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Credit risk measurement technology trends

Charting the course from legacy issues to strategic solutions

Risk Advisory

Contents

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Executive summary

Regulatory challenges are forcing firms to re-examine the cost, efficiency, sustainability and transparency of their risk management requirements. Technological change can address these challenges by optimising the end-to-end credit risk management process. This will give firms a firmer grasp on risk and allow firms time to focus on optimising their business and future pipelines.

There is a new sense of urgency in the market to reconsider the technology platforms used to manage credit risk. This is not only driven by the increased analytical complexity associated with regulatory and accounting requirements; but also by a recognition that banks and building societies (firms) need to keep up with the increased pace of innovation. Cost is also an important consideration; legacy infrastructure often creates an unnecessary overhead.

Firms are asking: "How do I migrate to a fully open-source (OS) platform and cut the significant costs incurred from proprietary software vendors?"

In reality, this question is much more complex. Such a strategic change in the underlying technology platform directly impacts the operating model of the credit risk function, affecting people, process and strategy. The resulting impact leads to a larger set of questions, with important considerations that should be explored as part of the decision.It is rare that any platform will be completely open-source or proprietary, and in reality most platforms fall into some hybrid category, where the strengths of OS are combined with commercial support packages.

The outcome of this debate will create transformation across the industry. Hence, we set out to explore the technology strategies firms are currently exploring in the UK and European market.

The open-source vs proprietary debate

Before diving into more detail we define the three general software paradigms below:

- **Proprietary software:** Software where there is no access to the source code and rights to the use of the software is owned by an individual or company that may restrict its use.
- **Hybrid open-source software:** Software where some of the code is covered by an open-source licence and some of it is not. This is typically a combination of proprietary and OS software, but can also be OS code sold and managed by a third party.
- **Open-source software:** Software where the underlying source code can be used without paying a licence fee and external parties can contribute to the software by adding capabilities.

Typically larger firms use proprietary software, licenced through vendors such as SAS, FICO, WPS or Moody's to develop, maintain and execute their Credit Risk Models. Smaller firms have continued to rely on spreadsheets and in-house developed code – an early form of open-source. However, in recent years open-source software has become more ubiquitous in the credit risk industry.

Overview of the survey

We spoke to experts from a range of different firms, from new digital challenger banks to large multinational banks.

Our survey identified five credit risk technology trends:

1. Strategic platforms are geared towards cost management as opposed to cost reduction
2. Sound data management has never been more important
3. Credit risk functions are looking to establish central model factories
4. Technology change is driving operating model and resource profile change, but not necessarily headcount reduction
5. Credit risk functions need to rethink their aversion to cloud deployment and managed services

In order to unpack some of the concepts discussed, we researched the credit risk technology platform options and the resulting case for change. Supported by a survey covering:

- The future credit risk technology strategies;
- What OS Proof of Concepts (POCs) have been explored;
- What credit risk technologies they are exploring as part of their future platform; and
- What the current credit risk technology platform is.

Technology change is inevitable

Technological innovation opens the door to more and better insight, at a lower cost. However, in order to access this value, accurate data is required, as well as the processing power to analyse this data. Furthermore, for regulatory and accounting models and processes, robust controls and governance need to be embedded in the end to end reporting process.

Our respondents overwhelmingly agree that some form of technology change is required. As part of this change there is also a need to break the current silos and establish integrated risk measurement platforms.

Whilst there is no one size fits all approach to credit risk technology platforms, our conversations highlighted some compelling considerations that should be taken into account when setting the vision and strategy for any future technology stack.

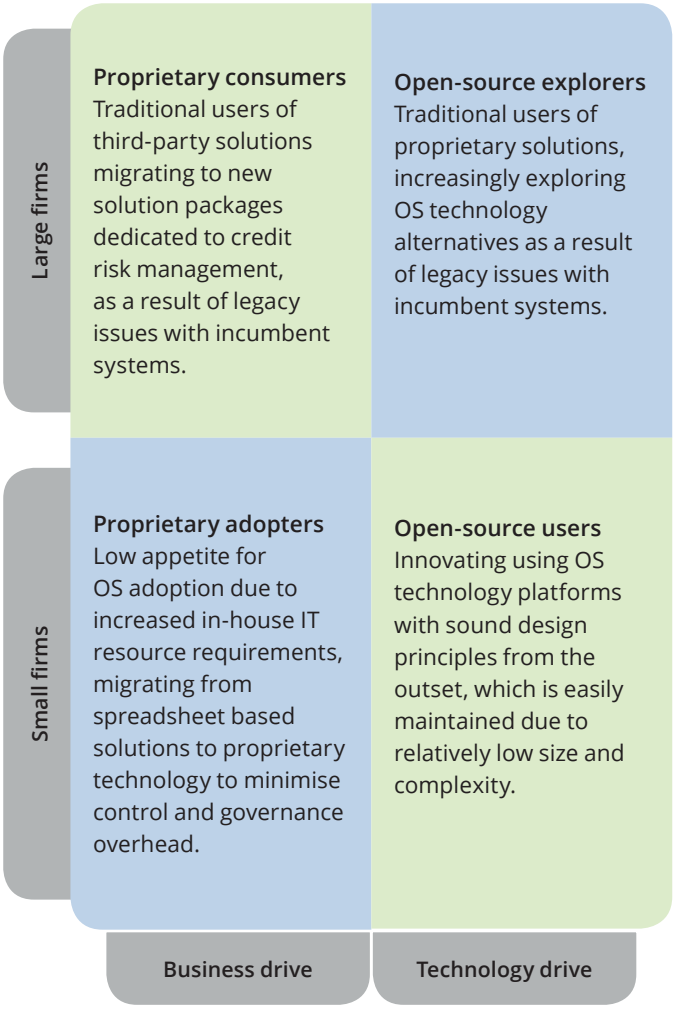
Open-source vs proprietary software

In many ways, OS software is seen as the new kid on the block, but these solutions have been used in the credit risk community for a long time. The increase in interest in these tools is mostly driven by the easy access that the OS community gives to advanced analytical approaches through a variety of packages.

Although there is a lot of talk in the industry about exciting new tools such as R and Python, which are both OS programming languages with a large community. However, few firms have explored production level use of these tools through POC exercises. Based on our discussions it would seem as though most firms are looking to adopt the use of these OS tools for model development.

However, when it comes to model execution and reporting, firms realise the benefit of new proprietary (i.e. third-party) solutions which can often provide the required controls and governance out of the box. Some of our respondents are, however, successfully using code based solutions built on OS tools.

Figure 1



What is driving firms to look to open-source?

Some of the respondents to our survey are major OS advocates. They all have different views in the debate, but we have summarised the three main talking points below:

1. Proprietary vendor solutions are not necessarily tailored to their individual needs.

2. Proprietary solutions create a dependency where you have minimal influence unless you are "the most important customer" and there is little room for negotiation in the licensing models.

3. There is a general feeling that software salesman "oversell, overpromise and then at the end under-deliver", where OS gives the flexibility to "take back control" of their platforms and benefit from the flexibility.

Which begs the question, are traditional vendor approaches to sales, marketing, relationship management and delivery acting as a catalyst to move to OS?

Five technology trends essential to your credit risk technology strategy

1

It's not always about cutting cost, but rather yielding wider benefits...

Firms are open to the fact that a technology upgrade may not result in direct cost reduction (and in some cases it is actually expected to increase the cost). However, the benefits anticipated from the new technology stack is expected to outweigh this increase in cost.

Trend 1:
Strategic platforms are geared towards cost management as opposed to cost reduction.

2

You can (and have to) get the data right

A central theme in our discussions was a recognition of the importance of data management to improve the quality of analytical insight. In the end, a model and risk report is only as good as the data you feed it, and the old adage applies "rubbish in, rubbish out."

Trend 2:
Sound data management has never been more important.

3

Containerising and creating a shared economy creates efficiencies

The rise of Application Programming Interfaces (APIs) is a hot topic across the industry. Moving towards an integrated platform that uses a de-coupled and containerised architecture, allows firms to establish central teams of specialised analytical resources that are shared across functions, which in effect becomes a model factory that services the business.

Trend 3:
Credit risk functions are establishing central model factories.

4

Resource profiles and operating models are changing

Removing manual inefficiencies through improved technology and increased automation will impact operating models without a doubt. However, not all firms are expecting this to reduce headcount within credit risk. It is rather expected that resource profiles will change.

Trend 4:
Technology will change operating models and resource profiles, but heads won't always roll.

5

Resistance to the cloud is futile...

There is still an aversion to cloud or alternative deployment models for credit risk calculations. There is, however, a misconception of the risk of cloud based deployment strategies. The firms who have already adopted such approaches are reaping the rewards.

Trend 5:
Credit Risk functions will need to rethink their aversion to cloud deployment and managed services as it can deliver tangible benefits.

How can we help?

Deloitte has unparalleled technical knowledge, breadth and depth of experience in the area of risk modelling, risk and capital system implementation and operating model change. We are uniquely placed to work together with clients who are interested in better understanding the benefits of a strategic change in their current risk operating model. Drawing on our deep technical expertise in both modelling and infrastructure configuration we can offer you a seamless and cost efficient service that meets the needs of your business.

Five technology trends essential to your credit risk technology strategy

The cost conundrum

Strategic platforms are geared towards cost management as opposed to cost reduction

More than 80% of respondents have a strategy in place to change their incumbent credit risk technology infrastructure.

Not surprisingly, one of the main drivers of these strategies is cost. However, when asked whether costs were expected to change over the lifetime of the solution, 65% of respondents said they expect the cost to either increase or stay the same.

This suggests that cost management is a greater priority than cost reduction. In the context of a credit risk technology infrastructure we define these as follows:

- **Cost management:** The long-term focused strategic management of costs. This is not price focused, but rather capability focused recognising that technology can yield wider benefits improving the competitive position of the organisation.
- **Cost reduction:** The short-term focused reduction of cost. This is price focused, with the aim of realising quick savings. Existing technologies are replaced by cheaper alternatives or increased automation is used to deliver headcount reduction.

For firms seeking to reduce cost an OS driven strategy may not necessarily be the right answer.

Cost considerations of open-source solutions

There is a perception by some in the market that OS is free. However, there are critical questions that need to be answered before choosing OS programs. One of the most difficult to answer is "what is the cost associated with developing and maintaining the solution in line with business requirements?" We investigate these considerations in more detail in Figure 1 below.

Flexibility and speed of delivery

Another key driver is flexibility and speed of delivery. In recent years, firms have been playing catch up in a regulatory environment that was constantly changing. As a result, respondents are now looking to implement solutions that are flexible and agile enough to quickly react to new regulatory changes.

Firms are taking active steps to future-proof their technology architecture:

- Implementing an integrated end-to-end platform supported by a single data structure;
- Removing manual inefficiencies through automation; and
- Designing a decoupled architecture that is API driven.

Such platforms not only support the flexibility and speed of delivery requirement, but are expected to support active cost management.

Figure 2: Open-source cost considerations

Headcount cost/average cost per FTE

- Difficult to recruit resources with the required skills as demand outstrips supply
- Attrition is apparent with regard to newly upskilled resources

Licence cost

- Significantly lower than vendor solutions
- OS licences would leave the firms free to use the software as per their requirements
- OS licencing structures can be aligned to business needs

Process/BAU cost

- Difficult to determine as it is largely dependent on the quality of the initial build
- Depends on the extent to which the end to end process is automated, thus removing the need for expensive specialist IT resource

Maintenance cost

- Difficult to determine as it is largely dependent on the quality of the initial build and how this aligns to requirements
- Cost can be highly variable

Integration cost

- Credit risk technology platforms will typically be built up of various applications
- OS tools are typically API friendly and integrate easily with one another (if well designed)
- OS tools can be less challenging and time consuming to integrate than the third party alternatives

Configuration cost

- OS tools gives the organisation more flexibility to configure the tool to their specific business needs
- Increased configuration effort is expected, which can be costly if the configuration effort is not properly managed

Key: High | Medium | Low

The biggest asset is data

Sound data management has never been more important

In the majority of our interviews, respondents talked about the importance of data management. The primary focus is to increase automation and improve data lineage so that less time can be spent on managing data. This is also driven by the introduction of important regulatory requirements such as BCBS 239.

Over recent years we have seen a rise in the data economy and firms have recognised that data is one of their biggest assets. However, historically data management has been poor and as a result credit risk teams spend more time managing data as opposed to producing meaningful insights.

Data management issues

Some of the primary issues associated with data management, that firms are now trying to address, are:

- The propensity to only initiate data collection of a specific attribute based on the immediate need;
- The poor quality of data† and a lack of ownership;
- The tendency to apply tactical fixes to data errors downstream rather than strategic fixes at source;
- The lack of a single data dictionary resulting in a misalignment of data used across the firm; and
- The barriers to accessing data across the firm.

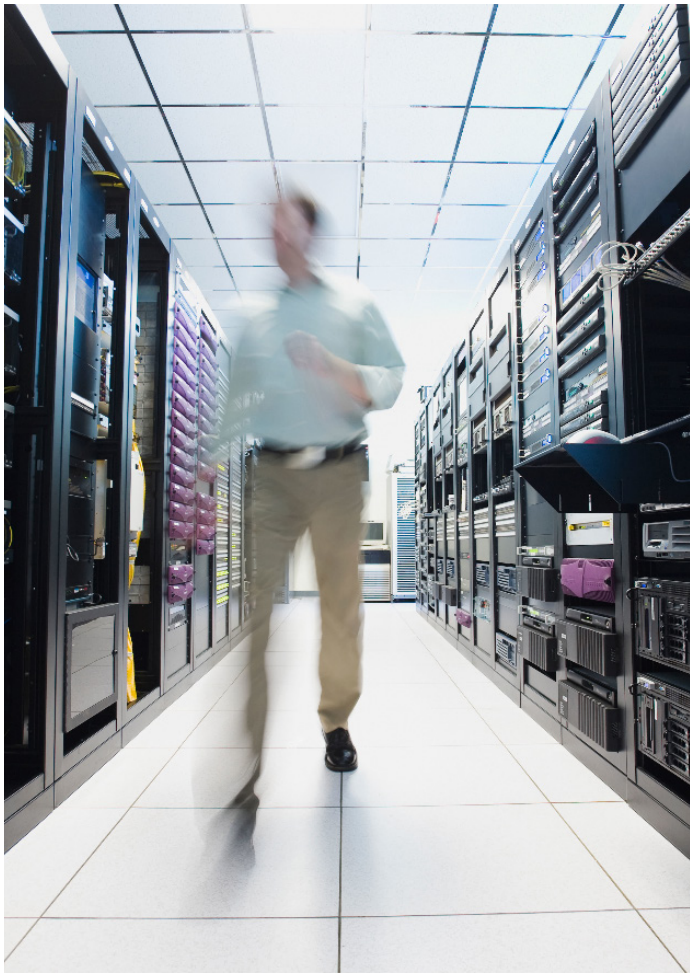
Nearly all of our respondents expect the new credit risk architecture to support the end to end management of data. Note that this is not owned by credit risk, therefore wider integration is required.

Whilst firms are at different stages of addressing their underlying data issues, one of our respondents in the Nordic market is on the verge of completing a major risk and finance transformation that will create data consistency across the firm.

Main success factors

The success factors to a successful data change programme are:

- Obtain business wide buy in and involvement of stakeholders from all business areas (risk, finance, treasury, and operations) at the outset;
- Establish a robust change programme with end to end project governance at the outset of the programme;
- Define project and data owners who are accountable for delivery; and
- Acquire access to skilled resources, sourced from various global locations (and come at a premium).

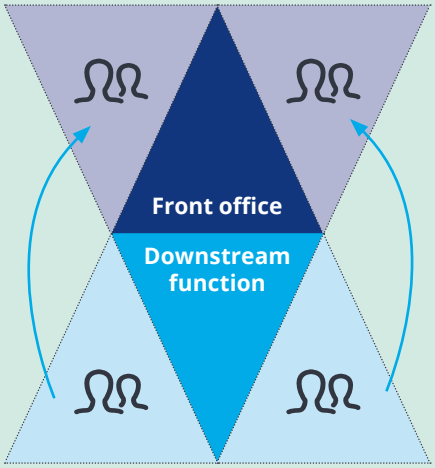


Data decoupling

The transformation programme, referred to previously, is built on the principle of data decoupling. The programme involved a complete strategic revamp of all risk and finance systems, moving to a single data infrastructure.

The strategic objective was to break all silos in the firm and develop a decoupled infrastructure where the engines are separated from the data (creating a modular structure). The risk and finance engines then pick up the data through APIs. At the end of the programme the firm will have broken down all silos (front to back office), migrating to a single infrastructure. This is illustrated in Figure 3.

Figure 3: Inverting the pyramid



Data quality is pushed upstream to the front office, removing the need for additional data management resources downstream.

Data is the biggest asset

Decoupling the data from the rest of the infrastructure, moves all data management to the front office, which takes full ownership of the data. Data stewards are appointed in the front office who are then incentivised to make sure that accurate and complete data is captured.

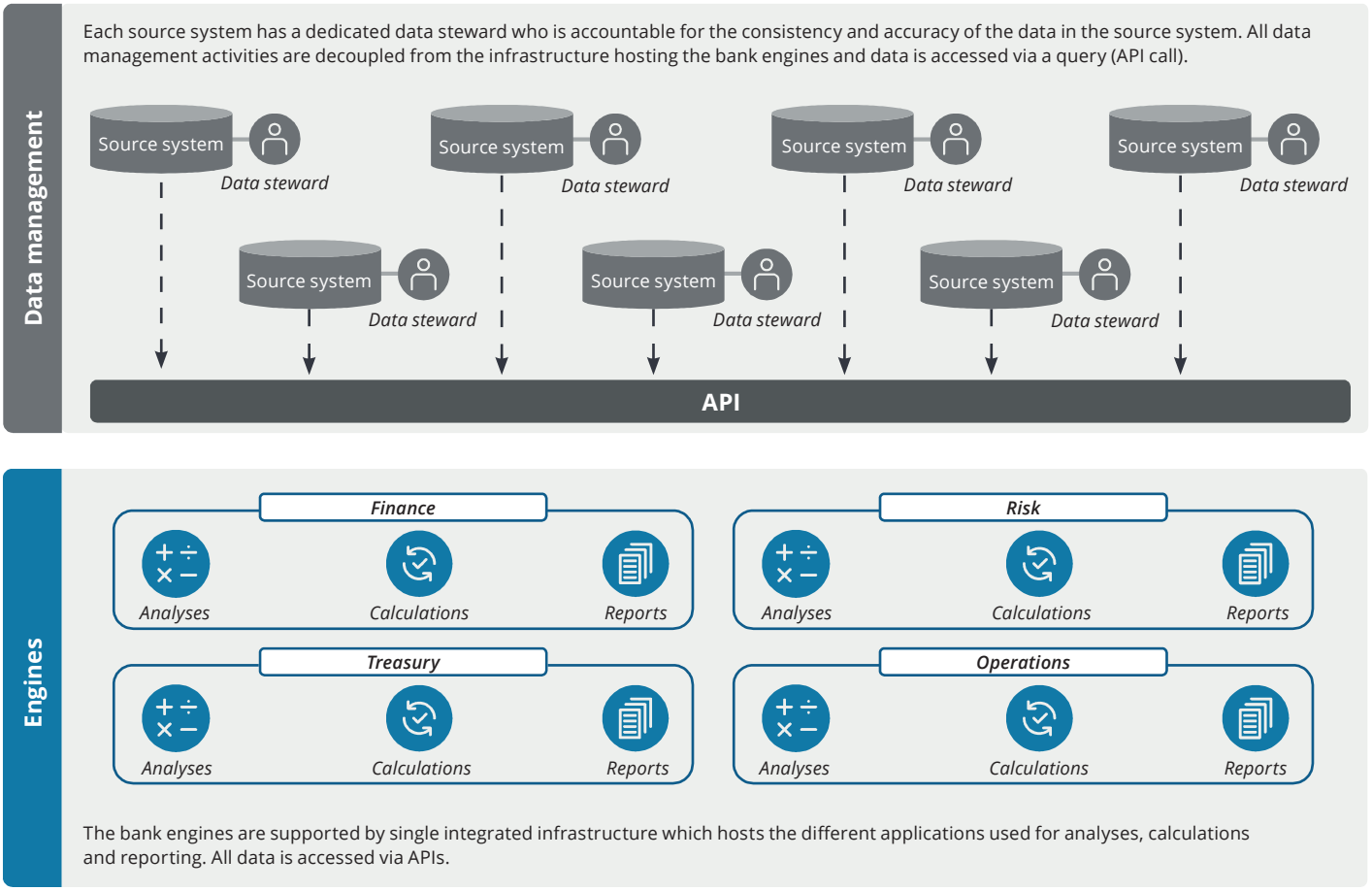
As a result, the front office is now in a position to service downstream data consumers. Prior to this change programme downstream functions spent 80% of their time on data cleansing. Now these resources focus on full time data analysis.

This has resulted in data management resources being diverted from downstream functions to the front office, where the data is owned. In essence this programme has therefore inverted the traditional pyramid.

Note that it took the bank in question 12 months to establish business buy in and project governance, which we recognise as a key success factor which is often overlooked.

† Note that the data challenges for model development and model execution teams are different, where the former depends on a rich and accurate data history to develop insightful models and the latter needs a well controlled process and data lineage for the execution of models.

Figure 4: The decoupled infrastructure



Talking point: Does bank size change the open-source vs proprietary software debate?

As highlighted by a respondent: "*… there's a threshold of size and complexity where you can get away with a more code managed solution. For smaller banks, like us, the flexibility benefits outweighs the need for cumbersome systems. However, setting the design principles at outset is fundamental for a code based solution and we do see data collection as the area that may be a pressure point, where a living data dictionary is a must. Small banks have an opportunity to leap forward through efficient and strategic use of technology where big banks are constrained by legacy IT.*"

Based on our discussions, it is clear that the legacy IT systems used by larger firms are difficult to migrate to a predominantly code based solution developed in OS.

Smaller firms are often better equipped to implement code based solutions. This is not only due to the cost benefits, but also as a result of the increased agility, smaller scale and lower complexity that may give them a competitive advantage. However, as the bank grows, the need for better controls and governance processes increases.

Vendor solutions provide the required controls and governance out of the box, removing the need to build from scratch. *"We acquired a vendor solution as we were no longer comfortable with the amount of model risk introduced by our code based implementation."*

The client in question embedded controls and governance through technology, which led to a less bureaucratic environment which was dependent on manual controls.

Naturally controls and governance can also be embedded in code based solutions developed in OS. This just requires robust design principles to be in place as well as access to skilled resources who know what the key risk areas are and how to appropriately mitigate them.

One parting thought: as vendors provide functional requirements out of the box, certain areas will always be more cost effective to acquire through a third party (e.g. capital calculations or regulatory reporting). However, depending on the organisation's strategy, code based solutions may offer a competitive advantage.

The shared economy of modelling expertise

Credit risk functions are looking to establish central model factories

One topic that came up in some of our conversations was the idea of model factories. This is generally aligned to the concept of data decoupling that was discussed previously.

The model factory

Firms are taking active steps towards establishing a centralised team of modelling resource. The vision is that this team will service the firm's analytical needs and manage/maintain all models used by the firms central functions. It is expected that the central modelling team will use a common framework to develop, implement, and maintain models. These models will then be made available to model consumers in the bank through APIs.

The central team of modelling resource then turns into a so called model factory. The model factory is illustrated in the figure below and works as follows:

1. All modelling requirements (business and regulatory) are submitted to the model factory that prioritises the required model development activities.
2. Based on the functional requirements the central modelling team will develop, document and implement the models in line with the firms policies and procedures subject to independent model validation.

As a central team is used to manage all modelling activity, it is expected that a consistent standard of development, documentation and implementation will be followed. Firms will benefit from potential people synergies as modellers are grouped together, with business analysts providing a link to the business.

3. The data architecture is maintained separately and the model factory needs access to consistent and accurate data.

As discussed in the previous theme, data decoupling removes the need to resolve data issues downstream. As a result less time is spent on data cleansing and more insightful models can be produced at a faster rate.

4. Once models are developed they are implemented as independent modules inside the firms systems; these models are listed in the central model library.

Note that the modelling and implementation teams are two separate teams. This is regulatory best practice and helps to reduce the model risk attributed to implementation error.

5. Model users can access and execute models in the model library through an API.
6. Models used in batch execution processes are called through the same API.

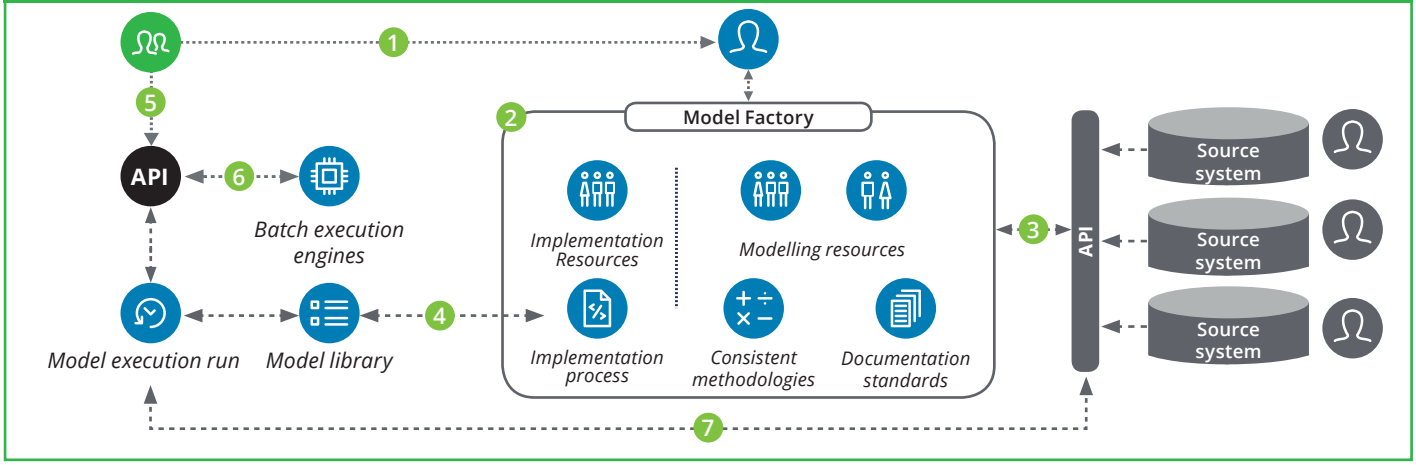
As the model library is owned by a central team, model users are guaranteed to use the most up to date model for any calculations.

7. When an API is called, triggering a model execution run, the model library calls data source API, to retrieve the required data.

This approach is expected to deliver strategic benefits, such as:

- Consistency across methodologies, implementation and documentation as common approaches are used across the bank;
- Speed of delivery of models as resources are familiar with the data; and Greater concentration of expertise.

Figure 5: The model factory



People and operating models will change

Technology change is driving operating model and resource profile change, but not necessarily headcount reduction

The vast majority (90%) of our respondents recognise that a change in technology infrastructure will affect the operating model. It is surprising that respondents expect automation to drive the largest scale of change and not architecture. Another unexpected finding is that less than half of respondents expect changing the technology architecture will deliver headcount reduction.

Increasing automation and consolidating technology platforms will certainly reduce the amount of time (and resources) required to perform certain tasks. Certainly one way to reduce cost is to then remove the people who are no longer required to complete these activities.

The risk function as a utility

Despite the increase in the volume of regulation and availability of new technologies and methodologies, the credit model risk functions continue to complete repeatable manual processes (whether build, validation or implementation). This offers the potential for standardisation with competitive advantage driven by greater automation and fewer manual interventions.

Firms are investigating how greater collaboration (e.g. via an internal or shared utility) could reduce costs and free up staff to undertake more productive purposes, such as analytics that support portfolio management.

Diverting resources

However, firms see technology change as an opportunity to transform the operating model; diverting resources to value add activities focused on analytics and insight.

"Risk is currently a cost function and can't deliver value add activities due to systems challenges... the risk function is reactive, focused on controls and regulation as opposed to using analytics to challenge the business and put ideas on the table."

The changing profile of resources

Respondents are looking to recruit resources with strong data analytics capabilities. However, it is clear that the focus is shifting away from just the technical; *"Interpretation skills will become more important and we require people who can handle conversations such as model 'explainability'."*

Figure 6: Purple people

Source: Deloitte Insight Driven Organisation survey (April 2017)

Within risk functions (and potentially the wider business), there is a need for resources (or teams) who are able to ask the right business questions, interrogate and model data to answer them, and then present the insights in a compelling way. These are referred to as "purple people".

Agile and DevOps

Our survey highlighted a feeling that "technology is innovating faster than business can keep up". However, organisations see agile project management and DevOps processes as a solution.

Implementing new operating models that support technology change is, however, a challenge. Where respondents expressed that the *"maturity of business adoption is the constraint, not the technology"*. This is often due to a lack of understanding of how agile differs from traditional waterfall based approaches, and how DevOps is not just a process but a methodology that needs to be aligned to an appropriate technology architecture.

Resistance to the cloud is futile

Credit risk functions will need to rethink their aversion to cloud deployment and hosted managed services

Only 35% of our respondents expect to deploy elements of the credit risk technology stack on the cloud. There is still an aversion to outsourcing certain capabilities to hosted managed services providers. The primary concern with regards to a cloud deployment is data security, respondents also voicing regulatory concerns.

Addressing cloud concerns

The EBA recognises that cloud computing is an important technology leveraged by financial institutions to deliver innovative financial products and services; and has set out supervisory expectations on outsourcing to cloud service providers in EBA/CP/2017/06.

These recommendations intend to clarify regulatory expectations relating to cloud computing, to allow firms to leverage the benefits of using cloud services, while ensuring that any related risks are adequately identified and managed.

In a nutshell, the scalability and agility benefits offered by cloud solutions allow firms to cut costs and innovate faster than ever before. This is why most up-and-coming retail firms are purely cloud based and no longer have any core physical infrastructure.

Cloud can offer improved infrastructure with stronger levels of protection than most firms current architectures, the only difference is that it is in a different location (with the added benefits around scalability), see Private Cloud in Figure 7. Some of the largest firms in the world are currently migrating to the cloud and are comfortable with hosting compliance data. Migration is inevitable and firms who fail to adopt cloud services can expect to be left behind by more nimble rivals.

Adoption of managed services

The idea of using managed services (effectively the outsourcing of internal processes) has been around for ages; and the adoption of thereof is also becoming more prevalent in the banking industry. As the use of managed services increase, firms (and regulators) are becoming more comfortable about the use of these delivery models.

In the Nordic market for example, one of the large lenders processes the impairment calculations for the majority of the savings firms in the region. In the UK there are also examples where third party companies offer similar services.

Deloitte's Managed Risk Services (MRS) is an established centre of excellence in leading the development and implementation of a portfolio of managed services which take on transforms and runs critical components of clients' risk, compliance, regulatory, technology and legal functions.

Benefits of alternative deployment models

The question is, how can managed services and cloud deployment deliver improved outcomes?

Scalable: The service/architecture can be scaled up or down depending on your requirements.

Outcome based pricing: The cost model is based on the outcomes of the service.

Agile: Flexible service models and scalable infrastructure makes it easy to respond to change.

Sustainable: The service fulfils an ongoing requirement rather than a one-off need.

Resource safeguarding: The service reduces BAU resource cost base and attrition risk.

These are but a few of the generic benefits of these alternative deployment models and depending on the functionality of the service or cloud architecture, more specific benefits may be realised.

Figure 7: Unpacking the cloud

Cloud types

Private
Extension of own network dedicated cloud infrastructure.

Public
Accessible on internet but secured to firm or service provider.

Community
Accessible on internet but secured to a community of firms.

Cloud services

Infrastructure as a Service (IaaS)
Provides a managed hardware stack to run the user's software (e.g. a server).

Platform as a Service (PaaS)
Provides managed computing functional capability as a resource (e.g. a database).

Software as a Service (SaaS)
Provides managed applications on demand (e.g. a credit risk application).

Managed Services — *Managed Service providers (e.g. Deloitte MRS) can provide third party services through any of the aforementioned channels.*

Credit risk technology change is inevitable

1

Strategic platforms are geared towards cost management as opposed to cost reduction

Firms are at a cross road where they need to rethink the cost, efficiency and sustainability of their approach to credit risk management. Regardless of whether the organisation is confronted by short term cost pressures or is considering long term strategic investment, some form of rational design needs to be applied to make sure that the platform delivers the business vision. The only way that such a vision is successfully delivered is through strategic transformation which has business buy-in and strong programme governance from the outset.

2

Sound data management has never been more important

Firms have a short window of opportunity where they can gain a competitive advantage from the wealth of data that they capture on customers. In order to do this, they will need to address data issues head on, establishing a robust architecture placing the responsibility for data quality firmly at the point of origination.

3

Credit risk functions are looking to establish central model factories

There are tangible benefits to establishing central model factories and firms are already moving in this direction. Model factories will lay the foundation for the collaborative consumption of value add third party services such as model development and model validation. The natural evolution to such a shared economy will drive innovation and standardisation across the industry helping firms to cut cost and focus on portfolio growth.

4

Technology change is driving operating model and resource profile change, but not necessarily headcount reduction

Technology changes are required to facilitate organisational change. One of the greatest challenges with such change programmes is that technology change is rapid, whereas changing an organisation is hard and slow, especially if this requires changing the skill sets in your resource base. One of the greatest challenges is to have a vision of future resource requirements before the new technology is implemented and in use. This further emphasises the importance of a robust change programme and establishing a programme with full buy in to the strategic objectives at the outset before any technology is implemented.

5

Credit risk functions will need to rethink their aversion to cloud deployment and managed services

The cloud is the future and will allow firms to focus on their role as a bank or building society rather than being an IT provider. Firms need to overcome misperceptions regarding the regulatory and security risk of the cloud and include this technology as part of their strategy. The cloud and managed services will not only play a big part in the shared credit risk modelling economies of the future, but also in all firms' end-to-end technology platform considerations.

Appendix 1

Credit risk management systems and the case for strategic change...

Setting the scene

Breaking down credit risk management platforms

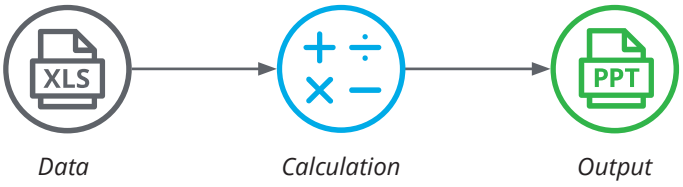
In the modern era firms depend on an array of sophisticated models to support decision making. Credit risk models originated from the need to make lending decisions more efficiently and consistently before being embedded in end to end risk quantification across the firm (e.g. to quantifying the amount of capital required across a bank's risk taking activities).

Credit risk models are now used in all aspects of the lending process. From a financial perspective credit risk models are primarily used to measure:

1. Capital requirements;
2. Impairment provisions; and
3. Forecasting and stress testing.

Regulatory requirements aside, the principle objective is to develop better ways to understand the business through analytical decision making. This requires access to accurate data, as well as a way to utilise that data to build insightful models. This enables firms to make informed decisions based on the output of the models.

Figure 8: Modelling in its simplest form



In the simplest form data can be collected in spreadsheets. The quantitative estimates can then be developed into models in the same spreadsheets and the models are executed on these spreadsheets. Finally, results are communicated through presentations on which firms can make decisions.

In practice, however, it is not always that simple. Typically the source systems that capture the data are complex and dedicated solutions are required to extract data for analysis. The size of portfolio datasets (especially for retail portfolios, which can contain millions of accounts) are too large for spreadsheets, and databases are required.

Furthermore, in order to exploit sophisticated modelling techniques, code based solutions are required to support the development of models. In order to execute these models in a timely and controlled manner, a robust model execution tool needs to be in place. Finally, using spreadsheets and presentations to report results is manual, and therefore prone to operational risk – introducing the need for greater controls or more automated solutions.

More effective use of technology supports the efficiency of the end-to-end process across:

- Data collection;
- Model development and implementation;
- Model execution;
- Model governance; and
- Reporting.

Note that the model developer needs to have access to all useful data characteristics (the long list) and then select the model (from a short list). This separates model development (long list) from model execution (short list).

Another key consideration is model risk (see extract from SR11-7 below). The end-to-end process needs to minimise the risk of error arising from data collection, model development and model implementation.

Finally, we summarise two key areas of consideration with regards to the implementation of models:

1. Model efficiency:

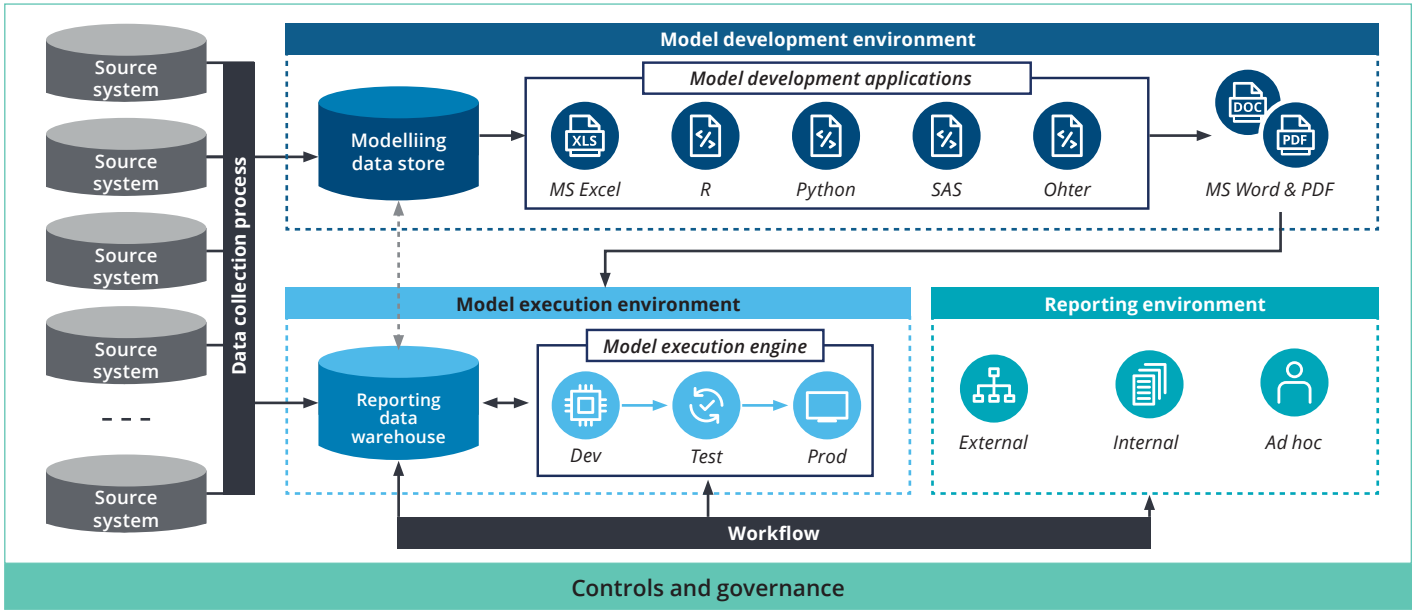
- How much effort will the model take to maintain?
- How long does the model take to generate outputs for users?
- How long does it take to implement updates to the model?

2. Model implementation risk:

- How is the model implementation controlled to reduce errors?
- What is the extent of functional and user acceptance testing?
- How do we guarantee appropriate use of models?

> ***Models typically are embedded in larger information systems that manage the flow of data from various sources into the model and handle the aggregation and reporting of model outcomes.*** *Model calculations should be properly coordinated with the capabilities and requirements of information systems. Sound model risk management depends on substantial investment in supporting systems to ensure data and reporting integrity, together with controls and testing to ensure proper implementation of models, effective systems integration, and appropriate use.*
>
> **- SR Letter 11-7 (Supervisory guidance on model risk management)**

Figure 9: Credit risk architecture at a high-level



In the figure above, we illustrate the conceptual architecture of a sophisticated credit risk technology platform (note that there is not a one size fits all approach). In this architecture the various components are independent modules. However, the platform as a whole is fully integrated. Let's consider these components in more detail.

Data collection

The data collection process supports the gathering of data from the firm's various source systems to enable:

i. the model development process, and

ii. the model execution process.

As part of the data gathering, remediation is typically applied to certain data fields which may be new requirements as part of changing regulation. Data is stored in various data warehouses, in the simplest form, a modelling data store and a central reporting data warehouse.

Model development

The model development environment supports the development of models and needs to contribute to key model development activities. This environment primarily supports the investigation of data to identify the correct modelling methodology. This includes the selection, preparation, exploration, and transformation of data sourced from the modelling data store, as well as the calibration of model parameters and subsequent validation and monitoring of developed models.

One fundamental element of the model development process is that the environment should be transparent, and include model version control in order to support the appropriate documentation of models.

As this is an exploratory environment, it isn't necessarily confined to a single model development programming language. It is also important to note that model execution scripts are not necessarily developed in the model development environment.

Model execution

The model execution environment embeds models in the firm's information systems, using monthly reporting data. At a minimum, this needs to be a robust and controlled environment that is transparent and auditable. It should also incorporate a clear implementation process which includes end-to-end testing of models before they are put into the firm's production system.

In order to make the process around the implementation of code, more agile and robust; firms are looking to implement DevOps type processes. See the previous section for more info.

Note that the underlying programming language is not necessarily the same as in the model development environment. It is also good practice to have two separate coding languages for model development and execution, as this forces a scripting process and reduces risks associated with copy and paste.

Reporting

The reporting environment supports three areas:

1. External reporting to regulatory authorities and investors;
2. Internal reporting to decision makers (e.g. downstream finance); and
3. Management information and additional analyses to support decision makers.

It is often challenging to evidence first reconciliation to the firm's general ledger. Traditionally this can be an intensive manual process especially if plagued by upstream data issues.

Different platforms for credit risk areas

The manner in which these systems have developed over the years has often led to independent silos being built for capital, impairment, stress testing and forecasting. The functional components are, however, largely the same for the different areas responsible for producing credit risk estimates.

Breaking the silos

The case for a strategic credit risk technology environment

How did we end up with fragmented silos?

Time and time again, in an attempt to comply with new policies and requirements, firms have added models, people, applications and processes to existing operations creating new functions. These were often stand alone tactical fixes, designed to merely meet the deadline in question (the most recent example of such a change is the IFRS 9 impairment standard).

Silos has hampered delivery and prevented any sense of strategic implementation and most firms will admit they make do with a mixture of irreconcilable systems, data feeds, and interfaces to support the different credit risk demands. As a result additional checks and controls are required in an attempt to manage the incremental risk as a result; all at real business cost.

While understandable, the tactical approach leads to significant operational and compliance risks, as well as costly inefficiencies. These challenges more importantly, rob management of the ability to fully understand the commercial impact of the underlying regulations.

Enabling strategic transformation

The only way to tackle increasing costs and reduce the growing operational and compliance risks in the long run, is to apply some rational design (and strategic investment in technology) to the process.

More and more firms are embarking on strategic transformation programmes to tie their risk analytics more effectively into their overall systems design. The aim of these programmes is to create synergies between analytics and wider business requirements (e.g. improving the speed to market of credit risk models to enable better capital management). These change programmes are not limited to any specific function and cover multiple functional areas such as Front Line, Portfolio Management, Finance and Risk (Capital and Impairment Management, Risk Appetite, Stress Testing, Decision Science and Risk Strategy).

Technological and business model change

Firms aspiring to cut costs and simplify the compliance task should be investing in a single, coherent, high performance infrastructure. This means implementing a collection of tools and solutions, each fit for a specific purpose, and supporting integration with one another. As an example, imagine an environment where you can manage the end to end model execution process from a single tool that helps to orchestrate the different steps in the workflow. The orchestration tool interacts with your data warehouses, your model execution tools as well as your reporting tools through APIs (see the following page for more details on APIs). Where each tool is targeted to your specific business requirements and the platform, as a whole, supports synergies across the business.

In order to drive these synergies, the new platform needs built-in flexibility as it may need to be tailored to the requirements of each business function – and we shouldn't expect any let up in new regulation. The platform should also provide a more robust, controlled and governed environment, that allows you to evidence reconciliation and audit trails to supervisors. Here's where the single, coherent infrastructure helps. The use of an integrated orchestration tool creates a golden thread between applications in the end-to-end process. Furthermore, as the analytical complexity of modelling solutions increases and firms find better ways of estimating risk, any new technology platform should not constrain the firms capability to execute and deliver new models.

Moving towards such an environment is how firms can simultaneously cut costs, lower compliance risks and better pursue their business strategies. Quicker cycle times, greater automation and fewer manual interventions will save money and free up staff for more productive purposes, such as analytics and portfolio management. Furthermore, as each firm moves from a fragmented process to an integrated solution, the management time required to establish and undertake a plethora of checks and controls (e.g. complete reviews and create reports) will reduce.

To achieve these objectives, risk modelling methodologies, reporting requirements and infrastructure should be in complete alignment. This requires a robust change delivery programme, to allow firms to achieve their wider strategic objectives such as efficiency, digitalisation and employee engagement.

How bad can it get?

The traditional lifespan for a technology platform is shortening as the pace of innovation is increasing. This means that there is an increased need for regular software and platform upgrades.

In the past firms had the tendency to push technology platforms past their end of life. Once applications become outdated, then there is an overall increase in the operational risk. If these platforms are used to perform regulatory or accounting calculations this risk becomes very real.

There is a recent example of a UK bank that failed to properly maintain the technology infrastructure that hosted the firm's capital calculation engine. The technology platform was no longer being supported by a vendor transitioning to a new software stack. This created an operational risk which became so significant, that an executive decision was taken to temporarily switch off the capital calculation engine. This resulted in regulatory scrutiny and ultimately and add-on to Pillar 1 IRB capital requirements until the issue was addressed.

This is an extreme, yet recent, example of how technology mismanagement can have serious consequences. The fragmented nature of many firms credit risk platforms also makes the management of these calculation engines challenging.

One area of risk that particularly suffers from a fragmented risk infrastructure is stress testing. In the ideal scenario the stress testing team develops the balance sheet evolution model and then the stress testing engine will call out to other risk engines such as the capital engine and impairment engine using APIs. This allows the stress testing team to use the most up to date, approved models from other credit risk areas to create a solid and controlled foundation.

However, in many organisations the stress testing team does not have access to central APIs and they are required to recode the same models for stress testing purposes. This is not only inefficient, but also introduces model risk in that the stress testing team might not be using the most up to date model parameters.

Many firms are aware of these risks and recognise that more needs to be done to reduce the operational and compliance risks of these solutions. Therefore, a number of large firms are looking at credit risk technology optimisation and transformation programmes.

What is an API? And how does it work?

An API (or Application Programming Interface) is a mechanism which enables a structured interaction between two computer programmes. In other words, APIs are used to send requests and receive response.

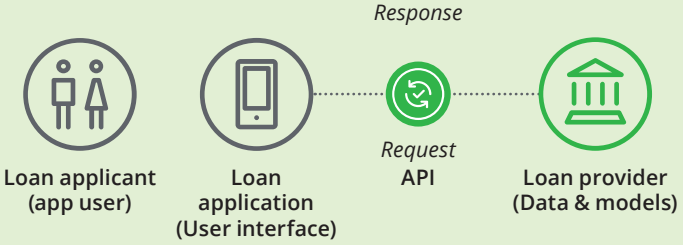
Consider the example of a loan application to the right; the loan applicant makes use of a mobile device (or personal computer) to submit the loan application. The firm uses an application (or app) to capture the required information to assess whether you are eligible for a loan. These inputs can be captured using a web-based application or an app on your phone.

The Loan Providers API allows the app to send the users details to the firm, who then processes the request and then sends back the response indicating whether the loan was accepted or rejected. The power of the API is that the app and the loan providers technology can be changed independently provided the API remains the same.

The user interface is how we interact with the application, in this example this is either the online loan application phone or your bank's mobile app. Therefore, the interface is how we communicate with the machine, but APIs also allows software application to communicate.

APIs are extremely useful as they:

- Facilitate the sharing of information assets;
- Enable seamless integration between different interfaces/ systems and workflow automation;
- Facilitate flexible, effective, and agile service delivery; and
- Enable digital transformation.



Appendix 2

Survey responses

Survey responses

Strategy

Credit risk technology change is high on the strategic agenda of firms across NWE, where our respondents are looking to improve the ability to make data-driven decisions.

Do you have a future vision for the Credit Risk Infrastructure?	More than **90% of firms have a future vision for the credit risk infrastructure,** and the majority of the firms aspire towards an integrated infrastructure.
Do you currently have a credit risk technology change strategy in place and what is the objective?	Not all firms have been successful in turning this vision into an objective. Over 80% of firms have a change strategy in place that affects the credit risk technology stack.
Not all firms have been successful in turning this vision into an objective. Over 80% of firms have a change strategy in place that affects the credit risk technology stack.	The top three drivers for strategic change are: 1. Managing cost; 2. Improving data management; and 3. Increasing the flexibility and speed to market of models. Other main drivers mentioned were: improving regulatory change management, improving model risk management, removing incumbent software limitations, and modularising the architecture.
How do you expect this to influence your operating model?	More than **90% of firms expect the change strategy to affect the operating model.** The main changes expected are: • Removing manual inefficiencies and improving governance through automation; • Improving data management with new processes and dedicated data management teams; and • Changing ways of working to DevOps and Agile frameworks.
Have you identified the capabilities your future credit risk tech will need to address?	The main capabilities identified by firms are: • Increase automation and improve data lineage so that less time is spent on managing data; • Support the faster pace of innovation and the use of more advanced analytics; • Provide a powerful user experience through an intuitive user interface; • Provide better documentation of the end to end system; and • Support governance and model management through robust controls and transparent workflows.
Is this a business led or IT led strategy?	• Over 60% of firms say that this is a business led strategy. IT led strategies are more prevalent in the newer challenger firms.
How have you future proofed it?	Two perceived threats to future proofing were mentioned: 1. Regulatory change; and 2. The pace of innovation. Firms are, however, taking active steps to future-proof their future technology architecture, such as: • Implementing an integrated end to end platform supported by a single data structure; • Removing manual inefficiencies through automation; • Designing a decoupled architecture that is API driven; and • Implementing an active environment management process with continuous maintenance and upgrades.

Proof of Concepts (POCs)

Whilst there is a lot of talk in the market about the potential benefits of OS software, not many firms have progressed to exploring this in a POC.

Have you tested the use of OS software through a POC within your credit risk function?	**Only 35% of firms have done a credit risk related POC using OS software.** Where two firms have tested OS software in other risk areas (e.g. Fraud).
Which area of credit risk did the POC cover?	All firms who tested OS software through a POC in credit risk looked at the use of machine learning for credit risk models. One respondent deployed their impairment solution using OS and the POC solution has now progressed to a production deployment.
What was the scope of the POC?	Firms who tested OS software **primarily used it for model development**, but one firm used OS software for model deployment and executing the monthly impairment process.
How long did the POC take?	The **duration of the POCs vary from two weeks to six months depending on scope.** The respondent who implemented the IFRS 9 solution took five months building an IFRS 9 R-engine, where the entire project took eight to nine months to develop the open-source API process. Furthermore, one of the smaller digital firms indicated that they would normally expect a new stand-alone technology installed and running on system within four weeks and configured within two months.
Was the POC regarded as successful?	75% of the firms who completed an OS POC regarded it as successful.
Have you progressed to a pilot or OS production deployment?	75% of the firms who completed an OS POC are looking to progress to a pilot or deployment.

75% of the firms who completed a POC using OS for credit risk regarded it as successful and are progressing to a pilot or deployment.

Future tech

Firms are at different stages of defining their future technology stack, where additional work is required to understand whether a change in architecture will require new tools.

What pain points do you expect will be addressed through a technology upgrade?	The main pain points the firms expect to address are: • **Resourcing challenges** associated with hiring and managing people; • **Manual inefficiencies** associated with more procedural processes as opposed to automated systems based implementations; • **Lack of auditability** and control in credit risk systems; • **Modelling constraints** around the use of advanced analytics due to data and systems limitations; • **Slow speed of model deployment and execution** time; and • **Lack of proper data lineage** and access to consistent data.
How long do you expect deployment of a new technology stack to take?	For larger firms the average deployment for a new credit risk technology stack is expected to take **three years regardless if the platform is OS or proprietary focussed.** The smaller digital firms however expect new platforms to become available in a period of two to four months.
Are you expecting to deploy on the cloud?	Only 35% of the firms currently expect to deploy elements of the credit risk technology stack on the cloud. The primary concern with regards to a cloud deployment is data security.
What additional risk mitigation techniques are you using in order to deploy your credit risk technology stack on the cloud?	Our firms provided varying views with regards to cloud migration, some key observations are: • One respondent indicated that they are currently developing an internal policy to deal with a potential cloud migration; • One respondent is in discussions with the regulator around using the cloud for the credit risk infrastructure; • One respondent indicated that there is no need for additional risk mitigation techniques as long as: data and transmission is secure, and disaster recovery is setup; and • Most firms are wary of migrating any personal client data to the cloud.
What skill sets are you expected to require for a new technology stack and where were will they sourced from?	The majority of the firms are currently looking to recruit individuals with strong data management, data analysis and data science skills. These resources are expected to have experience in agile was of working. 35% of our firms indicated that they are actively recruiting credit risk resources with R and Python skills. However, it was mentioned that these resources are challenging to recruit as demand outweighs supply. Another respondent also mentioned that they had success in internally training SAS resource to use R and Python, but then struggled with attrition.

> *We found it easy to train our skilled SAS resources to use Python... learning these new skills also engages the team... We did however have problems with attrition once resources added these new skills to their CVs.*

Was resource skills or training considered when looking at risk solutions? Were the skills readily available internally or did you have to go to market to recruit appropriate resource and was this easily achievable?	The majority of firms indicated that external recruitment isn't easily achievable and all firms are following an approach using internal upskilling augmented with contractor/ consultant resource. All firms are pursuing active graduate recruitment strategies supplemented with training. Additional observations include: • One respondent indicated that internal upskilling is successful as current resources are finding that it is easy to pick up Python programming skills from a strong SAS base. They are however experiencing problems with attrition after resources are upskilled; and • One respondent indicated that people are finding it difficult to adapt to agile ways of working.
How do you expect resource levels and cost to change over the life of the solution?	45% of firms expect the cost to increase, where 35% expect a decrease in cost and the remaining 20% expect costs to broadly stay the same. The majority of firms however expect resource levels to increase in the short term and then reduce again in the long run.
Do you expect the new technology stack to deliver a headcount reduction or remove the need for additional growth expectations or using expert resource on more efficient processes?	The firms are divided, and 45% expect an increase in headcount, 45% expect a decrease in headcount and the remaining 10% expect headcount to broadly stay the same. The firms expecting growth are primarily smaller organisations, who are developing their risk management capabilities, while larger players are expecting the technology change initiative to deliver headcount reduction. On the point of automation, some firms indicated that automation is not expected to outpace the increased need for regulation. Therefore, staff who are freed up through removing manual processing inefficiencies are expected to be diverted to value add activities.
What's your migration strategy? i) Big Bank ii) Product by Product iii) Build and then scale up on servers?	The majority of firms (80%) expect a product by product migration strategy, and 20% expect to build and then scale. No respondents are pursuing a big bank migration.

Additional responses by OS adopters

What were the key reasons why an OS solution was chosen? What were the expected financial benefits and have they been realised?	The firms who adopted OS technology as part of their software stack indicated that: • OS languages such as R and Python are known by graduates, therefore less technical upskilling is required and internal training can focus on business content. • Traditional vendor approaches seem to over-sell on capabilities and under-deliver, therefore developing in house appears more cost affective, however, benefits have not been realised. • OS packages bring certain functionality faster to market than vendors can release, and the OS community can resolve issues quicker than vendor teams.
Why was a vendor not selected and what are the key expected benefits (have these been realised)? Would you make the same decision with the benefit of hindsight?	Most of the OS adopters currently rely on some form of hybrid implementation and none of the firms currently use a full OS software platform. Increased use of OS is however an attempt to reduce costs.

Current tech

What tools are being used in your current Credit Risk software stack?

The majority of firms currently use code based solutions for model execution (e.g. R or Base SAS), accompanied by lots of manual inefficiencies on the internal reporting side where model outputs are output into MS Excel and then moved into MS PowerPoint.

How long does the governance cycle take from the start of model development to implementation of the approved model?

The average governance cycle from the start of model development to implementation of the approved model can take between six and 60 months.

The majority of the time (up to 80%) is spent on data gathering and validation. Where model development and subsequent implementation can be performed in a month and two months respectively if all data is readily available and golden source.

Efficient organisations can develop a new model in three months, and implement the approved model in the infrastructure in the same amount of time.

Regulatory approvals can cause major delays (in excess of a year), however, implementation timelines for many UK firms do not wait on regulatory approval.

In our experience, documentation of models pre implementation can be reduced with use of new technology (such as Natural Language Generation or improved reporting tools).

How long does the periodic model execution cycle and what-of analysis take for implemented models?

The periodic model execution cycle up to the point of internal and external report generation/ submission can take up to 2 weeks for larger firms, where smaller technologically enabled companies can manage the same task in less than half a day.

Respondents find What-If Analysis easy and can turn this analysis around in less than a day.

Can you give an indication of the current headcount required to manage the end to end process (excluding model development)?

Tier 1 Banks:	Tier 2, Large NWE & Building Societies:	New, Small or Niche:
50+	15 – 45	±10

What skillsets are needed for the current technology stack?

There are two key skills expected of analysts when it comes to firms' current technology stacks:

- SAS coding experience; and
- Data analysis and remediation skills.

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