haven't fully scaled up yet. However, as ML/AI is maturing, regulators have begun to look more closely at the usage of ML/AI applications. This will make the application of ML/AI more difficult, particularly in the areas of Pricing and Underwriting for insurance.

#### Barriers to deployment and scaling

As mentioned in an earlier section, there are still a portion of companies that are struggling to generate positive or meaningful returns on their AI investments. Gartner research shows only 53% of projects make it from artificial intelligence (AI) prototypes to production<sup>39</sup>. Gartner's survey indicated that CIOs and IT leaders find it hard to scale AI projects because they lack the tools to create and manage a production-grade AI pipeline.

There are several factors that currently hinder the scaling of ML/AI across an organization:

- **Lack of business alignment:** organizations struggle with engaging the business to define use cases that can be deployed with a meaningful impact
- **Death by proof of concept:** organizations are struggling to operationalize their ML/AI proofs of concept
- **Data-related issues:** companies are still suffering from data issues, particularly resulting from siloed data sources
- **Chasing the latest techniques:** many companies are too focused on newer ML/AI techniques like deep learning rather than maximizing their benefits from established techniques

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<sup>38</sup> <https://www2.deloitte.com/cn/en/pages/about-deloitte/articles/state-of-ai-in-the-enterprise-3rd-edition.html> (Accessed 9/2/2021)

<sup>39</sup> <https://www.gartner.com/en/newsroom/press-releases/2020-10-19-gartner-identifies-the-top-strategic-technology-trends-for-2021> (Accessed 9/2/2021)

A lot of the problems holding back ML/AI are organizational, not technical. In addition, there are several emerging risks that AI adopters are concerned about, one of which is the regulatory response to address ethics, transparency, and explainability in AI.

### Lack of business alignment

Often, executives and leaders embedded in the operations of a company fail to recognize what they actually want from their data and AI solutions. Leaders do not ask the right questions up front and teams are often asked to implement AI for the sake of implementing AI. On the other hand, data scientists often erroneously believe that their job is to build models rather than get a solution into production that will add value to the organization. Lastly, end users in the business often don't know what to do with the model and the corresponding results when handed over. It is important for the business to be asking the right questions and framing the problem correctly. Conversely, data scientists need to engage with the business to truly understand what adds value to the organization and how that value is measured. This will ensure that the created model will solve for a solution that is in line with the problem that actually needs solving.

To address these issues, organizations must educate and upskill their leaders and employees on the use and understanding of ML/AI. While they do not have to be trained on how to build models, they need to understand how to recognize a ML/AI problem when they see it and also need to be actively involved in helping the data scientists solve the problem at hand. Like with any tool, people in the business need to understand how ML/AI fits into the business processes, how it adds value, and what its limitations are. Furthermore, proper change management needs to be implemented to get alignment and buy-in over the value that ML/AI will add.

To get alignment across the business, companies cannot rely on their data scientists having all the skills necessary to meet the needs of a ML/AI pipeline. "AI talent is not one thing, it's multiple things," said Erick Brethenoux, research vice president at Gartner. "The biggest misconception in the journey to successfully scaling AI is the search for 'unicorns,' or the perfect combination of AI, business and IT skills all present in a single resource. Since this is impossible to fulfill, the focus, instead, should be on bringing together a balanced combination of such skills to ensure results."<sup>40</sup> Without going into too much detail, as this is out of the scope of this research, a proper multi-disciplinary team to support ML/AI projects would have a combination of the following disciplines/skillsets: Data Scientist, Data Engineer, Visualization Developer, Information Designer, Business Analyst, and Project Manager.

### Death by proof of concept

One of the biggest barriers toward the implementation of this technology is that organizations fail to recognize how to put the ML/AI models into production, i.e., ignoring the "last mile." Organizations tend to pile up on proofs of concept without going further into production. Furthermore, data scientists often spend too much time building the wrong solution as they do not consider how the model will be used by the end user, resulting in the proofs of concept getting put on the shelf. This issue needs to be addressed in the early design phases of any solution developed by considering: how will the solution add value to the business (rather than just proving that the math works), how will an end user use the results of the model, how will the end user's workflow change, how will the model go into production, and what are the barriers associated with putting the model into production. As a part of this design process, teams should consider these factors assuming their proof of concept will work, so that if and when the proof of concept is successful, a plan is already in place for how to put the solution into production.

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<sup>40</sup> <https://www.gartner.com/en/newsroom/press-releases/2020-10-01-gartner-survey-reveals-66-percent-of-organizations-increased-or-did-not-change-ai-investments-since-the-onset-of-covid-19> (Accessed 9/2/2021)

### Data-related issues

ML/AI continue to be plagued by issues related to data. While most are aware of the data quality issues that result in much time spent on cleaning data, one of the main barriers to scaling is that data tends to be located in separate, siloed systems. These leads to several issues:

- General lack of awareness of available data
- Finding the required data takes a long time
- Once data is found, it is difficult to understand and explain what the data represents, particularly across different lines of business.

This often results in ML/AL solutions confined to local line of business levels rather than being deployed across the enterprise.

To address these issues, proper data governance needs to be put in place to break down data silos by making data available to everyone with proper security measures in place by ensuring that data is explained so that end users know what the underlying data represents. Modern tools exist to help business users address these concerns – see Section 3.5. Data Governance and Sharing. In addition, companies could consider investing in cloud infrastructure, with a particular focus on building integrated data platforms to provide easier access to data across the organization.

### Chasing the latest techniques

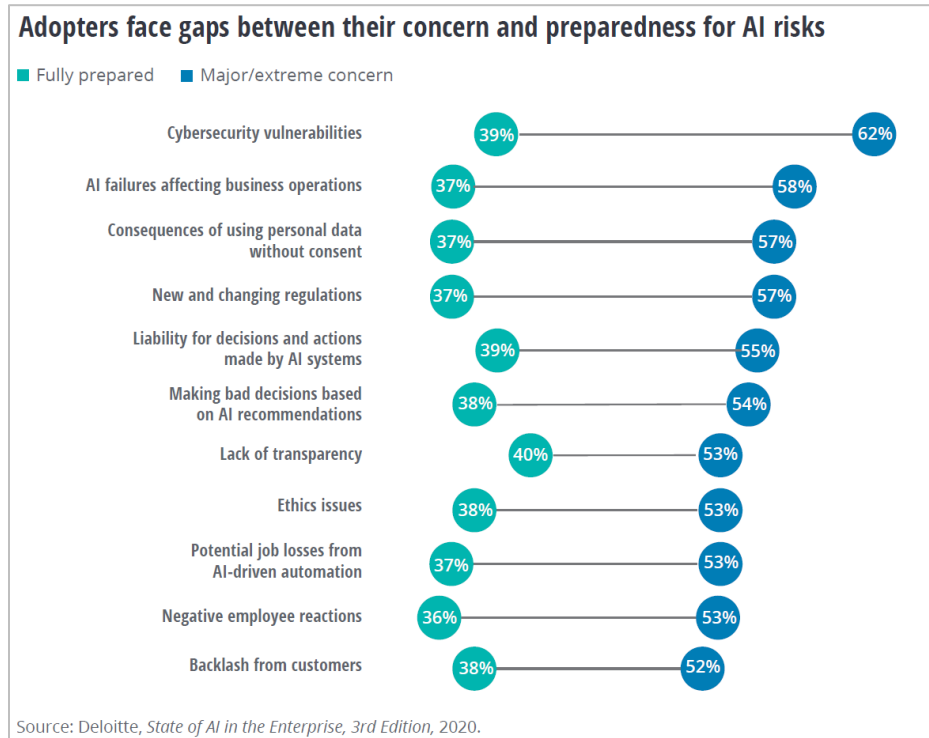
Often, the focus in developing an ML/AI solution is on building a better model or tuning the model to improve results. Companies frequently put too much effort into chasing the newest techniques, like Deep Learning, when established techniques (e.g., logistic regression for structured data) informed by business context is usually good enough. Rather than focus on improving models, greater focus should be placed on improving and augmenting data and ensuring that the model is fit for the purpose informed by the business context.



### Emerging risks, including regulatory responses to ethics, transparency, and explainability concerns

From another Deloitte study, it was found that 56% of AI adopters agreed their organization was slowing adoption of AI technologies because of the emerging risks<sup>41</sup>. The top emerging risks of concern for AI adopters are described in Figure 14 below.

**Figure 14**  
**CONCERNS FOR AI ADOPTION**



Source: Deloitte, *State of AI in the Enterprise, 3<sup>rd</sup> Edition, 2020*

Not surprisingly, many of the top risks are focused on ethics, transparency, and explainability. One particular tangible consequence surrounding these issues would be the regulatory response to such concerns. Fifty-seven percent of AI adopters have extreme concerns about how new and changing regulations could impact their AI initiatives. Adopters are anticipating the negative effects of factors such as the EU's "A European strategy for data," Canada's "Directive on automated decision-making," and proposed legislation concerning facial recognition. While companies agree that AI should be heavily regulated by government, many also fear that ineffective regulations will hamper research, innovation, and competitive advantage. In general for all risks, AI adopters should be proactively addressing risks and applying appropriate risk management practices. However, a detailed discussion of risk management is out of scope of this research paper.

<sup>41</sup> <https://www2.deloitte.com/cn/en/pages/about-deloitte/articles/state-of-ai-in-the-enterprise-3rd-edition.html> (Accessed 9/2/2021)

### 3.1.5 ACTUARIAL CURRENT STATE AND FUTURE OUTLOOK

Actuaries' familiarity with ML/AI, as seen in Section 3.0.1 Technology Familiarity, varies from little knowledge to extremely familiar. On average, actuaries have a reasonable understanding of ML/AI, but are not confident enough to explain it to someone else.

From Section 3.0.2 Implementation Maturity, we observed that ML/AI on structured data had both a wider range and higher average when it comes to implementation maturity compared to ML/AI on unstructured data. This can be explained by the larger number of companies planning to dip their toes into ML/AI by starting with structured data. In contrast, participants who are further along in their ML/AI journey will be the ones who are willing to pilot and implement this on unstructured data. Furthermore, Section 3.0.5 Technology Value vs. Ease of Implementation shows that participants are perceiving a higher potential for value that can be extracted from unstructured data, which is much harder to analyze using traditional techniques.

Surprisingly, Section 3.0.4 Implementation Maturity – Life vs. P&C shows that ML/AI on unstructured data is showing higher average maturity for Life participants compared to P&C ones. This could be due to a lower sample size for Life companies implementing this or could be a result of higher value realized from the use cases for Life vs P&C. However, given the relatively small sample size on ML/AI on unstructured data, it is difficult to conclude on the driver of this result with a large degree of certainty.

#### Overview: ML and AI – Structured data:

Out of the 14 participants interviewed (covering Life, Health, Pensions and P&C), ten mentioned that ML/AI on structured data is in use today among actuaries, meaning they have either completed a pilot, implementation, or beyond.

Amongst the 11 Life and P&C respondents:

- The majority have started implementing at least one use case using ML/AI on structured data or are currently scaling across their organizations.
- No respondents have indicated that they are still in pilot phase only.
- Two respondents have current plans to implement ML/AI on structured data over the next three years but have not yet started.

Amongst the health and pension respondents, two indicated they are currently using ML/AI on structured data.

#### Overview: ML and AI – Unstructured data:

Amongst the 11 Life and P&C respondents:

- Six respondents indicated ML/AI on unstructured data was being implemented or beyond for at least one use case involving actuaries.
- Three respondents had no plans in the next three years.
- Two provided no response.

Amongst the health and pension respondents, two indicated they were currently using ML/AI on unstructured data, but it was unclear the extent to which actuaries are involved.

Use of ML/AI (both structured and unstructured data) is trending upwards in actuarial work, but still subject to implementation challenges. However, the future outlook for actuaries using ML/AI is very positive, as one respondent describes:

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*“Our company has transitioned from using pure data scientists to actuaries for predictive analytics work. Actuaries running models are achieving 5-10x productivity over using pure data scientists due to their fundamental business knowledge and the ability to convert model outputs to consumable formats for downstream consumers to use. We have heard that several other companies are achieving similar results.” – one Life and Annuity respondent*

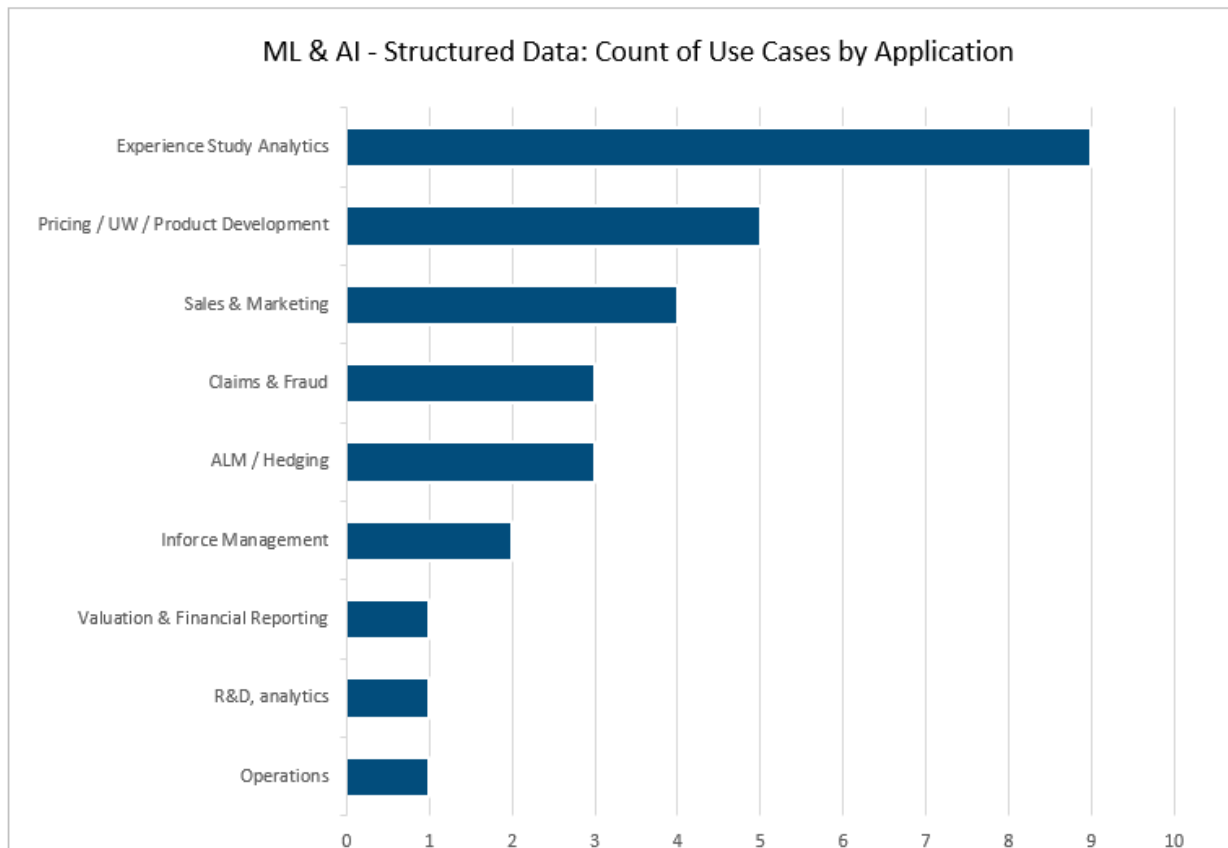
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Further details on the current state of actuarial usage and future outlook for actuaries are discussed below. In general, moderate value from ML/AI on structured data is perceived by respondents, but challenges in extracting further value from more complex techniques comes from the lack of comfort in the acceptance of results from leadership, auditors, and regulators due to their lack of familiarity. With regard to ML/AI on unstructured data, slightly higher value was perceived by respondents, but additional challenges come from the lack of expertise from actuaries, a large variance on potential value, difficulty in setting appropriate benchmarks, and difficulty in demonstrating high enough return on investment on some use cases due to high implementation effort. Overall, the potential for value is greater for unstructured data analysis as it can add much more than what is currently possible under traditional actuarial analysis, whereas analysis on structured data has only relatively moderate incremental value over traditional techniques unless new data sources are employed.

#### Current State: ML/AI – Structured data:

ML/AI on structured data is being considered or used in a wide range of applications, including experience studies, pricing/underwriting/product development, valuation/financial reporting, claims and fraud, etc. Figure 15 below shows the number of use cases mentioned across all respondents grouped by application. Some examples are provided in the list that follows the figure.

**Figure 15**  
ML AND AI STRUCTURED DATA USE CASES



Source: Actuarial interviews and Deloitte analysis

- Experience Study Analytics:**  
 Companies' experiences in their transition to using ML/AI instead of traditional actuarial techniques for experience studies varies greatly by each individual respondent. The front-runners have started using more complex ML/AI methods and have fully transitioned to ML/AI across several experience studies (e.g., mortality, morbidity, and lapse). On the other end of the spectrum, companies that are behind are still piloting GLMs or are using simpler regression analysis. However, most companies are moving from traditional techniques to GLMs and incorporating more advanced analytics methods for experience studies.
- Pricing / Underwriting / Product Development:**  
 Companies are using ML/AI for a variety of purposes in this area. The front-runners have started using more advanced ML techniques to replace GLMs in P&C for variable selection. This leads to a stronger fit of data but additional complexity in justification. Another example is the use of more advanced techniques such as GBMs for P&C territorial work. In addition, ML contributes to the acceleration of underwriting processes by reducing human touchpoints.
- Sales and Marketing, Claims and Fraud:**  
 ML/AI on structured data plays an important role for front runners in marketing/sales optimization, demand modeling, retention modeling, customer retention, call center analysis, etc. In addition, ML is used

by marketing/sales teams to identify or predict lapsed policies. ML/AI is also used by several companies for fraud detection.

- **ALM / Hedging:**

One advanced use case was collected where a traditional statistical model was used to predict interest sensitive lapse assumptions to calibrate for UL dynamic lapse (a use case which straddled the line between ALM and experience studies). Another pilot use case was mentioned where Neural Networks were used to approximate fair values to reflect hedging in projection systems for Variable Annuity guarantees. One other respondent mentioned no ongoing pilots, however, was looking into using Python for portfolio optimization SAA and investment strategy.

- **Inforce Management:**

ML models are used to score and monitor inforce portfolios to monitor mortality risk over time.

- **Research & Development (R&D) / Analytics:**

A wide set of ML models using structured data (e.g., XGBoost and Boosted methods) are used by actuaries in areas such as customer behavior models and operations. Some organizations are seeking alternative data sources to be used in R&D research that is not production-related or for ad-hoc analytics.

On the health side, there has been efforts to use social determinants of health (e.g., geographic data, behavioral data, etc.) to supplement claims to predict metrics relating to COVID such as incidence and death rates. The links between these social determinants of health and COVID incidence, for example, have been used to predict which counties might have higher incidence rates in the future.

Another health application has been performing predictive analytics on Medicare Star Ratings, which is an indicator of the performance of the health plan in several categories (e.g., quality of care, customer service, etc.). Health plans want to increase their star ratings, so they have aimed to determine what is driving those star ratings in terms of behaviors and specific measures. Further analytics is performed to determine what is causing those behaviors by looking at past behaviors. The analysis generates actionable insights with the goal that those actions ultimately increase the star ratings.

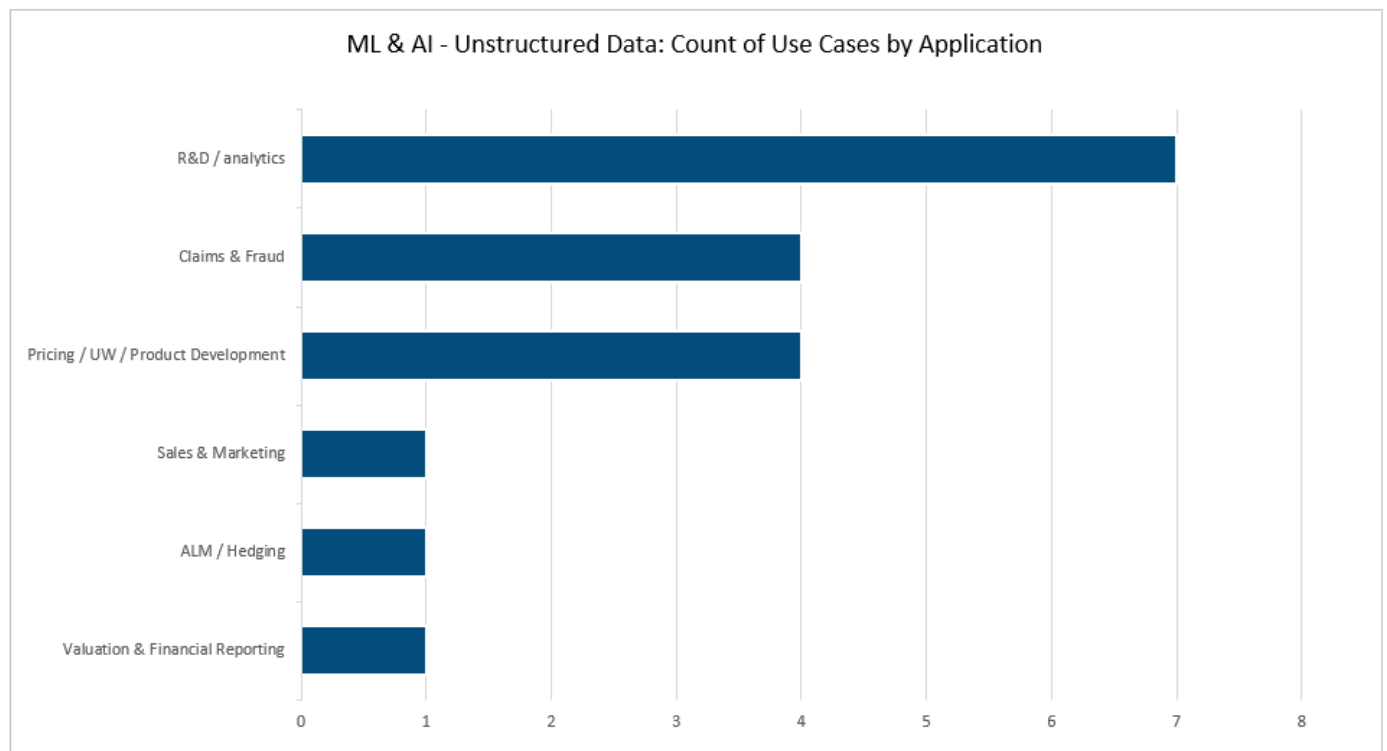
- **Valuation and Financial Reporting:**

Pilots have started using ML/AI on structured data in individual claims reserving and ultimate loss modeling for Commercial and Auto business. For health, there is a much lower need for complex techniques as the actuarial calculations are comparatively simple. However, predictive models can still be used on the health side for calculation of risk adjustment and analysis of claims data.

### Current State: ML/AI – Unstructured data:

Likewise, ML/AI on unstructured data is being considered or applied in a wide range of functions with higher concentration in R&D / analytics and pricing/underwriting/product development, as shown in Figure 16 below and expanded in the subsequent list.

**Figure 16**  
ML AND AI UNSTRUCTURED DATA USE CASES



Source: Deloitte analysis based on actuarial interviews

- Research & Development (R&D) / Analytics:**  
 With respect to use of unstructured data, front-runners mentioned the use of techniques such as Convolutional Neural Networks (CNN) in image recognition to perform tasks such as extracting data from household and satellite/aerial imagery and reading odometer photos. Several companies mentioned the analysis of text and call center conversations, such as for generating new explanatory variables. In addition, mortality and morbidity modeling is being performed using unstructured data (i.e., images and text).
- Claims and Fraud**  
 Image recognition techniques are used to examine damage and estimate costs from pictures of vehicles and homes. In addition, Natural Language Processing (NLP) techniques on text has been used for claims classification and reading claim summary reports. Fraud detection was another use case mentioned utilizing unstructured data.

- Pricing / Underwriting / Product Development:**  
 One Life use case was the digitization of unstructured data to accelerate underwriting files. Analysis of call center data has been mentioned here as well. On the P&C side, ML/AI is used on the information gathered from reading claim photos for the purposes of rating. In addition, risk rating is performed on segments of roads using accident information, which is then used to map out policyholders' risks based on home and work addresses.
- Sales and Marketing:**  
 ML/AI has been used to analyze unstructured data for the purposes of Net Promoter Score (NPS) analysis.
- ALM / Hedging:**  
 One respondent commented on plans to pilot unstructured data in their ALM process but did not provide specifics.
- Valuation and Financial Reporting:**  
 Text mining has been piloted for individual claims reserving in P&C. However, the value in applying ML/AI to reserving is situationally dependent – higher for new blocks of business and lower for stable blocks.

Note that we did not collect any health or pension use cases on analyzing unstructured data by actuaries. However, one health respondent commented on the analysis of unstructured text such as Electronic Medical Records (EMR) and test results in the context of care management. However, this application is not driven by an actuarial team; rather, actuaries would be involved as Subject Matter Experts or end users. Another non-actuarial health use case is the analysis of call centers to detect key words or themes as a basis for proactive engagement and outreach with the goal of increasing Medicare Star ratings.

#### Other comments on current state of ML/AI:

Our analysis illustrates, albeit with a small sample size, that P&C participants are further along in their ML/AI journey using structured data relative to the Life and Annuity companies in terms of the variety of use cases covered, which is in line with general perception amongst actuaries today. For example, P&C companies have been using GLMs for at least a decade and have been exploring a wider set of models. Currently, GLMs are commonly adopted by all actuaries thanks to their ease of implementation. Actuaries have also been starting to employ more complex techniques (e.g., Generalized Additive Models (GAMs) and Random Forests) to create more accurate fitting results, but ease of implementation can vary by project. Respondents have noted that they have had more difficulty in extracting value from complex techniques, despite realizing better model fits, because of difficulties in gaining comfort over relying on model results by leadership, regulators, and auditors resulting from the techniques being harder to interpret and understand. Given the current lack of understanding by various stakeholders, the risk of unintended consequences is higher.

For analysis on unstructured data, P&C respondents still have an edge when it comes to a variety of use cases, but Life companies are exhibiting a higher average implementation maturity on their use cases compared to P&C use cases. This might be due to the small number of responses received from Life respondents, which could be focused on higher value use cases where the benefits can be extracted with more certainty. Furthermore, Life companies might be more preoccupied with employing ML/AI techniques on structured data prior to pilot use cases on unstructured data. Again, we note that care must be taken in drawing too many conclusions due to the small sample size when split by line of business. Nevertheless, participants have mentioned there are difficulties in setting up appropriate benchmarks for good performance and in demonstrating business value of these complex concepts due to high implementation effort for such techniques.

Organizations have varied in the usage of only pure data scientists vs. actuaries in their journey of implementing ML/AI. One respondent suggested the transition from using pure data scientists to actuaries for running ML/AI models has achieved 5-10x productivity over using pure data scientists due to actuaries' fundamental business knowledge and the ability to convert model outputs to consumable formats for downstream consumers to use. The respondent heard that several other companies were experiencing similar results. This idea appears to be more prevalent for the front-runners of ML/AI usage, but is not the case for many of our participants who still maintain a much stricter separation between actuaries and data scientists.

### Future Outlook

More actuarial work is expected to be model driven over time as ML/AI on structured data become more sophisticated and easier to implement. However, the increased sophistication brings about less transparency, which results in a higher desire for explainability from external stakeholders. Looking ahead, more use cases can be explored with an advancement in data, software, and techniques. For example, automated modeling software might radically change the way models are implemented, but also require greater model governance and review. Actuaries can broaden their work by assisting operations in fraud detection, analysis of customer calls, disability claims management, analyzing customer interaction data, etc. While some effort to upskill actuaries to data scientists exists, the jump is not as large as many make it out to be, particularly for actuaries who have coding experience.

Streamlined data access will be helpful in downstream analysis (e.g., ML/AI or data visualization) and unstructured data will create new opportunities for both Life (e.g., mortality and morbidity modeling) and P&C (e.g., aerial images) business. However, the investment needed to analyze unstructured data can be rather high, so the return on investment will need to be considered with respect to actuaries learning how to employ these advanced techniques.

Roles outside of insurance companies have been demanding skillsets that are actuarial in nature. For health actuaries, as an example, this presents opportunities for them to get involved in other types of companies where other kinds of professionals, such as epidemiologists, health economists, etc., have been working. There have been an increasing number of roles in life sciences and healthcare companies -- particularly at medical technology companies, medical manufacturers, diagnostic companies, pharmaceutical companies, etc. -- over the last three years asking for skillsets that actuaries possess. This trend is still fairly nascent so companies will have to go through an initial adjustment period of figuring out how to leverage these actuarial skillsets.



## 3.2 BUSINESS INTELLIGENCE TOOLS AND REPORT GENERATORS

### 3.2.1 DEFINITION AND TERMINOLOGY

#### **Business Intelligence Tools (Data Visualization)**

Data visualization tools have emerged to support the communication and delivery of analytics and insights around data. Often, these tools are bundled in as part of self-service business intelligence (“BI”) reporting tools, which are also beginning to include additional analytics functionality. Nomenclature for these tools has changed over time so, as a starting point, we provide the following definition from the Gartner’s Magic Quadrant for Analytics and Business Intelligence Platforms<sup>42</sup>:

*“Analytics and **business intelligence (ABI) platforms** are characterized by easy-to-use functionality that supports a full analytic workflow – from data preparation to visual exploration and insight generation – with an emphasis on self-service usage and augmented user assistance.”*

This section’s focus is on the **data visualization** component of BI tools, where users “*build interactive key performance indicator (KPI) dashboards using common chart forms (bar/column, line/area, scatter, pie and geographic maps).*”<sup>43</sup>

For the purposes of this report, we will interchangeably refer to “BI tools” or “data visualization tools” when referring to the use of data visualization tools. We focus on the data visualization aspects of BI tools to provide separation from the data transformation component of BI tools, which would fall under Section 3.3 Extract-Transform-Load (ETL) / Data integration and Low-Code Automation platforms of this report. Using the same logic, we do not focus on ML/AI capabilities that are often bundled with BI tools since ML/AI is covered in Section 3.1 Machine Learning and Artificial Intelligence. Data visualization tool vendors range from offering tools that originally specialized in data visualization aspects (e.g., Tableau), those bundled as part of a broader BI platform (e.g., Microsoft Power BI), those bundled as part of a cloud platform (e.g., Amazon AWS, Microsoft Azure), and those that are part of general open-source programming tools (e.g., R, Python)<sup>44</sup>.

#### **Documentation Generators (Markdown / CommonMark)**

There are several variants of Markdown but they can generally be described as follows:<sup>45</sup>

***Markdown** is a lightweight, plain text markup language for creating formatted text in structured documents (usually HTML but can include other formats) using documentation generators (defined below). This allows a developer to produce a report or webpage as part of the code that is used in a program or script (e.g., data analysis).*

Implementations of Markdown have diverged considerably over time. As a result, CommonMark was proposed as a standard, unambiguous syntax specification for Markdown, along with a suite of comprehensive tests to validate Markdown implementations against this specification.<sup>46</sup>

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<sup>42</sup> Magic Quadrant for Analytics and Business Intelligence Platforms (Feb 15, 2021) - <https://www.gartner.com/doc/reprints?id=1-254T1IQX&ct=210202&st=sb> (Accessed 9/2/2021)

<sup>43</sup> <https://www.gartner.com/doc/reprints?id=1-254T1IQX&ct=210202&st=sb> (Accessed 9/2/2021)

<sup>44</sup> <https://www.gartner.com/doc/reprints?id=1-254T1IQX&ct=210202&st=sb> (Accessed 9/2/2021)

<sup>45</sup> <https://en.wikipedia.org/wiki/Markdown> (Accessed 9/2/2021)

<sup>46</sup> <https://commonmark.org/> (Accessed 9/2/2021)

A **documentation generator** is a programming tool that generates software documentation intended for programmers or end users from a set of source code files.<sup>47</sup> Many of these tools use Markdown as input to generate the documentation in HTML, PDFs, etc.

Common documentation generators include R Markdown, Sphinx, and MkDocs. Common features include automatic sync with version control system (described in Section 3.4 Collaboration and Connected Data), syntax highlighted code samples, and multiple versions of documentation to match different branches of development code.<sup>48</sup>

Note that, throughout this report, we will use the term “Markdown” synonymously with “Documentation Generators.”

### 3.2.2 VALUE PROPOSITION

#### **Business Intelligence Tools (Data Visualization)**

BI tools offer many benefits to organizations, including:

1. Enabling data-driven insights to be delivered to non-technical audiences in an easier manner
2. Faster production of visualizations within the business enhanced by easy self-serve analysis
3. Accessibility of results from a variety of data sources
4. Scheduled and/or programmatic production of results

One issue that BI tools address within organizations producing data-driven insights is poor and/or slow communication to non-technical audiences, particularly executives. In order to be effective, organizations require insights underlying increasingly large datasets to be prepared and communicated in an easy-to-understand format with a user-friendly interface that allows for easy access to drill-downs and iterative analysis. Often, data analysis does not allow for quick answers to ad-hoc questions underlying the insights presented using traditional methods, a problem usually mitigated by using layers of appendix material to create potential views of interest.

Furthermore, turnaround times for delivering these insights has historically been inhibited by the need to heavily rely on Business Intelligence (BI) developers residing in separate IT departments whenever a dashboard or visual analysis outside of Excel was required to deliver insights. This type of process requires more time and effort due to the dependency on BI teams, which often support multiple functions within an organization. Modern data visualization and BI tools move the onus of creating reports and dashboards away from BI developers to the analysts in the business line function. In addition, creation of such visualizations and dashboards can be developed much more rapidly than traditional tools. Many vendor designs are “low-code” and easy to learn, while the top vendors maintain strong design principles in their visualizations / dashboards, increasing the signal-to-noise ratio in the graphics presented. Essentially, by moving away from Excel to BI tools, end users in the business are empowered, with less help required from IT, to “self-serve” and create the analysis that drives faster comprehension of their data and corresponding decision-making by the executives and management.

Other benefits of BI tools include repeatable processes to reproduce or programmatically produce visualizations, potential live updates of data, connectors to a variety of underlying data sources, and new mediums to consume insights such as a website or app on a tablet.

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<sup>47</sup> [https://en.wikipedia.org/wiki/Documentation\\_generator](https://en.wikipedia.org/wiki/Documentation_generator) (Accessed 9/2/2021)

<sup>48</sup> <https://docs.readthedocs.io/en/stable/index.html> (Accessed 9/2/2021)

This technology sees most success in work involving open-ended data exploration and addressing targeted questions from executives to be answered on a regular basis where dynamic views and drilldowns are required. This becomes an essential benefit in the analytics pipeline where you need to explain the story behind the data to a non-technical audience. Often, using current tools, the production of an alternate view to address a question from management involves going back to the analyst's desk and scheduling a subsequent meeting to answer any questions raised. Alternatively, presenting an analysis might also rely on preparing many appendices to account for the various questions and cuts of data that could be requested by management.

With all the pros presented, there are also a few limitations to the technology, particularly:

1. Performance on larger datasets is dependent on proper data preparation and dashboard design
2. Value extracted from the tools is dependent on how the end user uses the tool and results
3. Dashboard distribution methods may reduce value for organizations, particularly for software that requires licenses to read the created dashboards
4. Misuse and misinterpretation can potentially occur as part of the self-service nature of dashboards without a proper explanation of the details underlying the data and metrics presented

In order to generate the analysis and outline the insight, data often needs to be preconfigured in a specific structure to maximize the benefits. Furthermore, poor dashboard design via the use of too many calculated variables, filters, etc. can hinder performance for end users. To mitigate these issues, thoughtful data preparation and dashboard design must be utilized for faster performance, particularly with larger datasets. When dashboards are configured to perform slicing and dicing on granular record-level data, the recalculations required to reproduce the view of the data can take several seconds, although the range of the performance outcomes highly depend on the situation. A similar analogy to dashboard performance would be that applied to spreadsheets, where a poorly designed model built in a spreadsheet can grind the user experience to a halt when every update of the spreadsheet requires the need to recalculate the spreadsheet. Such performance issues can hinder the uptake of such technologies, particularly where the latency in presenting insights causes friction in the user experience.

The value that comes from data visualization tools is highly dependent on how the end user utilizes the tools. Firstly, if the software used requires a license to simply read the dashboards, then value extracted from dashboards is dampened, not just from the licensing costs, but also from the increased friction needed to read the results. Secondly, how the user utilizes the tools can make a huge difference on the extracted value. For example, users are going to see limited value if the tools are simply used to produce static PowerPoint slides and export data tables into Excel. As a result, users need to be educated on how to use these tools and how to ask the right questions to maximize the value from BI tools.

### ***Documentation Generators (Markdown / CommonMark)***

Data analysis is just one part of a bigger process of delivering data-driven insights. When scripts are run and data is processed, the results need to be brought together in a presentable report and format for its target audience, be it other programmers on the development team or end users in the business. Under a traditional manual approach, this process takes up a good amount of time, from generating and saving outputs or source code snippets in a reader-friendly presentation and then pasting it into the final report. Furthermore, if a change took place within the data, analysis, or results, the entire process would need to be done again manually. In short, when using Markdown, there is no need for the preparer of the analysis to maintain a report that is separate and unlinked from the code. This direct production of documentation from the code is further enhanced when layered on top of Source Control Management tools (described in Section 3.4 Collaboration and Connected Data). This allows developers to automatically sync their documentation with the version of the program they are developing. Furthermore, such documentation generation tools allow for easier maintenance of multiple versions of documentation synced to different branches of the code. Lastly, these tools allow for the inclusion of easier to read syntax-highlighted code snippets within the documentation when such functionality is needed to explain the inner workings supporting the content in the report.

R Markdown, for example, provides quick and fully reproducible reporting using R<sup>49,50</sup>. It allows one to code and write a report in one document without having to spend time on copying and pasting the outputs from R to the final report. Since the report is coded within the document, changes that occur do not require repetition in the reporting process, with the coder simply needing to “re-knit” the document at the push of a button. This helps the individual focus more on the content while R takes care of the presentation for you. Using a “notebook” interface to weave together narrative text and code allows an analyst to produce elegantly formatted output while choosing from a variety of output styles such as HTML, PDF, or even PowerPoint slides. Furthermore, this enables any analysis contained in a report to be easily reproducible given that the report and analysis are contained together. R Markdown combined with other packages facilitates producing quick and reproducible reporting with embedded executable R code chunks. These chunks are unobtrusive and easy to read, making it easy for users to collaborate and share code.

R Markdown can also include interactivity with the use of Shiny and other packages<sup>51</sup>. The discussion of the use of Shiny and similar tools is documented as part of BI Tools in this section. In summary, Shiny allows someone to build web apps wrapped around their data analysis easily with minimal web development skills.

### 3.2.3 CASE STUDIES

#### ***Business Intelligence Tools (Data Visualization)***

Case studies of data visualization are commonly found in the public domain where data-driven insights are presented. For example, many readers have likely viewed various forms of dashboards in relation to COVID-19, such as the example below.

#### **Case Study 1: COVID-19 Economic Recovery Dashboard – Deloitte<sup>52,53</sup>**

Problem Statement: The COVID-19 pandemic has substantially impacted businesses around the globe and has left the economy in a constant state of flux. With the everchanging COVID-19 situation, many businesses do not have access to all the data needed to gain a clear understanding of the state of the economy and identify important turning points in this economic crisis. Traditional financial and economic metrics are often lagging, which can become quickly outdated during the COVID-19 pandemic, which is changing rapidly in real time. Therefore, alternative non-traditional indicators that could more quickly speak to rebound and recovery were sought after to give a more complete picture to leaders who need to analyze them quickly.

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<sup>49</sup> Introduction to R Markdown (rstudio.com) (Accessed 9/2/2021)

<sup>50</sup> Dynamic Documents for R • rmarkdown (rstudio.com) (Accessed 9/2/2021)

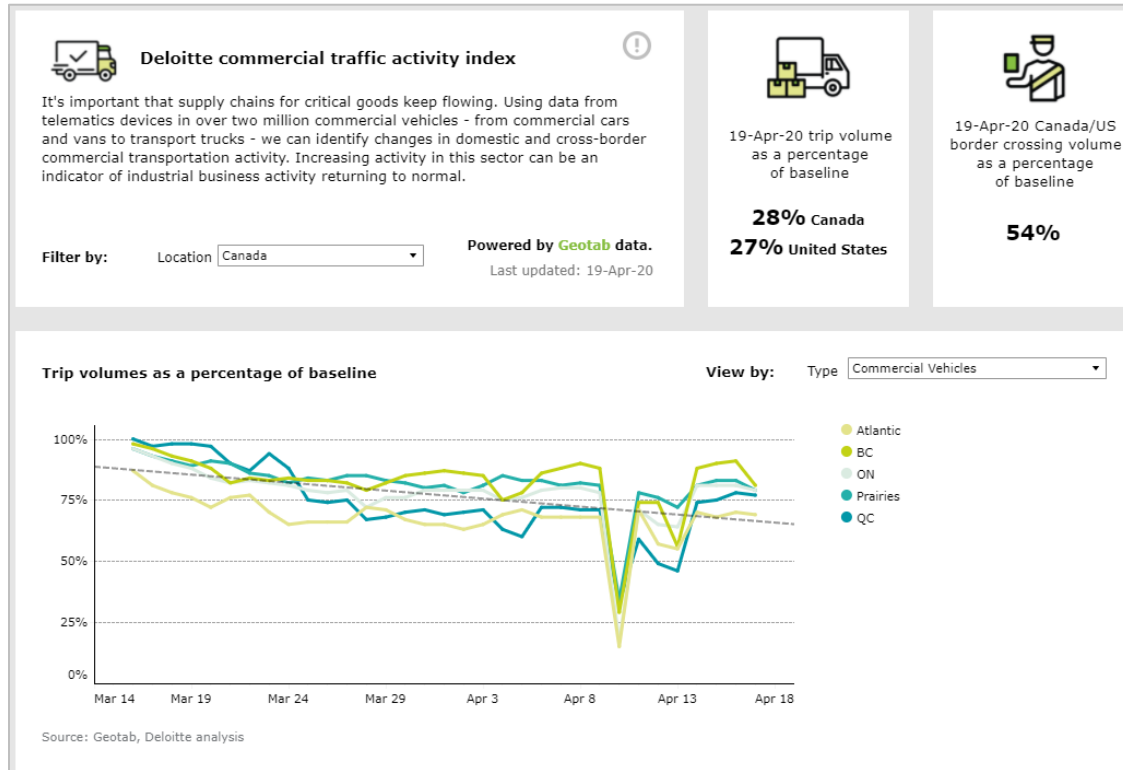
<sup>51</sup> Shiny - Introduction to interactive documents (rstudio.com) (Accessed 9/2/2021)

<sup>52</sup> <https://public.tableau.com/app/profile/deloitte.visual.analytics/viz/DeloitteCOVID-19EconomicRecoveryDashboard/DeloitteCOVID-19Analysis> (Accessed 9/3/2021)

<sup>53</sup> <https://www.tableau.com/about/blog/2020/5/how-business-leaders-can-use-deloitte-canadas-dashboard-track-recovery-covid-19> (Accessed 9/3/2021)

**Solution:** Using Tableau Public, a BI tool vendor, Deloitte developed a comprehensive, publicly available COVID-19 Economic Recovery dashboard. This dashboard combines several traditional and non-traditional metrics that creates a narrative regarding the current status of the economy in addition to the virus progress as they have both fluctuated during the COVID-19 pandemic. The excerpt of this dashboard in Figure 17 below highlights metrics surrounding commercial traffic activity leveraging data sourced from Geotab.

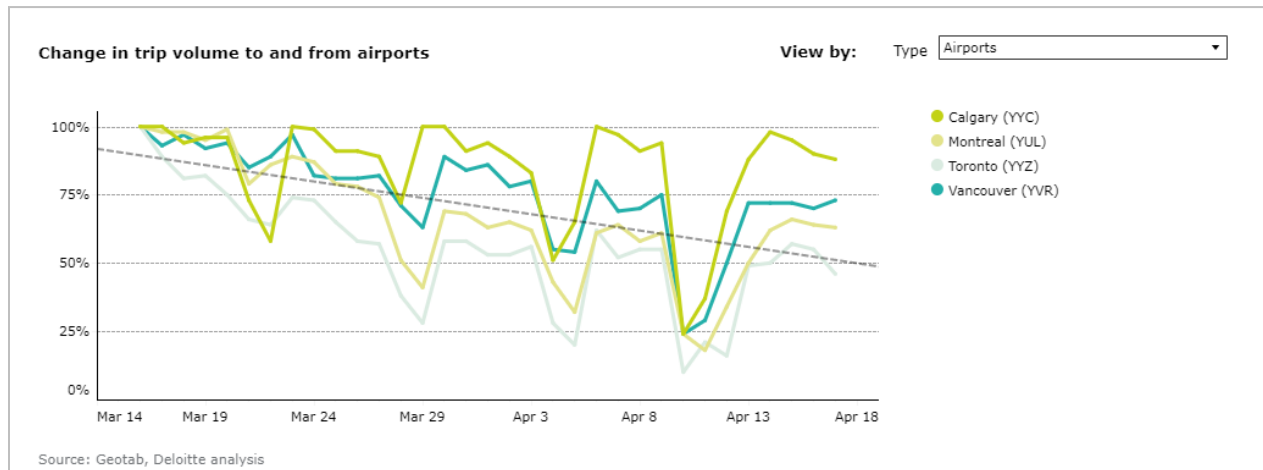
**Figure 17**  
**COVID-19 TABLEAU RECOVERY DASHBOARD EXCERPT**



Source: Geotab, Deloitte analysis

A user can access this dashboard on any device with an internet connection and start drilling down on results using the available drop-down lists to select region or method of transportation. For example, if you were interested in the change in trip volume experienced at large Canadian airports, you could select 'Airport' as the type of trip and the dashboard would automatically update with the filtered results without the need for an analyst or IT to create the view for the user. Figure 18 below shows the filtered results, which can be compared with other types of transportation to examine the impacts COVID-19 has had on the different types of trips.

**Figure 18**  
**COVID-19 TABLEAU RECOVERY DASHBOARD EXCERPT – AIRPORT VIEW**



Source: Geotab, Deloitte analysis

Value: The key benefits of building this dashboard in Tableau were:

1. An easy to manipulate dashboard enabling users to freely select and filter different areas of interest
2. One consolidated view of information from several different sources creating a view that is easy to follow
3. Dynamic graphics that reflect information updates automatically in response to user interaction or data updates
4. Freely accessible information from multiple sources to all parties in one place
5. Presentation of many data points in a way that is easily understandable and consumable to a broad audience via the use of design fundamentals

Business leaders who may have had access to 10-15% of this information in their own data gained access to a comprehensive dataset, allowing them to really focus on what they care about or see some trends they may not have been able to before. Leaders saw the value of having all of these metrics accessible in one place. Since the dashboard was first published in early April 2020, the Economic Recovery Dashboard has quickly become an in-demand resource from government and business leaders alike. The dashboard has seen significant viewership from a broad global audience since launch with consistent deployment of additional analysis to support companies monitoring the evolving situation.

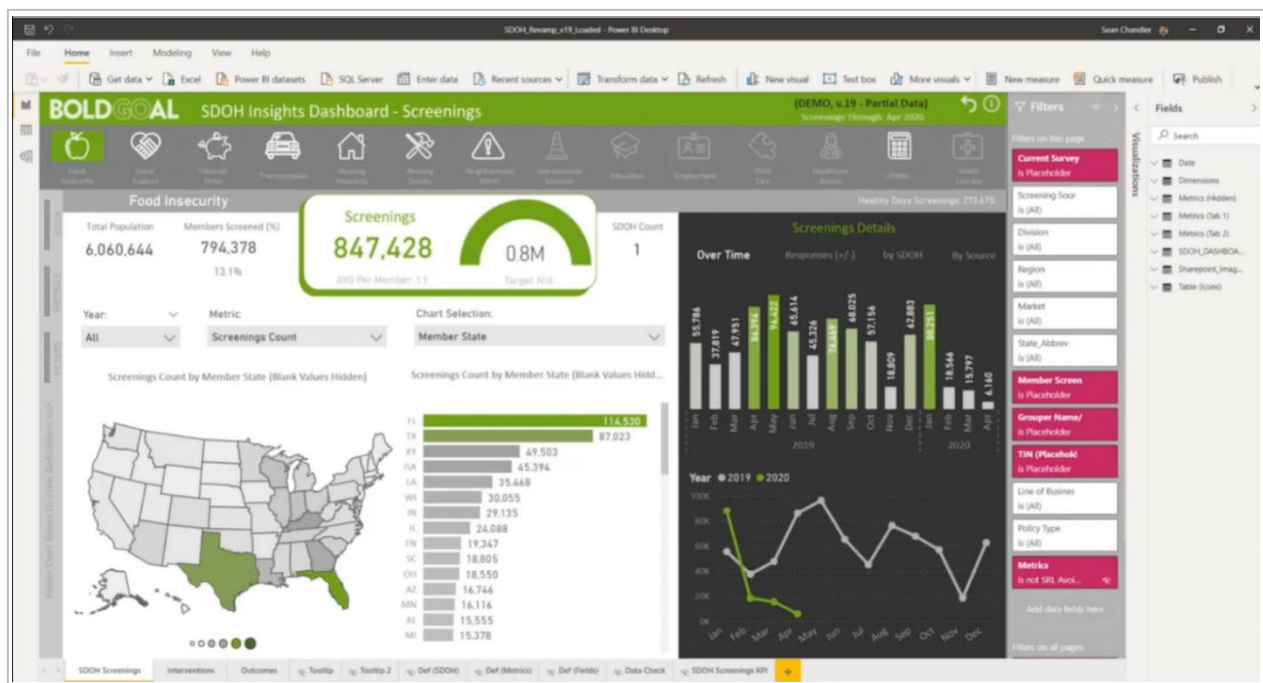
## Case Study 2: Analysis of social determinants of health - Humana<sup>54</sup>

**Problem Statement:** In 2018, Humana began its digital journey, formalized by its Digital Health and Analytics vertical. After surveying its analytics professionals utilizing digital health and analytics data, Humana discovered that it had 47 disparate data sources and BI tools being used throughout the company.<sup>55</sup> Humana realized that having such siloed systems proved a challenge, so their Product Implementation team worked to standardize its datasets and reporting tools, condensing its 47 disparate data sources and BI tools to a singular solution with Microsoft Power BI as its main BI tool.

A part of this strategy was the desire to analyze and track how social determinants of health and health-related social needs affect their individual customers. Social determinants of health are the conditions in the environment in which people live, learn, work, play, and worship, and age that affects a wide range of health functions and quality-of-life outcomes and risks. The big challenge in creating this Power BI report was taking survey data relating to social determinants of health from multiple vendors and combining it together with the goal of telling a cohesive story.

**Solution:** A Power BI report was created to analyze social determinants of health – see Figure 19 below. While Humana initially struggled with performance issues in loading the visuals, they were eventually able to optimize the load times by shaping the data for Power BI to effectively consume it.

**Figure 19**  
**POWER BI REPORT TO ANALYZE SOCIAL DETERMINANTS OF HEALTH**



Source: “Humana consolidates 47 data sources and BI tools into a singular Power BI and Azure solution”, Microsoft (Oct 2020)

The Power BI report was delivered in such a way that its consumers accessing this tool, who were first-time Power BI users, could seamlessly isolate and highlight certain parts of the data. A curated list of filters was selected to allow users to have a simple way to filter by categories such as market, region, and division. To take things a step further,

<sup>54</sup> <https://customers.microsoft.com/en-us/story/849874-humana-health-provider-power-bi> (Accessed 9/5/2021)

<sup>55</sup> Note that the case study also describes some solutions solved into the ETL capabilities of Microsoft Azure, which we do not dive into detail for this case study

a summary table was created that contains the different values within the respective dimensions and puts them into their own table that can then be connected back to the source dataset. The bookmark feature within Power BI has also been very impactful for Humana's reports. With bookmarks, users can toggle between commonly visited views regarding screening details. The changes, based on the selected bookmark, are also reflected within the other visualizations on the dashboard.

The Power BI tooltips feature has also been a great resource for users to break down screening information by geography or state. By integrating the Shape Map visual with tooltips, the Power BI engineering team was able to develop a specific visual for each individual state. Because of this feature, users have an easy way to access state-specific information, rather than spending time toggling through filters and bookmarks – see Figure 20 below. These specific visualizations also give business leaders an executive summary where they can immediately see key metrics for the geographical locations they are responsible for. Furthermore, when a user hovers over the gray lines on the left side, they can see the definitions of each social determinant of health and metric visualized in the report. Users can also view filter and field definitions. This capability brings more clarity about the underlying data in the report and ensures users utilize the information to the fullest extent.



Figure 20

## POWER BI REPORT DRILLDOWN AND TOOLTIP CAPABILITIES



Source: "Humana consolidates 47 data sources and BI tools into a singular Power BI and Azure solution", Microsoft (Oct 2020)

A big part of Humana's Power BI journey was getting users to adopt the tool and newly created reports. In the beginning, getting executive sponsorship and alignment was crucial. Executives needed to see and understand the effectiveness of Power BI and the potential that the tool had to transform their business. In the beginning stages of its Power BI journey, Humana spent a good amount of time showing users that Power BI was an all-encompassing tool, meeting all their BI needs. Implementing effective education and training simplified the transition from other tools. Creating common measurement criteria, like monthly active users, was critical for Humana in helping to set goals and stay on track with Power BI adoption.

**Value:** The Power BI report gave users an intuitive way to immediately filter to specific fields or domains. In the past, it had been difficult for Humana to quickly pinpoint data, but the simple and intuitive filtering in Power BI has made this task simple. The report allows users the opportunity to have quick and customizable visualizations at their fingertips, which is especially important considering the range of end users, scopes, and perspectives the tool caters to and the diverse needs of each user. Tremendous amounts of collaboration took place between the Power BI

engineering team and the Population Health Strategy team to ensure the final dashboard for this initiative met user expectations and utilized data as much as possible. The seamless collaboration with Power BI allows new versions of the dashboard to be rolled out in as little as a few days.

Humana later expanded its BI reporting capabilities with the advent of COVID-19 in order to understand a large amount of data in a short amount of time. Having access to Power BI tools to visualize all this information in real time has been critical for the company to form and execute appropriate strategies. Power BI allowed Humana to create reports and dashboards, form insights, and derive strategy quickly and effortlessly. With Power BI, Humana adapted on the fly and continues to collaborate even as everyone works from home, a critical capability now.

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*“Humana needed to understand new data and make some key decisions about how to respond. Having access to Power BI tools to very quickly build dashboards to visualize all that information and update it in real time was absolutely critical to both forming our strategy and executing it.”—Dr. Andrew Renda, AVP of Population Health Strategy at Humana*

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In the span of six months, monthly active users increased 97%, from ~1600 to ~3200. New apps and reports increased 37%, from ~4400 to ~6000. The active users were shown not only to come from developers, but also from users across all aspects of the business. Humana’s users were seeing how quickly Humana used Power BI to stand up in a crisis and realizing the resources the tool could also provide in their everyday workloads. In the future, Humana is focused on using Power BI to create more citizen data scientists and cultivate a data-driven culture.

### **Documentation Generators (Markdown / CommonMark)**

#### **Case Study 1: How R helps Airbnb make the most of its data<sup>56</sup>**

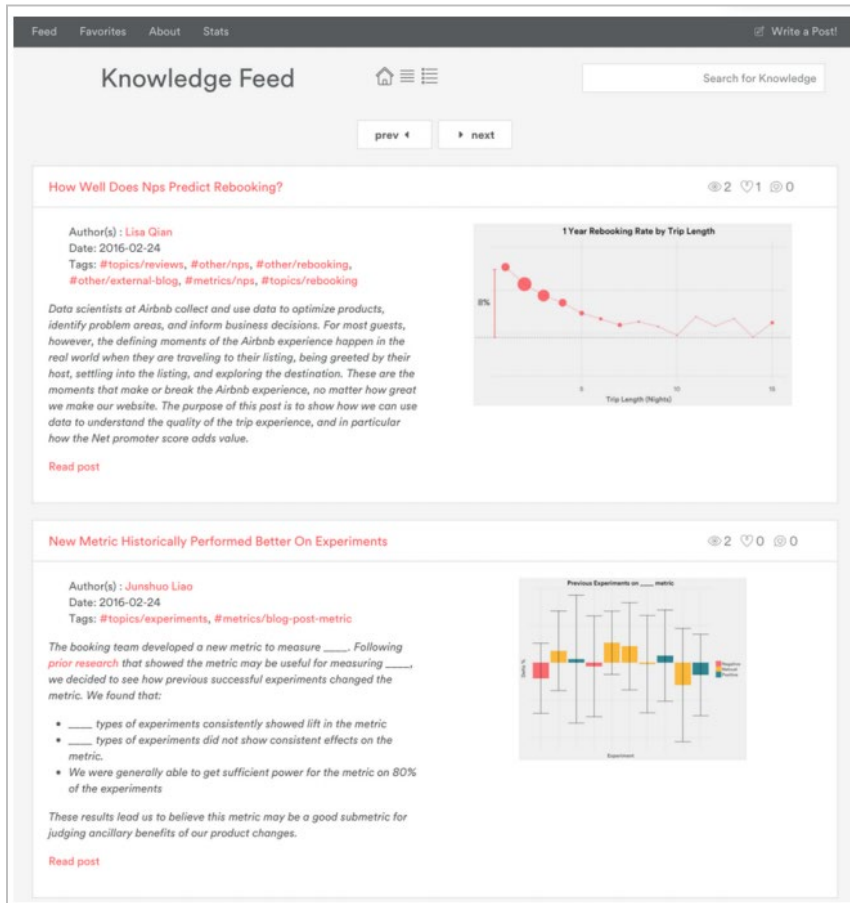
In 2017, Airbnb released a paper discussing the advantages and relief R had brought to their work. While R is generally seen as a tool for predictive modeling and exploratory data analysis, one of the ways they have integrated R to its maximum potential is by utilizing R Markdown. R Markdown has been a huge success for Airbnb, primarily due to its reproducible research with their internal Knowledge Repository.

Airbnb uses R Markdown to document all of its R analyses. Code and visualizations are combined within a single report, enabling review by experts in terms of content area and methodology used all in one place. In addition, users can share the R Markdown outputs and store them in the Knowledge Repository. Figure 21 below is an example of product insights written in R Markdown documents that makes it easy for anyone in the company, including non-technical business partners, to find analyses they might find useful. It also allows data scientists to learn both the context and technical details from previous work, as well as reuse code for other analyses. This simplified knowledge sharing and coordination across teams is in a user-friendly format that is also useful for technical audiences.

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<sup>56</sup> How R helps Airbnb make the most of its data (peerj.com).(Accessed 9/2/2021)

Figure 21  
R MARKDOWN SAMPLE REPORT



### 3.2.4 IMPLEMENTATION CONSIDERATIONS

#### **Business Intelligence Tools (Data Visualization)**

Adoption of BI tools vary considerably by industry. Leading companies, such as banks, are far ahead with established Centers of Excellence for BI tools. Some companies are still using BI tools ad-hoc and siloed across their organizations, many of which are using several different BI tools in each silo. As organizations implement BI tools, they will need to consider the following, detailed further in this section:

1. Investments in IT infrastructure and training
2. Designing processes around information distribution needs and limitations
3. Additional safeguards on sensitive information presented

Introducing data visualization tools will, of course, have barriers with respect to driving adoption. Investments in the IT infrastructure are required to increase data quality and accessibility in order to more efficiently deploy data visualization tools across an organization, although smaller scale implementation for such tools can be successful as well. Moreover, further training for employees is required to become acquainted with the tools so that they can apply it to maximize the results and efficiency. While these BI tools are often easy for individuals to learn and pick up, it takes considerably more effort to ensure that the right questions are being asked, data is properly sourced, dashboards are properly designed, an insights pipeline is efficiently developed, and processes are robustly deployed.

Although it will take time, everyone will need to be data literate and many will need to know how to use these tools for self-service analytics.

Companies will eventually have to figure out the workflows and deployment methods that makes sense for their end users. In particular, teams will want to understand how they plan on distributing their results to end users (local dashboard file, server edition of vendor software, embedded on website, etc.). This will require an understanding of how users plan on reading results, the company's existing technology stack, and any IT restrictions preventing the use of any of these distribution options. Furthermore, each option has trade-offs with respect to data transfer considerations, licensing fees, accessibility across devices, uptime, user access controls, administration, and sometimes dashboard functionality.

As BI tools become more engrained into day-to-day processes, companies will have to build in additional safeguards surrounding the use of these tools. For example, additional quality assurance efforts may be required to account for all the possible views of data that may be requested by the audience viewing the dashboards. One particular concern that comes from the additional potential cuts of data that can be produced is the need to build in safeguards for privacy. Dashboard creators will need to build in methods to censor any sensitive data presented when drilling down to very granular levels (e.g., salary information). Additionally, user access controls may need to be used for sensitive information so that only specified individual can view it.

### ***Documentation Generators (Markdown / CommonMark)***

While Markdown itself is a relatively simple but powerful tool, implementation within an organization may still have complications to consider with respect to people, processes, and technology. In summary, an organization needs to think about:

1. The medium in which the analysis is being created
2. The needs of the various users and creators in the analysis pipeline
3. The technology architecture of the processes involved

The use of Markdown will likely come with resistance to change, particularly where people are used to working on traditional word processors for their reports, especially from a reviewer's standpoint. The workflow involves a combination of coding and writing, which takes some time to get used to. While there is a learning curve, it is not steep from the preparer's point of view. From a reviewer's standpoint, the workflow change may be more difficult, especially when the reviewer isn't used to working outside of tools like MS Word.

In terms of workflow/process limitations, the main issue would be related to how the users will be interacting with the end reports. For example, if end users in the business viewing reports need to frequently edit the document in MS Word and track changes/comments, then using Markdown may not be ideal. With that in mind, external tools exist to convert between various Markdown implementations and MS Word, but they may be experimental and add another moving part to the analysis/reporting pipeline that can break.

As alluded to above, interoperability between the Markdown implementation and other tools used in the technology architecture is important. If the tools used by the various stakeholders don't play nicely with each other, then this can cause bottlenecks in the overall workflow.

### 3.2.5 ACTUARIAL CURRENT STATE AND FUTURE OUTLOOK

#### ***Business Intelligence Tools (Data Visualization)***

Actuaries' familiarity with BI tools, as seen in Section 3.0.1 Technology Familiarity, varies widely from little knowledge to extremely familiar. On average, actuaries have a reasonable understanding of BI tools and are somewhat confident in explaining them to someone else. However, a small number of respondents or teams within the responding companies had slightly lower familiarity with these tools.

Out of the 14 participants interviewed (covering Life, Health, Pensions and P&C), 12 mentioned that BI tools are in use today among actuaries, meaning they have either completed a pilot, implementation, or beyond. Two indicated plans to implement in the next three years.

Amongst the 11 Life and P&C respondents:

- The majority had started implementing at least one BI tool use case or were currently scaling across their organizations.
- A few had finished pilots, but not their full implementation of their first use case.
- One respondent had current plans to implement BI tools over the next three years but had not yet started.

Use of BI tools is trending upwards in actuarial work with a bright future outlook for actuaries. At some advanced companies, BI tools are used everywhere for actuaries, with one company saying:

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*There are very few actuaries at our company not using these tools. – one Life and Annuity respondent*

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Further details on the current state of actuarial usage and future outlook for actuaries are discussed below. For example, BI tools are used or will be used to some degree across all companies surveyed and across various actuarial functions to replace graphs done in Excel and expand on the analysis and reporting capabilities not seen today, particularly when combined with ETL tools. BI tools will have increasing usage in the near future to achieve self-service analysis capabilities.

#### Current State

BI tools are powerful for exploring results quickly and communication with senior management through to dashboards, ad-hoc analysis, or repetitive reports. These tools can be used as a business management application to provide actionable recommendations for business partners (e.g., investigation areas for operations). They are mainly used in three ways:

- 1) **Diagnosis of the results** – they provide a quicker way to check if the results make sense (e.g., compared to previous runs)
- 2) **Understanding of the results** – they can unveil deeper insights of the results and make the numbers speak for themselves (e.g., drilldowns, filtering, etc.)
- 3) **Performing function-specific applications** – for example, pricing actuaries tend to use the understanding in a predictive way, while valuation actuaries use it in an explanatory way

BI tools are used across a wide range of actuarial applications, such as pricing/underwriting, valuation/financial reporting, experience studies, analytics, modeling, and ALM. Below are examples of specific use cases within each application.

- **General reporting and analysis:** Actuaries are using these tools for quicker summarization of data without complex SQL code with drilldown capability on detailed results. All actuaries are using BI tools for presentations to executives (e.g., COVID dashboard for CEOs).
- **Pricing and Underwriting:** P&C actuaries are visualizing the impact of rate filing and understand how rating factors affect customers. They are also viewing underwriting and pricing statistics to monitor their business and understand it better. On the Life side, actuaries are also actively using BI tools to see statistics on underwriting results and pricing. Health actuaries are exploring data such as enrollment figures by state/county and benchmarking expense ratios.
- **Reserving / Valuation and Financial Reporting:** Actuaries are monitoring financial results, IFRS 17 projections, profit emergence, and trends. They are also using BI tools to review consolidated results from different databases, investigate tranches of data, summarize data trends, and review changes in segmentation over time. There are definitely uses for Pensions as well, but none reported today. Pension dashboards would have to be kept at a high level as the audience typically would not be examining the fine details.
- **Experience Studies:** Actuaries are using BI tools to analyze results/experience and view study results for several types of studies.
- **Analytics:** Actuaries use BI tools to perform general analytics about the business and review inputs/outputs for their analytics models.
- **Modeling:** Actuaries are using such tools in system conversions, basis changes and analysis of model changes.
- **ALM:** Actuaries are using dashboards for management reporting related to investment performance on portfolios and for commentary to senior stakeholders.

In general, BI tools seem to have been adopted well across the organizations of some respondents to showcase business performance with the goal to replace any business owned and repetitive processes involving the production of standard Excel tables and reports. They are considered moderately difficult to implement, with barriers mostly relating to getting the data in the right format for higher dashboard performance and from difficulties in adoption by senior actuaries used to an Excel-based workflow. A common problem associated with BI tools is the behavior of people overly relying on defaulting to familiar habits by dumping data into Excel to perform analysis that can be done easily in the BI tools. Generally, companies have recognized that the value delivered by BI tools scales with a proper data infrastructure.

#### Future Outlook

BI tools will be used on some level across all companies, all actuarial functions, and all lines of business to accelerate the production of graphs and ad-hoc views that would have been done previously in Excel, enabling faster analysis of results and dynamic reports that can iteratively answer questions on the spot. As such, actuaries will be expected to have a good understanding if not master these tools.

As companies improve their data infrastructure (e.g., with cloud data platforms and ETL tools), implementation of BI tools will be increasingly easy and actuaries will be able to accelerate their analysis of data across different datasets that were previously disjointed. Furthermore, they will be able to perform self-service analysis rapidly without the need to rely too much on IT to produce the views that the business requires.

As actuaries adjust their tools and processes, one might ask whether these revised processes will be accepted by auditors/regulators. Auditors and regulators are generally open to innovative technologies provided that proper

controls over such tools and processes exist. Every auditor will have different views, so it is important to discuss with all concerned audit parties before making any substantial process changes.

### ***Documentation Generators (Markdown / CommonMark)***

The range of familiarity with Markdown is huge among actuaries, as seen in Section 3.0.1 Technology Familiarity, from no knowledge to extremely familiar. On average, actuaries have a slight understanding of Markdown.

Out of the 14 participants interviewed (covering Life, Health, Pensions and P&C), nine mentioned that Markdown was in use today among actuaries, meaning they either had or were in the process of piloting, implementing or scaling. Five provided no response.

Amongst the Life and P&C respondents:

- Around half had started implementing at least one Markdown use case or were currently scaling across their organizations.
- Three respondents indicated that they were still only in the pilot phase.

The use of Markdown is starting to be adopted by actuaries to facilitate sharing and review of documentation and results. With increased usage of R/Python amongst actuaries, the future usage of Markdown will become more important. Further details on the current state of actuarial usage and future outlook for actuaries are discussed below.

### Current State

Markdown is currently used in several actuarial functions, particularly in experience studies, pricing, reporting and analytics.

- **Experience Studies:**  
Markdown is used to produce experience study reports automatically so documentation on results and calculations can be reviewed at the same time. Weekly reports have also been created to compare company mortality data to industry data with respect to COVID-19 reports.
- **Pricing:**  
Markdown is used by P&C pricing teams to automate reports for regulatory filing and external / internal reporting, including reports built in PowerPoint. In addition, it is used for data exploration, reporting on GLMs, and helping to compare a model's goodness of fit. It is a very common tool used for ad-hoc analysis/projects.
- **Valuation and Financial Reporting:**  
Markdown is used to produce various formatted reports with a generated narrative around some underlying analysis (e.g., quarterly movement analysis of inforce, analysis of Pension member data from period to period with specified thresholds to highlight which anomalies to investigate).
- **Risk Management:**  
Markdown has been used to generate documentation related to credit risk.
- **Analytics:**  
Markdown is used to auto-populate documentation for data exploration, predictive model performance measures, and model review/monitoring reports. It has been noted that it's easy to share and review amongst developers and end users.

## Future Outlook

Increased usage is expected as data becomes more accessible and R/Python is more commonly used by actuaries. Markdown can be used for any sort of documentation that requires reporting and reproducible results, particularly for any analysis done on a regular basis. The automation provided by Markdown will alleviate resourcing needs as it reduces the manual effort in producing documentation. Furthermore, such tools allow the static reports to integrate results for end users along with the code to act as documentation for actuaries to reproduce and learn how the analysis and code tie together with the outputs. Actuarial teams are identifying additional areas to use documentation generators, such as financial reports and additional model monitoring.

Usage will likely increase even further as actuaries adopt SCM tools (see Section 3.4 Collaboration and Connected Data) and can multiply the power of Markdown by connecting it to their code repositories to enable proper version control practices to be used on their documentation and directly linking different versions of the models to the accompanying documentation.

However, barriers arise where programming tools aren't used and existing non-compatible tools (e.g., actuarial valuation software) dominate actuaries' workflows. Furthermore, most actuaries and downstream users are still very embedded in using workflows based on Microsoft Word and Excel, which may make the change for management difficult.

## **3.3 EXTRACT-TANSFORM-LOAD (ETL) / DATA INTEGRATION AND LOW-CODE AUTOMATION PLATFORMS**

### **3.3.1 DEFINITION AND TERMINOLOGY**

#### ***Extract-Transform-Load (ETL) / Data Integration and Low-Code ETL Platforms***

In this study, we define the term, "Extract, transform, load (ETL)":

***Extract, transform, load (ETL)** is the general procedure of copying, moving, and/or integrating data from one or more sources into a destination system which represents the data differently from the source(s). ETL covers transformations such as (but not limited to) changes, appending/joining of datasets, and validations.*

***Low-code platforms**, in general, are development environments used to create application software through graphical user interfaces and configuration instead of traditional hand-coded computer programming. Besides describing these application development platforms, "low code" can also be used to describe products that are not meant for general application development but have a similar low-code style of customization.*

Traditional ETL tools (e.g., Informatica, IBM), sometimes known as data integration tools, have been around for quite some time, so on their own might not be necessarily be considered emerging for the purposes of the study. Robust ETL tools have historically resided with IT and have traditionally required multi-year transformation programs to implement. Other tools historically used to perform ETL operations include those built for other purposes, such as Excel, actuarial modeling tools with built-in ETL functions, and many programming languages (including R and Python, which come with packages/libraries to address ETL). However, a new generation of ETL tools has been emerging in the last decade, enabled by advances in technology and investments in cloud platforms. For example, cloud technology has allowed companies to build up data platforms in much less time and without costly investments in infrastructure. Another category of ETL tools that has emerged is referred to as **Low-Code ETL tools** (e.g., Alteryx, Datameer). This report generally focuses on these low-code ETL platforms (which in some cases may come as part of broader cloud data platforms), which allow analysts embedded in the business to perform similar ETL procedures without the need for extensive IT resources and significant coding expertise. Focus was not placed on traditional ETL tools and IT-focused modern ETL tools that require significant coding since they are likely not tools that will be used by actuaries themselves, although may indirectly impact the work that actuaries do.



API development tools are another area of potential interest with respect to creating, documenting, and managing APIs, which enable the sharing and access of data. We will first define some terminology for context:

***Application Programming Interfaces (APIs)** are a standardized, documented way for computers (in other words, digital platforms) to “communicate” with one another.<sup>57</sup> APIs are used where applications or software need to communicate with each other (or across a network in the case of Web APIs), which can be useful when analytic models, for example, need to be responsive and accessible in real-time from other tools and technologies.*

***API development tools** are tools that aid in the design, development, documentation, testing, and standardization of APIs.*

While APIs have been around for a long time, they have not been universally used amongst actuaries and emerging API development tools – such as Swagger, R’s Plumber, Python’s Flask, etc. -- have been making it easier to develop APIs for interconnectivity between software. This report focuses on the usage of APIs amongst actuaries with the idea that their use and creation is increasingly easy as a result of the emergence of API development tools. In this report, APIs will be grouped together with ETL tools just to keep the report simpler to read and easier to manage. It can be viewed as a tool for data access and distribution, although APIs cover much more than that.

### **Robotic Process Automation (RPA) and Low-Code Automation**

Robotic Process Automation (RPA) can conjure up images of physical robots performing tasks in place of humans. Today, understanding of RPA has matured, but we first define RPA for the purpose of the report:

***RPA tools** are software that automates repetitive, rules-based processes usually performed by people through the interaction with applications just as humans would.*

Many RPA vendors are examples of low-code automation platforms. Like many of the technologies in this report, RPA can work with a host of cognitive technologies like Optical Character Recognition (OCR), Natural Language Processing (NLP), and/or Task Mining to achieve desired outcomes. For example, RPA can use OCR and NLP as one step in an automated process to systematically extract and understand information from documents that humans normally would need to read and then manually feed into other systems. While it is difficult to separate out these additional functionalities in determining the business value and case studies, this report will attempt to focus on the core functionality of RPA, which is automation across disconnected applications and processes. While RPA may seem similar to low-code ETL tools or programming languages to perform ETL, there are differences, some of which are discussed in the next section.

## **3.3.2 VALUE PROPOSITION**

### **Extract-Transform-Load (ETL) / Data Integration and Low-Code ETL Platforms**

As organizations become more data-driven, they increase the demand for ETL around disparate data sources which need to be shared across the organization to unlock value. In today’s workspace, companies may lack sufficient resources with the technical expertise to process these data sources. Low-code platforms come in to enable business analysts to perform more complex ETL procedures without the need for extensive amounts of IT investment and multi-year transformation timelines.

Data integration and ETL tools, in general, aim to deliver insights via the integration of data sources to improve decision making and enhance trust in the data. By connecting data from disparate data sources and performing validations on that data, these tools enable the business to leverage an integrated dataset that is consistent across

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<sup>57</sup> <https://blog.rstudio.com/2021/05/04/rstudio-and-apis/> (Accessed 9/2/2021)

the organization. Such tools can handle multiple and large data sources faster and more reliably than spreadsheet tools and are, therefore, useful for organizations that are increasingly relying on their data. However, as mentioned previously, traditional ETL tools require its users to have sophisticated IT backgrounds and have a longer learning curve. Additionally, such tools tend to be costly to purchase, maintain, and implement. Other tools that contain ETL functions, but are not robust ETL tools – e.g., Excel – typically do not have the ability to easily scale over larger datasets and do not have the necessary governance, transparency, and controls needed for large-scale production processes.

Low-code ETL tools are a subset of ETL tools. As the name suggests, these tools require comparatively less coding knowledge, being Graphical User Interface (GUI) based. Thus, these do not require the same level of expertise and upfront investment as needed for traditional ETL platforms, providing greater ease of use and lowering the learning curve. Low-code tools also have their limitations, such as providing less customization for the processing of datasets due to abstracting away some of the technical functionality. To some extent, these tools may also limit performance vs. traditional ETL tools. On the other hand, the trade-off of less flexibility allows for a greater level of governance and processing speed when compared to Excel spreadsheets. Detailed trade-offs of the various platforms, however, are very much platform dependent.

It should be further noted that ETL tools are being integrated in broader data platforms (e.g., BI tools, analytics) in order to build a proper data foundation to enable insights across an organization. To facilitate analytics and insights around an organization's data, the data must meet quality standards and be readily accessible so the analysis process is not hindered by the time required to reshape and transform data. Therefore, having the proper ETL tools in place to build that data foundation is key to unlocking value from other tools used in the analytics pipeline.

APIs allow for programs to share their results and analysis in real-time with other applications, reducing the friction in integrating different analyses together and allowing the insights to be used much quicker compared to having the results sit in a report or dashboard. For example, if the insights from a predictive model need to be used to generate real-time predictions in other areas (e.g., sales), then APIs are prime examples of ways to share the model in a responsive and accessible manner to other tools and technologies<sup>58</sup>. Furthermore, APIs can be used to integrate such results with both internal and external partners.

APIs are used everywhere and relied upon by consumers on a daily basis. Some examples of API usage to illustrate how APIs add values to our lives include<sup>59</sup> a Google search that pulls weather data using a weather API in order to present that data embedded in the search query, travel booking sites that collect flight and hotel availabilities from providers and confirm bookings directly with the providers when they are made through the booking website, and Twitter bots that automatically tweet when new content is released on Netflix.

### ***Robotic Process Automation (RPA) and Low-Code Automation***

Business processes can be very repetitive and mundane. RPA addresses this issue by automating repetitive tasks, which benefits companies through cost reduction, improved efficiency, the ability to work 24/7, unlocking human capacity to be utilized in more meaningful pursuits, and higher accuracy by reducing human-introduced errors. Another significant benefit of RPA that should be highlighted is cost avoidance, meaning the ability to support first growth without increasing human teams in areas where automation is applied. It is important to emphasize that RPA is also a tool for enabling growth and not just a tool for cutting head count and jobs. Furthermore, the advent of COVID-19 has highlighted the need for automation in stressed scenarios where higher volumes than expected are processed. With the acceleration of remote working due to COVID-19, automation has enabled more remote working and addressed rapid increases in processing requirements, according to a global Deloitte survey on

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<sup>58</sup> <https://blog.rstudio.com/2021/05/04/rstudio-and-apis/> (Accessed 9/2/2021)

<sup>59</sup> <https://nordicapis.com/5-examples-of-apis-we-use-in-our-everyday-lives/> (Accessed 9/2/2021)

intelligent automation technologies<sup>60</sup>. Twenty-three percent of survey respondents said they had prioritized automations that would improve their organizational resilience.

There are a variety of tasks that RPA can accomplish with a great degree of accuracy and efficiency. Some of these tasks include:

- Gathering, collating, and validating information from a variety of sources
- Scraping UI or accessing databases, followed by synthesis and analysis of data
- Performing calculations
- Communicating using standard formats (e.g., emails)
- Orchestrating and managing the activities of both colleagues and robots
- Monitoring, detecting, and reporting

A few advantages of RPA in comparison to other automation tools, such as VBA and Python, include:

- Better management of access and security of both the code and the target application
- Efficient operations and management
- Better code versioning
- Seamless integration with capabilities like Task Mining, Process Mining, and task capture
- Ability to operate the automation in both attended (by humans) and unattended modes
- Built-in queries for the bots (in the case of VBA and Python, this will need to be separately coded)
- Efficient benefits tracking
- Command center capability via an orchestrator to control and monitor all bots across the enterprise

Not all processes can or should be automated using RPA. Ideal processes to be addressed with RPA should:

- Be manual and repetitive
- Handle high volumes
- Be usually prone to error due to manual human interaction
- Have defined exception-handling approaches
- Be rules-based
- Not have any added value by a human user executing it

RPA may not be suitable for those processes that do not meet the criteria listed above, so companies will need to evaluate the trade-offs when considering RPA (or any technology). Furthermore, RPA must be implemented in a way that considers potential future updates to the underlying processes. If a process automated by RPA is required to be updated, then companies must ensure that the knowledge of the process is not lost from the automation to ensure that processes can still be updated without issue. Further discussion on implementation considerations can be found in Section 3.3.4 Implementation Considerations.

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<sup>60</sup> <https://www2.deloitte.com/us/en/insights/focus/technology-and-the-future-of-work/intelligent-automation-2020-survey-results.html> (Accessed 9/2/2021)

### 3.3.3 CASE STUDIES

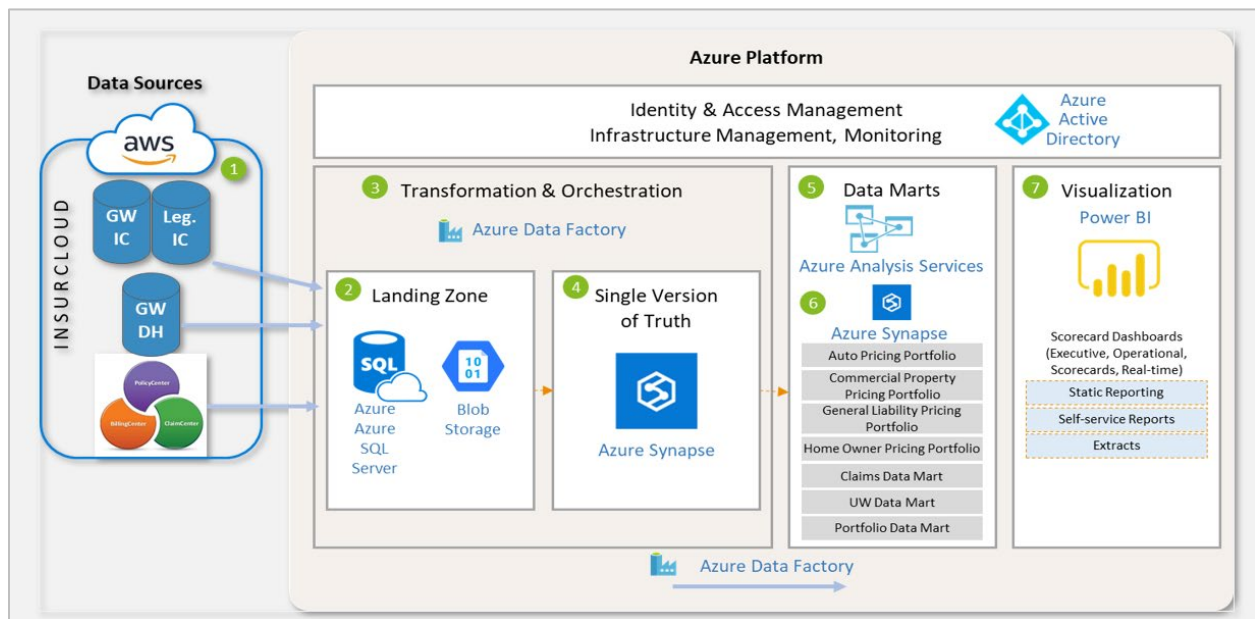
#### ***Extract-Transform-Load (ETL) / Data Integration and Low-Code ETL Platforms***

##### **Case Study 1: Integrated Data Ecosystem – Canadian P&C insurance company**

A Canadian P&C insurance company has been enhancing its data ecosystem by investing in an enterprise data platform and architecture in order to lay the foundation capabilities to enable data-driven analytics. The insurer moved its core source systems, both GuideWire and legacy systems, to a cloud-based ecosystem (“InsurCloud”) and consolidated/standardized the underlying data, along with external third-party data, to a Microsoft Azure platform containing a single version of truth. Relevant slices of the consolidated data were distributed to various LOBs and functions in data marts, which could be accessed by those departments for relevant consumption, reporting, and analytics. Through this process of delivering and transforming data, ETL scripts were utilized as part of the Azure platform. A depiction of the data architecture is contained in Figure 22 below.

**Figure 22**

#### **INTEGRATED DATA ECOSYSTEM – DATA ARCHITECTURE OVERVIEW DIAGRAM**



Source: Deloitte case study

While data warehouses and data marts have been around for some time, the main difference in modern era data platforms would be that they are moving away from traditional “ETL” into an “ELT”-based approach. That means that, where possible, raw data is loaded into the cloud data platform from a variety of sources and then transformed in the cloud. This approach increases flexibility and speed of delivery. In a traditional data warehouse, pulling additional data often requires additional rework of data pipelines that this “ELT” approach allows an organization to bypass. Although this is not an entirely new concept, the sheer power of modern cloud data platforms makes it more attractive and, therefore, is becoming increasingly popular.

The initial use cases delivered impacted Pricing/Actuarial, Underwriting, Claims, and Analytics teams in the following ways:

- 1) **Pricing/Actuarial** – The insurer was facing inefficiencies and data quality issues throughout their data provisions process to the Pricing Actuary. Pricing data marts were built for each LOB to enable actuarial analysis, self-serve analytics, and GLM/multi-variate modeling. This resulted in more accurate and trusted data delivered in a timelier manner.
- 2) **Operations (Underwriting and Claims)** – The insurer was suffering from inefficient, manual, and untimely tracking of KPIs surrounding activities and performance in the Underwriting and Claims departments. The data mart and enhanced reporting capabilities allowed for improved and faster data-driven decisions.
- 3) **Member Segmentation Analytics** – The insurer wanted to leverage third-party data for an enhanced view of its current and prospective members. The enhanced data ecosystem brought in and integrated third-party data to support the segmentation analysis with the goal of improved attraction, retention, and additional new insights.

### Case Study 2: Low-Code ETL Automated Creation of Meeting Materials – Danica Pension<sup>61</sup>

Problem Statement: A Danish Wealth Management unit of Danske Bank was struggling with their pension advisors spending 80% of their time on preparation and administration and only 20% of their time with the customer. The advisors walked through the same story line and professional presentation in every meeting with their customers but needed to tailor these presentations to be customer-specific.

Solution: Using Alteryx, a low-code ETL and analytics platform, the company built a “Slide Compiler” that created customer-specific slides collected from many different data systems (various SQL tables and csv files). Alteryx automatically updated text, numbers, and graphs in the PowerPoint presentations and sent them to the company’s advisors before meeting with the customer. The advisors were allowed the flexibility to hide, add, and delete slides before a meeting, but always trusted they had up-to-date slides with the most current data on all important client information.

Value: In the span of a year, the “Slide Compiler” generated over 3000 presentations with 80+ slides in each, saving advisors at least half an hour per meeting, giving them more time with their clients (a total of 1500 hours saved) and assurance that they always had up to date presentations and data for their meetings.

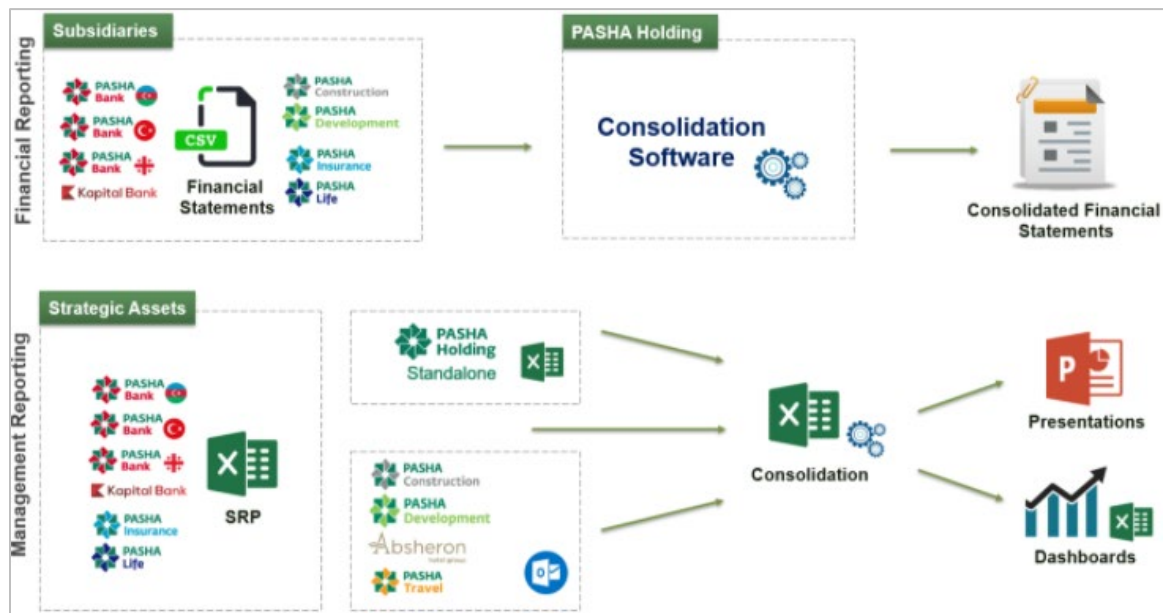
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<sup>61</sup> <https://community.alteryx.com/t5/Alteryx-Use-Cases/Slide-Compiler-From-Alteryx-to-PowerPoint/ta-p/198557> (Accessed 9/2/2021)

### Case Study 3: Low-Code Automated Reporting and Consolidation – PASHA Holding<sup>62</sup>

**Problem Statement:** An Azerbaijan-based holding company with 10+ subsidiaries had a monthly consolidation process where subsidiaries submitted management reports to PASHA Holding through an Excel-based package. PASHA Holding then consolidated, analyzed, and created certain dashboards / reports in Excel for submission to management. Subsidiaries also submitted their financial reports in CSV format through advanced consolidation software where PASHA Holding prepared its validated, reviewed / approved MS Excel extract-based consolidated financial statements subject to external auditors' audit and review procedures. The view of their process is depicted in Figure 23 below:

**Figure 23**  
PASHA HOLDINGS PROCESSES



Source: Alteryx Community

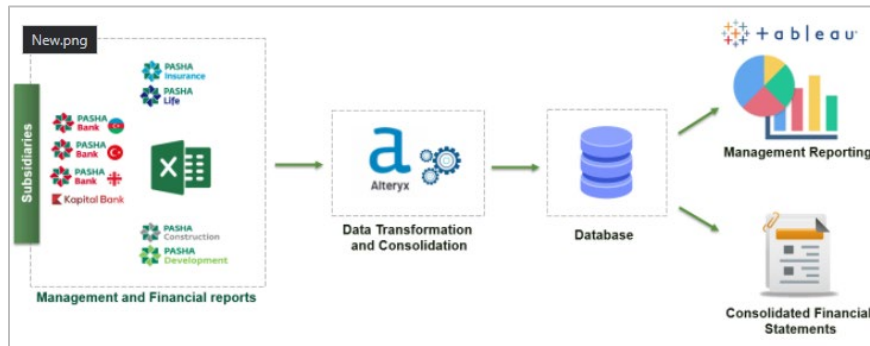
These processes had many pain points, including:

- High costs and rigid maintenance constraints of consolidation software
- High processing times
- Difficult learning curve and key person risk due to complex processes
- Low user satisfaction
- Large and difficult to open Excel files with long calculation times
- Time-consuming manual data blending in Excel, leading to accuracy and quality risks
- Limited reporting dashboard functionality in Excel
- Limited capacity remaining to analyze data

<sup>62</sup> <https://community.alteryx.com/t5/Alteryx-Use-Cases/PASHA-Holding-Saves-250-000-by-Automating-Financial-Reports-with/ta-p/734793?lightbox-message-images-734793=177673i93908812948CE65C> (Accessed 9/2/2021)

**Solution:** In order to eliminate the above pain points and optimize their processes, the company decided to create a single infrastructure on Alteryx with governance, consolidation rules, and data visualization capabilities as depicted in Figure 24 below:

**Figure 24**  
**PASHA HOLDINGS UPDATED PROCESS**



Source: Alteryx Community

To achieve the data transformation and consolidation, the company built their workflows in Alteryx to automate their Management and Financial reporting processes. These workflows were GUI-based and could be visually reviewed and traced rather than reviewing mountains of code.

As a result of the workflows built in Alteryx during those two months, the company fully automated their Management and Financial Reporting processes. In addition, management reports were automatically connected from Alteryx to Tableau, where the dashboards and reports were created. Now, with just one click on the “Run” button, the team receives its consolidated financial statements in Word, PDF, and Excel formats. In addition, validations were created to cross-check all figures across the report and inform the team in the event of any errors:

**Value:** The key benefits of implementing this process were:

1. Time savings of 720 hours per year preparing consolidated financial statements and 480 hours per year preparing monthly management reports
2. Annual cost savings from replacing their existing consolidation software with the cost of two Alteryx licenses
3. Quality and risk improvements through the replacement of manual processes performed in Excel

Note that these case studies have been leveraged from public sources where some key information is not always accessible (e.g., implementation costs).

#### Case Study 4: Risk Engine API – Dacadoo<sup>63,64,65,66</sup>

**Problem Statement:** Insurance companies are aspiring to increase and accelerate their pricing and underwriting capabilities with the use of third-party data to augment the internal data used in their own models. Customers are increasingly expecting products to be flexible and adapt to their habits. Insurers are responding by looking to make their products more flexible and increasing engagement with their customers. Rather than setting and forgetting the premiums upfront, an insurer might want to dynamically price a policy, reflecting the life and health risk characteristics of that policy over its lifetime.

However, insurers generally have limited health data on their customers after the time of underwriting and require a robust way to estimate mortality and morbidity risk of their customers over time in order to offer such personalized pricing over the policy's lifetime.

**Solution:** Dacadoo developed and operated its comprehensive digital Health Engagement Platform to motivate users to achieve and maintain healthy lifestyle habits. The company's technology is provided as a fully branded, white-label solution or it can be integrated into customer products through its API. "The company is now working with 30 Life and Health insurance operators globally. They either use our dacadoo Health Score Platform, our Risk Engine or dacadoo GO," says dacadoo CEO Peter Ohnemus. Dacadoo is also licensing its Risk Engine for real-time scoring of mortality and morbidity. The dacadoo Risk Engine calculates adverse health event probabilities based on a novel scientific model that includes more than 300 million people years of clinical data. The risk engine produces full datasets with 100 data points for each person by inputting estimated values for any missing, self-reported data.

Access to the dacadoo APIs allow insurers, reinsurers, and providers to use the continuously updated customer health data output of the dacadoo Risk Engine to augment and integrate with their own pricing and underwriting models.

**Value:** Insurers and reinsurers are able to refine their pricing engines, enabling accelerated or dynamic underwriting and dynamic pricing processes. This allows insurers and reinsurers to facilitate fluidless online underwriting and increase the amount of Straight-Through-Processing (STP). The continuously updated customer health data enables flexible premium pricing that is updated based on a customer's risk over his or her lifetime rather than just at the point of underwriting at issue. The results of the dacadoo Risk Engine allow insurers to increase the number of risk classes offered in their pricing, allowing for more granular pricing for their applications.

#### ***Robotic Process Automation (RPA) and Low-Code Automation***

Some of the common case studies where RPA can be a perfect fit are billing automation (Finance), recruitment and onboarding (Talent/HR), RFP management and opportunity tracking (Sales & Marketing) and performing searches (Risk Management). A couple of detailed case studies are discussed below.

#### **Case Study 1: Tracking timeliness of outgoing deliverables – major investment bank**

**Problem Statement:** The client had a business process which involved tracking around 2000 deliverables on a daily basis. These deliverables had different outgoing sources – some went out via email (often via several different team mailboxes), while some went out via different filesharing methods. The process involved tracking and noting down

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<sup>63</sup> <https://www.startupticker.ch/en/news/may-2019/dacadoo-sees-strong-revenue-growth> (Published May 2019, Accessed 7/15/2021)

<sup>64</sup> <https://www.dacadoo.com/products-services/dacadoo-health-risk-quantification/?lang=en> (Accessed 7/15/2021)

<sup>65</sup> <https://equarium.hannover-re.com/1186-pay-as-you-live-life-insurance-concept> (Accessed 7/15/2021)

<sup>66</sup> <https://equarium.hannover-re.com/174-dacadoo-health-engagement-platform-health-score-risk-engine> (Accessed 7/15/2021)



the times these deliverables were sent out, collating the results at the end of the day, and publishing reports on delays/trends every quarter. A team of five Full-Time Equivalents (FTEs) used to take turns every week in tracking these deliverables.

Solution: An RPA bot was implemented to automate this entire process. The bot was scheduled to start at 4am and run until midnight, tracking deliverables in mailboxes and FTP folders. The bot recursively kept tracking all deliverables, marking them as on time/late as appropriate. At the end of the run, post-midnight, the bot prepared an EOD report that documented which deliverables went out on time, which ones were late, and which ones were not delivered. At the end of every quarter, the bot would calculate metrics and trends that would be presented to higher management in their quarterly audits.

Value: The process was a very mundane, repetitive task that added no value to the users performing it. Implementing RPA to automate it resulted in freeing up users' time so they could focus on more meaningful pursuits. Having the bot also increased the speed and accuracy of tracking the deliverables, eliminating human-induced error.

### **Case Study 2: Tracking stock exchange announcements – large financial services organization**

Problem Statement: The manual business process involved visiting the country's stock exchange website, downloading announcements in PDF format, scanning them for certain keywords, and preparing a report for the clients. The announcements were irregular in frequency, and the PDF's ranged from 2 to 75 pages in length. A dedicated team of two used to monitor the stock exchange website eight hours a day for announcement-related PDFs, download any newly available PDFs and scan them for the keywords. The process was highly error prone as the PDFs used to be published at irregular intervals, and there was the human element where keywords would be missed.

Solution: An RPA bot was implemented to automate this entire process. The bot was programmed to check the stock exchange website at regular intervals, download new announcement PDFs when available, and open and scan through the PDF using Python Natural Language Processing (NLP) libraries.

Value: Implementing an RPA bot to replace the manual process made the process error free and fast. The bot was able to scan through huge PDFs much faster than a human could, and it was able to track all keywords without missing any of them. This increased process accuracy by almost 70%, as well as freed up the time of the users to work on more impactful work.

### Case Study 3: COVID-19 Contact Management Center – Police Service of Northern Ireland (PSNI)<sup>67</sup>

**Problem Statement:** To help address the unprecedented challenges of enforcing new COVID-19 regulations, the Police Service of Northern Ireland (PSNI) decided to rapidly develop an RPA solution that would alleviate fluctuating demand on their Contact Management Center (CMC). The issue had begun after new laws and guidelines were introduced in March 2020 and PSNI introduced an online reporting platform to allow the Northern Ireland public to report ‘lockdown’ breaches.

Initially every report made generated a PDF document, which the CMC staff then had to re-key into a PSNI command control system to create a record and enable a decision about action. The first weekend that the system was operational, 2,300 reports were made – coinciding with good weather – but, over the next days and weeks, use of the online platform fluctuated. A day with good weather might see 800 reports, but a rainy day might see only 150 reports.

To accommodate the days of high use, additional staff were required to process the reports, which was difficult to achieve as some staff members were self-isolating or shielding and many others were working remotely, following government guidance. Timely responses were critical in maintaining public confidence in the online platform and the new COVID-19 regulations more broadly. However, a backlog soon developed, and the decision was made to automate the connection between the online reporting platform and command control system.

**Solution:** The PDF produced by the online reporting platform was mapped to fields in the command control system. With the involvement of the CMC staff who had been re-keying the data and using existing technology, an automation was designed, developed, and deployed within seven days.

**Value:** The effect was immediate. Bots pulled data from the PDF to input in the system, and the automation created batches and prioritized reports. Every five minutes, two bots would re-key three batches of four reports. Previously, a call handler needed 11 to 12 minutes to re-key one report, but automation freed up time for them to enact timely responses. It also enabled the CMC to introduce a feedback loop, which informed the public of what action was taken as a result of their report.

#### 3.3.4 IMPLEMENTATION CONSIDERATIONS

##### ***Extract-Transform-Load (ETL) / Data Integration, And Low-Code Platforms***

Many organizations have either adopted or increased their use of traditional ETL tools over the years. That said, with the advent of cloud platforms, such tools are becoming more accessible without the need to invest upfront in costly on-premise infrastructure. Such platforms have provided companies with scalability, faster deployment, and lower costs in their automations. These benefits have been resonating with companies across all industries to the point where almost half of organizations surveyed in Deloitte’s 2020 Automation with Intelligence report<sup>68</sup> used cloud infrastructure for their automation solutions and 13% ran automations solely on cloud infrastructure. There are also low-code ETL platforms which serve a different target segment compared to traditional ETL platforms. While the traditional variants are targeted towards IT departments, the low-code versions are aimed at business analysts and their equivalents. These low-code versions have seen various levels of adoption from piloted to implemented in different organizations.

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<sup>67</sup> <https://www2.deloitte.com/us/en/insights/focus/technology-and-the-future-of-work/intelligent-automation-2020-survey-results.html> (Accessed 9/2/2021)

<sup>68</sup> <https://www2.deloitte.com/us/en/insights/focus/technology-and-the-future-of-work/intelligent-automation-2020-survey-results.html> (Accessed 9/2/2021)

The biggest hurdles for the successful scaling of ETL and data integration tools across an organization are process fragmentation, high costs, and the lack of technical expertise. Traditional ETL tools often come with high implementation costs and multi-year transformation programs and do not fix problems when data issues originate at the source where data is collected. In order to address some of these challenges, companies have been finding agile way to fund developments by starting with smaller scale projects. Furthermore, companies have had to increase their education around data management and the value it provides to all areas of the organization, often with this education delivered via a Center of Excellence or central user group. Low-code platforms have also reduced the need for technical expertise and the lead times in realizing value out of ETL tools. Such platforms can bridge the gap in situations that do not require robust enterprise-wide ETL tools but do need additional controls and auditability above what Excel provides. With respect to scaling, it is also important to not try to unnecessarily force standardization of one tool across the organization. Consideration should be given to individual team and user needs and preferences in order to maximize value in a short amount of time.

From an upskilling and education perspective, traditional ETL tools will still reside within IT departments. However, analysts embedded in the business, including actuaries, derive value in learning how to use low-code ETL tools to process data on problems that are not necessarily scaled across the entire organization. To enable the success of all types of ETL tools, leaders have required education in the value of leveraging their data and incorporating additional datasets in order to derive insights. Leaders must also be made aware of how proper ETL practices are needed as a foundation to enable the analytics on their organizations' data.

The need to use of APIs will depend on the nature of how models and results from applications will need to be consumed downstream. For APIs to be valuable downstream in the example of sharing results to other applications, processes should be repeated relatively regularly and require on-demand accessibility of upstream information called by the API. For example, if a predictive model is only built as a proof of concept and will not be integrated in other applications, then an API might not be the right tool for sharing results. Furthermore, usability is important when creating or using APIs. Downstream users need to be able to know how to write the API calls to gather the right information as intended and understand the nature of the data being grabbed from the upstream application, which requires a mixture of programming and domain knowledge. In order to facilitate the understanding behind what operations are being performed by the API calls, proper documentation around these APIs is important so that users know how to properly utilize the API calls to maximize their benefit. Other considerations, particularly when using publicly available APIs for critical applications, are the limitation of the number of API calls allowed, pricing on the usage of API calls, and uptime.

### ***Robotic Process Automation (RPA) and Low-Code Automation***

Organizations are at different levels of RPA adoption and use different approaches with respect to their implementations. Organizations that are implementing automation at scale differ from those in early adoption stages in one particularly pronounced area: their approach to change. Those that are more advanced are more likely to reimagine what they do, not just redesign tasks or re-engineer processes. They are re-envisioning how work can be done, which allows them to expand their ambitions, and evolve from taking small steps to achieving radical change<sup>69</sup>. On the other hand, organizations in the piloting stage are more likely to automate current processes with more limited change.

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<sup>69</sup> <https://www2.deloitte.com/us/en/insights/focus/technology-and-the-future-of-work/intelligent-automation-2020-survey-results.html> (Accessed 9/29/2020).

Even though RPA can have huge benefits, it is not yet easy to implement due to some barriers like lack of technology awareness, lack of process documentation, weak executive buy-in due to initial setup and licensing costs, as well as lack of good skilled RPA resources to meet demand.

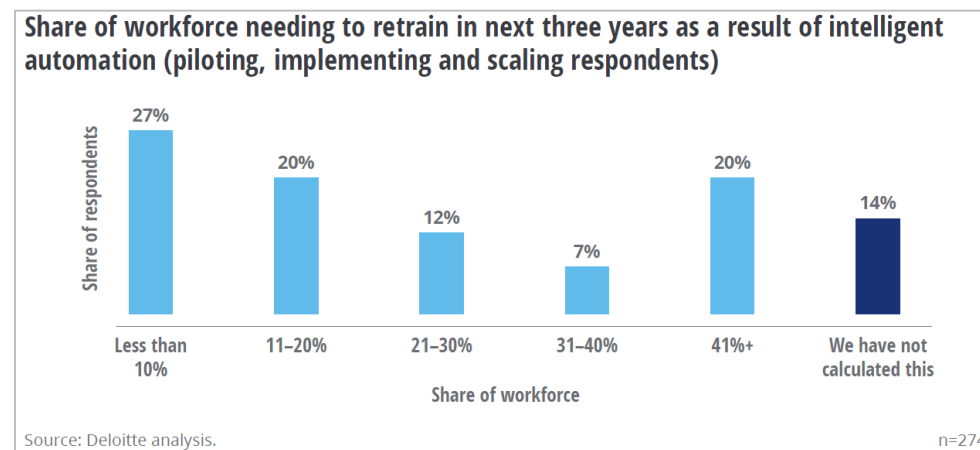
To address the challenges in implementation, the RPA journey needs top executive level sponsorship and nurturing. A Center of Excellence sponsored by a Chief Information Officer or equivalent would be the best way to handle this issue in many cases. Furthermore, the organization needs to be upskilled in various dimensions:

- 1) Leaders need to be educated on the benefits and functionality of RPA, particularly with respect to how RPA can fit into their respective businesses.
- 2) Business users need to be educated on RPA functionality, particularly on how to work alongside RPA bots.
- 3) Technology-related employees implementing the RPA bots need to learn the RPA technologies and how to deploy them.

As companies have gone through their RPA journeys, it is becoming clear that automation is affecting the workforce. The question is no longer if, but how. In the Deloitte report, “2020 Global Human Capital Trends,”<sup>70</sup> 54% of Chief Human Resources Officers stated that they believe the number of jobs in their organizations will remain the same, but that the nature of these roles will change. Over the next three years, it is expected that a significant share of the workforce (across all industries) will need to retrain as a result of intelligent automation (including RPA), as depicted in Figure 25 below.

**Figure 25**

**AUTOMATION IMPACT ON WORKFORCE**



Source: “Automation with Intelligence: Pursuing organization-wide reimagination”, Deloitte

<sup>70</sup> Deloitte Insights, “The social enterprise at work: Paradox as a path forward, 2020 Deloitte global human capital trends” (Accessed 9/29/2020).

### 3.3.5 ACTUARIAL CURRENT STATE AND FUTURE OUTLOOK

#### ***Extract-Transform-Load (ETL) / Data Integration, And Low-Code Platforms***

Actuaries' familiarity with low-code ETL tools and APIs range drastically, from no knowledge to extremely familiar. Generally, actuaries have a slight understanding of low-code ETL tools but have only just heard of APIs. Most actuaries are familiar with the concept of ETL through the use of SQL or the use of such techniques built into actuarial valuation software. However, familiarity with some of these emerging tools is not as high. Furthermore, adoption has lagged due to conflicts with existing ETL processes performed in VBA and Python.

While not explicitly asked in our actuarial interviews, several participants mentioned that their companies were currently investing in revamping their enterprise data platforms to be powered by the cloud. These cloud data platforms will be similar to the first case study discussed in Section 3.3.3 Case Studies and will integrate data across different functions in the organizations, enabling self-service analysis in downstream processes and applications (e.g., in BI Tools and ML/AI applications). While most of the implementation of such platforms will be done at an enterprise level, some actuarial teams have been looking into low-code ETL tools that come as part of these cloud platforms (e.g., Amazon AWS, Microsoft Azure).

Out of the 14 participants interviewed (covering Life, Health, Pensions and P&C), eight respondents and two respondents mentioned the current usage of low-code ETL tools and APIs, respectively, among actuaries, meaning that they either completed a pilot, implementation, or beyond.

One health respondent mentioned some usage of API with less actuarial involvement, but no specific description was provided. The pension respondent did not use low-code ETL tools as traditional automation tools were enough.

Amongst the 11 Life and P&C respondents, ETL usage was reported as follows:

- Seven started implementing at least one ETL use case or were currently scaling across their organizations.
- One respondent indicated they were still only in the pilot phase.
- One respondent did not have current plans to implement ETL over the next three years.
- Two provided no response.

Amongst the 11 Life and P&C respondents, API usage was reported as follows:

- One started implementing at least one API use case or was currently scaling across their organization.
- One respondent indicated they were still only in the pilot phase.
- Nine provided no response.

While there are some use cases of low-code ETL by actuaries, most companies either have most of their data prepared by separate IT teams or have their actuaries using more traditional ETL tools (e.g., SQL, Python, and R.). Therefore, future usage of low-code ETL codes will be dependent on the value such tools may have above the alternatives for each organization's situation.

Further details on current state of actuarial usage and future outlook for actuaries are discussed below.

## Current State

Traditionally, actuaries perform ETL using traditional ETL tools such as SQL, Python and R. For example, this can be applied to data manipulation in experience studies, data cleaning, grouping, and summary statistics.

Nowadays, a variety of ETL tools, including the low-code variants, are introduced into actuarial functions and applications – e.g., comparing source rates against model rates during model validation, calculating A/E in experience studies, and standardizing data and procedures generally. Below are descriptions of specific use cases that have been implemented.

- **Data aggregation for Dashboard Production**

Some ALM teams are using Alteryx to aggregate security-level data and produce risk dashboards (e.g., market, liquidity). The outputs are then compared to management thresholds and tied to the outputs used by actuaries (e.g., discount rates). This is easy to implement and has achieved a big improvement from the past when data was repeated in large number of spreadsheets and shared a common data source. The current implementation is the overarching process to aggregate data into a centralized data source, so that individual risk dashboards can feed data from a single source.

Other companies are applying a similar concept for all dashboards organization wide.

- **Table Conversion to Actuarial Software**

An insurer working on model validation found that table conversion workflow from admin system to actuarial software was extremely slow, and that the conversion queries were difficult to review and follow. Multiple Alteryx graphical workflows were created to help with the transformation. The master workflow was adopted by the insurer and frequently used in all model validation workstreams. The workflow was then tailored to validate key model assumptions based on the data format and structure. This made their model validation process more auditable and removed restrictions on the input data size or format.

- **Product Development / Innovation**

One company had actuaries using such tools to efficiently, but flexibly, produce prototypes that would be implemented later by IT.

- **Corporate Actuarial**

One company used such tools for post-projection processes, reporting/managing financial results (e.g., aggregation of BU results).

Several companies are actively trying to minimize the use of ETL by actuaries, although many still use traditional ETL tools. Tools like Alteryx has filled in some gaps where ETL needs are not met by the traditional tools or IT provided data. While Alteryx can potentially save costs and provide better data quality and auditability, the potentially high costs and lack of company skillset make it not that easy to implement. Similar low-code tools may be cheaper, but lack of training and existing expertise would also prove to be a problem.

Furthermore, some other respondents indicated some pilot use cases. One leverages AWS QuickSight to join datasets using a GUI-based platform for **experience study processes**. Another respondent mentioned the use of Tableau prep to **automate pricing** processes. Azure Data Factory was also mentioned as a platform to backup actuarial models automatically in **valuation and for general data manipulation** in experience studies.

In addition to ETL, a very limited number of companies have used APIs extensively. APIs can be applied in the front-end to retrieve data from websites, vendors, and providers. In addition, APIs can be deployed both internally and externally to share data with business partners. Internal APIs for sharing insensitive data within the organization

would be more accessible to actuaries, while external APIs to share data outside of the organization would be harder to use for actuaries due to security/IT/data protections. APIs have also been piloted to hand off analytics model scoring for real-time deployment to downstream applications. In terms of developing API, actuaries have either been deploying APIs themselves or as part of a broader team.

### Future Outlook

Low-code ETL tools will be useful where traditional ETL tools are not sufficient for business needs (e.g., too difficult to learn quickly for users or reviewers) or where IT is not able to provision data quickly enough. One particular scenario where this might occur is the result of systems transformations resulting from IFRS 17, where ETL tools may help with post-implementation investigations (e.g., digging into different drivers of results).

Low-code ETL platforms are likely to be considered by various actuarial functions:

- **Reporting:** there is interest in shaping ad-hoc or manual processes to be more repeated and controlled.
- **Pricing:** pricing processes will be automated by using ETL to manipulate admin system data for pricing.
- **ALM:** there is increasing focus on using more data, from a handful of policy limits to more limits. ETL tools are considered to accommodate large datasets with an increased level of automation.
- **Experience studies:** Alteryx was noted with potential to take off in adoption since it is easy to communicate what the program does to regulators/auditors. Also, low-code ETL tools could be an easy way to augment internal data for assumption setting augmented with external data.
- **Valuation** – low-code ETL tools could be used in data investigations to prepare data for valuation software. This use case was mentioned by a Pension respondent but could easily be applicable for multiple use cases and lines of business.

With respect to ETL tools, most of these use cases can be extrapolated beyond the functions and lines of business listed above. In general, low-code ETL tools can be useful to explain what data transformations are occurring to a non-technical reviewer, while maintaining greater transparency and auditability over any executed processes.

With respect to APIs, actuaries have demonstrated some limited use cases where they can be used and have acknowledged potential for actuaries to use APIs in the future. While actuaries historically have not acted as software developers, actuaries could potentially see a higher need to interact with APIs and API development tools, particularly due to the increased ease of developing APIs through these development tools. Furthermore, the greater need to access different sources of data for analytics purposes, the potential need to deploy predictive model insights in real-time, and the more prominent usage of R and Python for modeling will all increase the demand for the usage and knowledge of APIs. The likely scenario is that actuaries will work with IT in order to develop and deploy such APIs beyond just delivering business requirements.

One challenge with APIs is that not a lot of people outside of developers and IT understand what they are and how they can help the business. Further education and training are needed to help actuaries and other stakeholders in the business. Moreover, many things can go wrong with the real-time deployment of analytics to downstream applications such as outlier input data producing odd results in those applications. While deployment will largely sit with IT in most organizations, actuaries will likely be closely involved and certainly will need to be familiar with APIs.

### **Robotic Process Automation (RPA) and Low-Code Automation**

Companies showed a wide range of familiarity of RPA, ranging from just having heard the term to extremely familiar.

When asked about RPA's usage within actuarial, the 14 participants (covering Life, Health, Pensions and P&C) responded as follows:

- Two mentioned they completed either a pilot of RPA usage among actuaries and/or beyond.
- Eight did not have current plans to implement RPA over the next three years.
- One indicated no current use but was not clear on RPA's future outlook within actuarial.
- Three provided no response.

Despite the use of RPA in insurance operations, the usage by actuaries directly is very limited due to other automation tools/processes that are already in place (e.g., VBA macros, automation built into actuarial valuation software, R/Python). In most cases where RPA is used for actuarial processes, actuaries are only providing business requirements for the RPA developers, with actuaries having very little interaction with the RPA tools and their inner workings. Therefore, the future outlook for RPA being used by actuaries does not appear promising outside of providing requirements to a separate RPA development team.

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*One RPA software we tried did not take off because it's difficult to find a niche where this tool can be applied instead of VBA macros or Python. We are exploring another tool which may serve a similar purpose. – one Life and Annuity respondent*

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Further details on the current state of actuarial usage and future outlook for actuaries are discussed below.

#### Current State

Several companies mentioned existing automation capabilities in current processes through the use of other technologies. For example, VBA macros already serve this functionality for Excel files; auto scheduling runs in Moody's AXIS also already serve this functionality to a certain degree; R Shiny and R Markdown can also be a way to automate static reports in R. Despite the lack of RPA applications within actuarial functions, actuaries are generally familiar with the purpose that RPA serves, but in the context of other tools such as VBA, R, and/or Python. However, the issue behind RPA's lack of adoption is finding the niche that RPA fulfills for actuaries that can't be served by these other tools.

Many insurance companies have been utilizing RPA in operations but have had limited usage in actuarial. Where RPA is used for actuarial processes, the RPA development is usually driven by other dedicated enterprise teams and centers of excellence. The actuaries' involvement are generally limited to providing requirements and validating outputs without any need to understand how RPA works or what it is doing under the hood.

Some areas where RPA was applied for actuarial processes: model risk management processes, a process of producing triangles followed by automatically identifying outliers for user review and analysis, and some other unspecified ideas. However, many pilots have not been successful up until today due to software limitations or alternate tools available for automation that were often just as efficient or more efficient than using RPA.



## Future Outlook

A majority of the companies mentioned have no plan to implement RPA. Some companies have struggled with their RPA implementations and have started exploring other vendors to investigate whether RPA can still solve their automation objectives. One company mentioned on-going discussions but no concrete implementation plan in the next three years. A few others saw some value in automating high volume, repetitive actuarial tasks such as month-end and quarter-end processes and the automation of future IFRS 17 reporting; however, these companies also commented a combination of other tools -- such as ETL, low-code tools, R/Python, and BI tools -- could serve a similar purpose and would be likely preferable for actuarial uses.

In general, insurance companies see much more value in implementing RPA in their operations rather than actuarial. Where actuarial processes are automated with RPA, the use of informed actuaries working alongside developers to steer development work usually helps derive more value from RPA automations. In some cases, actuaries may be better skilled to do their own automation rather than having an extra layer of programming done by others. If several different software are being used in one process, RPA could be useful to streamline automation across these applications. Additionally, outdated legacy processes that have not been modernized could be another area that would benefit from RPA. However, it is still difficult to assess how far RPA can be generalized across different processes and potentially different environments. Ultimately, if there is not a high enough volume of processes across which to scale the RPA automations, then the cost-benefit trade-off of implementing RPA might not be worth the investment. That being said, RPA can be very powerful in the right circumstances and it would be worth it for insurance companies to at least consider it for their actuarial processes.

## 3.4 COLLABORATION AND CONNECTED DATA

### 3.4.1 DEFINITION AND TERMINOLOGY

#### ***Dynamic Collaboration Tools (Communication, Documentation, Project Management)***

The acceleration of remote work resulting from COVID-19 has increased the need for additional collaboration tools to enhance communication within and between teams. There are many tools that serve this need in different ways. For the purpose of this report, we define these tools as:

*Dynamic collaboration tools, which help with synchronous and asynchronous collaboration, co-authoring, enriching data with metadata, and elevating conversations through the mixing of modes of communication. Common examples include modernized intranet portals, employee experience hubs, self-service portals, Kanban/Agile boards, digital whiteboards, knowledge management wikis, etc. Such applications can include tools to help track a project's status/issues, share knowledge, and help geographically distributed teams collaborate and communicate easily, usually over a cloud-based software.*

Examples include: Microsoft 365 (MS Teams, OneDrive, etc.), Slack, Trello, Miro, PollEverywhere, etc.

#### ***Source Control (Version Control) Management Tools***

While source control management tools have been in use for many years by programmers for the code they write, they have traditionally been underutilized by actuaries. As actuaries increase their usage of programming tools, the need for version control systems to manage collaborative efforts will correspondingly increase.

*“Source control (or version control) is the practice of tracking and managing changes to code. Source control management (SCM) systems provide a running history of code development and help to resolve conflicts when merging contributions from multiple sources.”*

These tools create versions of artifacts (documents and code) and allow users to retrace their changes back to any version they wish. Modern SCM tools also allow for better collaboration as many people can simultaneously work on the same document and not worry about their edits overwriting the edits of other users. Such tools will have conflict management abilities and the ability to roll-back the code to prior versions without losing any history. Examples of SCM systems include Git, Subversion (SVN), etc.

There are several hosting and implementation options for version control systems. These allow the user to store and manage their project “repository” in a system that typically extends the functionality of the standard SCM. Popular examples for Git are GitHub and Bitbucket where additional functionality is provided beyond standard Git (e.g., project planning, issue tracking, etc.).

### **Connected Data, Reporting, and Financial Close Tools**

A number of platforms exist to automate the financial close to address the “record-to-report” process, which has been historically underserved in the technology space. These solutions address the time intensive manual processes, which traditionally reside in word documents, spreadsheets, e-mails, and hard copy documents.

*Connected Data and Reporting* platforms allow for collaboration in reporting across an enterprise by helping teams connect reports and data in various formats – primarily spreadsheets, PowerPoint, Word documents, etc. – to enable collaborative real-time reporting for compliance, financial, and management reports. Additional functionality may also exist to add controls, compile controls, and link to an organization’s controls framework. These platforms are often cloud-based and enable teams to work together on complex business reports or simple day-to-day activities, empowering them with automated reporting in an auditable and transparent manner.

*Close Automation* platforms allow financial reporting teams to manage their financial close and reconciliation processes in a controlled environment, often in the cloud. These platforms help streamline the reconciliation process and allow for a central location for all reconciliations, transaction matching of high-volume data across datasets, journal entry adjustments, etc. This is supported by automated rules-based workflows, embedded controls, and real-time dashboard reporting.

## 3.4.2 CASE STUDIES

### **Dynamic Collaboration Tools (Communication, Documentation, Project Management)**

#### **Case Study 1: Office 365, SharePoint Online, MS Teams implementation at a public sector organization**

Problem Statement: The organization wanted to modernize its workplace productivity and move towards its digital transformation goals. They identified that their content stores were unstructured and communications/meeting platforms were failing to meet their key organizational and strategic objectives, some of them being security, compliance, centralized device and user experience management, effective intra-office and external communications, and an engaging intranet portal. With content spread across the organization within SharePoint, file shares and user mailboxes, the need was to consolidate everything into a single-service offering.

Solution: Three collaboration tools – Office 365, SharePoint Online and MS Teams – were rolled out across the organization. The implementation team provided strategic direction and Teams architecture recommendations around the onboarding and offboarding of new Teams and SharePoint sites. The platform provided staff with productivity and collaboration tools that could be used securely on any device, anytime and anywhere while maintaining compliance with company policies.

Value: The new collaborative tools were dynamic and consistent with the organization’s branding and communications objectives. Benefits included not only enhanced security and compliance, but also ubiquitous access to services through smartphone apps (e.g., Outlook, MS Office) and access to some services through other computing devices (e.g., external PCs and tablets). In addition to overcoming all the challenges listed in the problem

statement, it also enabled teams to utilize dynamic news feeds, including the ability to highlight featured news, create announcement feeds, and recognize accomplishments via an Employee Spotlight section. The organization decreased its dependency on paper-based processes and provided more opportunities for its staff to work from home or other locations while maintaining the ability to collaborate and connect with colleagues.

### **Source Control (Version Control) Management Tools**

#### **Case Study 1: SCM implementation at a major healthcare provider**

Problem Statement: In order to support healthcare providers around the globe, a healthcare organization required an international team with thousands of employees worldwide to remotely work together. Seamless collaboration among a rapidly growing number of employees is a challenge for any company—especially when expanding through mergers and acquisitions. As the organization grew, new developers with a wide variety of technology stacks entered their workforce—making even the number of teams and toolsets difficult to count. This organization needed a standardized way to work together, particularly for its software development teams that were all using different sets of tools, many of which were lacking SCM.

Solution: The executives knew that standardized tools and digital transformation were a critical part of growing to scale. Based on data from over 20 software leaders across the firm, their solution was to create a DevOps solution team and build a community of software teams that delivered a cohesive technology stack, which included SCM as an integral cog in the wheel.

Value: In 16 months, the firm transformed over 30 siloed software engineering groups into a largely cohesive team. The DevOps COE started supporting over 25 engineering teams all over the world, allowing them to simultaneously collaborate and co-create applications on a common code repository. This led to huge efficiency returns to the development teams, and a one-off cost savings for the firm of \$350,000 per team.

### **Connected Data, Reporting, and Financial Close Tools**

#### **Case Study 1: Financial Reporting and Disclosure – Renewable energy company**

A Canadian renewable energy company has been manually preparing 23 entities Financial Statements with high volume trial balance and source data. Workiva was leveraged to automate the close process. Linkage was established between all source data and a master Financial Statements template was also created to automate Management Discussion & Analysis (MD&A) and Board reporting. As a result, the company was able to reduce the preparation time of MD&A reports and leverage dynamic, reusable reporting templates to rollforward for subsequent reporting.

#### **Case Study 2: Control database creation – Energy transportation company**

A Canadian public energy transportation company faced challenges of updating over 1000 internal controls. The legacy system was not intuitive and was becoming increasingly onerous to maintain. A Workiva database was set up to centralize their Risk and Control Matrices in an easily maintained platform and customized reports and dashboards were built that allowed management to understand the progress of their SOX program. As a result, over 1000 controls with over 500 key controls were established in the database, and linkage was created between risk assessment, controls, process narratives, flow charts, segregation of duties, process owners, and controls owners.

#### **Case Study 3: Managing risk in the cash over/short balance – Fashion retailer**

The differences between cash received at the bank and sales recorded in the General Ledger via Point of Sale (POS) systems are written off in the form of a “cash over/short.” A Canadian fashion retailer was struggling to manage the risk in cash over/short balance due to the lack of visibility. Their existing manual process covered only 7% of total transactions to match known exceptions only. A BlackLine Transaction Matching module was implemented to

enable and automate the detailed transactional matching of all sales transactions against cash collected. The module was configured to match the Point of Sale transactions against the bank data to identify variances or uncleared items requiring investigation. As a result of this implementation, coverage of cash over/short balance was increased from 7% to 100% of sales transactions without an increase in manual effort or headcount; an equivalent of 2,000 hours per month. With the new visibility into their cash position, the company was able to analyze variances for informed write-offs, prevent instances of employee fraud and ultimately reduced overall cash over/short write-off.

#### **Case Study 4: Finance Modernization – Canadian Dental Services Company**

**Problem Statement:** A finance modernization initiative wished to establish increased levels of confidence in the company's close processes. The project initiated the implementation of BlackLine, a close automation platform, to streamline the balance sheet account reconciliation and transaction matching processes. The business also required a design of reconciliation policy that leveraged technology to reduce manual efforts, strengthen control and supports audit and compliance requirements. Another goal of the project was to simplify and automate the reconciliation of high-volume bank transactions.

**Solution:** The project leveraged the automation functionality of the BlackLine Reconciliation and Transaction Matching modules to accelerate the Balance Sheet Accounts' reconciliation process, increasing efficiency and matching process completeness. The solution empowered finance teams to define matching logic across three different systems to automate manual effort for the bank reconciliation process.

**Value:** The equivalent of 560 hours of manual effort per month was automated for the bank reconciliation process, freeing up time for higher value activities. In addition, the platform increased coverage of transactions for reconciliation processes provided, resulting in improved visibility into transactional level detail to analyze discrepancies in a more efficient manner.

### **3.4.3 VALUE PROPOSITION**

#### ***Dynamic Collaboration Tools (Communication, Documentation, Project Management)***

Dynamic collaboration tools aid in the acceleration of remote work through the provision of tools that allow employees to work in any place, any network, and any device, all of which have been needed now more than ever due to COVID-19. These tools are helpful in collaborative working environments where conversations need to take place across multiple locations, files need to be exchanged across many devices, ideas need to be remotely discussed with visual aids, and documentation needs to be captured and stored seamlessly into systems for future recall. Virtual whiteboards and polling tools, for example, allow for sharing within meetings that would normally be difficult to implement unless in person. Furthermore, those ideas augment the physical variants through the ability to record conversations and save snapshots for later use. Other useful functionalities include tools facilitating the sharing of information and files across teams both within and outside the organization. In addition, collaborative tasks are made easier through automation. For example, a team might use a tool to automate follow-ups based on the tasks entered into a project management tool.

Implementation of a multitude of these dynamic collaboration tools that work seamlessly with each other can result in compounded benefits to an organization. Some of the biggest savings are owed to reduced travel costs, reduced turn-around times, and reallocation of FTEs to higher value work. These tools also enable information to be accessed faster, resulting in increased overall employee satisfaction due to less friction in day-to-day activities such as project management, issue tracking, etc. The combination of these tools in conjunction with analytics can allow for the analysis of where time is spent if, for example, teams utilize workflow tools or project management tools to document task stage/status. These insights can enable the discovery of new ways of working.

As with any new technology, the benefits come with some drawbacks. While two people meeting virtually is very convenient, it can never replicate the value we get from one-on-one human interaction. These tools also heavily rely on a strong and consistent internet connection. Employees need to be cognizant of what tools other teams and business partners use, since some tools cannot communicate with one another and some organizations are restricted in the tools that they use.

### **Source Control (Version Control) Management Tools**

Source Control Management (SCM) systems allow multiple people to work at the same time on the same project. Every individual edits their own copy of the files and chooses to share those changes at various checkpoints with the remainder of the team. Incomplete edits done by one person don't interfere with another person's work. SCM systems can then be linked to a central repository which allows the individual users to share their versions of their own local copies of the repository.

SCM systems also allow users to compare different versions of the same file, allowing them to decide whether they need to merge new changes or discard them. If two individuals have conflicting edits in the same line of a file (i.e., a "merge conflict"), the SCM will let the users decide what steps to take to resolve the conflicting code.

SCM systems also help maintain historical versions of the files. This can be insurance against laptop crashes or knowledge losses. If a current version gets corrupt, an SCM central repository enables users to roll back to any previous correct version. Maintaining code in SCM enables developers to reproduce old bugs at any point in the future.

### **Connected Data, Reporting, and Financial Close Tools**

#### *Connected Data and Reporting*

Financial reporting close processes are generally plagued with data from various sources, mostly in spreadsheets and documents, which contain data that flows from or alongside with controlled production processes, making it difficult to consolidate information from various team, departments, and potentially entities. Linked spreadsheets and manually pasted documents cause an issue where a change occurring in one dataset is not automatically reflected in all dependent documents, which can affect data consistency and accuracy. The need to check links between spreadsheets and other documents can take up a lot of time and can prove to deter productivity and the ability to meet deadlines during critical periods.

Connected data and reporting tools address these concerns. They ensure data is connected on a single cloud platform to confirm data remains consistent and accurate, reflecting and recording all the changes that take place with a visible and documented audit trail. With the help of these tools, changes or updates to the data in one part of the process are applied throughout all linked documents, saving a lot of time which can be essential at peak and busy times of the year. Furthermore, collaborative editing and communication features accelerate the reporting processes, particularly when multiple versions of files are being created and numbers need to be explained to other individuals and teams. With all the potential concurrent changes, these tools also provide line of sight over who is changing what data, when the changes are occurring, and where impacts to data are coming from. Additionally, sections of reports can be locked down where protections are required to control who can view, access, and edit the data. All of this is done in a familiar environment to business users – i.e., similar to Word, Excel, and PowerPoint. These controls provide comfort to an organization's reviewers and auditors over data and information included in its reports.

The functionalities described above reduce FTE time spent on manual activities that do not add value and can be used elsewhere (e.g., analysis, issue resolution). In addition, turnaround times can be shortened, particularly where there is a need for hand-offs and communication between departments. Visibility gained via progress tracking built

into the collaboration functions also adds a layer of risk management to reporting processes and ensures they are running on track and major issues are visible to appropriate stakeholders.

These tools have some limitations in that they are not meant to overhaul ETL processes and are designed to improve an Excel-based reporting process without too much change. In addition, vendors might not cover specific functionalities built into software like Excel (e.g., VBA macros, specific functions), so removals of those functions/macros or workarounds would be needed in scenarios where they are used.

#### *Close Automation*

Close Automation tools streamline the management of the financial close by automating transaction matching, generating journal entries, and performing account reconciliations. For example, such tools can match transactions and fields common across datasets. High volume reconciliations are enabled through custom matching rules and automated suggestions for unmatched transactions, all of which can be performed for multiple types of data sources. These tools reduce the time taken throughout the close process, which traditionally would require pulling up of accounts, performing rollforwards, printing, signing, scanning, etc. Such tools also improve visibility and execution by centralizing financial close tasks, using automated workflows, and utilizing real-time dashboards for tracking and reporting.

Both tools are ideal to enhance processes with:

- High volumes of manual work across spreadsheets that require lots of time performing updates and reconciliations, adding risk to the process
- Broad groups of individuals and teams involved, requiring data consistency and accuracy across the teams
- Need for collaboration and consistency using frequently updated files with both internal and /or external parties
- Need for control and line of sight over changes, who is making changes, and current status

### 3.4.4 IMPLEMENTATION CONSIDERATIONS

#### ***Dynamic Collaboration Tools (Communication, Documentation, Project Management)***

Adopting and scaling these technologies from team to organizational level can have some initial barriers and will depend on the starting maturity of an organization's investment into cloud infrastructure. Some barriers include the rate at which organizations and people can assimilate these changes and organizations having legacy systems that are not compatible with these new tools. The cost of employee training, both for IT professionals and the end users, can also act as a deterrent in adopting these new tools.

Some of the mentioned barriers can be addressed by ensuring there is top leadership buy-in into these technologies, enforcing organization-wide adoption and implementation. To facilitate adoption, teams could identify early adopters of the tool and assign them as technology champions responsible for identifying what else the tools can be used for. These champions can showcase success stories of one team to wider audiences to increase adoption rates. Digital technologies are replacing physical spaces and assets, which pose a significant change to the way people work. Organizations need to take steps towards making the employees comfortable with adopting these new tools, which can be done by emphasizing the well-being benefits by allowing teams to have flexibility to perform remote work when necessary. To address costs, these technologies need to not be viewed as a cost, but rather as a tool to assist their employees. Framing and quantifying the benefits for the employees will be important in getting buy-in from the organization.

### **Source Control (Version Control) Management Tools**

As with any tool/technology, implementing it successfully across the organization requires many factors to be satisfied. Some of the key barriers in successful implementation are lack of top management commitment and support, resistance to change among the development team, and lack of education and training for employees.

For a successful implementation, it is vital that the business leaders understand the benefits of SCM tools and disseminate this information to their teams. Support from top management will help middle management to enable and enforce best practices that come with SCM adoption. Teams need to understand the benefits over doing things “the old way” as there is a slight learning curve to adopting SCM.

As actuarial teams become more advanced in their use of programming tools and need to start scaling to production, they should consider complementing SCM tools with other deployment tools and evolving practices that have been emerging to accelerate the pace of development and operationalization. For example, a recent trend called DevOps<sup>71</sup> has emerged involving the practice blurring the lines between Development teams and Operations teams. Tools that enable practices such as containerization and Continuous Integration / Continuous Deployment in combination with Agile working styles have evolved to accelerate the pace of delivering applications and services over the speed at which this would be done under traditional software development and infrastructure management processes.

### **Connected Data, Reporting, and Financial Close Tools**

Across all industries, adoption of connected data and reporting tools varies by company and by region, but the technology has been around for many years. U.S. and Australia are more advanced, while Canada and the UK are a bit behind. Many companies are still in the evaluation stage, but some have deployed, and some have scaled.

The top barriers to scaling this technology would be the lack of IT resources to support the deployment and the lack of understanding for how the technology works. Companies are not aware of how to set up the tools and employees are not trained on the tool functionality, both of which dilute the effectiveness of the tools. However, with proper training and change management, these tools can be set up and running relatively quickly. Dealing with these barriers is not too challenging compared to some other tools that overhaul processes. Implementation and training employees to fully operate and extract value from the tool takes approximately four to twelve weeks. Of course, these tools evolve over time, so companies need to ensure they are leveraging the latest functionality that comes with tool updates.

## **3.4.5 ACTUARIAL CURRENT STATE AND FUTURE OUTLOOK**

### **Dynamic Collaboration Tools (Communication, Documentation, Project Management)**

As seen in Section 3.0.1 Technology Familiarity and 3.0.2 Implementation Maturity, most companies are very familiar with the technology and use these tools on a regular basis. Out of the 14 companies interviewed (covering life, health, pension, and P&C), 13 completed piloting and were beyond the stage of implementing dynamic collaboration tools. One provided no response.

Amongst the 11 Life and P&C respondents, all respondents indicated they were beyond the piloting stage. One health respondent indicated they used the tool only externally with their clients, but not internally. The pensions respondent indicated that such tools were used extensively for collaborative editing.

It is unquestionable that remote working environments resulting from COVID-19 have accelerated the usage of dynamic collaboration tools across companies. This is no different for actuaries. The commonly used tools are

<sup>71</sup> <https://aws.amazon.com/devops/what-is-devops/> (Accessed 7/15/2021)

Microsoft Teams, Office 365, and Sharepoint for remote collaboration such as video chats, conferencing, breakout rooms and file sharing. Additional tools such as Kanban, Azure DevOps, Trello, Miro, Wiki and Git have also been mentioned for project management and brainstorming functionalities.

### Current State

Generally, these tools are an IT-implemented enterprise-wide initiative, so ease of implementation was evaluated from the perspective of ease of adoption amongst actuaries. Apart from one response, companies indicated that the ease of persuading actuaries to adopt these collaborative tools has been high.

These tools cover many different functions and are broad in nature:

- Although there may be some variance between junior and senior actuaries in terms of frequency of usage, Microsoft Teams and Office 365 are, generally, frequently used for project management, collaboration and file storing across companies.
- The tools can enable knowledge sharing in new ways: for example, a prior discussion between two actuaries (e.g., as part of a pricing process) can be stored as transcript to be passed down to more junior actuaries, whereas previously that could only been done via emails or phone conversations which are forwarded to relevant team members, if possible. This new way of sharing knowledge makes that knowledge much more easily accessible to actuarial teams.
- Sharepoint is used to store and share information and also has limited version control capability. Sharepoint offers advantages over IT-controlled data in terms of the business being able to access information in a self-serve manner to derive insights from the data.
- One respondent mentioned an actuarial partnership with software developers and data engineers on tool/data development solutions whereby actuaries actively maintain a collaborative code library for knowledge and technique sharing with peers and data scientists
- Performing project management and brainstorming tasks with these tools, such as Confluence, is somewhat limited across participants but is rated as potentially useful.
- A few companies mentioned the implementation of Git for project management and tracking issue logs, whereas others mentioned using Slack messaging, Miro, Trello and Kanban boards.
- One company decided to attempt co-authoring an actuarial report but ended up deciding not to use that process anymore. However, another company is having success with working on reports concurrently in real-time.



## Future Outlook

Respondents were optimistic regarding overcoming resistance to the usage of these dynamic collaboration tools in the post-pandemic environment as actuaries partially return to the office.

One respondent mentioned the importance of reducing the manual burden of communication and project management in relation to the potential need to use more of these tools:

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*As productivity increases and actuaries are juggling more work, actuaries need to find better ways to manage the workload and stakeholder communication. It becomes crucial for actuaries to be involved in project management. Having actuaries with strong project management skills is more critical due to projects become more complex, undefined, and longer lasting. Everything needs to be documented (e.g., original objectives and timeline), and actuaries need to get better at explaining why projects are taking longer, why resources get pulled away, what roadblocks are encountered, etc.*

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Companies are generally pushing for more collaborative environments where actuaries need to work together on the same files. There also appears to be potential for additional use of digital whiteboarding and brainstorming tools amongst actuaries.

### **Source Control (Version Control) Management Tools**

As seen in Section 3.0.1 Technology Familiarity, actuaries have a huge range of familiarity with source control management tools, from no knowledge to extremely familiar. On average, they have a good understanding of the tools, which is the first step for using these tools in more advanced ways.

Out of the 14 companies interviewed (covering life, health, pension and P&C), eight completed piloting and were beyond the implementation stage ; one health respondent mentioned using SCM tools, while the other health respondent indicated that actuaries were not quite using these tools yet despite data scientists using them quite broadly. These tools were not currently used by the pension respondent.

Among the Life and P&C respondents:

- Seven had started implementing at least one SCM tool use case or were currently scaling across their organizations.
- One indicated that they were still only in the pilot phase.
- Three did not have current plans to implement source control over the next three years.

Git or equivalent tools are at an early stage of usage amongst actuaries and are attracting a growing level of interest. They appear to be growing in importance as more actuaries utilize programming languages such as R/Python to power their processes and modeling.

### Current State

Source control management tools, such as Github, Gitlab, and Bitbucket, are a growing area of interest and becoming more important. Git and its variants are used by actuaries for code storage, code/version control, code sharing, workflow tracking, collaboration, SCM tools in analytics, P&C pricing models, automation suites, ETL for inforce file building, and general productivity tools for actuaries. Benefits noted were the maintenance of code quality and shortened review/approval cycles.

While SCM tools are used by actuaries somewhat, they are seen as very IT/developer focused. The challenge in widening adoption is getting business users plugged into this environment. Furthermore, SCM tools can be perceived to be low value for leadership, despite being perceived as high value for actuaries which, therefore, makes it harder for organizations to obtain leadership approval to invest in the software.

A few companies mentioned the use of version control processes. Such alternative solutions to SCM tools to maintain version control included an in-house control methodology, i.e., End-User Computing controls, which is a streamlined control that prompts for review and approval when changes are observed. However, not only is this an emerging tool, this also does not cover all of the core functionality that SCM tools offer.

### Future Outlook

Source control management tool usage amongst actuaries is evolving quickly. More use cases are expected with Git or equivalent tools as actuaries can collaborate more effectively with R/Python and maintain sophisticated version control and simultaneous branching developments on the code. Actuaries would see the increased value if they moved out of Excel into code-based languages. Furthermore, having integration of code-based actuarial valuation software (e.g., Prophet) with Git would be a game-changer if it ever became available.

To ensure proper adoption of SCM tools, further education would be needed for actuaries at all levels to understand the benefits of SCM tools over traditional version control practices.

### ***Connected Data, Reporting, and Financial Close Tools***

Familiarity of Connected Data and Reporting tools was generally low with companies surveyed, although some were still relatively informed. In terms of implementation, we received very limited responses. Out of the 14 companies interviewed (covering life, health, pension and P&C), two completed piloting or had gone beyond the stage of implementing one use case; six respondents indicated no current plans to implement a Connected Data, Reporting and Financial Close tool over the next three years

Participants scored even lower in both familiarity and implementation maturity for Close Automation tools. None of the respondents indicated they were using or planning to use such tools. Two mentioned they had no plans to implement Close Automation tools in the next three years.

### Current State

We identified two current actuarial use cases for Connected Data and Reporting tools. One is Workiva, which is used for risk management global reporting in reviewing risk exposures on a monthly or quarterly basis where actuaries only key in the input data. Another indicated a use case to enable actuaries to trace data they are using in P&C rating work to the source. Several companies indicated they implemented the same types of principles to collaborate, review, and sign-off on results using alternate tools such as Dynamic Collaboration, ETL, BI, or in-house tools.

No respondents were using Close Automation tools and those that had seen them used in the organization viewed them as more related to accounting rather than actuarial. One respondent mentioned the use of BlackLine by

accountants at the group level for reconciliation, where actuaries simply login to the tool to verify that numbers are correct. Given the presence of other controls in the actuarial processes, using BlackLine was redundant for the actuaries in this case.

### Future Outlook

No future use cases were identified for Connected Data and Reporting tools by our survey respondents. However, we have observed several ongoing pilots within the wider industry outside of these respondents. One proof of concept was implemented to generate a memo for Cash Flow Testing for a life insurer, leading to improved user experience and reduced costs. Workiva's Wdesk platform is leveraged to automate the processing of memos by assimilating data from multiple sources (e.g., Excel, Word, PDF), enabling collaboration and establishing authorization through workflows. Similarly, another proof of concept was implemented to populate LDTI disclosure reports from spreadsheets without needing to manually copy and paste data from spreadsheet to report. The same process and benefits can be called out for IFRS 17 related reporting and disclosures.

These environments also provide ways for actuaries to highlight certain numbers contained in reports and see the history of changes to that specific value. In addition, the actuary can trace back those numbers to the spreadsheets providing those highlighted values in the report.

It appears that actuaries aren't fully aware of how these tools would help them over various alternatives, which might be contributing to their lack of adoption. Further investigation would need to be performed with the emergence of alternatives -- such as low-code ETL, BI, and Dynamic Collaboration tools -- to see whether Connected Data and Reporting tools work for each individual organization. Furthermore, actuaries may want to investigate how these tools might benefit their companies at a broader level beyond their own departments.

No future use cases have been identified for Close Automation tools and it appears for now that such tools are still in the realm of accountants only.

## **3.5. DATA GOVERNANCE AND SHARING**

### **3.5.1 DEFINITION AND TERMINOLOGY**

#### ***Data Governance Tools***

The increasing reliance on data to generate value across organizations has created a corresponding need for governance over said data, a task in which a number of tools specialize.

*“Data governance platforms manage the data landscape across an enterprise and integrate numerous content formats, including spreadsheets, PowerPoint, emails and other types of data into a single environment which enables automated data governance and reporting across departments in an auditable, transparent manner.”*

One obvious broad application of such tools would be to help insurance companies and, by extension, actuaries comply with regulations such as Solvency II, General Data Protection Regulation (GDPR), and others. However, these tools also enable organizations to discover, understand and trust their data by facilitating collaboration between businesses and IT on data-related topics and issues.

### **Privacy Enhancement Techniques (PETs)**

With the increased ability to unlock value from data due to the proliferation of ML/AI, companies have been exploring the possibility of enhancing the value derived from data through data sharing (both receiving and sending) with other organizations in specific scenarios (e.g., Open Banking). This might also occur in scenarios where there is a collective advantage to sharing benefit with competitors in a consortium (e.g., fraud), or in instances where you are using or providing data to companies in other industries while respecting regulatory frameworks.

We use the following definition:

*Privacy Enhancing Techniques (PETs) are those which allow institutions, customers and regulators to unlock the value in sharing data without compromising on the privacy and confidentiality of the “data owners” (i.e., customers) and “data stewards” (i.e., financial institutions). These techniques eliminate or greatly reduce the risks historically associated with collaboration and data sharing<sup>72</sup>.*

These techniques tend to be rooted in advanced mathematics and include Differential Privacy, Fully Homomorphic Encryption (FHE), Multiparty Computation (MPC), Zero-Knowledge Proofs (ZKP), and Federated Analysis. A detailed discussion of each of these techniques, their advantages, and their drawbacks are described in the paper “The Next Generation of Data-Sharing in Financial Services: Using Privacy Enhancing Techniques to Unlock New Value,” published by the World Economic Forum<sup>73</sup>. It’s worth noting that Differential Privacy adds noise to the dataset, calculations or outputs, while the other techniques add additional layers of protection to almost eliminate the risk of re-identifying individuals from the data.

### **3.5.2 VALUE PROPOSITION**

#### **Data Governance Tools**

Often, traditional data governance solutions do not address data governance across the enterprise, particularly with modern demands around the usage of data. Firstly, modern enterprise-wide data governance platforms break down silos by connecting all relevant data across an organization, regardless of the data sources. Secondly, traditional data governance has largely resided with IT with little interaction with those in the organization. Modern data governance tools allow the business to self-serve, without excessive reliance on IT, access the context, relationships, and lineage of the data in order to quickly understand the information behind it, which enables faster analytics leveraging this data. Thirdly, these tools can use advanced statistical techniques to uncover relationships between data, discovering similarities between metadata artifacts in the metadata repository, and unlocking their hidden associations. These tools allow teams relying on the data to:

- Cut down on time locating data and resolving data-related issues and errors
- Understand the context behind the data
- Be fully confident on the relevance and accuracy of the data (e.g., with the use of data dictionaries).

Given increasing legal and compliance demands, these features also improve the productivity of compliance teams and reduce risk due to the data and resources being readily structured, available in one place, and consistently defined across the organization. This also leads to a reduction of risk that would arise from the over or under

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<sup>72</sup> <https://www.weforum.org/whitepapers/the-next-generation-of-data-sharing-in-financial-services-using-privacy-enhancing-techniques-to-unlock-new-value> (Accessed 9/2/2021)

<sup>73</sup> <https://www.weforum.org/whitepapers/the-next-generation-of-data-sharing-in-financial-services-using-privacy-enhancing-techniques-to-unlock-new-value> (Accessed 9/2/2021)

retention of data for compliance purposes. Change management can also see an improvement in terms of their productivity.

In addition, this technology addresses the data governance issues with respect to the unstructured data, originating from varied sources (external and internal). Traditional data governance is not equipped with the ability to handle such variety or scale of data. As the data size and availability increases, concerns arise regarding its security and privacy, which are increasingly important in distributed environments for the migration of business-critical data from on-premises to cloud environments. The complexity of metadata collection, cataloguing and discovery processes often requires advanced techniques and approaches. These tools help fill the gap and address the security and privacy concerns that traditional data governance fails to offer.

Outside of cost and risk reduction, modern data governance tools can indirectly open doors to improved revenue outcomes by enabling data analytics usage. It can help constituents, such as business intelligence analysts or data scientists, by allowing them to move from finding data to applying data, thereby increasing productivity and quality of value-added work. This is enabled in various ways, including immediate access to metadata, standardized definitions, data ownership across the organization, and improved ability to share data<sup>74</sup>.

While the modern technology enhances the functionality and value that can be derived from given data, time and effort needs to be spent on integrating these tools into the systems. The complex IT landscape can prove to be incredibly complicated due to the addition of Cloud and Software-as-a-Service applications.

### ***Privacy Enhancement Techniques (PETs)***

As mentioned earlier, organizations are looking for data they can use to enhance their own insights. This data often lies with other organizations and there are mutual benefits of data sharing between silos provided the data-sharing risks are addressed appropriately. Data access had historically been identified as one of the top priorities for AI implementation, but competing obligations between driving value and maintaining privacy have hindered this, with 88% indicating a significant challenge in financial services<sup>75</sup>. In addition, other drawbacks have prevented the proliferation of data sharing, including potentially exposing competitive information and the “creep factor” of scaring consumers by knowing too much of their individual data.

However, PETs allow this data to be shared to broaden access to data while embedding privacy by design using various mathematical methods of various complexities, each with its advantages and drawbacks. These techniques can allow the sharing of datasets so that individuals are not re-identifiable or the sensitive information is not shared with other parties. This data can be shared internally within the organization to eliminate internal silos, with Business-to-Business partners, or with other organizations. This unlocks various benefits, including building customer trust, removing data transfer restrictions, identifying vulnerabilities with an aim to reduce them, pursuing innovative data monetization strategies, and sharing operational costs among multiple parties.

The difference between these techniques vs. traditional techniques that enable data sharing (e.g., de-identification) is that PETs are more sophisticated and secure. For example, simply removing personal information such as names and addresses from the input data is not secure by itself. PETs can also provide further security on any outputs that end users see. PETs can also enable the sharing of just enough customer data to fulfill the purpose that the data is being used for (e.g., for fraud and anti-money laundering), without needing to share the entire profile of these customers. In such an example, traditional techniques do not allow organizations to share enough data to capitalize on the benefits from sharing it without compromising intellectual property or other competitive information.

<sup>74</sup> "Quantifying the Business Value of the Collibra Data Governance and Catalog Platform", IDC, June 2018, <https://www.collibra.com/download/idc-full-white-paper> (Accessed 9/2/2021)

<sup>75</sup> <https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/publications/transforming-paradigms/> (Accessed 9/3/2021)

Technologies that implement privacy PETs help address common data-sharing issues like privacy and consent. They ensure that the degree of data shared is just enough – not more or less.

PETs add value everywhere organizations would benefit from more data that needs to be obtained securely while preserving privacy and confidentiality, particularly where that data is being used for modeling and deriving insight. The main drawbacks from using PETs would be the high computational requirements to use some of the techniques and the technical complexity underlying the algorithms. Some of these techniques require a strong understanding of the underlying mathematics employed and the implications of those methods on how the affected data can be used in downstream analysis. In addition to these factors, the need for changes in inter-organizational collaboration will need to shift. Organizations will need to find new and expanded ways of working together and mutually benefitting from each other's data, both within and outside of their own industries.

Another benefit of PETs is scalability across datasets, use cases, and data practitioners. With PETs, there is no need to change large input datasets all the time, which require massive amounts of investigation work to ensure that the inputs remain secure. A company may use PETs to provide access to an encrypted dataset instead and can do so efficiently, while allowing the accessing party to perform direct queries on the encrypted data to get the exact view that is needed. This provides a seamless experience of accessing sensitive datasets with the appropriate safeguards in place, which enables a user to find out whether that data is actually helpful, say, in their ML/AI models rather than needing to wait many months to receive approvals from IT/compliance to access the data.

### 3.5.3 CASE STUDIES

#### ***Data Governance Tools***

##### **Case Study 1: Data lake lineage and governance – P&C Insurance Company**

Problem Statement: The CEO asked questions regarding how to calculate a particular Key Performance Indicator that goes on a regulatory report to regulator. The questions included topics such as “what are the input data elements” and “what is their lineage.” These questions could not be answered quickly so they realized they needed to redo how they perform their regulatory reporting and specifically identified the urgency of addressing their data governance. The company wanted end-to-end governance over its metrics, particularly those that had to be filed with the regulator.

Solution: The company implemented data governance tools over data from source systems to end-user reporting. These tools enabled the tracking of data lineage, definitions, quality, and issue management.

Value: The solution is in its early phases, but expected benefits identified included lineage and governance over their enterprise data platform. Benefits also included increased assurance over their regulatory reporting.

##### **Case Study 2: Reference Data Management – Deloitte**

Reference Data is data leveraged to classify, categorize or qualify a master data entity or parts of a transaction. Current reference data management lacks holistic governance and ownership whereby the reference data is often inconsistent between the systems and lacks a defined source for system of record / system of reference. Reference data was being updated in multiple systems, at different point of time and there was a division for reference data source between structured and unstructured content. Therefore, setting proper management around Reference Data would help automate workflows, improve integration and collaboration, and enhance data security.

The Reference Data Governance solution was built on the Collibra cloud solution, which now provides a cross-organizational data governance platform to manage reference data, with the capabilities to consistently define business terms and ensure alignment of reference data across different systems. It also systematically supports governance processes to manage reference data where permissions, access and authorizations are part of the

solution. In addition, the customized dashboards can present different statistical views and track tasks specific to governance roles.

### **Case Study 3: Data transparency through governance – AXA<sup>76</sup>**

AXA XL, the P&C and Specialty risk division of AXA, had a vision for their data management program to help business users find data easily, know where the data was coming from, understand what the data meant, and allow them to trust the data they were using. Enhancing data transparency within the organization would also have significant benefits for business users who work with information every day in their roles. It would also enable the company to easily meet new regulatory requirements.

AXA XL implemented Collibra's cloud-based data governance product to support its data transparency efforts. One key element is the Business Glossary, which helps stakeholders across the organization to collaboratively agree on the vocabulary used for data discussion. In combining information from both the Data Catalog and Data Quality within the Data Governance Center, it provides a single view of data transparency to the entire organization.

As a result of this implementation, business users can connect with information in a one-stop shop for data transparency. All information regarding the data would be supplied when accessing a dashboard or report. This significantly helped users understand important information about the business data they were exploring.

### ***Privacy Enhancement Techniques (PETs)***

#### **Case Study 1: Differential Privacy used to share data – Canadian bank**

Problem Statement: The financial data of the Canadian bank struggled on how to safeguard confidentiality of information while satisfying the need to allow access by both internal and external users. It required a tool that allows users to access the data without compromising user privacy.

Solution and Outcome: The institution introduced a data access and management platform embedded with differential privacy technology. When data is being repurposed to new algorithms, or shared externally, differential privacy controls embedded in the platform can ensure the privacy of any Personal Identifiable Information (PII) while sharing aggregate insights from the data.

#### **Case Study 2: Multiparty Computation and Homomorphic Encryption in Fraud Data Collaboration – Financial Services**

Problem Statement: A large multinational financial services firm wanted to improve their fraud detection and risk models by accessing more data. Fraud is always an issue for financial institutions, but the COVID-19 crisis has fueled a rise in fraud and financial crimes, which has accelerated innovation in fraud detection at-large.

Solution: The institution introduced a third-party vendor that incorporated two complementary encryption in-use techniques: Secure Multiparty Computation (MPC / SMPC) and Fully Homomorphic Encryption (FHE). It enabled the firm to train their fraud and risk models on distributed data from participating partner banks, while maintaining all parties' security and privacy requirements.

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<sup>76</sup> [https://www.collibra.com/wp-content/uploads/CustomStory-AXA\\_XL.pdf](https://www.collibra.com/wp-content/uploads/CustomStory-AXA_XL.pdf) (Accessed 9/2/2021)

Outcome: The predictive accuracy of the fraud and risk models were largely improved, specifically in identifying outliers and fraudulent transactions. The increase in model performance further reduced volume and time in the manual review process.

### **Case Study 3: Anti-Money Laundering (AML) consortium**

Problem Statement: A group of UK banks was trying to solve a longstanding AML problem in the industry while maintaining confidentiality and privacy in the data being shared with each other.

Solution: The consortium created a Proof of Concept (POC) solution for the banks to query each other about higher risk customers and identify discrepancies in the customer due diligence (Know Your Customer) process. In the solution, the data owner was willing to provide controlled information regarding a specific query on the data in their internal KYC tool, while the data inquirer was able to retrieve information from the data owner without revealing query parameters.

Outcome: Each bank retained control, access and residency of the data assets they contributed to the pooling effort without centralizing the data. Bank A could directly query Banks B and C to see if their data from a common customer, “Alice,” matched across the banks. Aside from a “match verification,” Bank A saw nothing else about Bank B and C’s data.

## **3.5.4 IMPLEMENTATION CONSIDERATIONS**

### ***Data Governance Tools***

Adoption of these tools varies from company to company based on the maturity of the data governance function, executive commitment, complexity of data systems, etc. These tools are currently being operationalized in multiple countries. In Canada, several companies have done so, especially banks. The EU has adopted such tools in direct response to GDPR. Adoption becomes increasingly more important for companies that rely on multiple, disparate source data systems across the organization, often across different jurisdictions, that serve as sources for ML/AI applications and other analytics. The need for such solutions is further highlighted by companies that are challenged with legacy systems adopted through mergers and acquisitions.

The top barriers to scaling this technology would be executive support, change management, and integration into both IT architecture and business processes. Executive support is needed to ensure that organizations understand the importance of governance over data that is being used to enable the business. This can be supported with the appropriate training targeted to leadership. Their support is key to managing the change throughout the organization, particularly since data governance tools do not provide immediate tangible value to the business. Proper engagement of stakeholders is necessary, as well, with the appropriate Key Performance Indicators used to measure the success of sustained adoption. With regard to integration, prioritization of data sources and processes should be based on the value delivered and readiness. It would also help to use a phased approach for implementation, starting with early adopters to showcase the value delivered to the rest of the organization. The involvement of business and technology would help identify the sources and processes to assess the eventual impact to the entire organization.

### ***Privacy Enhancement Techniques (PETs)***

Adoption of these technologies varies by the technique considered, but most are still nascent and companies are still in the piloting phase with real-world use cases. Leveraging the benefits presented by PETs involves organization-level commitment, from investing in research and development to collaborating with the public sector and educating customers.



Some of the factors that could impede PET adoption include<sup>77</sup>:

- **Computational burden:** calculations can be inefficient and consume a lot of resources
- **Technically complex:** few people currently have expertise in these techniques
- **Underlying data issues:** PETs do not solve the issue difficulties in deriving insights originating from poor quality data, data fragmentation, and data that is difficult to access
- **Potential lack of regulatory response:** while PETs should address privacy and risk concerns around sharing data, the potential scenario of regulators in certain jurisdictions being slow to recognize PETs would slow the adoption of these tools, particularly where data needs to be shared across borders
- **Potential lack of social acceptance:** the public is increasingly skeptical and resistant to companies abusing their data, which may make it difficult to convince them that PETs are secure with respect to preserving privacy

Many of the above hurdles will be alleviated as technology improves and companies invest in integrated data ecosystems. Furthermore, several companies have emerged to bridge the technical expertise gap as a service, enabling institutions to take advantage of the benefits.

Education will be another large part of overcoming these hurdles. This comes in multiple dimensions:

1. **Practitioners** employing the techniques to obfuscate data, whether providing or receiving data, will need to understand the underlying math to understand how the data has been affected and how it affects subsequent data analysis.
2. **Leaders** of organizations considering PETs need to have a high-level understanding of the technologies, benefits, risks, and how they fit into their business. They particularly need enough understanding to identify relevant use cases for their respective organizations.
3. **The public and regulators** relying on or overseeing organizations employing PETs need to be educated on how these techniques preserve privacy and confidentiality in order to be assured that the techniques work. Furthermore, in order to garner trust and adoption by customers, institutions will need to focus both on protecting customers' data and helping customers feel protected.

Other considerations for a company looking to explore PETs include:

- **Feasibility** – i.e., suitability of data, availability of ideal partnerships, appropriate talent, optimal integration with other technologies, etc.
- **Viability** – i.e., alignment with strategy, innovation ambitions, business model, operating model, etc.
- **Desirability** – i.e., provides competitive advantage, addresses customer needs, aligned with current projects, etc.

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<sup>77</sup> <https://www.weforum.org/whitepapers/the-next-generation-of-data-sharing-in-financial-services-using-privacy-enhancing-techniques-to-unlock-new-value> (Accessed 9/2/2021)

### 3.5.5 ACTUARIAL CURRENT STATE AND FUTURE OUTLOOK

#### **Data Governance Tools**

The familiarity with data governance tools varies widely among actuaries, from no knowledge to extremely familiar. Generally, actuaries have heard of data governance concepts but lack understanding of the tools that help with this.

In terms of implementation amongst actuaries, we received a very limited number of responses. Three out of 14 mentioned that Data Governance tools were in use today among actuaries, meaning they either completed a pilot, implementation, or beyond. One health respondent did not indicate any current usage for actuaries but noted its importance in the future (discussed later in the future outlook section).

Amongst the 11 Life and P&C respondents,

- One respondent started implementing at least one Data Governance use case or was currently scaling across their organizations.
- Two respondents indicated that they were still only in the pilot phase.
- One respondent had current plans to implement Data Governance tools for actuaries over the next three years but had not yet started.
- Four respondents did not have current plans to implement Data Governance tools for actuaries over the next three years.

For most companies, data governance is seen as IT's domain and not an actuarial responsibility. However, actuaries recognize that they are still responsible for understanding the data that goes into their models and the corresponding results. Therefore, it's important for actuaries to ensure traceability and have a good understanding of data lineage and lifecycle.

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*“It is key for actuaries to have traceability to data. It helps in introducing new data elements and features faster and understanding data lineage and lifecycle to sign off on results and ensure that business requirements get carried through correctly.” – one Property & Casualty respondent*

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#### Current State

Overall, data governance tools currently are seen by several companies as having a low impact on actuaries, since actuaries are not directly dealing with protected data – such as Personally Identifiable Information (PII) or Protected Health Information (PHI) -- and are not sharing data; in such cases, IT is mostly driving the effort while actuaries only have a slight intersection.

Data governance tools are generally working behind the scenes and can be intertwined with financial reporting. Although actuaries are not directly involved with the implementation nor need to know how to program in certain data governance tools such as Informatica, actuaries are involved in providing business inputs regarding data elements as part of the metadata creation work and, ultimately, will be the users of such data initiatives. In addition, new and changing data elements can also have an impact on certain actuarial processes, requiring impact analysis of such changes, assurance over traceability of results, etc.

There are some data governance tools being piloted such as Alation. These tools would be used enterprise-wide as a central repository for metadata of all data sources, including data definitions. Once implemented, it will be used by

actuaries for several purposes, including storing and accessing industry aggregated data. It was noted, that while using the data governance tools is easy, generating the data/metadata for the tools is a challenge.

### Future Outlook

There are varying views on the future outlook of data governance tools. However, the front-running companies tend to note the importance of data governance tools in actuarial work. One participant noted that managing models and purchasing tools for managing models would get more complex but using such tools may not be an actuarial skillset. However, the same participant noted that it would be important for actuaries to ensure auditability and traceability when introducing new or changing data elements and features into their calculations. In addition, actuaries should have a good understanding of data lineage, data definitions, and lifecycle in order to respond to questions from management and auditors prior to signing off on results. Also, actuaries need to ensure that business requirements get carried through to results correctly. One company mentioned that IFRS 17 would also be a catalyst for such tools to be used at an enterprise level but would likely only indirectly affect actuaries.

Furthermore, the increasing reliance on additional data (including external 3<sup>rd</sup> party datasets) and data types (e.g., unstructured data) for analytics correspondingly increases the need for strong data governance. It is important for actuaries to understand the nature of the source data (e.g., how it was collected, definitions, etc.). Actuaries must ensure that the data is fit for the intended purpose and that its use does not result in unintended consequences (e.g., in the use of social determinants of health). As an understanding of the way to use new sources of data evolves, the need for proper data governance will grow in importance.

The continuous reliance on data for ML/AI applications requires the monitoring of data drift and data shift, exacerbating the need for data governance tools. Also, these tools can help actuaries find the data they are looking for and find out whether that data is sensitive, requiring special treatment under various data-related legislation. Of note, the most advanced companies in ML/AI have identified this as a need in their organizations. Outside of the actuarial profession, the market has also seen an increased need for these tools with the introduction of GDPR and related regulations surrounding the use of data around the world.

### ***Privacy Enhancement Techniques (PETs)***

Generally, actuaries don't have much understanding of PETs, which might be a result of limited involvement in their regular work since data sharing and transfer are often the responsibilities of IT. In terms of implementation, we received a very limited number of responses regarding current usage:

- One company responded that they completed implementation on one use case.
- Two were piloting.
- Four indicated they had no plan in the next three years.
- Seven provided no response.

None of the health or pension respondents are currently using PETs today.

### Current State

One actuarial use case is joining data to a third-party dataset for underwriting prediction and modeling (e.g., mortality, morbidity) in compliance with data usage regulations. In this case, the company is working with a vendor to de-identify/mask/encrypt data to join the datasets in a HIPAA (Health Insurance Portability and Accountability Act) compliant manner. Since the vendor takes care of the technical work, the tool is easy to use. One other respondent has implemented PET where trade secret data is used for pricing/rating but such data is not made available to the rest of the company. Another respondent's advanced analytics function was piloting the use of tokenization and encryption of data.

### Future Outlook

As regulations around the use of data evolve, these tools could potentially become more useful for actuaries indirectly. It is important for actuaries to realize that such tools exist to help deal with data usage regulations, especially when dealing with Protected Health Information (PHI) data or similar classifications of protected data, which may normally require lengthy times to receive approval simply to gain access the data before doing any analysis using that data.

One respondent mentioned that such tools could be useful for data transfer to external business partners and vendors, but that actuaries wouldn't be doing the encryption themselves. Rather, actuaries would have indirect influence as they have a responsibility to understand the procedures being done to the data. The most likely scenario for the use of such techniques would be via a third-party vendor that implements these techniques in their tools. Actuaries would need to use these tools and understand how the data is affected when processed by the PETs but would not need to implement the PETs themselves.

## **3.6 DIGITAL PROCESS DISCOVERY (PROCESS MINING AND TASK MINING)**

### **3.6.1 DEFINITION AND TERMINOLOGY**

An important component of re-engineering processes is discovering how the processes are actually run based on real usage data. Traditionally, process mapping is done manually by analysts using a combination of interviews, observation, or other manual methods. This gathering of process activities becomes automated to a certain extent with digital process discovery tools such as process mining and task mining.

*Process mining uses specialized data mining algorithms on event log data to identify trends, patterns and details on how processes actually get performed.*

Event logs will contain a case ID, activity name, and timestamp (among other elements), which can be traced across systems and activities.

*Task mining, a similar practice, refers to the use of a time and motion study to understand tasks completed by a series of individuals (rather than using event logs).*

Task mining is usually performed via visual recording with no interruption to the workforce. The videos are subsequently converted to structured data using machine learning algorithms to identify and map automatable processes.

While both process mining and task mining can be used to achieve similar outcomes, these complementary tools can be used at the same time to cover each other's deficiencies in order to present a complete picture of a process across systems and activities. These tools can be used as starting points for digital transformation, process automation (e.g., with RPA), or process reimagination.

### 3.6.2 VALUE PROPOSITION

As mentioned above, manual process discovery is a time-consuming activity traditionally conducted by analysts. Digital process discovery tools allow a company to capture how processes are actually performed using a data-driven approach in order to monitor compliance, derive insights regarding different process outcomes, and identify efficiency gaps. This saves a great deal of an analyst's time and ensures accuracy in process documentation, ultimately providing transparency over activities and a greater business case to support investments in process automation.

In addition to the benefits above, process mining specifically creates an end-to-end process visualization allowing someone to intuitively view all the variations in the process. Additionally, process mining provides immediate insights based on real-time data, allowing the understanding of which factors are slowing down the processes. These insights are updated dynamically through real-time monitoring (i.e., "process monitoring") unlike traditional process mapping exercises which are snapshots at one point in time.

Process mining is ideal where processes have large amounts of volume (e.g., transactions) running through them and is performed relatively regularly. It drives greater value where more contextual information and data is provided to enable further analysis (e.g., person, geography, dollar amounts). Process mining can be used on any set of systems that produce, at a minimum, a case ID, activity name, and timestamp. However, this implies that activities that do not provide this information (e.g., spreadsheet-based reporting) might not be ideal candidates. Furthermore, meaningful scope and size are required to realize return on investment, but this is true of most automation solutions.

Task mining achieves similar outcomes compared to process mining but does so in a different way through visual monitoring to capture activities performed on the desktop. This means that the log file needed for process mining is not required in this case to analyze the activities. However, the screen recording creates some perceived hurdles in relation to privacy.

### 3.6.3 CASE STUDIES

#### **Case Study 1: Process Mining of loan underwriting – large insurance carrier**

Problem Statement: A large insurance carrier in the U.S. desired to quantify the impact of process delays in FTEs and the potential cost savings should these delays be resolved. Challenges and pain points in loan processing led to delays negatively impacting the loan experience for both agents and customers. The client has a significantly higher number of resources than peers in their underwriting operations. The underwriting assessment was being done using inefficient process areas.

Solution: Process mining was deployed to identify process discrepancies, breakdowns, associated impact, and the monetary value of system inefficiencies. With the help of a consulting firm, the company modeled a targeted portion of the underwriting transaction utilizing innovative process modeling techniques. By investigating the process breakdowns, transformation targets were identified to be streamlined and automated.

Value: Utilizing process mining uncovered a process variant scenario in which 38% of the transactions were redirected. By eliminating this redirection, several activities were removed from the process that reduced the overall underwriting time by six days, translating to around 510 FTE hours saved each week, with a cost reduction of \$19M.

### Case Study 2: Process Mining analysis – German bank

**Problem Statement:** The client had a strategic goal of identifying inefficiencies within processes. There were multiple heterogeneous process and system landscapes due to legacy systems. There was a lack of guidance and standardization in the processes, as well as a lack of clarity around the responsibilities between teams for the resolution of service request categories.

**Solution:** The project approach was aimed to deliver helpful Process Mining insights within a short period to support objectives. Delivery of end-to-end process transparency and identification of request category differences were facilitated by using a Process Mining Framework and intuitive, custom-made Celonis dashboard. Process anomalies and optimization approaches were analyzed in interactive workshops to boost Process Mining insight discoveries. Benchmark comparisons were done among service teams, regions and categories that led to quantified evidence on a strong variation of utilization ratios and workload.

**Value:** Process mining helped identify almost 60,000 manual reassignments that had caused additional effort, requiring 38 FTE and resulted in extending the issue resolution time by three days on average. A bottleneck in the centralized ticket routing was detected that was originally causing an average resolution delay of five days. Process mining also helped identify a significant impact on the regional structure setup that led to 50% workload variation between teams.

### Case Study 3: Task mining for loan processing and reporting (Home Mortgage Disclosure Act) – financial services company

**Problem Statement:** A financial services company had a three-year goal of reducing operating expense and improving productivity without needing additional staff. Normally, process assessment and discovery would have been manual and performed by a team of seven people. In addition, many processes had become tribal knowledge (i.e., unwritten processes/information not commonly known by others within the company) and had many variations, making it difficult to assess all possible variations in the processes. These inaccurate assessments made it difficult to implement successful RPA projects.

**Solution:** The company undertook a four-week engagement and deployed FortressIQ, a software that implements task mining, across six desktop computers. The software captured over one million events and collected over 1GB of data to automatically discover, map, and document the processes performed. The solution automatically delivered a “Level 5 Process Definition Document (PDD),” i.e., very detailed task-level process descriptions.

**Value:** The solution was able to cover 100% of the processes and systems, including web applications and desktop applications like Excel. As a result, several sub-processes were discovered along with multiple variations of the same process. This enabled process improvements that saved an estimated 2000+ hours each year.

#### 3.6.4 IMPLEMENTATION CONSIDERATIONS

Adoption maturity has varied depending on country but has picked up rapidly over the last year in North America. Most companies are in the learning and piloting stages, but some have been utilizing these tools for 8-9 years.

Some barriers to scaling are the cost (depending on the vendors used), a lack of understanding of the tools’ capabilities, difficulties in seeing the value upfront, and a perceived concern with data quality. For task mining specifically, privacy related to the screen recording is a perceived concern as well. The best way to address these concerns is to educate employees and executives on the tools’ capabilities, what is collected vs. what is not, and how the findings from implementing the technology can create value for the business in the long run. It is best to start off on smaller, but meaningful, wins with a longer-term view towards scaling across the organization.

Another consideration for companies is what to do with the FTE savings. When streamlining processes, it is important to maintain internal knowledge about such processes – including an understanding of the underlying system calculations/procedures, knowledge of what-if scenarios, and intuition regarding expected outputs/results. Failure to do so may result in the inability to resolve issues and questions that arise over time across different scenarios. With that in mind, decisions based on process mining and task mining tools should consider the possibility that the data feeding such tools may not be reflective of future realities that could manifest under different scenarios and economic environments.

### 3.6.5 ACTUARIAL CURRENT STATE AND FUTURE OUTLOOK

Familiarity of such technology was generally poor from the companies surveyed. In terms of implementation maturity, all respondents that were able to comment on this technology mentioned that they had “no current or planned usage in next 3 years” for both Process and Task Mining. Specifically, four respondents and one respondent mentioned that they did not have plans to implement Process and Task Mining, respectively, in the next three years. The remaining respondents provided no response.

#### Current State

We did not identify any current application nor any specific plans in the next three years from the participants. A couple of companies mentioned usage of such tools in operations and underwriting, but with no actuarial involvement. In another case, IT is capturing process data, but for compliance purposes only, not for mining insights from the log data. One company noted that their analytics teams used a Python package to perform analysis on their new business, but did not specify whether actuaries were involved

#### Future Outlook

Caution should be noted around automating a bad process as companies often will end up streamlining inefficient processes while on the journey to automation. These tools can help with the discovery of such inefficient processes based on real-time data rather than people’s estimates of how processes occur. Process mining and task mining can be combined to piece together the picture of a process where system logs do not exist.

In terms of specific applications in the future for actuaries, one participant provided an idea that such tools could potentially be used to understand different behavioral patterns leading up to claims, which could help with experience studies or claims intervention. Extrapolating from that, these tools could potentially be used to understand customer behavior across their journey in order to model customer behavior and recommend actions to address the observed behavior.

## Section 4: Conclusions and Other Implications

### 4.1 OUTLOOK OF THE TECHNOLOGIES FOR THE ACTUARIAL PROFESSION AND CURRENT COMPANY POSITIONING

#### 4.1.1 TECHNOLOGY OUTLOOK

Based on our analysis of actuaries’ current usage and the future outlook of the technologies reviewed, we have grouped the technologies into four segments based on their potential readiness for actuaries in the future: in use today, ready in the next three years, potential opportunity in the future, and likely no actuarial usage. Figure 26 below summarizes the first three of these segments.

**Figure 26**  
TECHNOLOGY OUTLOOK FOR ACTUARIAL USAGE

Technology Outlook for Actuarial Usage					
In use today / imminent		Will be ready in next 3 years		Potential opportunity in the future	
ML/AI – structured data	BI Tools (Data Viz)	ML/AI – unstructured data	Data Governance	Digital Process Discovery (Process/Task Mining)	Connected Data & Reporting
Low-Code ETL & Low-Code Programming	Documentation Generators (Markdown)	Application Programming Interfaces (APIs)	Privacy Enhancement Techniques (PETs)	Robotic Process Automation (RPA)	
Dynamic Collaboration	Source/Version Control Management	DevOps Tools			

Source: Deloitte analysis

In the figure above, we also added DevOps tools in blue as we did not explicitly cover this in our initial scoping of technologies but identified such tools as having potential for use by actuaries in the next three years. Please also note that these technologies do not include those that affect actuaries but are not directly used by actuaries (e.g., cloud data storage platforms, Blockchain, etc.). Such technologies will be important and potentially even enablers of many of the technologies in our scoped list. However, such technologies were evaluated to not be used directly by actuaries, hence the exclusion of these tools.

The technologies along with example vendor implementations (which are not meant to be endorsements of specific vendors) are summarized in further detail in the following list split by level of adoption by participating companies in our study and by future outlook:

- **Technologies that have reached widespread adoption today:**
  - **Dynamic Collaboration Tools** – e.g., Microsoft Teams, Slack, Miro – Most companies are now using this type of technology. Some are using the different functionalities (e.g., digital whiteboarding, project management tools, etc.) more fully than others at this time.
- **Technologies that are reaching early majority adoption today:**
  - **Business Intelligence Tools (Data Visualization component)** – e.g., Tableau, Power BI -- Most respondents had started their journey in using these tools, with many having implemented solutions. While a few respondents were lagging in its adoption, some companies had scaled applications of this technology to all actuaries. BI tools will change and accelerate the way actuaries diagnose and understand results and communicate insights to stakeholders.



- **ML/AI on structured data** – e.g., R, Python – Most respondents had started their journey in using these techniques, but the level of maturity varied widely. The average maturity was beyond the piloting phase amongst our respondents. These are employed for a wide range of uses in actuarial functions, including pricing business, modeling demand, performing experience studies, predicting lapses to support sales and marketing, producing individual claims reserves in P&C, supporting accelerated underwriting and portfolio scoring on inforce blocks.
- **Documentation Generators (Markdown)** – e.g., R Markdown, Sphinx – Many respondents had started using these tools, but maturity level varied widely. The average maturity for those who had started was beyond the piloting phase. As the use of R/Python becomes more prolific amongst actuaries, the ability to simultaneously generate documentation and reports for developed applications and processes will increase in importance.
- **Low-Code ETL and Low-Code Programming** -- e.g., Alteryx, Azure Data Factory – Amongst respondents who provided responses, most had started their journey in using these tools, but the level of maturity varied widely. The average maturity was beyond the piloting phase. Low-code ETL tools will be useful where traditional ETL tools requiring IT support are not sufficient for business needs (e.g., too difficult to learn quickly for users or reviewers, ad-hoc processes) or where IT is not able to provision views of data quickly enough.
- **Source Control Management** – e.g., Git, SVN - A sizeable proportion of the respondents were currently using these technologies. Amongst them, solutions had already been implemented. These technologies will become more important in the context of maintaining code quality for programming-based models and tools such as those developed in R/Python. The value of the technology will further be enhanced with the adoption of DevOps practices and tools, which blur the lines between Development and Operations teams to accelerate the deployment of applications/programs.
- **Technologies not yet adopted by the majority but moving closer to that adoption level in the next three years:**
  - **ML/AI on unstructured data** – e.g., R, Python – For the participants who provided responses, a sizeable portion had started their journey in using this technology, but the level of maturity varied between piloting and implementing and beyond. The average maturity amongst those that had at least started planning was beyond the piloting phase. These techniques are used for a wide range of uses across actuarial functions; however, the use cases are more concentrated in Research & Development / Analytics and Pricing / Underwriting / Product Development in comparison to the use cases on structured data.
  - **Data Governance** – e.g., Collibra – There was a low level of adoption and familiarity of these tools by respondents since data governance has been seen by actuaries as an IT responsibility. However, front-running companies that see this technology as providing high value to actuaries are beginning to pilot such tools. Increased reliance on data, particularly in ML/AI applications, will require companies to be more involved in preventing and managing risks associated with the misuse of data and changing data dimensions over time, which will be better managed with the use of governance tools.
  - **Application Programming Interfaces (APIs)** – e.g., Swagger, R's Plumber – Respondents had a very low level of familiarity and adoption of APIs. However, some companies had identified opportunities for APIs to be deployed in future actuarial applications. For example, as ML/AI models need to be deployed in real-time to downstream applications, usage of APIs will likely increase in importance.
  - **Privacy Enhancement Techniques (PETs)** – e.g., Privitar, CryptoNumerics - Respondents also had a very low level of familiarity and adoption of PETs. However, companies that did use them or were looking into them identified these tools as having high value. As privacy regulations around the use of data evolve, these tools could potentially become more useful for actuaries indirectly in terms of helping them share data and join datasets in a manner that is compliant with those regulations.

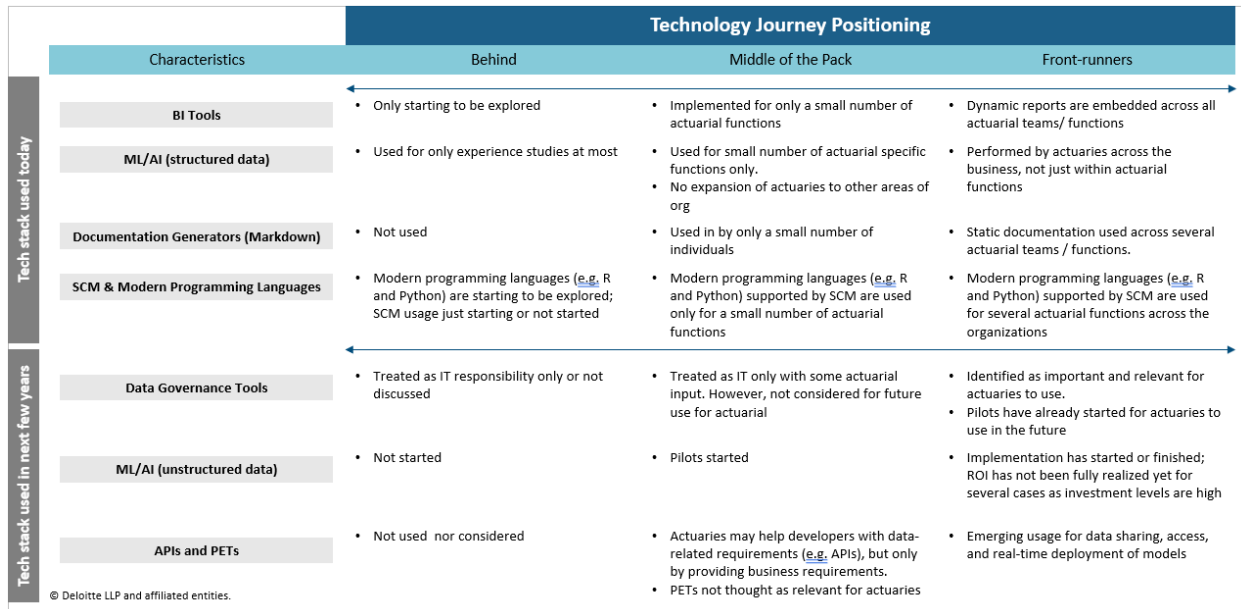
- **Potential opportunity in the future:**
  - **Robotics Process Automation (RPA)** – e.g., Automation Anywhere, UiPath - The direct usage of RPA by actuaries is very limited due to other types of automations that are already in place or because IT is implementing RPA with virtually no use by actuaries. Many companies that are using RPA at the enterprise level are not doing so for actuarial processes. It should also be noted that most of the respondents indicated no plans to adopt RPA over the next three years. However, if several different applications are being used in one process, RPA could be useful to streamline across applications. That being said, it's not clear whether such processes would be better served by a combination of other automation tools (i.e., R/Python, low-code ETL, and automation built into actuarial software).
  - **Connected Data and Reporting** – e.g., Workiva, BlackLine - Respondents also had a very low level of familiarity and adoption of Connected Data and Reporting tools. Respondents that were using this were only doing so in a very limited fashion, generally for inputs in accounting. It appears that actuaries aren't fully aware of how these tools would help them over alternative tools. For example, one company was trying to pilot a collaborative editing element using a Dynamic Collaboration tool instead. Further investigation would need to be performed to see how these tools might benefit actuaries in combination with other departments.
  - **Digital Process Discovery (process mining and task mining)** – e.g., Celonis, FortressIQ – There was no current application nor any clear implementation plan from the respondents, however, a few ideas were offered with respect to process flow creation and help in understanding behavioral patterns.
- **Likely no actuarial usage:**
  - **Close Automation** – e.g., BlackLine – Most respondents were not familiar with these tools; however, those who were saw such tools as more accounting focused and felt the tools did not appear to have much actuarial application.

#### 4.1.2 TECHNOLOGY JOURNEY POSITIONING OF INSURANCE PARTICIPANTS

Based on the responses from the actuarial interviews documented in Section 3: Analysis – Deep Dive into Technologies, Case Studies, and Actuarial Implications, we clustered companies together based on their demonstrated characteristics with respect to the technology stacks, which are “used today” and “ready in the next few years.”

The technology journey positioning clusters are relative groupings across the respondents (only Life and P&C since the Health and Pension ones would not be comparable due to being answered by consultants). Each technology in Figure 27A below shows a differentiation in behaviors and characteristics across the participants, resulting in them falling into three buckets: “Behind,” “Middle of the Pack,” and “Front-Runners.” The figure also summarizes the separation in characteristics between each of the clusters for each technology. It should be noted that being behind is not necessarily a bad position. A company's position is subject to its technology strategy and corresponding decisions regarding where and when to invest in such technologies.

**Figure 27A**  
TECHNOLOGY JOURNEY POSITIONING



Source: Deloitte analysis based on actuarial interviews based on actuarial interviews for this research paper

Please note that the figure above excludes both Dynamic Collaboration tools and Low-Code ETL tools. Dynamic collaboration tools are now being used by all companies, with slight differences in practices being the types of functionality used; however, the difference in companies is not very significant. Usage of Low-Code ETL tools varies from company to company with no discernable pattern between participants that are behind and those that are ahead. While ETL tool usage will be minimal for actuaries, there will be some light ETL tool usage in small niches, such as using ETL capabilities built into BI tools for dashboard creation, piloting solutions that are difficult to build in Excel, etc.

Based on the summarized criteria above, we reviewed each company’s responses to assess their technology adoption position qualitatively and quantitatively for the technology stack used today and the one ready in the next few years. The aggregated results are outlined in Figure 27B below (to reiterate, Health and Pension responses were excluded as they came from consultants and were, thus, not directly comparable). Note that a company’s positioning sits on a continuum rather than in discrete buckets, so a number of companies sit on the boundaries of the buckets and could be viewed differently, particularly if focusing on Life or P&C segments only.

**Figure 27B**  
TECHNOLOGY JOURNEY POSITIONING - DISTRIBUTION OF INSURANCE PARTICIPANTS

	Behind	Middle of the pack	Front-runners
Tech stack used today	3	3	5
Tech stack used in next few years	5	3	3

Source: Deloitte analysis based on actuarial interviews for this research paper

**Tech stack used today:** Figure 27B above shows that, out of the 11 Life and P&C respondents, we observed five Front-runners, three Middle of the Pack and three Behind. Within this group of technologies, a larger variation was observed in the usage of Source Control Management and Documentation Generators (Markdown). Respondents who were considered behind provided no response or no plan for consideration, whereas the Front-runners identified several implemented use cases across more than one actuarial function. For Business Intelligence and ML/AI on structured data, the differentiation mainly resided in the degree to which the tools had been scaled across the organizations: the middle of the pack and slightly behind respondents only identified applications within a limited number of actuarial functions, whereas the front-runners had wider adoption of such technologies.

**Tech stack used in next few years:** For this category, we received fewer responses indicating that companies are implementing these technologies today. Figure 27B above shows that, out of the 11 Life and P&C respondents, we observed three Front-runners, three Middle of the Pack and five Behind. For APIs and PETs, many companies had not started any plans to use these tools amongst actuaries, whereas the Front-runners provided at least one piloted use case. For ML/AI on unstructured data, Front-runners had gone beyond the pilot stage for at least one use case, whereas the respondents who were behind had not begun plans to use such techniques amongst actuaries. For Data Governance, the Front-runners identified the technology as important for actuaries and at least planned for implementation with actuaries, whereas the Behind respondents still considered the technology as solely driven by IT and had not considered it for their actuaries.

### 4.1.3 OTHER CHARACTERISTICS

In addition to the technologies listed in Figure 27A, a number of companies mentioned important characteristics that we noted were different between the more advanced companies and those that were behind. Such characteristics, i.e., data infrastructure and operating model, appear to have a correlation with the maturity of technology adoption amongst the actuarial teams of our participants. Since these topics were not explicitly covered, we did not have data from all companies to confirm whether this phenomenon was widespread. Companies that have been able to scale the emerging technologies for actuaries have shown distinguishing characteristics in their data infrastructure and operating models – see Figure 27C below.

**Figure 27C**  
**TECHNOLOGY JOURNEY POSITIONING**

Characteristics	Technology Journey Positioning		
	Behind	Middle of the Pack	Front-runners
<b>Data infrastructure</b>	<ul style="list-style-type: none"> <li>Traditional data warehouses locked behind IT</li> </ul>	<ul style="list-style-type: none"> <li>Traditional data warehouses locked behind IT, perhaps discussing move to modern cloud data platform</li> </ul>	<ul style="list-style-type: none"> <li>Moving away from traditional “ETL” into an “ELT” based approach. That means that, where possible, raw data is loaded into the modern cloud data platforms from a variety of sources, and then transformed in the cloud. Idea is not new, but has been picking up traction due to powerful cloud data platforms</li> </ul>
<b>Operating model</b>	<ul style="list-style-type: none"> <li>Strict delineation between Actuaries and IT or Pure DS</li> <li>Actuaries at best provide requirements for analytics and any data requirements</li> </ul>	<ul style="list-style-type: none"> <li>Actuaries are only moderately involved or only doing analytics work for Experience Studies and Pricing</li> <li>Starting to explore self-service data processing / analytics</li> </ul>	<ul style="list-style-type: none"> <li>Using actuaries extensively for ML/AI work rather than purely IT-type or pure DS</li> <li>Self-service analysis, enabled by emerging tools towards this paradigm, allow for flexible implementation of data transformation and analysis to serve rapidly evolving business needed</li> <li>Implementation still enabled, but not constrained, by central IT team.</li> </ul>

Source: Deloitte analysis

This correlation makes intuitive sense since data infrastructure and operating models allowing for self-service would result in actuaries doing more work and having more mature use cases when it comes to looking at actuarial work. However, this linkage does not just point to more work being done by actuaries; the front-runners have also noted a performance difference in terms of productivity when getting actuaries more involved with performing self-service analysis and ML/AI across the organization. Furthermore, investments in data infrastructure should naturally enable the use of and extraction of value from other data-related technologies.

#### 4.2 OTHER IMPLICATIONS FOR THE ACTUARIAL PROFESSION

As actuarial teams and leaders evaluate emerging technologies, they will need to consider factors aside from the functionality of these tools, detailed further in this section, such as:

1. Their organization’s current strategy, operating model, processes, technology landscape, and data infrastructure
2. Their organization’s future state with respect to the previous point and the ease of enacting change to reach that future state
3. The ability to demonstrate a return on investment through the use of a proof of concept
4. Future legal and regulatory changes that may potentially impact the application and governance around these technologies

As the actuarial profession reviews the information regarding the technologies in this report, they will need to consider that several tools have overlapping functionality that solve similar problems. The choice between certain technologies will depend heavily on their company’s existing technology stack, what other adjacent users (e.g., management, other departments) are comfortable working with, what sort of training the company is willing to provide to bridge any implementation gaps, and budget to cover the total cost of ownership. As there are dependencies among these technologies and with other enabling technologies (e.g., data infrastructure), companies will need to evaluate the sequencing of the technology investments made to maximize the value of their investments.

Another consideration around the actuarial adoption of technologies is the company’s current and target operating models. For example, many technologies might be considered to be solely under the responsibility of an enterprise team, which results in actuaries not needing to use such tools. The responsibilities of actuaries and other employees in each company should be carefully considered given the advent of new technologies enabling changes in the future of work for every role in the organization. Such considerations will be different for each company, their respective profiles (e.g., size, geographic distribution, etc.), and their strategy. In many cases, however, return on effort is higher when actuaries are working closely with enterprise teams to implement the technological change.

To help evaluate their decisions regarding adopting any of these technologies, actuaries may want to consider producing small proofs of concept to demonstrate the capabilities of these tools in order to better understand how they can be applied and whether they serve the needs of their organization. Care must be taken to ensure that any proof of concept is not done on an environment that is too different from a company’s actual environment in order to minimize the risk of an inability to fully implement a proof of concept. Companies looking to transition to full implementation will need to evaluate the fit and impact of these technologies on their organization’s people, processes, and technology architecture. This should be done relatively early in the development and implementation processes.

As these technologies evolve, companies need to be mindful of legal and regulatory changes that are adapting to these emerging technologies, which could be interpreted as “models” in some cases. Current focus has largely been on ML/AI as they cause new risks with respect to privacy and fairness. For example, guidance has been released by

various organizations on the use of AI – e.g., OECD Principles on Artificial Intelligence<sup>78</sup>, Canadian Federal Government’s Directive on Automated Decision-Making<sup>79</sup> for its own services, etc. However, regulators have been looking to evolve their regulations further as well. The Office of the Superintendent of Financial Institutions (OSFI) in Canada recently (September 2020) released a consultation accompanied with the publication of a discussion paper, “Developing financial sector resilience in a digital world: Selected themes in technology and related risks.”<sup>80</sup> Their aim is to focus on risks arising from rapid technological advancement and digitalization affecting the stability of the Canadian financial sector.<sup>81</sup> This consultation supports OSFI’s strategic objective to ensure that federally-regulated financial institutions and pension plans are better prepared to identify and develop resilience to non-financial risks before they negatively affect their financial condition. The U.S. regulators have been requesting information on financial institutions’ use of ML/AI for the purpose of understand how to use ML/AI in a safe manner.<sup>82</sup> In the absence of specific ML/AI guidance, companies can refer to existing guidance relating to model risk, which is currently being debated with regard to what types of models it should cover. For example, U.S. regulation SR 11-7 “Supervisory Guidance on Model Risk Management” has been noted to be applicable to ML/AI models for banks. However, a detailed discussion of such regulations is out of scope of this report.

### 4.3 RECOMMENDATIONS

As actuaries update the technologies they use and target more effective use of technologies, we recommend the following in light of this research with considerations for different actuarial levels and stakeholders:

1. Actuaries should *embrace technologies that enhances the remote working experience* within their internal teams and across departments by investigating functionalities beyond messaging and video calls. Such tools can be used to reimagine day-to-day communication, such as facilitating engagement within the actuarial community, co-authoring, and enhancing knowledge transfer.
  - a. *Leaders* need to lead adoption of such tools from the top and establish a common set of practices to prevent fragmentation of communication tool usage.
  - b. *Middle managers* need to find ways to integrate these tools in their workflow and could consider adopting some of the novel functionalities that the tools offer. They could also act as champions to promote good practices with the tools and demonstrate use cases to help drive adoption.
  
2. Actuarial organizations and employers should *examine technologies where there is a wide range or gap in maturity and familiarity*, evaluate whether a knowledge gap exists and whether any gap is due to a lack of education and training. Furthermore, they should investigate how these tools may impact their actuaries’ work, either directly or indirectly (e.g., data governance tools supporting ML/AI and financial reporting, PETs supporting the usage and sharing of data enabled by the additional safeguards of these advanced techniques, digital process discovery tools to uncover inefficiencies in actuarial processes, etc.). Furthermore, consideration could be given to certain tools that might add value at an enterprise-wide level even if the added value to actuaries in isolation is not as high.

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<sup>78</sup> <https://www.oecd.org/going-digital/ai/principles/#:~:text=The%20OECD%20Principles%20on%20Artificial,Council%20Recommendation%20on%20Artificial%20Intelligence.> (Accessed 9/2/2021)

<sup>79</sup> <https://www.tbs-sct.gc.ca/pol/doc-eng.aspx?id=32592> (Accessed 9/2/2021)

<sup>80</sup> <https://www.osfi-bsif.gc.ca/Eng/osfi-bsif/med/Pages/tchrsk-nr.aspx> (Accessed 9/2/2021)

<sup>81</sup> <https://www.osfi-bsif.gc.ca/Eng/wn-qn/Pages/tchrsk.aspx> (Accessed 9/2/2021)

<sup>82</sup> <https://www.federalregister.gov/documents/2021/03/31/2021-06607/request-for-information-and-comment-on-financial-institutions-use-of-artificial-intelligence> (Accessed 9/2/2021)

- a. *Leaders* should review the technologies in conjunction with their organization’s strategy and current architecture to understand what technology implementation decisions make sense for their companies.
  - b. *Middle managers* should understand these tools and their functions and work with their leaders to see if the benefits would be aligned with overarching organizational considerations.
  - c. *Actuarial associations and societies* should identify any potential knowledge gaps and supplement actuarial education with targeted education of these technologies where it would make sense in light of strategy priorities for the associations.
  
3. Actuaries should *consider bolstering their communication methods amongst themselves and with other stakeholders by using insight delivery tools* such as BI and Report Generation tools. Actuaries can drive change at all levels of their respective organizations.
  - a. *Leaders* would be best positioned to sponsor and drive changes to technology and processes, with the approval of IT and other relevant stakeholders.
  - b. *Middle managers* play a role in understanding how these tools enhance and fit into the day-to-day processes of their teams’ work.
  - c. *Actuarial students* can prepare for the future by learning these tools and applying them to their projects, be it at work or in their personal lives.
  - d. *Actuarial associations and societies* could use these tools to continue enhancing their communication methods with respect to the data and reports sent to members.
  
4. Actuarial leaders, regulators, and auditors need to *become more familiar with ML/AI techniques in order to gain comfort with their results*. This comfort will unlock the ability for companies to extract further value from more complex ML/AI techniques. These concepts are further discussed in other SOA research papers, such as those entitled [\*Interpretable Machine Learning for Insurance\*](#) and [\*Validating Algorithmic Underwriting Models - Expert Panel Report\*](#).
  - a. *Leaders* should become ML/AI fluent, but don’t necessarily need to be technical experts. They need to be aware of the capabilities and pitfalls of ML/AI in order to ask the right questions when reviewing the outcomes of applications of ML/AI.
  - b. *Middle managers* need to learn how to explain ML/AI in a way that makes sense to all stakeholders -- including leadership, regulators, and auditors -- in a way that provides an assurance of results. They will also need to understand how the use of such techniques complies with relevant regulations and actuarial standards of practice.
  - c. *Actuarial students* can prepare for the future by learning these tools and how they would be applied in practice.
  - d. *Actuarial associations and societies* should continue to expand education around ML/AI fluency and update their actuarial guidelines and standards of practice to account for these new techniques.
  
5. As the use of programming tools (e.g., R, Python) matures for ML/AI applications and other automation applications, companies will need to *investigate potential revisions in their processes and technology surrounding the deployment (i.e., SCM tools, DevOps, etc.) of models and applications* relying on these programming tools.
  - a. *Leaders* should become fluent in such tools and practices in order to make informed decisions with regard to their potential use in their organizations.
  - b. *Middle managers* should learn the functionality of such tools and practices in order to take advantage of their features to go from development to deployment a lot faster and in a more secure fashion.

- c. *Actuarial associations and societies* should continue to expand education around programming related tools and practices to broaden awareness and to equip our actuaries for their future work.
  
6. Actuaries should *become familiar with data governance tools tailored to business users and look into working with IT to drive change* in this area. Data governance principles will grow in importance with the increased reliance on data for decision-making. This will likely be accelerated by the requirement to have access to detailed cash flow projections under the evolving accounting and regulatory standards. This will necessitate a higher need to monitor data drift, maintain data dictionaries, record data lineage, etc. to reduce the risk of misuse of data in downstream applications.
  - a. *Actuarial leaders* should first consider investigating how such tools would add value to the actuarial function. If their companies were implementing such tools, then they would need to work closely with the enterprise to ensure that data governance initiatives are not just an IT-only initiative and drive the solution so that it brings value to the business.
  - b. *Middle managers* should consider understanding the benefits of such tools to envision how they would help their teams.
  
7. Actuarial organizations should continue to *evaluate and promote the potential expansion of areas where actuaries can work* (Data Science roles, Life Science and Pharmaceutical companies, etc.). Insurance companies using actuaries in Data Science roles have seen a marked improvement in productivity over pure statisticians and Data Science employees with the prerequisite domain knowledge. Actuaries are well positioned with the advantage of strong domain knowledge and an understanding of how non-technical users in their business need to consume insights and other outputs from their analytical work.
  - a. *Leaders* should consider alternative operating models in light of these emerging technologies, enabling new ways of working and new roles for actuaries.
  - b. *Middle managers* should evaluate the use of actuaries in other areas of their organizations to see whether their actuaries can use their current skillsets or upskill to serve in new roles (e.g., analytics roles across operations).
  - c. *Actuarial students* could consider additional non-traditional roles demanding analytical skillsets and evaluate whether additional upskilling is needed to fulfill those roles
  - d. *Actuarial associations and societies* should continue to evaluate the training needed for actuaries to fulfill emerging non-traditional roles and promote the experiences of actuaries working in such roles.

#### 4.4 FUTURE TOPICS FOR EXPLORATION

Future topics and ideas beyond the scope of this paper to explore for further research, if not done already, include:

- Expanding the emerging technologies usage survey to a larger sample size to cover more actuaries at insurance companies, health plans, consulting firms, insurtech companies, and other non-traditional roles;
- Performing a survey of top vendors for each technology used by actuaries and/or other areas of their organizations to obtain further insights into possible platforms;
- Investigating actuarial usage of DevOps tools and practices – including Continuous Integration/Continuous Deployment (CI/CD), containerization platforms, etc. – surrounding ML/AI and any other areas where programming tools are used by actuaries;
- Performing a deeper study of tools with which actuaries are less familiar to understand how they may impact actuaries, not only in terms of prospective tools for actuaries to use, but also on how they might perform their work with existing tools;



- Assessing the impacts of enabling technologies not directly used by actuaries – e.g., Cloud Data Platforms (Amazon AWS, Microsoft Azure, Snowflake), Blockchain (note that a relevant paper was recently [published by the SOA](#)), and the use of additional data sources;
- Performing a survey on the operating model – particularly around the split of responsibilities between actuaries and IT – used to implement/operate each technology in different contexts (e.g., projects, R&D, production, etc.);
- Conducting a survey on the extent of use of R/Python and useful packages/libraries for actuaries;
- Researching and assessing the impact on future actuarial work of evolving regulations and guidance surrounding emerging technologies, such as the discussion paper “Developing financial sector resilience in a digital world: Selected themes in technology and related risks” by the Office of the Superintendent of Financial Institutions; and
- Performing a research study on the potential impact of technologies that would occur beyond the three-year time horizon (e.g., quantum computing).



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## Section 5: Acknowledgments

The researchers' deepest gratitude goes to those without whose efforts this project could not have come to fruition: the Project Oversight Group and SOA staff for their diligent work overseeing the scope development and reviewing this report for accuracy and relevance.

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Munich Re (Life)

Nationwide (Life)

State Farm (Life)

State Farm (P&C)

Primerica

RBC Insurance

Reinsurance Group of America, Incorporated

Santa Barbara Actuaries

TD Insurance (P&C)

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## Appendix A: Scope and Definitions

The exercise of identifying emerging technologies that may significantly affect the actuarial profession over a three-year horizon requires that we define terminology. This provides a clear framework to specify the scope of the research and to achieve a common understanding for users of the research. This exercise is important as it provides structure for both the identification of emerging technologies and their application to various use cases relevant to the actuarial profession. However, it is important to keep in mind that the purpose of the categorization is to ultimately identify case studies used outside of the actuarial profession which can be applied to actuarial work; therefore, a rigorous and 100% accurate taxonomy is not the goal for this research.

### EMERGING TECHNOLOGY

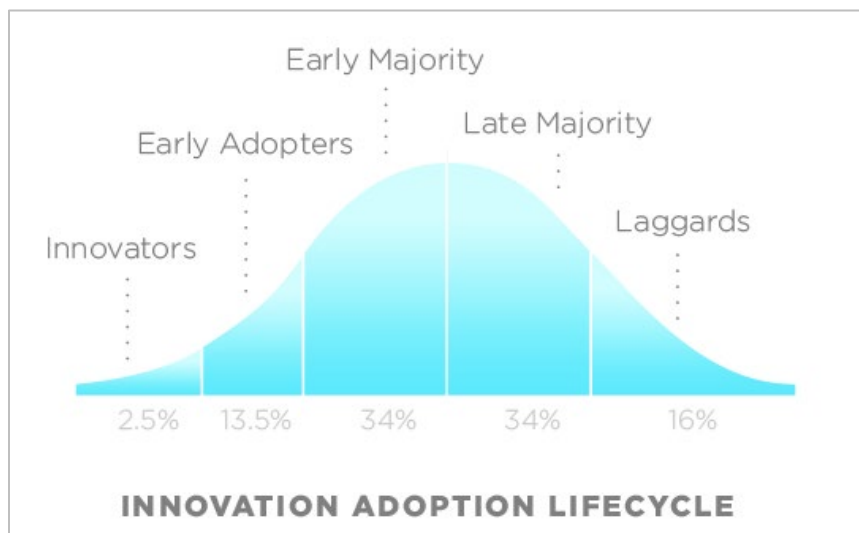
#### WHAT DO WE DEFINE AS EMERGING?

For the purposes of this research paper, we need to define emerging in the contexts of actuarial usage and non-actuarial usage, as the views of what is emerging are respectively different. In particular, we need to find tools that are not already established in the actuarial field and that are used in practice across all industries and professions.

First, we must formalize how we define what is no longer emerging in usage amongst actuarial professionals. The simplest way to define this is by looking at the tools and technologies with which many actuaries are expected to be familiar within their specific industry. To view the definition in a more structured manner, we use the technology adoption lifecycle<sup>83</sup> depicted in Figure 28 below as reference.

**Figure 28**

#### INNOVATION ADOPTION LIFECYCLE



Source: Everett Rogers Technology Adoption Lifecycle model, Wikipedia

This model illustrates how a technology is adopted by various groups, according to demographic and psychological characteristics, over time. New technologies are first adopted by the “innovators,” then the early adopters, and so

<sup>83</sup> [https://en.wikipedia.org/wiki/Technology\\_adoption\\_life\\_cycle](https://en.wikipedia.org/wiki/Technology_adoption_life_cycle) (Accessed 9/8/2021)

on. Applying this model to our research, we define a technology to be “established in the actuarial field” when the “early majority” of actuaries in a given industry (i.e., Life, P&C, Pension, etc.) have adopted usage of the tool in practice within their teams. Technologies falling in the mature category would be those that have reached the “Late Majority” or “Laggard” phase – e.g., models built in spreadsheet software (Excel), static presentation tools (PowerPoint), and arguably GLMs in Personal Auto (in the U.S.) but not for Life insurance. As a general rule of thumb, if a technology was not immediately apparent as being considered mature amongst the actuarial profession, it was scoped in for initial consideration, unless other factors discussed below contributed to its exclusion. Further phases of research were then used to confirm the degree of usage via interviews with actuaries.

Now that we have defined what is emerging for actuaries, we need to draw the line between technologies that are theoretical in nature versus those that are practical. The study defines this by drawing the line at technologies that are used in other professions/industries “today or to be used in the near future,” which we interpreted as either currently released to production or the public within the next year. The goal of separating the two categories is to ensure the appropriate focus on technologies that can be demonstrated at a minimum as a proof of concept, as opposed to future technologies that have potential from a theoretical point of view but have not yet been shown to be practically viable.

### WHAT IS DEFINED AS TECHNOLOGY?

In the review of emerging technologies, we briefly discuss what is considered a technology and what is not. If we go by the dictionary definition, then technology is “the practical application of knowledge especially in a particular area” or “a capability given by the practical application of knowledge”<sup>84</sup>. We distinguish this from the implementation of such technology in a specific platform or vendor. For example, stochastic modeling can be considered a “technology,” whereas the numerous actuarial modeling software platforms that implement it are not considered technologies, but rather platforms or vendors. Please note that this paper uses the terms “tool” and “technology” interchangeably.

The motivation for distinguishing between technology and platform becomes apparent when one looks at general purpose or multi-purpose tools. For example, use of programming languages such as R or Python for the application of various data science methods may cause certain difficulties when evaluating the emerging technology being considered. For example, one can implement both a discounted cashflow model or a Neural Network, both of which can be implemented in R, Python, or other programming languages or platforms. To not overcomplicate the analysis and simplify understanding, similar types of tool will be grouped together where appropriate – e.g., for Machine Learning algorithms, supervised learning techniques will be grouped together.

## SIGNIFICANTLY AFFECTING THE ACTUARIAL PROFESSION

### WHAT DOES IT MEAN TO “AFFECT” THE PROFESSION?

In order for a technology to affect the actuarial profession, the identified technology must be a tool that actuaries can use themselves, but not necessarily for their specific work (e.g., actuaries who work in marketing) and must be relevant for insurance risk assessment. This restriction implies that new technologies solely affecting inputs to work that are already performed by actuaries would not be in scope, if they do not offer tools for actuaries in their work (e.g., data gathered from drone scanning, health/genetic data, etc. that simply provide new inputs to existing actuarial analysis). While it’s important to recognize that enhanced data enables the usage of emerging tools, the

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<sup>84</sup> <https://www.merriam-webster.com/dictionary/technology> (Accessed 9/2/2021)

data itself are not considered tools themselves for the purpose of this study. The limitation to insurance risk assessment covers all areas related to insurance risk (aiming to cover key actuarial functions such as pricing and underwriting, valuation, capital management, risk management) and includes fields of practices such as Life, Health, P&C, Pension (specifically longevity risk), and Asset-Liability Management (ALM). It should be noted that, while ALM is included, asset management and investments are not. Although it should be acknowledged that actuaries may work in other areas aside from insurance risk, explicit consideration of those areas are outside the scope of this paper.

Aside from the specific industries covered, we examine the various ways that a technology can affect the way actuaries do their work. We considered the following dimensions of actuaries' work and assessed whether changes in each dimension resulting from the use of a tool would constitute a meaningful impact to the actuarial profession:

- **How is the work being done?** Tools that change the way actuaries perform their usual actuarial work (e.g., GLMs for experience studies / rate indications) would be considered as affecting the actuarial profession. Additional computing power or tools that don't directly change an actuary's day-to-day process on how they perform their work do not count, even though increased computing power has aided in the use of stochastic models, for example.
- **What type of work is being performed?** Technologies that increase or decrease the scope of work that falls under the responsibilities of an actuarial skillset (e.g., claims management using analytics models developed and maintained by actuaries) would be considered as affecting the actuarial profession. A discussion on the type of work performed by actuaries continues in the next section.
- **Who is doing the work?** If a technology impacts who is doing work normally done by actuaries, then the impact is likely a secondary impact resulting from changes in how the work is done (e.g., data scientists performing some aspects of actuarial work or vice versa). Considering another type of example, technology that allows actuaries in other locations (e.g., remote access tools, applications that allow for actuaries to be hired via crowdsourcing or freelancing) to do the same work were not considered in scope for this reason alone.
- **Where is the work performed?** Technologies that solely affect the location of the work performed (e.g., remote desktop environments, cloud environments, etc.) were not considered as affecting the actuarial profession for the purposes of this paper. However, communication tools that change how actuaries communicate would be in scope.

#### WHAT IS DEFINED AS WORK PERFORMED BY ACTUARIES TODAY?

Actuaries get involved in many types of tasks. To determine what types of tools might affect their work, we briefly describe in a general sense the typical types of tasks being done today.

1. **Data Analysis** – includes integrating, transforming, and describing data; excludes the acquiring, gathering, and storing of raw data. To further elaborate, new sources of data such as sensors, drones, etc. would be considered to be tools that acquire data and are, therefore, excluded.
2. **Actuarial calculations** – includes calculations such as experience studies / rate indications, cashflow models, claim triangles, etc.
3. **Project/team communication** – includes intra-team communication, project management, documentation, etc.
4. **Review of results and governance** – includes analysis and investigation of results, governance over data and calculations, etc.

5. **Presentation to stakeholders** – includes presentation of results to stakeholders via reports, slides, dashboards, etc.

## HOW DO WE DEFINE “SIGNIFICANT” IMPACT OVER THE SPECIFIED TIME HORIZON?

To briefly define what constitutes a significant impact in terms of moving the needle on technology adoption within the actuarial profession, we reference the earlier discussions with respect to the technology adoption lifecycle. A significant impact is defined as definitively moving past the early adopter phase into the early majority phase within the specified time horizon of three years. The technology must not have already reached the mature phase (past early majority) of the lifecycle as of the beginning of 2021 within the scope of work performed by actuaries, as defined in a previous section, to have been considered for this study.

## WHAT MARKETS ARE WE EXAMINING WHEN MEASURING TECH ADOPTION BY ACTUARIES?

Various factors affect the level of innovation exhibited within the actuarial profession (and in all professions) across locations. Discussion of such factors are out of scope of this paper. However, we should acknowledge that some markets are more innovative than others and, therefore, further along the technology adoption lifecycle with respect to certain emerging technologies. When assessing a particular technology’s adoption rate, we looked towards more mature markets employing actuaries. Our interviews focused on practitioners based out of North America, but some of these results and interviews covered a representation of global divisions within multi-national companies. Potential impact on the actuarial profession and potential actuarial use cases will attempt to encompass all markets.

## OTHER TERMS AND DEFINITIONS

### GENERAL TERMS

#### ***Lead users / lead experts***

The study defined “lead users” for the purpose of identifying people suitable to contact during Phase 2 (the lead user interviews) of the research. A *Lead user* is someone familiar with the technology and its use cases across multiple functions, preferably having led the implementation of the technology across multiple projects and, if possible, multiple industries. This could be a vendor, a consultant, a leader of an innovation team, etc.

#### ***Case Studies***

For the purpose of identifying case studies about how a technology is being used today, a *case study* involves an organization that applies one or more use cases to solve a problem or aspiration in order to achieve an outcome and gain value.

#### ***Use Case***

A *use case* can be described using the following: “Do x (functionality) based on y (data) in order to address z (need)”<sup>85</sup>.

#### ***Machine Learning and AI related terms***

**Artificial Narrow Intelligence (ANI)** - An AI able to match human capabilities and ways of thinking in specified domains (e.g., chess, image recognition, speech recognition, optimization, scheduling)

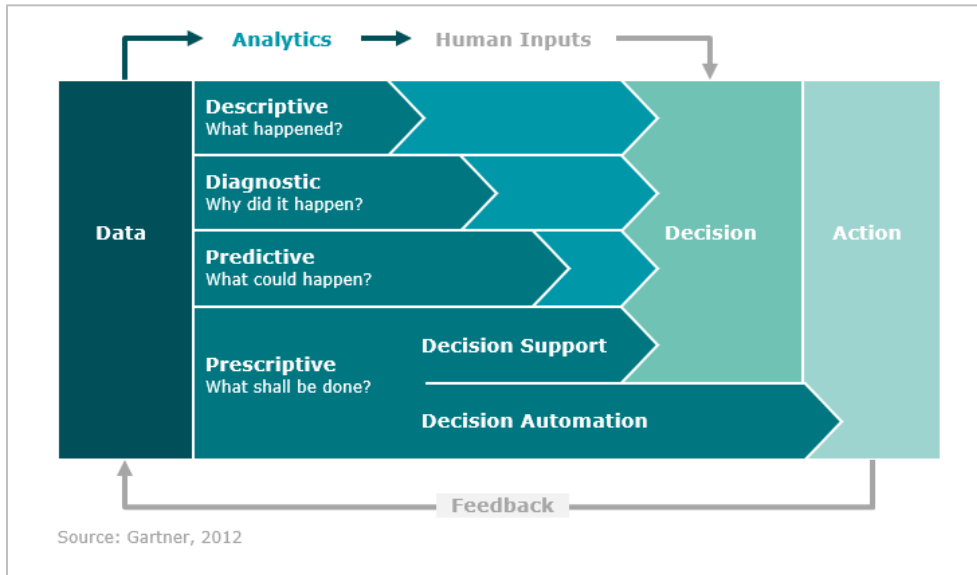
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<sup>85</sup> Artificial-Intelligence-in-Insurance-Whitepaper-deloitte-digital.pdf (Accessed 9/2/2021)

**Artificial General Intelligence (AGI)** - An AI matching human capabilities and ways of thinking in **any domain**

**Analytics** – the process of turning data into insights (see Figure 29 below)

**Figure 29**  
**DATA ANALYTICS PROCESS**



Source: Gartner, 2012

**Supervised Learning** - A method of training an algorithm on labelled data, meaning that parts of a document are “tagged” with a known response (e.g., classification, regression, prediction, estimation, forecasting)

**Unsupervised Learning** - A method of training an algorithm on unlabeled data, meaning the algorithm identifies concepts and patterns entirely on its own. (e.g., clustering, association)

**Structured Data** - Data that has been organized in a well-defined structure, usually in a database, and can be easily stored, accessed, queried and analyzed

**Unstructured Data** - Data that either does not have a pre-defined data model or is not organized in a pre-defined manner (e.g., audio recordings, music, images, videos, etc.)



**SCM related terms**

**Continuous Integration**<sup>86</sup> – a software development practice where developers regularly merge their code changes into a central repository, after which automated builds and tests are run. The key goals of continuous integration are to find and address bugs quicker, improve software quality, and reduce the time it takes to validate and release new software updates.

**Continuous Deployment**<sup>87</sup> – a software development practice where code changes are automatically built, tested, and prepared for a release to production. It expands upon continuous integration by deploying all code changes to a testing environment and/or production environment after the build stage. When continuous delivery is implemented properly, developers will always have a deployment-ready build artifact that has passed through a standardized test process.

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<sup>86</sup> <https://aws.amazon.com/devops/what-is-devops/> (Accessed 9/2/2021)

<sup>87</sup> <https://aws.amazon.com/devops/what-is-devops/> (Accessed 9/2/2021)

## Appendix B: Research Methodology

Our research was divided into three phases, with each phase dependent on preceding ones, if any:

1. Technology Identification
2. Technology Lead User Interviews
3. The Art of the Possible: Actuarial Use Cases

### PHASE 1 – TECHNOLOGY IDENTIFICATION

In this initial research phase, we performed research on identifying new technologies and combed through their resources, including books, publications, websites, and journals. A main criterion for shortlisting technologies should be that those technologies are in use by teams outside of the actuarial profession. We also gathered information to further investigate potential case studies.

Given the broad range of technologies we expected to encounter, we catalogued our findings into the below listed categories, thereby ensuring that our coverage was broad and comprehensive:

- **Process Automation** – This refers to the use of technology to replicate the actions in a business process that would otherwise be done by a human user. The chosen technology could either perform the process in full or partially (with human intervention), thus drastically reducing the time spent by a human if the same process would be performed entirely in a manual way. Such technologies are neither self-learning nor predictive on their own.
- **Data Analysis and Insights** – This refers to the process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making.<sup>88</sup> In this context, this encompasses summary statistics, data processing/exploration, descriptive statistics, and data visualization among other topics. We separate this from the Machine Learning and Artificial Intelligence category by not including anything predictive in this category.
- **Machine Learning (ML) and Artificial Intelligence (AI)** – this refers to the use of ML and/or AI algorithms, either to generate a prediction or as part of a solution that is powered by such algorithms. A ML algorithm is an algorithm that is able to “learn” from data. In this context, “learning” involves learning from experience  $E$  with respect to some class of tasks  $T$  and performance measure  $P$ , if its performance at tasks  $T$ , as measured by  $P$ , improves with experience  $E$ <sup>89</sup>. More generally, AI is the study of “intelligent agents”: any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals.<sup>90</sup> There are many discussions around what the difference is between ML and AI, but for the scope of our research, it is not important to distinguish them.

This classification mainly served as a simplified framework with respect to the grouping of technologies for the purpose of identifying use cases. This was not meant to be a formal or rigorous taxonomy and it was expected that some tools would straddle the line between two or all of these categories. Consider, for example, an application powered by AI, which includes other aspects such as an automated retrieval of information from a data source and/or presenting information to the user via an interface.

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<sup>88</sup> [https://en.wikipedia.org/wiki/Data\\_analysis](https://en.wikipedia.org/wiki/Data_analysis) (Accessed 9/2/2021)

<sup>89</sup> <https://www.deeplearningbook.org/contents/ml.html> (Accessed 9/2/2021)

<sup>90</sup> [https://en.wikipedia.org/wiki/Artificial\\_intelligence#cite\\_note-Definition\\_of\\_AI-3](https://en.wikipedia.org/wiki/Artificial_intelligence#cite_note-Definition_of_AI-3) (Accessed 9/2/2021)

Phase 1 produced a list of technologies that was covered as part of the research and further investigated in the Interview Phase (Phase 2).

## **PHASE 2 – TECHNOLOGY LEAD USER INTERVIEWS**

In this interview phase, the lead experts for each technology identified in the Technology Identification Phase were invited for a detailed discussion/interview. The steps in this phase included:

1. Identifying lead experts for each technology. These could include the application owners, as well as business leads who actively use these technologies.
2. Developing a questionnaire which covered useful information about the technologies and their applications such as: pros and cons of adopting the technology, strengths and limitations, challenges encountered during implementation and how they were addressed, business processes that are most suited to the use of this technology, and detailed case studies.
3. Completing the interviews by gathering the information to address the questions covered in the questionnaire.
4. Summarizing the findings.

Industries covered included:

- Consumer & Industrial Products
- Public Sector
- Technology, Media & Telecom
- Energy & Resources
- Financial Services
- Life Sciences & Health Care

Phase 2 produced a summary of the findings about each technology and a description of non-actuarial cases studies for each technology.

## **PHASE 3 – THE ART OF THE POSSIBLE: ACTUARIAL USE CASES**

The non-actuarial case studies gathered in Phase 2 were supplemented with actuarial case studies identified in this phase. These practices formed the basis upon which we identified what more could be done or done more broadly within the actuarial profession.

In addition to categorizing the case studies by the broad types of technologies as described in Phase 1, we also categorized them according to actuarial functions such as pricing and underwriting, valuation, capital management, risk management, etc.

The steps in this phase involved:

1. Developing a collection framework and questionnaire.
2. Identifying companies and actuaries to be interviewed, ideally covering all actuarial functions to understand what emerging technologies were currently being used.
3. Conducting the interviews.
4. Documenting the authors' own experiences and observations of using emerging technologies in the areas identified in Phase 1.
5. Brainstorming further applications of these technologies in actuarial science and documenting potential use cases. We also performed additional research that we identify in this step as beneficial to the final report.

6. Producing and finalizing the report containing all findings.

Phase 3 produced a list of actuarial case studies representing the current use of the technologies for each function and recognized further areas within the actuarial profession that would benefit from using these emerging technologies.

## Appendix C: Mapping of Technologies to Technology Groups

Several tools and technologies were identified for further investigation through the course of this study based on numerous criteria. These were grouped together into 6 categories by similarity for ease of understanding in the final report.

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>➤ <b>Machine Learning (ML) and Artificial Intelligence (AI)</b></li> <li>➤ <b>Business Intelligence Tools &amp; Report Generators</b> <ul style="list-style-type: none"> <li>➤ BI Tools (Data Visualization)</li> <li>➤ Documentation Generators (Markdown)</li> </ul> </li> <li>➤ <b>Extract-Transform-Load (ETL), Low-Code Platforms, and APIs</b> <ul style="list-style-type: none"> <li>➤ Low-Code ETL</li> <li>➤ Robotic Process Automation (RPA)</li> <li>➤ Application Programming Interfaces (APIs)</li> </ul> </li> </ul> | <ul style="list-style-type: none"> <li>➤ <b>Collaboration and Connected Data</b> <ul style="list-style-type: none"> <li>➤ Dynamic Collaboration Tools</li> <li>➤ Connected Data &amp; Reporting</li> <li>➤ Close Automation</li> <li>➤ Source/Version Control Management Tools</li> </ul> </li> <li>➤ <b>Data Governance &amp; Sharing</b> <ul style="list-style-type: none"> <li>➤ Data Governance</li> <li>➤ Privacy Enhancement Techniques (PETs)</li> </ul> </li> <li>➤ <b>Digital Process Discovery Tools (Process and Task Mining)</b> <ul style="list-style-type: none"> <li>➤ Process Mining</li> <li>➤ Task Mining</li> </ul> </li> </ul> |
|---|--|

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