SCM Development Checklist

*OFFICIAL*

Should Cost Modelling



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# Context

## The requirement to produce a Should Cost Model (SCM) when making sourcing decisions and contracting outside suppliers for the delivery of **public services** is set out within the [Sourcing Playbook](https://www.gov.uk/government/publications/the-outsourcing-playbook) (see Chapter 3) and for **public works projects or programmes** within the [Construction Playbook](https://www.gov.uk/government/publications/the-construction-playbook) (see Chapter 5).

## The Sourcing and Construction Playbooks set out when contracting authorities should produce an SCM, which functions are responsible for them (see Ownership, Knowledge, Understanding and Awareness framework), and how SCMs fit within the procurement lifecycle. The accompanying [SCM Guidance Note](https://www.gov.uk/government/publications/the-outsourcing-playbook) provides high-level guidance on SCMs. It is part of a set of Cabinet Office guidance relating to SCMs:

## [**SCM Guidance Note**](https://www.gov.uk/government/publications/the-outsourcing-playbook) - outlines what SCMs are, when and why contracting authorities should produce them, and key considerations around developing and/or procuring them;

## **SCM Development Guidance** - provides contracting authorities with guidance on using internal resources to design, develop, test and manage SCMs; and

## **SCM Technical Build Guidance** - guidance, based on good practice principles for building SCMs. It is technical in nature and aimed at people who will be building SCMs.

## Practitioners should also consult existing good practice guidance including HM Treasury’s [Macpherson](https://www.gov.uk/government/publications/review-of-quality-assurance-of-government-models) report, [Aqua Book](https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government) and [Green Book](https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent).

## This Development Checklist is one of a number of practical Tools and Templates produced by Cabinet Office to support the development of SCMs and to help reinforce good practice approaches. These, together with the guidance set out above, are aligned to different phases/ stages of the model development lifecycle (see Figure 1).

## The guidance herein should be applied in a manner that is proportional to the risks associated with a specific SCM and its use. Whilst adherence to it is not mandated, it is recommended where there is nothing similar in use within the contracting authority.

## You should consult the Cabinet Office Sourcing Programme for further information or before planning an SCM for complex services, projects or programmes via [sourcing.programme@cabinetoffice.gov.uk](mailto:sourcing.programme@cabinetoffice.gov.uk).

# Introduction

## Effective governance, Quality Assurance (QA) and testing is an essential element of Should Cost Modelling. It helps to ensure that SCM outputs have integrity and that decisions based upon them are made with an appropriate understanding of evidence, including of associated risks and uncertainties.

## This Development Checklist is used to document QA and other good practice activities performed over the course of a model’s development lifecycle. This, together with supporting documentation, such as Test Memos, QA Reports and signed-off model documentation, will provide an audit trail and evidence to demonstrate the performance of QA and testing, and demonstrate the application of good practice and the governance processes followed.

## It poses a series of questions designed to both inform and check the application of governance, QA and testing, and good practice model development principles over the course of a model’s lifecycle.

## It aims to help manage the risks that an SCM is not developed in-line with the needs of the decision-making community; is not built in line with good practice; is not well governed or has not been subject to appropriate QA and testing.

## It has been designed to be completed over the course of model development and not once a model has been built. The relevant section of this Development Checklist should be completed before progressing to the next phase / stage of model development (see Figure 1).

## This Development Checklist includes key checks which should be considered when developing an SCM. When completing it, consider the criticality and the sophistication/ complexity of the SCM and tailor this Development Checklist accordingly. For models supporting low impact decisions that are simple in nature there may be a number of ‘No’ or ‘NA’ responses.

## Before using this Development Checklist, the following points should be noted:

## There is no ‘one size fits all’ approach to SCM governance, QA and testing which are not delivered through a single activity. They are delivered through a range of measures and activities over the model’s lifecycle;

## Some decisions are more important than others and some SCMs that support those decisions pose a greater risk than others. In-turn, the level of governance, QA and testing applied should be proportionate (see [Aqua Book](https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government));

## The proportional approach to governance, QA and testing should also apply to the seniority of responsibilities and to the skills and experience of those involved in developing the SCM. Higher risk SCMs increase the level of responsibilities and demand higher levels of skills and experience;

## This Development Checklist is not an exhaustive list and completing it provides no guarantee of an SCM’s fitness for purpose. Broader measures and activities, such as those outlined in the [Aqua Book](https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government) and the other publications noted above, will need to be considered and applied;

## Some contracting authorities may require additional measures and activities and they may use different terminology to that contained herein. This Development Checklist should be tailored to the requirements of individual contracting authorities and SCMs; and

## This Development Checklist is primarily aimed at SCMs developed in spreadsheet-based applications, such as Microsoft Excel. However, the general principles are applicable to SCMs developed using other software, such as databases.

**Figure 1: Model Development Lifecycle** (Including SCM Governance Process Overview and Supporting Cabinet Office Guidance, Tools and Templates)



*\*Key documentation to produce included in square brackets ‘[ ]’ are optional, depending on requirements.*

## This Development Checklist is divided into a number of sections that align with the Model Development Lifecycle phases / stages (see Figure 1):

## **Plan Checklist** focuses on checking that the risks associated with the model are understood, that model scoping process is sufficient and that decision makers have input into the model requirements and high-level design;

## **Design Checklist:** focuses on checking that the model has been designed in sufficient detail, that appropriate data is available and that sign-offs have been secured before proceeding with model build;

## **Develop Checklist:** focuses on checking the application of good practice model build guidance and approaches to incorporating and documenting the data used within the model;

## **Test Checklist:** focuses on the formal QA and testing applied to the model during the test phase and whether tests have been performed to help manage development risk; and

## **Use Checklist:** focuses on the application of controls and the availability of documentation to support the model when in use.

## A consolidated list of checks covering each of the above sections is available in Appendix I.

## This Development Checklist uses GCF branding for illustrative purposes. Please remove GCF branding and update to reflect the branding of your contracting authority prior to populating it.

## Consider the need to add Protective Markings to this Development Checklist ahead of populating it.

# Plan Checklist

Checklist

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | https://lh6.googleusercontent.com/Q4HOqmu4KmIZ5Oy_heTLv5_skJQM0sXOs92Vme6jqs8m0dlW9PDxRZgdH159zv-EaOJBMitfMX_HZQ-UKe9MqiVt10jgxnVWF-zuXgll5_RKeMYmVIJ9LmwFrhlFBGkzP5UN3402O-Qhttps://lh3.googleusercontent.com/nZtsqpnLJfpaNy5-NAOaZmBKSDWB6Zi7kGTZjPLyTYj2kOxvjolYPByAs-MdXlaJOLnTav-P9JrOUAwkLdUQRmZl8WKq2Yuf7vHtv-or8KM-dTDta4lMQlnYv4YWp25c0x_xvCtZJ44**Question** | **Ref** | **Y/N/NA** | **Details / Notes** |
| 1 | Has an Initial Model Assessment been undertaken and the results communicated to key stakeholders? | 3.1 |  |  |
| 2 | Has a clear and comprehensive model Scope been prepared? | 3.2 |  |  |
| 3 | Have necessary resources been identified in the model Scope and made available to the programme? | 3.3 |  |  |
| 4 | Has the approach to QA and testing been clearly set out? | 3.4 |  |  |
| 5 | Has a preliminary Delivery Plan been prepared? | 3.5 |  |  |
| 6 | Has sufficient time and specialist resource been allocated to undertake formal QA and testing to an appropriate level? | 3.6 |  |  |
| 7 | Has a single, named, Model SRO been appointed? | 3.7 |  |  |
| 8 | Have the model Scope, Delivery and QA Plans, been socialised with key stakeholders? | 3.8 |  |  |
| 9 | Have the model Scope, Delivery and QA Plans, been signed-off for use? | 3.9 |  |  |

Guidance

## **Has an Initial Model Assessment been undertaken and the results communicated to key stakeholders?**

The [SCM Guidance Note](https://www.gov.uk/government/publications/the-outsourcing-playbook) sets out the requirement to undertake an Initial Model Assessment (IMA) to help gauge the risks associated with an SCM and inform governance, QA and testing activities. It is important that all key stakeholders are aware of the SCM’s risk profile as it will impact on their responsibilities and the performance of their roles.

An IMA Tool has been developed by the Sourcing Programme to help contracting authorities to select appropriate and proportionate approaches to develop and test SCMs. This is informed by the Cabinet Office [Tiering Tool](https://khub.net/group/gcf-community/group-library/-/document_library/Sz8Ah1O1ukgg/view_file/70330206?_com_liferay_document_library_web_portlet_DLPortlet_INSTANCE_Sz8Ah1O1ukgg_redirect=https%3A%2F%2Fkhub.net%3A443%2Fgroup%2Fgcf-community%2Fgroup-library%2F-%2Fdocument_library%2FSz8Ah1O1ukgg%2Fview%2F70329062%3F_com_liferay_document_library_web_portlet_DLPortlet_INSTANCE_Sz8Ah1O1ukgg_navigation%3Dhome%26_com_liferay_document_library_web_portlet_DLPortlet_INSTANCE_Sz8Ah1O1ukgg_orderByCol%3DmodifiedDate%26_com_liferay_document_library_web_portlet_DLPortlet_INSTANCE_Sz8Ah1O1ukgg_orderByType%3Ddesc%26_com_liferay_document_library_web_portlet_DLPortlet_INSTANCE_Sz8Ah1O1ukgg_fileEntryTypeId%3D-1), which should be used to provide an initial indicator of the criticality of the decision that the SCM is designed to support

## **Has a clear and comprehensive model Scope been prepared?**

The model Scope sets out and enables communication and agreement on why an SCM is required and what it needs to do. The model Scope, Delivery and QA Plans, contain key information that helps to set the high-level design of a model and the activities required to deliver it. In general, they cover:

## **Overview** -project background; the decision or issue the model is intended to solve; approximate value of the decision; required model outputs; user requirements; how accurate the model needs to be; project and model development timescales; stakeholders; approvers; key deliverables (e.g. the model, User Guide, Book of Assumptions / Data Log); etc.

## **Costs** - the range of costs (and benefits) to be included in the model; the main assumptions behind these costs; the key cost drivers; cost characteristics (e.g. fixed or variable, direct or indirect); the required granularity or depth of analysis; the model time period and periodicity; KPI requirements; limitations and out of scope areas; etc.

## **Modelling Techniques** - the required techniques (e.g. Monte Carlo); the need for specialist input and how it will be secured; how risk and uncertainty will be managed; which inputs are subject to uncertainty; what risks will be included; the need for scenarios, sensitivities and switching values; the approach to optimism bias; etc.

## **Data and Assumptions** - the key data requirements and collection processes; the expected data volumes, types and formats; the need for data validation checks; the expected frequency of data updates during and after development; the need for assumptions in place of data sets; etc.

## **Tool Selection** - what tool will be used (e.g. MS Excel); if there is a pre-existing model or if a new model is required; if add-ins or specialist software are required; whether the model will need to interact with other systems (e.g. feeder models or databases); whether the model needs to conform to specific guidelines (e.g. the SCM Technical Build Guidance); how long the model will be required for; etc.

## **Quality Assurance Plan** - the required level of assurance over model outputs (informed by the Initial Model Assessment); the required test and review procedures (e.g. verification and validation); if there is a need for review and testing by an independent entity; the availability of independent, suitably qualified and experienced resource; if sufficient time has been allowed for testing, including model developer self-testing; whether specialist software is required; if UAT is required and has been scheduled; how will model development be governed; etc.

## Further details on model scoping can be found in the [SCM Guidance Note](https://www.gov.uk/government/publications/the-outsourcing-playbook). An SCM Scoping Template, produced by the Sourcing Programme, is also available to help contracting authorities in the preparation of a model Scope.

## **Have necessary resources been identified in the model Scope and made available to the programme?**

Model development is resource intensive and demands specialist skills and experience. It is important to identify appropriate resources and agree the time commitment required to support production of a model. Notably, considerations should extend beyond resources required to build and test the model and also include areas such as data provision or providing subject matter expertise.

When identifying resources, it is important to consider whether they have the required skills and experience. For example, if development of the model requires the use of VBA or specialist techniques (e.g. Monte Carlo simulation), then quality assurers should have appropriate skills and experience (see [SCM Guidance Note](https://www.gov.uk/government/publications/the-outsourcing-playbook) for typical roles in the development of an SCM and guidance on resourcing). This check assesses whether appropriate resources have been identified and confirmed as available when required.

## **Has the approach to QA and testing been clearly set out?**

SCMs can pose substantial risks to a contracting authority and the need for effective QA and testing cannot be overemphasised. These risks extend beyond financial risks and include reputational, regulatory, legal and other risks. The IMA (see Section 3.1) will help to inform appropriate and proportional QA and testing activities. These activities, which should be tailored for each SCM, should be clearly set out within a QA Plan. They should include details of the specific tests that need to be performed prior to and following release of the model (e.g. logic testing, analytical review, etc.). Notably, they must extend beyond checking the model’s calculations for errors and its alignment with the specification (verification) and must also include checks that the model is appropriate, i.e. fit for the purpose for which it is being used (validation). The QA Plan should also include overall governance procedures, which are broader than testing.

Further details on QA and testing can be found in the [Macpherson](https://www.gov.uk/government/publications/review-of-quality-assurance-of-government-models) report, [Aqua Book](https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government), and the SCM Development Guidance. An SCM QA Plan Template has also been produced by the Sourcing Programme to help contracting authorities in the preparation of a QA Plan.

## **Has a preliminary Delivery Plan been prepared?**

Preparing a Delivery Plan is an important part of model planning. It is a key project management aid that provides clear timelines and milestones to work towards. It helps to ensure that sufficient time has been allowed for key activities, such as model testing, can provide insights into the impact of delivery risks, and enables the delivery schedule to be shared and agreed with stakeholders. A preliminary Delivery Plan should be prepared at an early stage and updated throughout model development.

An SCM Planning Template has been produced by the Sourcing Programme to help contracting authorities in the preparation of a Delivery Plan.

## **Has sufficient time and specialist resource been allocated to undertake formal QA and testing to an appropriate level?**

The [Aqua Book](https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government) highlights the importance of specialists with sufficient time to undertake formal QA and testing. As a broad ‘rule of thumb’, and with reference to the development lifecycle (see Figure 1), model testing will consume around one third of development time. The remaining two thirds being split between the plan & design and develop phases. This is an approximation, which will vary from model-to-model, but the rationale for deviations should be clearly understood.

Notably, in situations where there are unavoidable time constraints that impinge upon the ability to perform an appropriate, proportional level of QA and testing, this should be explicitly acknowledged and reported (see [Aqua Book](https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government)). Consider whether both the planned QA and testing activities are appropriate and that sufficient time has been allocated to appropriately skilled and experienced quality assurers (see [SCM Guidance Note](https://www.gov.uk/government/publications/the-outsourcing-playbook) for guidance on resourcing with suitably qualified and experienced personnel).

## **Has a single, named, Model SRO been appointed?**

All models should have a single, named, Model Senior Responsible Owner (Model SRO) who is responsible for the model throughout its lifecycle, from initial planning through model use and beyond. This includes the ultimate responsibility for model planning, designing, developing, testing, model governance and control, and model outputs and their use (see [Aqua Book](https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government) for more details on the responsibilities of the Model SRO and other governance roles and groups).

The Model SRO’s seniority should be proportionate to the model’s risk and impact. Prior to using the model (see Section 7), the Model SRO needs to be content and confirm that the QA process followed is appropriate and compliant, that model risks, limitations and major assumptions are understood by all users of the model, and that the model and its outputs are fit for purpose. Model SROs do not need to be modelling specialists but must ask the right questions to satisfy themselves that the model is fit for purpose.

## **Have the model Scope, Delivery and QA Plans, been socialised with key stakeholders?**

It is important to ensure that the model Scope, Delivery and QA Plans, are understood by stakeholders affiliated with the programme. One of the key areas within the model Scope focuses on identifying stakeholders of the model. The model Scope needs to be socialised with them so that stakeholders have an opportunity to input into and challenge the scope of the model. Stakeholders need to be content that the model Scope is sufficient to meet the stated requirements, its limitations are acceptable, the Delivery Plan aligns with their needs and the approach to QA and testing is sufficient to help mitigate the associated risks to an acceptable level.

## **Have the model Scope, Delivery and QA Plans, been signed-off for use?**

Once input has been gained from stakeholders it is important to have the model Scope, Delivery and QA Plans, signed-off by the Model Senior Responsible Owner (Model SRO). Iteration and rework raises the risk of model errors and becomes more disruptive the closer a model is to being complete. This sign-off provides assurances that the high-level direction of the model meets the needs of the stakeholder population and reduces the likelihood of rework once substantive development activity has taken place. It also evidences the Model SRO’s acceptance of the proposed approach, QA and Delivery Plans, resource requirements and model limitations/out of scope areas.

# Design Checklist

Checklist

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | https://lh6.googleusercontent.com/Q4HOqmu4KmIZ5Oy_heTLv5_skJQM0sXOs92Vme6jqs8m0dlW9PDxRZgdH159zv-EaOJBMitfMX_HZQ-UKe9MqiVt10jgxnVWF-zuXgll5_RKeMYmVIJ9LmwFrhlFBGkzP5UN3402O-Qhttps://lh3.googleusercontent.com/nZtsqpnLJfpaNy5-NAOaZmBKSDWB6Zi7kGTZjPLyTYj2kOxvjolYPByAs-MdXlaJOLnTav-P9JrOUAwkLdUQRmZl8WKq2Yuf7vHtv-or8KM-dTDta4lMQlnYv4YWp25c0x_xvCtZJ44**Question** | **Ref** | **Y/N/NA** | **Details / Notes** |
| 1 | Have model input templates been prepared and are they appropriately laid out? | 4.1 |  |  |
| 2 | Have model output templates been prepared and agreed? | 4.2 |  |  |
| 3 | Is the model’s level of granularity appropriate and has it been agreed? | 4.3 |  |  |
| 4 | Has the model’s calculation logic been documented and agreed with relevant stakeholders and subject matter experts? | 4.4 |  |  |
| 5 | Has risk and uncertainty been appropriately considered and addressed? | 4.5 |  |  |
| 6 | Have model limitations and out of scope areas been set out? | 4.6 |  |  |
| 7 | Has a model map been developed? | 4.7 |  |  |
| 8 | Have the logic flows within the model been designed? | 4.8 |  |  |
| 9 | Has a model style guide been created? | 4.9 |  |  |
| 10 | Have data requirements and associated data sources been identified? | 4.10 |  |  |
| 11 | Have data custodians been identified and a Data Plan prepared? | 4.11 |  |  |
| 12 | Have data sources been reviewed for quality? | 4.12 |  |  |
| 13 | Have any required data maturity plans been prepared? | 4.13 |  |  |
| 14 | Does the model Specification (inc. Design) reflect and meet the requirements set out in the model Scope? | 4.14 |  |  |
| 15 | Has the model Specification (inc. Design) been socialised and agreed with relevant stakeholders and signed off by the Model SRO? | 4.15 |  |  |

Guidance

## **Have model input templates been prepared and are they appropriately laid out?**

Producing templates for model inputs (e.g. data and assumptions) prior to engaging in substantive model development has numerous benefits. For example, it can inform data collection, help to ensure that data is received in the required format, inform model design and help to reduce the risk of requirements misinterpretation. When reviewing the templates consider if the inputs have been set out in a logical manner. For example, consider if there is a clear and logical separation between the different types of inputs and whether their organisation helps to reduce the risk of confusion. Consider if appropriate labels (including a unit of measurement) have been included to guide users as to the different input types.

## **Have model output templates been prepared and agreed?**

Producing model output templates prior to engaging in substantive model development effort is an important activity. It enables the target outputs of the model to be socialised, agreed and signed off by the decision-making community. Iterating the model during the design phase is more efficient than after substantive development has taken place. This approach helps to manage the risk that the model will not produce the required outputs or present them in the desired way.

## **Is the model’s level of granularity appropriate and has it been agreed?**

With the model inputs and outputs laid out it is important to consider if the level of detail that the model outputs will provide is appropriate. There can be too much detail as well as too little and, as a general rule, greater detail increases complexity. This check assesses whether the level of granularity has been socialised and agreed before commencing substantive model development activities.

## **Has the model’s calculation logic been documented and agreed with relevant stakeholders and subject matter experts?**

Writing calculations ‘long-hand’ enables them to be socialised and agreed. Agreement should be sought from relevant stakeholders (e.g. model customers) and subject matter experts (as required). Documenting calculations increases the transparency and overall understanding of the model. It also helps to streamline testing by providing a reference against which the model can be compared (see Section 6). Setting out model calculations within a dedicated section of the model Specification will aid socialising calculation logic and their later inclusion within the model.

## **Has risk and uncertainty been appropriately considered and addressed?**

Models are a representation of the real world and are invariably subject to risk and uncertainty. This can have a material impact on model outputs and the model Specification should set out how risk and uncertainty will be addressed. This should include the identification of risks and uncertainties, how they will be evaluated and quantified, and any dependencies between them (for more details on risk and uncertainty see [Aqua Book](https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government) and [Green Book](https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent), which also addresses Optimism Bias).

The evaluation of risk and uncertainty invariably demands input from specialists and, depending on the approach taken, can be time and resource intensive. It is important, therefore, to understand how different approaches, such as probabilistic methods, sensitivity or scenario analysis, will impact the ability to make informed decisions, so that the most appropriate approach can be adopted.

The ultimate aim of risk and uncertainty analysis is to quantify its combined impact on model outputs and to present this combined impact alongside model outputs. This will enable decision makers to understand the extent to which model outputs can be relied upon for a particular purpose. Notably, decision makers should be informed as early as possible of any difficulties or expected difficulties in the quantification of risks and uncertainties.

## **Have model limitations and out of scope areas been set out?**

Models are designed for a specific purpose and will have inherent limitations on what they can do or what they should be used for. Explicitly stating both what is out of scope and what are the key limitations within the model Specification increases the shared understanding of the model's planned capabilities. It both helps to ensure that requirements are met and that effort is not wasted in developing aspects that are not required to support the decision. It also helps to reduce miscommunication and the risk of the model not meeting the needs of stakeholders.

## **Has a model map been developed?**

Collectively, the model map and logic flows (see Section 4.8) are central to the structural design of the SCM. It is important that these are both carefully considered ahead of model development as structural changes can be hard to implement once development has commenced. A model map enables the high-level design, informed by the model Scope and Specification, to be translated into a visual depiction of how the model will be assembled and operate once in use. This can help to improve understanding and support QA and testing activities. A model map that clearly shows how each of the model components (e.g. worksheets) are arranged should be prepared and included within the model to enable navigation and enhance the user experience.

## **Have logic flows within the model been designed?**

Logic flows show how the different model components (e.g. worksheets) within the model interact. They depict how data flows from inputs through calculations to outputs. The model map should include logic flows that articulate which inputs inform which calculations and which calculations produce which outputs. These flows should be visually represented within the model map and reviewed. See SCM Technical Build Guidance for more details on good practice approaches to model design.

## **Has a model style guide been created?**

A model style guide should be created prior to undertaking substantive development activity. Formats to be employed and how objects are to be presented in the model should be documented as part of the design activity. Establishing a style guide for the model will drive consistency across development, help to reduce the risk of errors and improve usability and understanding once the model is released for use. Note, this step will likely be covered off if using a model build template, with predefined styles already set up.

An SCM Build Template, that is set up with predefined styles, has been produced by the Sourcing Programme for adaptation and use by contracting authorities.

## **Have data requirements and associated data sources been identified?**

With the model input templates prepared, consider if the data requirements are clear and if appropriate data sources have been identified and documented in a Data Plan. Identifying the data that a model will need and assessing its availability are essential steps from a data planning perspective. The purpose of this check is to help manage the risk of developing a model without due consideration of all the data required to enable its operation.

The Data Plan will form the basis for the Book of Assumptions / Data Log, which should be maintained throughout the model’s life. An SCM Book of Assumptions / Data Log Template has been produced by the Sourcing Programme for adaptation and use by contracting authorities.

## **Have data custodians been identified and a Data Plan prepared?**

Consider if data owners have been identified, points of contact established and whether named individuals are aware of their responsibilities, including associated timelines. Being able to identify owners of data sets allows for a dialogue to be established and questions relating to its availability and quality answered. Having nominated individuals will facilitate the gathering of model data, assist with refreshing the model, and help with answering output questions or testing points.

## **Have data sources been reviewed for quality?**

Data targeted for inclusion into the model should be reviewed critically. If it is not fit for purpose alternative sources may need to be considered and/or it may necessitate changes to the model design. Data quality should therefore be considered early in the model development lifecycle. Data sources should be looked at to determine whether they are, for example:

* **Accurate** – sufficient fidelity for the intended purpose;
* **Valid** – sourced using the correct rules and definitions;
* **Reliable** – sourced using a stable and consistent collection methodology;
* **Timely** – collected within appropriate timeframes;
* **Relevant** – usable in support of the current task; and
* **Complete** – free from gaps with all necessary fields completed.

## **Have any required data maturity plans been prepared?**

Upon reviewing the data sources, and where deficiencies have been observed, it can be useful to prepare a plan to remedy these deficiencies.

## **Does the model Specification (inc. Design) reflect and meet the requirements set out in the model Scope?**

The model Specification (inc. Design) and Book of Assumptions / Data Log will ultimately supersede the model Scope. The model Specification should build on and include much of the content set out in the model Scope (e.g. project background, model purpose, etc.). This is a check to establish if the outputs from the model design phase align with and meet the requirements set out in the model Scope. If there are deviations, it is important to ensure that all stakeholders engaged in production and approval of the model Scope are made aware and appropriate approvals are obtained.

An SCM Specification Template Example has been produced by the Sourcing Programme for adaptation and use by contracting authorities.

## **Has the model Specification (inc. Design) been socialised and agreed with relevant stakeholders and signed off by the Model SRO?**

The model Specification (inc. Design) and Data Plans need to be socialised and approved by the decision-making community, including the Model Senior Responsible Owner (Model SRO). Iteration is to be expected at this stage, for example, in terms of the model’s proposed data sources, level of detail, calculation methodology, output presentation and/or the model’s organisation. It is important to formally agree and to gain approval of the model Specification (inc. Design) before commencing substantive model development activities.

# Develop Checklist

Checklist

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | https://lh6.googleusercontent.com/Q4HOqmu4KmIZ5Oy_heTLv5_skJQM0sXOs92Vme6jqs8m0dlW9PDxRZgdH159zv-EaOJBMitfMX_HZQ-UKe9MqiVt10jgxnVWF-zuXgll5_RKeMYmVIJ9LmwFrhlFBGkzP5UN3402O-Qhttps://lh3.googleusercontent.com/nZtsqpnLJfpaNy5-NAOaZmBKSDWB6Zi7kGTZjPLyTYj2kOxvjolYPByAs-MdXlaJOLnTav-P9JrOUAwkLdUQRmZl8WKq2Yuf7vHtv-or8KM-dTDta4lMQlnYv4YWp25c0x_xvCtZJ44**Question** | **Ref** | **Y/N/NA** | **Details / Notes** |
| 1 | Have formulas been reviewed for consistency with the model Specification? | 5.1 |  |  |
| 2 | Have formulas been reviewed to check that they are free from constants? | 5.2 |  |  |
| 3 | Have formulas been reviewed to check that they are free from unnecessary complexity? | 5.3 |  |  |
| 4 | Have formulas been reviewed to check that only recommended formula have been used? | 5.4 |  |  |
| 5 | Have in-built model checks been developed, are they sufficient and have they been tested? | 5.5 |  |  |
| 6 | Have all worksheets been reviewed for consistency? | 5.6 |  |  |
| 7 | Has all labelling been reviewed for completeness? | 5.7 |  |  |
| 8 | Has any included Conditional Formatting been reviewed to check that it is operating as intended? | 5.8 |  |  |
| 9 | Has appropriate cell, worksheet and workbook protection been applied? | 5.9 |  |  |
| 10 | Have the outputs been reviewed to ensure that they contain the correct labelling? | 5.10 |  |  |
| 11 | Have graphs and charts been reviewed to ensure that they are linked to the correct data sources? | 5.11 |  |  |
| 12 | Have outputs been setup for printing? | 5.12 |  |  |
| 13 | Have any development features (e.g. notes, dummy data, test calculations, etc.) been removed? | 5.13 |  |  |
| 14 | Are all elements of the model visible? | 5.14 |  |  |
| 15 | Have all Named Ranges been reviewed for appropriateness and documented? | 5.15 |  |  |
| 16 | Have all external links been reviewed for appropriateness and documented? | 5.16 |  |  |
| 17 | Has the VBA been tested to confirm that it operates as intended? | 5.17 |  |  |
| 18 | Has a Version Control Log been included? | 5.18 |  |  |
| 19 | Has a spell check been performed? | 5.19 |  |  |
| 20 | Has a User Guide been developed to support the model? | 5.20 |  |  |
| 21 | Has a Technical or Developer Guide been developed to support the model? | 5.21 |  |  |
| 22 | Has all required data been provided? | 5.22 |  |  |
| 23 | Has all legacy data been cleansed prior to incorporating new data sets? | 5.23 |  |  |
| 24 | Has the Book of Assumptions / Data Log been prepared and are all data records complete? | 5.24 |  |  |
| 25 | Has all data pre-processing or manipulation been documented? | 5.25 |  |  |
| 26 | Has the maturity of the data within the model been assessed and approval to use the data been obtained? | 5.26 |  |  |
| 27 | If scenarios are being modelled, have the configuration settings for the scenario been recorded? | 5.27 |  |  |
| 28 | Has an Important Notice been added to the model? | 5.28 |  |  |
| 29 | Has the build been signed-off as appropriate to submit for formal QA and testing? | 5.29 |  |  |

Guidance

## **Have formulas been reviewed for consistency with the model Specification?**

The model Specification should contain a detailed list of long-hand, written, calculations that the model will perform (see Section 4.4). The developer, as part of the model build process, should review all formulas for compliance with the model Specification prior to releasing it for testing. It is important that the model Specification is current and accurate.

## **Have formulas been reviewed to check that they are free from constants?**

Constants, such as dividing an annual number by a static ‘365’, should not be contained within formula. It is important to remove any static or constant numbers from formulas and include them as labelled and delineated inputs to the model (see SCM Technical Build Guidance for further details, including acceptable deviations). A review is necessary to ensure that any ‘placeholder’ calculations have been cleansed from the model and replaced with formulas that are in line with good practice.

## **Have formulas been reviewed to check that they are free from unnecessary complexity?**

There are many modelling solutions that can produce the desired result. Complex formulas can be used to achieve the desired result but are more prone to error, take longer to review, detract from understanding and decrease overall usability. Formulas should be reviewed for unnecessary complexity and targeted for replacement. Where complexity has been identified it may be appropriate to break them out into smaller sub-components (e.g. over a number of rows or columns) or to reconsider the model’s operational logic to simplify it.

## **Have formulas been reviewed to check that only recommended formula have been used?**

Akin to complexity, there are often alternative formulas and/or mechanisms to achieve the same result. Some formulas are more robust and more capable of handling changes, including with a reduced risk of error, than others. Moreover, some formulas, such as MS Excel’s NPV formula, do not provide the level of transparency that is desired of good practice. The SCM Technical Build Guidance lists numerous formulas that should, where possible, be avoided in the construction of models. A check should be performed, by reference to the SCM Technical Build Guidance, to check formulas that should be avoided are not included in the model.

## **Have in-built model checks been developed, are they sufficient and have they been tested?**

Checks should be developed within the model to give confidence that, when the model is in use, it continues to function within the bounds of the checks. A review should be performed on in-built checks to test whether they are sufficient to help mitigate common risks and that they are all working as intended. Considerations should include:

* Arithmetical correctness - do the numbers add up?
* Outliers - do balances lie outside expected ranges?
* Format - are the entered inputs of the correct type?
* Completeness - have all inputs been populated?

If there is an inadequacy of in-built checks, revisit the development and consider implementing additional checks and/or controls within the model. It is essential that checks are networked (linked to a master check) and overtly visible to users. If an issue is present, regardless of where it is in the model, it should be flagged to the user. Error checks should be overtly clear wherever the user is within the workbook, including on output sheets. All checks should be tested by the developer to confirm they are working correctly.

## **Have all worksheets been reviewed for consistency?**

Worksheets should have consistency to drive maintainability, usability and understanding, and to help reduce the risk of error. Columns should be used consistently and labels should serve the same purpose wherever they are in the workbook. Each worksheet should be reviewed to check that the model is arranged uniformly and that styles, formats, layouts and labels are consistent, both within each worksheet and across the entire workbook.

## **Has all labelling been reviewed for completeness?**

Each point of data entry, calculation or output should be appropriately labelled, including with applicable units. Consider if a review has been performed to check that each object within the model is appropriately labelled, with a description that is sufficient to inform a user as to its purpose.

## **Has any included Conditional Formatting been reviewed to check that it is operating as intended?**

MS Excel’s Conditional Formatting can aid the usability of a model and reduce the risk of erroneous use. However, if it is not applied correctly the reverse may also be true and it can pose a risk to the integrity of a model. For example, Conditional Formatting could indicate to a user that input cells were not in use or no inputs were required when the reverse was true. It could also mask the presence of errors within the in-built error check network. It is important to review and, moreover, stress test the application of any Conditional Formatting within the model.

## **Has appropriate cell, worksheet and workbook protection been applied?**

Cell protection can be used to help manage the risk of a model being inadvertently corrupted (e.g. by inputting data into a calculation space). As part of development checks, it is important to consider where protection should be applied and to test that it has been applied correctly. Notably, cell protection in itself needs to be combined with worksheet protection to be effective. Workbook protection can add further robustness, including to the structure of the model.

Any use of passwords (which are not necessary to apply protection) should follow contracting authority policy. If passwords are used, it is important to ensure that measures are in-place to help manage the risk of password loss (e.g. using a central vault). See SCM Development Guidance.

## **Have the outputs been reviewed to ensure that they contain the correct labelling?**

As part of the preparation of the model Specification, example outputs will be prepared (see Section 4.2). As they become fully developed within the model, it is important to check that the labelling, including on graphs and charts, is sufficient to explain outputs to users and to help reduce the risk of misinterpretation and misuse. For models that can be configured differently (e.g. for different scenarios or sensitivities) it is important that the output labelling reflects the model’s active configuration. A review should be performed to check that the model outputs are appropriately labelled and designed in a way that is aligned with the needs of the user community.

## **Have graphs and charts been reviewed to ensure that they are linked to the correct data sources?**

Graphs and charts can convey greater meaning than data alone and can also help with testing. For example, it can be easier to identify anomalies from graphs and charts than in tables of data. It is important to check that graphs and charts link to the correct data sources and that their labelling is appropriate. For models that can be configured differently (e.g. for different scenarios or sensitivities) it is important that the labelling of graphs and charts reflects the model’s active configuration.

## **Have outputs been setup for printing?**

Whilst the printing of model outputs is not routine, it is good practice to ensure that outputs are setup for printing. This includes orientation and page breaks as well as inclusion of key information in sheet headers such as timelines, and footers such as file version name, date and Protective Marking. This facilitates printing at short notice and helps to reduce the risk of an outdated paper copy from being relied upon.

## **Have any development features (e.g. notes, dummy data, test calculations, etc.) been removed?**

It is commonplace during model build to write temporary calculations, to add development notes, and to use dummy data to test the operational logic of the model or to support stakeholder feedback. Prior to release, a check should be performed to ensure that anything that has been used to support the development has been cleansed from the model. This helps to manage the risk that development effort misleads users or inappropriate information is shared when the model is released.

## **Are all elements of the model visible?**

This check looks to ensure that the model is transparent and nothing remains hidden. Hidden elements can confuse users either as to the operation or the underlying logic of the model. In some situations, they can also increase the risk of inadvertent model corruption. There should be no hidden rows or columns within the model’s used range. Notably, this does not apply to MS Excel’s Group feature, which can aid usability.

The requirement to hide worksheets should be carefully considered and should generally be avoided if the ability to understand model logic will be hampered.

## **Have all Named Ranges been reviewed for appropriateness and documented?**

A variety of errors can be masked within MS Excel’s Named Ranges. They should all be reviewed to confirm that they cover the correct area, are not unnecessarily duplicated, are at the appropriate level (e.g. workbook or worksheet) and do not include #Ref! errors. It is good practice to list them in the model / model documentation along with details of their coverage and purpose. The SCM Technical Build Guidance provides good practice in relation to the use of Named Ranges, including naming conventions. Any redundant or bogus Named Ranges, (which can be inadvertently introduced when copying from another file) should be removed. All Named Ranges should be reviewed for accuracy, adherence with good practice, redundancy and documented.

## **Have all external links been reviewed for appropriateness and documented?**

A variety of errors can be masked within external links (e.g. to feeder files). It is generally advisable to avoid the use of external links. Where used, they should be reviewed to confirm that they link to the correct source data and that their update settings are appropriate. It is good practice to list them in model documentation along with details of the linked data, source files and update protocols. The SCM Technical Build Guidance provides good practice in relation to the use of external links, where they are deemed necessary. This includes their delineation and organisation with the model, and their use and the documentation of their onward use within source files. Any redundant or bogus external links (which can be inadvertently introduced when copying from another file), should be removed. All external links should be reviewed for accuracy, adherence with good practice, redundancy, and documented.

## **Has the VBA been tested to confirm that it operates as intended?**

In comparison to MS Excel, VBA is typically less transparent, less accessible and more susceptible to errors. The SCM Technical Build Guidance advises against the use of VBA or macros, including custom functions, to perform calculations that impact SCM outputs. Where VBA is used to perform calculations or for purposes other than calculations (e.g. for User Interface functionality), the SCM Technical Build Guidance notes that:

* Only those who are suitably qualified and experienced should develop VBA;
* The VBA code should be developed in line with good practice principles; and
* Independent, suitably qualified and experienced resource should test the VBA.

It is important to ensure that VBA has been appropriately developed and tested. Notably, aspects of this testing should include confirming that the VBA operates as intended in the target operating environment and, if applicable, when the SCM is configured in a locked/protected state (see Section 5.9).

## **Has a Version Control Log been included?**

As the model is developed it is good practice to periodically save interim versions of the model. This can enable roll-back or comparison with prior versions and also helps to reduce the impact of inadvertent file loss or corruption. Adopting an appropriate version naming convention will support this process. Providing a record of changes between versions within a Version Control Log is considered good practice. This level of rigour is particularly important after development where individuals, other than the developer, interact with the file. In the case of testing, for example, multiple different versions of the model may pass between developer and quality assurer as issues are addressed by the developer and then checked by the quality assurer. In the absence of effective version control, the risk of the wrong model being tested or developed is heightened. A version naming system should be adopted and an up-to-date Version Control Log included within the model.

The SCM Build Template, produced by the Sourcing Programme, includes a Version Control Log that that can be adapted and used within the SCM Build Template or another workbook as required.

## **Has a spell check been performed?**

Misspelling and typographical mistakes can reduce confidence in the model and a spell check should be performed prior to release.

## **Has a User Guide been developed to support the model?**

A User Guide should inform the user on how to operate the model. It should contain instruction on how to run the model, how to update inputs, configure scenarios etc. It is important not to underestimate the utility of having written instruction on how to work with the model once it has been developed. User Guides help to reduce the risk of misusing the model and minimise questions on operation by helping users to be more self-sufficient when operating the model. The development of a User Guide is particularly recommended for:

* Models that are not, or may not be, operated by the model developer;
* Models that are expected to be, or may be, in use for an extended period; and
* Models where there will be no access, or a risk of no or limited access, to the model developer.

The User Guide needs to be sufficient to enable a new user to run the model, interpret outputs and, as required, to configure the model and to refresh inputs.

## **Has a Technical or Developer Guide been developed to support the model?**

A Technical or Developer Guide should explain technical aspects of a model to support maintenance or change. It also has utility in the context of QA and testing, especially for atypical and/or complex models. It should cover the model’s construction and how different elements function and interact with each other. More complex or atypical features require the greatest clarification. Technical or Developer Guides may also cover how to modify or expand the model. Even the requirement for a simple change to a model may render it unusable if it cannot be reliably achieved.

Whilst most models would benefit from a Technical or Developer Guide, it is particularly important and may be a requirement for some models. For example, those that:

* May be or are expected to be iterated or changed over time;
* Are expected to be used or required for an extended period of time;
* Are complex or contain advanced features, such as VBA;
* Are used to support key or business critical decisions; and
* Are externally procured or where access to the original developer of the model at a future point in time is considered to be less likely.

Notably, where the model operator is responsible for both using and maintaining the model it may be appropriate to combine the Technical or Developer Guide with the User Guide and model Specification.

## **Has all required data been provided?**

This is to check whether all data required by the model has been provided and is available for use. This helps to inform where the model is in terms of being operational and allows for focus on outstanding data and required actions to make it available.

## **Has all legacy data been cleansed prior to incorporating new data sets?**

It is important to cleanse legacy data from the model to manage the risk that updated results are inadvertently corrupted by data that should not be included. This check looks to test that old or invalid data (e.g. test data) has been deleted from the model. This is an essential step in repopulating or reconfiguring the model. Removing all legacy data in a structured manner (e.g. on a worksheet or section basis) before incorporating new data can help to reduce the risk of inputs being overlooked.

## **Has the Book of Assumptions / Data Log been prepared and are all data records complete?**

It is important to ensure that model data is appropriately sourced and that assumptions are clearly articulated and recorded. Maintaining a record of the data used by the model and their provenance is necessary to inform the user and preserve analytical integrity. Furthermore, in the absence of a Book of Assumptions / Data Log, the time taken to test a model may increase significantly. Allowing models to be socialised and used without a record of the underlying data and assumptions can hamper the ability to understand model outputs in totality and can also draw the model’s credibility into question. Whenever inputs are incorporated into a model, a corresponding entry should be made in the Book of Assumptions / Data Log, which should be maintained and shared within or alongside the model.

An SCM Book of Assumptions / Data Log Template has been produced by the Sourcing Programme for adaptation and use by contracting authorities.

## **Has all data pre-processing or manipulation been documented?**

Prior to bringing data into the model it may have been pre-processed, manipulated or transformed. For example, it may have been normalised, combined with other data or data subsets or may have been extracted from data sources. It is important that this is documented in a way that would enable an independent person to repeat the steps and regenerate the data. For simple transformations it may be possible to record this in the Book of Assumptions / Data Log. However, for more complex transformations, additional, supplementary documentation may be required. This documentation both provides an unambiguous audit trail and, moreover, is essential to the effective performance of QA and testing (see Section 6.1).

## **Has the maturity of the data within the model been assessed and approval to use the data been obtained?**

Data can be at differing levels of maturity. For example, data based on the opinion of a subject matter expert is less mature than historical cost data. Assessing how mature the data is and socialising this with the decision-making community is an important activity. Indicative data requirements will have emerged from data planning and it is important to make decision makers aware of the data that will power the model and any perceived limitations. Decision makers need to have the ability to input into the analysis produced by a model. With data being a necessary component of modelling an analytical output, being able to understand and approve the data that a model will use is an important part of making transparent decisions. When assessing the maturity of data, it is important to use a consistent and structured framework. For example, a Data Readiness Level (DRL) framework with clear, well defined and widely understood categorisations. Both the maturity of data should be assessed and approval to use the data obtained from the key stakeholders, such as model customers.

## **If scenarios are being modelled, have the configuration settings for the scenario been recorded?**

If models are designed to allow different scenarios to be run, the settings or configuration of those scenarios should be captured within the model so that they can be replicated as required. Being able to replicate model outputs, should options be reconsidered, in a quick and consistent way is facilitated by recording configuration settings within the model (e.g. via a Configuration Control Log).

## **Has an Important Notice been added to the model?**

Before the model is shared it is important to consider whether it includes an appropriate Important Notice. For example, this may include the model status (e.g. ‘draft and not to be relied upon’), the Protective Marking and any associated handling instructions (see Section 7.6), and who or which organisations the model is intended to be used by and the basis of distribution.

## **Has the build been signed-off as appropriate to submit for formal QA and testing?**

It is important that the model submitted for formal QA and testing is not going to change (other than as a result of the QA and testing process itself). If changes are made to a model once it is tested, it will require retesting in order to satisfy QA requirements. To help manage this risk, formal agreement that there will be no more changes should be obtained from the stakeholder community. This will require the model and its accompanying documentation, such as the model Specification , to be socialised. However, the physical sharing of the model ahead of formal QA and testing needs to be carefully considered. It is good practice to clearly label models in this state ‘DRAFT’. There is a risk that outputs from an unassured model may be used and, if errors are identified, that confidence in the model may be reduced. Alternatives may include demonstrating rather than sharing the model to the stakeholder community and scheduling any required User Acceptance Testing (UAT) after formal QA and testing. In either case the associated risks need to be considered and carefully managed.

# Test Checklist

Checklist

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | https://lh6.googleusercontent.com/Q4HOqmu4KmIZ5Oy_heTLv5_skJQM0sXOs92Vme6jqs8m0dlW9PDxRZgdH159zv-EaOJBMitfMX_HZQ-UKe9MqiVt10jgxnVWF-zuXgll5_RKeMYmVIJ9LmwFrhlFBGkzP5UN3402O-Qhttps://lh3.googleusercontent.com/nZtsqpnLJfpaNy5-NAOaZmBKSDWB6Zi7kGTZjPLyTYj2kOxvjolYPByAs-MdXlaJOLnTav-P9JrOUAwkLdUQRmZl8WKq2Yuf7vHtv-or8KM-dTDta4lMQlnYv4YWp25c0x_xvCtZJ44**Question** | **Ref** | **Y/N/NA** | **Details / Notes** |
| 1 | Has appropriate documentation been provided to support testing of the model? | 6.1 |  |  |
| 2 | Has the model been tested in line with the QA Plan and have procedures been documented? | 6.2 |  |  |
| 3 | Has the model been tested with ‘real data’? | 6.3 |  |  |
| 4 | Has the model been stress tested to ensure it remains performant? | 6.4 |  |  |
| 5 | Has the model been tested in the target operating infrastructure? | 6.5 |  |  |
| 6 | Have feeder models and any data manipulation or pre-processing files been subject to appropriate QA and testing? | 6.6 |  |  |
| 7 | Have all issues arising from QA and testing and requiring attention been addressed? | 6.7 |  |  |
| 8 | Were quality assurers both suitably skilled and experienced and independent of the development team? | 6.8 |  |  |
| 9 | Has model documentation, such as the User Guide, been updated to reflect any changes following QA and testing? | 6.9 |  |  |
| 10 | Have QA limitations, including areas not addressed by QA and testing, been included in both QA Reports and highlighted within the model/model documentation? | 6.10 |  |  |
| 11 | Has the QA and testing, including the acceptability of any limitations, been formally signed off? | 6.11 |  |  |

Guidance

## **Has appropriate documentation been provided to support testing of the model?**

The testing of an SCM involves checking it against a basis of comparison. In the case of a good practice critique, for example, this might include checking an SCM’s adherence to the SCM Technical Build Guidance or contracting authority equivalents. However, the basis of comparison for other tests will need to include model-specific documentation, such as the model Specification (inc. Design), Book of Assumptions / Data Log, User Guide and Technical or Developer Guide. For example, in the context of data, one test might include checking that the model’s data aligns with that in the Book of Assumptions / Data Log, which must be available in order to undertake such a test. Notably, if a model is confirmed as being fit for purpose without reference to model documentation that, for example, sets out its purpose, the robustness of testing should be brought into question.

## **Has the model been tested in line with the QA Plan and have procedures been documented?**

Simply stating that a model has been tested does not specify what has been done or how. The QA Plan will specify the different types of tests that that will be performed on the model, such as logic testing or analytical review (see Section 3.4). These tests will include checking the model for errors and alignment with its specification (verification) and checking that the model it is appropriate, i.e. fit for the purpose for which it is being used (validation). All tests within the QA Plan should be complete prior to releasing a model for use and documented in a way that would enable them to be repeated by someone independent. Where tests have not been undertaken it is important to both understand the potential impact on model integrity and to obtain appropriate sign-off.

The SCM Testing Procedures, produced by the Sourcing Programme, include an example Test Memo and QA Report for adaption and use by contracting authorities.

## **Has the model been tested with ‘real data’?**

A model and its data are intrinsically linked. Effective testing therefore needs to cover both, and testing should be performed on a model that is populated with ‘real data’. If it is absent, the effectiveness of testing may be reduced.

Some models will be developed and implemented prior to some or all of the ‘real data’ being brought into them, for example generic models. Putting aside the need to perform testing in relation to the data at that point, they will need to be tested before implementation. This can, to an extent, be achieved through testing them with ‘dummy data’ although there may be shortcomings. For example, ‘real data’ may need to be transformed for use, or the model may not operate as intended with unexpected input value combinations. Where possible, therefore, it is important to test the model with ‘real data’.

## **Has the model been stress tested to ensure it remains performant?**

Prior to implementation, the model should be tested at both numerical and data volume extremes. Stress testing the model helps to manage the risk of the model being released into an environment in which it struggles to operate or fails to operate correctly.

## **Has the model been tested in the target operating infrastructure?**

Where the development environment relies on different infrastructure to the operating environment it is important to test that the model will operate as intended, with no reduction in functionality.

## **Have feeder models and any data manipulation or pre-processing files been subject to appropriate QA and testing?**

It is sometimes necessary to process or manipulate data prior to incorporating it within the model. This includes data that is, in itself, an output from a supporting or feeder model. It is important to confirm that all applicable files have been considered and subject to appropriate and proportional QA and testing. These files should be covered within the SCM’s QA Plan (see Section 3.4).

## **Have all issues arising from QA and testing and requiring attention been addressed?**

Invariably the QA and testing process will identify issues with the model. These will vary from actual errors through potential errors to good practice points or clarifications. The extent to which each issue needs to be addressed and when it needs to be addressed will vary and decisions should be informed by subject matter expertise. This check tests that all issues requiring attention have been appropriately addressed. Any unaddressed issues should be referenced in QA Reports (see Section 6.10) and model documentation updated accordingly.

## **Were quality assurers both suitably skilled and experienced and independent of the development team?**

QA and testing needs to be performed by appropriate people. Quality assurers need to be both suitably skilled and experienced to discharge their responsibilities and independent from those involved in model development (see [Aqua Book](https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government)). The need for independence arises from the risk that those involved in development fail to observe errors because of their familiarity with the model.

## **Has model documentation, such as the User Guide, been updated to reflect any changes following QA and testing?**

## Changes to the model as a result of issues identified during QA and testing may necessitate updates to model documentation. This includes, although is not limited to, the model Specification, User Guide, Technical or Developer guide and the Book of Assumptions / Data Log. This is a check to confirm that model documentation is up-to-date.

## **Have QA limitations, including areas not addressed by QA and testing, been included in both QA Reports and highlighted within the model/model documentation?**

Any issues identified through QA and testing that have not been addressed (see Section 6.7) together with any limitations of the QA and testing itself should be made explicit in QA Reports and highlighted within the model/ model documentation. For example, only a subset of model data may have been tested or certain tests may have been omitted. Whilst these limitations should have been considered and agreed during QA planning (see Section 3.4), it is important that they are made explicit in QA Reports and highlighted within the model/ model documentation. This check helps to ensure that the risks associated with using the model are appropriately considered by stakeholders.

## **Has the QA and testing, including the acceptability of any limitations, been formally signed off?**

This check looks to ascertain if there is an audit trail between the documented performance and limitations of the QA and testing and the communication with stakeholders. This will help to ensure that the risks associated with using the model are appropriately considered by stakeholders. Documentation of the QA and testing performed, any identified limitations and QA and testing sign-off should be evidenced.

The SCM Testing Procedures, produced by the Sourcing Programme, include an example Test Memo and QA Report for adaption and use by contracting authorities.

# Use Checklist

Checklist

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | https://lh6.googleusercontent.com/Q4HOqmu4KmIZ5Oy_heTLv5_skJQM0sXOs92Vme6jqs8m0dlW9PDxRZgdH159zv-EaOJBMitfMX_HZQ-UKe9MqiVt10jgxnVWF-zuXgll5_RKeMYmVIJ9LmwFrhlFBGkzP5UN3402O-Qhttps://lh3.googleusercontent.com/nZtsqpnLJfpaNy5-NAOaZmBKSDWB6Zi7kGTZjPLyTYj2kOxvjolYPByAs-MdXlaJOLnTav-P9JrOUAwkLdUQRmZl8WKq2Yuf7vHtv-or8KM-dTDta4lMQlnYv4YWp25c0x_xvCtZJ44**Question** | **Ref** | **Y/N/NA** | **Details / Notes** |
| 1 | Is there an escalation route and have any voiced concerns over model usage been appropriately considered? | 7.1 |  |  |
| 2 | Has the model been version controlled to denote that it is the release version? | 7.2 |  |  |
| 3 | Have appropriate file management procedures been established? | 7.3 |  |  |
| 4 | Have appropriate change management procedures been established? | 7.4 |  |  |
| 5 | Have appropriate model maintenance and ongoing QA and testing procedures been put in place? | 7.5 |  |  |
| 6 | Have appropriate data protection measures including Protective Markings been applied? | 7.6 |  |  |
| 7 | Has the model been signed off for use by the Model SRO and does the model version correspond to the quality assured version? | 7.7 |  |  |
| 8 | Has any necessary training been performed and are model operators and users of model outputs aware of the model’s risks and limitations? | 7.8 |  |  |
| 9 | Are model outputs presented in a way that clearly articulates risk and uncertainty to decision makers? | 7.9 |  |  |

Guidance

## **Is there an escalation route and have any voiced concerns over model usage been appropriately considered?**

Prior to implementing a model, it is important to ensure that any concerns over its use have been appropriately considered. Such concerns may stem from a broad range of stakeholders and for a variety of different reasons. For example, they may come from model developers who may have felt pressure to drive model outputs in a particular direction. An escalation route should be in place to enable individuals to voice any concerns they may have (without retribution) and their concerns must have been appropriately considered.

## **Has the model been version controlled to denote that it is the release version?**

Model development will invariably involve iterations to the model. Amendments and changes to the model during the development and test phases will have necessitated updates to the model’s version number. To help manage the risk that a development version of the model is used, it is important to both use a release version number and to record it in the model’s Version Control Log (see Section 5.18) and associated documentation, such as the model User Guide (see Section 5.20) and Book of Assumptions / Data Log (see Section 5.24).

## **Have appropriate file management procedures been established?**

Once a model is released the focus is on using it to make an informed decision and focus on other areas of good practice (such as updating model documentation) can get neglected. Given that there will be a need to maintain the model and its associated documentation (e.g. QA Report and User Guide) it is important that file management is considered prior to implementation. This should include file locations, conventions, access rights, etc. Notably, all supporting documentation should be up to date and available when the model is initially released for use. Further details on file management are available in the SCM Development Guidance.

## **Have appropriate change management procedures been established?**

Following release of the model there may be a requirement to make changes to it. For example, data, structural, labelling or formatting changes. It is important that change management procedures are socialised and agreed to help ensure that the model remains fit for purpose. The scope of these procedures will vary from model-to-model but may cover roles and responsibilities as well as processes and sign-off steps. Notably, model documentation, which will include key information such as the calculation logic (see Section 4.4), should be kept current and reflect any changes to the model.

## **Have appropriate model maintenance and ongoing QA and testing procedures been put in place?**

For models designed for enduring use, a one-time sign-off of the model’s QA and testing and its use for a specific purpose is unlikely to be sufficient. For enduring models, it is important to ensure that they are maintained and remain fit for purpose when in use. Ongoing maintenance and QA may include, although will not be limited to, activities to help ensure that:

* Use of the model remains appropriate and in-line with the original purpose and in-line with initial sign-off;
* Model operators and those who will use outputs from the model are appropriately trained and informed;
* Any key-person dependencies are considered and managed;
* Any issues or potential issues with the model are documented and appropriately communicated;
* Any issues or potential issues with the data that powers the model are documented and appropriately communicated;
* Any potential enhancements or changes to the model are documented so they can be considered for future development;
* The data within the model is kept up-to-date and the Book of Assumptions / Data Log is maintained;
* Model outputs can be regenerated if required, such as through Version Control Logs and Configuration Control Logs;
* The model is subject to periodic retesting, to confirm the sufficiency of testing and to ensure testing is documented; and
* Any central logs, such as inventories of ‘Business Critical Models’ (BCMs), are, where applicable, reflective of the model’s status.

## **Have appropriate data protection measures including Protective Markings been applied?**

Models and their documentation may contain material of a sensitive nature and/or be subject to Intellectual Property (IP) restrictions. It is essential that appropriate protective measures are put in place and, where required, markings are visible. This check looks to establish that requirements have been considered and appropriate measures applied prior to implementation. Notably, this should have been considered during model planning and appropriate measures put in place from the outset of model development.

## **Has the model been signed off for use by the Model SRO and does the model version correspond to the quality assured version?**

A model that has been through QA and testing does not necessarily mean that it is appropriate to use. For example:

* Models are built for a specific purpose and if requirements change or if a model is used for something other than what it was originally designed for, it may not be fit for purpose;
* The model may have limitations, including those identified during or relating to QA and testing (see Section 6.10), that constrain how it should be used or what it should be used for; and
* Models may be modified after having been subjected to formal QA and testing. These modifications include both structural alterations or additions, and updates or changes to the model’s data or assumptions.

These factors should be carefully considered prior to sign off by the Model Senior Responsible Owner (Model SRO) before the model is implemented for use. Sign-off should be obtained before use of a specific version of the model for a particular application. Notably, if there is a desire to reuse the model for a different purpose, this sign-off should be reconfirmed. Sign-off and version alignment should both be evidenced.

## **Has any necessary training been performed and are model operators and users of model outputs aware of the model’s risks and limitations?**

This check seeks to evidence that appropriate training has been provided to model operators and to those that will use model outputs. This includes training on how to operate the model as well as raising awareness of the model’s limitations, major assumptions and the risks associated with using it. This check helps to reduce the risk that the model cannot be operated or that it is used erroneously. Evidence for both of these criteria should be retained.

## **Are model outputs presented in a way that clearly articulates risk and uncertainty to decision makers?**

Risk and uncertainty will have been considered during model planning and the approach to representing it set out within the model Specification (see Section 4.5). However, simply representing it within the model is not enough. Decision makers must be made aware of the magnitude of uncertainty in model outputs and the potential impact of risks materialising in order to make informed decisions (see [Aqua Book](https://www.gov.uk/government/publications/the-aqua-book-guidance-on-producing-quality-analysis-for-government) for more details on risk and uncertainty).

Given its technical nature, it is important that risk and uncertainty is articulated in a way that enables decision makers to understand the extent to which model outputs can be relied upon for a particular purpose. How model outputs will be presented and explained to decision makers is an important consideration and one that may require specialist input. For example, communicating complex analysis can be especially challenging and the approach may need to be tailored for different audiences.

In the event it has not been possible or practical to provide a quantitative assessment of risk and uncertainty, it is important to undertake a qualitative assessment for decision makers and to communicate it alongside SCM outputs. In such situations, every effort should be made to provide range estimates for qualitative assessments to help reduce ambiguity and the risk of misinterpretation.

# Appendix I: Consolidated Checklist

Plan Checklist

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| **#** | https://lh6.googleusercontent.com/Q4HOqmu4KmIZ5Oy_heTLv5_skJQM0sXOs92Vme6jqs8m0dlW9PDxRZgdH159zv-EaOJBMitfMX_HZQ-UKe9MqiVt10jgxnVWF-zuXgll5_RKeMYmVIJ9LmwFrhlFBGkzP5UN3402O-Qhttps://lh3.googleusercontent.com/nZtsqpnLJfpaNy5-NAOaZmBKSDWB6Zi7kGTZjPLyTYj2kOxvjolYPByAs-MdXlaJOLnTav-P9JrOUAwkLdUQRmZl8WKq2Yuf7vHtv-or8KM-dTDta4lMQlnYv4YWp25c0x_xvCtZJ44**Question** | **Ref** | **Y/N/NA** | **Details / Notes** |
| 1 | Has an Initial Model Assessment been undertaken and the results communicated to key stakeholders? | 3.1 |  |  |
| 2 | Has a clear and comprehensive model Scope been prepared? | 3.2 |  |  |
| 3 | Have necessary resources been identified in the model Scope and made available to the programme? | 3.3 |  |  |
| 4 | Has the approach to QA and testing been clearly set out? | 3.4 |  |  |
| 5 | Has a preliminary Delivery Plan been prepared? | 3.5 |  |  |
| 6 | Has sufficient time and specialist resource been allocated to undertake formal QA and testing to an appropriate level? | 3.6 |  |  |
| 7 | Has a single, named, Model SRO been appointed? | 3.7 |  |  |
| 8 | Have the model Scope, Delivery and QA Plans, been socialised with key stakeholders? | 3.8 |  |  |
| 9 | Have the model Scope, Delivery and QA Plans, been signed-off for use? | 3.9 |  |  |

Design Checklist

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| **#** | https://lh6.googleusercontent.com/Q4HOqmu4KmIZ5Oy_heTLv5_skJQM0sXOs92Vme6jqs8m0dlW9PDxRZgdH159zv-EaOJBMitfMX_HZQ-UKe9MqiVt10jgxnVWF-zuXgll5_RKeMYmVIJ9LmwFrhlFBGkzP5UN3402O-Qhttps://lh3.googleusercontent.com/nZtsqpnLJfpaNy5-NAOaZmBKSDWB6Zi7kGTZjPLyTYj2kOxvjolYPByAs-MdXlaJOLnTav-P9JrOUAwkLdUQRmZl8WKq2Yuf7vHtv-or8KM-dTDta4lMQlnYv4YWp25c0x_xvCtZJ44**Question** | **Ref** | **Y/N/NA** | **Details / Notes** |
| 1 | Have model input templates been prepared and are they appropriately laid out? | 4.1 |  |  |
| 2 | Have model output templates been prepared and agreed? | 4.2 |  |  |
| 3 | Is the model’s level of granularity appropriate and has it been agreed? | 4.3 |  |  |
| 4 | Has the model’s calculation logic been documented and agreed with relevant stakeholders and subject matter experts? | 4.4 |  |  |
| 5 | Has risk and uncertainty been appropriately considered and addressed? | 4.5 |  |  |
| 6 | Have model limitations and out of scope areas been set out? | 4.6 |  |  |
| 7 | Has a model map been developed? | 4.7 |  |  |
| 8 | Have the logic flows within the model been designed? | 4.8 |  |  |
| 9 | Has a model style guide been created? | 4.9 |  |  |
| 10 | Have data requirements and associated data sources been identified? | 4.10 |  |  |
| 11 | Have data custodians been identified and a Data Plan prepared? | 4.11 |  |  |
| 12 | Have data sources been reviewed for quality? | 4.12 |  |  |
| 13 | Have any required data maturity plans been prepared? | 4.13 |  |  |
| 14 | Does the model Specification (inc. Design) reflect and meet the requirements set out in the model Scope? | 4.14 |  |  |
| 15 | Has the model Specification (inc. Design) been socialised and agreed with relevant stakeholders and signed off by the Model SRO? | 4.15 |  |  |

Develop Checklist

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| **#** | https://lh6.googleusercontent.com/Q4HOqmu4KmIZ5Oy_heTLv5_skJQM0sXOs92Vme6jqs8m0dlW9PDxRZgdH159zv-EaOJBMitfMX_HZQ-UKe9MqiVt10jgxnVWF-zuXgll5_RKeMYmVIJ9LmwFrhlFBGkzP5UN3402O-Qhttps://lh3.googleusercontent.com/nZtsqpnLJfpaNy5-NAOaZmBKSDWB6Zi7kGTZjPLyTYj2kOxvjolYPByAs-MdXlaJOLnTav-P9JrOUAwkLdUQRmZl8WKq2Yuf7vHtv-or8KM-dTDta4lMQlnYv4YWp25c0x_xvCtZJ44**Question** | **Ref** | **Y/N/NA** | **Details / Notes** |
| 1 | Have formulas been reviewed for consistency with the model Specification? | 5.1 |  |  |
| 2 | Have formulas been reviewed to check that they are free from constants? | 5.2 |  |  |
| 3 | Have formulas been reviewed to check that they are free from unnecessary complexity? | 5.3 |  |  |
| 4 | Have formulas been reviewed to check that only recommended formula have been used? | 5.4 |  |  |
| 5 | Have in-built model checks been developed, are they sufficient and have they been tested? | 5.5 |  |  |
| 6 | Have all worksheets been reviewed for consistency? | 5.6 |  |  |
| 7 | Has all labelling been reviewed for completeness? | 5.7 |  |  |
| 8 | Has any included Conditional Formatting been reviewed to check that it is operating as intended? | 5.8 |  |  |
| 9 | Has appropriate cell, worksheet and workbook protection been applied? | 5.9 |  |  |
| 10 | Have the outputs been reviewed to ensure that they contain the correct labelling? | 5.10 |  |  |
| 11 | Have graphs and charts been reviewed to ensure that they are linked to the correct data sources? | 5.11 |  |  |
| 12 | Have outputs been setup for printing? | 5.12 |  |  |
| 13 | Have any development features (e.g. notes, dummy data, test calculations, etc.) been removed? | 5.13 |  |  |
| 14 | Are all elements of the model visible? | 5.14 |  |  |
| 15 | Have all Named Ranges been reviewed for appropriateness and documented? | 5.15 |  |  |
| 16 | Have all external links been reviewed for appropriateness and documented? | 5.16 |  |  |
| 17 | Has the VBA been tested to confirm that it operates as intended? | 5.17 |  |  |
| 18 | Has a Version Control Log been included? | 5.18 |  |  |
| 19 | Has a spell check been performed? | 5.19 |  |  |
| 20 | Has a User Guide been developed to support the model? | 5.20 |  |  |
| 21 | Has a Technical or Developer Guide been developed to support the model? | 5.21 |  |  |
| 22 | Has all required data been provided? | 5.22 |  |  |
| 23 | Has all legacy data been cleansed prior to incorporating new data sets? | 5.23 |  |  |
| 24 | Has the Book of Assumptions / Data Log been prepared and are all data records complete? | 5.24 |  |  |
| 25 | Has all data pre-processing or manipulation been documented? | 5.25 |  |  |
| 26 | Has the maturity of the data within the model been assessed and approval to use the data been obtained? | 5.26 |  |  |
| 27 | If scenarios are being modelled, have the configuration settings for the scenario been recorded? | 5.27 |  |  |
| 28 | Has an Important Notice been added to the model? | 5.28 |  |  |
| 29 | Has the build been signed-off as appropriate to submit for formal QA and testing? | 5.29 |  |  |

Test Checklist

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| **#** | https://lh6.googleusercontent.com/Q4HOqmu4KmIZ5Oy_heTLv5_skJQM0sXOs92Vme6jqs8m0dlW9PDxRZgdH159zv-EaOJBMitfMX_HZQ-UKe9MqiVt10jgxnVWF-zuXgll5_RKeMYmVIJ9LmwFrhlFBGkzP5UN3402O-Qhttps://lh3.googleusercontent.com/nZtsqpnLJfpaNy5-NAOaZmBKSDWB6Zi7kGTZjPLyTYj2kOxvjolYPByAs-MdXlaJOLnTav-P9JrOUAwkLdUQRmZl8WKq2Yuf7vHtv-or8KM-dTDta4lMQlnYv4YWp25c0x_xvCtZJ44**Question** | **Ref** | **Y/N/NA** | **Details / Notes** |
| 1 | Has appropriate documentation been provided to support testing of the model? | 6.1 |  |  |
| 2 | Has the model been tested in line with the QA Plan and have procedures been documented? | 6.2 |  |  |
| 3 | Has the model been tested with ‘real data’? | 6.3 |  |  |
| 4 | Has the model been stress tested to ensure it remains performant? | 6.4 |  |  |
| 5 | Has the model been tested in the target operating infrastructure? | 6.5 |  |  |
| 6 | Have feeder models and any data manipulation or pre-processing files been subject to appropriate QA and testing? | 6.6 |  |  |
| 7 | Have all issues arising from QA and testing and requiring attention been addressed? | 6.7 |  |  |
| 8 | Were quality assurers both suitably skilled and experienced and independent of the development team? | 6.8 |  |  |
| 9 | Has model documentation, such as the User Guide, been updated to reflect any changes following QA and testing? | 6.9 |  |  |
| 10 | Have QA limitations, including areas not addressed by QA and testing, been included in both QA Reports and highlighted within the model/model documentation? | 6.10 |  |  |
| 11 | Has the QA and testing, including the acceptability of any limitations, been formally signed off? | 6.11 |  |  |

Use Checklist

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| **#** | https://lh6.googleusercontent.com/Q4HOqmu4KmIZ5Oy_heTLv5_skJQM0sXOs92Vme6jqs8m0dlW9PDxRZgdH159zv-EaOJBMitfMX_HZQ-UKe9MqiVt10jgxnVWF-zuXgll5_RKeMYmVIJ9LmwFrhlFBGkzP5UN3402O-Qhttps://lh3.googleusercontent.com/nZtsqpnLJfpaNy5-NAOaZmBKSDWB6Zi7kGTZjPLyTYj2kOxvjolYPByAs-MdXlaJOLnTav-P9JrOUAwkLdUQRmZl8WKq2Yuf7vHtv-or8KM-dTDta4lMQlnYv4YWp25c0x_xvCtZJ44**Question** | **Ref** | **Y/N/NA** | **Details / Notes** |
| 1 | Is there an escalation route and have any voiced concerns over model usage been appropriately considered? | 7.1 |  |  |
| 2 | Has the model been version controlled to denote that it is the release version? | 7.2 |  |  |
| 3 | Have appropriate file management procedures been established? | 7.3 |  |  |
| 4 | Have appropriate change management procedures been established? | 7.4 |  |  |
| 5 | Have appropriate model maintenance and ongoing QA and testing procedures been put in place? | 7.5 |  |  |
| 6 | Have appropriate data protection measures including Protective Markings been applied? | 7.6 |  |  |
| 7 | Has the model been signed off for use by the Model SRO and does the model version correspond to the quality assured version? | 7.7 |  |  |
| 8 | Has any necessary training been performed and are model operators and users of model outputs aware of the model risks and limitations? | 7.8 |  |  |
| 9 | Are model outputs presented in a way that clearly articulates risk and uncertainty to decision makers? | 7.9 |  |  |



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