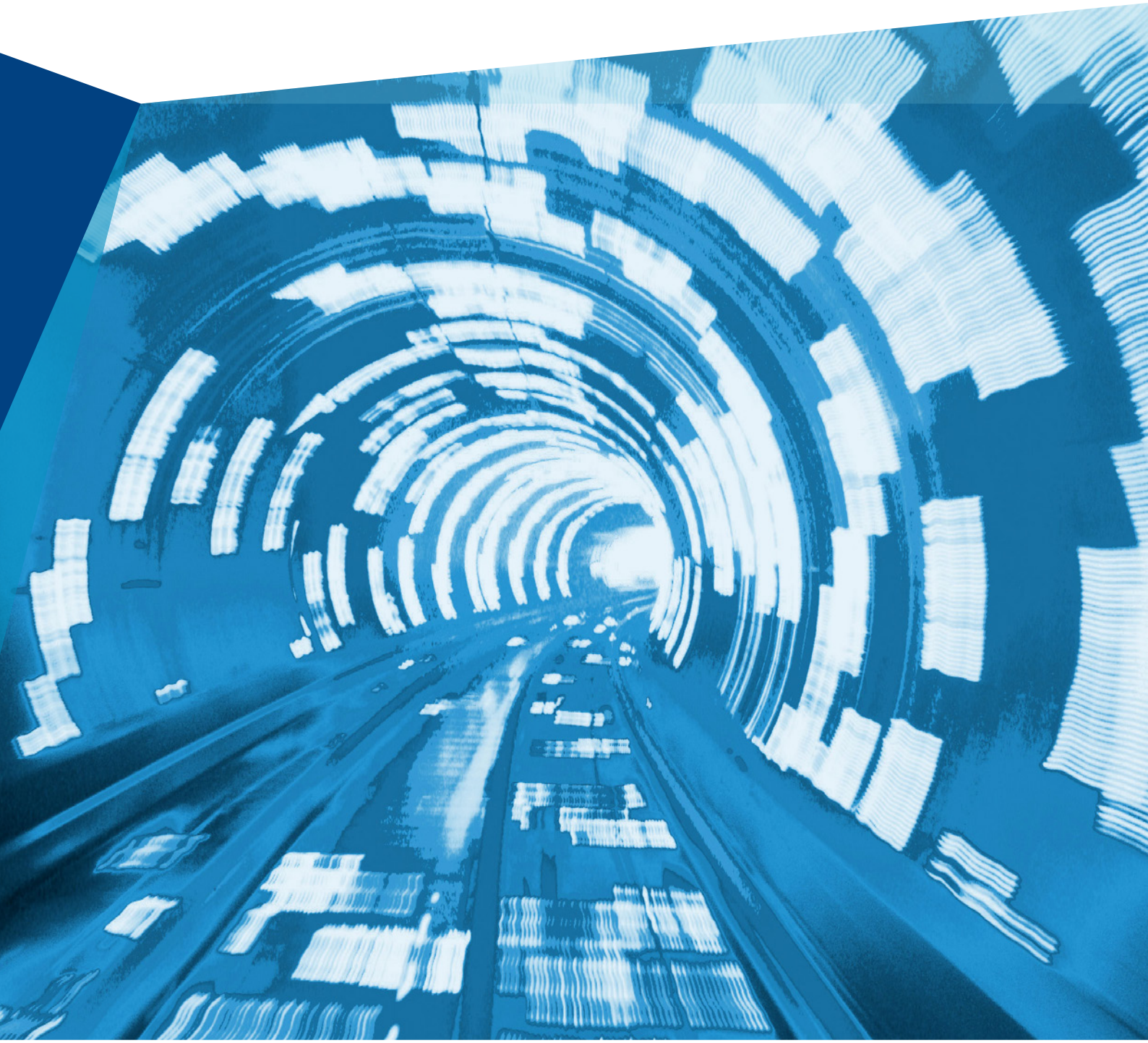
MARSH & McLENNAN COMPANIES | Asia Pacific Risk Center | PARIMA By Risk Managers For Risk Managers

TARGETING A TECHNOLOGY DIVIDEND IN RISK MANAGEMENT



MARSH GUY CARPENTER MERCER OLIVER WYMAN

KEY TAKEAWAYS

1. In an uncertain world, the risk function is becoming a crucial focus for firms as they navigate increasingly unpredictable economic headwinds, a rapidly evolving technological landscape, and shifting socio-political and regulatory trends.

2. Given the rising importance of risk management, it is crucial to note that risk professionals can gain large dividends by leveraging three key technologies: data, analytics, and processes. Using these technologies, risk professionals can digitize their risk function and achieve real cost savings for their firms.

3. Unfortunately, digitizing the risk function is an extremely challenging task. This was made clear by the results of The Emerging Tech in Risk Management Survey 2017, produced by PARIMA in partnership with Marsh & McLennan Companies. Drawing on the responses of over 130 professionals across a range of industries in the Asia-Pacific region, the survey results show that the risk function requires significantly more attention and resources from the C-suite. Constrained by investment budgets and a lack of support from senior management, risk managers today have to figure out how to do more with less.

4. While many risk managers recognize the importance of harnessing emerging technologies, our survey results show that few have implemented these solutions on a wide enough scale to be able to claim a fully digitized risk function.

5. An examination of several business cases in which data, analytics, and processes have been implemented to mitigate risk demonstrate that the long-term benefits of these technologies widely outweigh the initial costs. It is therefore crucial for risk managers to push forth with digitizing their firms' risk functions, despite the challenges.

6. We describe five practical steps for kick-starting the digitization of the risk function. Implementing these steps will be key to fueling the evolution of the risk manager into a future-proofed and dynamic profession of tomorrow.

PREFACE

We are excited to present the result of the very first collaboration between PARIMA, a leading professional association for risk and insurance managers, and Marsh & McLennan Companies (MMC).

Business leaders today are facing a confluence of risks arising from the backdrop of an increasingly complicated and shifting business landscape. Macroeconomic challenges, new hidden risks such as cybersecurity and technology risks, as well as renewed regulatory landscapes are causing growing uncertainty and threats. While risk managers are under unprecedented pressure to redefine and connect risk to strategy and performance, they are still facing the same resource and capacity constraints, leading to a conundrum of doing more with less.

On the other hand, with dramatic changes coming from technological sources, including data, advanced analytics and process automation, this changing landscape offers substantial opportunities for risk managers to target productivity gains. As a result, we envision the next generation risk management and risk managers to be more effective and productive through embracing technological advancements.

To better understand business executives' opinion of and current status on leveraging technological advancements to improve the efficiency of the risk management function, we conducted the "Emerging Tech in Risk Management" survey 2017. This survey spanned 17 different industries in Asia-Pacific with over 130 survey respondents, and included a series of interviews with business leaders for insights.

We hope that this report will generate discussion in the risk management community on the importance of emerging technology, and that it will contribute to developing solutions for future-proofing the role of the risk manager.

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Chairman, PARIMA

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GROWING UNCERTAINTY: THE CHANGING GLOBAL RISK LANDSCAPE

Many drivers are shaping the context of risk management today. Macroeconomic headwinds, global geopolitical uncertainty, and ever more frequent and damaging cyber events have been in the vanguard of the challenges leading to heightened risk perceptions.

MACROECONOMIC HEADWINDS

Macroeconomic headwinds driven by global and Asian debt levels,[1] low growth, anti-globalization sentiments, increasing policy uncertainty and the expected hike in US interest rates, all represent significant challenges. As Andrew Glenister, Regional Risk Advisor at BT Hong Kong, notes: "Macroeconomic and geopolitical risks are an increasing part of our internal discussions, particularly across Asia and Africa, and recent surprises on the world's political scene have demonstrated that nothing can be taken for granted, and that the experts aren't always right! At the same time our business is facing new challenges from the changing regulatory and global environment and can be impacted by a far greater range and variety of events from across the world."

These challenges are particularly pronounced for export-dependent economies, which comprise most of Asia. Concurrently, many leading economies in Asia-Pacific such as China, Singapore, and Australia are struggling to maintain labor productivity and productivity growth. Productivity-enhancing policies are required, including capital investments in new technology and workforce development. These new technology-powered productivity strategies will inevitably bring modifications to risk management and the role of the risk function. Risk teams will need to use their established capabilities to anticipate potential implications of this context, and develop new capabilities for managing risks using emerging technologies.

1 Bloomberg 2017. Asian Nations Swimming in Debt at Risk From Fed Rate Hikes.

HIDDEN RISKS ARISING FROM NEW TECHNOLOGIES

Global perceptions of risk, as measured in Marsh & McLennan Company's annual work with the World Economic Forum, are more elevated than ever.[2] Technological advancements, for example, are increasingly exposing organizations to emerging risks such as data fraud and cybersecurity threats. Indeed, the WannaCry and Petya ransomware attacks were a harsh reminder of this for firms across the globe. This point of view is well echoed in our survey, in which 51 percent of respondents state that cybersecurity risk is the second-most impactful risk for their firms, following strategic risk (Exhibit 1).

Two of the three most pressing global risks identified by risk managers relate to technology and cybersecurity.

In fact, two of the three most pressing global risks identified by risk managers relate to technology and cybersecurity. Moreover, as reflected in the MMC Asia Pacific Risk Center's annual Evolving Risk Concern in Asia-Pacific report, the interconnectedness of risks – which may not be apparent to businesses – compounds the impacts of risk events. For example, the effects of advancement in automation may lead to rising economic inequality as it threatens to displace manufacturing jobs that have been the main livelihood of millions of lower-income Asians.

As Susan Valdez, Senior Vice President and Chief Corporate Services Officer of Aboitiz Equity Ventures (and a PARIMA Philippines board member) points out, "Corporate digital transformation creates a whole new set of risks and could alter the context of cyber risk and information security risk. Because of the evolving nature of threats from hacking, malware, phishing and other forms of attacks, existing mitigations are constantly challenged and need to be continually updated to address vulnerabilities." The confluence of risks facing Asia-Pacific is posing significant challenges to businesses.

2 World Economic Forum 2017. The Global Risks Report 2017, 12th Edition.

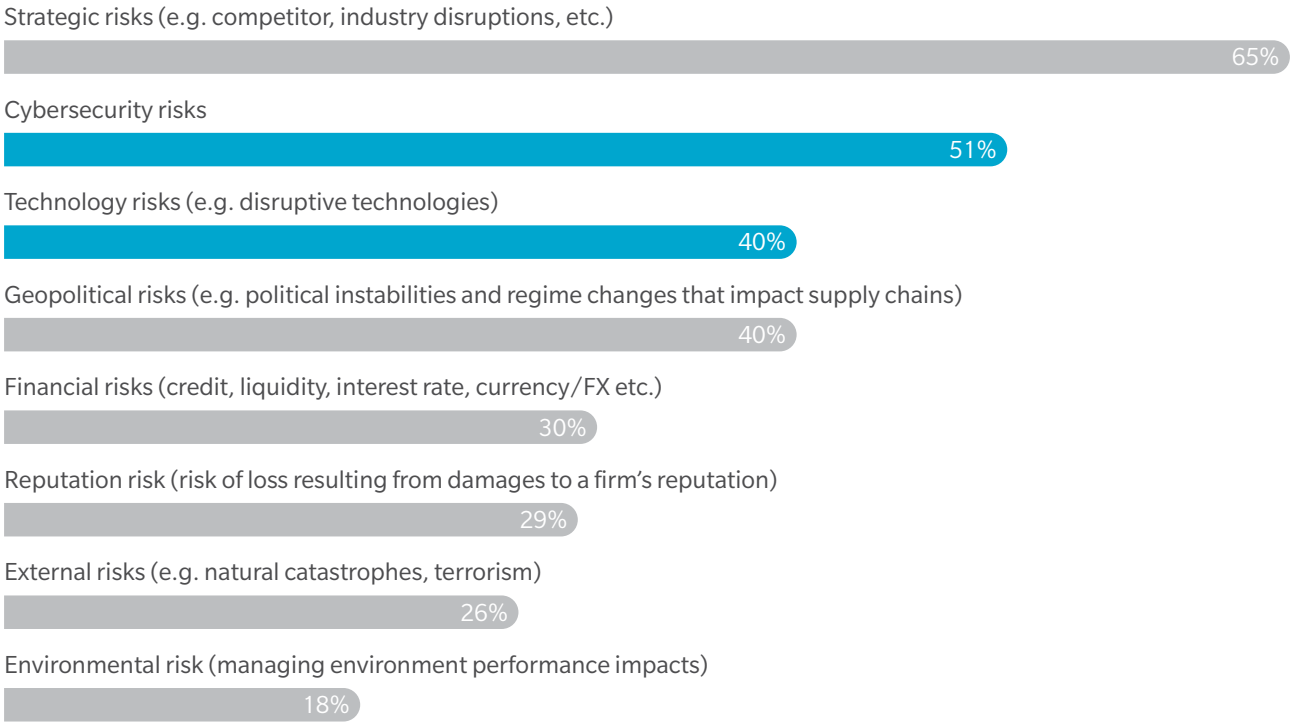
THE EVOLVING REGULATORY LANDSCAPE

A "deluge of regulation" has followed the dramatic events of the Global Financial Crisis, especially in financial service industries. Non-financial service industries also face a rising tide of regulation, motivated by trends such as cyber-security concerns, rising anti-globalization sentiments and climate change, just to name a few.[3] Asia-Pacific regulators are following international precedent by increasing oversight of multiple areas including stress testing, recovery and resolution planning, as well as in required capital estimation regulation.

An increasing number of Asia-Pacific countries including China, Singapore, and Australia have recently introduced cybersecurity laws to be in line with the global best practice. Moreover, rising protectionism including sudden changes in trade policies, taxes or tariff regulations have been witnessed in other regions, which also create increased pressure on risk management.

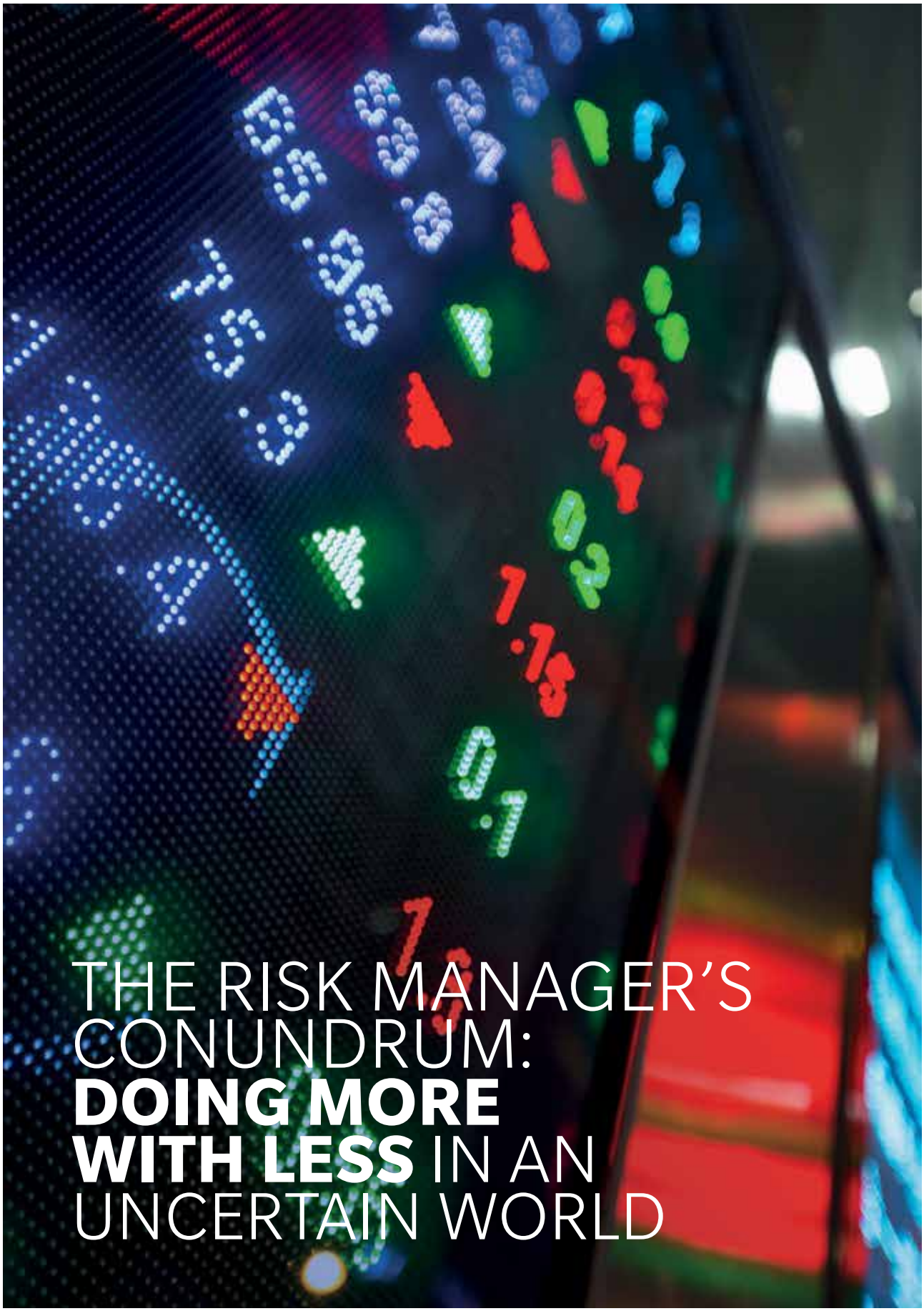
EXHIBIT 1: TOP RISKS IDENTIFIED BY MANAGERS

WHAT DO YOU BELIEVE ARE THE TOP THREE RISKS CURRENTLY IMPACTING YOUR ORGANIZATION?
(% OF RESPONDENTS)



Source The Emerging Tech in Risk Management Survey 2017

3 Asia Pacific Risk Center 2017. Evolving Risk Concerns in Asia-Pacific.



THE RISK MANAGER'S CONUNDRUM: **DOING MORE WITH LESS** IN AN UNCERTAIN WORLD

While the global risk profile is evolving rapidly, there is little evidence to suggest that material changes have been made in the risk management function. More than half of the respondents surveyed indicated that risk managers today are still playing traditional roles such as managing financial and regulatory risks of operations. Only about 17 percent of respondents stated that risk management is playing a front and center role in making or informing business decisions.

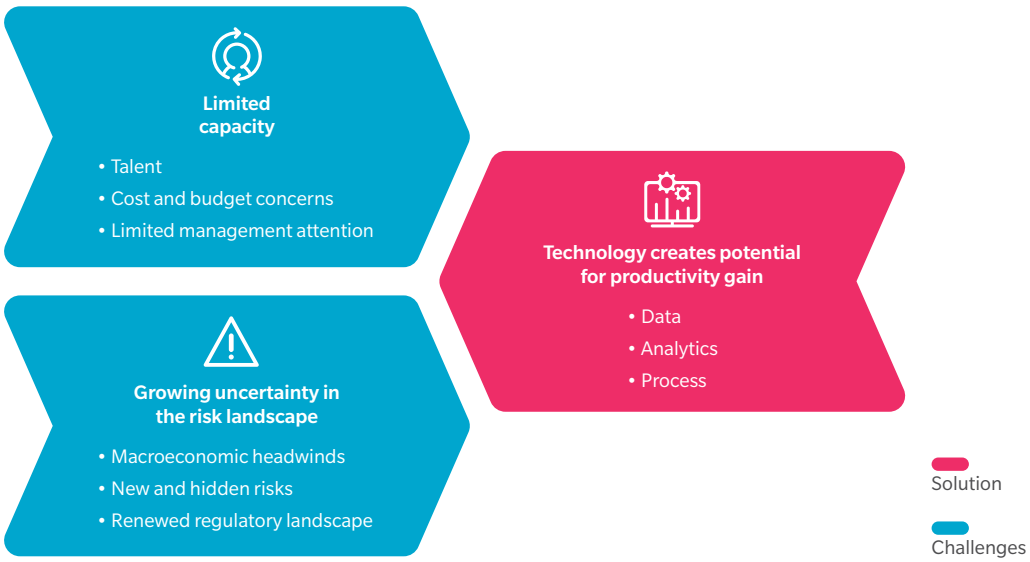
On the other hand, risk managers' abilities to make critical changes are constrained by cost and budgeting factors. In our survey, 67 percent of respondents reported that cost and budgeting concerns are the most significant obstacles holding them back from transforming the risk management function. Indeed, Andrew Glenister tells us that "the internal fight for investment and resources creates a constant struggle for political and cross-functional support, and a need for innovative and efficient solutions."

Only about 17 percent of respondents stated that risk management is playing a front and center role in making or informing business decisions.

The result of this is that risk teams are being asked to do more with less. In a more uncertain world, investment decisions in risk management are under pressure.

Facing cost constraints and ever-growing uncertainty in the business landscape, risk managers need to leverage technology advancements in order to solve for newer uncertainty with the same capacity. Augmenting the effectiveness of the risk function and enhancing the insights risk managers bring to business conversations will be critical and technology must play a key role in that transformation.

EXHIBIT 2: SOLVING THE RISK MANAGER'S CONUNDRUM



Source APRC analysis

TARGETING A TECHNOLOGY **DIVIDEND**

While radical technological changes and disruptions pose potential problems for risk management, technology must also be part of the solution. As Renato Castillo, Senior Vice President and Chief Risk Officer of First Gen Corporation tells us, "In this age, disruptive technologies will threaten the very core existence of major industries. The only way that the risk management framework of any organization will be able to cope with these developments will be through a technology-enabled risk management system."

Risk must target a technology dividend in order to maintain "match fitness" and build new capabilities, and to address rising demands with limited resources.

Advanced analytics, non-traditional data, and natural language processing, together with process digitization, present compelling opportunities for risk management. These include raising productivity, producing greater insights from new technology, and potentially achieving a competitive advantage in a digital world. Although cashing in on a technology dividend in this way presents a compelling prize, it will require wholesale change in current practices. Senior leadership focus and support will be critical as multiple functions will need to learn new skills and change their habits.

Although the number of organizations using emerging technologies for risk management is currently low, substantially more companies are actively evaluating or planning to adopt emerging technologies in the future to drive the next phase of risk management transformation.

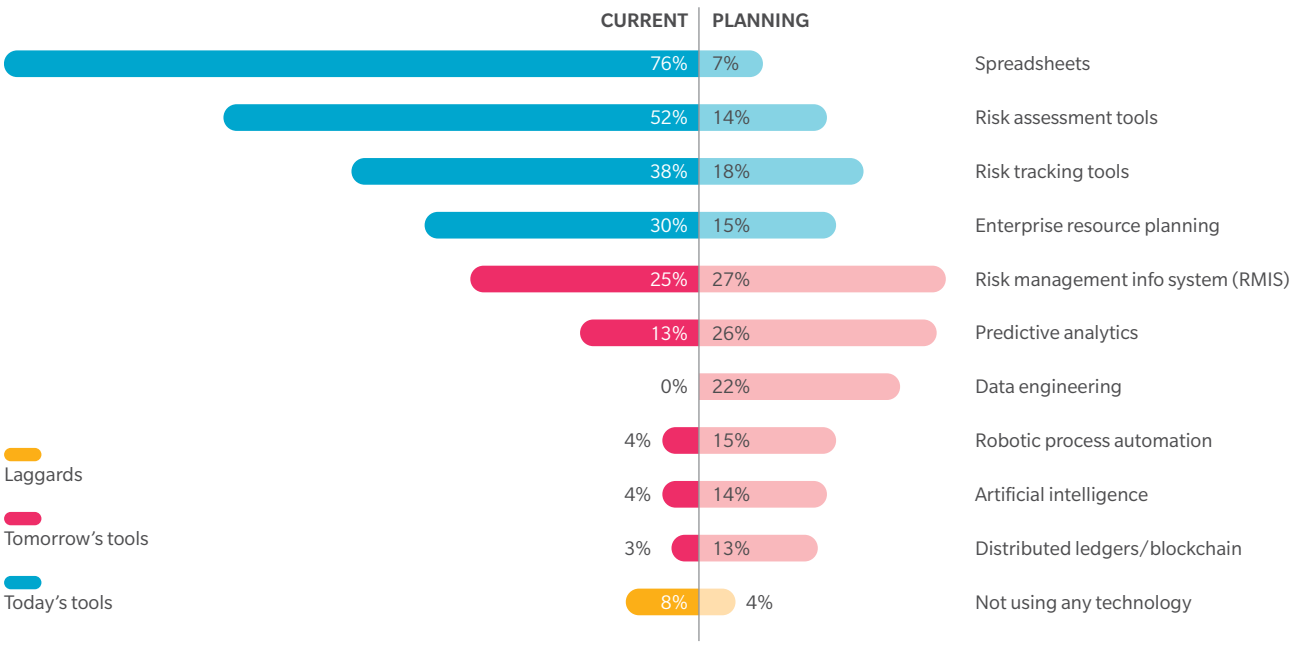
Based on our survey results (Exhibit 3), it seems that the penetration rate of emerging technologies in the risk management function is still low across industries. A majority of organizations today are still using traditional technologies to manage risk, with spreadsheets (76 percent) being the most commonly used tool among all technologies. Moreover, 8 percent of respondents stated that they are not using any technologies for risk management at all.

Given the substantial opportunities we can expect from technology advancements, there is huge potential both for productivity gain and for the enablement of more efficient decision-making in risk management functions. There are a myriad of places in the day-to-day activities of risk management where gains can be realized through the use of technology. However, in order to avoid a "boil the ocean" exercise a critical first step will be to identify specific technologies that provide the largest upside to the risk function.

We recommend that three major levers be considered to evaluate potential opportunities across the risk value chain, with the objective of targeting two to three initiatives to kick-start a broader technology pivot.

EXHIBIT 3: TECHNOLOGIES USED FOR RISK MANAGEMENT FUNCTIONS

WHAT TECHNOLOGIES IS YOUR ORGANIZATION CURRENTLY USING OR ACTIVELY EVALUATING TO MANAGE RISK IN THE FUTURE?
(% OF RESPONDENTS)



Source The Emerging Tech in Risk Management Survey 2017

Data

Risk management functions must ensure that they develop a consistent and comprehensive data set. New sources for data collection need to be considered, from cloud accounting, to application programming interfaces (APIs) for Open Banking, to social media, geolocation software, precipitation measurement technology, industrial sensors, and more. Risk functions will need to extract forward-looking insights from large amounts of real-time data, and incorporate new data sources into their models as they emerge.

Analytics

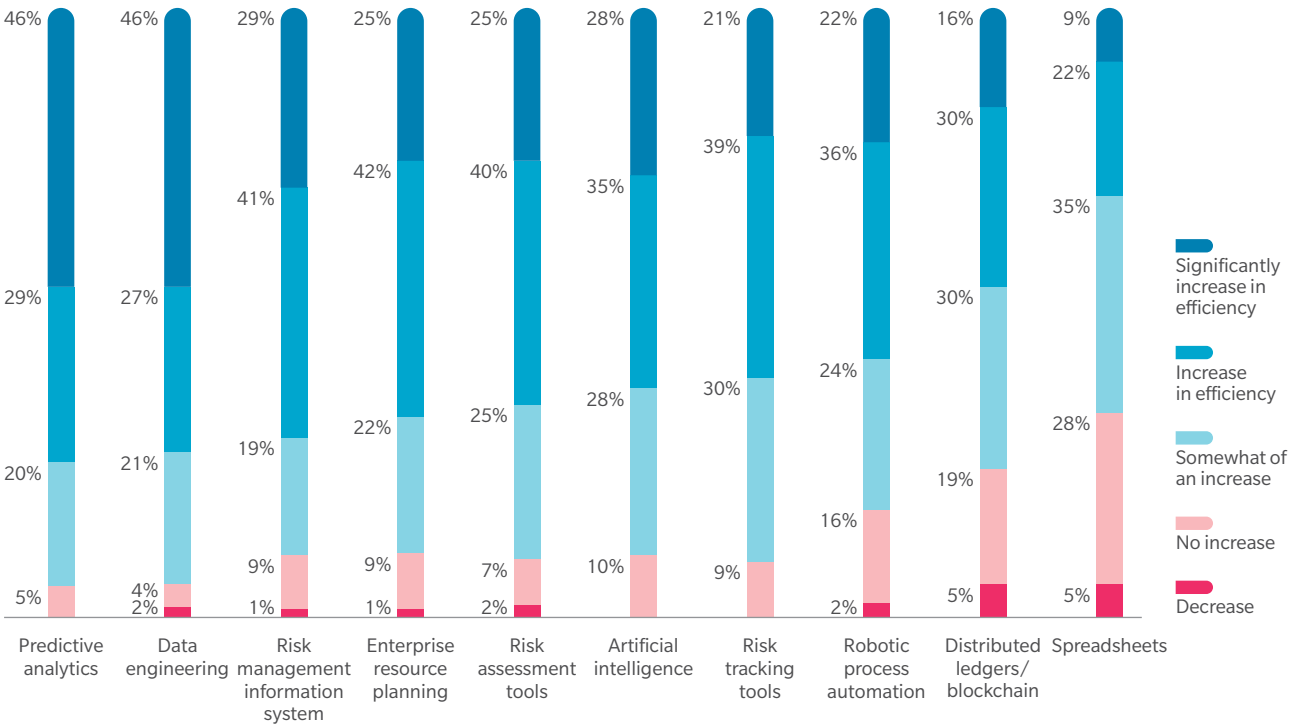
Machine learning and other advanced analytics have become affordable and readily available, and are already providing dividends through applications in predictive maintenance in airline and railway industries, risk underwriting, and market forecasting. Developing an advanced analytics capability is a minimum requirement for businesses seeking to attain parity with competitors.

Processes

The risk function must promote the digitization of business. Digitization provides opportunities to automate and create new risk monitoring processes for managing emerging or hidden risks. Robotic process automation (RPA) is maturing and can now be applied to an increasing number of standardized tasks to increase efficiency and reduce cost.

EXHIBIT 4: EFFICIENCY GAINS FROM RISK MANAGEMENT TECHNOLOGIES

TO WHAT EXTENT DO YOU BELIEVE THESE TECHNOLOGIES ARE INCREASING/WILL INCREASE EFFICIENCY OF RISK MANAGEMENT?
(% OF RESPONDENTS THAT HAVE USED/EVALUATED THE TYPE OF TECHNOLOGY)



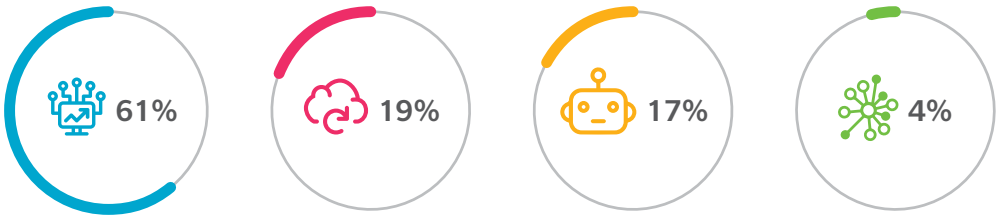
Source The Emerging Tech in Risk Management Survey 2017

Our survey shows that although the number of organizations using emerging technologies for risk management is currently low, substantially more companies are actively evaluating or planning to adopt emerging technologies in the future to drive the next phase of risk management transformation. Among all technologies, predictive analytics and data engineering are showing the most promise as the risk management tools of tomorrow, with 26 percent and 22 percent of respondents planning on deploying these technologies respectively (Exhibit 3).

Compared to traditional technologies, risk managers are also placing greater hope on emerging technologies. About 46 percent of respondents who have used or evaluated predictive analytics and data engineering believe these two technologies could increase efficiency significantly, compared to only 9 percent for spreadsheets and 25 percent for enterprise resource planning tools (Exhibit 4).

Our survey also asked respondents to rank, in terms of priority, how they plan to use technology in risk management development over the next five years. Transforming the risk function through big data and analytics capabilities was ranked as risk managers' top priority by far (see Exhibit 5).

EXHIBIT 5: PRIORITIES FOR THE FUTURE RISK MANAGEMENT FUNCTION



Transforming forecasting, risk management, and understanding of value drivers through improving **big data and analytics capabilities**

Making significant change to the risk management function skill set, improve **digital technology skills** in area such as mobility, cloud and SaaS

Improving efficiency and effectiveness through increasing **adoption and usage of emerging technologies** such as robotics and process automation

Driving efficiency improvements through **offshoring, shared services and outsourcing**

Source The Emerging Tech in Risk Management Survey 2017

DATA

Data is being created at unprecedented volumes – over 90 percent of data currently available was created in the last five years. As managing this data has become both easier and cheaper, organizations are increasingly exploring the use of varied and novel data sources such as social media, telecom data, transactional and locational data sources to unlock greater insights. For instance, commodity traders are already incorporating alternative data such as news and social media feeds into their early warning systems to have more accurate predictions for short term market changes.

Kimberley Pelly, Risk and Compliance Advisor to Queensland Airport (and a PARIMA Australia board member) notes that "big data will be a main player in the next few years. Through big data we will be able to better understand our risks, measure the impact of our mitigation strategies and, crucially, we will be able to enhance our risk management reporting to the board through the provision of 'real-time performance metrics'. For example, I have spent the last 2 years developing an in-house Governance, Risk and Compliance (GRC) system which requires risks to be looked at from an operational and strategic perspective. The next few years will see us use this system to generate trend analysis information."

Concurrently, there is also a drive for greater data openness from the public sector – for example, both the Australian and Singapore governments have launched portals that enable public access to data from government agencies to promote greater transparency.[4] As part of the ASEAN Banking Integration Framework, the Philippines, Malaysia, Thailand, and Indonesia have entered into various agreements to open up the banking industry with greater financial integration across Southeast Asia. As this trend gains momentum, it will open up many new avenues of information and data collection for firms and risk managers.

Moreover, granular and real-time data collected through Internet of Things (IoT) sensors and smart devices have increasingly made risk prediction more accurate and personalized. This capability could have profound implications for the health care and insurance industries. For example, with better access to information including pulse, blood pressure, respiratory rates, and sleep patterns of patients collected by wearable devices, healthcare providers could offer more timely and precise treatments, as well as dosages and care settings, leading to more effective outcomes, reduced medical misdiagnoses and reduced overall costs of prevention of chronic illnesses.[5]

4 Open data is the free use of data without restrictions from copyrights, or other mechanisms of control. For example, government websites publish public data in Australia (data.gov.au) and Singapore (data.gov.sg).

5 Dimiter, Dimitrov, Jul 2016, Medical Internet of Things and Big Data in Healthcare, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4981575/.

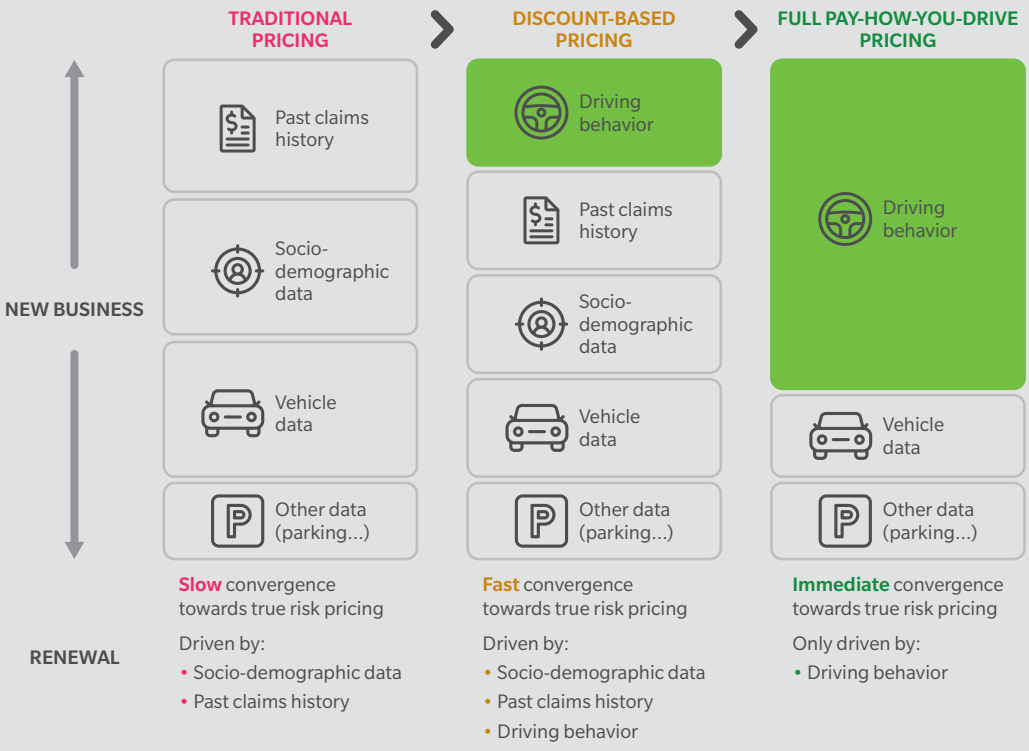
CASE STUDY 1

HARNESSING THE PREDICTIVE POWER OF TELEMATICS IN CAR INSURANCE PRICING AND ACCIDENT RISK REDUCTION

Data is a higher priority for the insurance industry than it has ever been, especially from a vehicle insurance pricing perspective. In the past, driver-risk has been measured based on self-reported rating variables, which include the driver's age and gender, model of car they own, driver's claims history and vehicle usage. However, most of these factors are historical data, and hence may be less optimal in representing a driver's actual driving behavior and may not accurately predict accident risk. Moreover, vehicles are getting smarter: a report from Oliver Wyman shows that the share of vehicles with some level of autonomous capabilities could jump from a little more than 10 percent in 2015 to close to 40 percent of all vehicles in 2025.[6] As a result, vehicle insurers have been seeking more granularity in their risk assessments and market segmentations.

This challenge can be solved by collecting driving data via telematics devices. Telematics data including the average driving speed, trip details during the policy period and road type for each trip could allow insurers to better quantify drivers' accident risk, hence helping individualize premiums and offering customers the option to pay as they drive.[7]

EXHIBIT 6: USAGE OF BEHAVIORAL DATA IN PREMIUM CALCULATION



Source AXA

6 Oliver Wyman, 2017. The Rocky Road for Autonomous Vehicle Insurance.

7 Oliver Wyman, 2017. The Rocky Road for Autonomous Vehicle Insurance.

Through monitoring policy holders' motoring habits on a real-time basis, insurers can better differentiate those who drive safely from those who are merely perceived as being safe on paper, hence rewarding truly careful drivers with lower premiums and promoting responsible driving – which will eventually lead to less accidents, improved road safety, and less risk overall. As a result, insurers can also benefit from reduced cost through fewer claims. Thus, by closely aligning insurance policies to real-time risk quantifications, insurance providers can reach higher levels of actual fairness and stop charging drivers premiums based on classifications that are far too general.

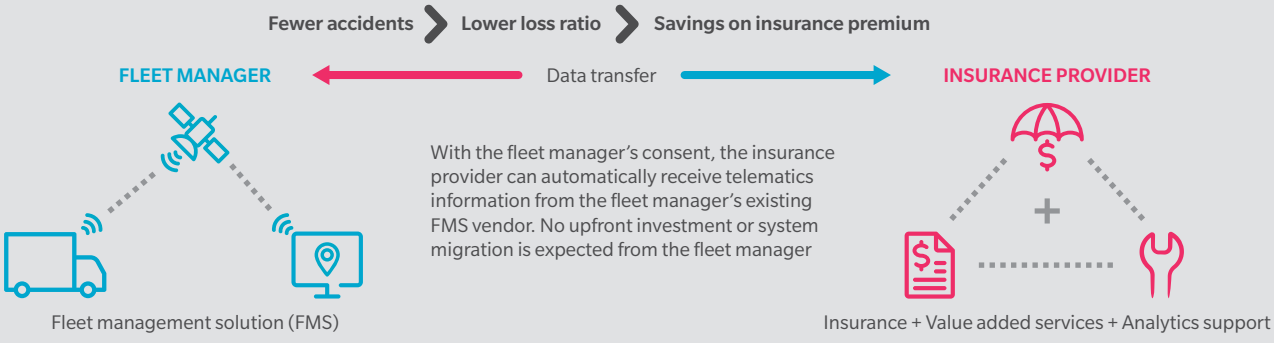
Apart from using data to provide better pricing by analysing driving style, insurers are increasingly leveraging data for many more purposes. For example, real-time data can immediately inform insurers when a driver has had an accident and provide emergency services or roadside assistance. In addition, using telematics data could help insurers better understand the cause of an accident and effectively speed up the claiming process and prevent fraud claims, all of which will eventually reduce cost and risk to car insurers.

The ability of insurance providers to use data for an expanding suite of purposes is crucial for corporations looking to mitigate risk as well. In the field of fleet management, AXA Insurance Singapore has partnered with Fleet Management Solution (FMS) providers in order to offer value added services to their existing customers already equipped with fleet management devices for data collection (telematics devices). From the data collected by the FMS telematics device, AXA is able to rank the drivers according to their driving style using information such as that provided by the accelerometer, including data on cornering and harsh breaking.

On the basis of the information collected, drivers are given a propensity score measuring the probability of that specific driver getting into an accident. A personally tailored safe driving program is then introduced to incentivize drivers to improve their driving behavior and reduce the risk of accidents, lowering the loss ratio of the fleet and therefore the premium at renewal.

AXA's crash reconstruction feature also enables a faster and more transparent management of own damaged claims as well as a fair settlement and just treatment of third party claims. Through the reconstruction of the accident using the collected data points, the system can proactively detect bodily injury exposure to prevent exaggerated or fraudulent claims, thus reducing litigation costs and expenses while enabling faster turnaround times.

EXHIBIT 7: A CONNECTED FLEET SOLUTION FOR RISK MANAGEMENT



Source AXA

ANALYTICS

Machine learning, natural language processing, and self-learning algorithms are not just for future use in risk management – they are already here. One good example is the banking sector. Rich in data, the sector is ripe for advanced analytics application and has already begun to employ the technology.

We have, for example, already seen credit risk modeling being significantly improved in the banking sector through the use of machine learning algorithms.

We have also seen card firms driving fraud discovery down to milliseconds, and are increasingly seeing natural language processing revolutionizing conduct monitoring forensics and customer support. Widespread advanced analytics is also increasingly applied in many other industries for risk management (Exhibit 8).

As discussed, about 61 percent of respondents cited "transform forecasting, risk management, and understanding of value drivers through improving big data and analytics capabilities" as their top priority for the future risk management development in the following five years (Exhibit 5). This capability is considered particularly important among big organizations with more than $5 billion in turnover, 78 percent of which chose this as their priority. Jayant Raman, Principal in Oliver Wyman's Finance & Risk Practice points out: "It is not a question of if, rather where can risk managers use analytics to make better decisions for the organization".

About 61 percent of respondents cited "transform forecasting, risk management, and understanding of value drivers through improving big data and analytics capabilities" as their top priority for the future risk management development in the following five years.

EXHIBIT 8: APPLICATION EXAMPLES OF ANALYTICS IN DIFFERENT INDUSTRIES

INSURANCE AND RISK
Increased behavior data collected via telematics devices leads to better policy pricing and risk underwriting

PUBLIC AND SOCIAL
Predictive analytics based on smart algorithms and historical crime data allows for real-time responses to illicit activities and terrorism

MANUFACTURING
Digital quality control systems, based on machine learning on historical quality control data, reduce the risk of false defect detection and defeat slippage by 21% with a reduction in the number of human inspectors required[8]

AIRLINE
Predictive maintenance based on machine learning and big data analytics helps to predict parts failure before they cause breakdown, reducing the risk of operations disruption and machine failures

TELECOMMUNICATIONS
Growth in mobile data volumes enables telecoms to use predictive analytics to predict the lifetime value and risk of churn associated with individual customers

HEALTHCARE
Smart algorithms and real-time data collected via IoT sensors ensure timely and accurate treatments, leading to reduced misdiagnoses, incorrect dosages, and drug interactions

Source The Emerging Tech in Risk Management Survey 2017

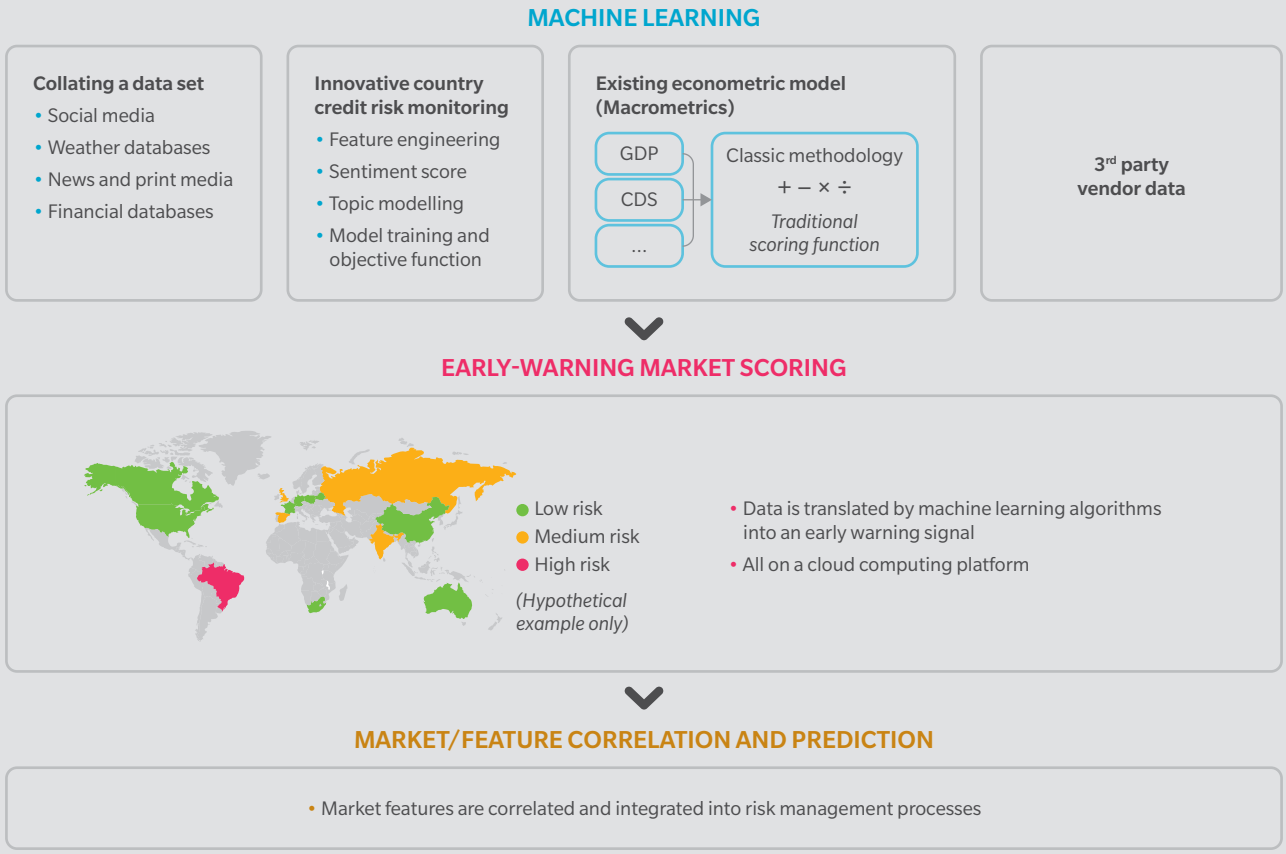
CASE STUDY 2

A SENTIMENT-BASED GLOBAL EARLY WARNING SYSTEM

With the omnipresence of data and computational power, global corporations not leveraging appropriate technologies stand to fall behind as the landscape of data analytics evolves. Global trends can now be identified and tracked more easily as data collection and processing becomes less costly and more effective at extracting intelligence. Decision-making in both day-to-day commercial operations and in risk management draws on intelligence from a variety of sources – ranging from social media, to weather outlets, to other financial outfits, to even freely available google data platforms such as GDELT or Google Trends.

Earlier this year, Oliver Wyman helped a global institution enhance its strategic foresight capabilities by building a sentiment-based model to dynamically map and track country risk from the underlying physical supply chain. The underlying machine-learning algorithm processes real-world incident data as well as natural language data from news events, financial databases, third-party vendors and social media platforms such as Twitter, and extracts a trackable sentiment score against which risk limits and other early-warning mechanisms can be calibrated (Exhibit 9).

EXHIBIT 9: SIMPLIFIED MODEL ARCHITECTURE FOR PREDICTING COUNTRY RISK



Source Oliver Wyman analysis

Especially hard-to-quantify political and reputational risks are now covered more holistically in the client strategic steering and risk management framework. The data gathered and processed includes: Geopolitics, weather at key industrial sites, media coverage, and key entities and politically exposed persons.

Several methods were tested in combination with existing econometric models and data – including regression methods, decision-tree based methods, and support vector machines (Exhibit 10) – to generate the best possible early warning signal. The client gained in foresight and response time to incidents and hence was able to upgrade critical business processes.

EXHIBIT 10: METHODS FOR TRAINING THE EARLY WARNING SYSTEM MODEL

INTERPRETABILITY (LOW > HIGH)	METHOD/ CLASSES	MODEL	DESCRIPTION	WHEN WE MIGHT USE IT	COMPUTATIONAL EXPENSE
	BAYESIAN	NAIVE BAYES	Simple probabilistic classifier assuming feature independence	Create a baseline prediction	Very low
	LOGISTIC REGRESSIONS	LOGISTIC REGRESSION	Simple linear classifier	Classify linearly separable data	Low
	REGRESSIONS	GENERALIZED LINEAR MODELS (GLM)	Basic but powerful classifiers and regularized linear regression (LASSO, Ridge, Elastic Net)	Model linearly separable data (or non-linear interactions can easily be built)	Low
		MULTIVARIATE ADAPTIVE REGRESSION SPLINES (MARS)	Non-parametric regression performs variable selection and reduces overfitting	Non-linear separation with many features	Low
	DECISION-TREE-BASED METHODS	GRADIENT-BOOSTED TREES	Simple decision tree classifiers reweighted on misclassified points	Non-linear separation with many features	Medium
		RANDOM FOREST	Averaged decision tree classifiers trained on random subsets of data and features	Non-linear separation with many features	Medium
	SUPPORT VECTOR MACHINES	SVM	Similar to logistic regression but typically combined with Kernels (point > feature)	Non-linear separation with few features and many data points	High
	NEURAL NETWORKS	NEURAL NETWORKS	Network of logistic regressions (or similar classifiers) with one hidden layer	Few features and not linearly separable	High
		MULTI-LAYER NEURAL NETWORKS	Network of classifiers with multiple hidden layers	Few features and highly complex, non-linear separation	Very high
	ENSEMBLE LEARNING	ENSEMBLE METHODS	Combination of multiple models in series	If error analysis of other models suggests additional performance gain	High to very high

Approaches used in project

Source Oliver Wyman analysis

PROCESSES

Risk processes in many companies are still heavily paper-based with large volumes of manual interventions and long turnaround times. Inconsistent process standards and a lack of streamlining often lead to variations in service levels and are high in human error. In order to achieve productivity gains, risk functions need to be digitized with risk processes incorporating new products and workflows from their inception instead of appending them afterwards.

One way to achieve that goal is through robotic process automation (RPA), which not only significantly creates productivity gain and cost saving by automating key processes, but also aids firms in overcoming systems fragmentation by consolidating data from disparate departments. More importantly, RPA is enterprise-scalable and non-disruptive. As a result, employees can easily train the robot to perform new tasks and access additional platforms without any programming skills being required.

The Allianz robotic cash pooling program, for example, replaced the 6-8 hour manual process of reconciling cash pool balances with a 5-minute automated process. Oliver Wyman more recently helped a property and casualty insurance company develop an automated insurance renewal process, and the RPA-enabled renewal process reduced total process time by about 68 percent. Robotics solutions are also able to interface directly with the existing user interface, preventing companies from experiencing costly IT infrastructure changes. In general, the replacement of high cost human labor by low-cost robots can lead to up to 60-80 percent in cost savings.[9]

Bot types for RPA differ in their ability to handle different levels of complexity, as summarized in Exhibit 11. Artificial intelligence-based bots are the next logical step on the complexity scale.

About 17 percent of respondents in our survey (Exhibit 5) chose "Improve efficiency and effectiveness through increasing adoption and usage of emerging technologies such as robotics and process automation" as their priority for the future development of risk management function. The percentage is more than doubled among small organizations with less than $10 million in turnover (38 percent).

Beyond the cost reduction point, this can lead to a rebasing of the relationship of risk function with their internal customers, as Jayant Raman from Oliver Wyman explains: "As more and more institutions reimagine customer-facing processes through journeys, risk managers should reimagine risk-related processes for their own 'customers' in a more digitized world."

About 17 percent of respondents chose "Improve efficiency and effectiveness through increasing adoption and usage of emerging technologies such as robotics and process automation" as their priority for the future development of risk management function.

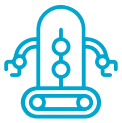
9 Association for Financial Professionals, Marsh & McLennan Companies, Starfish, 2017. Emerging Technologies and the Finance Function

EXHIBIT 11: ROBOTIC PROCESS AUTOMATION TYPES AND APPLICATIONS

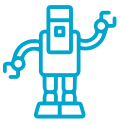
Simple, repetitive tasks → Complex, multi-system

Task Bots

Meta Bots



IQ Bots



Artificial Intelligence (AI)

	Task Bots	Meta Bots	IQ Bots	Artificial Intelligence (AI)
Description	• Replicates complex process actions • Performs actions taken by humans at presentation layer of any desktop-based application • Capable of executing multi-step processes	• Leverages API-level integrations to create system-to-system automations • Shares automations with Task bots • When combined with Task bots, Meta bots are ideal for multi-skill processes	• Learns and adapts over time • Becomes independent but with fewer errors • Leverages unstructured data • Capable of making decisions based on accumulated learning and experience	• Combines smart data and smart algorithms • Decision-making based on machine learning and synthesis of large datasets
Best for	• Repetitive, rules-based tasks relying on structured data	• Complex, scalable processes	• Managing through fuzzy rules and processing unstructured data	• Language interaction, processing and dealing with high amounts of unstructured data
Timeframe	• Exists today	• Exists today	• Coming over next 3-5 years?	• Coming over next 3-5 years?

Source APRC analysis

CASE STUDY 3

SUPPLY CHAIN RISK MANAGEMENT IN THE LOGISTICS INDUSTRY

The logistics industry handles increasingly large amounts of shipments while having to meet growing customer expectations of delivering goods within shorter periods of time. The operational risk of losing goods in transition, missing out on damaged items, or getting an order wrong has never been higher. Furthermore, disruptions in major trade or transportation routes that lead to delays could also lead to huge financial losses.

With innovative technological applications like the IoT,[10] logistics companies now have the ability to effectively manage these risks. IoT technologies such as microprocessors, sensors and wireless connectivity provide dynamic data that allows for real-time tracking of all inventories, goods in transit and assets across the supply chain. Robotic processing technologies can automatically collect, organize and present this data to help curb several operational risks across supply chains (see Exhibit 12).

Beyond mitigating typical operational risks, processing technologies are also useful in preparing for contingencies in black swan scenarios. Oliver Wyman developed a scenario planning tool for a major logistics operator that integrates and processes data from various weather sources and that also models route disruption scenarios as part of the company's risk management exercise. This tool assists in the creation of contingency flight routing decisions and was responsible for enabling the company to continue with its delivery routes following the 2010 volcanic eruption that halted most flights in Europe. In this instance, technology not only mitigated a key risk but also provided a business edge as the company was the first among its competitors to resume service into Europe, allowing it to increase its market share.

Today, the largest logistics operators utilize a Supply Chain Risk Management Portal, like DHL's Resilience360.[11] The portal's data processing capabilities provide a holistic perspective of the end-to-end supply chain, allowing companies to track delivery progress and quickly respond in the event of disruptions. Technology has undoubtedly become an integral part of the logistics company's risk management process, allowing firms to satisfy their customers in every situation.

EXHIBIT 12: EXAMPLES OF RISK MANAGEMENT TECHNOLOGIES IN THE SUPPLY CHAIN[12]

WAREHOUSE FORKLIFT ACCIDENTS
Sensors attached to forklifts and programmed to slow the forklifts down whenever persons or other forklifts are detected help reduce accidents

LOST SHIPMENTS AND DAMAGED GOODS
Multi-sensor tags transmit data on location and condition (e.g. temperature, pressure, humidity thresholds) of goods to ensure complete integrity during transportation

TRUCKING ACCIDENTS
Cameras on trucks monitor driver fatigue by tracking pupil size/link frequency and request breaks where necessary

LOST ITEMS IN WAREHOUSES
Pallet tagging in warehouses provides an overall view of all goods

NON-DETECTION OF DAMAGED GOODS
Cameras that scan for imperfections in goods assist in detecting damages

Source The Emerging Tech in Risk Management Survey 2017

10 Internet of Things (IoT) is defined as the interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data

11 Internet of Things in Logistics, DHL Trend Research & Cisco Consulting, 2015

12 Internet of Things in Logistics, DHL Trend Research & Cisco Consulting, 2015

CASE STUDY 4

PREDICTIVE MAINTENANCE IN THE AIRLINE INDUSTRY

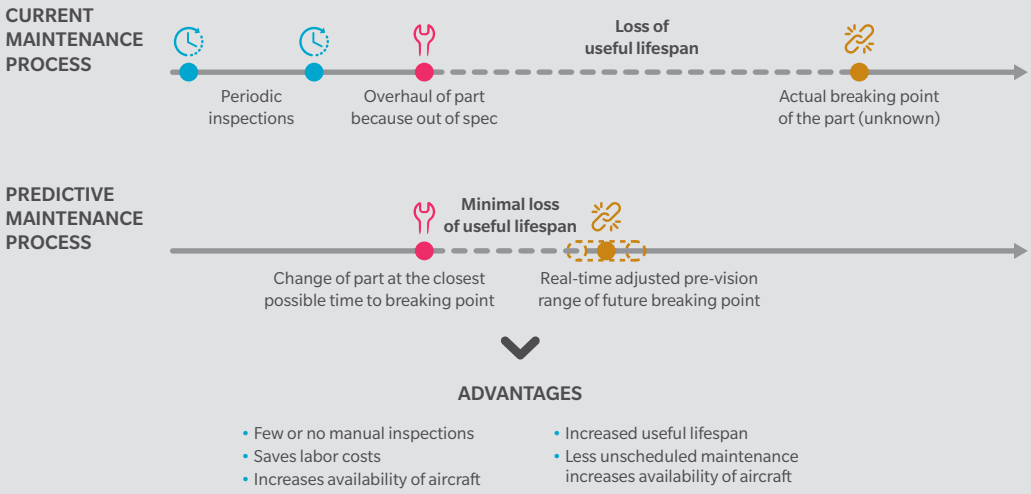
Airlines are facing escalating maintenance costs and increasing risk of operations disruptions due to sub-optimal maintenance and replacement processes, which are tedious, time-consuming and subjective in nature. Operational disruptions including flight delays, cancellations, and flight accidents could lead to severely negative customer experiences, harmful press and reputational damage, and ultimately serious economic consequences. Re-evaluating maintenance systems in the airline industry is crucial for mitigating these risks, and can be enabled by data processing solutions.

The surge of data availability in the airline industry is gradually leading to major changes in how modern aircraft are cared for, and in how aircraft perform. According to Oliver Wyman, the global fleet could generate up to 98 million terabytes of data by 2026.[13]

To leverage this surge of data, airline operators, Maintenance, Repair & Overhaul teams (MROs) and Original Equipment Manufacturers (OEMs) are increasingly adopting, utilizing, and investing in advanced robotics and process automation technologies, particularly relating to aircraft health monitoring (AHM) and predictive maintenance (OM) systems. These technologies increase maintenance efficiency and ensure safe, reliable, and cost-effective airplane performance.

How exactly does automated processing work to produce predictive maintenance systems that mitigate risk? Predictive maintenance RPA programs are designed to help determine the condition of in-service equipment in order to predict when maintenance should be performed. In the case of predictive maintenance for airliners (Exhibit 13), processing can be seen as a tool for solving an optimization problem that surrounds one central question: when should a part be ordered?

EXHIBIT 13: INTRINSIC ADVANTAGES OF PREDICTIVE MAINTENANCE



Source Oliver Wyman analysis

13 Oliver Wyman, 2016. MRO Big Data – a Lion or a Lamb?

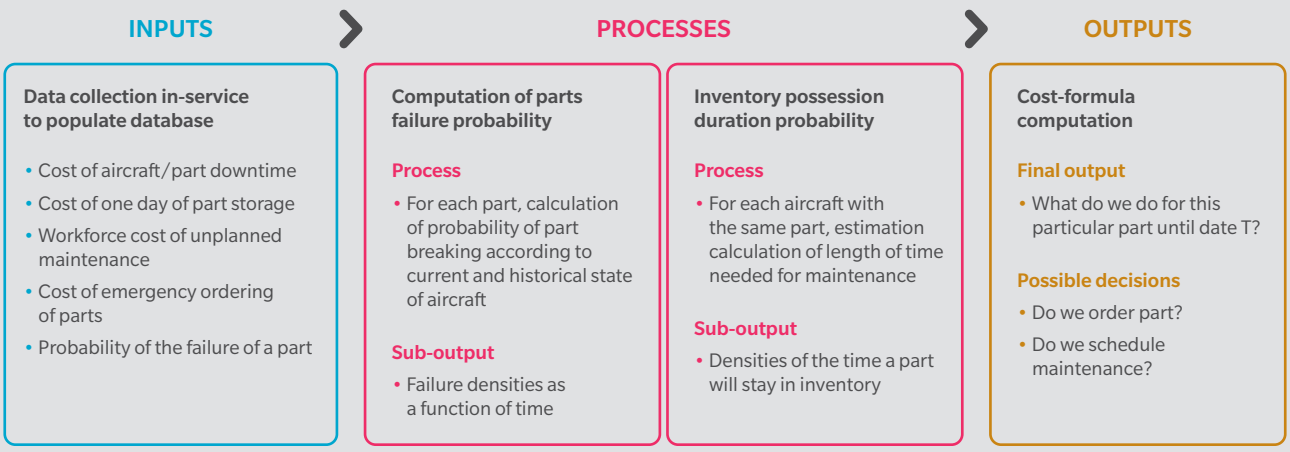
By relying on time-based aircraft sensor data and maintenance logs, operators can limit part failure and reduce total part costs by replacing components before they cause breakdowns. This solution may also help to keep parts-inventory at its optimum. With the help of analyses of historical inventory levels at various hubs, these processes can facilitate the movement of the right parts to the desired location in a timely manner, minimizing aircraft on ground (AOG) risk by having the right parts in the case of unscheduled repairs. In addition, the approach cuts labor costs by reducing unscheduled repairs, out-of-service events, and costs for employee time-on-tools.

Solving for this problem therefore involves the evaluation of a vast and complex variety of parameters, including (but certainly not limited to):

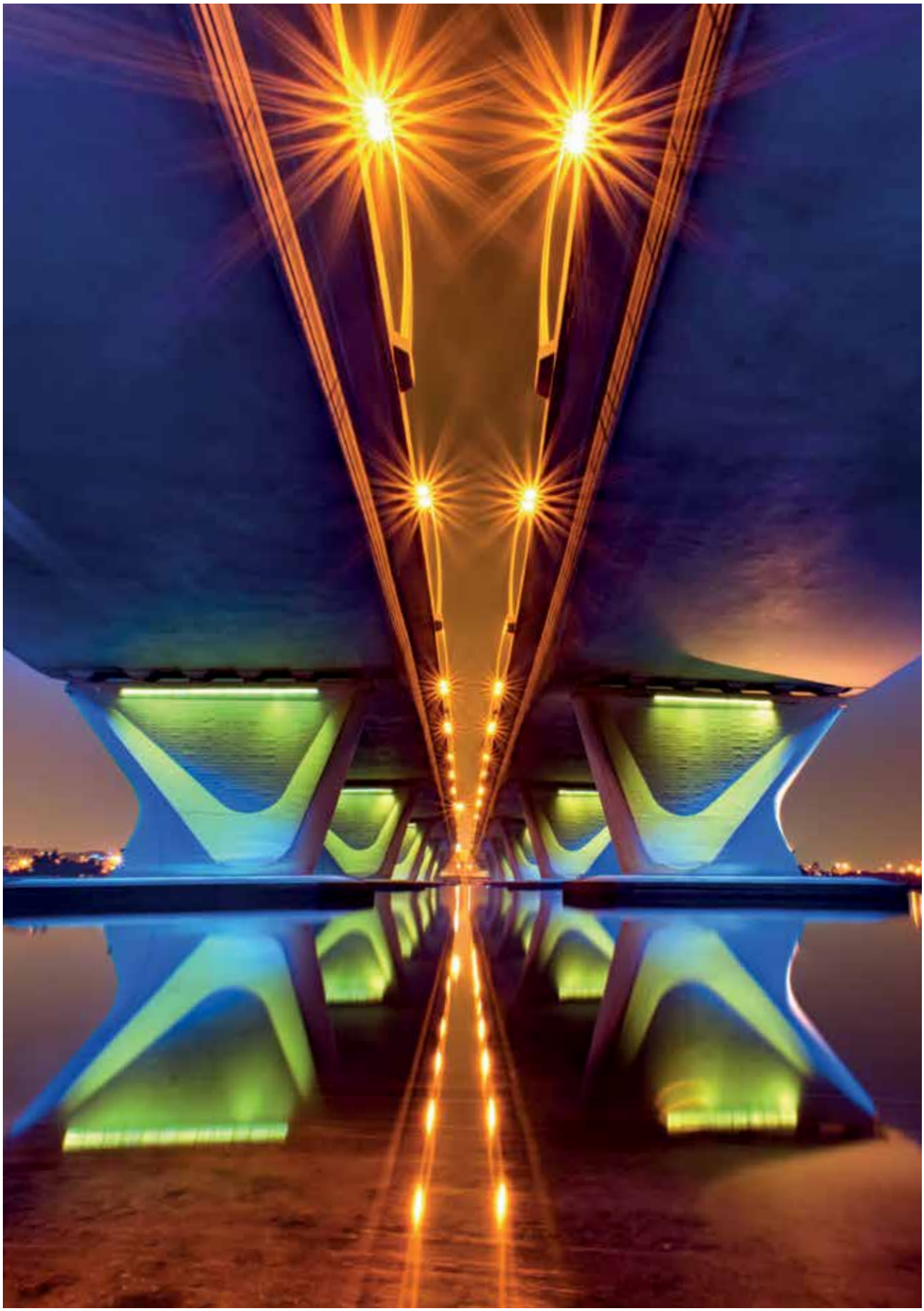
- Cost of downtimes of a part
- Expected lifespan of a part
- Workforce availability and cost in the event of unplanned maintenance
- Cost of part storage
- Cost of emergency ordering of parts
- Inventory volume
- Probability of the failure of a part

Harnessing RPA technologies allows for the efficient optimization of this highly complex problem by computing these myriad parameters automatically and dynamically, all based on passively collected operational and contractual data. Effective processed analytics will be able tell a risk manager quickly and accurately whether a part should be ordered immediately, or whether to have operations staff wait until the probability of the part's failure rises. For example, Oliver Wyman recently partnered with a North American railroad to predict the reliability of specific railcar components. Within weeks, the team was able to train a model that could predict certain component failures up to 40 days in advance, with an accuracy of up to 78 percent. In a cost and time-efficient manner, this technology can help the risk function play an important role in maintenance and operations across the transportation sector – minimizing the risk of vehicular accidents or unpreparedness and maximizing returns for firms.

EXHIBIT 14: THE PROCESSING PATH FOR PREDICTIVE MAINTENANCE



Source Oliver Wyman, APRC analysis



HORIZONS OF CHANGE

Fully benefitting from the digital revolution will mean a complete change in risk management processes, people, systems, and data. "Enhancing the credibility and positioning of risk managers in order to expand their footprint and scope of responsibilities is an ongoing challenge," says Franck Baron, Chairman of PARIMA. "Getting the right support for risk management needs, as well as securing sophisticated risk financing expertise, will also be constant challenges." However, this should not prevent organizations from getting started given the attractive returns that can be gained.

In order for firms to truly reap the rewards of their investment in risk management technologies, digitized risk functions will have to look very different from the risk functions of today. We see three horizons of change for the risk organization as it undergoes the digital transformation.

Level 1: Traditional risk function optimization

Many organizations have undertaken multiple initiatives to streamline and automate their existing risk value chains. Although traditional strategies such as automation and near/offshoring remain a major source of efficiency gains, the full value chain of core risk activities including risk governance remains in-house. We have seen 15-20 percent efficiency gains typically achieved through what could be termed "traditional" optimization.

As expected, 57 percent of our survey respondents reported that their organizations are currently adopting "traditional" optimization to improve efficiency in the risk management function, which is highest among all three levels (Exhibit 14). However, this figure dropped to only 14 percent when we asked whether the future planning of risk management development included "traditional" risk management activities as well.

Level 2: Progressive risk function foundation

Using an advanced risk data and IT architecture, the abilities of individuals and organizations to extract insights and manage these systems will become paramount. Coding skills and capabilities in advanced analytics will be essential. Risk leadership will require a mix of traditional risk and analytics background, but with strong capabilities in managing technology and operations. Laying the foundation for the human capital and career path implications of this phase early on will be vital.

The survey results show that only 2 percent of respondents believe that their organizations have achieved Level 2 digitization. Nevertheless, achieving productivity gains by applying both traditional strategies and emerging technologies is in many risk managers' plans (48 percent) for the next five years.

Level 3: Fully digitized risk function

Ultimately, many risk processes may no longer remain in-house. While many different scenarios can be envisaged, the most likely scenario is risk "stacked in the cloud". In this scenario, organizations no longer need a fully in-house risk management function. The bulk of risk analysis and processes is outsourced to third parties. Vendors and utilities will leverage their larger scale new technologies to provide standardized solutions, risk estimates and releases through APIs.

Importantly however, oversight and control will remain in-house. The focus of risk thus shifts from "scanning the horizon" activities to identifying new risks and managing vendors, providers and interfaces. Team sizes in any area of high human touch will diminish, resulting in expected 60-80 percent efficiency gains. The lead candidate area for headcount reduction will likely be credit, as risk decisions are increasingly supported by analytics.

To our surprise, a significant 7 percent of respondents claimed that they have already achieved full digitization in their risk management functions (Exhibit 15). Meanwhile, 24 percent of respondents are planning to fully digitize the risk function in the following five years, and almost half of all respondents (48 percent) plan on achieving a progressively digitized risk function in that time.

"There is still hot debate over whether the risk management function is adding value to the organization instead of just serving as a compliance or a trophy position for companies to put in their disclosure notes. Therefore, the support of the senior management will be critical in making this technology dividend a reality."
Victoria Tan, Head of the Group Risk Management and Sustainability Unit at Ayala Corporation

It is crucial to note that there seems to be a level of cognitive dissonance here between firms' plans for digitization and their plans for implementation. For example, while 48 percent of respondents plan on achieving a Level 2 risk management function, the number of respondents who actually plan to deploy key technologies falls far short of this number. Only 26 percent plan on deploying predictive analytics to manage risk in the future, just 22 percent plan on deploying data engineering, and only 15 percent plan to deploy robotic process automation technologies (Exhibit 3).

Even further, 12 percent of respondents either do not currently use or do not plan to use any technology in the risk function – and worryingly, none of our respondents have currently deployed data engineering technologies for the risk function (Exhibit 3). It therefore seems unlikely that 7 percent of respondents (Exhibit 15) have actually reached a fully digitized risk function, suggesting a clear perceptions-reality gap between how prepared risk managers believe themselves to be for the future and how ready the community truly is.[14]

As expected, higher levels of ambition in digitizing risk will entail larger transformation and investment. However, the upside opportunity is similarly very high. For a typical medium-sized bank, this is expected to translate into cost savings in the tens of millions[15] along with higher levels of effectiveness, oversight, and insight generation. However, as shown in Exhibit 16, the complete transformation journey will be complex with multiple interlinked elements. As such, the organizational implications need to be carefully and proactively anticipated and managed.

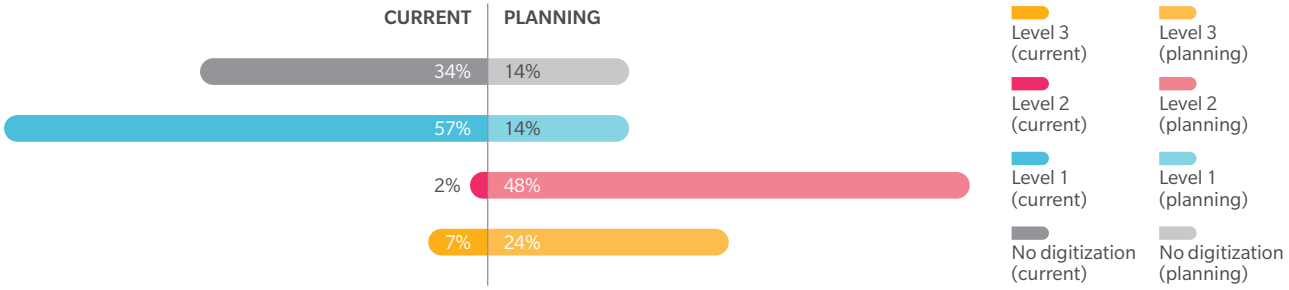
14 It is also possible, of course, that our questions may have been misinterpreted by our respondents, thus producing these inconsistent results; we will aim to shed further light on this question in future research

15 Oliver Wyman analysis

As Victoria Tan, Head of the Group Risk Management and Sustainability Unit at Ayala Corporation (and a PARIMA Philippine board member) emphasizes: "Giving proper consideration to the digital risk transformation will definitely help risk managers add value to their respective organizations. However, nothing is without challenges, and there is still hot debate over whether the risk management function is adding value to the organization instead of just serving as a compliance or a trophy position for companies to put in their disclosure notes. Therefore, the support of the senior management will be critical in making this technology dividend a reality."

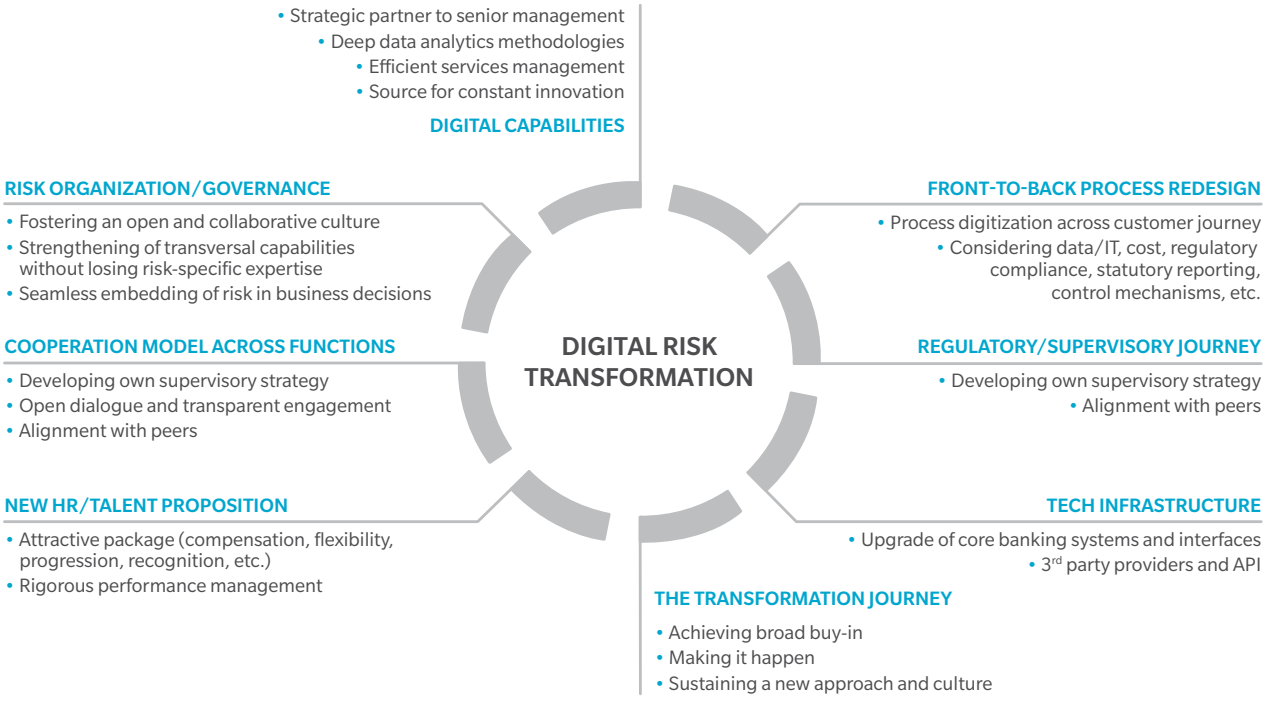
EXHIBIT 15: LEVEL OF DIGITIZATION IN THE RISK MANAGEMENT FUNCTION

TO WHAT EXTENT HAS YOUR ORGANIZATION DIGITIZED OR HAD PLANS TO DIGITIZE THE RISK MANAGEMENT FUNCTIONS?
(% OF RESPONDENTS)



Source The Emerging Tech in Risk Management Survey 2017

EXHIBIT 16: NEEDS AND OPPORTUNITIES FOR TRANSFORMING RISK MANAGEMENT



Source Oliver Wyman analysis

GETTING **STARTED**

Technology is already a game changer for risk, and investment in digital risk enablement is essential to remaining relevant. As the tools of tomorrow begin to become mature and accessible, the time for the risk function to act is now. There are five major steps to get started today:

Launch "quick wins" and longer-term efforts based on a digital risk activity map

Understand the potential for efficiency gains across risk processes. Prioritize high impact and quick win areas. Launch a shortlist of initiatives to establish and fund the longer-term ambition.

Scan the competitive landscape to understand current positioning in comparison to peers

The global industry, including all players in your ecosystem, should be well understood such that you can develop transferrable insights, and anticipate where to partner and where to compete.

Define the digital ambition for risk and vision for the future of risk management

Strategy and positioning for the future should be outlined and communicated to key stakeholders to ensure alignment.

Align regulatory strategy and relationship

Continuously monitor global and local regulatory changes relating to emerging technologies (such as changes in risk management practices, use of cloud data, cyber risk management, data security and privacy laws) to understand the potential consequences. Regulators should be kept abreast of the firms' thinking, given the shared incentives by both stakeholders for a stable system with well-managed risk. Digital change brings material uncertainty, and regulatory bodies will need to be comfortable with your organization's response plan.

Establish required talent model and implement recruitment strategy

Understand and anticipate the long-term talent needs and implement recruitment strategy and training schedules to support the future vision. As automation and analytics streamlines risk tasks, talent will become an important differentiator in leaner risk teams, made clear by the fact that a strong 19 percent of respondents stated "making significant change to the risk management function skill set" as their priority for future development (Exhibit 5). Aboitiz Equity Ventures' Susan Valdez notes, for example, that "change management is the biggest challenge facing the risk management profession. With new skill sets required in digital transformation, risk management plays a key role in ensuring that new and emerging people-related risks are addressed."

As management teams build tomorrow's risk management function, they will need to find fewer but more broadly skilled talent. As reflected in our survey, compared with current risk management team structures which contain mostly traditional risk management and compliance talents (91 percent), over half of our respondents mentioned that they believed future risk management teams need to have differentiated roles – such as highly talented data scientists (56 percent) and experts in data analytics methods (48 percent) – to fully embrace technological changes and improve productivity.

To complement technological advancements, the risk management's operating model must evolve to support the shift.

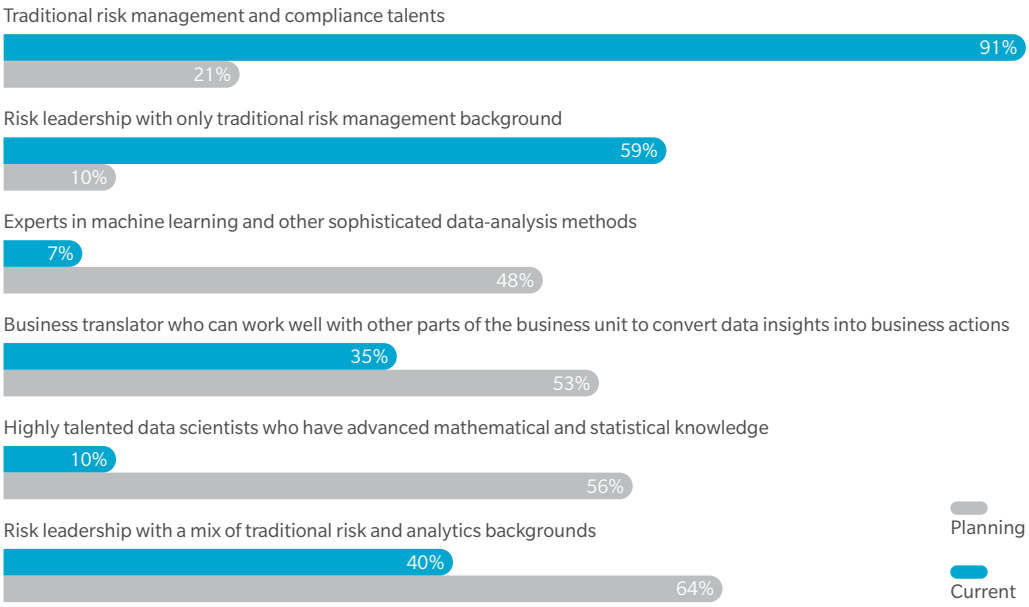
As Susan Valdez of Aboitiz Equity Ventures additionally notes regarding the shape of the risk industry over the next 10 years: "The digitized risk and insurance industry will change traditional managerial risk into a more proactive approach, using technology, innovative tools, and more involvement of the risk communities, and use of analytics to identify and evaluate future risks." Indeed, moving forward, risk managers will need to be proficient in directing teams executing advanced analytics, managing external partnership with SaaS providers, and all while acting as advisors to business as they do today. Thus, process-based jobs with standardized tasks, defined inputs and outcomes, will be fewer. Instead, insight-based roles, where risk teams will operate under more uncertainty, will represent a greater proportion of tasks.

Valdez comments as well that "the next phase for risk maturity for Aboitiz Group is heading towards adoption of GRC: the implementation of a more integrated and systematic approach to Governance, Risk, and Compliance. Using technology to integrate the management systems and link with risk management information systems will be crucial in bringing about this transformation."

In this endeavor to integrate technology into the risk function it will also be crucial for risk managers and professionals to form a community and produce a unified voice on the skills that are required for the future. Digitizing the risk function is a key step to future-proofing the risk profession, and will require constant skills and knowledge development.

EXHIBIT 17: TALENT FOR NEXT GENERATION RISK MANAGEMENT

IDENTIFY SKILLS/TALENT YOU THINK THE RISK MANAGEMENT CURRENTLY CONTAINS AND THAT YOU WOULD LIKE TO ADD/MAINTAIN IN THE NEXT 5 YEARS?
(% OF RESPONDENTS)



Source The Emerging Tech in Risk Management Survey 2017

HOW WILL THE DIGITIZATION OF THE RISK FUNCTION CHANGE THE ROLE OF THE RISK MANAGER?

As this report shows, leveraging the capabilities of big data, analytics and process automation will be key for risk managers seeking to digitize their risk departments. Targeting a selection of risk management functions for automation will be crucial. This will allow risk managers to shift away from manual, number-heavy and compliance-related tasks, and move toward providing higher value strategy-oriented analysis for the C-Suite.

A digitized risk function will change the risk manager's role in three ways:

Innovation

- The risk manager's fundamental mind-set will shift. Instead of solely measuring and setting limits on the day-to-day operational and financial risks of the firm, technology will allow risk managers to develop a wider understanding of industry innovation trends to help guide firm activities. This broader understanding of risk will help identify the many systemic and hidden risks that may arise from today's emerging and disruptive technologies
- Not only will risk managers be pushed to understand these new sources of risk, but they will need to be innovators themselves. Devising new ways to collect and analyse data will be a central aspect of the role. In particular, finding ways to prepare for and model future shocks that do not have historical precedent or data will be paramount in this widely uncertain and rapidly changing global risk landscape

Communication

- Despite the focus on hard skills that digitization will inevitably bring, risk managers will still need to maintain some key soft skills. One of the most important of these will be communication: the ability to interpret masses of data and "tell the story". Being able to simplify, contextualize, and explain the information produced by machines will be something only a human risk manager will be able to do effectively. In a digitized risk function where data processing is largely automated, communication skills will be more important than ever for risk managers

Strategy

- Automation will refocus skills away from "traditional" activities related to report-production and compliance. Instead, risk managers will be able to become flexible, adaptable sources of analysis and advisory skills. With risk management capabilities being thus heavily augmented by new technologies, risk managers will be able to provide more value-added services for the firm's strategy as a whole
- The risk manager's purview is also set to expand widely as a result of digitization. The risk function will increasingly find itself having to provide input for strategic decisions such as supplier/vendor/partner selection, M&A structuring, and the valuation of technological investments against their exposure to cyber-risk

Crucial as part of this transformation will be both the ability of risk managers to educate themselves, and expand their networks within and outside their organization. Becoming conversant in "tech-speak", attracting "new-age" talent like data scientists into the risk function, and being personally familiar with data science will be critical. Risk managers will therefore benefit from obtaining updated certifications for this rapidly transforming discipline. Additionally, being able to expand the networks of the risk function across company siloes into IT departments, and finance and strategy departments, will also help a newly-transformed risk function capitalize on its promising future.

As Suchitra Narayanan, Head of Risk, Air Asia (and PARIMA Malaysia board member) incisively describes: "There are immense opportunities to shape and cultivate the profession and set the direction for the future. That being said, there are some changes in the short term that need to be implemented for the profession to really grow and, in my opinion, this needs to start with a drive by the board and management to set the tone and risk culture and communicate their expectations to risk managers."

Associations such as PARIMA that provide certification, accreditation and resource-pooling will be key in enabling the development of the risk profession as the technological landscape evolves. Narayanan goes on to say: "I have found that the support out there among risk and insurance managers is phenomenal. The PARIMA conferences, for example, bring together some of the best talent in the industry and there is increasingly a community that risk managers can rely on or bounce ideas off and this sharing of knowledge is vital to the risk management journey."

Given the importance and magnitude of this task, leaving risk decisions to chance or intuition has become a thing of the past. As David Jacob, CEO of Marsh Asia notes: "There are plenty of tools available in the market to help risk managers, management executives, and board members adopt a scientific approach in identifying areas of vulnerability, prioritizing threats, devising mitigating strategies, as well as optimizing costs of risk.

Organizations need to look beyond immediate costs of taking the modern approach to their risk strategies. Unfortunately, there are some business functions that get taken for granted as the value of their contributions to the firm are hard to quantify – risk management is one of those. It is only when things fail that people realize their importance, and by then, the damage may not be reversible."

Organizations need to look beyond immediate costs of taking the modern approach to their risk strategies. Unfortunately, there are some business functions that get taken for granted as the value of their contributions to the firm are hard to quantify – risk management is one of those. It is only when things fail that people realise their importance, and by then, the damage may not be reversible.

In addition, using data and analytics in risk management enhances accountability. As David Jacob warns: "when things go wrong, it is easy for stakeholders (including shareholders, clients, and the media, for example) to point fingers and speculate. It is only when there are hard figures and models available to back decisions that management executives and risk managers can prove that the firm embarked on the best course - taking calculated risks, literally."

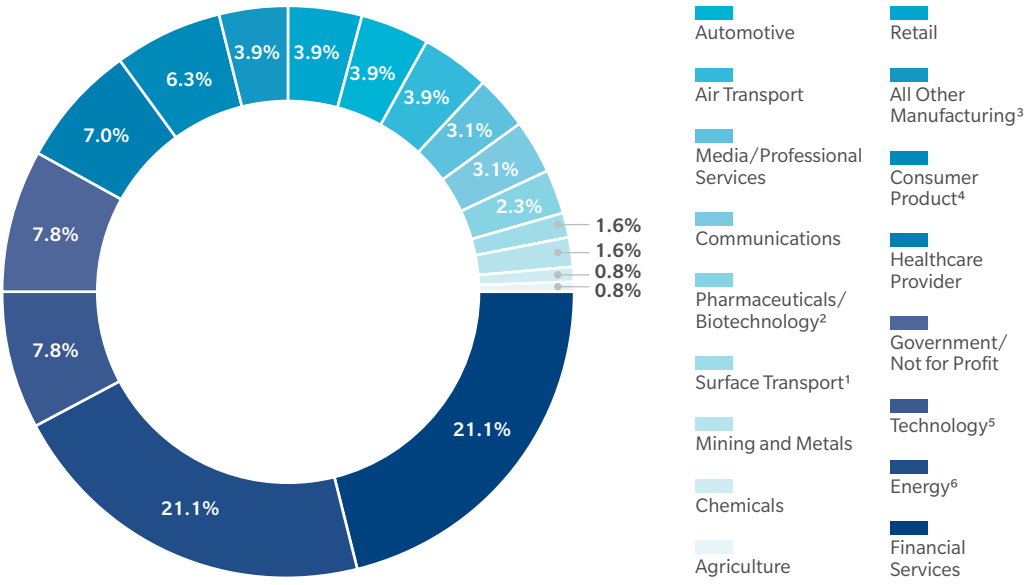
Marsh & McLennan Companies (Marsh, Oliver Wyman, Guy Carpenter and Mercer) have developed a suite of analytical and modelling tools to help our clients deal with the evolving threats of today and tomorrow. Do get in touch to see how we can help safeguard your organization's future.

ABOUT THE SURVEY

The Emerging Tech in Risk Management Survey 2017 sampled a range of executives across 17 different industries in the Asia-Pacific region to understand business' status and opinions of using emerging technologies to improve productivity in risk management function. The survey was conducted between September and late-October 2017. About 22 percent of respondents to this survey were C-suite executives (68 percent of whom were Chief Risk Officers), and 67 percent of respondents were Manager level or above. The sample reflects views across major geographic markets in the Asia-Pacific region, with Southeast Asia representing 68 percent of inputs, and Greater China and Japan accounting for 19 percent and 15 percent respectively. The balance came from Central Asia, South Asia, South Korea, Australia and New Zealand.

EXHIBIT 18: INDUSTRY COMPOSITION OF SURVEY RESPONDENTS

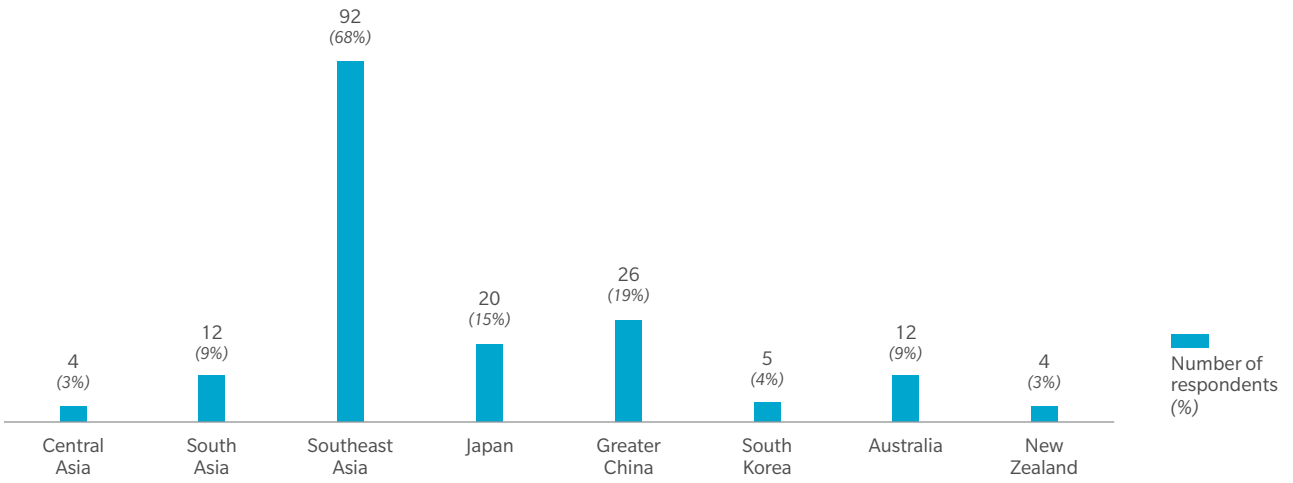
WHICH INDUSTRY CLASSIFICATION BEST DESCRIBES THE INDUSTRY IN WHICH YOUR ORGANIZATION OPERATES?



Source APRC analysis

EXHIBIT 19: REGIONAL COMPOSITION OF SURVEY RESPONDENTS

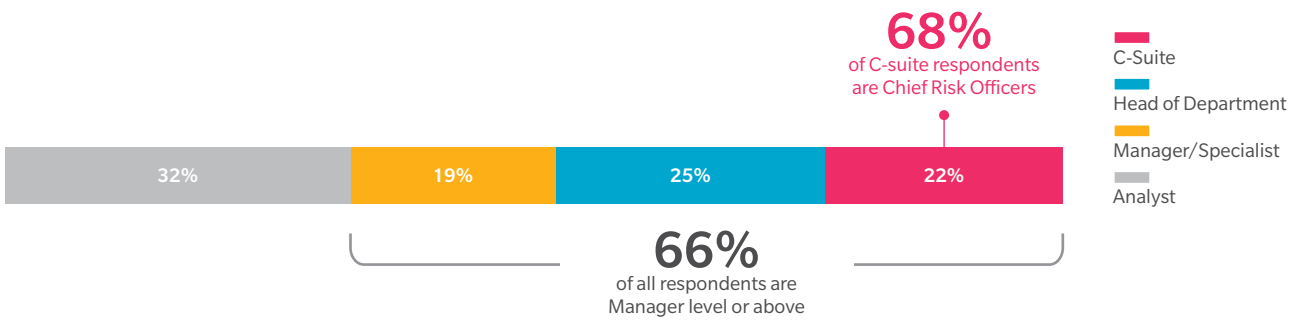
WHERE DOES YOUR ORGANIZATION OFFER GOODS OR SERVICES?
(SELECT ALL THAT APPLY)



Source The Emerging Tech in Risk Survey 2017

EXHIBIT 20: SENIORITY COMPOSITION OF SURVEY RESPONDENTS

IS YOUR ROLE AT YOUR ORGANIZATION ANY OF THE FOLLOWING POSITIONS?



Source The Emerging Tech in Risk Survey 2017

To read the digital version of Targeting a Technology Dividend in Risk Management, please visit **www.mmc.com/asia-pacific-risk-center.html** or **http://parima.org/.**

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About PARIMA

PARIMA is the Pan-Asia Risk and Insurance Management Association. It is a not-for-profit professional association dedicated to developing risk management as a profession and providing a platform for risk & insurance managers to connect. We aim to strengthen and enhance the culture of risk management by creating opportunities for education and dialogue within the community. We aim to strengthen and enhance the culture of risk management by creating opportunities for education and dialogue within the community.

For more information on PARIMA and its activities, please visit http://parima.org/.

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MARSH & McLENNAN COMPANIES (NYSE: MMC) is a global professional services firm offering clients advice and solutions in the areas of risk, strategy and people. Marsh is a leader in insurance broking and risk management; Guy Carpenter is a leader in providing risk and reinsurance intermediary services; Mercer is a leader in talent, health, retirement and investment consulting; and Oliver Wyman is a leader in management consulting. With annual revenue of $13 billion and approximately 60,000 colleagues worldwide, Marsh & McLennan Companies provides analysis, advice and transactional capabilities to clients in more than 130 countries. The Company is committed to being a responsible corporate citizen and making a positive impact in the communities in which it operates.

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Marsh & McLennan Companies' Asia Pacific Risk Center addresses the major threats facing industries, governments, and societies in the Asia Pacific Region and serves as the regional hub for our Global Risk Center. Our research staff in Singapore draws on the resources of Marsh, Guy Carpenter, Mercer, Oliver Wyman, and leading independent research partners around the world. We gather leaders from different sectors around critical challenges to stimulate new thinking and solutions vital to Asian markets. Our digital news service, BRINK Asia, keeps decision makers current on developing risk issues in the region.

For more information, please email the team at contactaprc@mmc.com.

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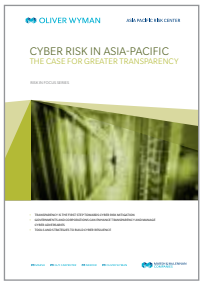

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