national highways

Lean Collaborative Planning

Minimum Standards
V1.2 April 2023

Contents


M 3
Southampton 11
(Ringwood 27)
(Portsmouth 28)
(Bournemouth 38)
Winchester
A 3090

1

Purpose of the standard

This standard provides the minimum requirements for Lean Collaborative Planning (LCP) on National Highways projects, adding detail to National Highways general guidance found in *An Introduction to the Collaborative Planning System*.

The standard is for National Highways and supply chain teams working on any project in the optioneering, design and delivery phase. It is to be used in conjunction with the minimum standard for Visual Performance Management.

National Highways has benefited from the implementation of Lean Collaborative Planning across Major Projects, therefore taking the lead by introducing this minimum standard for Lean Collaborative Planning for adoption across the business.

2

Lean Collaborative Planning at a glance

Lean Collaborative Planning can improve productivity through better communication, resource management and information flow. The basic steps of Collaborative Planning are shown on the next page:

COLLABORATIVE MAPPING

PRODUCTION CONTROL

CONTINUOUS IMPROVEMENT

HIGH LEVEL PLANNING

'Working together to plan the overall job'
Teams understand the deliverables, risks and opportunities within the project.

High-Level Planning Workshop → High-Level Plan

LOOK AHEAD PLANNING

'Working together to plan the next 8-12 week period'
Defines when work programme activities will be carried out in detail (day-by-day)

Look Ahead Planning Workshop → Look Ahead Plan

MAKE READY

'Identify everything needed to complete the work'
Reliability improvement due to tasks being filtered to go and do.

Make Ready Workshop → Work Plan → Make Ready Checklist & Constraints Management Board

PRODUCTION REVIEW

'Record progress and adjust the plan'
Ensures transparency of progress & performance understanding and removing the blockers

Update → Work Plan → Production Review Meeting → Update → Task Performance Tracking

DAILY ACTIVITY BRIEFING (DAB)

'Brief the people who will do the work and listen to their feedback'
Work can be implemented safely and in accordance with the Make Ready Plans.

Update → Work Plan → Daily Activity Briefing → 3C → 3C Board

CONTINUOUS IMPROVEMENT

'Small/simple steps that add up to continuous improvement'
Raises awareness of the team's performance delivering critical activities, therefore improving commitment to completing tasks.

Continuous Improvement Review → 1 Blank Suggestion Forms | 2 Submitted Suggestions | 3 Instigated Suggestions | 4 Completed Suggestions

Lean Collaborative Planning facilitates co-ordination of information, labour, plant and materials that are required to arrive at the right place, at the right time and in the right sequence.

Step	1	2	3	4	5	6
Name	High-level Planning	Look Ahead Planning	Make Ready	Production Review	Daily Activity (DAB)	Continuous Improvement
Slogan	'Working together to plan the overall job'	'Working together to plan the next 8-12 week period'	'Identify everything needed to complete the work'	'Record progress and adjust the plan'	'Brief the people who will do the work and get their feedback'	'Small/ simple steps that add up to continuous improvement'
WHAT	The start of the Collaborative Planning process. The point where the project team gains a common understanding of the project.	Developed by the project team to create a more detailed plan.	A detailed 2-week (up to 4 week) day-by-day short term Lookahead Plan detailing upcoming work activities.	Weekly Review to present progress made that week and confirm the plan for next week.	Daily briefing implemented to manage work activities and reflect short term control.	Enables the project team to understand how areas are performing against the project requirements and improve where needed.
WHEN	At the beginning of the project and updated at major milestones.	Recurring 8 – 12 weeks.	Recurring 8 – 12 weeks.	Recurring every week.	Recurring every working day.	Recurring every working day.
WHY	Teams understand the deliverables, risks and opportunities within the project.	Defines when the programme work activities will be carried out in detail (day-by-day).	Reliability improvement due to tasks being filtered to go and do.	Ensures transparency of progress and performance, understanding and removing the blockers.	So that the work can be implemented safely and in accordance with the Make Ready Plans.	Raises the awareness of the team's performance delivering critical activities, therefore improving commitment to completing tasks.
HOW	Identify all appropriate team representatives and ensure they are briefed on the requirements of the upcoming LCP workshop.	Sequence by discipline. Populate with daily activities for each discipline on a day-by-day basis.	Confirm the work activity sequence, critical path activities, task durations, requirements and how interfaces between disciplines are managed.	Review & update. Review & adjust Lookahead & update the daily work plan Make Ready Action Dates Concerns.	Focused on planning and production. Review achievements and progress made during previous shift and confirm the plan for the next shift.	Visualisation of the data. Use of business intelligence tools.
WHO	Project Manager Contractor Mgr. Planners Sub-contractors Contract Leaders Team Leaders Section Engineers Logistics, buyers LCP Facilitator.	Project Manager Contractor Mgr. Planners Sub-contractors Contract Leaders Team Leaders Section Engineers Logistics, buyers LCP Facilitator.	Sub-contractors Team Leaders Contract Supervisors Section Engineers.	Team Leaders Team Members Sub-contractors Contract Supervisors Engineers.	Sub-contractors Contract Supervisors Team Leaders Team Members Engineers.	All

3

Benefits of Lean Collaborative Planning

Lean Collaborative Planning has been used throughout the construction industry for more than 20 years. When applied to a good standard it enables better performance in design, supply chain management and delivery of projects through:

- Increased programme predictability.
- Enhanced delivery, reliability and overall stability.
- Providing the mechanism that enables teams to meet challenging programme requirements.
- An understanding of the requirements, constraints and critical points within a programme.
- Emphasis on connections between activities and how the actions of one group or work stream impact on another.
- Providing clear visibility of the steps involved in a projects design and build phase and enables the identification of threats and opportunities.
- Analysis of critical path activities, identification of mitigation actions that protect the critical path.
- Enable Continuous Improvement activity.
- Recognition of the needs of all stakeholders on the network.
- Integration of works to optimise efficiency.

Importantly, Lean Collaborative Planning should be viewed as an enabler to achieving the aspirations of a robust contract programme – not as the means to replacing it.

4

What is Lean Collaborative Planning?

Lean Collaborative Planning is a structured approach to planning, monitoring, controlling and improving work activities.

The main principles are:

- Improve workflow.
- Improve plan reliability.
- Improve plan predictability.
- Achieve challenging targets.

Lean Collaborative Planning works when:

- Project leadership encourages and demonstrates working together.
- Project goals and the criteria for success are clearly defined.
- All stakeholders contribute and are engaged in participation.
- Teams are willing to positively embrace transparency.
- Teams are prepared to be constructively honest yet direct with each other.
- There is a commitment by all to get involved and learn by participation.
- A designated area and time is available to facilitate teams coming together.
- Good facilitation skills are available to keep meetings concise and focused.

Collaborative Mapping

Enabling better planning through the whole team through the development of High-level and detailed Lookahead Plans.

Collaborative mapping is a process that:

- Enables the project team to create agreed medium and long-term plans.
- Aligns with the required project milestones.
- Requires team members from different disciplines and/or organisations to work together and develop an agreed plan .
- Provides visibility and transparency of each discipline's work activities, constraints and drivers.
- Builds and fosters team spirit and collaborative behaviour.
- Provides an environment where team members collaborate and negotiate with each other in a proactive and productive way.

Collaborative Mapping

Enabling improved productivity through better communication, resource management and information flow. Co-ordination of information, labour, equipment and materials are required to arrive at the right place, at the right time and in the right sequence. Production Control is the means by which we manage these inputs, controls and resources to achieve efficient delivery.

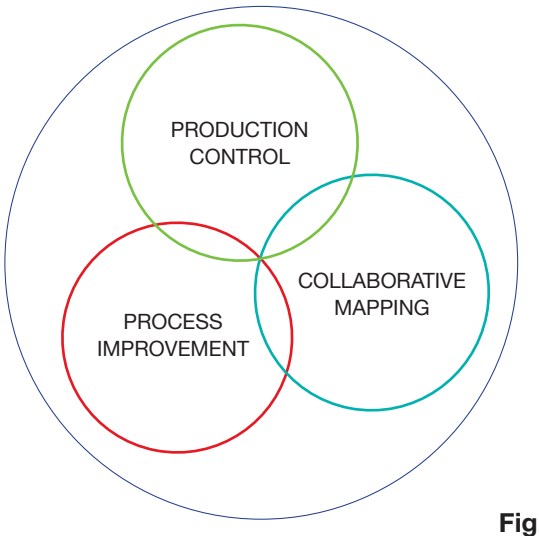


Fig. 1
Essential elements of the Lean Collaborative approach

The Production Control toolkit consists of:

- Work Planning - Get the team to meet regularly to create Work Plans, by using the Plan-Do-Check-Act (PDCA) cycle (see Figure 2) and focus on making and keeping reliable promises - say what we do, do what we say - measuring and learning as they go.
- Make Ready - Encourage the team to understand and remove the blockers stopping them from doing work before starting the task at hand.
- Percent Plan Complete (PPC).
- Data Analysis - Use measurement and learning to inform the areas to improve performance.

Continuous Improvement

Continuous Improvement is the process of collaboratively taking a step back during project delivery or after key milestones in order toevaluate lessons learned, analyse reasons andrecurring patterns of incomplete commitments. The team can exploit root causes usingstructured problem solving tools/ techniques,and strive towards 'right first time' following the PDCA cycle.

Continuous Improvement sessions should be attended by all key people (decision makers, project managers, commercial partners, technical leads) as well as those who actually perform the work.

The Production Control toolkit consists of:

- Team identifies problems - areas for improvement.
- Team identifies root causes of problems.
- Team defines desired outcomes.
- Team collaboratively determines suitable solution using structured problem solving.
- Team implements and actively manages solutions.
- If successful, teams knowledge share the solutions for wider benefit, capturing and documenting in the projects lessons learnt log.

The idea behind the PDCA cycle is the following:

- Team first plans what they should, can, and will do (PLAN).
- Team performs the work planned (DO).
- Team reviews the reasons for non-completion and root causes of identified issues and explores opportunities for learning and improvement (CHECK).
- Team defines desirable outcomes and solutions to issues, as well as other suggestions striving towards Continuous Improvement, applies solutions in the next PLAN step of the PDCA cycle and, if successful, transfers knowledge to other areas of the process, project, business sector (ACT).

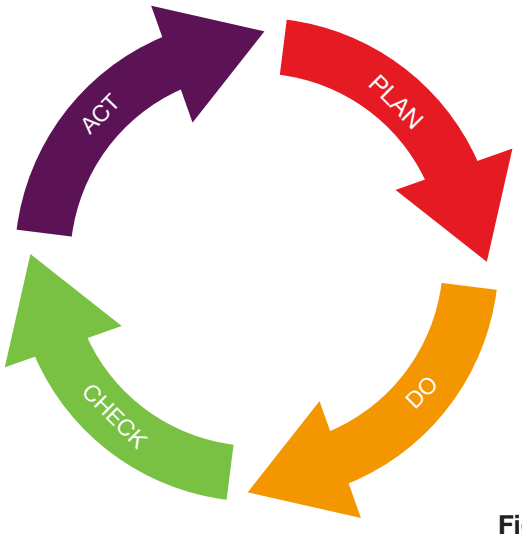


Fig. 2
The PDCA Cycle

4.1 6 Steps of Collaborative Planning

Collaborative Planning, Production Control and Continuous Improvement elements and their key activities can be mapped out as shown in Figure 3.

Typical deployment of the Lean Collaborative Planning approach in a project will see High-level Planning occur first. This pre-stage planning and the recurring cycle of Lookahead Planning, in both design and construction, can be seen in Chapter 11.

It is important to note the requirements of Lean Collaborative Planning do not remove the necessity of planning the project in accordance with contract requirements.
It is essential that when activities are reviewed during Lookahead Planning and Weekly Production Control meetings that any adjustments to the scheduling of the planned activities are reflected on the project programme (in Major Projects commonly referred to as the P6 Programme or P6 Schedule).

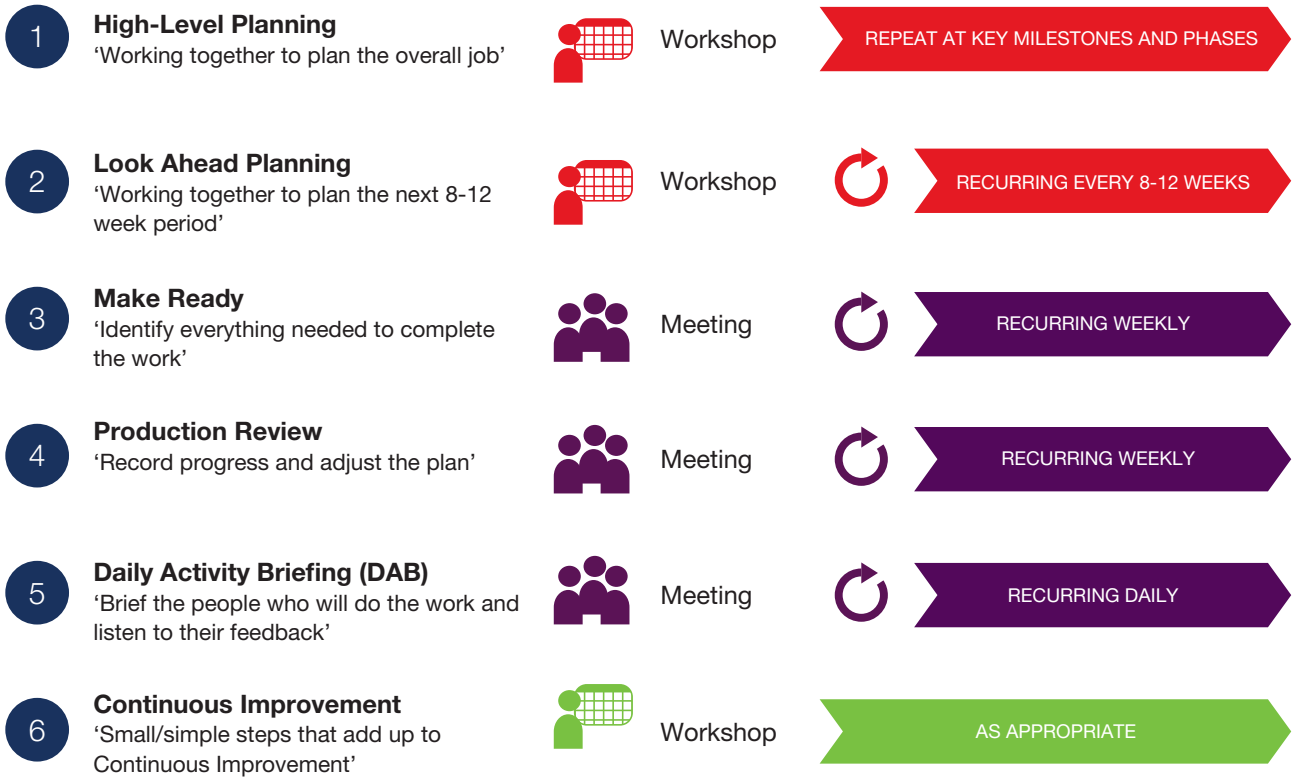


Fig. 3
Lean Collaborative Planning Timeline

5

Collaborative Mapping

5.1 Step 1 - High-level Plan

Who

Required project personnel include (the list is not exhaustive, participation by others may be required):

- Contractor Project Manager/Director.
- National Highways Project Management.
- Programme Planners.
- All subcontractors/sub-consultants.
- Contract and Performance leaders.
- Supervisors and section team leaders.
- Section engineers.
- Logistics leads, buyers, resource managers, commercial advisors, planning specialists as and when required.
- Lean Collaborative Planning facilitator.

Why

The High-level Plan ensures:

- Teams understand the deliverables, risks and opportunities within the project.
- All parties understand not only their individual activities but importantly interdependencies and the activities of others.
- The team review the critical path and agree the best approach of activity sequencing.

Working together to plan the overall job

What

The High-Level Plan is:

- The start of the Lean Collaborative Planning process and the point where the whole project team gains a common understanding of the proposed project.
- A simple, visual and collaborative way of getting team members engaged to create an agreed plan.
- Populated with key activities for each work stream, which builds a picture of all the work that needs to be done to achieve the desired milestones.
- Carried out by the people who will undertake the project's scope of work, supported by senior decision makers on the project.

When

At the beginning of the project and updated at major milestones to track progress before moving into subsequent phases.

1 **High-Level Planning**
'Working together to plan the overall job'

Workshop

REPEAT AT KEY MILESTONES AND PHASES

How

Key Steps for successful planning are:

- People - Identify all appropriate team/ discipline representatives and ensure they are briefed on the requirements of the upcoming Lean Collaborative Planning workshop.
- Planning window - Before the workshop, define the project timescales and develop a master programme dateline.
- Milestones - Identify all key programme milestones, and populate them onto the programme.
- Work break down - Decide how to break up works (per discipline, per trade etc.) and assign each trade/discipline/team a colour to distinguish them on the programme.
- Sequence between discipline/team - Identify the appropriate sequence of disciplines to conduct the planning exercise.
- Sequence within discipline/team - Agree the High-level work activity sequence for each discipline.

Use the Pull Planning technique by working from a target milestone backwards, tasks are defined and sequenced so that their completion releases work to meet this milestone. Each discipline captures the work activities to populate the programme (i.e. on sticky notes/task cards).

Work Activities detail and describe the work required and assumptions to the team

- Task description
- What will be done? (e.g. ducting)
- Where it will be done? (e.g. E/B)
- When it will be done? (e.g. 31/01)
- Who will do it? (e.g. sub-contractor B)

Challenge - Each team member openly challenges the work activities of others, so outcomes are agreed.

Critical Path - Agree the critical path activities and ensure these are highlighted on the plan.

Concerns - Populate a 3Cs board (Concern, Cause, Countermeasure) to assign actions and resolve any issues that may affect the programme e.g. design approvals, procurement, methodology, consents etc.

Actions - Capture assumptions, risks and actions and assign ownership and due dates.

Update - if key milestone and activity dates have changed prior to the beginning of distinct phases update: the High-level Plan the contractual programme (i.e. P6 schedule)

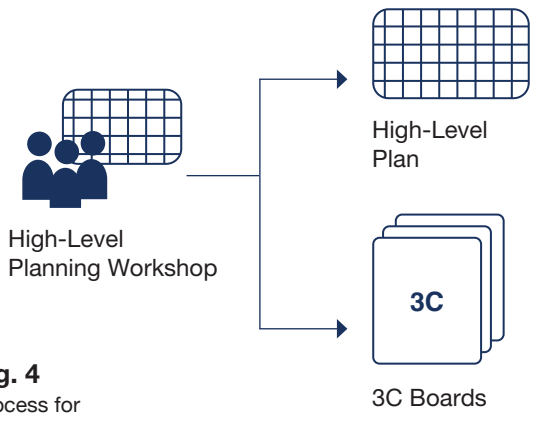


Fig. 4
Process for
High-level Planning

5.2 Step 2 - Lookahead Plan

2 **Look Ahead Planning**
'Working together to plan the next 8-12 week period'

Workshop

RECURRING EVERY 8-12 WEEKS

When

Recurring 8-12 weeks

Working together to plan the next 8-12 week period

Who

Required project personnel to include (the list is not exhaustive, participation by others may be required):

- The start of the Lean Collaborative Planning process and the point where the whole project team gains a common understanding of the proposed project.
- A simple, visual and collaborative way of getting team members engaged to create an agreed plan.
- Populated with key activities for each work stream, which builds a picture of all the work that needs to be done to achieve the desired milestones.
- Carried out by the people who will undertake the project's scope of work, supported by senior decision makers on the project.

Why

The Lookahead Plan ensures:

- The project team define when the programmed work activities will be carried out in detail (day-by-day) and how the sequencing affects other planned work.

What

The lookahead plan in:

- Developed by the project team to create a more detailed plan, of 12 weeks in duration, with planned activities added daily (this may be weekly for projects in the optioneering and design phases). It should be reviewed at least every 8 weeks.
- Also known as Phase Planning.

How

Key Steps for successful planning are:

- People - Identify all appropriate team/ discipline representatives.
- Planning window - confirm the detailed Lookahead Planning window, typically 12 weeks.
- Milestones - Develop the detailed Lookahead Plan based upon the High-level Plan. Layout can be similar to the High-level Plan in date sequence or alternatively a time chainage plot.
- Work break down - Adopt a similar method to the High-level Plan by assigning each trade/ discipline / team a colour to distinguish them on the Lookahead Plan.
- Sequence within discipline/team - Populate the plan with daily activities for each discipline on a day by day basis.

Use the Pull Planning technique by working from the High-level Plan dates backwards, tasks are defined and sequenced so that their completion releases work to meet the High-level Plan dates.

Each discipline captures the work activities (i.e. on sticky notes / task cards) and populates the Plan detailing the work required and assumptions to the team.

- Task description.
- What will be done? (e.g. install ducting).
- Where it will be done? (e.g. E/B Ch2200).
- How long will it take? (e.g. 2 days).
- When it will be done? (e.g. 31/01).
- Who will do it? (e.g., company, crew size).

Challenge - Each team member can then openly challenge the work of others, so outcomes are agreed.

Critical Path - Agree the critical path activities and ensure these are highlighted on the plan.

Concerns - Populate the 3Cs board to assign actions and resolve any issues and risks that may affect the programme.

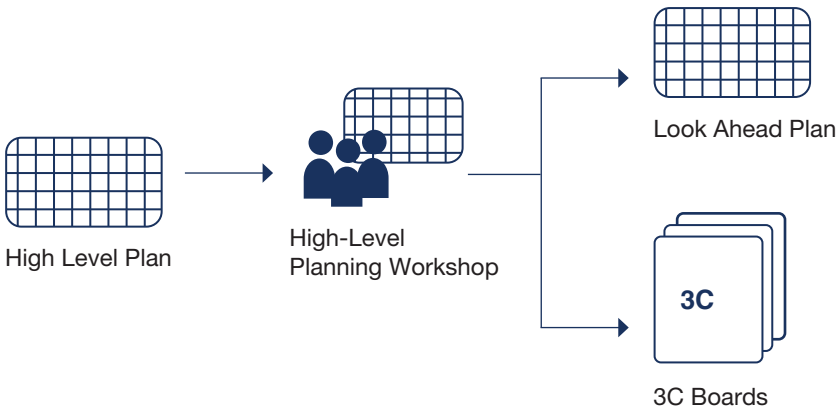


Fig. 5
Process for
Look-ahead Planning

6

Production Control

6.1 Step 3 - Make Ready

3 **Make Ready**
'Identify everything needed to complete the work'

 Meeting

RECURRING WEEKLY

What

Make Ready is:

- A detailed 2-week (up to 4-week) day-by day short term Lookahead Plan detailing upcoming work activities.
- Built from the work sequence created in the detailed 12-week Lookahead Plan and shows a more detailed sequence of work.
- A rolling detail day-by-day plan (for construction phase) or week-by-week (for optioneering and design phases), which should never be more than a week out of date.
- Identification of everything needed to be in place in order to start the work.
- The removal of issues/constraints roadblocks before they impact work.
- Also known as Weekly Work Planning, plan for Stage Meeting, Stability Review Meeting or Constraints Analysis.

Working together to plan the overall job

When

Recurring every week.

Why

The Make Ready ensures:

- improvements in reliability, as tasks are 'fitter' to go and do.
- abortive work will be reduced.

How

Key steps for successful planning are:

- Sequence - Confirm the work activity sequence, critical path activities, task durations, requirements and how interfaces between disciplines and trades are managed.
- Clarify - all things necessary to start and complete the works, agree on actions and owners, identify what actions are required that will address any outstanding issues or blockers and identify any opportunities for improvement. Complete a Make Ready checklist for key activities.
- Review - the Make Ready plan at weekly Production Control meetings and by work teams at the daily work plan briefings. This is the Make Ready meeting.
- Constraints - Assess the constraints which may affect delivery of the plan, record and identify actions with target dates and owners to resolve in the Constraints board.
- Concerns/ Problems – Resolve any problems that may affect the programme, using Lean Structured Problem Solving.

Who

Required project personnel includes:

- Subcontractors/sub-consultants
- Discipline team leaders
- Contract supervisors
- Phase/section team leaders
- Section engineers

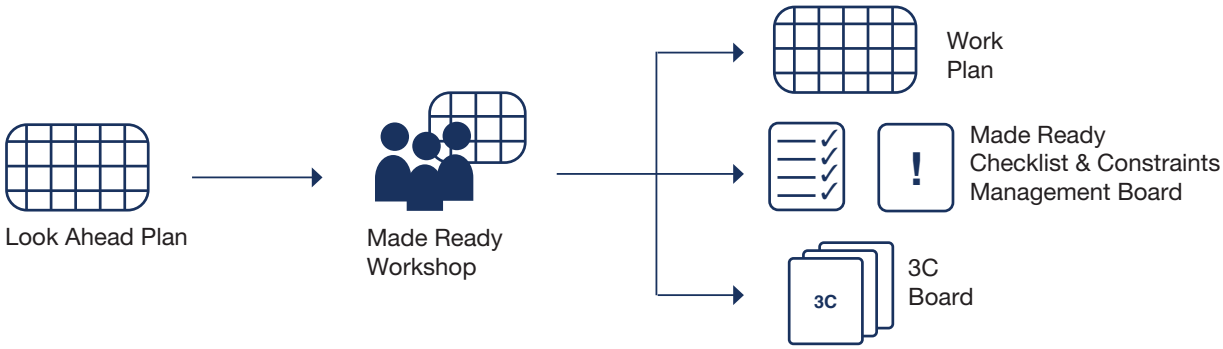


Fig. 6
Process for Make Ready Workshop

6.2 Step 4 - Production Control/Production Review

4 **Production Review**
'Record progress and adjust the plan'

Meeting

RECURRING WEEKLY

What

Production Control or Production Review meeting is:

- A weekly review meeting that should be held at the most appropriate point in the week to review progress made that week, and to confirm the plan for next week's activities. The meeting should last no-longer than one hour.
- Also known as Weekly Production or Learning.

Who

Required project personnel includes:

- Team leaders
- Team members
- Subcontractors/sub-consultants
- Contract supervisors
- Engineers

Record progress and adjust the plan

When

Recurring every week

Why

Production Control ensures:

- Transparency of progress and performance, understanding and removing blockers to get the work done.
- Continuous Improvement activity highlighting areas of performance or processes that require attention.

How

Key steps for successful Production Control:

- Review and update - Review previous week's activities. Each completed task should be crossed out on the programme or marked as complete in some other way.
- Record and update PPC tracker.
- Log reasons for non-completion on a weekly PPC tracker.
- Review and adjust - Review the current plan for the following week's activities, reschedule incomplete works and assess the impact on follow-on activities and resources.
- Lookahead and update the daily work plan. Assess whether any future activities can be pulled forward for programme improvement.
- Make Ready - Verify all Make Ready needs to ensure that all required resources are available for the planned activities. Update Make Ready checklist.
- Action - Agree actions, owner and target.
- Dates - Agree dates where issues need to be resolved by.
- Concerns - Update 3Cs Board.
- Record - Within the performance tracker:

PPC - the Percent Plan Complete (PPC) activities for that week. This is a binary measure, activities are either complete or incomplete; i.e. an activity that is 80% finished will be marked as incomplete and the PPC for that activity will be 0%. This Is true for the over production; i.e. an activity that is at 120% will be marked as over-production and the PPC for the respective activity will be 0%. The reason for this is simply that over-production is a waste (please refer to TIMWOODS: the 8 wastes).

Productivity - against each key work item undertaken in the week. Productivity measurements should be appropriate to the item e.g. m/day, m^2/day m^3/day etc. Productivity should be measured against target levels for the project and compared with centrally agreed expectations from National Highways.

Visualise - Generate performance visuals to enable future improvement actions. Microsoft Power BI (or similar data analytics applications) can be used to analyse and display key team performance data.

Collect data – Store production and productivity data on projects to enable comparison across programmes, regions, suppliers and teams.

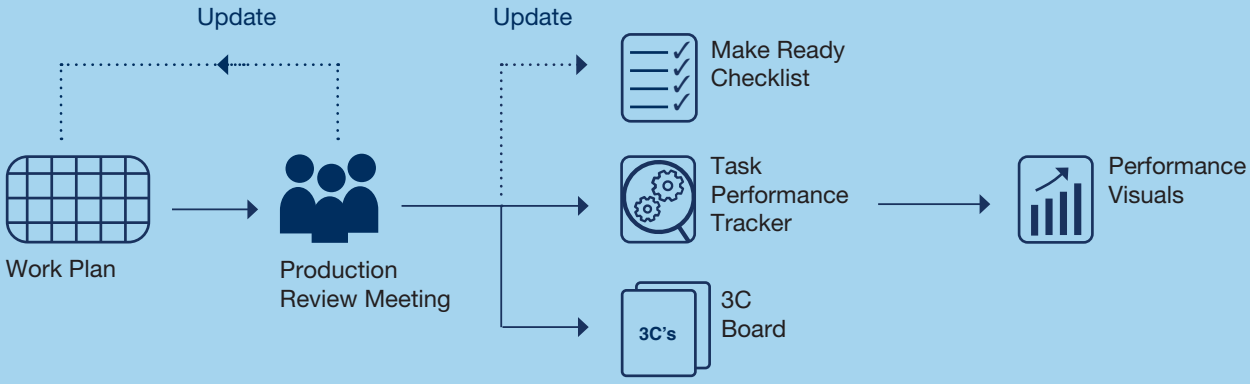


Fig. 7
Process for Production Control/ Production Review

6.3 Percent Plan Complete (PPC)

Percent Plan Complete (PPC) is a management tool used to assess the performance of the short-term plans. It is also known as ‘Percentage Promised’. The PPC is commonly used at Production Control within this standard.

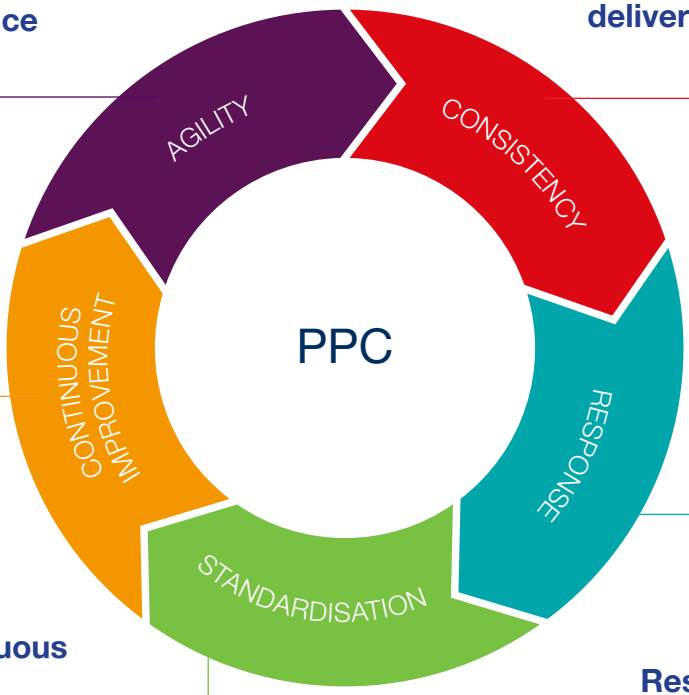
The value is calculated by dividing the number of successfully completed tasks by the number of planned tasks over a given period (usually a week).

N.B. This is a binary measure: individual activities are either complete or incomplete. It is the number of complete activities that gives us the percentage.

- PPC measures the reliability of the Collaborative Planning process.
- Performance against the plan is visible, shared and acted upon by the team.
- PPC enables National Highways to complete root cause analysis and drive Continuous Improvement in planning and scheduling.

Agility on project delivery: Issues are identified faster, and corrective measures put in place immediately

Consistency in the planning process and delivery, and best practice in planned works

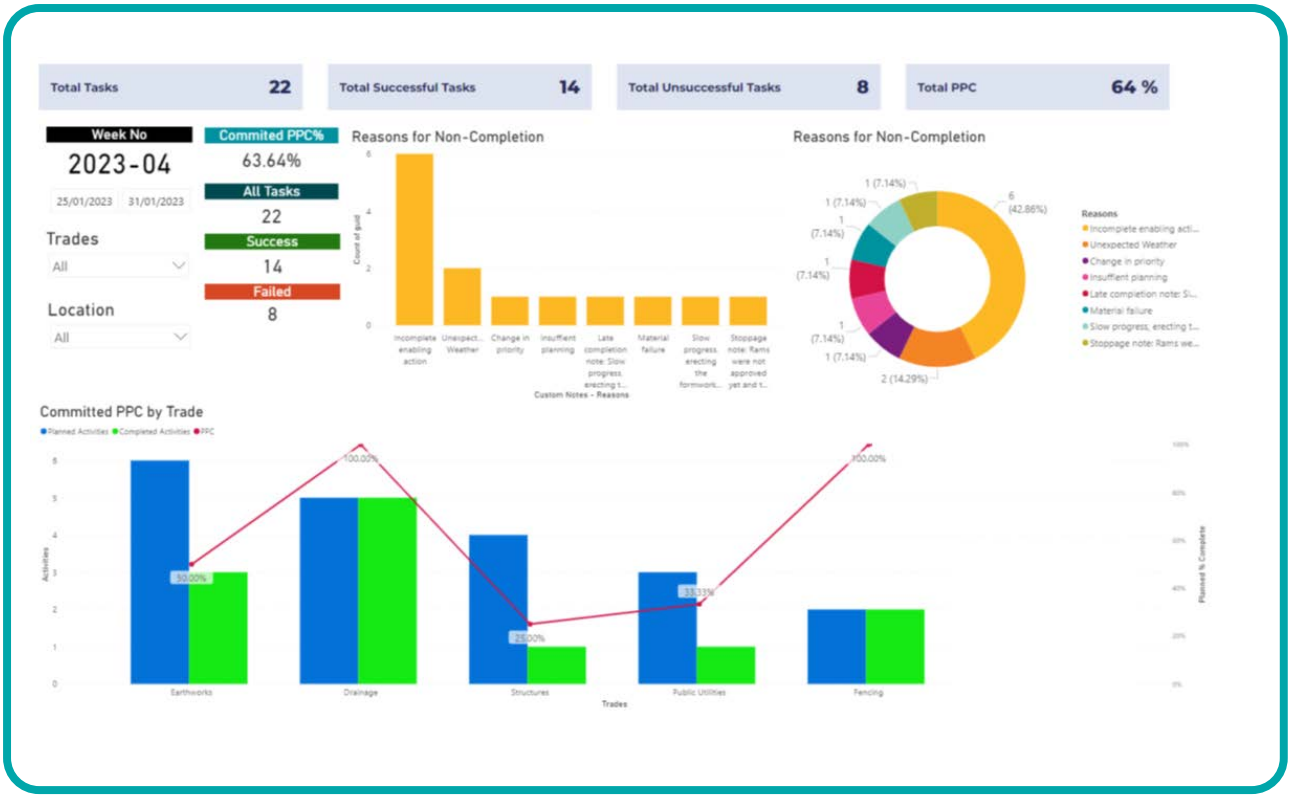


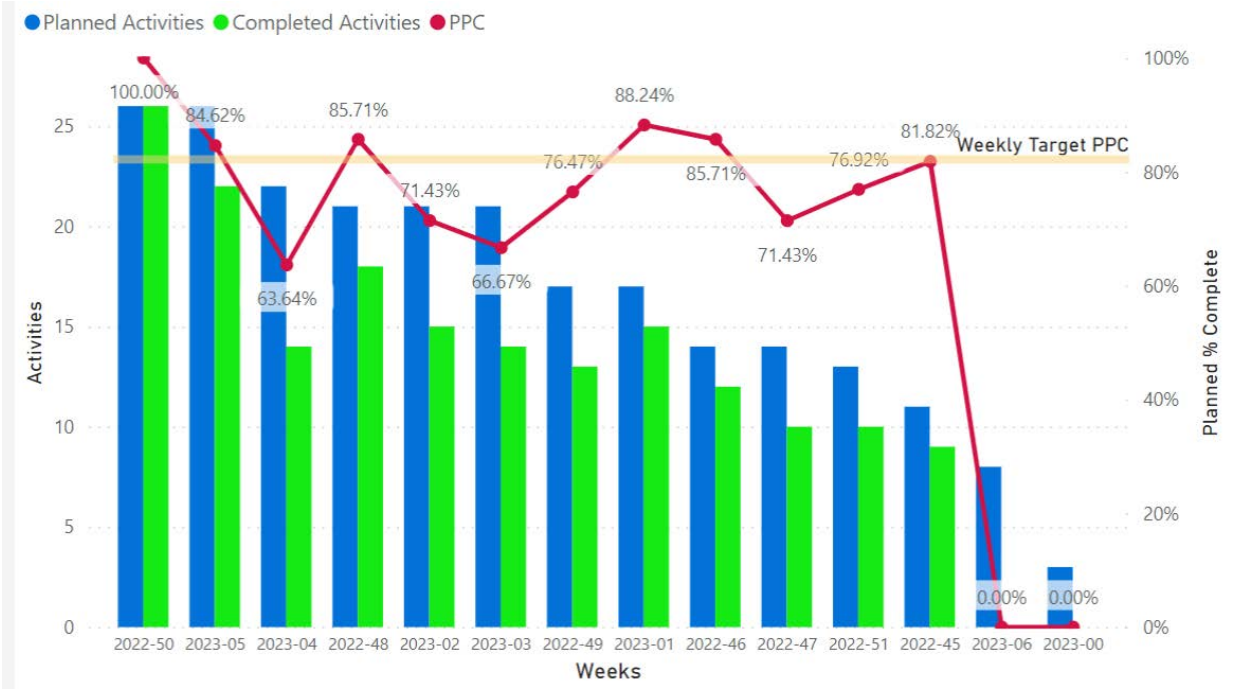
Platform for Continuous Improvement: Root cause analysis can inform best practice to reduce waste. Improved 'Make Ready' planning can lead to productivity improvements

Standardise the project working environment and routines

Respond appropriately when circumstances change

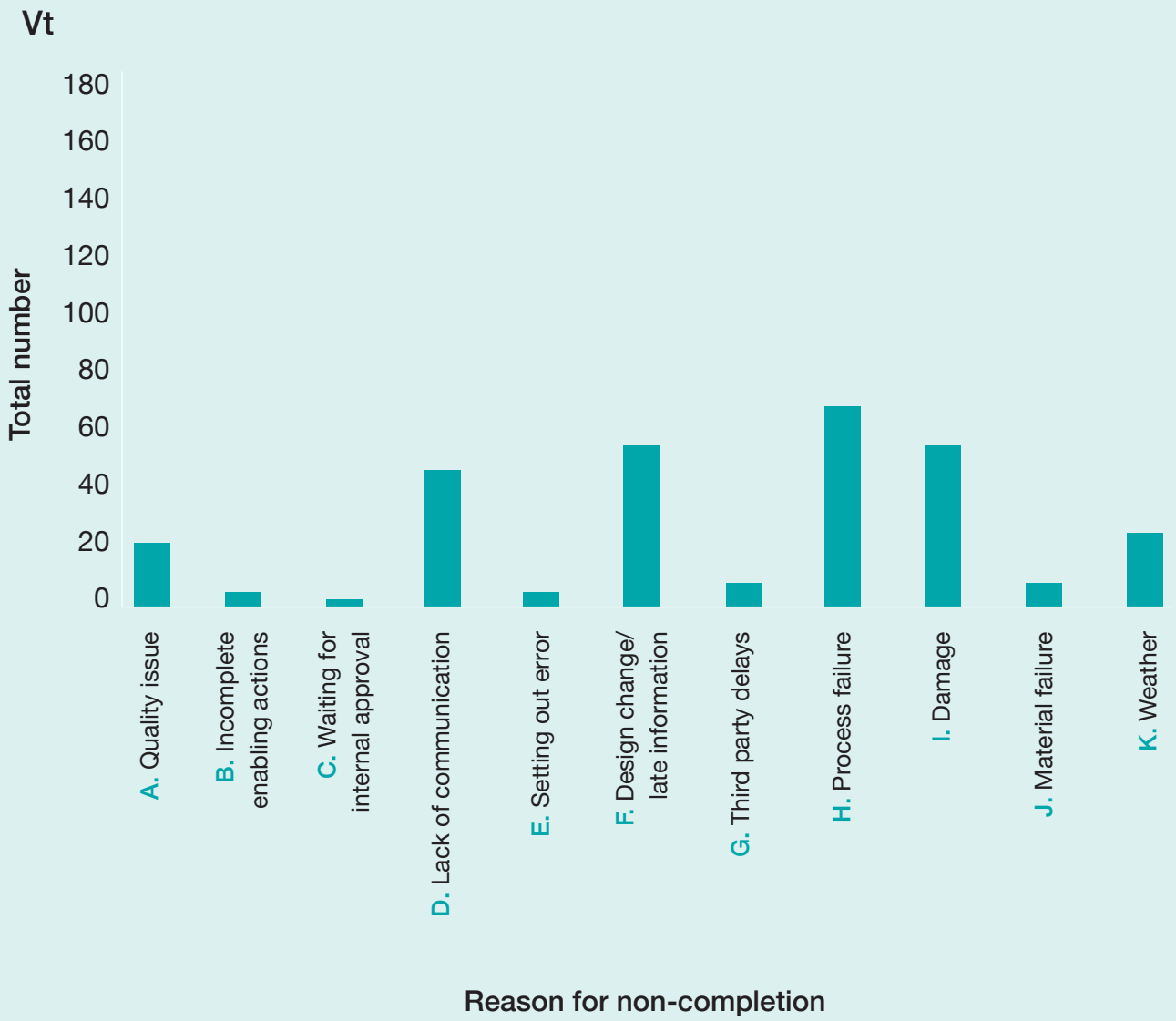
Examples of Use and Display PPC





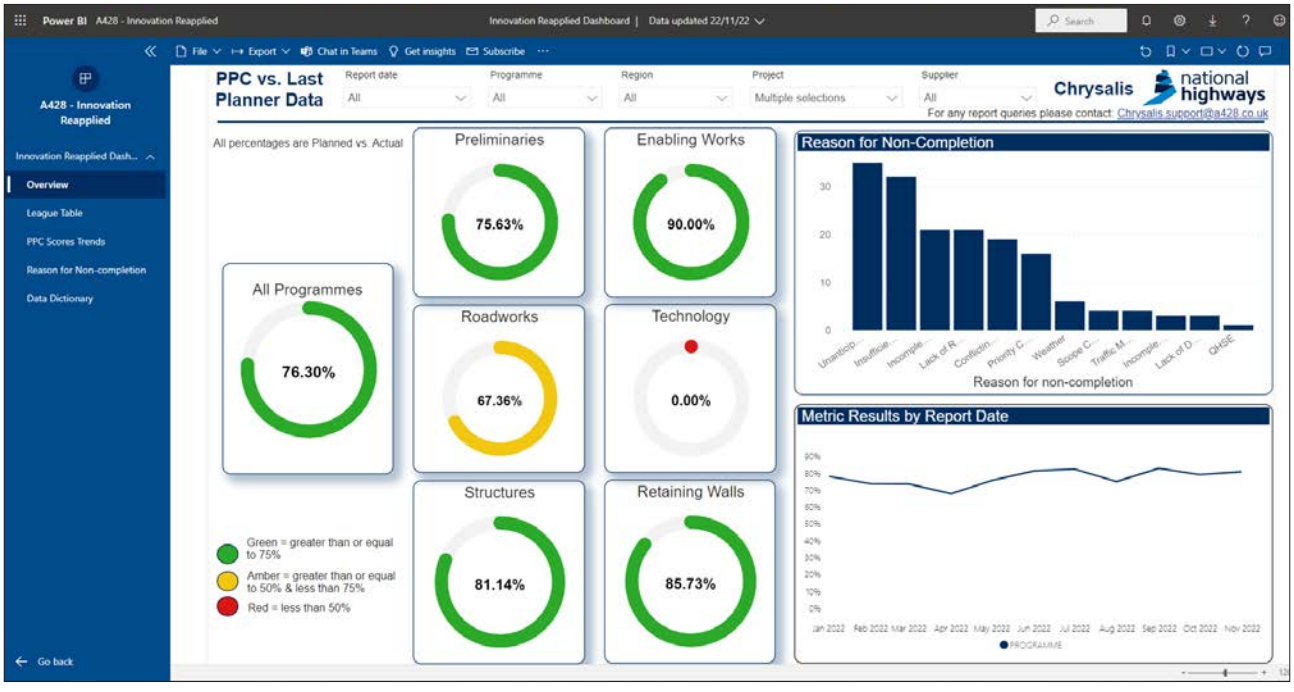
Current Practice

A populated Task Performance Tracker is updated that enables the capture of reasons for non-completion and the generation of PPC metrics.



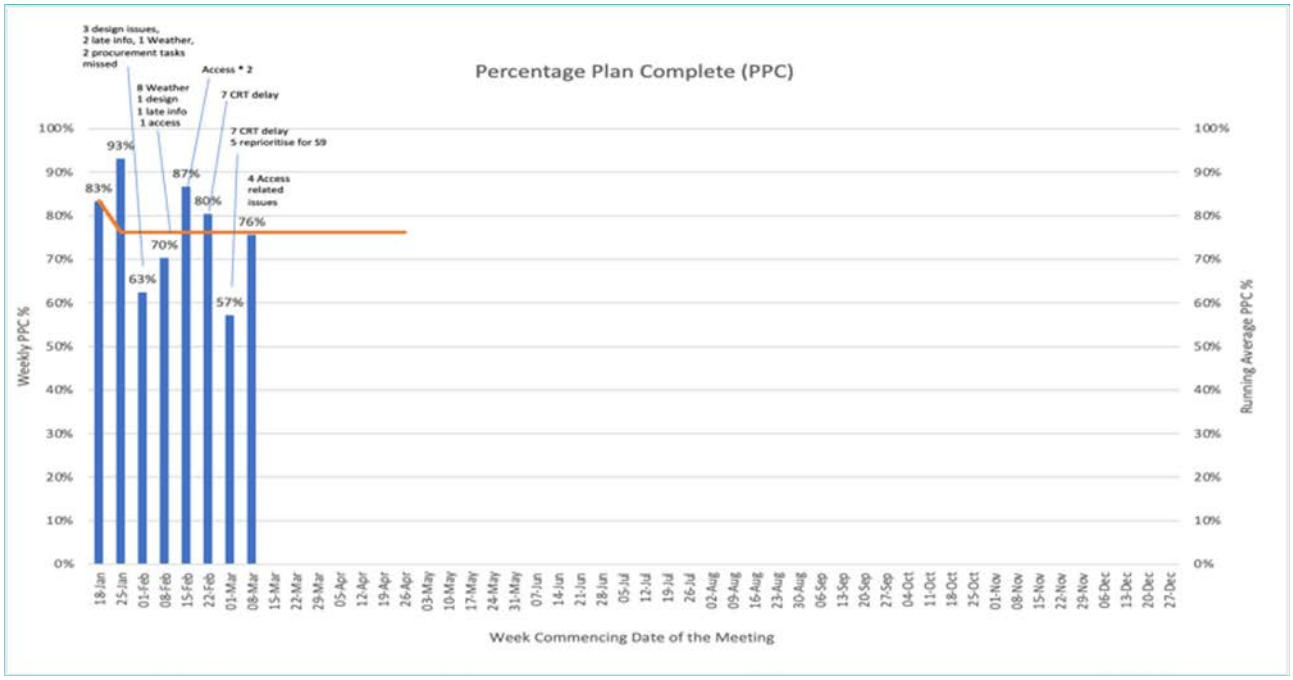
Current Practice

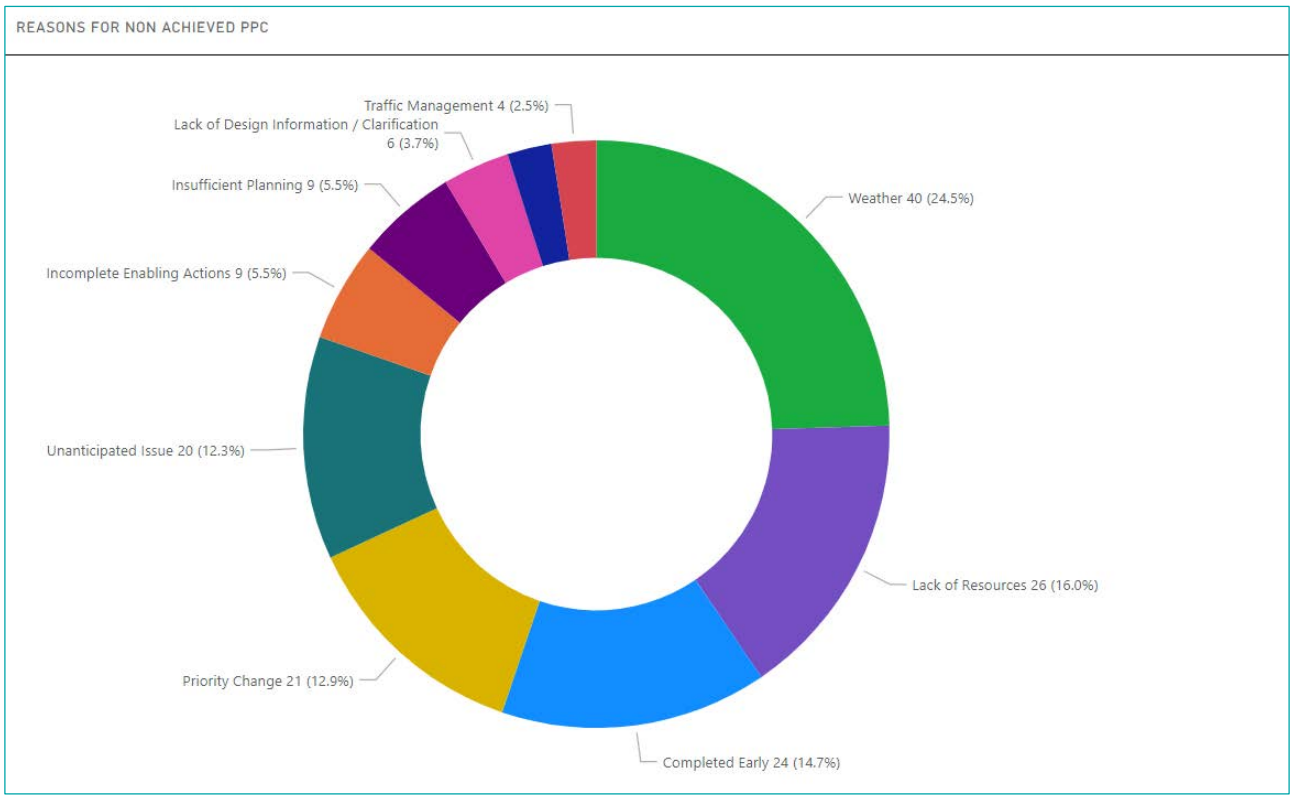
Example of PPC VPN in Power BI



Visal examples of PPC

Visual examples of PPC metrics allowing the reader to analyse reliability of delivery by time and work breakdown structure. Used during Production Review meetings and Continuous Improvement workshops.





6.4 Step 5 - Daily Activity Briefing (DAB)

5 **Daily Activity Briefing (DAB)**
'Brief the people who will do the work and listen to their feedback'

Meeting

RECURRING DAILY

What

The Daily Activity Briefing (DAB) is:

- A daily project briefing implemented to manage work activities and reflect short term control.
- Also known as Weekly Production or Learning.

Who

Required project personnel includes:

- Subcontractors/sub-consultants
- Contract supervisors
- Team leaders
- Team members
- Engineers

Brief the people who will do the work and listen to their feedback

When

Recurring every working day

Why

The Daily Activity Briefings ensure:

- Work can be implemented safely and in accordance with the Make Ready Plans.

How

Key steps for a successful Daily Activity Briefing:

- This meeting should be focused on planning and production (no more than 15 minutes). Other matters should be dealt with outside of the meeting.
- Review - achievements and progress made during previous shift, and to confirm the plan for the next shift.
- Update - daily work plan activities should be updated as required.
- Actions - should be recorded, owners and target dates identified for the issues to be resolved or responded to. An escalation process should be in place where issues cannot be resolved at the work location.
- Concerns - update the 3Cs board to assign actions and resolve any issues that may affect the programme.

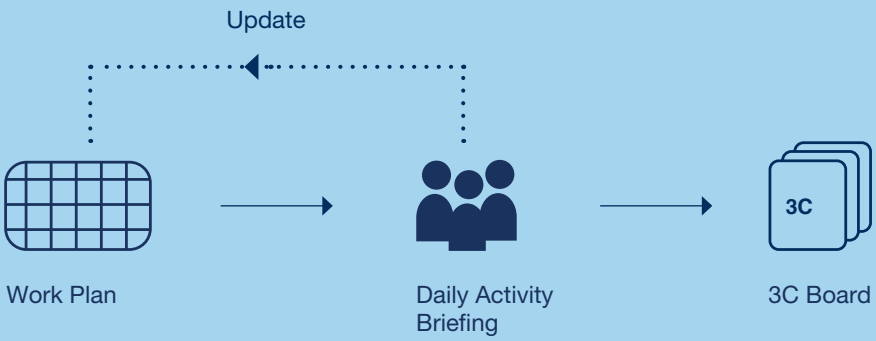


Fig. 8
Process for the Daily Activity Briefing (DAB)

7

Continuous Improvement

7.1 Data Capture and Analysis

6 **Continuous Improvement**
'Small/simple steps that add up to Continuous Improvement'

Workshop

AS APPROPRIATE

Simple steps which add up to Continuous Improvement

Measuring the performance of individual work activities on a project will enable the project team to understand how areas are performing against the project requirements and improve the predictability of programme delivery.
If the delivery of activities is not measured it is not possible to understand where there are bottlenecks in the flow, with activities impacting dependent activities resulting in key milestones being missed.

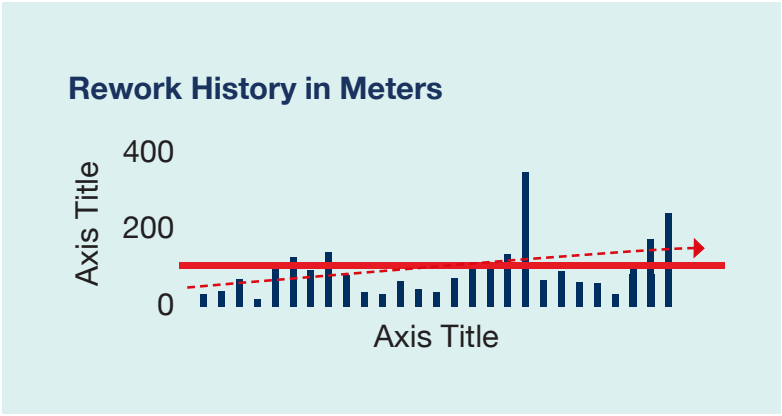
Analysis will:

- Raise awareness of the team's performance delivering critical activities therefore improving commitment to completing tasks.
- Performance trending creates awareness of work rates and can be used to decide where changes are necessary.
- Recording actual works completed versus planned and analysing the factors that prevented planned activities from being completed informs Continuous Improvement activity.
- Provide information to understand how projects are performing against target expectations and productivity improvements.

Typical analysis of metrics includes:

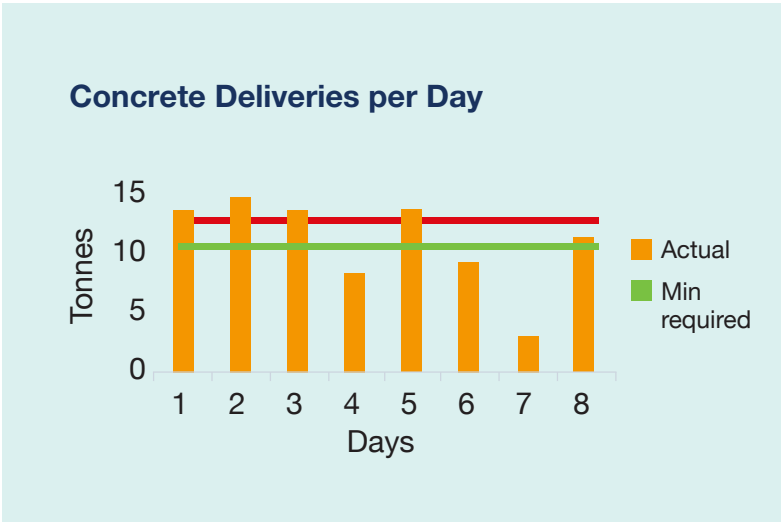
- Trends behind task completion/ non-completion
- Reasoning behind task non-completion
- Root cause analysis of reasoning
- Commitment reliability (using PPC)

Visualisation of the data assists analysis and trend identification. Data captured in digital form enables quick creation of various visual charts and graphs. Business intelligence tools, such as Microsoft Power BI, enable the generation of reports and dashboards that support effective analysis and insights to the data collected. Typical examples can be found in Chapter 11.



Bar Chart With Target and Trend

Ideal for displaying the trend over a period of time and pin-point where the problems are and improvements need making.



Bar Chart for Gap Visualisation

Ideal for displaying the gap in performance. This can be used at the stage when we set the targets for improvements.

7.2 Lean Improvement Activities

When activities are not delivered in accordance with the plan it is essential for the team to undertake an improvement activity focused on identifying and resolving the root causes. By continuously identifying causes and resolving issues, the predictability of programmed activities will improve for the project.

Key steps for Continuous Improvement are:

- Analyse performance data to reveal key and recurring issues which then become the focus for root cause analysis, problem solving and resolution.
- For the highest value items, work studies should be completed to analyse the efficiency of processes being undertaken. Improvement activities should be undertaken to improve productivity with targets that align with National Highways' requirements.
- Lean problem solving techniques should be used on the project focusing on defining the problem (a problem is anything that deviates from the standard or target) and effectively and in good time, stopping the problem from getting worse through containment, before undertaking root cause analysis (RCA) in order to identify solutions or countermeasures. For more information see National Highways Practical Problem Solving Guide.
- A structured approach towards Continuous Improvement could use some or all the systems below:
  - 'Four Folders' system
  - Waste Identification
  - Trend Analysis
- Interventions should be planned to make sure that benefits deliver the maximum value in terms of safety, time, cost and quality.
- Learning should be captured and publicised to help improve subsequent projects.

Four Folders System

1	2	3	4
BLANK SUGGESTION FORMS	SUBMITTED SUGGESTIONS	INSTIGATED SUGGESTIONS	COMPLETED SUGGESTIONS

TIMWOODS Waste Classification

- Transportation
- Inventory
- Motion
- Waiting
- Over-production
- Over-processing
- Defects
- Skills

7.3 Benefits Management

The benefits of Lean Collaborative Planning should be recorded and publicised to ensure effective knowledge transfer between projects and to embed a Continuous Improvement culture.

Key steps for benefits management are:

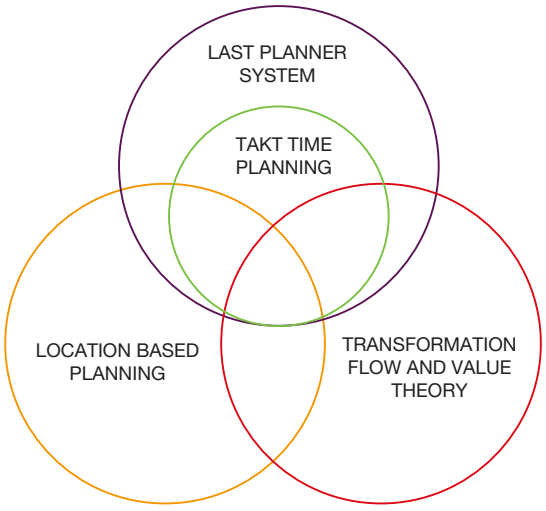
- Identify benefits that will be derived as a result of applying Lean Collaborative Planning.
- Establish the performance and high value productivity baselines.
- Establish project milestones and stage durations.
- Assess the impact of improvement activities against the baselines to establish the benefits of Lean Collaborative Planning and Continuous Improvement.

7.4 Modern Methods of Highway Construction

Modern Methods of Highway Construction (MMHC) is a process focused on the production of better-quality highways in a more efficient way, concentrating on modularisation and prefabrication as well as continuously improving the on-site construction methods.

7.4.1 Takt Time in Highway Construction

The relationship between Takt Time and Collaborative Planning can be seen in the diagram opposite. Takt Time is an integral enabler of the Last Planner system.




TOO HARD
time management
KEEP GOING!
REFUSE 2 LOOSE
GROWTH
flexibility

8

Lean Collaborative Planning & Production Spaces

8.1 Physical Collaboration Spaces

For Lean Collaborative Planning to be effective it is essential a dedicated space is allocated for Lean Collaborative Planning, Performance and Production Control meetings.

Space Purpose

- The space should be accessible to the whole project team to facilitate collaboration and communicate the progress of the project.
- The collaborative plans should not be restricted and accessible for regular review.
- Production Control weekly and daily reviews should have priority use of the space.
- Virtual spaces need to be accessible to participants located in other organisations and work places.

Location

- Ensure the space can be easily accessed and is in a place such that planning and performance boards are visible to all project participants and visitors.
- Centrally located, close to project teams.

Floor Space

- Ensure there is adequate room for the full meeting attendees. A minimum size of 5m x 10m would suit most projects.
- Ensure there is suitable space for reviewing wall charts, free standing boards or visual display screens.

Wall Space

- Ensure there is sufficient wall space to show adequately the:
  - Lookahead Plans
  - Make Ready Plans
  - 3C board

8.2 Digital Collaboration Spaces

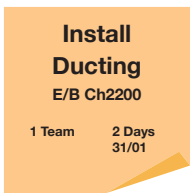
It is not always possible to have all team members co-located in one place. Lean Collaborative Planning principles can be applied in virtual spaces with digital plans facilitated using video conferencing such as Microsoft Teams and Microsoft WhiteBoard to integrate Lean Collaborative Planning systems. Further guidance on tools and techniques can be found on the Lean Digital Collaboration page on the The Innovation Reapplied Website.

Benefits of using Digital:

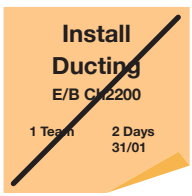
- Ease of accessibility and interaction.
- Live document.
- Digital time stamps capture adjustments.

Sticky note information requirements

Sticky note milestone example



Sticky note task example



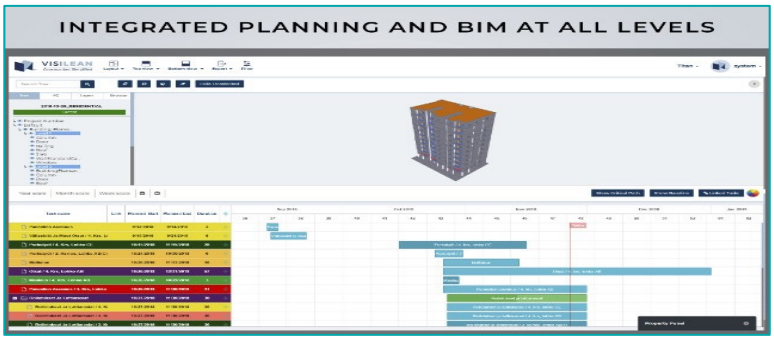
Sticky note completed task example

When creating or selecting a digital collaboration platform or tool the following functionality should be present:

- Must be accessible to all team members (consider what equipment the team requires to view and update tasks such as tablet devices on site or large touch screens in office).
- Must be able to visually separate tasks between workstreams / teams / disciplines as you would with a physical plan.
- Must enable live collaboration - an updated task is visible to all team members.
- Must enable the connection of task successors and predecessors and therefore the ability to visualise the critical path activities.
- Must allow Production Control and therefore the tracking of committed tasks, capture of reasons for non-completion and resulting percent plan complete metrics.
- Should offer integrated performance data visualisation and analysis tools.
- Should allow for the capture of productivity measures.
- Could offer integration with the BIM Model allowing alignment of activity with physical components of the project within consideration to time and cost.

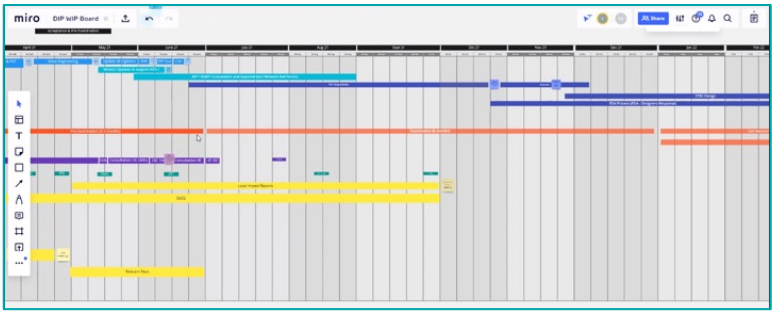
Visilean Platform

- Predictable and manageable projects.
- Real Time collaboration and tracking.
- Information at-hand at all times.
- Improving performance.
- Better communication with all on board.



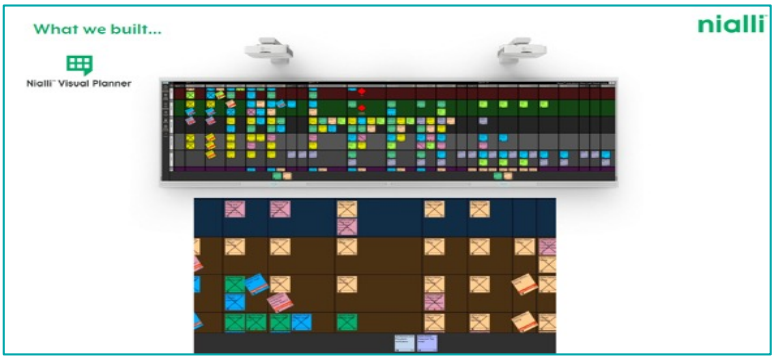
Miro Platform

Miro allows team members to collaborate in real-time on a shared digital canvas, regardless of their physical location.



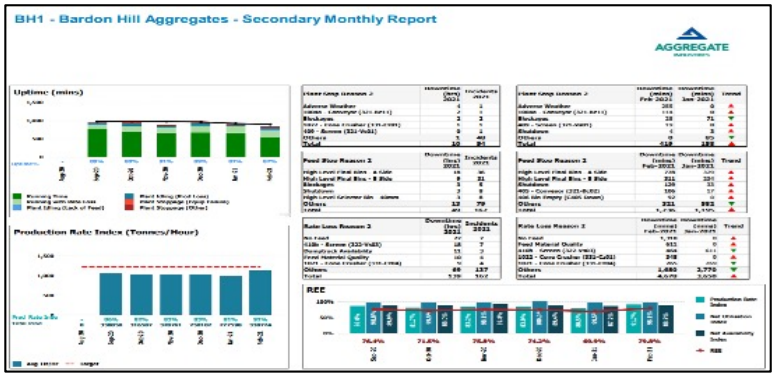
Nialli Platform

- Manage project complexity with tools to visualize conversations and workflows.
- Nialli has solutions for virtual pull planning, design planning and more.



SIC Platform

- SIC App Qlikview reports
- Daily
- Weekly
- Monthly
- Exception Report
- Standardisation of Data



9

Lean Collaborative Planning and Visual Performance Management

While Lean Collaborative Planning can be used as a standalone technique, the benefits it delivers can be enhanced by Visual Performance Management. The figure below shows how these two techniques complement each other. At its core, the Lean Collaborative Planning approach is focused on planning to do work. Similarly, Visual Performance Management is focused on putting people to work.

The quality of work assignments distributed via Daily Activity Briefings (DAB) can be enhanced through the use of Production Control Techniques by ensuring that all inputs, controls and resources required to successfully complete assignments are in place prior to stating work. In addition, the Continuous Improvement Activity spans both techniques as they both work towards performance and process improvement activity. Together, they provide teams with a set of tools to add value and reduce waste.

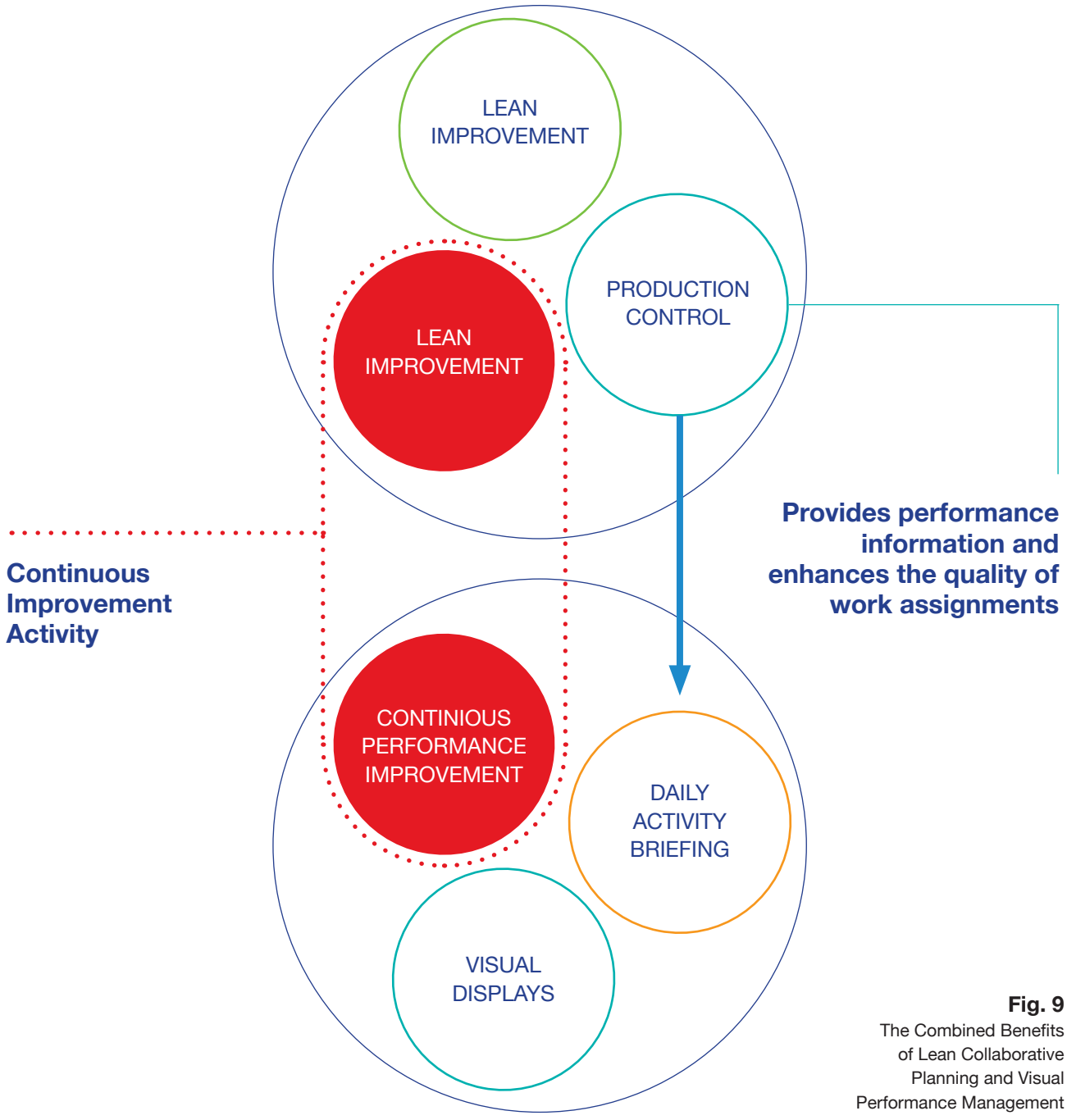


Fig. 9
The Combined Benefits of Lean Collaborative Planning and Visual Performance Management

10

Modern Methods of Highway Construction (MMHC)

10.1 Definition, Benefits and Categorisation

Modern Methods of Highway Construction (MMHC) is a process focused on the production of better-quality highways in a more efficient way, concentrating on modularisation and prefabrication as well as continuously improving on-site construction methods.

Modularisation and prefabrication can be innovative and provide many benefits – quality, safety, efficiency, speed of construction, reduced waste value, ease of maintenance, etc. Like standardisation, how these elements are used and arranged is the creative challenge for the designer to ensure a sense of place is not eroded.

The MMHC definition framework is a new seven category definition framework that enables a full and future-proofed range of modern methods of highways construction used in road building and maintenance to be better understood with regularised terminology.

The framework takes into consideration:

Construction Typology

- Motorways
- Dual carriageways (2 and 3 lane)
- All lane running (4 and 5 lanes)
- Technology enabled motorways

Material Genre

- Mass concrete (MC)
- Reinforced concrete (RC)
- Light gauge steel frames (FGS)
- Hot rolled fabricated steel (HRS)
- Hot rolled/ light gauge steel combination (SC)
- Sheet piling
- Hot and cold rolled asphalt
- Traffic management technology
- Emergent materials and technologies

Category Definitions

Category 1	Category 2	Category 3	Category 4	Category 5	Category 6	Category 7
Pre-Manufacturing - 3D structural systems	Pre-Manufacturing - 2D primary structural systems	Pre-manufactured components	Additive Manufacturing (Structural and Non-Structural)	Pre-Manufacturing	Traditional building product led site labour reduction/ productivity improvements	Site led process labour reduction productivity and assurance improvements
 MS4 Standardised Gantry	 2 Bridge Span Components	 Pre-fab Slot Drain	 Slipform Concrete Barrier	 Underground Utilities	 V Ditch Bucket	 Drone Surveys
Complete modular 3D units factory produced and transported to site for final installation	2D units produced in factory conditions that when assembles create complete structures / assets	Standardised and mass engineered components that can be assembles and connected together (Pre-cast)	Components formed to a specific digital design / mould including remote or site based printing of parts	Non structural items and components brought together to make an asset	Building products manufactured for easy on-site assembly. Error proof designed tools / components	Site led process improvements using innovative-oriented solutions
Offsite Industrial / Automated Manufacturing				Onsite Construction		


K LINE

10.2 Modern Methods of Highway Construction (MMHC)

Category	Visual	Examples
Category 1 Pre-manufacturing (3D primary structural systems)		A. Structural element only– not finished B. Structural element installed complete C. Structural element, finished with cladding complete D. Structural element and finished – plug and play **Any of the above variants can be used in the following 3 configurations:** i. Whole element systemised ii. Hybrid construction– whole element part systemised; part traditional iii. Hybrid construction– secondary structure enhance system performance
Category 2 Pre-manufacturing (2D primary structural systems)		A. Basic structural frame only including structural elements B. Enhanced consolidation– railings, restraint systems, cabling C. Further enhanced consolidation– railings, safety equipment, lighting, security equipment, technology cabling routes and ducting's, etc.
Category 3 Pre –manufacturing components (non-systemized primary structure)		A. Driven/ screw piling B. Pre-fabricated pile caps/ ring beams C. Columns/ shear walls/ beams D. Slab/ bridge decks E. Integrated columns, beams and slabs F. Staircases G. Pre -assembled structure– gantries
Category 4 Additive manufacturing (structural and non-structural)		A. Substantive structural forms / components a. Central reserve barrier b. 3d printed footbridges c. 3d printed pumping stations or head walls B. Non-structural components a. 3d printed kerbing b. Computer controlled slip forming
Category 5 Pre-manufacturing (Non-structural assemblies and sub-assemblies)		A. Whole control room assemblies (including enclosing structure) B. Monitoring room assemblies (including enclosing / supporting structure) C. Control and monitoring room combined assemblies (including supporting structure) D. In unit M&E central equipment assemblies (utility cupboards etc) linear assemblies E. Façade assemblies (non-structural) including solid cladding, metalwork F. Deck assemblies / cassettes– pre-finished deck sections G. In unit M&E distribution assemblies H. Infrastructure M&E assemblies – risers / main distribution I. Infrastructure M&E assemblies – central plant & equipment J. Deck cassettes with horizontal services / finishes added K. Gantry cassettes – with horizontal & vertical services / technology added L. Railings and barriers (pre-installed, finished with fixtures and fittings)
Category 6 Traditional building product led site labour reduction / productivity improvements		A. Large format products – retaining walls B. Large format products – header walls C. Large format decking finishes D. Pre-sized and cut to measure traditional materials– component level systemisation E. Easy site install / jointing / interfacing features– brick slips, modular wiring, flexible pipework
Category 7 Site process led site labour reduction / productivity / assurance improvements		A. Site encapsulation measures– weatherproof and environmentally-controlled enclosures B. Use of standardised or sacrificial temporary works – modular scaffold, tunnel form in-situ concrete, insulated concrete formwork C. Use of BIM connected lean delivery framework– digitally enabled workflow planning D. Site worker augmentation – visual (i.e. AR/VR) E. Site worker augmentation – physical (i.e. exoskeletons, assisted materials distribution F. Site worker productivity planning tools (GPS, wearables etc) G. Site process robotics and drones (rebar, masonry, waterproofing, white lining, surveying etc) H. Autonomous plant and equipment and drones (driverless cranes, diggers etc) I. Digital site verification tools (photogrammetry, site worker video, LIDAR scanning

10.3 Takt Time Definition and Formula

Takt Time can be implemented in the construction of highways wherever we have:

- Repetitive operations, such as ‘Pre-manufacturing’,
- Processes that are executed away from final workface, including in remote factories, near site or on-site ‘pop up’ factories.

What is Takt Time Planning?

Takt Time planning is a work structuring method. ‘Takt Time’ is a term used in manufacturing to describe pacing work to match the customer’s demand rate.
Takt Time planning, is one method for work structuring around a set pace of work. The goal of Takt Time planning is to create a reliable plan, with the input of the entire team, which balances workflows for specific phases of work. It is important to start this process early in a project, because whether design professionals realise it or not, they are critical to defining the means and methods when they create design documents and specifications.

Why Do We Use Takt Time?

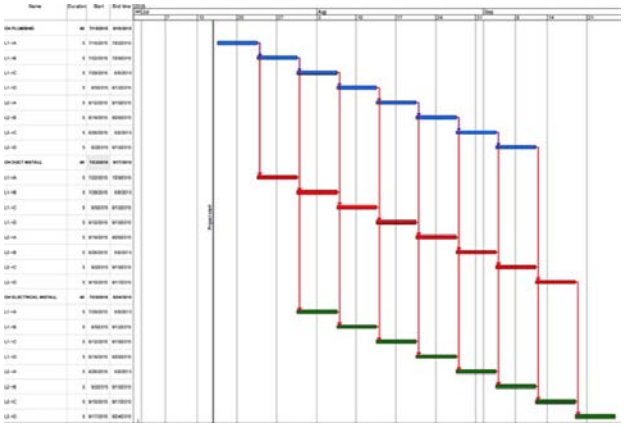
We need a systematic way of improving production if we are to improve over the long term. When activities are all moving at different paces, then projects naturally become more chaotic. Stable flows help reveal bottlenecks, which are the areas to improve upon.

Takt Time can be calculated using the formula:

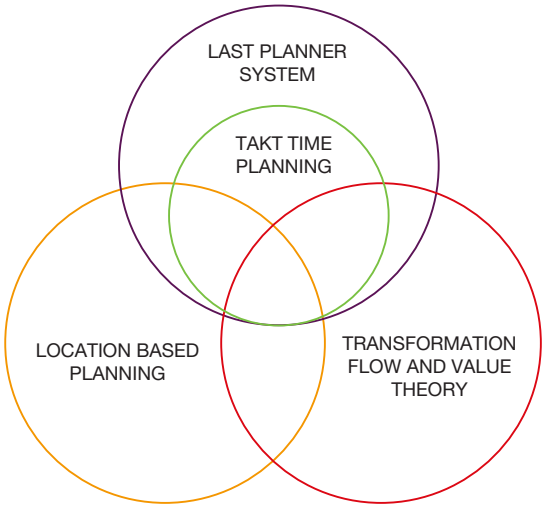
$$\text{Takt Time} = \frac{\text{Time available (net)}}{\text{Demand in the time available}}$$

This calculation is slightly different on construction sites because it is essential to consider the set up time (time required to achieve the first unit).

Below is a simple construction example schedule resulting from Takt Time Planning. In this example the work is planned with plumbing (blue) going first, followed by duct (red), and electrical conduit (green). The work is all paced at a 5 day Takt Time, moving through quadrants on two floors.



The relationship between Takt Time and Collaborative Planning can be seen in the diagram below. Takt Time is an integral enabler of the Last Planner system.



Defining the Takt area:

In the definition of the Takt area, first the SSA (Standard Space Area) must be identified. The SSA is the smallest repeatable unit of space in the functional area. In the defined sequence of works to be completed, this area cannot be further divided and all the required tasks can be completed within these areas independently from one another. For a civil construction project, the logical unit of measure for the SSA can be either m2 or station numbers (measured often in meters). For a road construction project the preferred unit of measure is station number. In road projects the road to be constructed is often divided into sections (e.g. 20m) and the station numbers are presented for example as station 0, 20, 40, 60… and so on. The definition of SSAs and Takt areas will differ from project to project.

Project divided in to station-numbers:

On a road construction project, the quantity of excavation varies drastically along the line of the road. This means that there needs to be flexibility in the combination of SSAs into Takt areas. There can be no rigid Takt area for all the work packages. The size of Takt area must flow through the project according to the amount of work in each SSA. The capacity / rates of the different work tasks must be used as a base for calculating the amount of SSAs in each Takt area. The Takt Time is set as rigid but the Takt area must be flexible.

Truck movements:

In the case of trucks removing spoil or delivering construction materials, due to the variability in the capacity of each work-package operating in the Takt area (SSA), there can be no complete train of trucks passing through the project. For these movements, the Takt plan will look more like a flow line schedule in the sense that there will be time buffers between some trucks due to the capacity of some being much higher than others. For example, the task of paving with asphalt will move through the project much faster than the excavation works.

In summary:

The method for doing Takt planning to highway construction is that the Takt Time must be chosen according to the completion rate of the project. If the project is fast paced with a lot of machines working, the Takt Time must be appropriate so that the follow-up is accurate enough to notice changes / problems. It is likely in this case that the Takt Time will be one day. The unit for the Takt area is chosen depending on the project. The Takt area will be a flexible combination of SSAs for each task. Where it is feasible to harmonise the tasks, the Takt area will be the same to create flow of all the tasks. For variable workloads, like excavation the Takt approach must be to consider variable Takt areas depending on the workload for each SSA.

10.4 Example of Takt Planning in a Civil Construction Project

Service tunnel: The works included rock reinforcement, paving and technical refurbishments. Different SSAs and Takt Times were developed for each main task as they differed so greatly form one another. The Takt schedule can be seen in the diagram below.

It is noticeable that the tunnel project has been divided in the middle and is executed in 2 directions at the same time. This is not possible to make as visually clear using a Gantt-chart method (Figure 11).

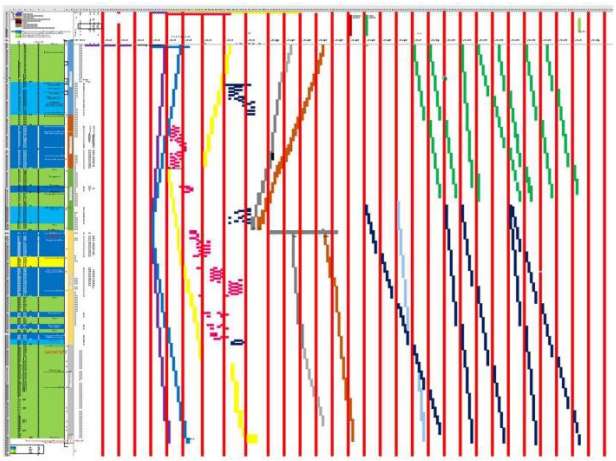


Fig. 10
Takt driven Time and Location visual for the Construction Project

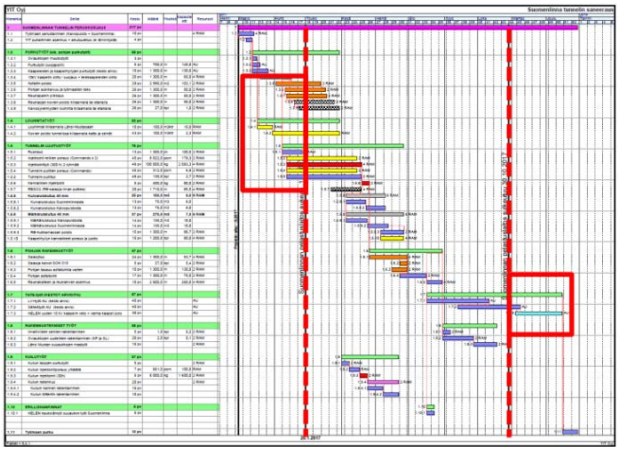


Fig. 11
Gannt Chart for the Construction Project

11

National Highways Lean Collaborative Planning Assessment

Collaborative Planning Assessments have been created to help baseline the application of Lean Collaborative Planning and to help projects identify areas for improvement and to ensure a high standard is achieved.

Regular assessment will capture maturity of Collaborative Planning application, good practice and key lessons for the benefit of all.

This assessment should be carried out by experienced personnel who are familiar with the principles of Lean Collaborative Planning together with the National Highways Lean team, who will support assessors and moderate the scoring across projects.

The assessment focuses on five areas, of which the scores attract an equal weighting (scoring between levels 0-4). A minimum attainment of level 3 is expected for all projects.

The assessor will note areas where there may be 'opportunity to improve' and elements of 'good practice'. The assessment should take no more than two hours, including observation, scoring and submission.

The initial assessment must take place at the beginning of the project, following introduction of Collaborative Planning. This initial assessment helps establish a baseline to measure the Collaborative Planning deployment and helps measure any improvements throughout the duration of a project.

The five areas assessed are:

- Planning as an integrated team
- People engagement and collaboration
- Production Control process
- Visual Performance Management
- Problem Solving and Continuous Improvement

11.1 Scoring

Each section is scored based upon the assessor/s view of the maturity of Lean Collaborative Planning on the project. The overall maturity of Lean Collaborative Planning will be the average of the five section scores.

The assessment focuses on five areas, of which the scores attract an equal weighting (scoring between levels 0-4). A minimum attainment of level 3 is expected for all projects.

Level Classification and Expectation	Typical Activities and Behaviours
Level 4 – Excellent continuous improvement culture adopted for whole project delivering significant benefits with all team members/suppliers/stakeholders engaged.	All team members adopt all aspects of the Lean Collaborative Planning (LCP) system and proactively undertake Continuous Improvement activities. Evidence of an improved system being developed as the project progresses.
Level 3 – Good practice and performance improvement evident in all key and many other areas.	All senior and most other team members support Lean Collaborative Planning (LCP) and undertake Continuous Cmprovement activities, good practice is shared with wider highways community. Benefits are tracked and high-performance levels are evident in key areas.
Level 2 – Developing and delivering in specific areas.	Processes are widely adopted by most team members, Continuous Improvement visible in specific areas and its performance is routinely tracked to identify areas for action. Benefits are being realised.
Level 1 – Initial fragmented activity.	Priority change.
Level 0 – Process not started and no systems in place.	There is little evidence of the process taking place and where implemented activity is sporadic, benefits are not recorded and lacks focus.

11.2 How The Assessment Will be Used

Project Team

This assessment shall be supported by experienced personnel from the project team who are familiar with the principles of Lean Collaborative Planning together with the National Highways Project Manager.
The assessment will be conducted by an assessor and representative from National Highways Lean Team. Reference should be made to the National Highways minimum standard for Collaborative Planning which explains the terms used.

Evidence to support this assessment

The scheme representatives shall provide evidence to demonstrate compliance in each area being assessed. Failure to provide evidence will result in a no score; the onus will be on the scheme representatives to provide evidence. The assessment level will be representative of the project not individuals/suppliers.

Recording Scores

If the project does not achieve the minimum of 3.0 in any area, it will be assessed at failing to meet the requirements of implementing effective Lean Collaborative Planning.

An improvement plan must be completed and submitted to the National Highways Project Manager and National Highways Lean Improvement team. Failures will be reported through the performance management process.

How to assess against levels

Individual questions should be answered using a system of 5 choices:

- No evidence
- Little (or sporadic evidence)
- Some (evidence)
- Most (cases have evidence)
- All (consistent evidence)

The overall LCP assessment value will be an average of the 5 section scores rounded down to the nearest 0.5.

Recording Scores

Projects can record the score of their Completed Lean Collaborative Planning assessment on the Assessment Toolkit.

Distribution

Assessment results are to be distributed to:

- National Highways Project Manager
- Supplier's Project Manager
- National Highways Lean Improvement team

The assessment may be reported in performance reviews.

11.3 Evidence Examples

A	Planning as an Integrated Team	Possible Evidence
1	Are collaborative mapping reviews held at key dates in the project, e.g. start up, beginning of phase, etc.	Records of meetings, outputs, photos
2	Is phased collaborative planning / mapping held every 4/12 weeks?	Records of meetings, outputs, photos
3	Has the principle of pull planning been adopted for the collaborative plans with a focus on outcomes?	Record of process, observations from sessions
4	Has the critical path been identified, is it visible, communicated and evidence of it being protected?	Displayed on visible plans
5	Is the contractual project programme updated from the Lean collaborative plan?	Updated P6 which aligns with CP
6	Is the collaborative plan free from float and contingency?	Process showing removal of float
7	Is there a hierarchy of collaborative plans for each group of team activities?	Process and visibility of plans

B	People Engagement and Collaboration	Possible Evidence
8	Are collaborative mapping reviews held at key dates in the project, e.g. start up, beginning of phase, etc.	Attendance list and tracking
9	Is phased collaborative planning / mapping held every 4/12 weeks?	Attendance list and tracking
10	Has the principle of pull planning been adopted for the collaborative plans with a focus on out-comes?	Observations from sessions. Not dominated by one person
11	Is the critical path been identified, is it visible, communicated and evidence of it being protect-ed?	Evidence of start and finish times
12	Is the contractual project programme updated from the Lean collaborative plan?	Mood boards, observation from meetings, collaboration between suppliers and teams.
13	Is the collaborative plan free from float and contingency?	Process showing removal of float
14	Is there a hierarchy of collaborative plans for each group of team activities?	Evidence from training support sessions

C	Meeting Behaviour	Possible Evidence
15	Questions raised appropriately and driving solutions	Opportunities and Benefits Tracker
16	Actions are captured during the meeting including owner and due dates	Actions Tracker
17	After the meeting follow-up actions identified to ensure ownership of tasks	Owners listed on Action Tracker
18	Overdue actions are challenged to get resolved / escalated	Status shown on Actions Tracker
19	The project / business status is clear and weekly updates sent to Senior Leadership Team and Stakeholders	Evidence of updates sent

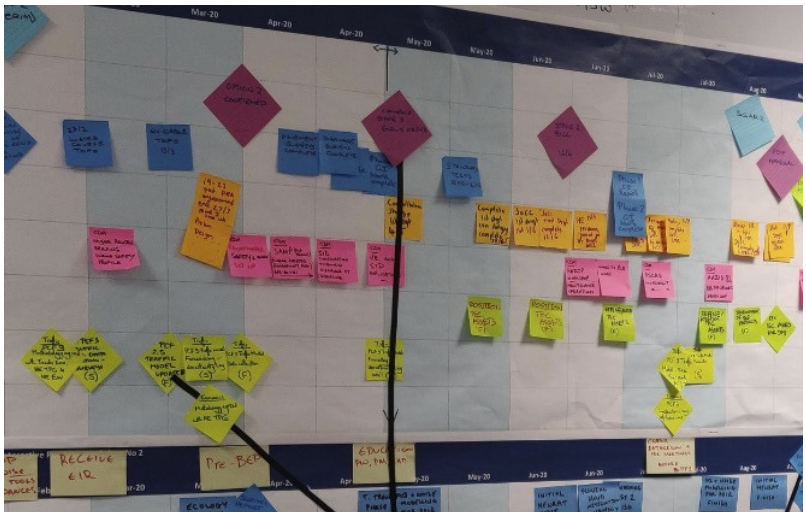
D	Visual Performance Management	Possible Evidence
20	Does the primary visual display board include sections for team performance, people and Continuous Improvement?	Team performance, people and Continuous Improvement information displayed on visual board
21	Does the board have an owner, is it up-to-date with the latest information?	Observations from sessions, handwriting, editing evidence
22	Is the visual display located in a central and convenient position that encourages engagement?	Location of up-to-date board
23	Does the board show Percent of Plan Complete (PPC), trend analysis and reasons for incomplete activities?	Up-to-date PPC on visual board
24	Are the 3Cs up-to-date, with owners identified and close out dates indicated?	Evidence of updated 3Cs board

E	Problem Solving and Improvement	Possible Evidence
25	Is there specific evidence that the 'causes of incomplete activities' are analysed and addressed?	Improvement projects
26	Where improvements and benefits occur, are these communicated to the rest of the team?	Newsletters, improvement boards
27	Do project leaders review and remove blockers and support improvement activities?	Constraint stracked and acted upon
28	Is there a constraints management process to ensure critical activities are prioritised?	Following structured process e.g. DMAICT,5S
29	Are the production control plans updated on a daily basis and / or between weekly production meetings?	BenefitsTracker

12

Examples of Current Practice

12.1 High-level Plan



A High-level collaborative milestone plan, populated by the team, which is aligned with the project milestones, critical path activities highlighted and shows how activities are sequenced.

12.2 Lookahead Plan

A detailed Lookahead Plan populated by the team, which is aligned with the High-level Collaborative plan, critical path activities highlighted and shows how activities are sequenced.

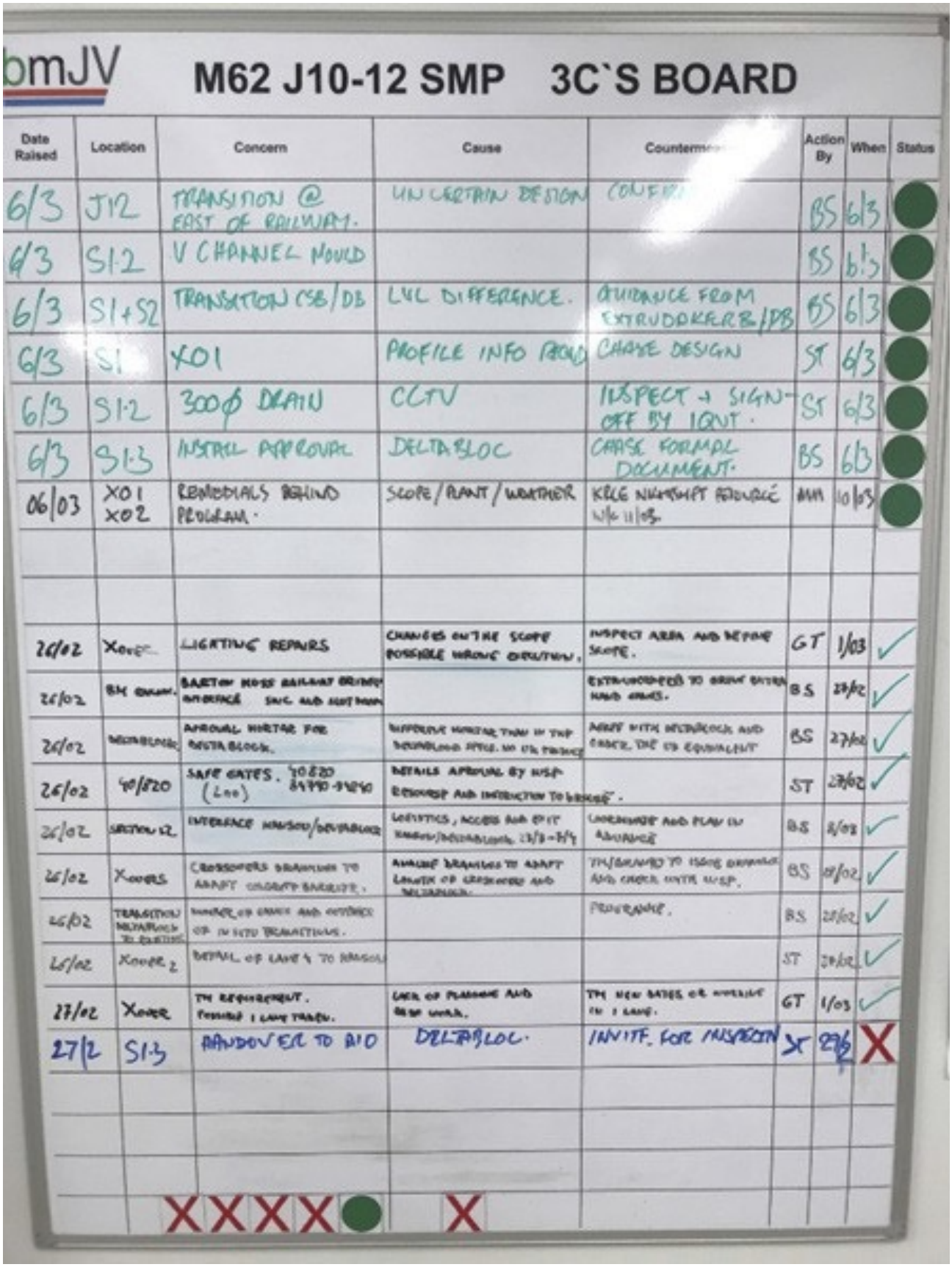
12.3 Make Ready Checklist

Make Ready checklist with all things necessary to start and complete key activities, agree actions to address any outstanding issues or blockers and identify any opportunities for improvement.

Make Ready Meetings							
Operation Planned Start	Drainage – South Bound – J18-17				21-Mar	Company	CRC Civils
Activity	RAG	Action	T – 4 Weeks	T – 3 Weeks	T – 2 Weeks	T – 1 Week	Week 0
Site Visit	In Hand	Monray					
Design (RFI/TQ, etc)	Ready						
RAMS	Action	Monray				To be approved	
Temp Works	In Hand	Monray				Design for trench boxes to be submitted	
Trial Holes	Ready						
Service Diversions	Action	Monray					
3rd Party Notification	Ready						
Environment	Ready					Final check for env. controls	
Materials	Ready						
Material Approvals	Action	Monray				Approvals required for all material	
Setting Out	In Hand	Monray					
Quality (ITP's,etc)	In Hand	Monray				ITPs with Agents - to be signed off prior work starting	
Permits	In Hand	Monray					Issue permits as required
Attendance	Ready					No attendance required	
Training	Ready	N/A					
Other Equipment	Ready	N/A					
Plant	In Hand	Monray		Plant requirements to be determined from RAMS		Confirmation required that plant has been ordered	
Labour	In Hand	Monray		Labour requirements to be determined from RAMS		Confirmation required that labour has been secured	

12.4 Concerns (3Cs)

A populated 3Cs board with each issue/ concern including the proposed action, owner and target date for resolution.

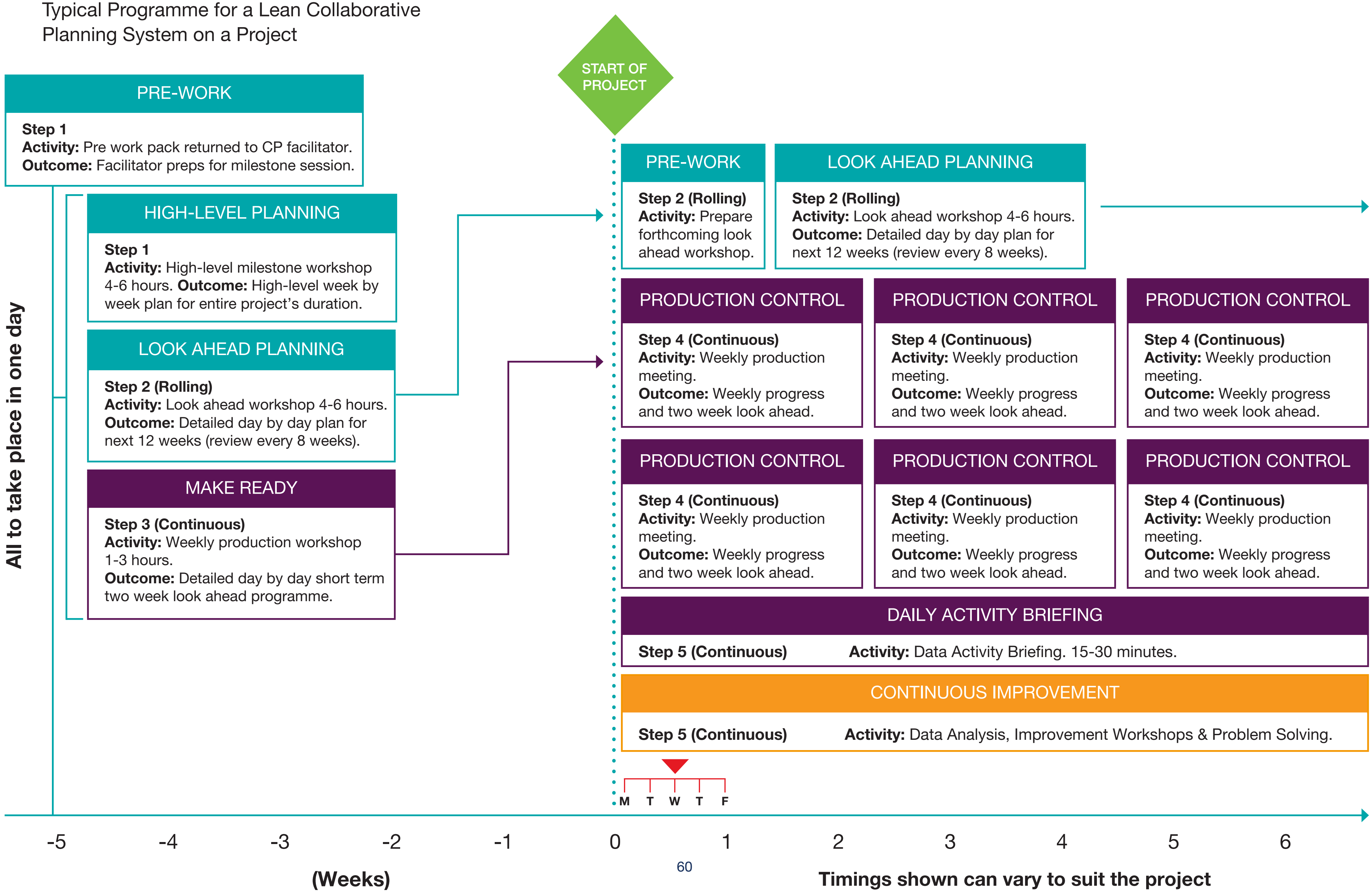


13

Timelines, Agendas & Templates

13.1 Typical Programme

Typical Programme for a Lean Collaborative Planning System on a Project



13.2 Reasons for Non-completion

	Optioneering and Design Phase	Delivery Phase
1	Lack of Supervision / Management	Lack of Supervision / Management
2	Process Failure	Process Failure
3	Waiting for Client input / approval	Material Failure
4	Quality Issue	Quality Issue
5	Misalignment of expectations / scope	Lack of communication
6	Waiting for internal approval	Damage
7		Setting out Error
8	Scope change	Design change / late information
9	Insufficient Planning or Production Control	Insufficient Planning or Production Control
10	Lack of resources	Lack of Resources
11	Incomplete information / data	Incomplete documentation
12		Defect plant / equipment
13		Clash between drawing and specification
14		Drawing error
15		Change in priorities
16		Weather
17		Procurement
18	Third Party Delays	Third Party Delays
19	Change in priorities	Insufficient materials
20	Incomplete enabling actions	Incomplete enabling actions

13.3 Lean Collaborative Planning Timeline on a Project Agenda

Time	Agenda Item	Who
5 min	Overview of the workshop agenda and introductions	Facilitator
15 min	Objectives and desired outcomes of the workshop	Facilitator
30 min	Project specific challenges	Project Manager
30 min	Lean Collaborative Planning main exercise	Facilitator
1–3 hrs	Develop high level collaborative mapping milestone plan	All
1 hr	Collaborative plan review and challenge	Facilitator / All
30 min	Schedule for production control and weekly plan reviews	Facilitator

13.4 Detailed 12-week Lookahead Plan Agenda

Time	Agenda Item	Who
15 min	Objectives of the workshop + overview of the agenda introductions	Lean Collaborative Planning project lead
1 hr	Review agreed high level collaborative plan and develop the detailed 8-12 week look ahead plan	All
15 min	Update the plan to protect	All
15 min	Close and expectations benefits, concerns and next steps	Lean Collaborative Planning project lead

13.5 Make Ready Checklist

Make Ready Checklist									
Activity	RAG Status	Actions	Teams	Owner	T-4 Wks.	T-3 Wks.	T-2 Wks.	T-1 Wk.	T-0 Wk.
	Action	N/A							
	In Hand	N/A							
	Action								

13.6 Weekly Work Plan Template

Weekly Work Plan																		
Project Workstream:				Area:								Week Commencing:						
Ref No	Trade	Activity	Make Ready Needs	MON		TUE		WED		THU		FRI		Sat	Sun	PPC Analysis		
				AM	PM	AM	PM	AM	PM	AM	PM	AM	PM			Y	N	Reasons for Variance

13.7 Task Performer Tracker Template

Activity Information				More Information			Start			Finish		
Tracker ID	Line Item	Owner	Status	Activity Code	Task Duration	Commen-tary	Planned start Date	Forecast Start Date	Actual Start Date	Estimated Finish Date	Forecast Finish Date	Actual Finish Date

13.8 Opportunities and Benefits Tracker Template

Opportunity & Benefits Tracker							
Board Owner:		Updated By:			Last Updated:		
No.	Item / Opportunity	Description	Benefit Received	Owner	Raised by	Date	Status

13.9 3C Strip Template

3C Problem Follow-up Sheet					Owner		
					Activity		
No.	Concern Description	Cause	Countermeasure	Action By	When	Cat	Status

13.10 3C Board Template

Project 3C's Board						
Board Owner:		Updated By:		Last Updated:		
Date	Concern	Cause	Countermeasure	Action By	Review Date	Status

14. Glossary

Andon: A device that calls attention to defects, equipment abnormalities, other problems, or reports the status and needs of a system typically by means of lights - red light for failure mode, amber light to show marginal performance, and a green light for normal operation mode.

Collaborative Planning: (Last Planner®): The structured approach to planning, monitoring, controlling and improving work activities.

DMAICT: Define, Measure, Analyse, Improve, Control and Transfer is a data-driven quality Strategy used to improve processes.

Five whys: The practice of asking "why" five times whenever a problem is encountered; repeated questioning helps identify the root cause of a problem so that effective countermeasures can be developed and implemented.

Flow: The progressive achievement of tasks and/or information as it proceeds along the value stream, flow challenges us to reorganise the value stream to be continuous… "one by one, non-stop".

Key Performance Indicators: (KPI): A method of tracking or monitoring the progress of existing daily management systems.

PDCA Cycle: Plan-Do-Check-Act. An iterative four-step problem solving process typically used in quality control. It is also known as the Deming Cycle, Shewhart Cycle, Deming Wheel, or Plan-Do-Study-Act.

Pull: Principle that no one upstream function or department should produce a good or service until the customer downstream asks for it.

Root Cause: The ultimate reason for an event or condition.

Standard Work: An agreed upon set of work procedures that effectively combines people, materials, and machines to maintain quality, efficiency, safety, and predictability; establishes A routine for repetitive tasks, provides a basis for improvement by defining the normal and highlight.

Value: When a product or service has been perceived or appraised to fulfil a need or desire, as defined by the customer, the product or service may be said to have value or worth.

Visual Management: The connection between people, project and data. It is where information is provided in a simple format that is easy to understand and available in the workplace. It enables teams to view their performance and provide information on what they need to action and where they can improve.

Voice of the Customer: The desires and expectations of the customer, which are of primary importance in the development of new products, services, and the daily conduct of the business.

Waste: Any operation or activity that takes time and resources but does not add value to the product or service sold to the customer. Four Folders: The 'Four Folder' approach aims to capture improvement suggestions generated by the team, facilitating team members to influence the way that they work and reduce waste.

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