

ASX Trade Refresh Project – IBM Independent Review

Executive Summary of IBM Independent
Expert Review – Final Report June 2021



Contents

1.	Introduction and Scope	04
2.	Conclusions	05
3.	Recommendations Overview	08
4.	Conclusions – Detail	09
5.	Recommendations - Summary	23
6.	Recommendations - Detail	29

2. Executive Summary



IBM was engaged to provide an independent review of the conduct and performance of the ASX Trade Refresh Project as a result of the 16th November 2020 market outage.

ASX, in agreement with the Australian Securities and Investments Commission (ASIC) and the Reserve Bank of Australia (RBA) (the Agencies), undertook a requirement to commission an independent expert review (the Review) of the Project. The purpose of the Review was to examine the Project and assess whether it met internationally recognised standards or frameworks and relevant securities industry practices, noting the critical nature of services provided by the ASX Trade platform.

Review Objective

- The core objective of this review was to provide an expert opinion **on, and to ascertain if it was reasonable to expect the new trading platform was ready for successful production implementation and ongoing availability.**
- To support the project objective, IBM considered the following questions during the review:
 - Whether the Project had sufficient resources (including financial, technological, and human resources)
 - The robustness and rigour applied to risks and issues management by ASX during the Project
 - The efficacy of the change control processes employed throughout the Project
 - The Project test plan effectiveness and whether it was commensurate with risk appetite and the criticality of the ASX Trade system
 - The implications of the Project on stakeholders, including technology providers (vendors), other market operators, the Agencies, and customers
 - Whether during the 2020 Incident, ASX took into consideration the lessons learnt from the 2016 Incident
 - The aspects of the Project that met, exceeded, or did not meet accepted industry standards, frameworks, or practices

Review Scope

- During the review, IBM obtained inputs from ASX, third-party suppliers, and market participants [REDACTED]
- IBM considered all aspects of the Project that would have had a material bearing on the successful implementation and ongoing availability of a trading system or equivalent system. For the avoidance of doubt, the following were the specific areas that were reviewed (In Scope):
 - Project Governance
 - Project Risk Management
 - Project Design and Testing
 - Project Resourcing
 - Project Implementation
- The review established a body of evidence that comprised ASX provided documentation, interviews, and validated observations which taken together, have been used to form the findings within this report. During the review, IBM confirmed the factual basis of the observations with ASX.
 - For the avoidance of doubt, the following were not included in the scope of the review:
 - Services to remediate gaps or implement improvements that are identified as part of the Review
 - Except for the in-scope 3rd party suppliers and participants noted above, interviewing the Client's suppliers, or collecting or reviewing documentation from other Client suppliers
 - Evaluation of "Fair, Orderly and Transparent" markets on the day of the incident

Final Report Overview

- IBM has delivered a detailed final report to both ASX and the Agencies as required on the 22nd of June 2021.
- The contents of the report is as below:
 - Chapter 1 – Introduction
 - Chapter 2 – Objectives and Scope
 - Chapter 3 – Review Conclusions
 - Chapter 4 – Recommendations
 - Chapter 5 – Detailed Findings by Phase
 - Chapter 6 – Framework Assessment
 - Appendices (inc. documents received, and interviews conducted)

IBM made 8 conclusions in relation to the in-scope key questions. Each conclusion is based on detailed findings that are contained Chapter 5 of the Final Report (1/2)

Question	Conclusion
<p>1. If it was reasonable to expect the new trading platform was ready for successful production implementation and ongoing availability</p>	<p>Notwithstanding the fact that the formal implementation readiness processes were completed and verified by multiple parties without objection to go-live, the following factors suggest that the platform was not ready for go-live considering ASX’s near zero appetite for service disruption as an operator of a systemically important national infrastructure:</p> <ul style="list-style-type: none"> • historical software product quality indicators • the additional testing need noted [REDACTED] • the quantity of open defects (1 Critical (appropriately risk accepted), 1 High, 40 Medium, 17 Low) • gaps in end-to-end test coverage • the proximity to participant year-end change freeze windows • [REDACTED] risk likelihood [REDACTED] • There was no evidence of challenges being raised to either the risk rating or to the go live
<p>2. Whether the Project had sufficient resources</p>	<p>IBM has concluded that the Project was provided with and had access to sufficient resources at all stages of delivery to meet its objectives, whether that be financial, time, people or technological. However, the Project would have benefited from additional and independent scrutiny.</p>
<p>3. The efficacy of the change control processes employed by ASX during the Project</p>	<p>The Project Change Requests (PCRs) process was executed consistently to ASX standards, for example to request additional testing resource and changes to the overall Project timeline. The PCRs were reviewed by the appropriate governing bodies and were all deemed suitable for acceptance.</p>
<p>4. The robustness and rigour applied to risks and issues management by ASX during the Project</p>	<p>IBM has concluded that there were gaps in the rigour applied to the Project delivery risk and issue management process expected for a project of this nature. These gaps in rigour include:</p> <ul style="list-style-type: none"> • Opportunities to identify additional risks were missed. Examples include risks that could have been prompted by the output from the Project Risk/Process Risk assessments, from an expanded scope of risk categories and input from independent parties. • The delivery risk templates varied from the enterprise delivery risk process in force at the time. • Project issues, whilst being managed, were not routinely updated in the tooling as evidenced by long closure periods. • Enterprise Risk Management (ERM) Line 2 would have benefited from an involvement of resources with greater experience in technical projects throughout the course of the Project and especially during the readiness phase. • Whilst there was a strong governance process in place from several governance bodies, the shift of primary governance from the Strategic Governance Group (SGG) to the Trade Services Portfolio Working Group (TSPWG) did not transfer the CIO into this primary governance body. In addition, this change, as the TSPWG dealt with all the Trade Services projects and portfolio, diluted the attention on the Trade Refresh project. • The delivered risk rating [REDACTED]

IBM made 8 conclusions in relation to the in-scope key questions. Each conclusion is based on detailed findings that are contained Chapter 5 of the Final Report (2/2)

Question	Conclusion
5. Whether it was reasonable to expect the Project test plan would be effective, commensurate with the risk appetite and criticality of the ASX Trade system	Without extensive functional and non-functional, scripted and non-scripted randomised testing in a production-like end-to-end environment, there was a high inherent risk of latent defects. IBM has therefore concluded it was not reasonable to expect the test plan used would meet the near zero appetite for service disruption for a systemically important national infrastructure as stated in the ASX Test Policy.
6. The implications of the Project on stakeholders including technology providers, market operators, Agencies and customers	There were negative implications experienced by both market participants and the Regulator (ASIC) as a consequence of the incident, however, ASX was unable to anticipate the emergence of these implications on stakeholders. Communications with key stakeholders, including participants, Chi-X as a data feed provider and the Regulator (ASIC) as a market surveillance supervisor, were appropriately managed during project delivery, pre go-live, and post go-live. The incident management actions taken by the ASX were deemed appropriate, within policy and resulted in the correct course of action to reduce the impact upon Project stakeholders.
7. Whether during the 2020 Incident, ASX took into consideration the lessons learnt from the 2016 Incident	IBM has concluded that ASX's actions during the 2020 incident management process were appropriate and reflected the lessons learned from the 2016 incident.
8.1 The aspects of the Project that met or exceeded accepted industry standards, frameworks, or practices	IBM has concluded that the majority of ASX Project practices met the expectations of leading Industry Practices. Business case development and project change management stood out as areas that exceeded accepted practices. Evidence of continuous improvement, during and post the Project, has also been noted in enterprise practices, especially Risk, Project Delivery and Business Continuity Management. There is good alignment to COBIT for Governance, ISO 31000 for Risk Management practices and PRINCE2-like practices for Program/Project Delivery Whilst only an indication, using the framework described in Figure 2, of the 75 capabilities in scope, 58 met or exceeded accepted industry Practices for a project of this nature.
8.2. The aspects of the Project that did not meet accepted industry standards, frameworks, or practices	Whilst the majority of ASX Project practices met the expectations of leading Industry Practices, IBM has concluded that Project risk & issue management, Project compliance to ASX practices, Project requirements, and the Project test strategy/planning did not meet accepted industry practices. Regarding the test practices employed by ASX during project delivery, IBM has concluded that ASX's test documentation and related process implementation were largely not consistent with leading industry practice expectations. The existing governance processes failed to act on the ASX Trade Platform asset & capacity management needs timely enough resulting in an extended period of time before an upgrade was performed, raising the operating risk. <p>IBM noted that ASX does not have a formal quality management process. There are opportunities for improvement of ASX enterprise project practices in the domains of formal quality management and risk-based pathways for project deliveries.</p> Whilst there were sufficient formal and informal control mechanisms in place, the only identified external independent contribution was with the specialist testing supplier. The role of this supplier was limited to the specific scope of the Statements of Work employed and did not entail providing an independent point of view.

Chapter 4 of the report documents the IBM recommendations proposed for the remediation of findings identified in this review. The recommendations have been aligned to the conclusions and findings.

59 discreet recommended tasks have been developed by IBM to address the findings in this report. These discreet tasks have been grouped in 7 Domains (Level 1), 17 Sub-Domains (Level 2) and Recommendations within each sub domain (Level 3). Each of the tasks have been estimated with a positive impact of implementation, complexity to deliver, duration to deliver and overall effort estimate.

Domains (Level 1)								
	1. Risk	2. Governance	3. Delivery	4. Requirements	5. Vendor Mgmt	6. Testing	7. Incident Mgmt	
Recommendations (Level 3)	<p>1.1 Actively promote a risk aware culture, where risks and issues throughout the project delivery cycle are freely identified and managed in accordance to the ASX project policies, ASX enterprise policies, the ASX risk appetite and its responsibility as an operator of a systemically important national infrastructure. (1 Task)</p>	<p>2.1 Review and adjust the composition of project governance forums to ensure appropriate coverage and independence.. (1 Task)</p>	<p>3.1 Review and revise the project delivery procedures to emphasise lessons learned, need for quality management, reporting and tracking of expectations. (4 Tasks)</p>	<p>4.1 ASX should maintain their own detailed requirements log to mitigate against over reliance upon a single vendor and in the event ASX would ever need to change supplier. This log would provide a means to validate the vendor's position and would be in addition to the test cases, documenting non-functional, process, integration as well as functional needs. (1 Tasks)</p>	<p>5.1 Review and revise the technology vendor management practices to establish clear contractual arrangements, establish clear lines of dialogue regarding quality and maturity issues and establish a contractual acceptance criterion that supports ASX's quality and risk management program. (3 Tasks)</p>	<p>6.1 Create a program to raise awareness of the ASX Testing Vision and its implications on testing plans, invest in an independent QA function alongside a program of continuous test process improvement. (3 Tasks)</p>	<p>6.4 Review and update the test planning processes, test selection and design guides, templates, and reporting to align with the revised ASX Test Policy and reflect the alignment with the vision statement in the Policy.. (8 Tasks)</p>	<p>7.1 Document a policy about closing the market based on a pre-determine period of uncertainty due to an outage. (1 Task)</p>
	<p>1.2 Review and revise the risk policies and templates for project initiation and business case development (6 Tasks)</p>		<p>3.1 Implement risk-based paths for project delivery, tied to the PRA assessment and periodic review of the PRA. These paths should mandate key checkpoints and control gates. Project management functions and governance will follow the requirements for the risk path selected. (7 Tasks)</p>			<p>6.2 Enhance in-house capabilities for combinatorial testing strategies, methods, tools and datasets to combine functional, negative-functional, non-functional and operational testing at volume with representative data (real or simulated) in an end-to-end environment to create "production-like" testing scenarios targeted at reducing the risk of latent defects causing catastrophic failures in production situations. (2 Tasks)</p>	<p>6.5 Adopt and implement a metrics framework with an associated dashboard for testing metrics and quality tracking and reporting. (4 Tasks)</p>	
	<p>1.3 Repeat risk analyses at key points during the project lifecycle, ensure that risks are identified and logged from a variety of key sources, that key risk metrics are reported to governance functions and ERM Line 2 is involved early by suitably qualified staff (10 Tasks)</p>					<p>6.3 Revise and align the ASX Testing Policy and Guidelines to the ISO 29119 Guidelines and create a training program to familiarise the teams with the ASX Vision, objectives and approach to ensuring delivery of quality products to its customers consistent with the responsibilities of ASX as an operator of a systemically important national infrastructure. (3 Tasks)</p>	<p>6.6 Ensure that the new ASX Trade Refresh project is prioritised for the upcoming annual ITDR exercise to increase confidence and reduce risk. (1 Task)</p>	
	<p>1.4 Ensure that Customer related risks to be logged by the Technical Account Managers. (1 Task)</p>						<p>6.7 Review the policy to consider whether mixing any form of customer testing with go-live weekend activities is appropriate for critical new system deliveries. (1 Task)</p>	

2. Conclusions Detail



1. If it was reasonable to expect the new trading platform was ready for successful production implementation and ongoing availability

Conclusion

Notwithstanding the fact that the formal implementation readiness processes were completed and verified by multiple parties without objection to go-live, the following factors suggest that the platform was not ready for go-live considering ASX's near zero appetite for service disruption as an operator of a systemically important national infrastructure:

- historical software product quality indicators
- the additional testing need noted [REDACTED]
- the quantity of open defects (1 Critical (appropriately risk accepted), 1 High, 40 Medium, 17 Low)
- gaps in end-to-end test coverage
- the proximity to participant year-end change freeze windows
- [REDACTED] risk likelihood [REDACTED]
- There was no evidence of challenges being raised to either the risk rating or to the go live

The formal implementation readiness documents and processes were completed and verified by multiple parties. There were grounds for raising a concern to go-live due to the identified need for extra systematic and random volume testing that had been identified alongside gaps in the end-to-end testing scope.

[REDACTED]

Whilst it was noted that there was ERM Line 2 challenge in the implementation readiness process, ERM Line 2 was not invited to the four implementation readiness workshops and received the readiness document one day before the go-live readiness meeting. IBM identified two gaps in the risk assessment risk ratings. The risks identified consisted of a mix of inherent and residual risks, as some were controls/treatments and others were recovery/reactive in nature.

[REDACTED]

IBM noted that notwithstanding the concerns expressed in the 23rd October 2020 meeting, the implementation readiness process was considered complete. [REDACTED]

[REDACTED]

[REDACTED]

2. Whether the Project had sufficient resources

Conclusion

IBM has concluded that the Project was provided with and had access to sufficient resources at all stages of delivery to meet its objectives, whether that be financial, time, people or technological. However, the Project would have benefited from additional and independent scrutiny.

The Project's business case was clear, in depth, reasonable and transparent, documenting the Capital Expenditure at [REDACTED], Operating Expenditure at [REDACTED] and initial Go-Live as June-July 2020 with the actual target go-live date noted as being flexible. The Project had the second largest CapEx project budget allocation in FY20 (after the CHESSE Replacement). At completion in November 2020, the Project was financially within [REDACTED] of the initial estimate and [REDACTED] of the planning estimate.

The ASX Trade Refresh had cross dependencies with the SMARTS Integration and Secondary Data Centre projects. These projects were aligned from the outset, which was a reasonable decision. The Project was estimated to use the majority of the trading platform team members for a year and was fully staffed from initiation based on the planned requirements.

Where there were resourcing gaps identified, they were resolved using the change control process.

As described in further conclusions, the Project would have benefited from additional scrutiny.

3. The efficacy of the change control processes employed by ASX during the Project

Conclusion

The Project Change Request (PCRs) process was executed consistently to ASX standards, for example to request additional testing resource and changes to the overall Project timeline. The PCRs were reviewed by the appropriate governing bodies and were all deemed suitable for acceptance.

There were sixteen PCRs raised during the delivery phases and, although a relatively large quantity, the change control process was executed consistently. All PCRs were approved by the appropriate governance functions. The Project followed the ASX project management framework in managing resource contentions. Reporting occurred monthly alongside weekly Project stand-up meetings. The change requests were managed in accordance with the processes in place.

4. The robustness and rigour applied to risks and issues management by ASX during the Project (1/3)

Conclusions

IBM has concluded that there were gaps in the rigour applied to the Project delivery risk and issue management process expected for a project of this nature. These gaps in rigour include:

- Opportunities to identify additional risks were missed. Examples include risks that could have been prompted by the output from the Project Risk/Process Risk assessments, from an expanded scope of risk categories and input from independent parties.
- The delivery risk templates varied from the enterprise delivery risk process in force at the time.
- Project issues, whilst being managed, were not routinely updated in the tooling as evidenced by long closure periods.
- Enterprise Risk Management (ERM) Line 2 would have benefited from an involvement of resources with greater experience in technical projects throughout the course of the Project and especially during the readiness phase.
- Whilst there was a strong governance process in place from several governance bodies, the shift of primary governance from the Strategic Governance Group (SGG) to the Trade Services Portfolio Working Group (TSPWG) did not transfer the CIO into this primary governance body. In addition, this change, as the TSPWG dealt with all the Trade Services projects and portfolio, diluted the attention on the Trade Refresh project.
- The delivered risk rating [REDACTED]

Concept and Initiation Phase

The Project was required as the risk of the status quo was greater than the risk of change due to aging assets, capacity limitations, and quality concerns in the existing platform.

The principle of performing the Project with minor functional change to reduce customer impact and risk was sensible. The pre-Project Design Study was ASX's due diligence exercise where ASX and Nasdaq jointly explored functional changes, core architectural changes, the platform maturity in the market, testing tools, planning and commercials. [REDACTED]

The [REDACTED] process should have considered the risk in change alongside delivery risk and the Project's cross dependencies (SMARTS Integration and Secondary Data Centre projects). The [REDACTED] process itself [REDACTED] lacked the requirement for a non-Project team review. [REDACTED]

Despite being under-classified in the early stages of the Project [REDACTED] there was no material difference in Project activities or oversight. It was subsequently reclassified by the Project team [REDACTED].

Whilst the Enterprise Risk Management (ERM) function has significantly improved in depth and breadth in recent years, the ERM Line 2 team would have benefited from the involvement of additional team members providing complementary and diverse sets of experiences. [REDACTED]

[REDACTED] experienced resources would have added to the robustness of the self-assessment conducted by the Project team. [REDACTED]

The Design Authority was appropriately involved and, as the software was a customised off the shelf product, the Design Authority function was not in a position or expected to analyse the internals of the Nasdaq software architecture.

The Business Case that brought these elements together described key risks that were clear and the decision to undertake an early Beta test phase and the option for an extended acceptance process were prescient.

4. The robustness and rigour applied to risks and issues management by ASX during the Project (2/3)

Conclusions

IBM has concluded that there were gaps in the rigour applied to the Project delivery risk and issue management process expected for a project of this nature. These gaps in rigour include:

- Opportunities to identify additional risks were missed. Examples include risks that could have been prompted by the output from the Project Risk/Process Risk assessments, from an expanded scope of risk categories and input from independent parties.
- The delivery risk templates varied from the enterprise delivery risk process in force at the time.
- Project issues, whilst being managed, were not routinely updated in the tooling as evidenced by long closure periods.
- Enterprise Risk Management (ERM) Line 2 would have benefited from an involvement of resources with greater experience in technical projects throughout the course of the Project and especially during the readiness phase.
- Whilst there was a strong governance process in place from several governance bodies, the shift of primary governance from the Strategic Governance Group (SGG) to the Trade Services Portfolio Working Group (TSPWG) did not transfer the CIO into this primary governance body. In addition, this change, as the TSPWG dealt with all the Trade Services projects and portfolio, diluted the attention on the Trade Refresh project.
- The delivered risk rating [REDACTED]

Delivery Phase

[REDACTED] The Project used an outdated risk template [REDACTED].

Project issues, whilst being managed, were not numerous and were not routinely being updated in the tooling as evidenced by long closure periods.

Further risks, from a broader set of risk categories (e.g. Third Party, Business Continuity, Information Security, Personnel, Migration, Compliance, Legal, Change Freeze windows, known testing gaps) could and should have been identified, managed and reported to the governance functions where appropriate.

The Project would have benefited from greater independent challenge from ERM Line 2 and from external independent parties to overcome the potential for normalcy biases originating from being too close to the day-to-day project activities. An earlier risk in change identification process and the frequent repetition of both the Project Risk and Process Risk assessments may also have increased the scope of the risks identified.

In November 2019, the Strategic Governance Group (SGG) governance as it related to the Project ceased, turning over the role of primary governance to the Trade Services Portfolio Working Group (TSPWG). When this happened, the CIO's involvement was not transferred over and separately, there was no direct test management function representation in this governance forum. The Nasdaq and ASX governance process through the Joint Steering Group was well documented and effective, however, this governance group also did not include any direct ASX test team representatives.

[REDACTED]

4. The robustness and rigour applied to risks and issues management by ASX during the Project (3/3)

Conclusions

IBM has concluded that there were gaps in the rigour applied to the Project delivery risk and issue management process expected for a project of this nature. These gaps in rigour include:

- Opportunities to identify additional risks were missed. Examples include risks that could have been prompted by the output from the Project Risk/Process Risk assessments, from an expanded scope of risk categories and input from independent parties.
- The delivery risk templates varied from the enterprise delivery risk process in force at the time.
- Project issues, whilst being managed, were not routinely updated in the tooling as evidenced by long closure periods.
- Enterprise Risk Management (ERM) Line 2 would have benefited from an involvement of resources with greater experience in technical projects throughout the course of the Project and especially during the readiness phase.
- Whilst there was a strong governance process in place from several governance bodies, the shift of primary governance from the Strategic Governance Group (SGG) to the Trade Services Portfolio Working Group (TSPWG) did not transfer the CIO into this primary governance body. In addition, this change, as the TSPWG dealt with all the Trade Services projects and portfolio, diluted the attention on the Trade Refresh project.
- The delivered risk rating [REDACTED]
[REDACTED]
[REDACTED]

Readiness and Go-Live Phases

ERM Line 2 was not invited to the four implementation readiness workshops and received the readiness document only one day before the go-live readiness meeting. Gaps were noted in the implementation readiness risk assessment and some controls/treatments were corrective in nature, hence were a mix of inherent and residual risks.

This assessed rating was not challenged [REDACTED]
[REDACTED]
[REDACTED]

5. Whether the Project test plan was effective and commensurate with the risk appetite and criticality of the ASX Trade system (1/4)

Conclusions

Without extensive functional and non-functional, scripted and non-scripted randomised testing in a production-like end-to-end environment, there was a high inherent risk of latent defects. IBM has therefore concluded it was not reasonable to expect the test plan used would meet the near zero appetite for service disruption for a systemically important national infrastructure as stated in the ASX Test Policy.

Due to the significant materiality of this question, IBM have detailed below critical support information:

The need for a beta testing phase was prescient and confirmed that there were early quality issues with the software.

Post the beta phase, the test strategy and associated plans were written prior to embarking on the contractual acceptance testing processes. The testing strategy for the Project was based on extending and automating the test cases from the Genium V3 trading system that had been in operation for more than 10 years. Notwithstanding the lack of functional changes to the new system, the test plan did not reflect the impact of the complexities and changes introduced within the Nasdaq Financial Framework software.

As there were no planned functionality changes to the new trading system, the functional testing program design relied on the automation of existing Genium V3 test cases supplemented by additional test cases reflecting unique new NFF features. The non-functional testing program design included the use of a specialist firm, ExactPro.

The upgrade to NFF was intended by ASX to be a like-for-like functional upgrade from Genium V3, however, based on the results from early testing the underlying architecture and design exhibited a high degree of change and defects.

ASX added resources and adjusted the Project timeframe in reaction to the observed product quality challenges. Additional test cases were created to address the changes and defects identified.

The process whereby requirements (Nasdaq Functional Descriptions) were written by Nasdaq and approved by ASX, alongside test cases written by ASX had been effective for over a decade. The process does have the risk of ambiguity in the shared understanding of detailed requirements as it relies heavily on ASX's software supplier maintaining a log of requirements and customisations made over the years whilst ASX only maintain test cases.

Neither Nasdaq nor ASX tested the exact conditions of the scenario that led to the outage on 16th November 2020.

As it relates to the MO37/TMC/Bait incident that caused the outage on the 16th November 2020, there was a mutual understanding between Nasdaq and ASX of the business requirement and necessary configuration that continued from Genium V3 to NFF. Early in the project, an ASX test case found a defect for a top of book scenario that was subsequently fixed, however, neither party tested the exact conditions of the scenario that happened on 16th November 2020.

5. Whether the Project test plan was effective and commensurate with the risk appetite and criticality of the ASX Trade system (3/4)

Conclusions

Without extensive functional and non-functional, scripted and non-scripted randomised testing in a production-like end-to-end environment, there was a high inherent risk of latent defects. IBM has therefore concluded it was not reasonable to expect the test plan used would meet the near zero appetite for service disruption for a systemically important national infrastructure as stated in the ASX Test Policy.

Whilst the capability, methods, data and tooling existed to perform repeated production-like combined functional and non-functional testing, it was not repeated after September 2019, with a mature functional baseline version, using a representative market profile.

End-to-end testing was not sufficiently robust to identify issues resulting from defects manifested in downstream systems.

There is limited evidence of a level of depth and breadth in the test cases, that were carried out in an integrated end-to-end system environment, sufficient enough to identify defects originating in NFF but manifesting in downstream systems.

The external ASX:Chi-X feed supporting External Best Bid and Offer (EBBO) and National BBO (NBBO) was not prioritised by ASX in end-to-end testing, was not tested with live or near live market data. These decisions were not identified as risks.

The coverage of the automated regression tests that were undertaken during the first two acceptance test phases was ~45% of the final test case coverage. The acceptance test phases occurred prior to the formal ASX functional and non-functional testing phases.

5. Whether the Project test plan was effective and commensurate with the risk appetite and criticality of the ASX Trade system (4/4)

Conclusions

Without extensive functional and non-functional, scripted and non-scripted randomised testing in a production-like end-to-end environment, there was a high inherent risk of latent defects. IBM has therefore concluded it was not reasonable to expect the test plan used would meet the near zero appetite for service disruption for a systemically important national infrastructure as stated in the ASX Test Policy.

Adequate time and scope were given for the Customer testing activities and communications with Customers was deemed “good”.

A Customer Test environment, three Dry Run exercises and four Dress Rehearsals from 20th January 2020 to 24th October 2020 provided adequate time for Customers and ASX to prepare themselves for go-live. Conformance was achieved in advance of go-live. The associated publicly available documentation and instructions were clear.

Customers/Participants generally felt the communications leading up to the release were good, including from their Technical Account Managers. [REDACTED]

A full ITDR/BCP test was not performed and instead was planned for execution post go-live in 1H21.

[REDACTED]

[REDACTED]

6. The implications of the Project on stakeholders including technology providers, market operators, Agencies and customers

Conclusion

There were negative implications experienced by both market participants and the Regulator (ASIC) as a consequence of the incident, however, ASX was unable to anticipate the emergence of these implications on stakeholders. Communications with key stakeholders, including participants, Chi-X as a data feed provider and the Regulator (ASIC) as a market surveillance supervisor, were appropriately managed during project delivery, pre go-live, and post go-live. The incident management actions taken by the ASX were deemed appropriate, within policy and resulted in the correct course of action to reduce the impact upon Project stakeholders.

Communication and involvement of external stakeholders by ASX was appropriate during project delivery and utilised the existing channels that ASX had historically used in previous projects. The Project, and its implications on stakeholders was communicated as a software upgrade with minimal functional change which was an appropriate representation at the time. A Customer Test environment, three Dry Run exercises and four Dress Rehearsals were conducted during project delivery. These activities provided adequate time for Customers and ASX to prepare for the Project go-live. It was also noted that the associated publicly available documentation and instructions for these exercises published by ASX were clear. Conformance was achieved in advance of the Project go-live.

During project delivery, external stakeholders were kept abreast of implications through both the release of technical documentation updates and, bilateral meetings held between the customer and their assigned ASX technical account manager. There were post incident implications experienced by external stakeholders as result of the actions taken in response to the incident that occurred at go-live and the subsequent outage of the ASX Trade Platform. The following represents a subset of implications that

IBM noted during the conduct of this review:

- Whilst keeping the market in Enquire State was within ASX's operating rules, external stakeholders had to remain on alert for a potential reopening of the market. The length of time before making the decision to close the market resulted in high levels of uncertainty.
- External stakeholders had their normal trading routines and operations disrupted by the unavailability of Tailor-Made Combinations until 21st December 2020. Nevertheless, whilst now available (at the time of this report), operates in a functionally limited mode.
- [REDACTED]
- [REDACTED]
- [REDACTED]
- The required inputs to determine the National Best Bid and Offer (NBBO) for market equities was disrupted due to the EBBO failure and its impact on the Centrepoint system.

7. Whether during the 2020 Incident, ASX took into consideration the lessons learnt from the 2016 Incident

Conclusion

IBM has concluded that ASX's actions during the 2020 incident management process were appropriate and reflected the lessons learned from the 2016 incident.

Whilst there was no formal Crisis Management Team raised at the time of the 2020 incident, all of the necessary members of the Crisis Management Team were already in place for the go-live and participated in the decisions made during the management of the incident. Based on the technical guidance being provided to the Major Incident Management team, the decision to keep the market in Enquire State was appropriate and took into consideration lessons that ASX gathered through market consultation post the 2016 incident. Based on the Participant interviews, IBM analysis noted that communication with Participants during the incident were considered timely and accurate albeit without a significant amount of new information.

8. The aspects of the Project that did not meet, met or exceeded accepted industry standards, frameworks, or practices

Aspects that met or Exceeded

IBM has concluded that the majority of ASX Project practices met the expectations of leading Industry Practices. Business case development and project change management stood out as areas that exceeded accepted practices. Evidence of continuous improvement, during and post the Project, has also been noted in enterprise practices, especially Risk, Project Delivery and Business Continuity Management.

There is good alignment to COBIT for Governance, ISO 31000 for Risk Management practices and PRINCE2-like practices for Program/Project Delivery

Whilst only an indication, using the framework, of the 75 capabilities in scope, 58 met or exceeded accepted industry Practices for a project of this nature.

Aspects that did not meet

Whilst the majority of ASX Project practices met the expectations of leading Industry Practices, IBM has concluded that Project risk & issue management, Project compliance to ASX practices, Project requirements, and the Project test strategy/planning did not meet accepted industry practices.

Regarding the test practices employed by ASX during project delivery, IBM has concluded that ASX's test documentation and related process implementation were largely not consistent with leading industry practice expectations.

The existing governance processes failed to act on the ASX Trade Platform asset & capacity management needs timely enough resulting in an extended period of time before an upgrade was performed, raising the operating risk.

[REDACTED]

IBM noted that ASX does not have a formal quality management process. There are opportunities for improvement of ASX enterprise project practices in the domains of formal quality management and risk-based pathways for project deliveries. Whilst there were sufficient formal and informal control mechanisms in place, the only identified external independent contribution was with the specialist testing supplier. The role of this supplier was limited to the specific scope of the Statements of Work employed and did not entail providing an independent point of view.

3. Recommendations Summary



Chapter 4 of the report documents the IBM recommendations proposed for the remediation of findings identified in this review. The recommendations have been aligned to the conclusions and findings.

59 discreet recommended tasks have been developed by IBM to address the findings in this report. These discreet tasks have been grouped in 7 Domains (Level 1), 17 Sub-Domains (Level 2) and Recommendations within each sub domain (Level 3). Each of the tasks have been estimated with a positive impact of implementation, complexity to deliver, duration to deliver and overall effort estimate.

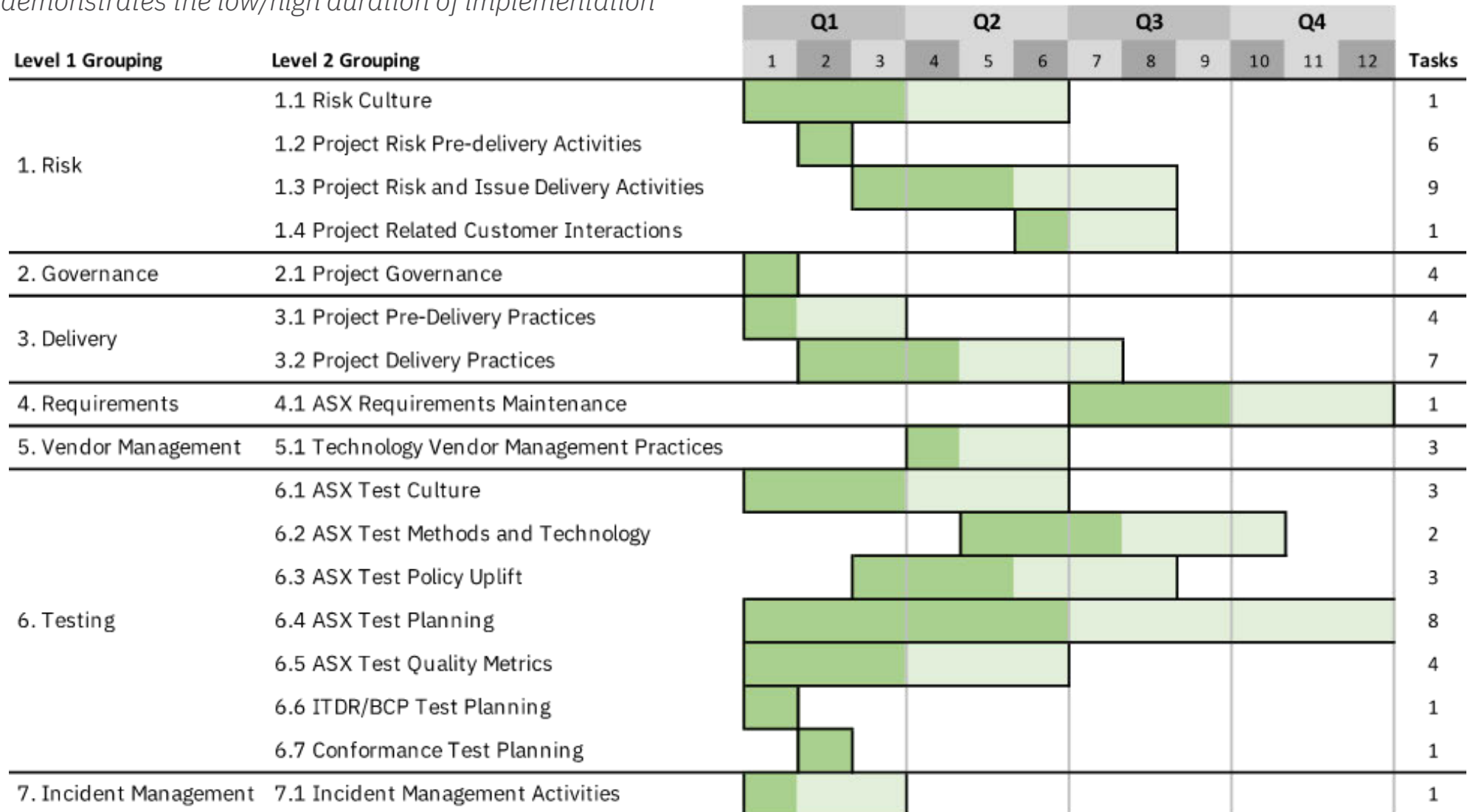
Domains (Level 1)								
	1. Risk	2. Governance	3. Delivery	4. Requirements	5. Vendor Mgmt	6. Testing	7. Incident Mgmt	
Recommendations (Level 3)	<p>1.1 Actively promote a risk aware culture, where risks and issues throughout the project delivery cycle are freely identified and managed in accordance to the ASX project policies, ASX enterprise policies, the ASX risk appetite and its responsibility as an operator of a systemically important national infrastructure. (1 Task)</p>	<p>2.1 Review and adjust the composition of project governance forums to ensure appropriate coverage and independence.. (1 Task)</p>	<p>3.1 Review and revise the project delivery procedures to emphasise lessons learned, need for quality management, reporting and tracking of expectations. (4 Tasks)</p>	<p>4.1 ASX should maintain their own detailed requirements log to mitigate against over reliance upon a single vendor and in the event ASX would ever need to change supplier. This log would provide a means to validate the vendor's position and would be in addition to the test cases, documenting non-functional, process, integration as well as functional needs. (1 Tasks)</p>	<p>5.1 Review and revise the technology vendor management practices to establish clear contractual arrangements, establish clear lines of dialogue regarding quality and maturity issues and establish a contractual acceptance criterion that supports ASX's quality and risk management program. (3 Tasks)</p>	<p>6.1 Create a program to raise awareness of the ASX Testing Vision and its implications on testing plans, invest in an independent QA function alongside a program of continuous test process improvement. (3 Tasks)</p>	<p>6.4 Review and update the test planning processes, test selection and design guides, templates, and reporting to align with the revised ASX Test Policy and reflect the alignment with the vision statement in the Policy. (8 Tasks)</p>	<p>7.1 Document a policy about closing the market based on a pre-determine period of uncertainty due to an outage. (1 Task)</p>
	<p>1.2 Review and revise the risk policies and templates for project initiation and business case development (6 Tasks)</p>		<p>3.1 Implement risk-based paths for project delivery, tied to the PRA assessment and periodic review of the PRA. These paths should mandate key checkpoints and control gates. Project management functions and governance will follow the requirements for the risk path selected. (7 Tasks)</p>			<p>6.2 Enhance in-house capabilities for combinatorial testing strategies, methods, tools and datasets to combine functional, negative-functional, non-functional and operational testing at volume with representative data (real or simulated) in an end-to-end environment to create "production-like" testing scenarios targeted at reducing the risk of latent defects causing catastrophic failures in production situations. (2 Tasks)</p>	<p>6.5 Adopt and implement a metrics framework with an associated dashboard for testing metrics and quality tracking and reporting. (4 Tasks)</p>	
	<p>1.3 Repeat risk analyses at key points during the project lifecycle, ensure that risks are identified and logged from a variety of key sources, that key risk metrics are reported to governance functions and ERM Line 2 is involved early by suitably qualified staff (10 Tasks)</p>					<p>6.3 Revise and align the ASX Testing Policy and Guidelines to the ISO 29119 Guidelines and create a training program to familiarise the teams with the ASX Vision, objectives and approach to ensuring delivery of quality products to its customers consistent with the responsibilities of ASX as an operator of a systemically important national infrastructure. (3 Tasks)</p>	<p>6.6 Ensure that the new ASX Trade Refresh project is prioritised for the upcoming annual ITDR exercise to increase confidence and reduce risk. (1 Task)</p>	
	<p>1.4 Ensure that Customer related risks to be logged by the Technical Account Managers. (1 Task)</p>						<p>6.7 Review the policy to consider whether mixing any form of customer testing with go-live weekend activities is appropriate for critical new system deliveries. (1 Task)</p>	

The level 1 recommendations have been plotted on a matrix to demonstrate the duration vs the impact of the recommendations

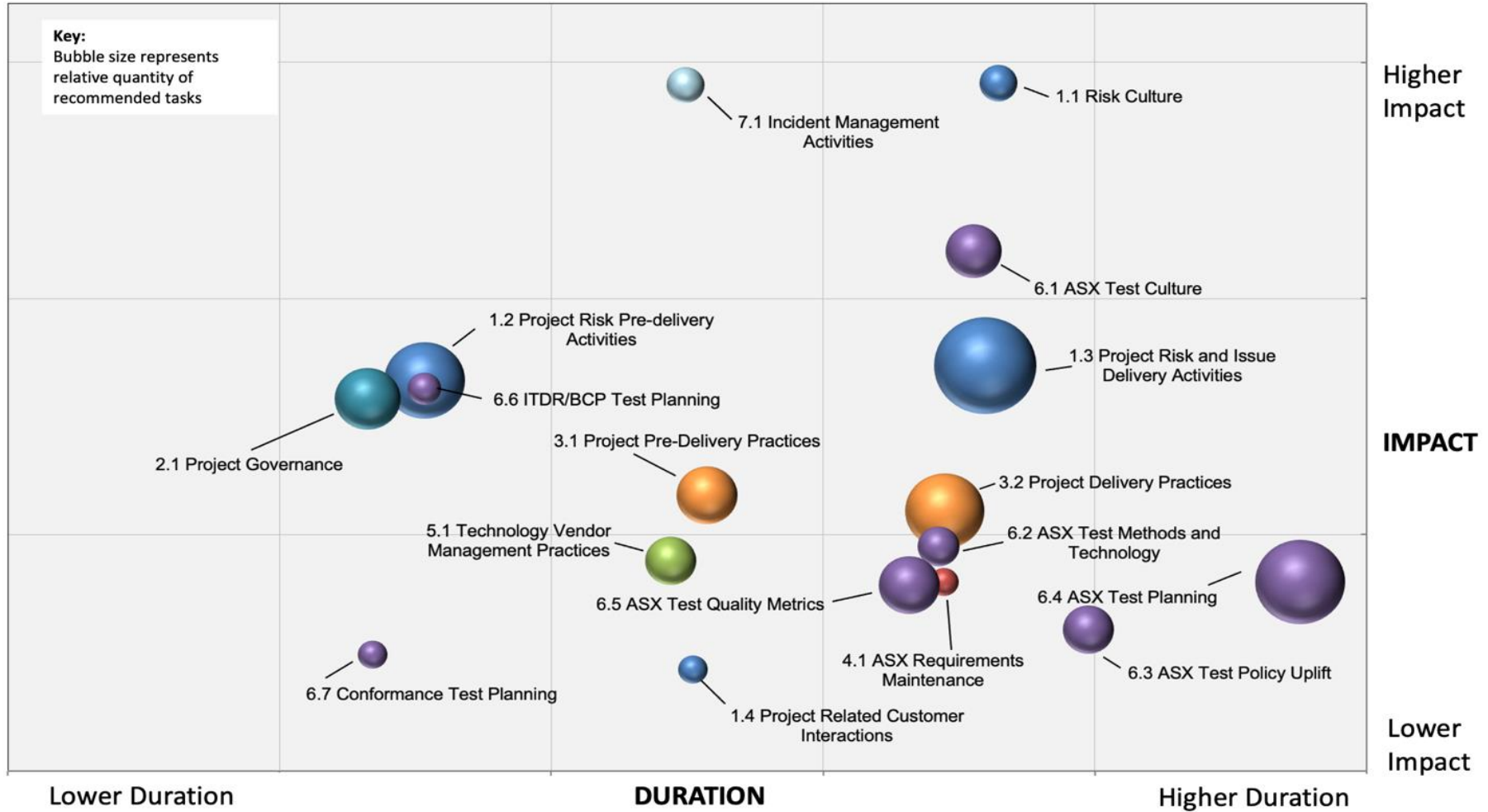


The recommendations have been sequenced with a recommended timeline for implementation

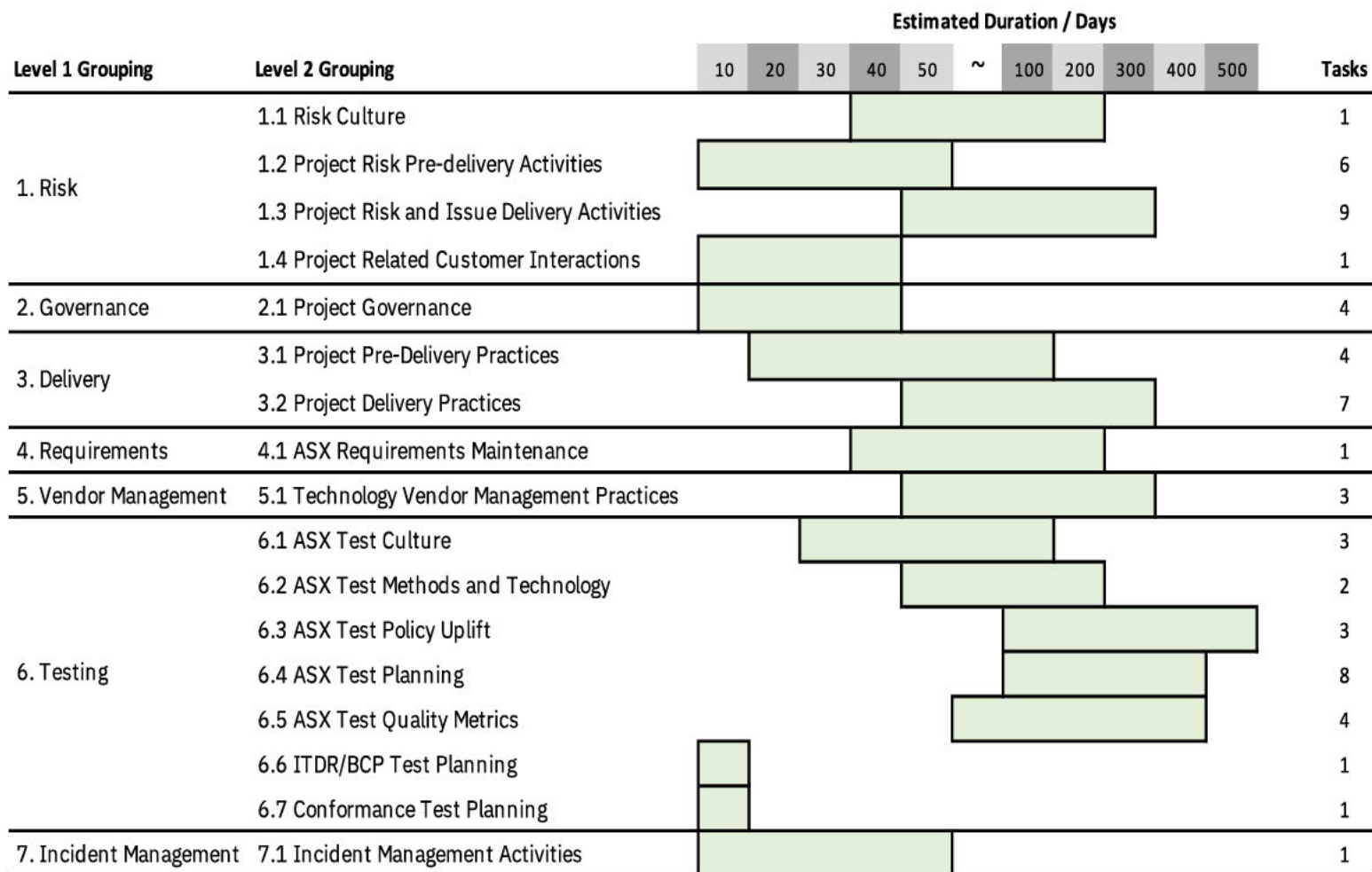
The graph below demonstrates the low/high duration of implementation



The level 2 recommendations have been plotted on a matrix to demonstrate the duration vs the impact of the recommendations



IBM has estimated the potential number of days required to action the recommendations and associated tasks. The below graph demonstrates this with a low – high range



4. Recommendations Detail



1. Risk Domain (1/2)

1.1 Risk Culture

Actively promote a risk aware culture, where risks and issues throughout the project delivery cycle are freely identified and managed in accordance to the ASX project policies, ASX enterprise polices, the ASX risk appetite and its responsibility as an operator of a systemically important national infrastructure.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
1.1.1	Enhance the risk aware culture, where risks and issues are freely identified, documented, analysed, managed, and treated appropriately.	40-200 days	3-6 months	Very High	Low	Operational	3	16	APO12, APO11, P4.04, APO11

1.2 Project Risk Pre-delivery Activities

Review and revise the risk policies and templates for project initiation and business case development

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
1.2.1	Ensure that ERM Line 2 resources assigned to projects have sufficient expertise such that they can provide adequate oversight and challenge to the project. Post the Project Risk Assessment exercise, a suitable ERM Line 2 expert or set of experts should then be assigned to the project, based upon the detailed understanding of the scope.	<10 days	Negligible months	Very High	Low	Operational	3	7	APO12, P1.02, APO11
1.2.2	Update the necessary policies to ensure that at project initiation and especially during the Project Risk Assessment phase, resources with relevant risk expertise should be involved to leverage their diverse expertise.	<10 days	Negligible months	High	Low	Operational	3	7	APO12, P1.02, APO11
1.2.3	Enhance the control framework to ensure that there are suitable controls, alternative and independent viewpoints during the Project Risk Assessment template completion exercise and/or after the template completion by the project teams. This will add alternative diverse viewpoints and is a means to challenge the team's rationale. Consider the use of the Delphi technique to independently complete the form, and use the average output or use the range, to reduce risk of groupthink. This is also relevant to the Process Risk Assessment exercise.	<10 days	<1 month	High	Low	Operational	3	6	APO12, P1.02, APO11, P2.06
1.2.4	Update the necessary policies to ensure that the risks highlighted in the Project Risk Assessment are transferred to the delivery risk register. This is also relevant to the Process Risk Assessment exercise.	<10 days	Negligible months	High	Low	Operational	3	6	APO12, P1.02, P2.06, P4.04
1.2.5	Expand the scope of the Project Risk Assessment template to consider both delivery risk and the future delivered risk, to also include the transition/migration/cut-over risks.	<10 days	<1 month	Medium	Low	Operational	3	6	APO12, P1.02, P4.04, P2.06
1.2.6	Review the categorisation and differences in approach between the various project priority levels to ensure it is suitable against risk appetite and control needs.	<10 days	<1 month	Medium	Low	Operational	N/A	5	APO12, P1.02, P2.06, APO11

1. Risk Domain (2/2)

1.3 Project Risk and Issue Delivery Activities

Repeat risk analyses at key points during the project lifecycle, ensure that risks are identified and logged from a variety of key sources, that key risk metrics are reported to governance functions and ERM Line 2 is involved early by suitably qualified staff

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
1.3.1	Update the necessary policies to ensure that the Project Risk Assessment and Process Risk Assessment are revisited at key points in the delivery project, as this will provide an additional set of risk identification dimensions that may have been omitted by the delivery team.	<10 days	<1 month	Very High	Low	Strategic	3	6	APO12, P1.02, P2.06, APO11
1.3.2	Ensure that risks are identified and logged from key sources, such as the Project Risk Assessment, Process Risk Assessment, Governance functions meetings and minutes, delivery team stand-ups, independent teams, ERM Line 2, Internal Audit/Line 3.	10-40 days	1-3 months	Very High	Low	Operational	3	16	P1.02, APO11, APO11
1.3.3	Ensure that the full project risk and issue log metrics are shared with the governance functions – e.g. number of open risks, number of risk owners, number of risks in delivery vs risks in change, categorisation of risks (e.g. how many are strategic vs delivery, how many are infrastructure vs personnel, how many are supplier vs in-house) in addition to the key risks that the project team deem material.	10-40 days	3-6 months	Very High	Low	Operational	3	16	APO12, P1.02, APO11
1.3.4	Ensure that key roles and responsibilities are included in the governance functions using a RACI aligned to Project Priority and Risk Assessment, for example, as it relates to the test function to ensure independence, focus and continuity.	10-40 days	<1 month	High	Low	Operational	N/A	18	APO12, P1.01
1.3.5	Ensure that the ERM Line 2 function (could be more than one person) are invited by the project delivery team in good time, ideally contributing in the preparation workshops, business case production and project risk assessment exercises.	<10 days	<1 month	High	Low	Operational	3, 8	36	APO12, P1.02, P4.04, APO11
1.3.6	Project risks should periodically be identified using a Delphi-style technique to reduce risk of group think and normalcy biases. Other risk identification techniques described in ISO 31010 should also be considered at key project milestones. Risk identification should also be tagged against standard categories, to enable reporting of categorisation coverage to control functions.	10-40 days	1-3 months	High	Low	Operational	3, 8	36	APO12, P1.02, P4.04, APO11
1.3.7	Update the implementation readiness templates and supporting guidance, such that the risks in the implementation readiness document clearly highlights whether they are inherent or residual in nature. The likelihood and impact assessment should be noted, to produce the risk rating. Controls/treatments should be tagged clearly as whether having been performed (preventative) or actions to take should an event occur (detective / corrective). In addition, the listed risks should have lineage to the project risk register.	10-40 days	1-3 months	High	Low	Operational	3, 8	36	APO12, P1.02, P4.04, APO11
1.3.8	Ensure that project risks, issues and statistics are tracked to completion and reported to governance functions in a timely fashion – e.g. average time to close issues, longest open issue, ownership quantities, number of open risks.	10-40 days	3-6 months	Medium	Low	Operational	3	16	APO12, P1.02, P4.04
1.3.9	Project risks should be quantified in likelihood and impact terms, according to standard definitions of risk assessment.	<10 days	<1 month	Medium	Low	Operational	3, 8	36	APO12, P1.02, APO11

1.4 Project Related Customer Interactions

Ensure that Customer related risks to be logged by the Technical Account Managers.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
1.4.1	Ensure that Technical Account Managers formally document risks and issues from customers/participants so such information can be factored into Executive decision making.	10-40 days	1-3 months	Medium	Low	Operational	4	31	APO12, P1.02, P7.04

2. Governance

2.1 Project Governance

Review and adjust the composition of project governance forums to ensure appropriate coverage and independence.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
2.1.1	Document the key roles and functions that must be in attendance of a governance function, based on the risk, complexity, priority and needs of the project. In addition, include roles independent from the project and ideally the organisation.	<10 days	<1 month	High	Low	Operational	3	14	APO11, BAI06, BAI01
2.1.2	Evaluate the need to update the necessary policies to require an independent viewpoint, that the delivery team and its reporting line cannot exceed a given percentage of the total governance function membership.	<10 days	<1 month	High	Low	Operational	3	14	APO11, BAI06, BAI01
2.1.3	Evaluate the need to update the policies to require that for Priority 1 and High-Risk projects key governance functions have dedicated meetings that only cover the project.	<10 days	<1 month	High	Low	Operational	3	14	BAI11
2.1.4	Update the policies such that the governance forums check that the project is tracking and reporting against the metrics defined at project initiation.	<10 days	Negligible months	Medium	Low	Operational	3	14	APO11

3. Delivery

R3.1 Project Pre-Delivery Practices

Review and revise the project delivery procedures to emphasise lessons learned, need for quality management, reporting and tracking of expectations.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
3.1.1	At project initiation, formally determine metrics that are carried over, and tracked during project delivery defining the boundaries of operation. Examples include financial variance, product quality, business outcomes, risks, productivity, delivery quality, earned value, customer satisfaction and schedule.	10-40 days	1-3 months	High	Low	Operational	1, 3	10	APO11
3.1.2	Produce a due diligence checklist to increase scope of coverage and to capture material lessons learned.	10-40 days	1-3 months	Medium	Medium	Operational	3	3	APO12
3.1.3	Update the project delivery process and policies to require that prior Post Implementation Reviews\Lessons Learned are considered, especially in the initiation phases of the project.	<10 days	1-3 months	Medium	Low	Operational	N/A	11	P1.07
3.1.4	Update the project delivery process and policies to require that for priority 1 projects the Enterprise Project Management Office (EPMO) team is directly involved from initiation in establishing, for example, the delivery framework, reporting, risk/issues register, financial management systems.	10-40 days	1-3 months	Medium	Low	Operational	2	15	BAI06

R3.1 Project Delivery Practices

Implement risk-based paths for project delivery, tied to the PRA assessment and periodic review of the PRA. These paths should mandate key checkpoints and control gates. Project management functions and governance will follow the requirements for the risk path selected.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
3.2.1	Implement risk-based paths for project delivery, tied to the PRA assessment and periodic review of the PRA. For example, medium and high-risk projects should execute the product development lifecycle differently, with variance in scope, control needs or constraints, e.g. pooled vs dedicated staff. The Project Risk Assessment is the right foundation for assessing the risk in delivery and change. A High-Risk project could have a mandatory independent assessment at certain key gates for example, the depth of requirements that need to be produced could also be linked to the risk rating.	10-40 days	1-3 months	High	Medium	Operational	7	46	BAI06
3.2.2	Investigate and determine the benefits of formalising upon quality management framework (e.g. ISO 9001 or similar), for embedding into project process and policies.	10-40 days	1-3 months	Medium	Medium	Operational	7	46	APO11
3.2.3	Update the policies such that for Priority 1 projects the EPMO team is part of the governance functions to ensure compliance to ASX's processes, this is to ensure quality before a Line 3 audit is involved.	<10 days	Negligible months	Medium	Low	Operational	2	15	BAI06
3.2.4	Consider enhancing the policies such that for Priority 1 and Medium/High Risk projects, governance related reporting frequency is increased to every 2 weeks. In addition, consider the move to a dynamic dashboard-style reporting rather than document-based.	40-200 days	3-6 months	Medium	Medium	Operational	2	15	P1.04, BAI06
3.2.5	Delivery gaps should be challenged and highlighted by the governance, delivery, and EPMO functions during delivery addressed prior to Line 3 internal or external audit involvement.	<10 days	<1 month	Medium	Low	Operational	3	20	P1.04, BAI06
3.2.6	Update the policies such that Priority 1 projects are required to be run by in-house project managers who have detailed knowledge of the ASX delivery processes, procedures and tools. If this is not viable, then an EPMO member should be accountable for compliance to the project delivery processes.	<10 days	<1 month	Medium	Medium	Operational	3	20	BAI06
3.2.7	Ensure that key go-live related meetings are minuted and actions are clearly documented.	<10 days	<1 month	Medium	Low	Operational	8	34	P8.08

4. Requirements

R4.1 ASX Requirements Maintenance

ASX should maintain their own detailed requirements log to mitigate against over reliance upon a single vendor and in the event ASX would ever need to change supplier. This log would provide a means to validate the vendor's position and would be in addition to the test cases, documenting non-functional, process, integration as well as functional needs.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
4.1.1	ASX should maintain their own detailed requirements log to mitigate against over reliance upon a single vendor and in case ASX would ever need to change supplier. This log would provide a means to validate the vendors position and would be in addition to the test cases, documenting non-functional, process, integration as well as functional needs.	40-200 days	3-6 months	Medium	High	Operational	4	12	BAI02, P4.01

5. Vendor Management

R5.1 Technology Vendor Management Practices

Review and revise the technology vendor management practices to establish clear contractual arrangements, establish clear lines of dialogue regarding quality and maturity issues and establish a contractual acceptance criterion that supports ASX's quality and risk management program.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
5.1.1	Perform contract acceptance at the end of the project lifecycle, once integration and end-to-end testing have also been factored in. This would also increase the percentage of test cases and automated test cases available to execute with greater confidence. We note that this is subject to existing contractual terms and obligations, so may not always be possible.	<10 days	Negligible months	High	Low	Operational	4	17	BAI06
5.1.2	Create guidelines for supplier related contract acceptance testing e.g. X% of the final functional and non-functional test cases must be available to start the process, e.g. Y% of functional and non-functional test cases must be automated.	10-40 days	<1 month	Medium	Low	Operational	4	17	APO11
5.1.3	At the next major upgrade, ASX should evaluate the need to create a clean contractual baseline with Nasdaq to reflect current ways of working, terminology, conditions, schedules.	40-200 days	1-3 months	Low	Medium	Regulatory and Legal	N/A	19	APO10

6. Testing (1/3)

R6.1 ASX Test Culture

Create a program to raise awareness of the ASX Testing Vision and its implications on testing plans, invest in an independent QA function alongside a program of continuous test process improvement.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
6.1.1	Create a program to raise awareness of the ASX Testing Vision: "ASX is entrusted to operate systemically important national infrastructure with a near zero appetite for service disruption on many of our services. Customer and industry testing is critical and ongoing customer confidence must be instilled and maintained through early quality."	10-40 days	1-3 months	High	Low	Operational	5, 7	48	APO11
6.1.2	Establish an independent testing quality assurance service for internal projects.	10-40 days	3-6 months	High	Medium	Operational	5, 7	48	APO11
6.1.3	Design, document and implement a Continuous Test Process Improvement process.	10-40 days	1-3 months	Medium	Medium	Operational	5, 7	48	APO11

R6.2 ASX Test Methods and Technology

Enhance in-house capabilities for combinatorial testing strategies, methods, tools and datasets to combine functional, negative-functional, non-functional and operational testing at volume with representative data (real or simulated) in an end-to-end environment to create "production-like" testing scenarios targeted at reducing the risk of latent defects causing catastrophic failures in production situations.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
6.2.1	Enhance in-house capabilities for combinatorial testing strategies, methods, tools and datasets to combine functional, negative-functional, non-functional and operational testing at volume with representative data (real or simulated) in an end-to-end environment to create "production-like" testing scenarios targeted at reducing the risk of latent defects causing catastrophic failures in production situations.	40-200 days	3-6 months	High	High	Operational	4	24	APO11, P5.05
6.2.2	Review and update the central repository for all testing related policies, procedures, methods, tool description, to prove a uniformly accessible source for reference.	10-40 days	1-3 months	Low	Low	Operational	5, 7	48	APO11, P5.05, BAI09
6.2.1	Enhance in-house capabilities for combinatorial testing strategies, methods, tools and datasets to combine functional, negative-functional, non-functional and operational testing at volume with representative data (real or simulated) in an end-to-end environment to create "production-like" testing scenarios targeted at reducing the risk of latent defects causing catastrophic failures in production situations.	40-200 days	3-6 months	High	High	Operational	4	24	APO11, P5.05

R6.3 ASX Test Policy Uplift

Revise and align the ASX Testing Policy and Guidelines to the ISO 29119 Guidelines and create a training program to familiarise the teams with the ASX Vision, objectives and approach to ensuring delivery of quality products to its customers consistent with the responsibilities of ASX as an operator of a systemically important national infrastructure.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
6.3.1	Describe role based ASX test training program within the ASX test policy that supports the ASX test policy and guidelines, the ASX test methodology, and their concepts.	40-200 days	3-6 months	Medium	Medium	Operational	5, 7	48	APO11, P5.05
6.3.2	Define and document the risk-based testing approach and techniques in the testing policy.	10-40 days	<1 month	Medium	Low	Operational	5, 7	48	APO11, P5.05, BAI06
6.3.3	Adopt an overarching and detailed ASX Test Methodology which includes templates, methods and processes, job role and guidelines to ensure any compliance to ISO29119 guidelines.	40-200 days	1-3 months	Medium	Medium	Operational	5, 7	48	APO11, P5.05

6. Testing (2/3)

R6.4 ASX Test Planning

Review and update the test planning processes, test selection and design guides, templates, and reporting to align with the revised ASX Test Policy and reflect the alignment with the vision statement in the Policy.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
6.4.1	As part of the Design Authority checklist, include a solution maturity assessment that covers the market and technology maturity dimensions.	<10 days	<1 month	Medium	Low	Operational	3	9	APO03
6.4.2	Engage the market to understand the benefits and demand for the re-introduction of a performance testing environment. Post market engagement, determine the required implementation, if any.	40-200 days	6-12 months	Medium	High	Technology	4	31	P7.04
6.4.3	The final IWT/DR test weekend for High Priority projects should be more co-ordinated in nature between Participants, whilst preceding weekends remain for conformance testing purposes. For example, suggest partitions, instruments, product types and scenarios that Participants share to ensure matching.	<10 days	1-3 months	Medium	Medium	Operational	4	31	P8.07
6.4.4	Evaluate the need to update the necessary policies to require that a full ITDR/BCP test be conducted as part of the testing program prior to implementing any major system or raise a formal delivered risk.	<10 days	1-3 months	Medium	Low	Operational	5	45	RUN03
6.4.5	Create a detailed interface and integration log, and for high importance interfaces ensure that end-to-end test coverage is completed. Where interfaces are not tested, then a clear rationale should be identified, the risk should be logged in the risk register and added to the implementation readiness document. Require that all high-risk feeds and interfaces, internal and external must be included in integration and end-to end tests using test or live feeds rather than a virtualised or simulated stub.	10-40 days	1-3 months	High	Low	Operational	4	28	P4.03
6.4.6	Design, document and implement a test selection and prioritisation process supported by test design optimisation methods and/or combinatorial test tools.	10-40 days	1-3 months	High	Low	Operational	5, 7	48	APO11, P5.05
6.4.7	Document a test planning guide that prompts delivery teams to consider a wider coverage of the requirements due to inherent risks and complexities involved. For example, consider dynamic functional scenarios e.g. at start of day, in a slow market, in a very fast market, with many cancels, in a top of book scenario, in a non-top of book scenarios, across partition.	10-40 days	1-3 months	High	Low	Operational	4	13	APO11, P5.05
6.4.8	For complex high-risk projects, consider using an independent specialist party for an independent review of the plan and provide for a wider set of test capabilities in addition to internal testing. For example, for the test strategy and planning, to extend the depth and breadth of risk identification, greater test plan execution coverage.	<10 days	Negligible months	High	Medium	Operational	4	27	APO11, P5.05

R6.5 ASX Test Quality Metrics

Adopt and implement a metrics framework with an associated dashboard for testing metrics and quality tracking and reporting.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
6.5.1	Institute on-going defect analysis techniques (including defect prediction and defect modelling). Work with production tracking systems to accurately track Defect Leakage into production. Define and implement a method of linking defects to specific releases, tests and business functions. Begin tracking Defect Removal Efficiency into UAT and Production and Mandate Root Cause recording in defect analysis.	40-200 days	3-6 months	High	Medium	Operational	4	29	APO11, P5.05
6.5.2	Design and implement a rigorous quality metrics framework and testing quality index for both Testing (Product Quality) and Quality Assurance (Process Quality).	10-40 days	3-6 months	Medium	Medium	Operational	4	29	APO11, P5.05, APO11
6.5.3	Design, document and implement a test coverage tracking approach to measure coverage of tests to be executed. Apply the tracking to the current base of test cases to ensure proper coverage.	10-40 days	1-3 months	Medium	Medium	Operational	5, 7	48	APO11, P5.05
6.5.4	Create metric-based definitions for the Quality Sentiment in the test reports to understand the difference between ratings (e.g. Defined difference between good and average). Additionally, identify what actions should be taken as a result of a Quality Sentiment rating.	<10 days	<1 month	Medium	Low	Operational	4	17	APO11, P5.05, P6.06

6. Testing (2/3)

R6.6 ITDR/BCP Test Planning

Ensure that the new ASX Trade Refresh project is prioritised for the upcoming annual ITDR exercise to increase confidence and reduce risk.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
6.6.1	Ensure that the new ASX Trade Refresh project is prioritised for the upcoming annual ITDR exercise to increase confidence.	<10 days	<1 month	High	Low	Operational	4	33	P7.04

R6.7 Conformance Test Planning

Review the policy to consider whether mixing any form of customer testing with go-live weekend activities is appropriate for critical new system deliveries.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
6.7.1	Review the policy to consider whether mixing any form of customer testing with go-live weekend activities is appropriate for critical new system deliveries.	<10 days	<1 month	Medium	Low	Operational	4	30	P8.07

7. Incident Management

R7.1 Incident Management Activities

Document a policy about closing the market based on a pre-determine period of uncertainty due to an outage.

#	Task	Effort	Duration	Impact	Complexity	Category	Conclusions	Findings	Framework
7.1.1	During an outage where the Market is not in a fully open state, identify what length of time would require a default decision of closing the market and performing end of day activities, unless there are other overriding circumstances.	10-40 days	1-3 Months	Very High	Low	Operational	5	41	RUN10



This Independent Expert Report ("Report") sets out the IBM assessment of the conduct and performance of the ASX Trade Refresh Project and the IBM expert opinion on whether it was reasonable to expect the new trading platform was ready for successful production implementation and ongoing availability [REDACTED]

[REDACTED] In preparing the Report, IBM requested and relied upon ASX providing complete, accurate, relevant, timely and correct information, and all necessary rights and permissions to use such information to generate and share the Report.

[REDACTED] IBM made the final decision about the content of this Report.

The Report has been prepared for ASX, ASIC and the RBA. No other party beneficiary rights are granted or intended, and any use of this Report by another party is at its own risk.

IBM is neither a law firm nor an accounting firm. No part of the services performed constitutes legal advice, the rendering of legal services, accounting advice, or the rendering of accounting or audit services.