Optimisation of Maintenance Regimes:

Delivering Operational Efficiency and Wellbeing

A comprehensive guide by SFG20

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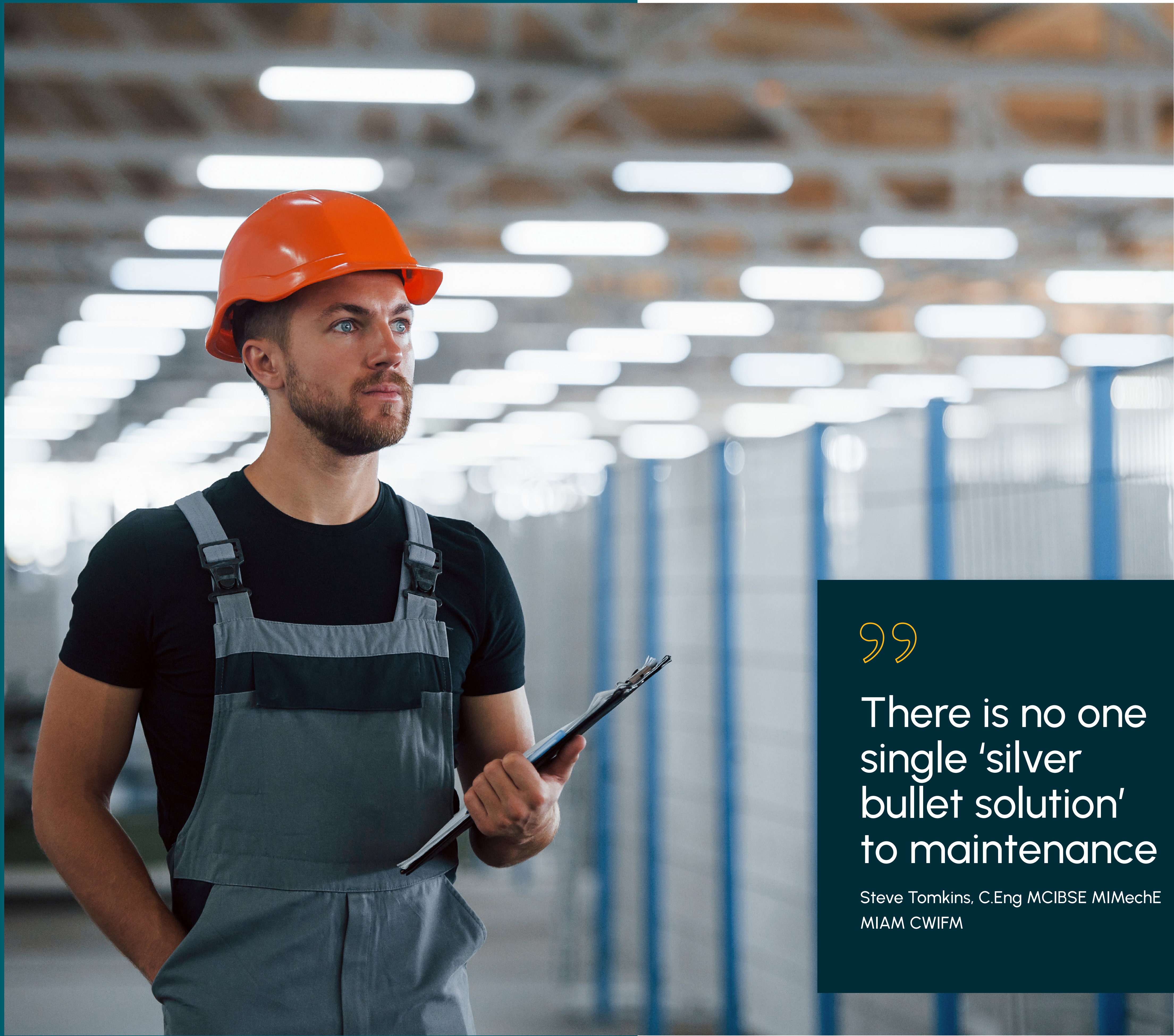
Introduction

This SFG20 Guide is intended to help building owners, contractors and consultants understand the areas for consideration when looking to optimise their maintenance to best suit their buildings and the sectors in which they operate.

There is no one single 'silver bullet solution' to maintenance. Instead, a blend of different maintenance tactics should be applied, based on the impact and risks that asset failure could cause in an organisation.

We will explore Reactive Maintenance, Planned Preventative Maintenance, Condition Based Maintenance and Predictive Maintenance and the role each one has in driving cost-effectiveness in the changing environment we face today. We will also discuss the role of risk and asset availability in maintenance design and consider the key drivers for optimisation.

This guide is written by the Building Engineering Services Association who developed, publish and operate SFG20, the definitive industry standard for planned preventative maintenance.



> There is no one single 'silver bullet solution' to maintenance
>
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Types of maintenance

The act of a maintenance intervention by its very nature is designed to sustain and or restore an asset or systems service. With this in mind understanding the range of approaches that could be adopted is important. In one academic study of the sector[1], over thirty types of maintenance strategy were identified.

Taking a broader view, we can describe the four most common types of maintenance strategies found in the property sector as shown below.

1. Reactive Maintenance

Reactive maintenance essentially means that equipment is run until it fails and is then repaired or replaced. This sounds like an undesirable approach for all maintenance, but it need not necessarily be the case for some types of equipment.

Taking a reactive approach across an entire building or estate, is not recommended. Allowing all assets to run until they break down would not only be highly likely to be in breach of legal requirements, it could also be very costly in terms of time, staffing levels and budgets.

Unplanned maintenance also causes disruption to the wider business and could be detrimental financially. For contractors, the reactive approach is equally disruptive if applied too far – making it difficult to provide a reliable service to clients because resource planning would be almost impossible.

Reactive Maintenance Cycle and its Impact

Decreased Life Expectancy of Assets:

Faster asset deterioration.

Collateral Damage:

Minor issues escalating into total system failures.

Unplanned Expenditure:

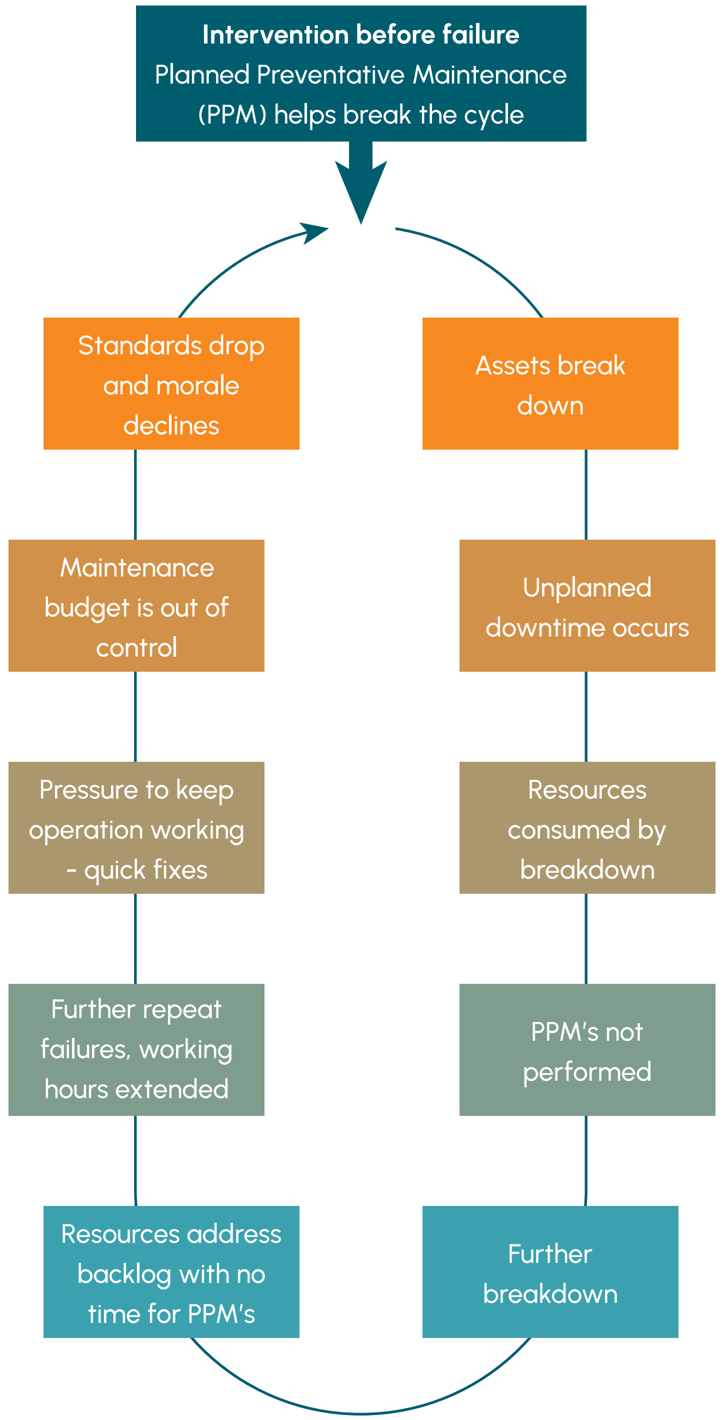
Unpredictable failure causes financial budgeting difficulties.

Safety Issues:

Time pressures associated with reactive repairs cause increased risk taking.

Unplanned Asset Downtime:

Assets are 'offline' for uncertain or lengthy periods.



Increased Energy Costs:

Damaged assets often have higher energy consumption.

Reduced Productivity:

Waiting times for spare parts delivery, access and permit approvals.

Reduced Efficiency:

Unscheduled repairs leads to disruption and delay.

Repeat Issues:

Temporary repairs and 'symptom mamagement' lead to repeat issues as PPM is then not carried out.

Figure 1 - Reactive Maintenance – breaking the cycle

The diagram above shows that inappropriate use of reactive maintenance can become a vicious circle of failure created by a lack of strategic approach

But there are some instances, for non-critical equipment particularly, where run-to-failure is more cost effective than sending a maintenance professional to check on a non-critical asset while it is still operating. For instance, a extract fan in a toilet could be deemed less critical due to the purpose is serves and can be potentially be defined as a reactive response on failure, but in contrast the same (hot) air extract function in a data centre is by definition operationally critical.

When using the run-to-fail approach it is vital to understand the impact of an asset on the organisation as a whole. Impact assessments are an important aspect of this maintenance tactic, and other considerations such as operational inefficiency and early asset mortality impacts should be also be considered.

> A fully reactive approach is unlikely to be appropriate for the majority of businesses as it doesn't take account of legal requirements and makes budgeting and resource planning very difficult

2. Planned Preventative Maintenance (PPM)

PPM is a structure of maintenance activities designed to have pre-emptive intervention before an asset fails based on time and usage.

By adding an element of time planning to maintenance, PPM increases asset reliability and efficiency, reducing the likelihood of unplanned downtime, while allowing maintenance managers to better organise their team and resources.

The time element of PPM is crucial. Checks, measurements and fault-finding are timetabled months in advance. By following a formal schedule, requirements for repair or replacement are more easily anticipated and budgeted for. These can also be scheduled at times when it is most convenient for the organisation (common examples, such as heating systems in the summer and air conditioning in the winter).

The timing of checks and monitoring can be based on manufacturer recommendations, regulatory requirements, industry best practise or general experience of the maintenance team based on asset condition and performance. For maintenance contractors and clients, the PPM method offers a more managed and predictable approach.

However, a static blanket PPM approach has potential pitfalls where assets are operating either more or less hours outside 'standard expect operating norms' or in environment where external factors could impact asset utilisation (e.g. a pre-long periods of exceptional unseasonal weather, or asset condition). Therefore, with a fixed PPM regime this can potentially lead to under or over maintenance of assets, but more commonly there is a degree of tolerance that accounts for minor variances enabling a window of opportunity for the planned maintenance intervention. In cases where asset interventions fall outside a 'standard' profile, the regime frequencies should be assessed and revised.

> PPM gives greater certainty of budget and facilitates resource planning

3. Condition Based Maintenance (CBM)

CBM is driven by access to data on the performance of building services assets around a building. It is based on detection of indicators such as vibration, noise levels, flowrates and other feedback such as temperature rises.

Sensors and monitoring equipment are becoming more prevalent in assets thanks to a falling price point of the technology, along with new building management systems to keep track of equipment performance.

CBM, once the preserve of high value and critical assets, is therefore becoming more widely applied to building assets.

Remote monitoring from a central location (either on or off-site) allows maintenance teams to take the sensor data collected from equipment as diverse as pumps and valves to air handling units and apply this to rules-based logic.

These models establish what conditions will create a requirement for maintenance intervention either, for example, investigating possible unforeseen fault or maintenance service activity such as replacing a clogged filter. It is only as these conditions (moving out of predefined tolerances) are met that maintenance is required.

While PPM is essentially timetabled maintenance, CBM is responsive to the condition of a particular asset at a given time. The use of pertinent sensor data enables maintenance to occur before asset failure as soon as equipment falls below its defined performance.

The benefit of CBM is that, thanks to assets being constantly monitored, intervention can be made at the appropriate time. Maintenance teams are able to quickly detect when an asset has moved out of standard operating parameters and an appropriate action can be applied. This not only reduces critical downtime, it also helps optimise the asset performance and energy use.

It is important to bear in mind that whilst CBM has its benefits, there can also be potential downsides and issues for maintenance teams. When applying CBM as strategy, the key aspect that requires consideration is the duration from the indication of a probable failure to actual failure and whether it is feasible to respond with the correct resource in time. CBM also may lead to multiple assets indicating maintenance requirements at the same time. This can lead to unpredictable peak times that can challenge both in-house and contractor teams.

It is also important to consider that with the application of CBM technology there is usually an additional cost associated. Whilst the costs of asset monitors are falling, they do still need to be factored into budgets.

Also, the need to overlay sensor data with algorithms to create a notification when non-optimal performance is detected requires specialist knowledge, which is a more expensive skillset.

As with other approaches to maintenance, it is important to regard CBM as an option that should be applied appropriately in order to make the most of its benefits.

Historically CBM solutions have been applied in conjunction with a fixed PPM regime on high value assets to monitor and ensure erroneous service interruptions can be detected between PPM service intervals, thus ensuring asset uptime. Essentially 'a belt and braces' approach on high risk, value and service assets.

Condition based maintenance is becoming a more mainstream tool thanks to a drop in the price of monitoring equipment but is still often overlaid on top of a PPM strategy for high value or critical assets.

CBM can also be overlayed on existing PPM regimes, monitoring equipment performance and utilisation to determine maintenance regimes and intervals. Often with the application of CBM monitoring, selected assets will be piloted on new regimes to determine the effectiveness before application to wider asset populations.

One modern day example of the application of CBM is within data centre environments where operational downtime is simply not an affordable option and asset uptime is critical. Combining a planned regime and continuous monitoring gives indications of unforeseen performance issues that could impact the operation.

4. Predictive Maintenance (PM)

Digital technologies are impacting all areas of our lives, and building maintenance is certainly no exception. Our increasingly-connected world includes building services that are enhanced with connectivity – it is not uncommon to find equipment as small as valves which can now send data and collect instructions from the 'cloud'. Terms such as 'big data' and 'machine learning' are heard more frequently in the facilities and maintenance fields.

The cost of technology continues to fall, putting the benefits of connectivity into the reach of more building owners and occupiers. Smart sensors can be widely applied to collect information about what is happening around a building at any time. And this data can be used to build digital models or 'twins' of a building in order to aid design, construction and operation.

Although still in its infancy, the creation of a 'digital twin' through the use of Predictive Maintenance data collection has the potential to bring significant benefits to FM

One possible outcome of greater use of technology is Predictive Maintenance, a more advanced form of Condition Based Maintenance. In order to apply a Predictive Maintenance approach, it is often a precursor that CBM be applied to capture and record asset performance against utilisation over a period of operation. The resulting data then can be used to predict the next maintenance intervention requirement. The application of this approach brings significant benefits in asset energy management as well as planning resources and resource management efficiencies.

The predictive approach is still in its infancy in some sectors. It is used in the advanced manufacturing field and there is significant potential for its growth in the built environment.

The goal is to have good operational data, ideally over a large population of assets, in order to perform analysis and predict interventions to a greater degree of accuracy.

The creation of a digital twin of a building can offer insights into the scenarios that lead to poor performance. This means maintenance can be based on patterns of actual building performance that allow the maintenance team to make a prognosis of potential failure and take action accordingly.

There are clear benefits to the application of technology, but it also requires maintenance providers to develop their skills in order to make the most of it – and to apply it correctly. It's also important to bear in mind that no matter how well faults can be predicted, the basics of complying with health and safety regulations will still be required even in the most advanced buildings.

The graphic below illustrates a mature maintenance strategy by the application of the appropriate maintenance approach to an asset type.

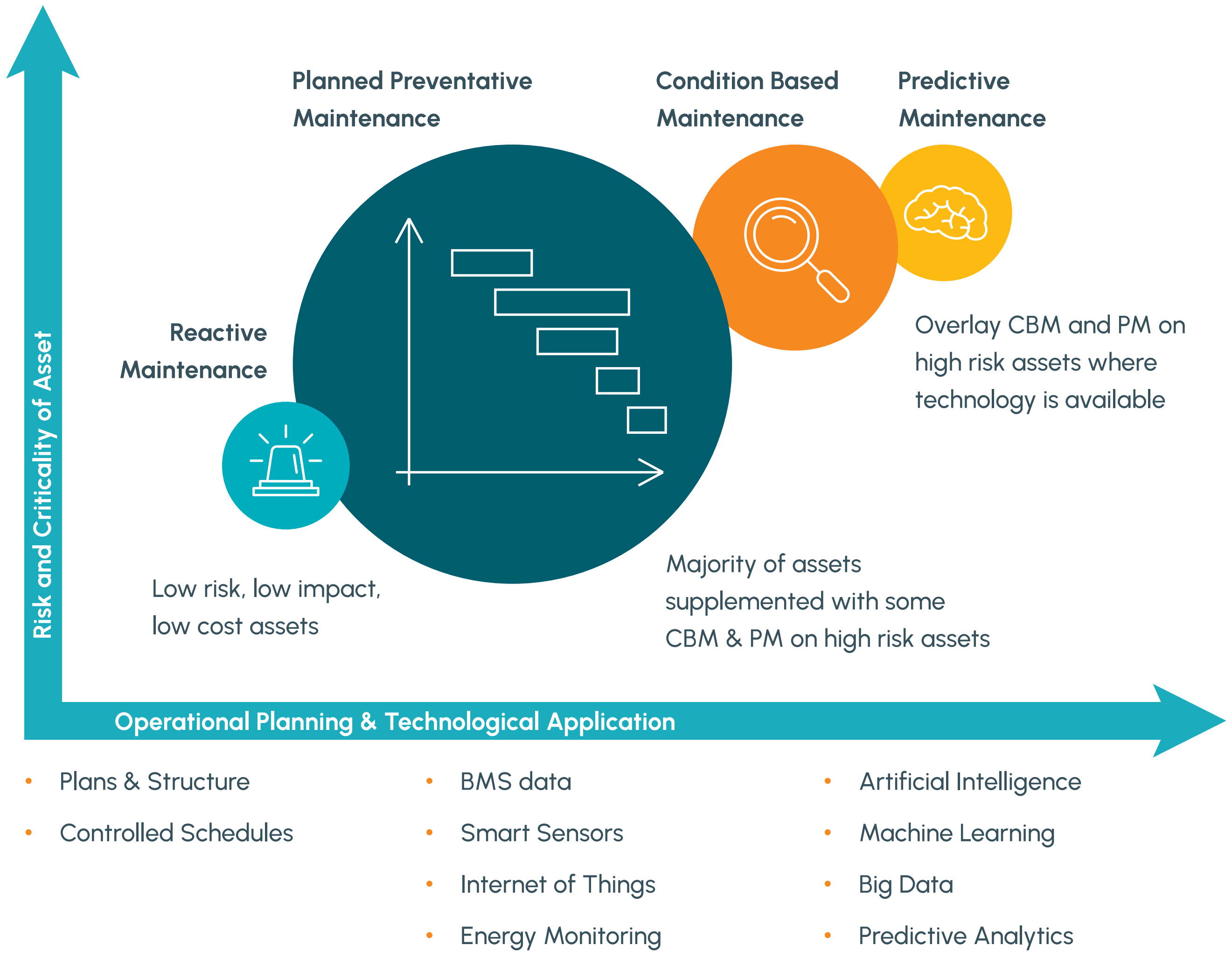


Figure 2 – A balanced strategy based on risk and technology

Focus on Risk

The impact that random, unsuitable, over or under maintenance can have on products and services, operating costs and the business bottom line is significant. Maintenance professionals need to develop a strategy that takes a balanced approach. In order to develop this balanced approach, the focus should be on risk – the probability and impact of failure.

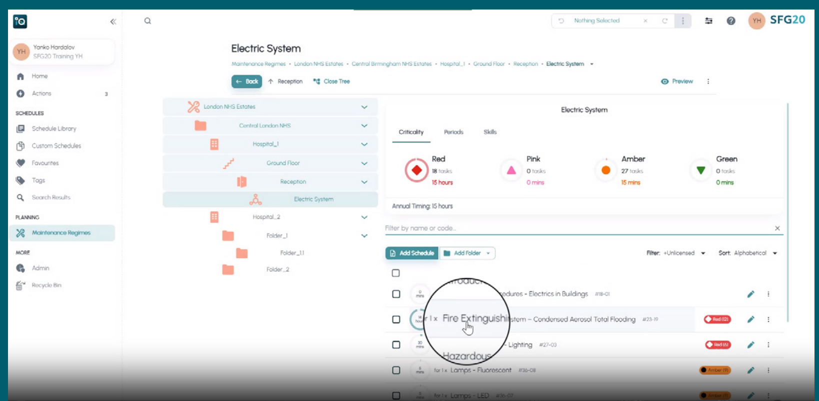
There are a number of publications detailing guidance methodologies and techniques to assess organisational risk for maintenance requirements.

Publications including BSRIA's Business-Focused Maintenance (BG 53/2016)[2] and CIBSE Guide M: Maintenance and engineering management to the application of Reliability-Centred Maintenance (RCM2)[3].

For example, the latter provides a table which compares hazards such as loss of electrical supply, environmental spillage or explosion in a pressure vessel. The likelihood of these is then offset against the severity and business impact (measured in £000s).

Risk is an approach which SFG20 puts at the heart of its definitive standard. Its library of task schedules highlight four levels of risk, which are colour coded to help users make informed decisions:

- Statutory (red) – ensuring legal compliance (e.g. checking and testing fire safety systems, water hygiene)
- Mandatory (pink) – ensuring regulatory and sector/ organisation compliance. For example, complying with Health Technical Memoranda (HTMs) in the healthcare sector.
- Function critical (amber) – maintaining business-critical assets and avoiding over- or under-maintaining applicable assets. This could include a focus on optimising cost efficiencies against risk when appointing maintenance contractors.
- Discretionary (green) – maintaining non-critical assets and meeting non-business critical commitments. These tasks should be assessed in context of impact on other dimensions including asset efficiency/ energy use and preservation of initial capital in the asset's residual value.



However, with a risk-based approach to maintenance, it is vital that a strategy meets organisational requirements as closely as possible. Factors including the asset's age and condition, or previous service history may need to be assessed when applying and customising maintenance strategies.

The risk-based approach to maintenance has its challenges. For example, it requires knowledge of exactly what assets are being maintained – information which is unfortunately not always readily available in existing buildings.

If a comprehensive asset list or as-built digital model are not available, it may be necessary to take an accurate survey of plant and components. However, the investment taken to build this strategy pays dividends in terms of reduced risks to the organisation and better budgeting of maintenance.

> Consider creating an asset list for your building or estate, it can pay dividends in terms of reducing risk and improving budgeting.

The role of asset availability

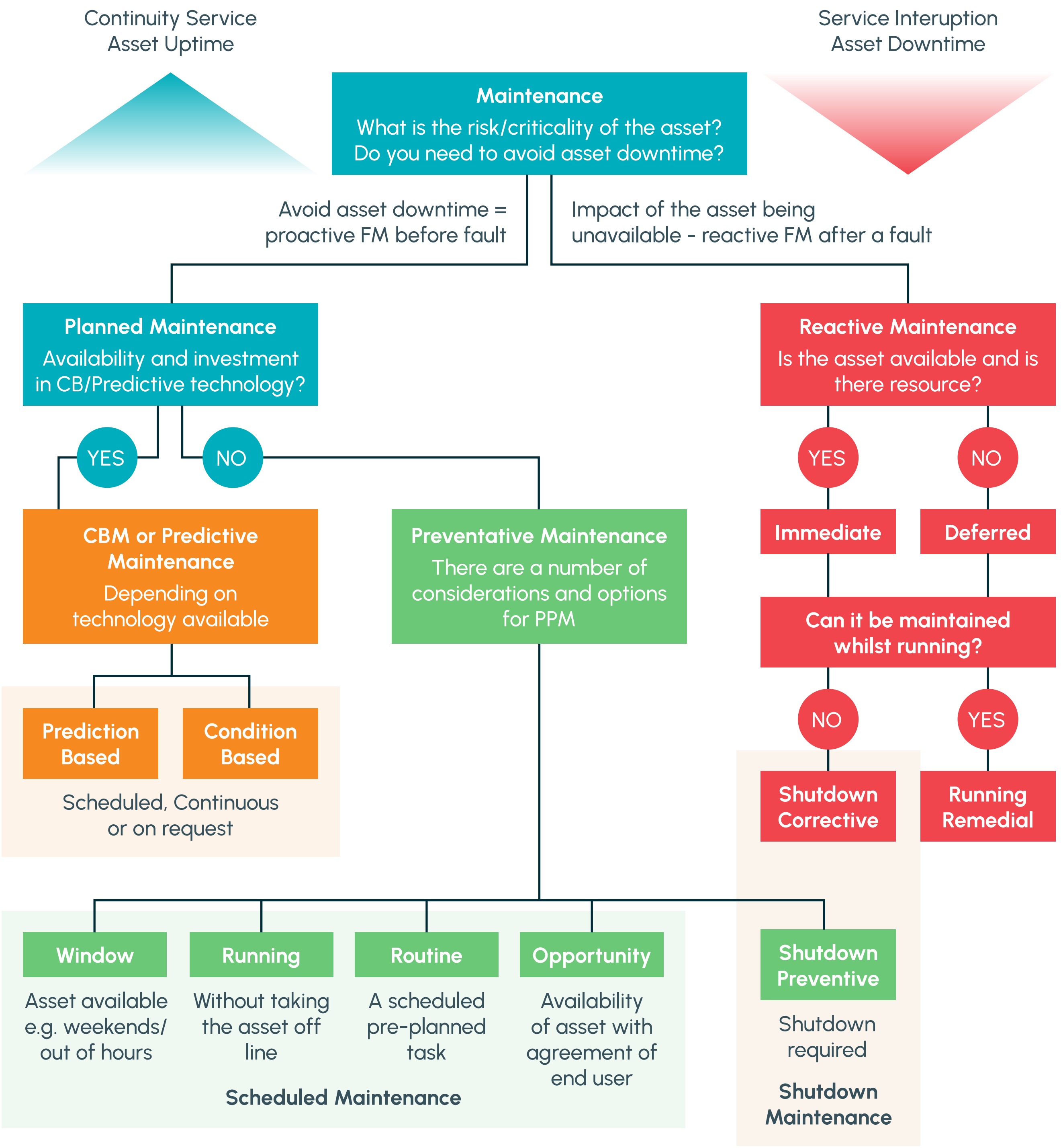
The next piece of the jigsaw in developing an appropriate maintenance strategy is understanding the asset availability for maintenance. Consider when the asset is not required for operational service. If you can plan maintenance at a time when assets are either not needed or their absence does not cause any operational issues, this is the time to plan maintenance to optimise asset performance and critical uptime.

This might be related to seasons, for example, heating systems may not be required during summer months and air conditioning may not be required in winter months. Alternatively, there may be times of the year when a whole estate or parts of an estate are out of general use, for example schools during holidays.

Creating a Balanced Strategy

Once you have assessed risk and asset availability it is possible to create a balanced approach to your maintenance regime which will help maximise asset uptime and optimise overall asset cost.

The diagram on the right shows how a mix and selection of maintenance strategies may be determined within an organisation. Assets where risk and criticality mean asset uptime is desired would follow the left hand planned maintenance decision tree whilst other low risk assets where service interruption is deemed acceptable would follow the right hand decision tree route.



RED: Reactive maintenance, which will include run-to-fail on equipment that has no direct impact on operation capability or service.

ORANGE: Condition based and predictive maintenance, typically used for assets where uptime and uninterrupted service is critical; high utilisation – this requires the availability of technology, resource and financial investment.

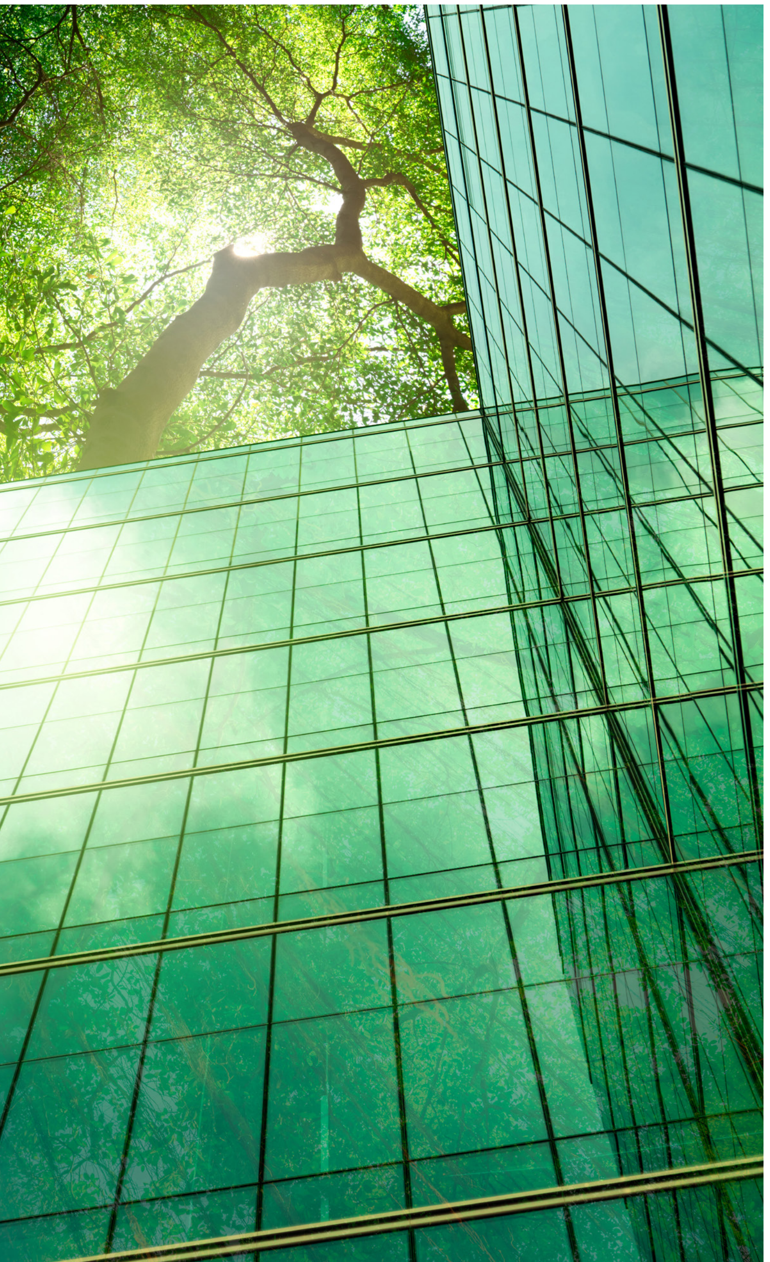
GREEN: Preventative maintenance delivers good asset uptime and the ability to plan resource. A flexible approach to scheduling maintenance tasks means maximising resource planning to fit business needs.

BLUE: Planned Maintenance helps sustain asset uptime, optimise resources and reduce overall asset cost.

The drivers for optimised maintenance

Far from being a 'back room' issue, maintenance today takes an increasingly central role in delivering critical organisational objectives such as energy savings, carbon reporting and reduction, occupant wellbeing and resilience in the face of climate change. Without the relevant maintenance budgets being set, operational goals will fail and operational assets will need replacing more frequently, increasing capital budgets and corrective maintenance budgets.

This means that optimising your approach is crucial for success.



1. Health, safety, and wellbeing

Wellbeing of occupants is an adjunct to health and safety. Going beyond the basic requirements set out in Building Regulations and other laws, wellbeing focuses on enhancing the performance of occupants within the workplace. Employees continue to be the most expensive investment made by organisations, so optimising the working environment to support human productivity is now being actively targeted by businesses.

The impact of correctly maintained ventilation systems and air filtration has been highlighted due to the Covid-19 pandemic. Another factor is the revolution in data collection and analysis that means we have a better understanding of the impact of the built environment on occupants.

2. Energy use and carbon emissions

Buildings are significant users of energy, and they have been the target of a great deal of sustainability legislation in the past few years. Regulation in this field is growing tougher as the UK Government aims to reach its Net Zero Carbon target by 2050.

Building services such as heating, ventilating and air conditioning represent a large proportion of any building's energy consumption, even more so since the Covid-19 pandemic, so optimising their performance is now at the heart of much of the work carried out by facilities teams.

There are other issues to consider that relate to other aspects of sustainability in the built environment. For example, the circular economy is something that relates to carbon in the fabric and equipment used in buildings.

For maintenance and facilities teams this requires consideration of issues such as disposal of old equipment when it is replaced; the carbon footprint of materials used in maintenance; and how the business is optimising use of equipment to reduce waste.

3. Resilience

The issue of resilience is one that affects all organisations. The breakdown of air conditioning in summer, for instance, may result in lower sales in a retail environment as shoppers overheat in stores. A malfunctioning office or warehouse heating system in winter may mean staff are sent home as temperatures drop.

Resilience may also be regarded as a general long-term consideration, particularly in the face of ongoing external factors such as climate change.

For example, is a building in an area that is becoming more prone to flooding on a regular basis? If average temperatures continue to rise, how can occupant comfort be assured? The maintenance team will need to consider these factors and others over the lifetime of a building.

4. Working patterns

Over the past five years, the office market has seen significant shifts in usage. With the rise of small start-up businesses, co-working spaces have been a booming market.

The requirement for a building to offer optimum flexibility to provide space for small and growing organisations has never been so pressing. The impact of Covid-19 on the rise of home working and flexible working is accelerating these shifts.

For facilities teams, it is a trend that offers its own challenges. Not least is the unpredictability of occupant levels at any one time. Flexible offices require more flexible building services such as lighting, cooling and heating – often provided on the back of increasingly complex building management systems (BMS).

5. Resource efficiency

The Institute of Workplace and Facilities Management (IWFM)[4] estimates that over the past three decades, facilities management has shifted from being a largely in-house function to one which is now far more likely to be carried out, and even managed, by external service providers.

It is all too easy for both sides of the client/contractor equation to under or over estimate the time required for maintenance tasks. Calculating the balance between paid time, availability, utilisation, effectiveness and productivity is fraught with potential pitfalls that can result in both parties being poorly served by the relationship.

As can be seen from the diagram on the right, time paid for is not necessarily time spent on maintenance tasks. Not only do these issues impact on the quality of maintenance, they also mean that building services are not operating optimally – creating further problems down the line with unplanned outages and breakdowns.

A planned approach to maintenance helps to reduce the impact of unavailability, utilisation and in-effectiveness – hence maximising productive time.

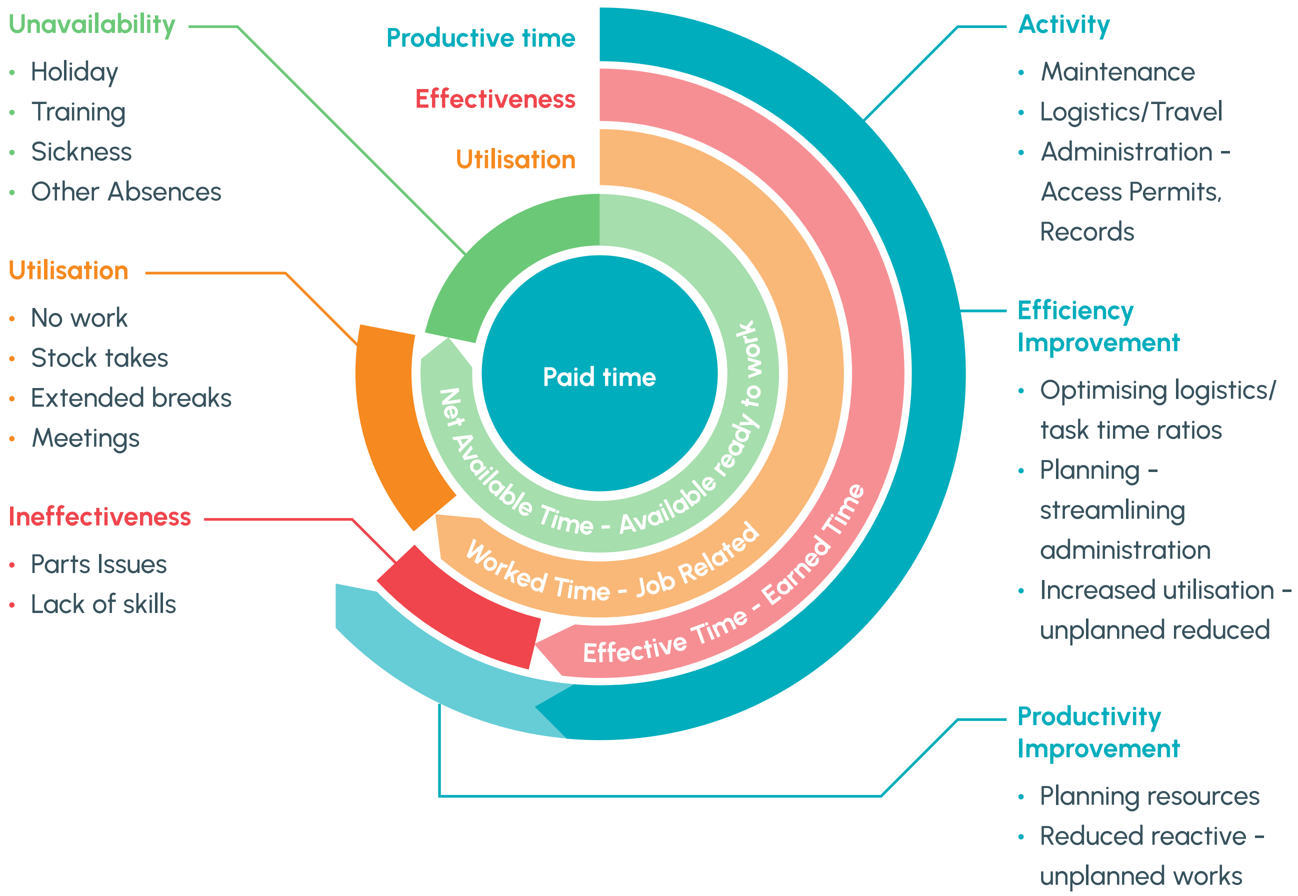


Figure 5 – Optimising resource productivity

Maintenance is as much a part of any organisation as finance or HR – its poor performance will impact on others. The ability to plan and resource efficiently is therefore central to the role of maintenance and one which should not be underestimated.

6. Digital Methods

The idea of a digital record of any building is central to Building Information Modelling (BIM). In the UK, use of BIM is being increasingly required by government (construction's largest client) in order to improve the industry's efficiency.

With the digitisation of buildings at the design stage, integration down the line will result in greater use of digital information for commissioning, handover and ongoing maintenance practice.

Optimising maintenance will increasingly involve use of digital tools that can integrate with systems used by other building professionals – from the architect to the facilities team.

Conclusion

In conclusion, when selecting and blending maintenance strategies it is key to understand the overarching objectives for the assets and systems. These are usually (but not limited to) the sustained health and wellbeing of user and operators, ensuring asset availability now and in the future, and reducing energy use and carbon emissions.

To create a balanced maintenance strategy, it is important to blend different maintenance approaches based upon the risks associated which each asset type and its availability.

Well-maintained assets will not only provide a sustained operational service continuity but will operate efficiently and realise the design life expectancies. Applying maintenance strategies in a holistic approach will benefit the asset in terms of its performance and enable optimised productive time and resources for the support services.

There will always be trade off considerations when seeking an optimised strategy, the objective is to strike the right balance in meeting business objectives and wider requirements against capabilities available.

The Covid-19 pandemic is a prime example where risk and priorities have been dynamically assessed whilst bringing sharply into focus the importance of managing our indoor environments.

The challenge for the future Carbon Net ZERO 2050 is a key area where maintenance optimisation has a crucial role to play. SFG20 can play a vital role in providing a robust foundation to develop and benchmark where improvement opportunities can be identified.

The continued digital revolution of information capture, reporting and integrations, together with fallingtechnology price points will enable further maintenance improvements to be realised.

Where maintenance is performed well it will remain an invisible service to end users, taken for granted, the challenge is ensuring further optimisation can be achieved using holistic approaches.

SFG20: Facilitating optimised maintenance

SFG20 was developed by BESA, the Building Engineering Services Association, in response to a need for a best practice standard for maintenance.

SFG20 has been designed and developed over three decades to keep pace with the changing maintenance profession, and it provides a technically robust standard that is also highly customisable to individual building needs. The SFG20 standard is accessed and used via Facilities-iQ, a totally unique software solution designed for facilities managers, building owners, contractors and consultants. It enables you to stay compliant whilst saving time, energy and money.

The SFG20 standard is comprehensive, offering over 2000 maintenance schedules which cover the various aspects of a building and its operation – from building fabric and catering to water systems, heating and security. Each of these schedules provides insights into what maintenance procedures are legal requirements. It then further helps to categorise risk by indicating which tasks are optimal and discretionary.

The standard includes step-by-step detailed requirements for each maintenance task, with timings required for each – making scheduling and resource management easier. This can also prove particularly helpful for the tendering process. A client or consultant can create a clearly defined maintenance plan for contractors to quote for on a comparable basis.

This also saves contractors significant time in the tendering process or in developing maintenance programmes for clients.

With legal compliance at its heart, the SFG20 standard is constantly monitored and updated by a team of technical authors to ensure that it reflects the latest laws. A committee of industry professionals ratifies updates to ensure that any guidance reflects industry best practice. This saves users significant time, as well as giving peace of mind that their organisations will be fully compliant.

One of the most important aspects of SFG20 for clients and contractors is that it provides flexibility as well as standardisation. Users of Facilities-iQ can tailor their own schedules to reflect the building (or buildings) that they maintain – enabling users to combine their site-specific knowledge with the power of the SFG20 standard.

Facilities-iQ can also be integrated with FM systems for operational planning and the SFG20 companion app. can be used to access task instructions by engineers in the field and those that perform user checks.

For more details on SFG20, Facilities-iQ or to request a demonstration with one of our experts, visit: SFG20.co.uk.

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