Module 10: Tactics Optimisation

Maintenance Work Management

Rules of engagement in the VILT environment

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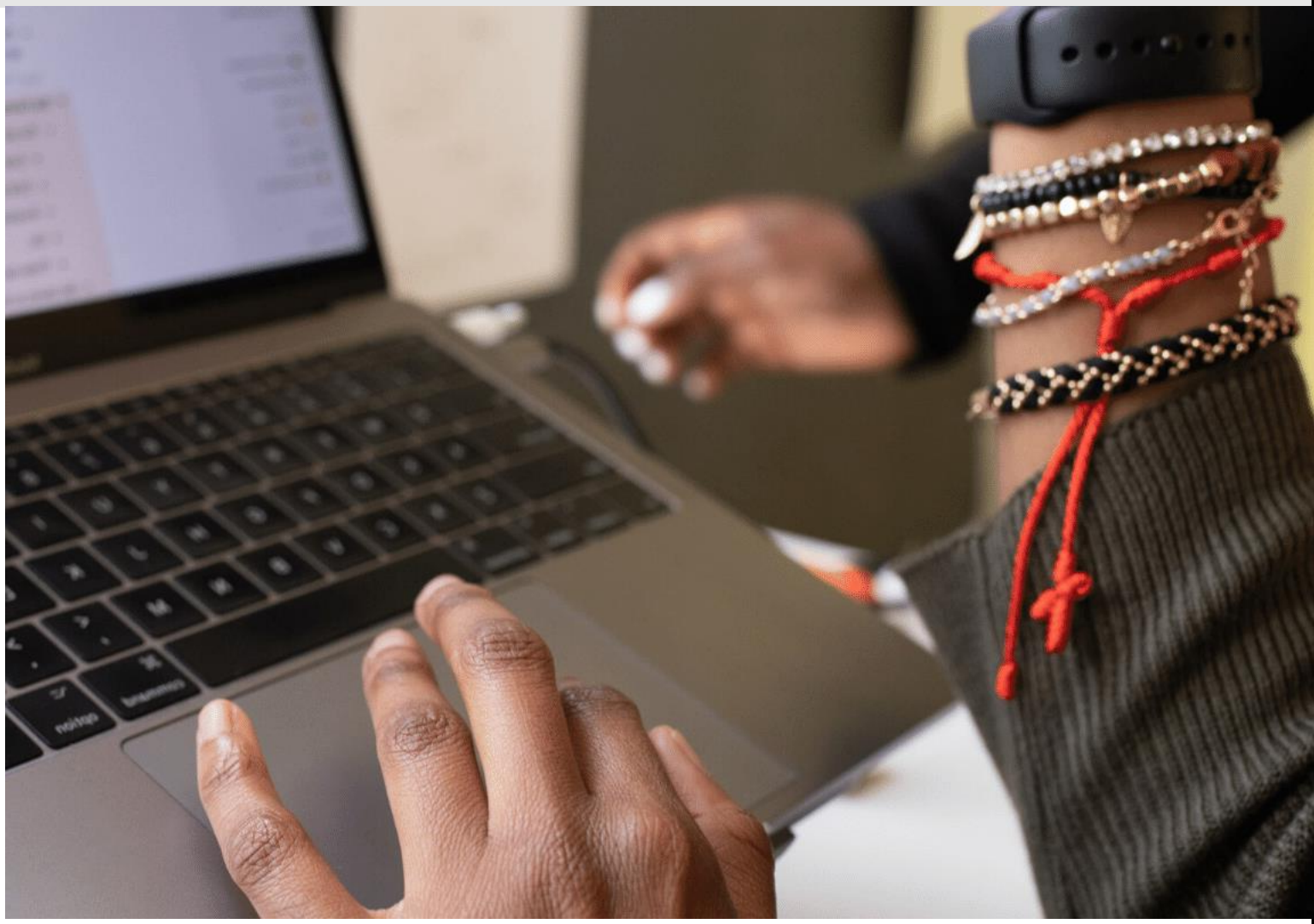
2. Close your email and any other distractions on your desktop and mute your phone notifications.
3. Let us know if you step away from the session, just type us a note in the chat.
4. Participate and be prepared to be called upon by name to give a response.
5. Speak up, use the chat, or raise your hand when you have a question or comment.
6. Use annotations when instructed to do so.



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Schedule for this session – Day 3

Time	Content to be covered
	Welcome
60 minutes	**Module 08: Resourcing**
120 minutes	**Module 09: Long-term Work Plan**
	Lunch
90 minutes	**Module 10: Tactics Optimisation**
90 minutes	**Module 11: KPIs, Reporting and Analysis**

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Ice-breaker

Do you have a favourite song that you identify with or just simply enjoy?

Type your answer using the public chat feature.

Learning objectives for this module

- Explain the concept of addictive maintenance.
- Explain the strategies to be employed to break the addictive maintenance cycle.
- Explain the benefits of the transactional review process.
- Use asset / component failure characteristics to identify maintenance tactics optimisation opportunities.
- Given feedback information on work orders, review the feedback for updating tactical task lists.
- Given feedback information on work orders, evaluate the quality of the tactical task lists and update planning and scheduling processes / master data to address gaps.

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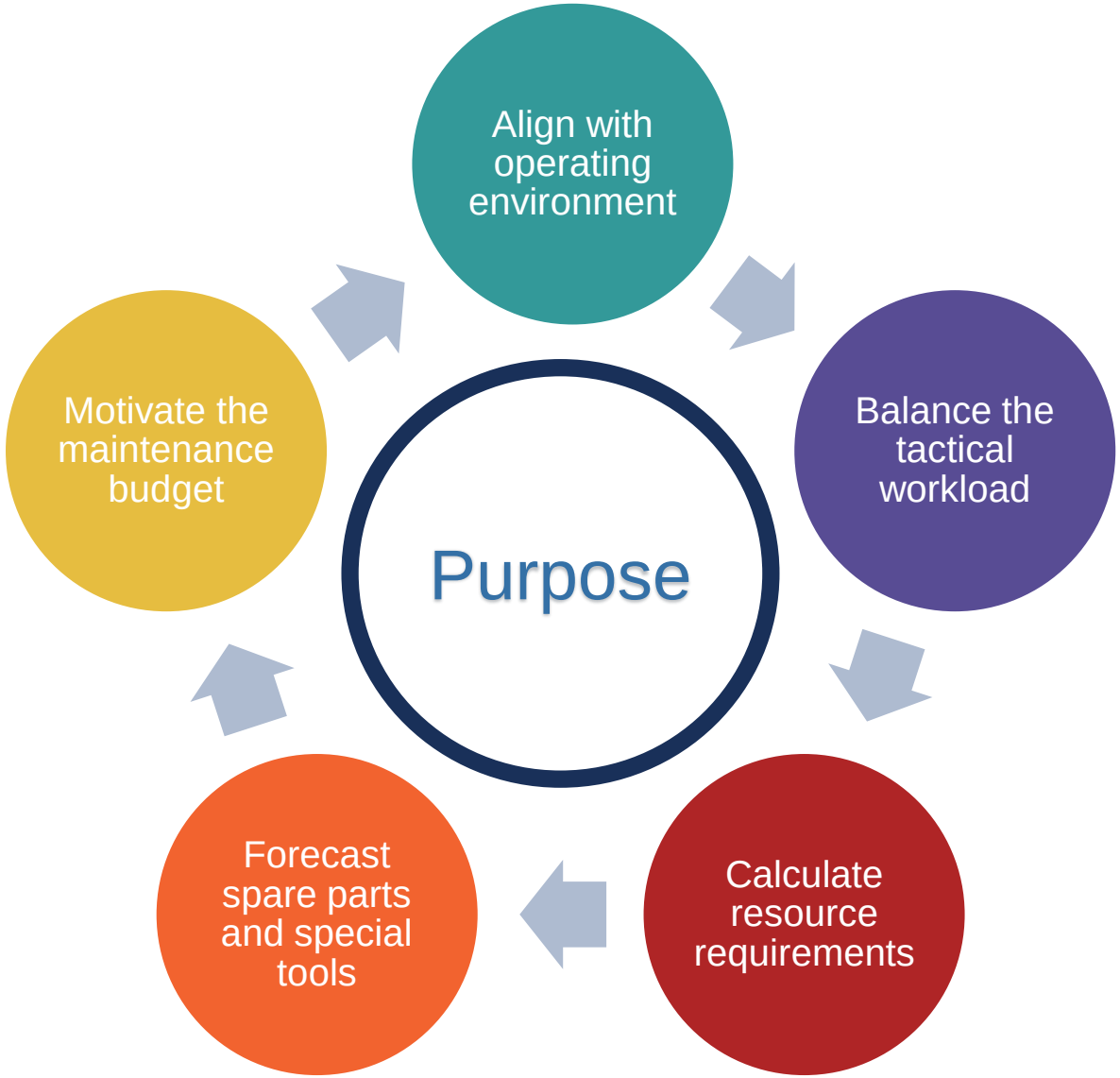
The long-term work plan



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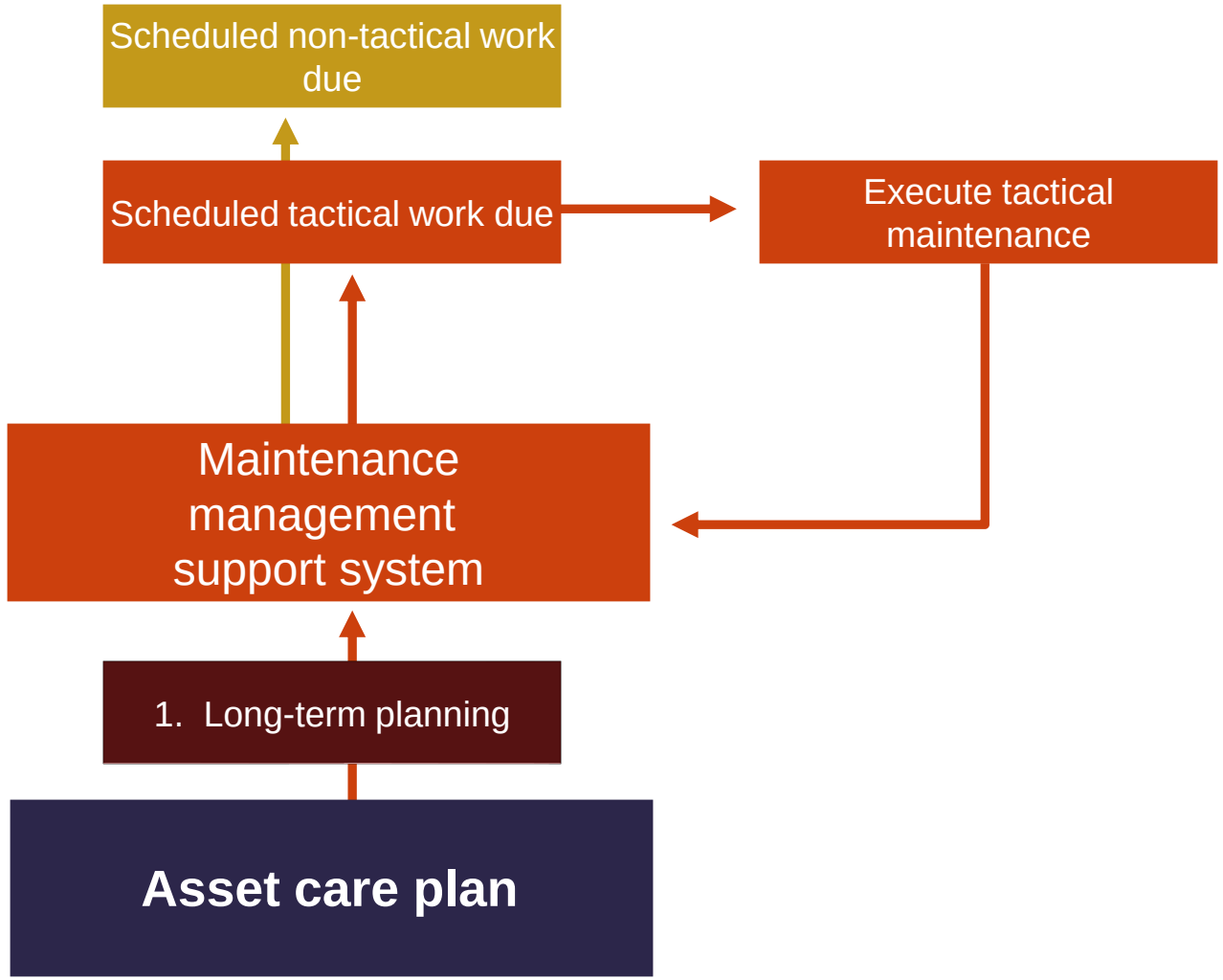
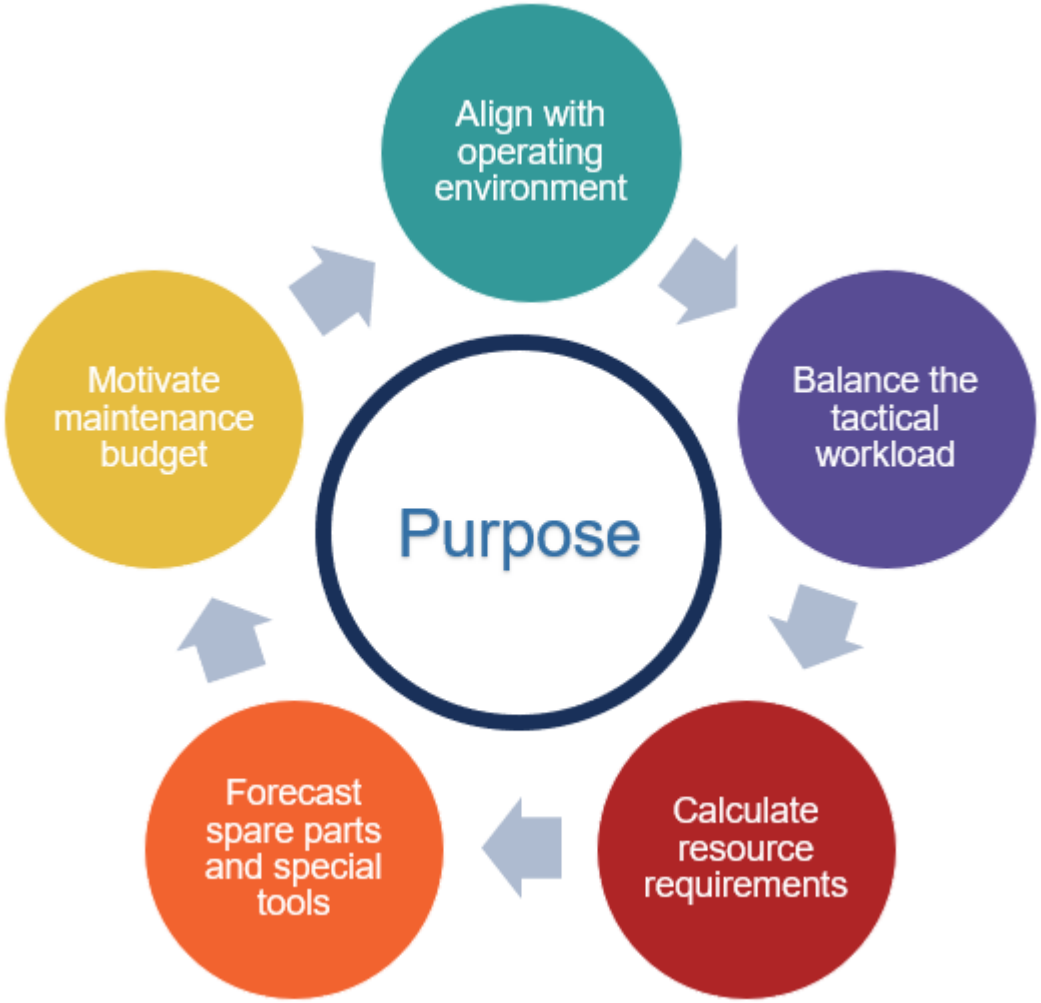
The influence of the long-term plan





Addictive maintenance

How can we describe addictive maintenance?

“A maintenance tactic dictated by the inability to change, and is defined by what has happened previously.

There is no optimisation component, and seemingly no capacity for improvement.”

Grahame Fogel

Asset management consultant

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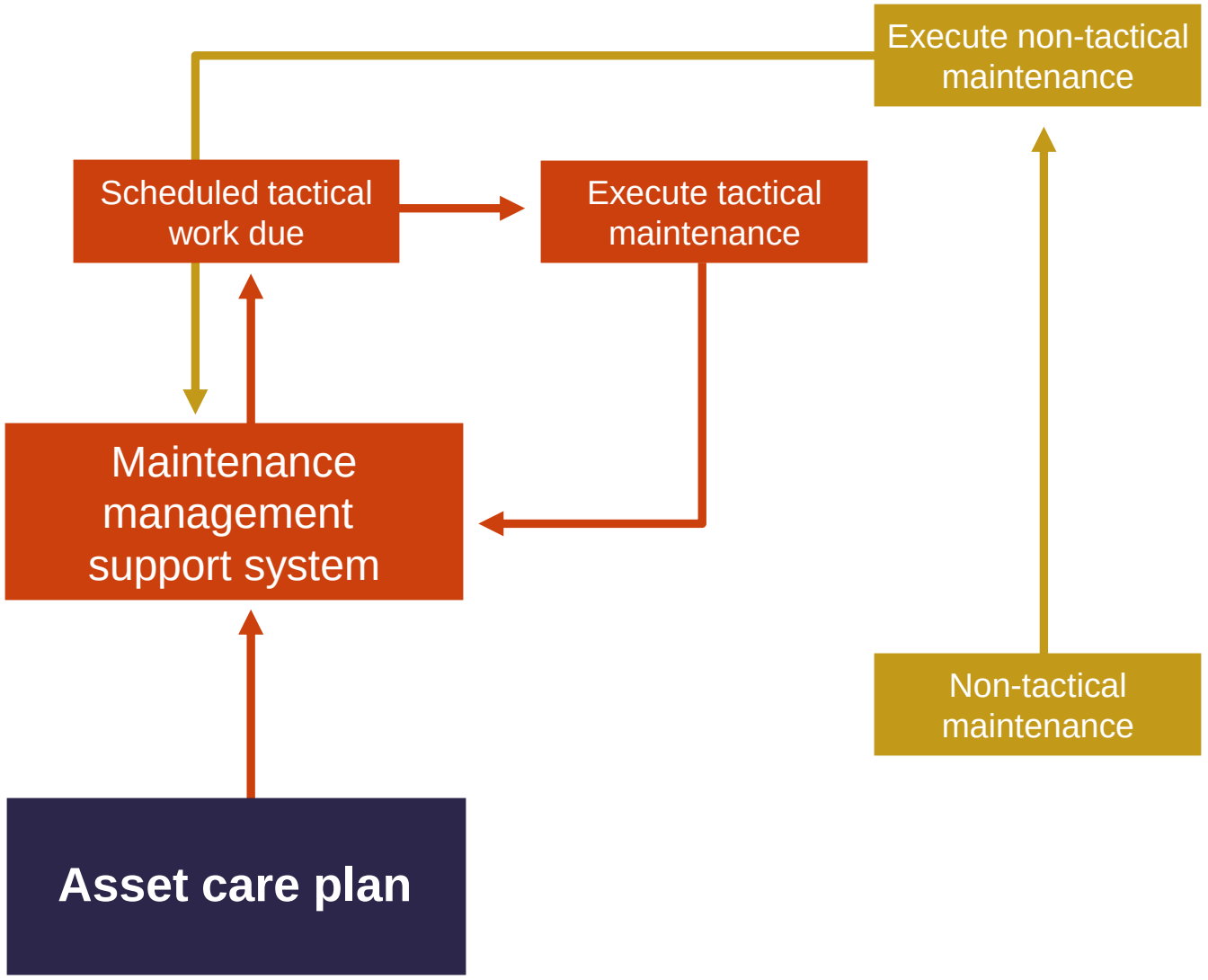
Addictive maintenance



Addictive maintenance

Why do you think some sites or operations just do addictive maintenance?

Type your answer into the public chat.

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Optimising maintenance plans

What information do you need so that you can break the cycle of addictive maintenance?

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Why do we have to optimise?

Maintenance is the effort required to fix something **before** it is broken.

The purpose of maintenance is to ensure the **maximum efficiency** and availability of production equipment, utilities and related facilities at optimal cost and under satisfactory conditions of quality, safety and protection for the environment.

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Optimising maintenance plans

When plants are not optimised, there are numerous issues. Which one of the following impacts your site the most?

A. Inefficient use of resources

B. Shorter life expectancies of assets

C. Interference with planned, preventive work

D. Sporadic equipment downtime

E. Repeat issues

The article Disadvantages of a Reactive Maintenance Programme (RM) has been uploaded on the LMS for your reference.

Failure profiles

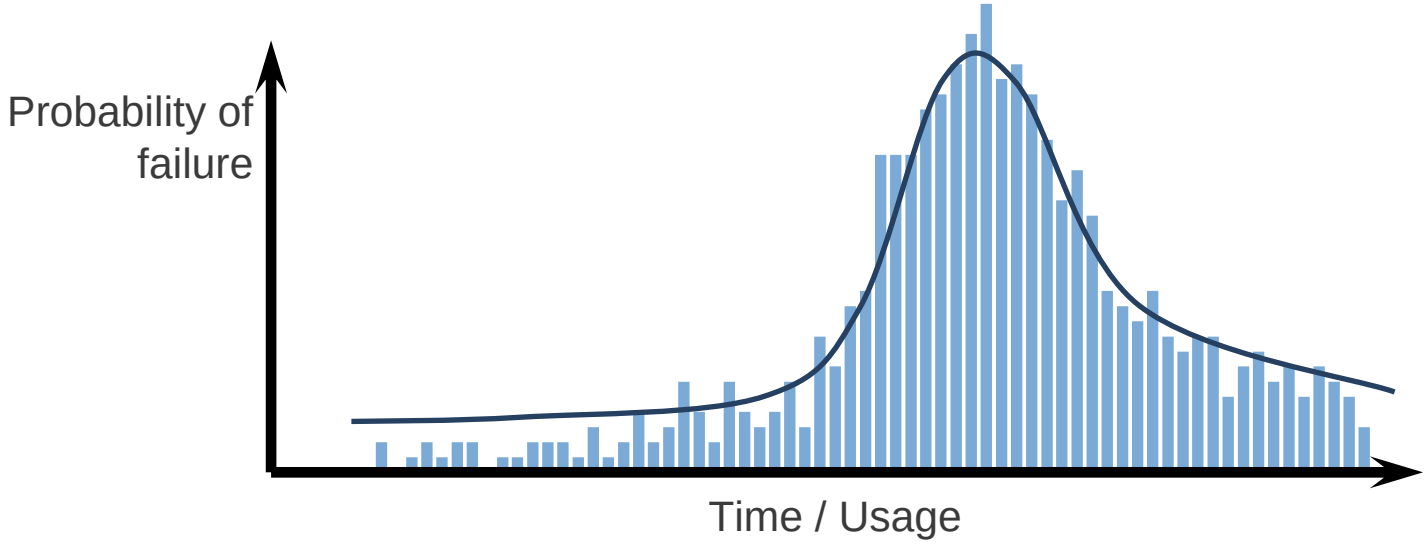
Think of failure profiles and a few of the profiles that you can remember.

Use the public chat feature to provide a few examples of these failure profiles.

Age-related failures

This failure profile applies to components that wear out over time and are more likely to fail as they get older.

Typical examples include moving mechanical components, such as bearings, gears, belts, pipes, etc.



The implication of this failure profile is that there is a specific age at which we can replace a component to prevent its failure.

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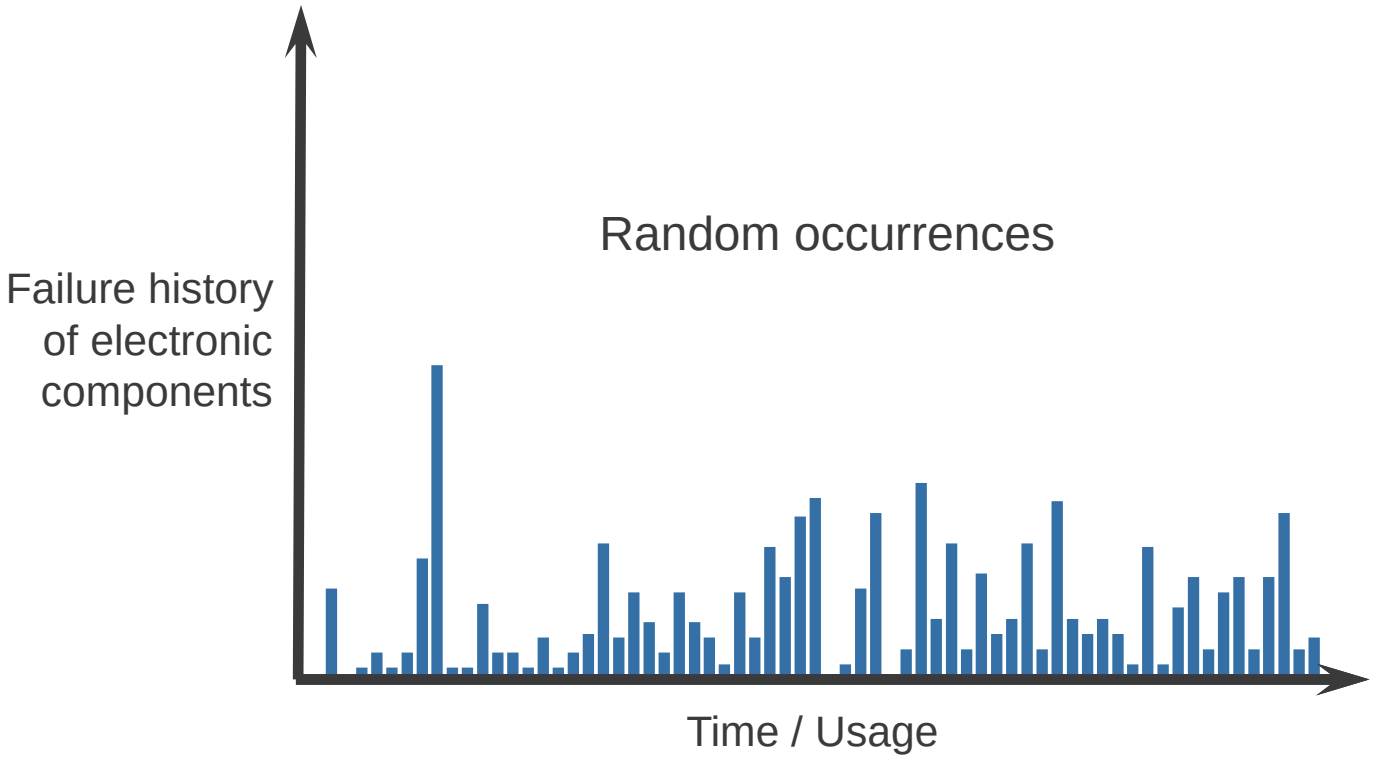
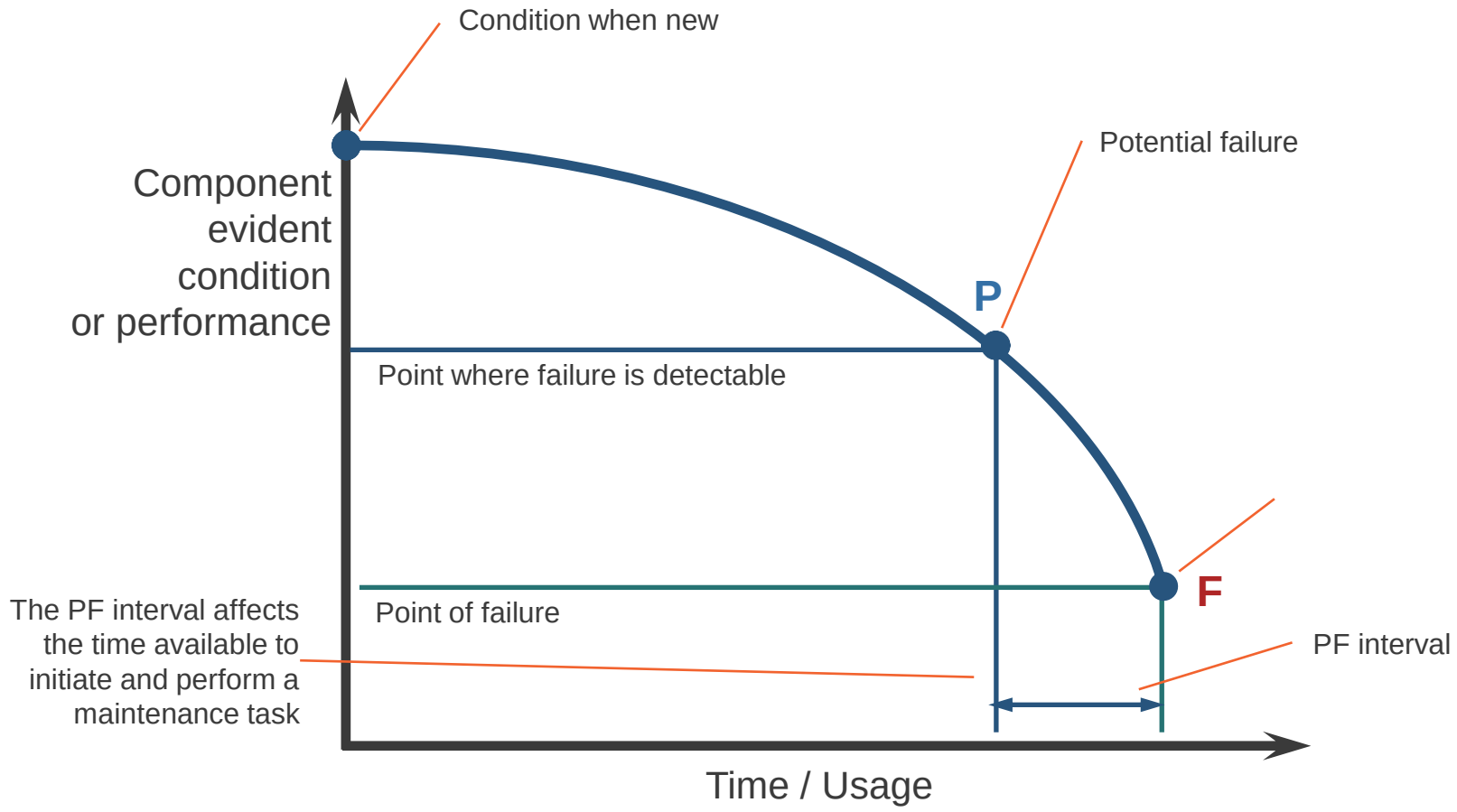
Random failures



The implication of this failure profile is that there is not a specific age at which we can replace a component to prevent its failure. It could fail immediately after being replaced!

Failure progression with a PF curve



The implication of this failure profile is that we do not have to replace the component (sometimes unnecessarily) at a fixed age – we can wait for the warning signal (picked up through ConMon or inspections) and then replace it.

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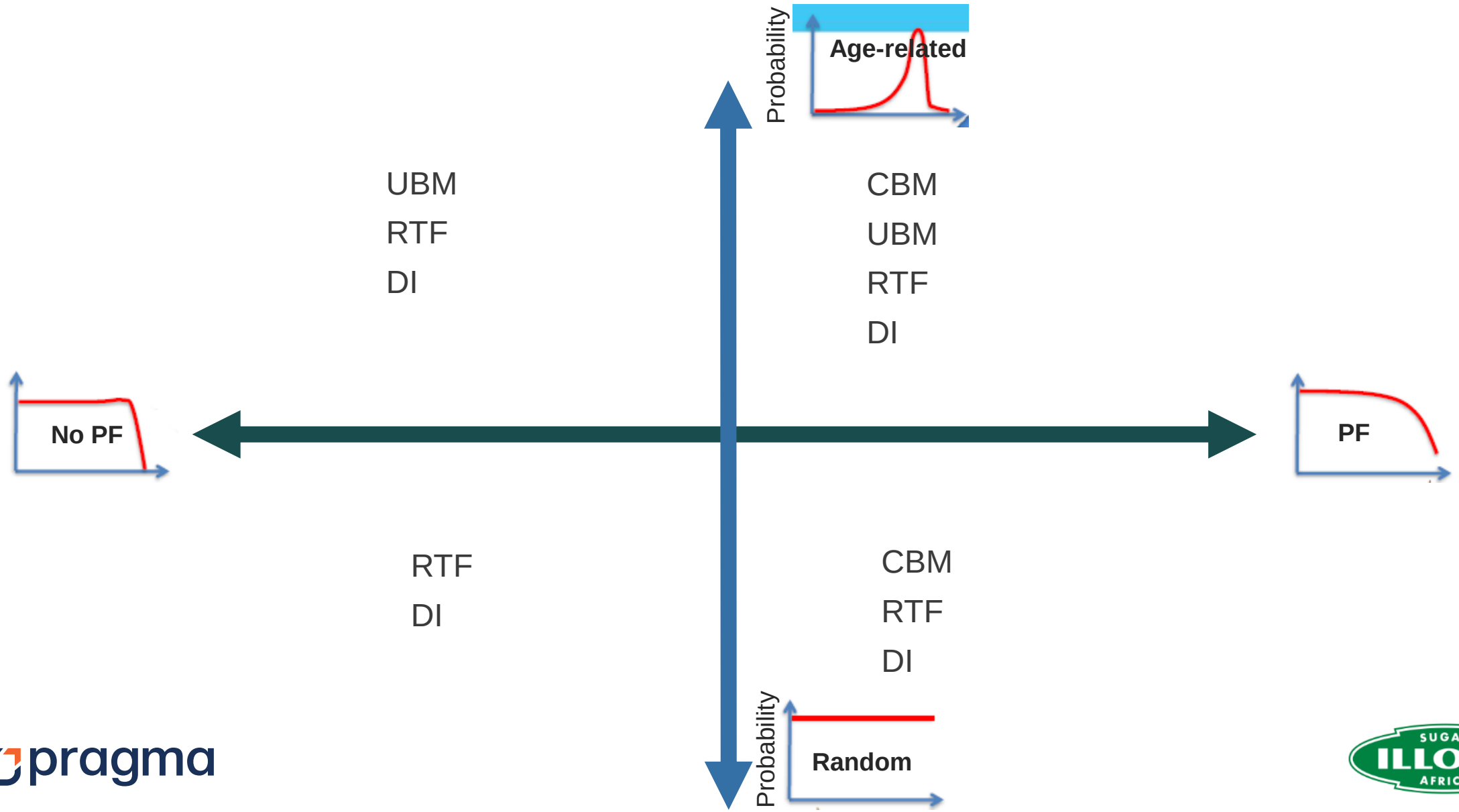
Summary: maintenance tactic selection logic



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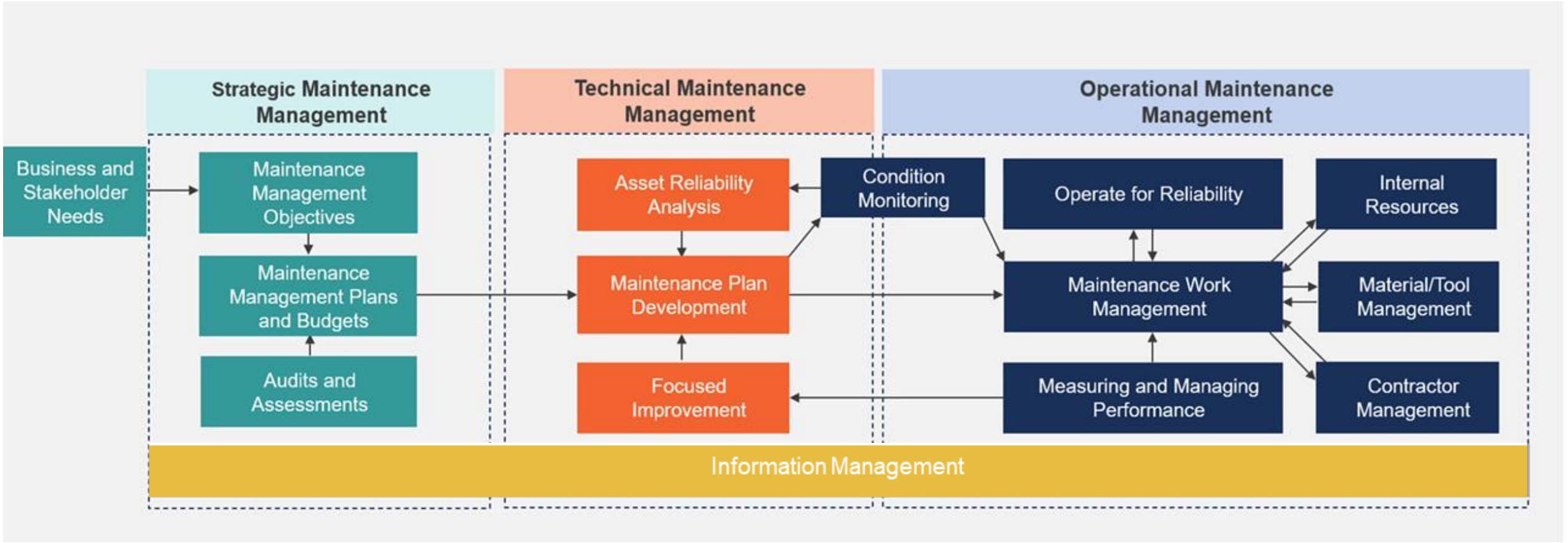
The Maintenance Management Model



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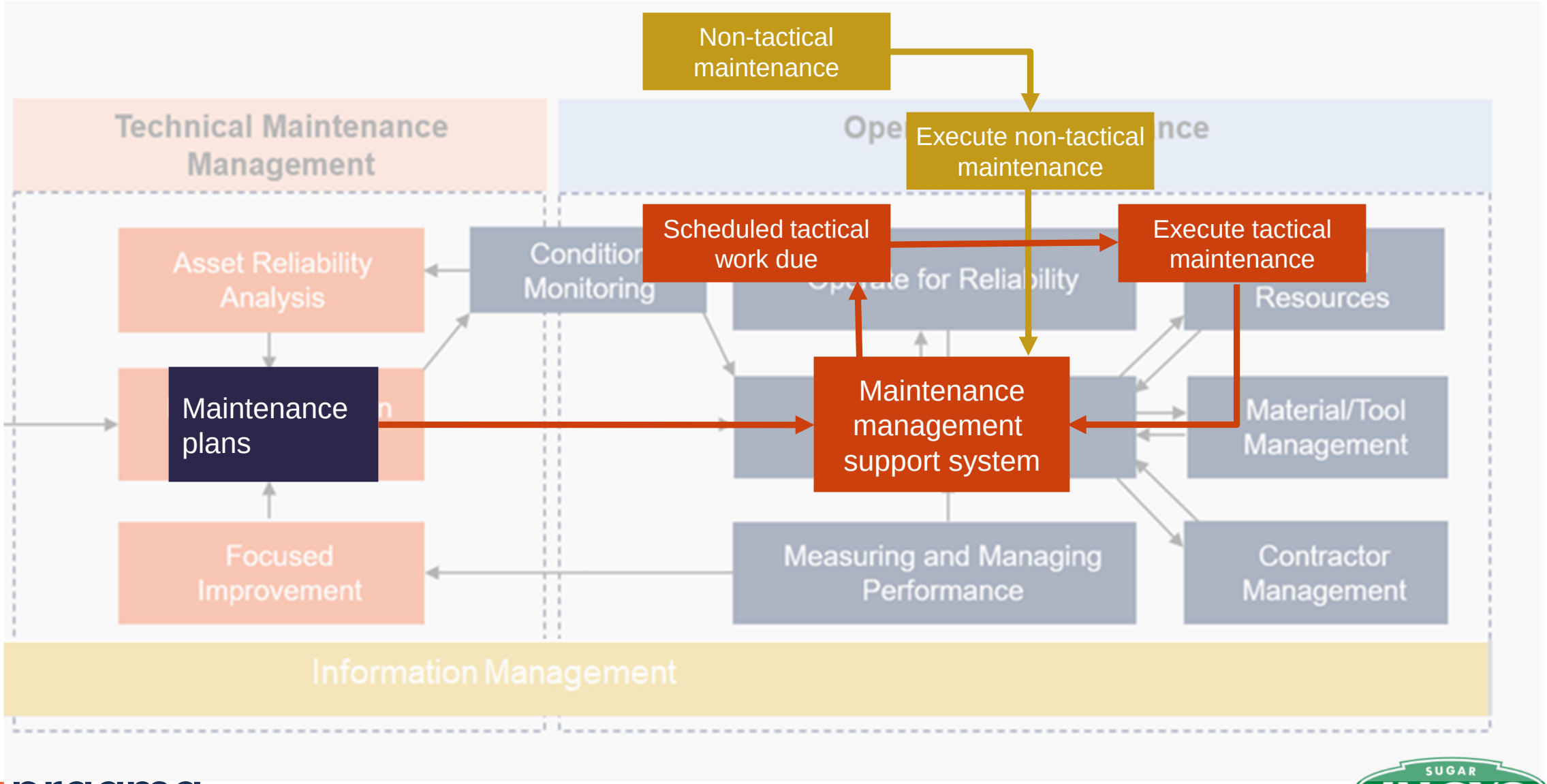
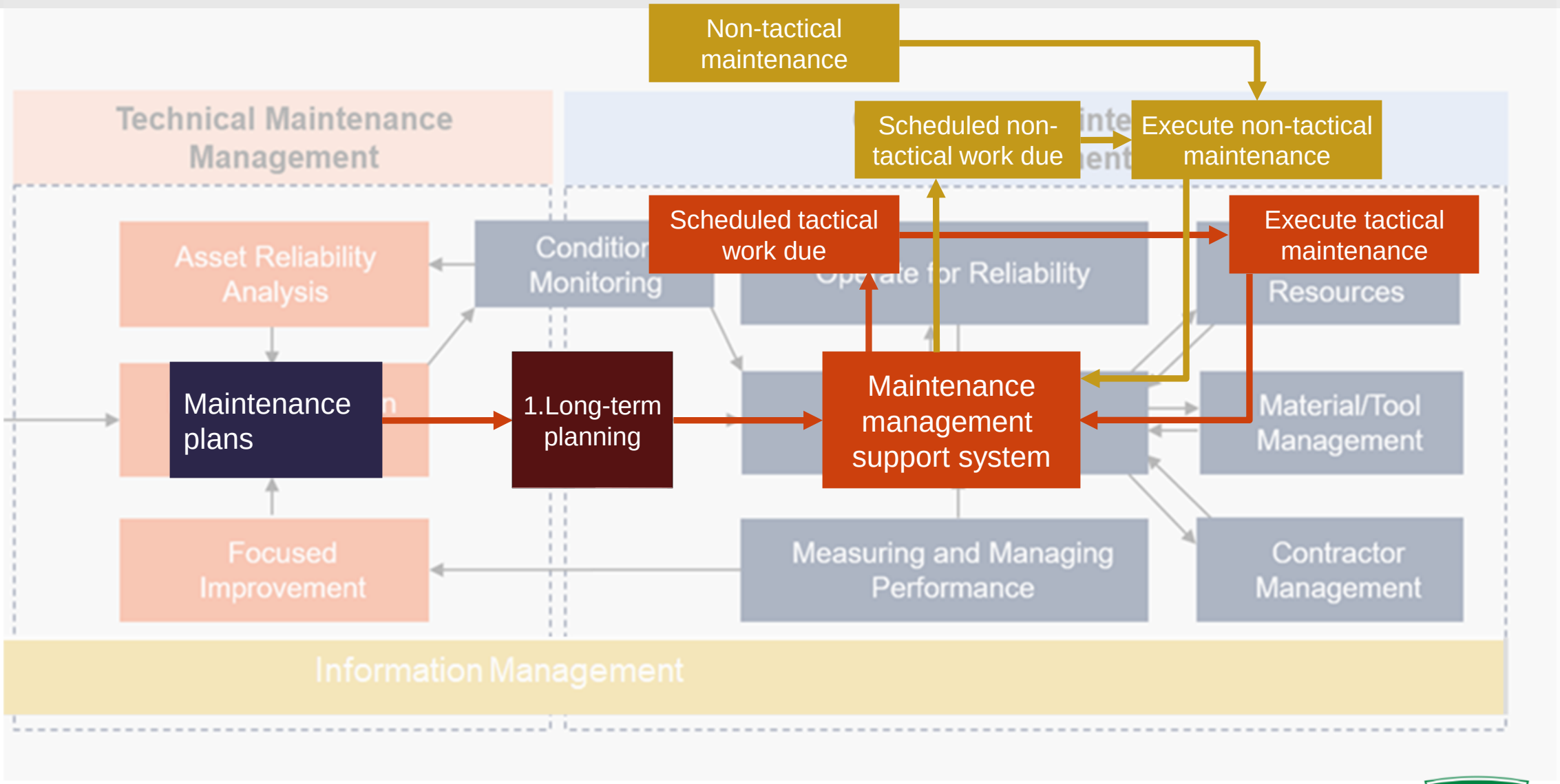
The MWM Model – survival mode



The MWM Model – stabilising



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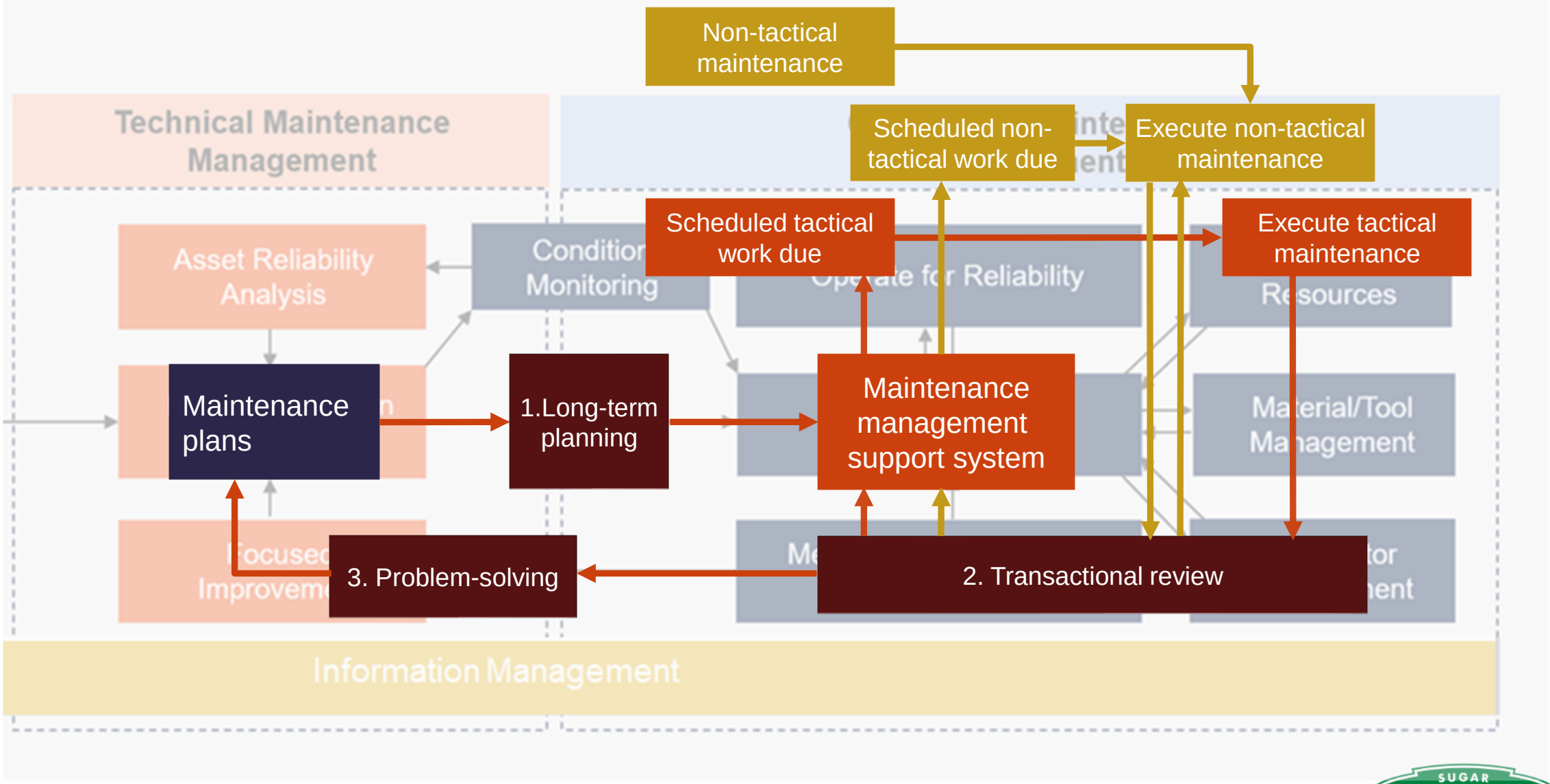
The MWM Model – optimising



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Problem-solving for planners and schedulers

Departmental

Problems that are typically within the control of the planner:

- Transactional reviews
- master data is missing
- incorrect – master data change request.

Cross-over

Problems that require interaction with supply chain, frontline managers or reliability department and usually procedural in nature:

- incorrect spare parts delivered and accepted at stores
- work order information has not been completed correctly
- the task lists are not correctly defined or sequenced.

Systemic

Problems that are systemic in nature and require the input of SMEs, management, interdepartmental cooperation across the organisation:

- ongoing failures on critical assets, despite high schedule attainment
- pre-mature failures on components recently changed out
- tasks being executed repeatedly but not adding value (rate of deterioration is not evident or is extremely slow - high PF-interval with high frequency.

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The frequency of meetings

Let us use the public chat to **reflect** on the following:

- How frequently should the departmental, cross-over and systemic meetings happen?

Share your thoughts with the rest of the class.

The triggers to initiate meetings

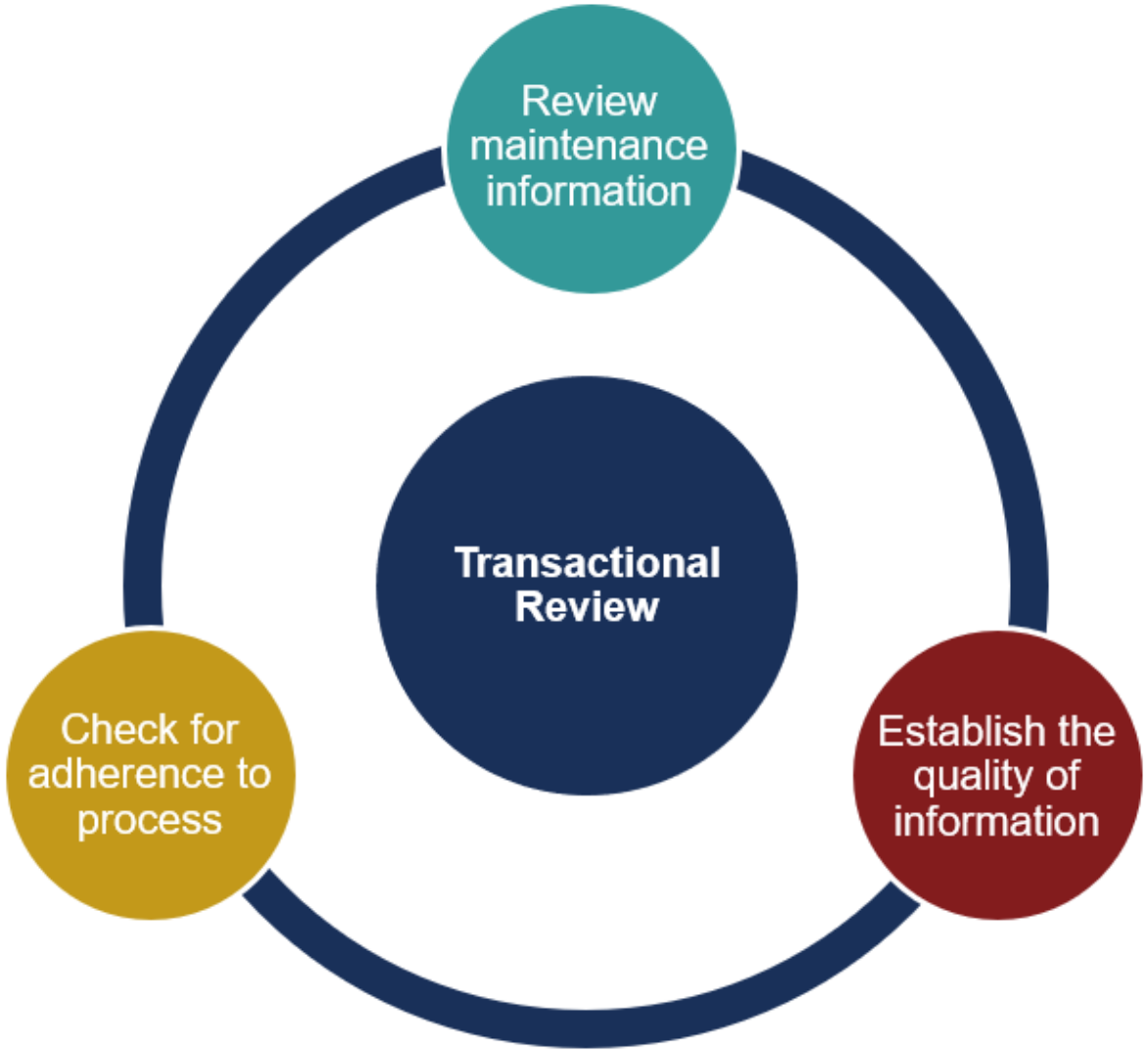
Let us use the public chat to **reflect** on the following:

- What are the abnormal “triggers” that would initiate these meetings?

Share your thoughts with the rest of the class.

The purpose of the transactional review

A transactional review can provide validation of the accuracy of reports and the adequacy of controls. A transactional review can identify errors and weaknesses that need to be addressed to drive optimisation.



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Grouping tasks in packages

Review maintenance information

We now know the tactic – but what are all the details of the ACP?

How long will it take? Who must do it? What spare parts are required?

We need to "plan" the ACP

The planner must review the PM02 "work packages" to ensure optimisation of artisan utilisation and equipment downtime.

Is this being done effectively at your site and who is responsible for the review?

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Describing the tasks and resources in detail

Review maintenance information

What happens if we put all the developed ACPs together?

Do we have the budget and enough resources to perform all the tasks?

How well are the ACPs balanced over a week-to-week basis?

Review the description of these tasks in detail as if they were being planned.

What details should be covered in this step?

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Reviewing the maintenance plan

Review maintenance information

What defines a job or task?

- What must be done? (instructions in sequence – is it correct?)
- What are the risks and potential hazards? (risk assessment – are these all accounted for and documented effectively).
- Who must do it? (trade – skill level? Experience?)
- What spare parts are required? (stock items and direct requisitions – were there requisitions made that should have been planned for?)
- Which special tools and special resources are required?
- How long will it take? (compare estimate duration and work hours – why is there a variance?)
- Was the asset in the right state? Should the asset be standing or running?
- Include a reference to safety: Reference special safety instructions and applicable safety procedures.

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Reflecting on the tactics development process

Join your breakout rooms and discuss the following questions:

- If the preventive maintenance tasks are described in detail and grouped effectively, is there still a need for these tasks to be planned by the Planner?
- What are the dangers of cancelling or postponing tactical work?
- How should any changes to the tactical tasks in your EAM system be managed and controlled?

Prepare to share your answers with the rest of the class.

Example of a mill discharge pump gearbox

What further information is needed to effectively define these tasks?

Sub-system	Compo-nent	Function	Failure mechanisms	Failure cause	Age-related (Y/N)	PF Interval (Y/N)	Selected Tactic	Task Description
Gearbox	Bearing	To provide maximum motor torque to gear drive at rpm	Wears	Abrasion	Yes	Yes	CBM	Collect vibration data on gearbox bearings and send for analysis
	Bearing		Seizes	Adhesion	Yes	Yes	CBM	Take a thermography image of the gearbox
	Bearing lubrication		Degrades	Usage	Yes		CBM	Take gearbox mid-stream oil samples for lab analysis
	Desiccant breather		Blocks	Contamination	Yes		CBM	Check gearbox desiccant breather
	Fastener		Shakes loose	Vibration	Yes		CBM	Measure torque on gearbox holding down bolts
	Gear Tooth		Pits	Misalignment	Yes		CBM	Check gear frequency harmonics
	Oil	Contain oil	Drops	Usage	Yes		CBM	Check gearbox oil level on sight inspection glass
	Seal		Degrades	Age	Yes		CBM	Inspect gearbox housing for leaks

Example of a mill discharge pump gearbox

Sub-system	Compo-nent	Primary Task Description	Primary Task Limits	Freq	Online / Offline	Secondary Task
Gear-box	Bearing	Collect vibration data on bearings and send for analysis	Overall vibration < 2 mm/s RMS	4 weeks	Online	Notify supervisor and initiate investigation
	Bearing	Take a thermography image of the gearbox	No hotspot > 10C above ops temp	12 weeks	Online	Notify supervisor and initiate investigation
	Bearing lubrication	Take gearbox mid-stream oil samples for lab analysis	Clean > 18/16/13; water < 300 ppm; TAN < 1 mg KOH/g; Viscosity < 10%	4 weeks	Online	Additional oil filtering until cleanliness is obtained; if metal content is significant, replace gearbox and refurbish; if TAN or viscosity limits exceeded, replace oil
	Desiccant breather	Check gearbox desiccant breather	Refer to spec for acceptable colour	4 weeks	Online	Replace desiccant breather
	Fastener	Measure torque on gearbox mounting bolts	Hydraulic nut pressure at 1200 bar	48 weeks	Off-line	Torque bolts to 1200 bar
	Gear Tooth	Check gear frequency harmonics	TBD	4 weeks	Online	If scuffing or pitting, monitor PQ@ index on oil sampling; if visible cracks, replace gearbox and refurbish
	Oil	Check gearbox oil level on sight inspection glass	Level between min and max	1 day	Online	Top up gearbox oil
	Seal	Inspect gearbox housing for leaks	No leaks	1 day	Online	Replace the gearbox with spare and send for refurbishment

Transactional review

Establish the quality of information

What questions do you have to ask?

- Are there inspections being carried out that are not adding value?
- Are the task lists properly defined? Is it clear:
  - What to do?
  - What the acceptable limits are?
  - What the risks are?
  - What the appropriate sequence of the tasks should be?
- Are the special resources properly defined?
- Are the spare parts properly defined?
- Is the appropriate trade identified on the task list?

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Transactional review

Establish the quality of information

What do you have to review?

- Review actual vs estimated times.
- Task list verification (follow-up work, PF intervals, costs, etc).
- Originator sign off, accepting work done.
- Tradesperson sign off.
- Completeness of feedback.
- Technical correctness of failure feedback.
- Delay time analysis (tool time, waiting for spare parts, equipment availability, transport, etc).

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Process adherence review

Check for adherence to the process

Process adherence review enables the planner to assess how well and how often the role players follow the work management process as designed.

Reviews enable opportunities for coaching to be highlighted. Often the non-adherence to process is due to behaviours driven by KPI attainment, that is misaligned with the long term potential value.

Defined problems are prioritised and where necessary flagged for analysis at the Area meeting where the control action specification is defined.

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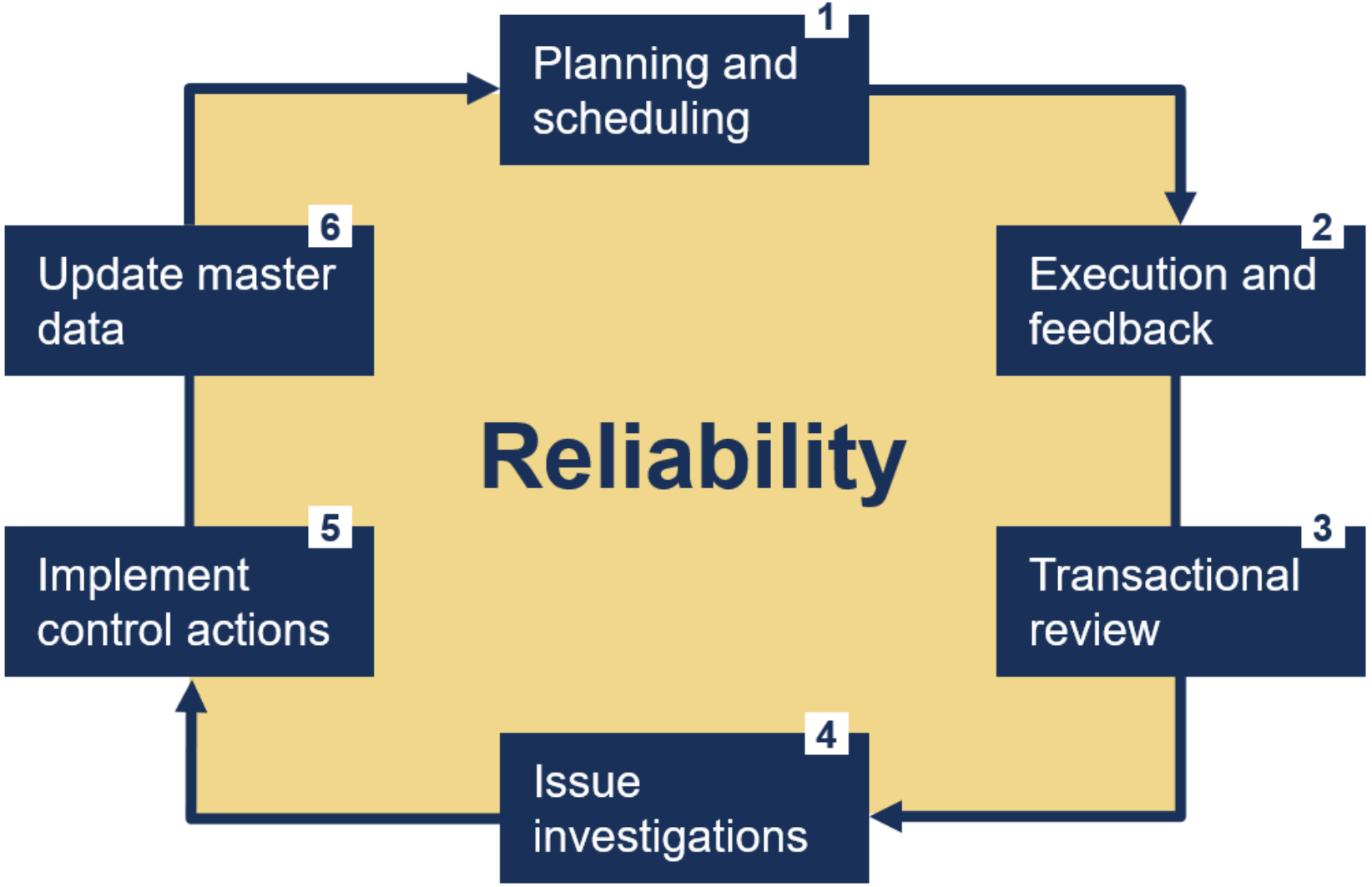
The link between planning, scheduling and reliability



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How does the planning function drive reliability?

Tactical tasks properly defined and resourced at the appropriate frequency are scheduled and executed with the objective of failure prevention.

Tactical and non-tactical tasks are executed as scheduled; 5-Why analysis on non-tactical work highlights potential causes of non-tactical work.

Transactional review of tactical and non-tactical work orders identifies:

- work that is routinely executed but adds no value – flag tasks for removal/frequency adjustment
  - ie no follow-up tasks or breakdowns are experienced on the component/asset
- work that is scheduled and completed timeously but breakdowns continue – flag tasks for investigation, ie hidden failures, wrong PF interval, poor workmanship, etc
- work that is scheduled, not completed and no breakdowns are experienced – flag tasks for removal / frequency adjustment
- process deviations or quality information on work order feedback – flag for follow-up.

Reflect on the learning objectives of this module

Are you able to:

- explain the concept of addictive maintenance
- explain the strategies to be employed to break the addictive maintenance cycle
- explain the benefits of the transactional review process
- use asset / component failure characteristics to identify maintenance tactics optimisation opportunities
- given feedback information on work orders, review the feedback for updating tactical task lists
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Module 11: KPIs, Reporting and Analysis

Maintenance Work Management

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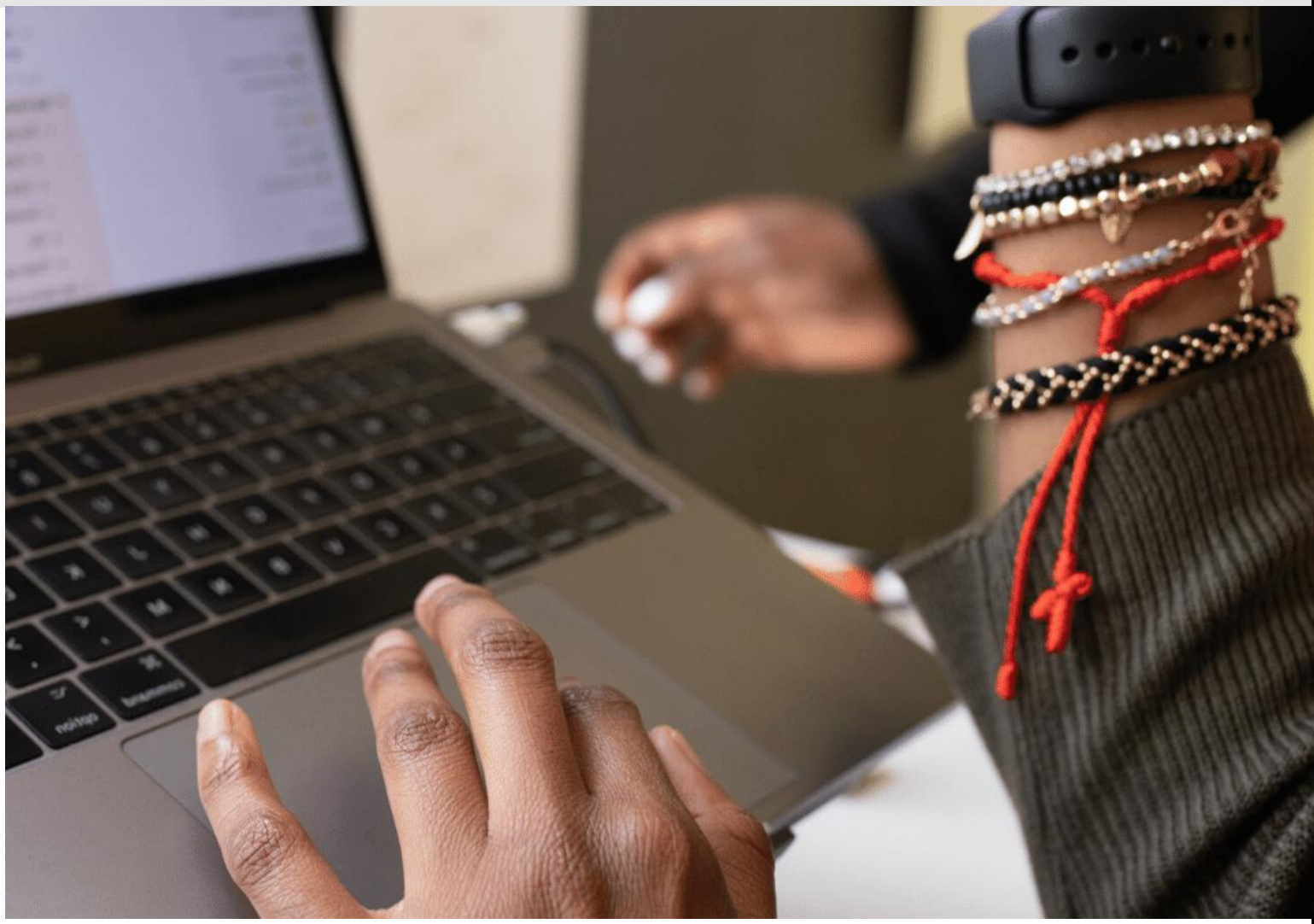

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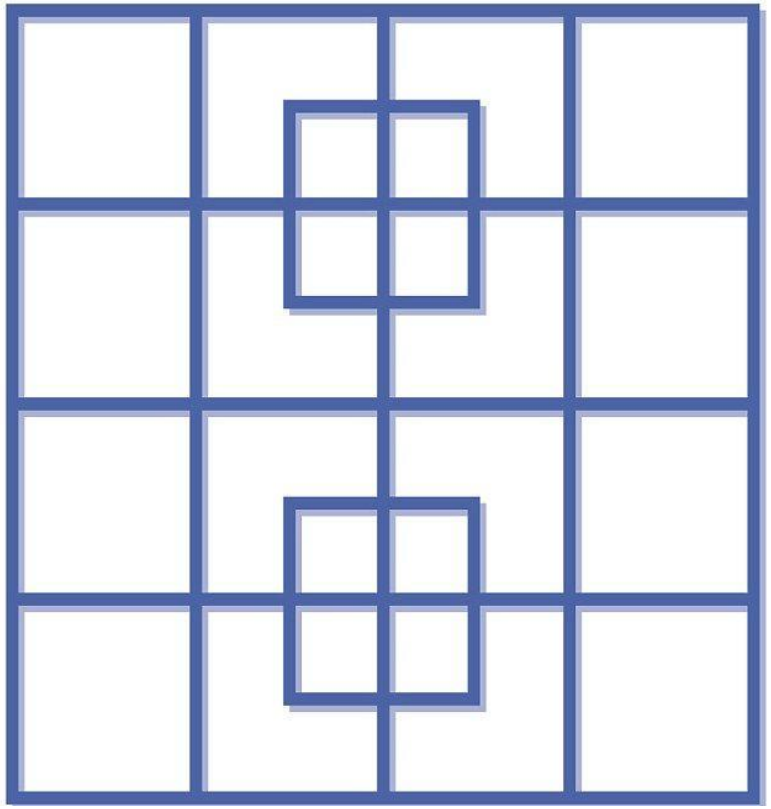
Ice-breaker

How many squares are in the puzzle?

You have 30 seconds to type your answer into the public chat.



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Learning objectives for this module

- Explain how maintenance KPIs are derived.
- Explain the links between maintenance KPIs and the organisation’s business goals.
- Explain leading and lagging KPIs and how they are used to continuously improve asset availability.
- Explain and interpret specific KPIs frequently used to drive continuous improvement in maintenance work management.
- Interpret common maintenance work management report requirements and identify standard reports for use.
- Interpret reports related to maintenance work management and asset availability and highlight deviations for investigation.

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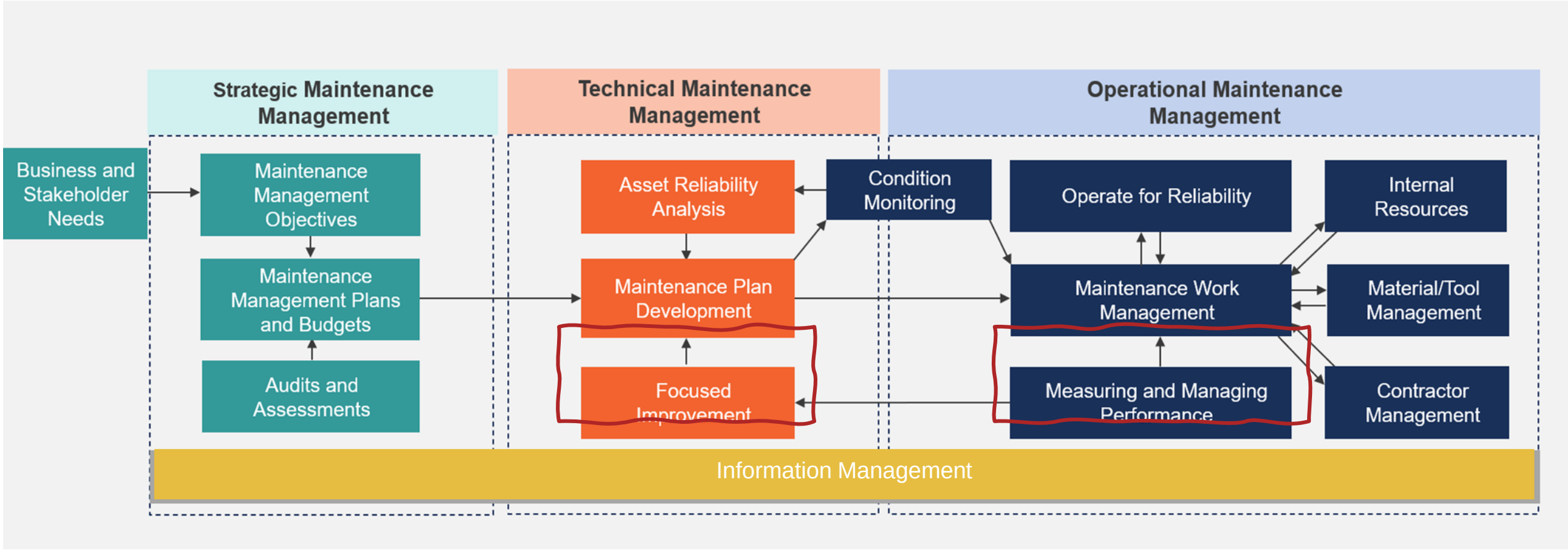
The Maintenance Management Model



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Key performance indicators

What is a maintenance KPI?

A maintenance KPI is a quantifiable value that shows how well you are moving towards a maintenance goal.

It answers the following questions:

- Where are we now?
- How far is that from the goal?
- What needs to get done to get closer to the goal?

Reflect on your KPIs

Join your breakout room and make a list of all the KPIs that you are measured on.

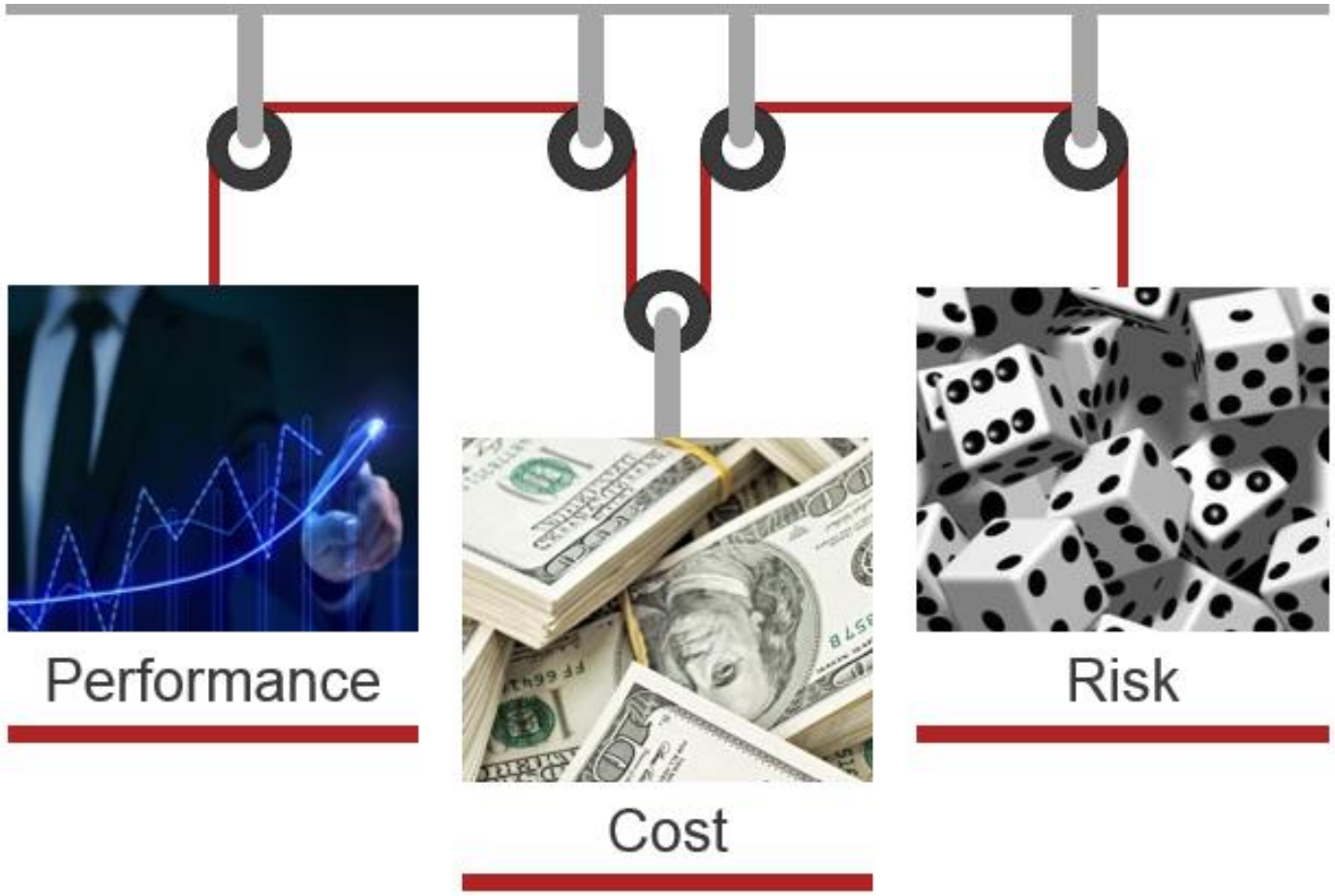
Your have to split your KPIs into three categories:

- daily
- weekly
- monthly/annually.

As you are perhaps not all in the same role or at the same site, find consensus on the KPIs where you have synergy with those in the group.

What informs our KPIs?

Asset management objectives



Business KPIs

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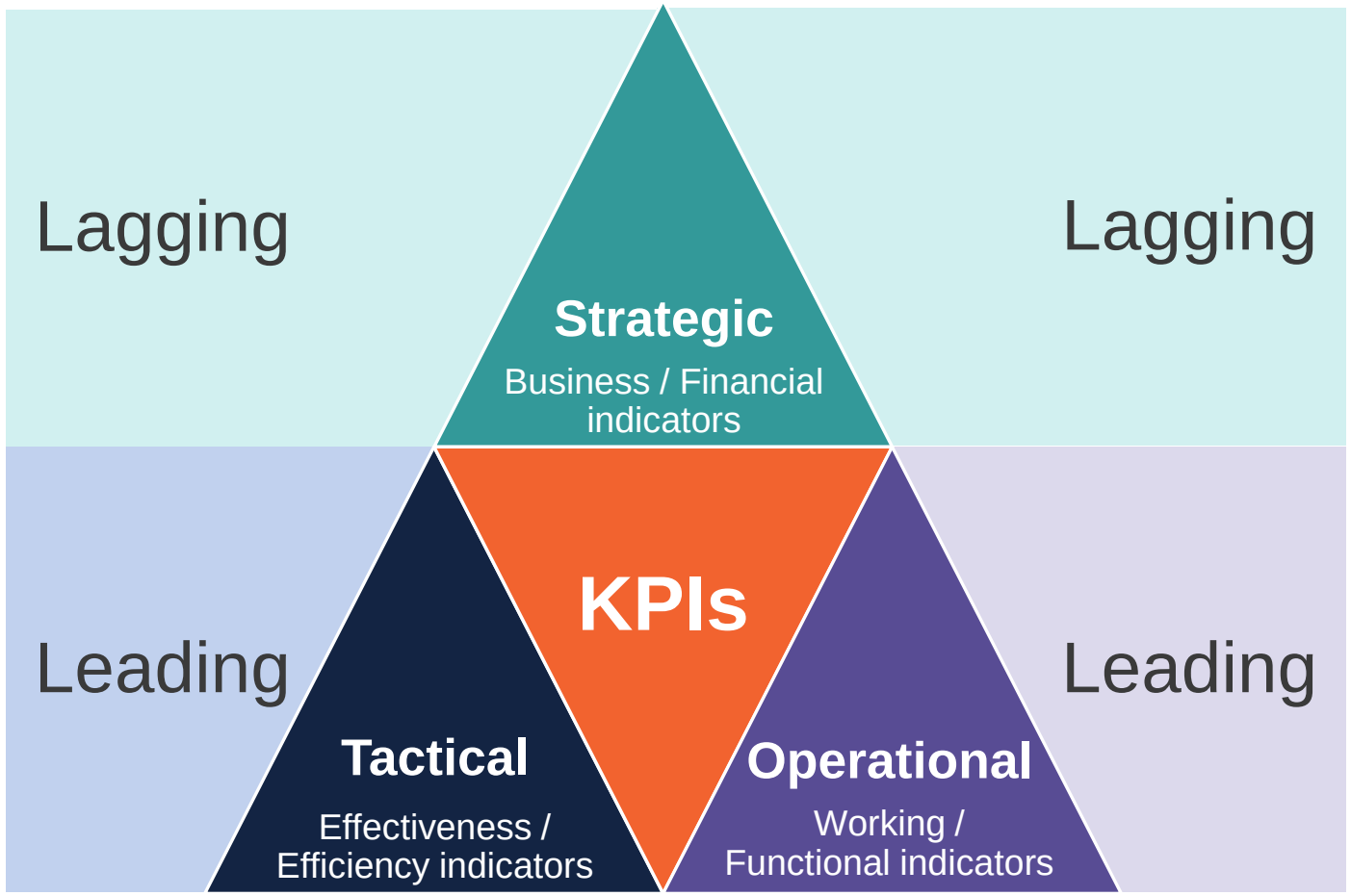
All KPIs are linked to the business goals

Business goals are all supported by the concept of a hierarchy of KPIs. The same applies to asset management.

KPIs must all support the asset management strategy in support of the overall business strategy.

A business KPI which exhibits under performance will need to be analysed further to determine the underlying reasons.



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What are leading and lagging KPIs?

Leading KPIs are those that give you a perspective on future performance. Take the Schedule Attainment (%) metric, for example, If this is high, then it follows that non-tactical maintenance and downtime will decrease in the future.

On the other hand, lagging indicators are like looking in the rear-view mirror, ie the past. They are usually results-type metrics an example is maintenance costs. This is because the cost comes at the end of the maintenance process.

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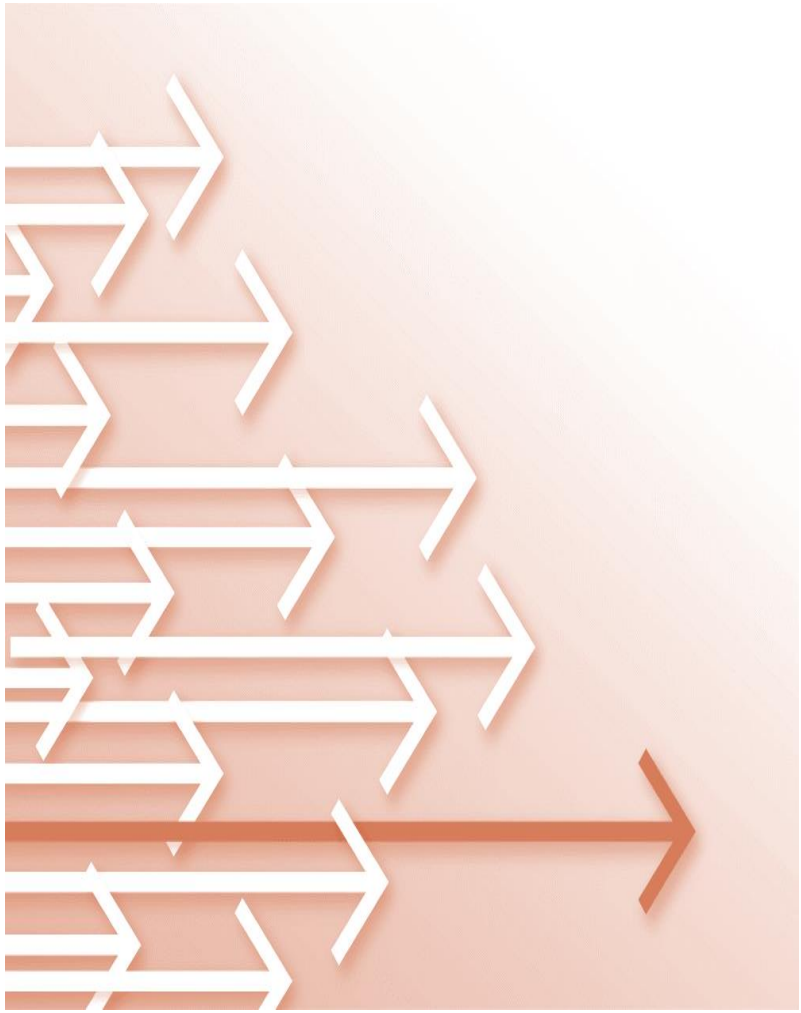
Examples of leading and lagging indicators

Leading indicators

Proactive measures that can influence and predict the desired outcome:

- Training attainment
- Reliability schedule attainment
- Lubrication schedule attainment
- HSSE near misses
- RCA Completions
- Employee morale
- Artisan utilisation



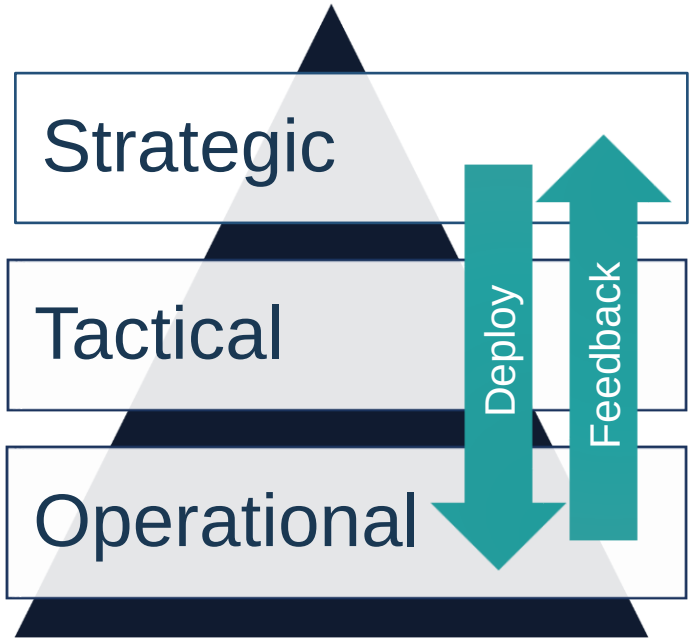
Lagging indicators

Measured historically “after the fact”

- No of breakdowns
- No of call outs
- Ratio of planned maintenance hours versus actual maintenance hours
- Maintenance costs
- Safety incidents/accidents
- Mean Time Between Failures
- Number of stock-outs

There has to be a balance between leading and lagging indicators.

Deployment of KPIs



“Line of sight”

The strategic-level KPIs need to be deployed to lower levels in the organisation according to the contribution they can make to achieve these strategic KPI targets.

We therefore end up with a hierarchy of KPIs, with a clear line of sight to the Maintenance objectives.

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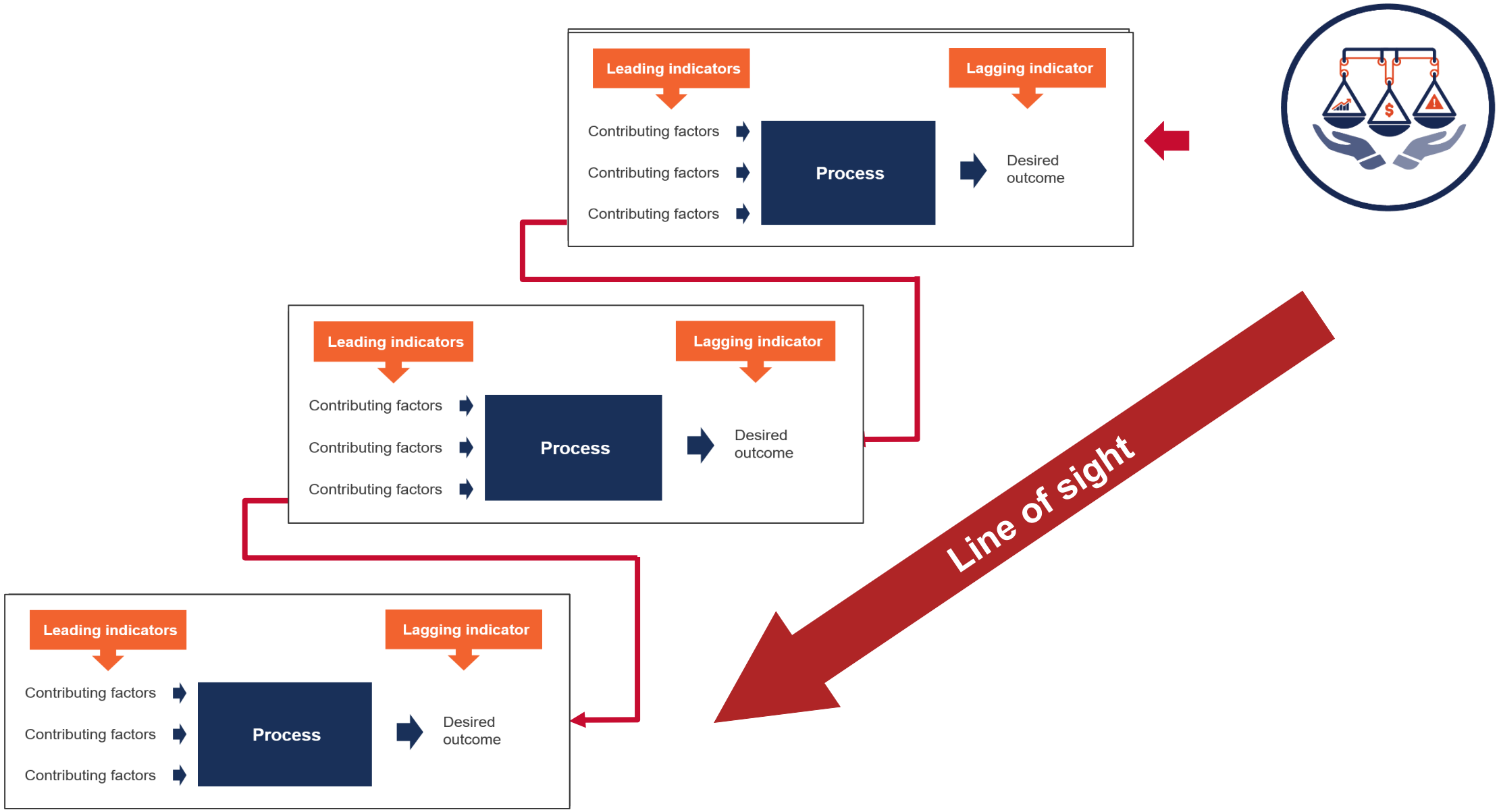
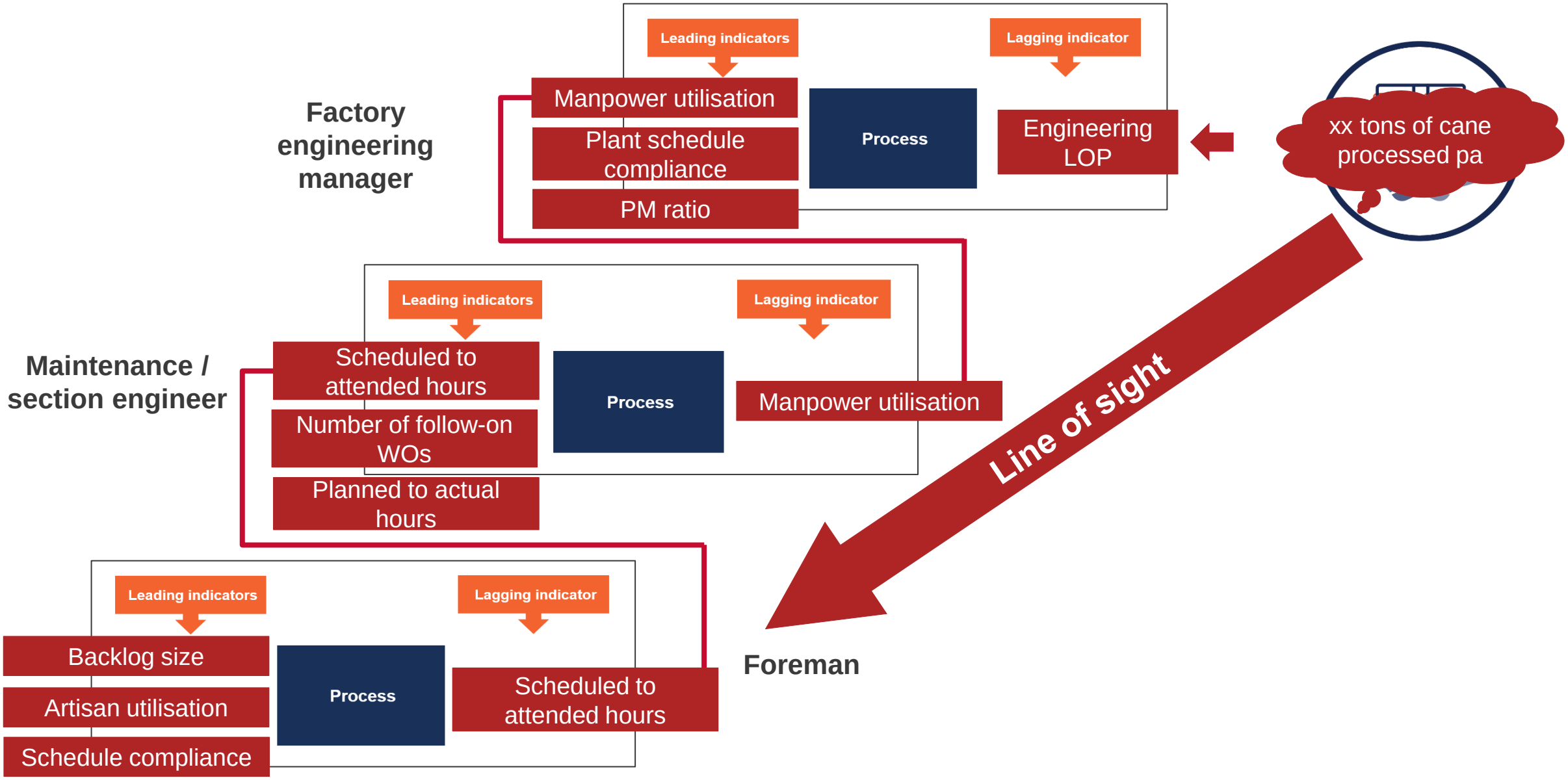
Deploying KPIs – the model



Deploying KPIs – the model



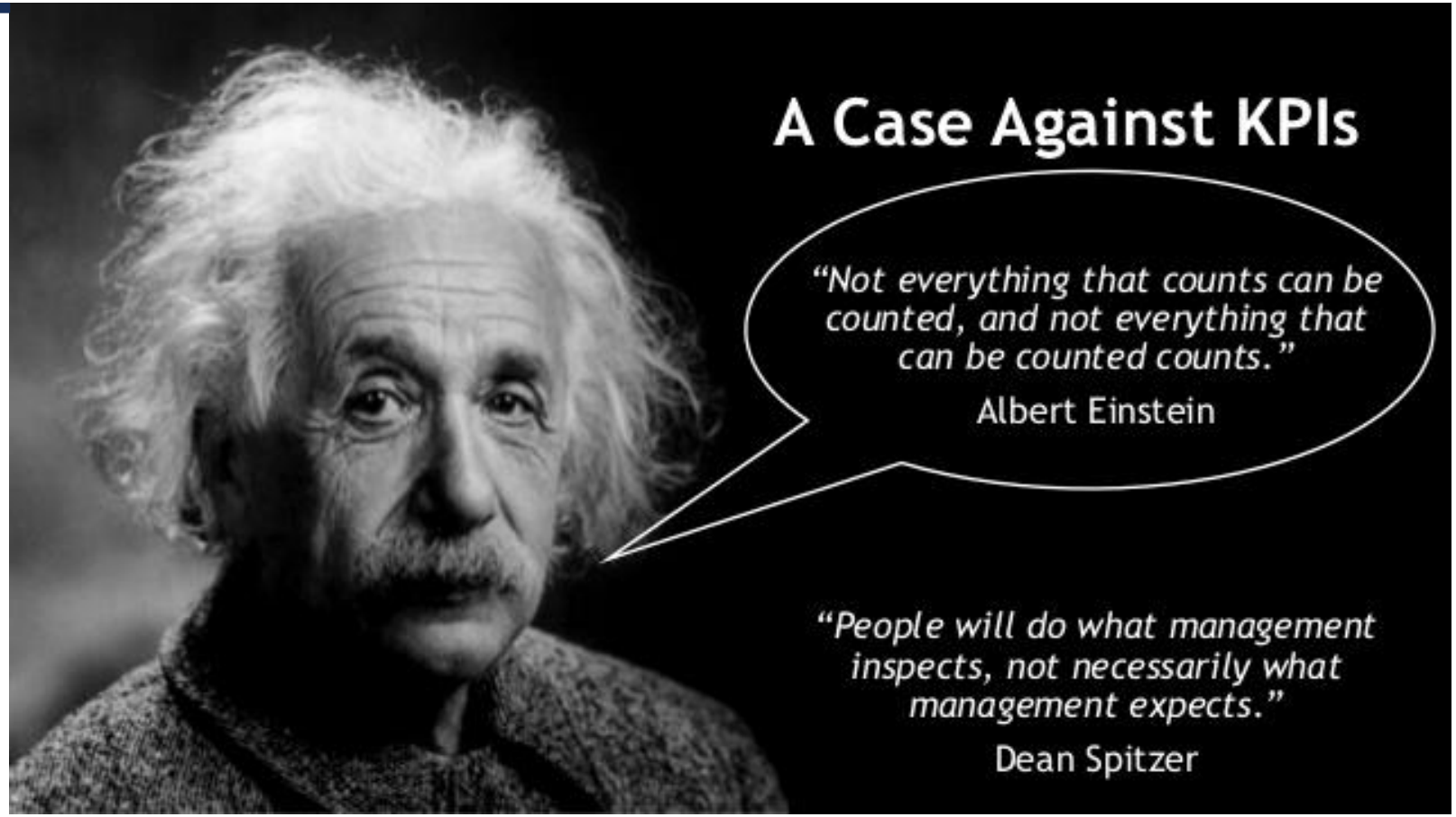
KPIs must remain relevant

Is Dean Spitzer's quote applicable to your organisation?

A. Yes.

B. No.

C. I am not sure.



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Planning and scheduling KPIs

Key performance indicator (KPI)	KPI description
Schedule intensity	This measures the amount of hours that have been scheduled over the total number of available hours to show a % of scheduled hours.
Percentage scheduled work	This measures the amount of hours that have been scheduled over the total number of hours worked
Manpower utilisation	This will measure the % of time spent completing work orders as a function of the number of hours spent at work.
Manpower efficiency	This weekly measure considers the actual hours spent on work orders against the number of hours that were planned.
Maintenance backlog	The amount of work orders hours that is currently overdue or due in the week following the current week as a function of the work centre capacity
Asset data completeness	The number of assets with completed technical information requirements.
Work order lead time	The delay in days between the notification reporting date and the Required Start Date
Age of notifications	The average age in days between the report dates and the notification reporting date per notification
Actual vs planned work order costs	The actual costs of work orders as a function of the planned costs of the work orders

Work management KPIs

Key performance indicator (KPI)	KPI description
Percentage old work orders	Number of approved work orders older than four weeks as a function of the total number of approved work orders
Work order completion	Number of work orders completed as a function of the number of work orders issued.
Work order compliance	The number of work orders per classification ie. lubrication, inspection, scheduled etc issued as a function of the number of work orders completed
Breakdown vs follow-on	The number of breakdown work orders as a function of the number of follow-on work orders. The desired outcome is an increase in follow-on work as potential failures are detected before there is a breakdown.
Percentage of emergency work	Number of emergency work orders completed as a function of all the work orders completed
Maintenance mix	Number of Preventive work orders as a function of the number of preventive and corrective work orders
Mean time to repair (MTTR)	The average time required to repair or replace a failed asset or component.
Mean time between failures (MTBF)	The total time that a technical object is available for production as a function of the number of failures in a period.
Maintenance cost / asset replacement value	The cumulative maintenance cost per year as a function of its replacement value

Interpretation of data

Join your breakout room and use the data provided on the next slide to make an assessment of the three KPIs mentioned below.

Key performance indicator (KPI)	KPI description
Manpower utilisation	This will measure the % of time spent completing work orders as a function of the number of hours spent at work.
Schedule intensity	This measures the amount of hours that have been scheduled over the total number of available hours to show a % of scheduled hours.
Maintenance mix	Number of Preventive work orders as a function of the number of preventive and corrective work orders

Make a summary of your key findings to present back to the class.

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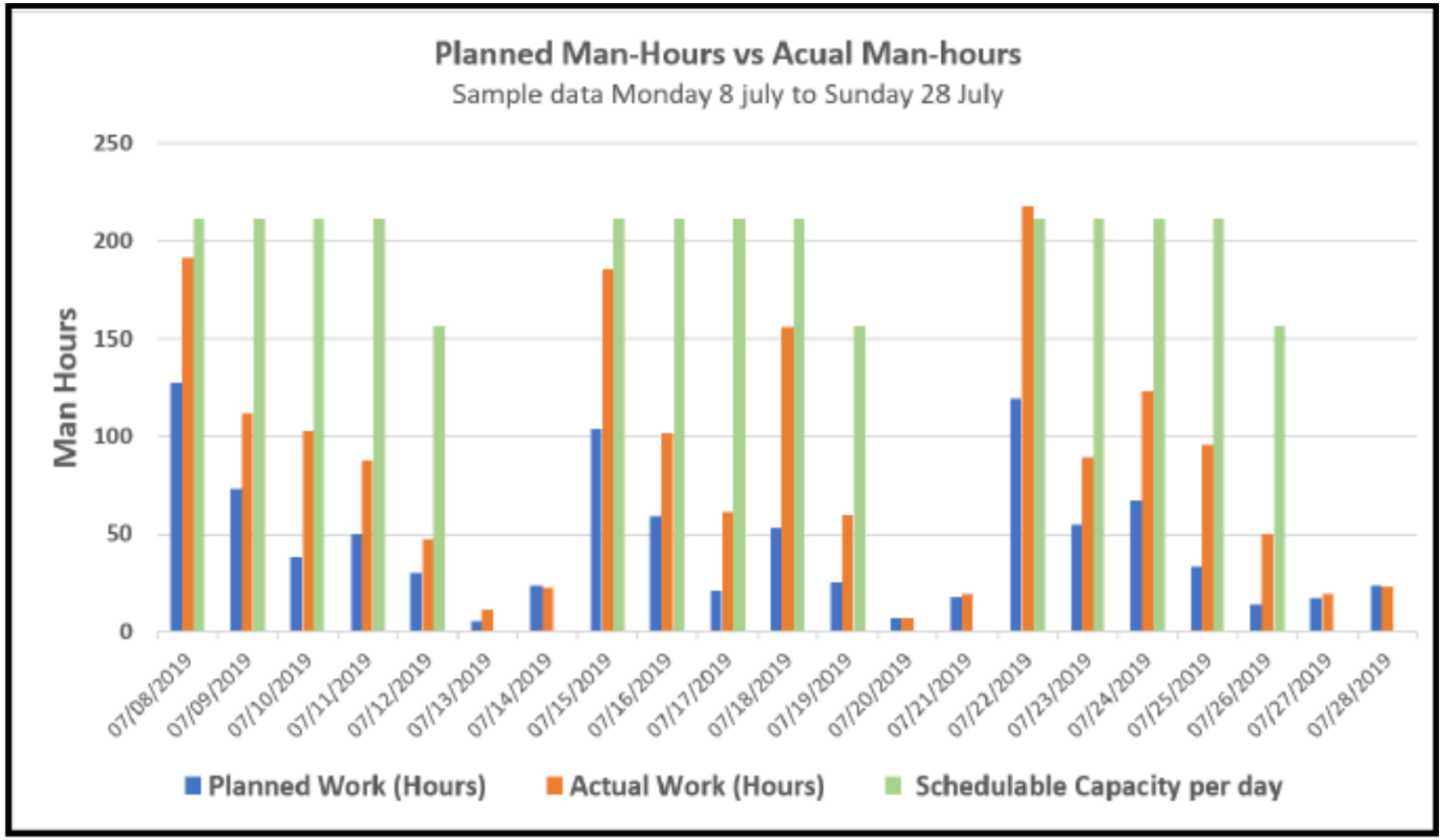
Manpower utilisation



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Maintenance reporting

Maintenance performance data converted to information is business intelligence.

It is a competitive advantage.

Maintenance stakeholders, decision-makers and key people of influence need dashboards and reports to get a rapid overview of maintenance performance and KPIs.

Maintenance decisions must be data-driven to be effective.

Trends and performance changes must be picked up quickly.

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Why are tracking maintenance KPIs important?

Maintenance KPIs are a great way to make sure your goals are clear.

It is one thing to say you want to increase up-time and cut costs, but when you say you want to increase up-time by 10% and cut costs by 20%, now you have objective standards to measure progress.
The advantage comes with the process of establishing goals, revisiting how you are currently running the department, your current workflows and processes, and identifying opportunities for improvement.

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Difference between maintenance KPIs and maintenance performance metrics

Maintenance actions, the things that the team is doing, can be measured using maintenance performance metrics.

How quickly they are able to take a failed asset and get it up and running again is the performance metric.

These metrics eventually add up to KPIs.

You have a KPI related to downtime. For example, you want to cut downtime by 10%. To get there, you need to look at the metrics that together affect downtime – such as how quickly techs overcome failures and how many maintenance work orders are not done each week.

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Important Maintenance KPIs to track

- Maintenance mix
- Unplanned downtime (LTA)
- Corrective maintenance work hours
- Mean time to repair (MTTR)
- Mean time between failure (MTBF)
- Work order compliance

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Work order cycle time

The work order cycle time KPI is the time from the initialisation of a work order until it is technically closed in the EAM system.

The objective is to understand how long it takes to complete work, from creation to completion. If your average trend is increasing, then you will have good reason to investigate the root causes. Maybe you have delays in spare parts ordering, resource issues, planning problems, or unexpected spare part lead times.

It is a simple calculation:

Work order cycle time = work order completion date – work order creation date (in days)

The work order creation date is when it was entered into the EAM system and the work order completion date is when it was technically closed and includes further data such as work done, hours worked, parts used, planner feedback, and more.

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Unplanned downtime (LTA)

- Unplanned downtime KPIs help maintenance managers analyse how successfully they have implemented maintenance strategies.
- Unpalnned Downtime (%) = (hours of unplanned downtime / total period measured [inc. planned downtime]) * 100.
- Downtime affects your costs. There is a straightforward calculation to measure it:
- Unplanned downtime losses ($ per hour) = parts per hour x profit per part.

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Unplanned maintenance work hours

When you can plan all your maintenance activities, you will have stable, predictable costs. And you will be in control of your assets and production runs.

In the reactive approach, failures occur unexpectedly, and technicians waste vital time in panic mode looking for manuals, spare parts, and special tools.

Here's how the unplanned work KPI is calculated:

- Unplanned work (%) = [work that breaks into the weekly schedule (hrs) / Total Maintenance Labour Hours] × 100
- UPW (%) = (WBS / TML) × 100

For this KPI, you should focus on lowering the % of unplanned maintenance work orders as much as possible.

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Maintenance mix

This calculation compares all the time spent on planned work orders to all the time spent on unplanned, on-demand ones.

This ratio helps identify how often an asset is available. Ideally, 90% of your maintenance activities should be scheduled ahead of time.

Planned maintenance percentage is a vital indicator for tracking the health of a planned maintenance program and identifying avenues to decrease break-in maintenance.

Planned Maintenance percentage can also be used to figure out the reason of equipment downtime, poor efficiency, and lack of proper implementation so that these issues can be handled.

Planned Maintenance percentage = (scheduled maintenance time/total maintenance hours) x 100.

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Schedule attainment (work order compliance)

Measures the percentage of maintenance work orders scheduled and completed during a set time, and helps organisations measure the effectiveness of their tactical maintenance programmes. For example, you might have 80 work orders scheduled but only 68 completed at the end of the week.

To calculate schedule attainment: (68/80) x 100 = 85%.

With this KPI you will need to be very careful to align your measure to your scheduling period:

If you schedule daily, you must measure work completed each day vs scheduled work each day.

If you schedule weekly, you must measure work completed each week vs scheduled work each week.
If work is completed in the day / week after the cut-off it cannot count to the attainment. In this way you will develop a healthy KPI that drive the right behaviour.

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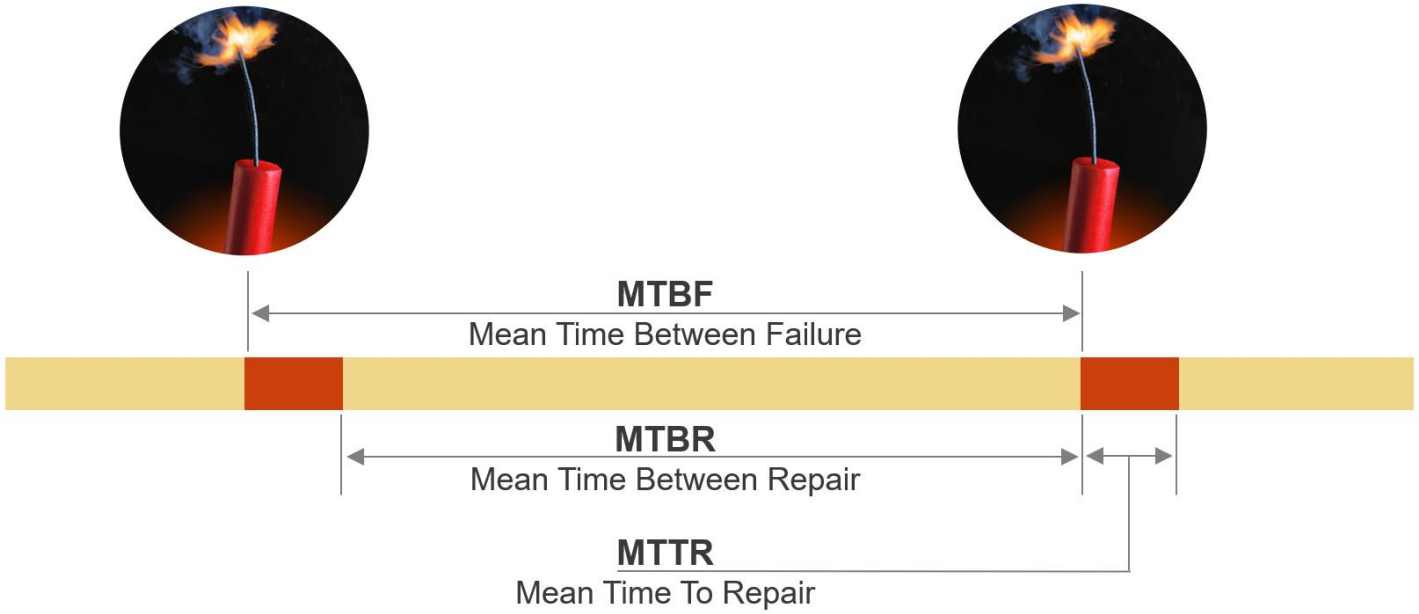
Mean time to repair (MTTR)

- MTTR is the average time taken for an asset to be diagnosed, repaired, and rehabilitated after a breakdown or failure. The idea is to reduce MTTR as much as possible by speeding up the recovery process.
- By tracking this KPI, organisations improve asset availability.
- MTTR = (total downtime periods/ total number of repairs).



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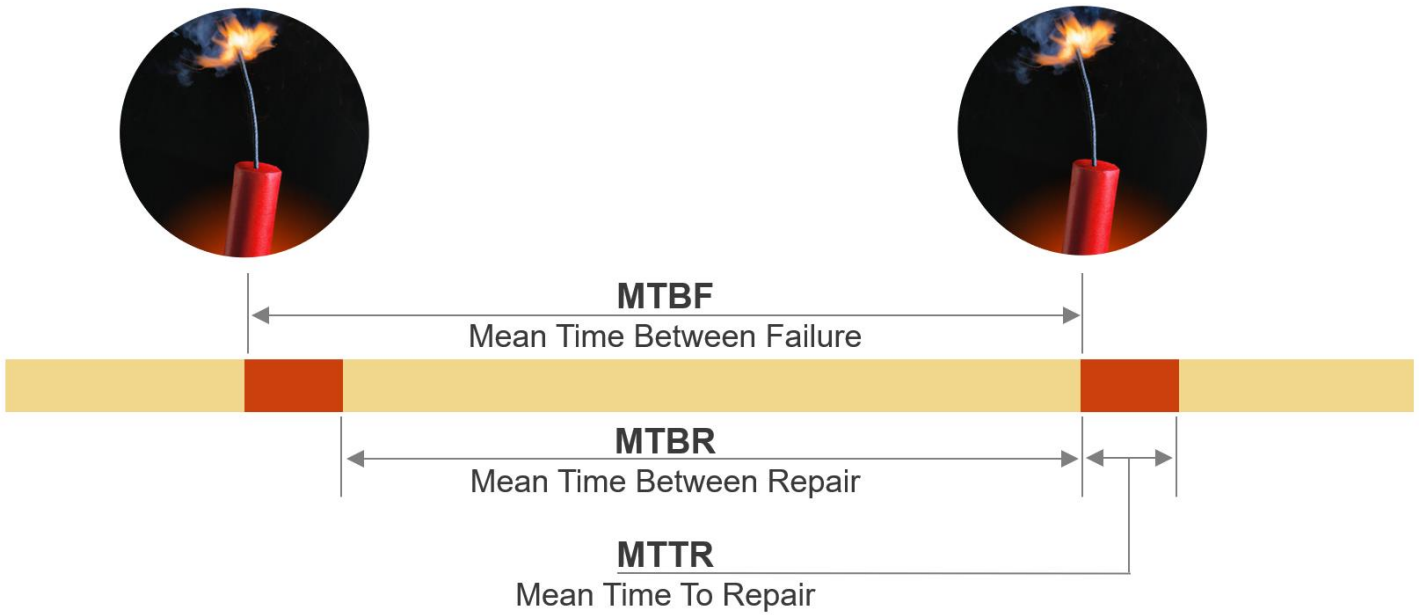
Mean time between failure (MTBF)

Measures the average time an asset is up and healthy between bouts of unplanned downtime. Basically, it tells you the average time an asset runs between failures.

The KPI helps identify how long a specific asset or its parts generally last, allowing you to set your preventive maintenance schedule. If an asset usually runs about three weeks between failures, think about setting your PMs for every two and a half weeks.

MTBF= (sum of operational time/total number of failures)



Report and analyse

Time spent on reporting

How much time do you spend generating or explaining reports?

Type your answer into the public chat.

Tracking and data collection

- You need an efficient way to collect, store, and leverage data.
- Once you have the data, you need to check, clean and crunch.
- Data is mostly collected automatically as you generate work orders and close out work orders.
- It is important to review and drive accountability for the quality of the data which is being collected.

Remember: an overload of information is also a problem!

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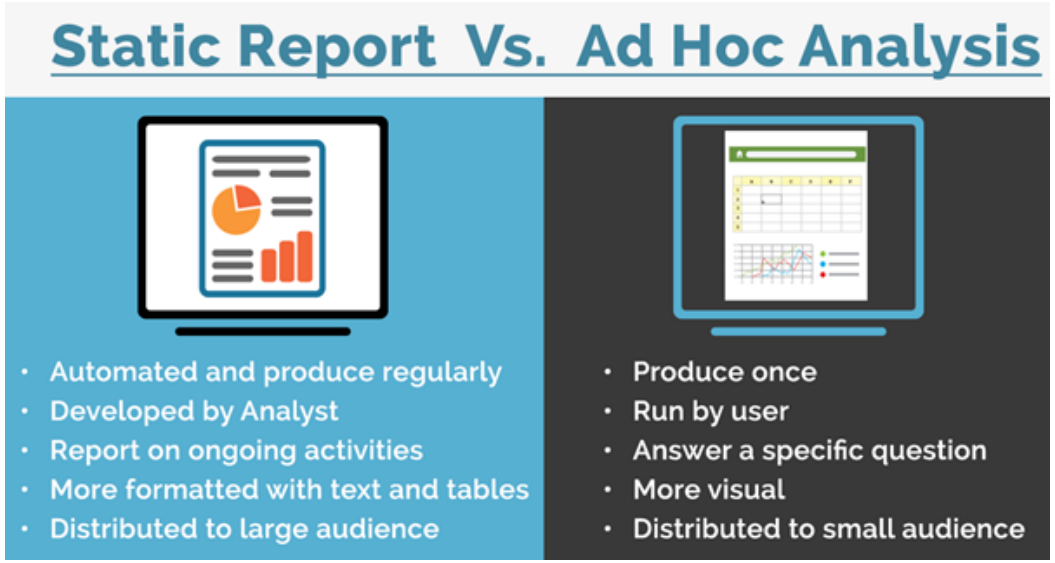
Ad-hoc reporting

On the next slide you have 15 possible ad-hoc reports which can be requested at any given time. Join your breakout room discuss these reports and divide them into three categories:

- Reports than will take a few minutes to generate.
- Reports that we can do but it will take a bit of time to stitch together some data.
- Reports that we will not be able to do.

Reflect on the frequency and usefulness of the requests for these reports.



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Planners should be able to generate ad-hoc reports

1. How much did the maintenance cost on a particular asset cost over the last five years?
2. What is the most costly equipment in terms of maintenance cost?
3. What is the current backlog in term of work hours?
4. What is the current backlog of work waiting for spare parts?
5. What is the current backlog of work for electricians in terms of work hours?
6. What work orders caused lost availability over the last week?
7. Is this a trend that is rising?
8. What work orders could be worked tonight if there was a short notice shutdown?
9. What is the trend of non-tactical vs tactical work orders over the last 2 years?
10. Which section has the greatest amount of failures occurring in the equipment it maintains?
11. Which work orders are waiting for planning?
12. Which work orders are completed, but not closed because of drawing revisions needed?
13. Are there planned work orders that can be worked along with breakdown WOs?
14. How many hours are spent on tactical work?
15. How many hours are spent on follow-up work that is generated from inspections?

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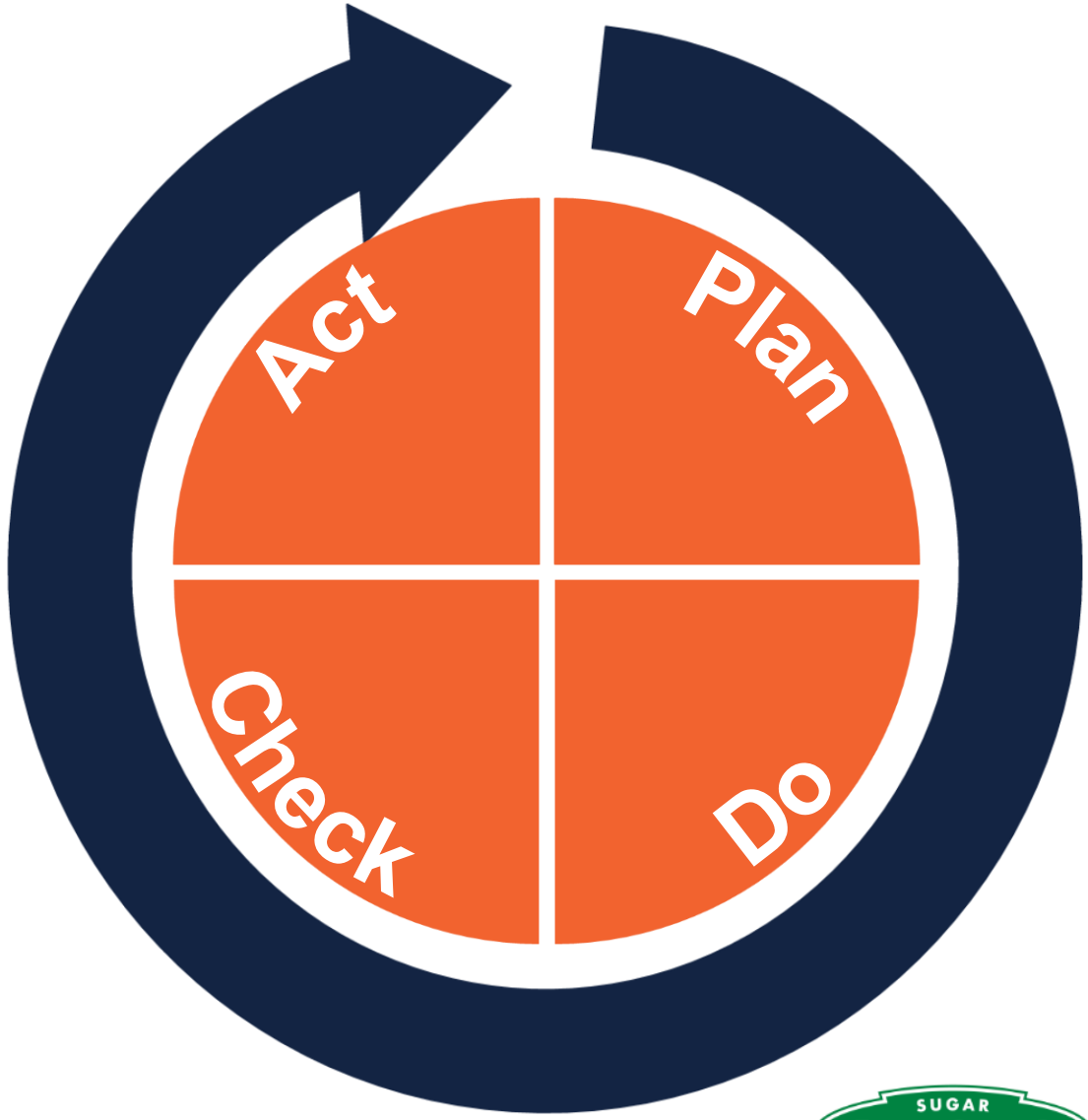
What do you do with the KPI results?

Now we need to **ACT** on the KPIs:

- The responsible parties must review the performance against the targets.
- Identify the problem areas.
- Find the root cause of the problems.
- Agree on improvement actions.
- Implements them and monitor the effect on the performance.



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Review meetings to drive improvements

Inputs

Maintenance work orders.

Daily production reports.

Meeting

Teams with people from different departments: Production, Maintenance, Supply Chain, BI etc.

Outputs

Action plan.

Root cause analysis.

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Reflect on the learning objectives of this module

Are you able to:

- explain how maintenance KPIs are derived
- explain the links between maintenance KPIs and the organisation’s business goals
- explain leading and lagging KPIs and how they are used to continuously improve asset availability
- explain and interpret specific KPIs frequently used to drive continuous improvement in maintenance work management
- interpret common maintenance work management report requirements and identify standard reports for use
- interpret reports related to maintenance work management and asset availability and highlight deviations for investigation?