Programme Development for Road Asset Renewals and Replacements

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This article focuses on Programme Development for Road Asset Renewals and Replacements, including commentary on the AWM System, required inputs, data quality impacts, the process, and a data flow diagram.

Systems Use in Programme Development (Renewals & Replacements)

Programme development is a fundamental aspect of road asset management, focusing on identifying *what* work is needed, *where*, *when*, and *why*, to ensure the road network meets defined levels of service in a cost-effective manner. For renewals and replacements, this process is heavily reliant on robust data and analytical tools, with systems like the Asset and Work Manager (AWM), incorporating the former RAMM database capabilities, serving as the central repository for the data required to support programme development providing key decision support evidence.

Renewals and Replacement Programme Development - AWM System

The AWM system, building on the foundation of systems like RAMM, is designed to store, manage, and provide access to vast amounts of asset data. This data is the cornerstone of effective programme development for renewals and replacements.

- **Data Repository:** AWM acts as the principal repository for inventory and condition information for most roading networks. This includes details about assets like pavements, bridges, culverts, drainage structures, and others. Information stored includes asset type, location, size, material, installation/construction date, and historical maintenance activities. For renewals and replacements, having accurate records of when assets were constructed or last renewed is vital for estimating remaining life. As-built data, submitted after construction or significant renewal works, is fed back into the AWM inventory to keep it current.
- **Condition and Performance Tracking:** AWM stores current and historical data on asset condition and performance, such as roughness, rutting, cracking, and deflection for pavements, or specific condition ratings for bridges and drainage. This data is essential for identifying assets that are deteriorating and approaching the end of their useful life or falling below acceptable levels of service. For renewals, condition data directly informs deterioration models and highlights the *need* for intervention.
- **Integration with Decision Support Tools:** While AWM itself is primarily a database and information system, it provides the essential input data for dedicated decision support systems and tools used in programme development. Tools like the Treatment Selection Algorithm (TSA) or more advanced pavement deterioration modelling software such as dTIMS use AWM data to:
  - Predict future asset condition based on deterioration models.
  - Identify when assets are predicted to fail or fall below target levels of service.
  - Recommend appropriate treatments (including renewals and replacements) based on condition, traffic, and established criteria.
  - Optimise treatment timings and selection to achieve desired outcomes (levels of service) at the lowest whole-of-life cost, considering various factors like agency costs and user costs.
- **Supporting Financial Forecasting:** The treatment recommendations and timing outputs from decision support tools, based on AWM data, translate physical needs into financial requirements for maintenance, renewal, and improvement programmes over the long term (typically 10 to 20 years or more). AWM data can

also inform asset valuations, which are useful for estimating long-term renewal needs, especially for asset classes not covered by sophisticated modelling tools.

- **Output for Works Programmes:** The primary output of the asset management function, supported by AWM and associated tools, is the Forward Works Programme (FWP). This programme details specific maintenance and renewal treatments required for different sections of the network, including the reason for scheduling (e.g., cracking, skid resistance, structural capacity) and the expected design life. For renewals and replacements, this is where the planned projects are listed for implementation.
- **Monitoring and Review Inputs:** AWM stores data on implemented works. This historical data, along with subsequent condition/performance data collection, is crucial for monitoring the effectiveness of renewal and replacement treatments and validating deterioration models, feeding back into the continuous improvement cycle of asset management.

In essence, AWM is the foundational database that enables the analytical processes necessary to develop robust, evidence-based programmes for road asset renewals and replacements, moving from simply tracking assets to proactively managing their lifecycle.

Developing Renewals and Replacement Programmes

Effective programme development relies on a variety of data inputs. These can broadly be categorised based on their necessity for a functional process. Following sets out the required inputs grouped by the Essential data to Mature fully evolved data set to support programme and development in full.

Required Inputs (Essential for basic programme development):

- **Asset Inventory Data:** Knowing *what* assets you have and *where* they are is the absolute minimum requirement. This includes fundamental details like asset type, location (e.g., road name and chainage/displacement), material, and key dimensions (length, area, diameter). This data is stored and managed in AWM.
- **Basic Condition Data:** Having some form of condition assessment, even if it's basic visual ratings or simple metrics like the presence of potholes or severe cracking, is necessary to identify assets needing intervention. For renewals and replacements, this indicates current deterioration. Frequency of collection is important to establish trends in condition.
- **Basic Network Segmentation (Treatment Lengths):** This is the segmenting of the network into homogenous performing sections. A basic approach would use the current top surface data as starting point to break the network into manageable sections.
- **Traffic Data:** Understanding the traffic volume, particularly heavy vehicles, is crucial because traffic loading is a primary driver of pavement deterioration and influences the required structural capacity for renewals. Basic AADT and heavy vehicle percentage are key.
- **Defined Levels of Service (LoS):** Clear statements of expected asset performance and service quality are necessary to determine the *target* for maintenance and renewal activities and identify when an asset is failing to meet expectations.
- **Cost Data:** Knowing the unit costs for different maintenance and renewal treatments is required to estimate programme budgets and evaluate treatment options.
- **Simple Treatment Selection Model:** Simple treatment selection model can be developed and used where the input data is of basic nature and only require the defined inputs as noted above and defined the triggers limits i.e. Defined Level of Service. These sorts of models can be developed in spreadsheets.

Mature State (Continual Improvement State)

To enable significantly enhance programme development accuracy, optimisation, and strategic value the following is required. This is the continual improvement state.

- **Enhance Asset Inventory:** This is an improvement state which would require detailed asset data accurate build dates, last replaced, e.g. detailed pavement data would hold such things as subgrade strength, pavement layer depths, pavement design strength, surfacing history. This enhanced knowledge of the asset make and history coupled with the following information provides a comprehensive understanding of past and current state. Allowing a future state to be determined from sophisticated performance models.
- **Detailed Condition Performance Data:** More detailed quantitative measures provide a more precise understanding of asset condition and performance. Examples of these measures include:
    - International Roughness Index (IRI)
    - Rut depth
    - Pavement deflection
    - Surface/pavement cracking data
    - Skid resistance
    - Texture.

This enables more sophisticated deterioration modelling and refined treatment selection. This data is typical collected through advanced survey equipment such as high speed multi laser collection systems which profile the road surface. Or Falling Weight Deflectometre (FWD) enabling the inference of pavement strength.

- **Network Segmentation (Treatment Lengths):** This is the segmenting of the network into homogenous performing sections. As opposed to basic segmentation this would be a more comprehensive sectioning of the network based on the detailed condition data. Providing a more accurate segmentation set allowing programme analysis to more accurate and quantifiable.
- **Condition Trends:** This requires the collection of condition data over time to establish a condition trend. This is the corner stone of a mature programme development process. This allows future state assessment to use past condition and trends to more accurately predict future performance based on the current performance models used today.
- **Comprehensive Traffic Data:** More detailed data, such as equivalent standard axles (ESA) calculations or seasonal variations, improves the accuracy of pavement loading estimates and deterioration predictions.
- **Historical Maintenance and Renewal Data:** Records of past works provide insights into asset performance trends, effectiveness of previous treatments, and calibration data for deterioration models. This is recorded in AWM.
- **Risk Assessment Data:** Information on identified risks (e.g., related to safety, network accessibility, environmental impact) associated with asset deterioration or failure allows for risk-based prioritisation of renewal projects.
- **Economic Data (User Costs/Benefits):** Data on vehicle operating costs, travel time, and accident costs enables formal economic evaluations (LCC, NPV, BCR, CBA) to demonstrate the value for money of renewal investments and optimise programs from a broader societal perspective.
- **Environmental Data:** Detailed data on subgrade conditions (e.g., CBR), drainage effectiveness, and climatic factors (e.g., moisture, temperature, frost) are critical inputs for pavement design, deterioration modelling, and selecting appropriate renewal treatments.
- **Advanced Treatment Selection Model:** Where the data and approach are in a mature state the need for a more advanced treatment selection to analyse and use all the available data becomes more relevant. These models are specifically designed software. Providing more complex analysis approaches and outcomes, for Example dTIMS or HDM4. These analysis software packages will tend to have the capability to undertake scenario testing, treatment optimisation amongst other modelling capabilities.
- **Continual Improvement:** This is a core part of the Mature programme development state. Continual data/systems and process improvement review ensures that opportunities for improvement and enhanced accuracy are not missed. These sorts of reviews should consider all aspects of the process such as

advancement in technologies and approaches.

Examples of Excellent data versus Poor Data Quality

The quality of the data held in AWM directly impacts the reliability and effectiveness of programme development.

- **Excellent Data Quality Scenario:**
  - **Situation:** A high-traffic urban arterial road network segment with continuous, reliable traffic counting (including classification for heavy vehicles), recent high-speed data surveys capturing detailed roughness, rutting, texture, and skid resistance data, annual visual condition surveys, and accurate as-built records in AWM.
  - **Impact on Programme Development:** This allows for the use of sophisticated pavement deterioration models (e.g., dTIMS) that can accurately predict future condition based on traffic loading and observed performance trends. Treatment selection tools can precisely identify the optimal timing and type of renewal or rehabilitation (e.g., thin asphalt overlay, structural overlay) to maximise asset life and minimise lifecycle costs. Economic evaluations (LCC, NPV, BCR) are robust and clearly demonstrate the value for money of proposed interventions. The Forward Works Programme for this section is highly reliable, allowing for accurate efficient long-term financial planning and resource allocation.
- **Poor Data Quality Scenario:**
  - **Situation:** A low-volume rural unsealed road network segment with limited, infrequent traffic counts (possibly just ADT estimates), condition assessed only through irregular visual inspections, and incomplete historical maintenance records in AWM. The inventory data might be incomplete or inaccurate regarding material types or construction dates.
  - **Impact on Programme Development:** Deterioration models are less reliable or may not be applicable, making it difficult to predict when assets will require renewal (e.g., regravelling or resheeting). Programme development might rely heavily on expert judgement, simplified triggers (e.g., fixed regravelling cycles or response to public complaints), or reactive maintenance. Economic evaluations are based on broad assumptions, reducing confidence in the results. Forecasting long-term financial needs is less precise, potentially leading to budget shortfalls or overspending. For unsealed roads specifically, frameworks less reliant on condition data, using material properties and historical records, become more relevant in such scenarios.

The Programme Development Process

Developing programmes for renewals and replacements within the asset management framework, utilising systems like AWM, follows a systematic process. This process is iterative and cyclical, feeding into the overall asset management cycle.

1. **Define Strategic Context and Objectives:** Review and align with higher-level plans such as the Long Term Plan (LTP), Regional Land Transport Plan (RLTP), and Government Policy Statement (GPS). Establish strategic objectives and define desired outcomes for the transport network.

2. **Define/Review Levels of Service (LoS):** Clearly articulate the desired Customer and Technical Levels of Service that the assets are intended to provide. Ensure these are understood and agreed upon by stakeholders. These LoS provide the performance targets for the network.

3. **Collect and Manage Data:** Continuously collect, validate, and update asset data in AWM, including inventory, condition, performance, traffic, maintenance history, and cost information. Ensure data accuracy and consistency.

4. **Analyse Needs and Performance Gaps:** Analyse the current and predicted future performance of assets against the defined Levels of Service. Utilise AWM data and potentially integrated tools to perform gap analysis.

5. **Predict Future Performance and Deterioration:** Apply deterioration models (simple or sophisticated depending on data availability and asset type) to forecast asset condition over the planning horizon (e.g., 10-20 years).

6. **Identify and Evaluate Treatment Options:** Identify a range of potential treatment options (including maintenance, renewal, rehabilitation, or replacement) that could address the identified needs and restore/maintain LoS. Evaluate these options based on their effectiveness, impact on future condition, costs (agency and user), risks, and fit with strategic objectives.

7. **Optimise Programme:** Use decision support tools and/or engineering judgement to select the optimal set of treatments, considering resource constraints (budgets), risk appetite, and desired LoS. This involves trade-off analysis between cost, risk, and service levels.

8. **Develop the Forward Works Programme (FWP):** Compile the selected treatments, specifying location, type of work, timing, objectives, and estimated cost for the planning period. Renewals and replacements are key components of this programme.

9. **Prioritise and Finalise Programme:** Further refine and prioritise the programme within expected funding constraints. This results in the proposed programme for budgeting and approval.

10. **Seek Approval:** Submit the proposed programme as part of the AMP and LTP process for formal adoption by the governing body.

11. **Implementation:** Extract the Current Work Programme from the FWP and undertake the construction/delivery of the planned renewal and replacement projects.

12. **Monitor, Audit, and Review:** Monitor the progress and outcomes of implemented works. Audit the implementation process. Review the effectiveness of the overall programme development process and the accuracy of predictions. Feed lessons learned and updated data back into step 3 and step 1 for continuous improvement.

Life Cycle Context and Process flow Diagram

Below is a representation of a typical infrastructure life cycle management process and its relationship to asset data. Asset Data reside at the core of this process. Providing context of the importance of the asset data on programme development as it relates to an asset management system like AWM.

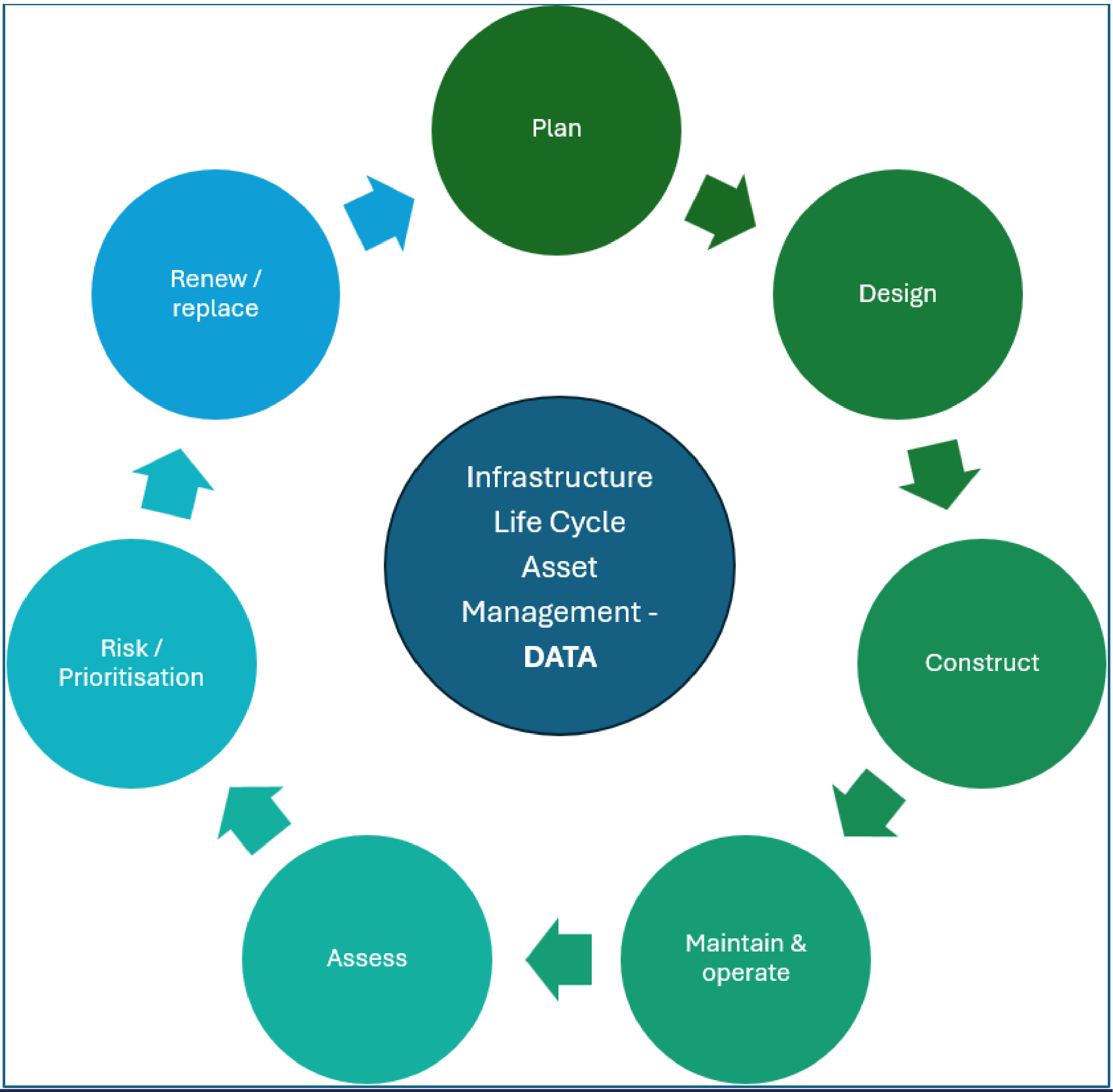

Figure 1: Typical Infrastructure Life Cycle Overview

Figure 2 illustrates a linear representation of the programme development. However, note that there is cyclic process within the linear process that show various inputs feed into other outputs and need to be reassessed. With AWM system being core aspect, which in turn supports analytical tools to generate needs and forecasts.

These outputs are then processed into the final works programmes, which are implemented, monitored, and reviewed, creating a continuous feedback loop that drives improvement in asset management practices and data quality over time.

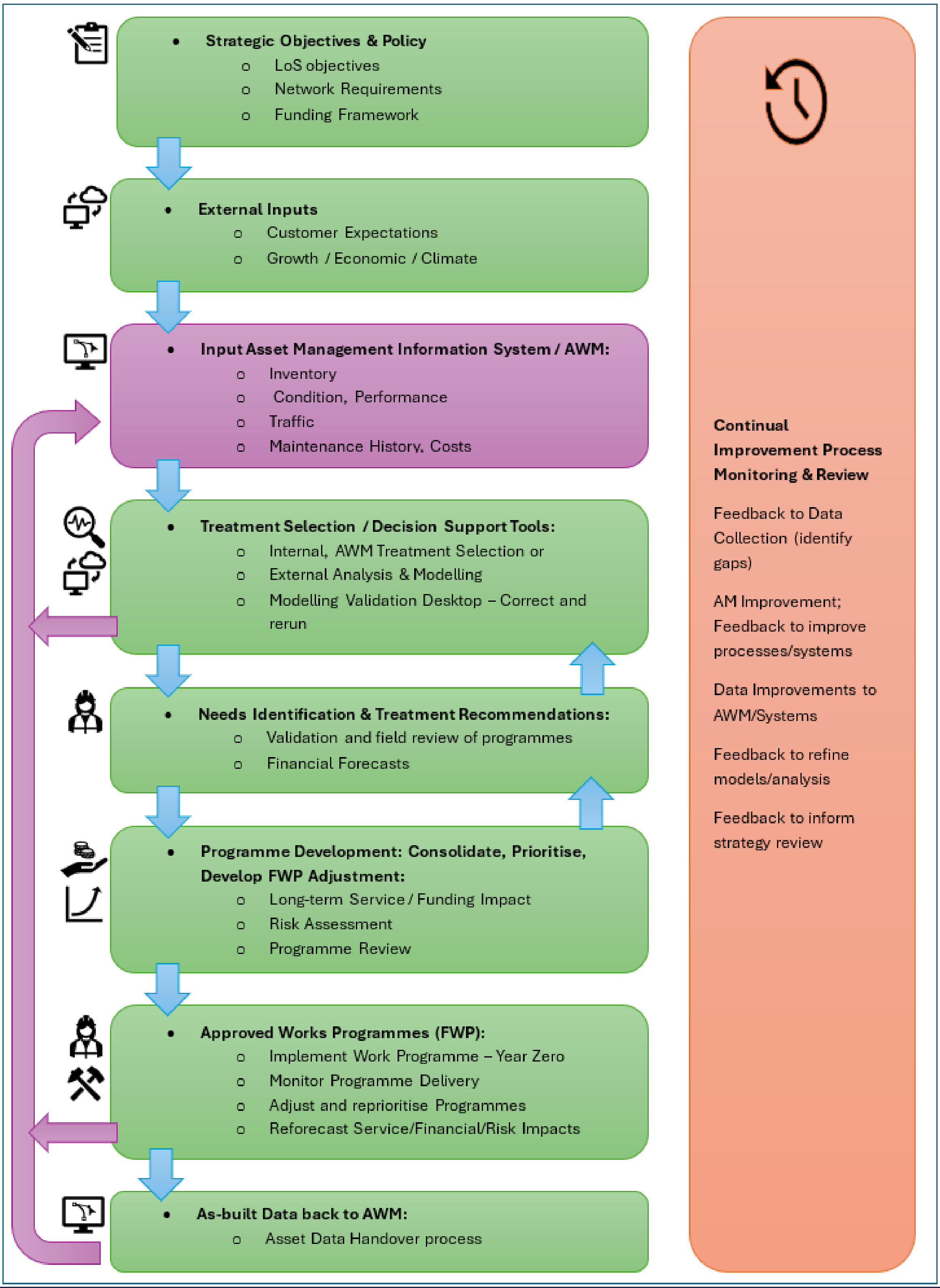

Figure 2: Programme Development Overview