CS500006

Using Technology and Software to Create More Sustainable Designs

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Learning Objectives

- Assess how to implement technology and improved processes that produce more sustainable design, processes, and practices
- Identify what contract terms or documentation will support and require more sustainable design, processes, and practices
- Implement internal processes and documentation to improve sustainability in working practices
- Assess how their organisation can successfully implement a more sustainability-focused ethos and design processes

Description

Sustainability in construction is a complex issue. As the world becomes more environmentally focused, how do we implement this in practice? There are so many pieces to the sustainability puzzle, but technology - like Autodesk's AEC Collection and Construction Cloud - are key pieces to solving this. Buro Happold, known for its technology-forward thinking, has long been working towards an equitable and green recovery, adapting our business to mitigate climate change and the biodiversity crisis. Our vision for the future is for a regenerative ecosystem – both natural and built – that provides suitable habitats for humans and non-humans alike. In the class, we consider how implementing processes, documentation and software can help support more sustainable and environmentally-friendly design including sharing lessons Buro Happold has learnt on how to effectively use technology to achieve these aims.

Speaker

May is the Global Director of Commercial, Legal and Digital Risks at Buro Happold, where she takes the lead in progressing and managing the legal issues arising from new and established digital services and processes. Recognized for her legal specialism in BIM and construction technology, May has a passion for innovation in the industry. She has provided pragmatic advice on the legal impact of construction technology to clients and at events worldwide for some years. May has authored and co-authored various documents in this field, including an ISO19650-compliant Information Protocol and an upcoming book chapter analyzing Construction 4.0. She is one of the co-authors of the Centre for Digital Built Britain’s Digital Twins Toolkit Report,

and a member of a number of industry groups seeking to support the industry in progressing and implementing digital technology. She is a UK BIM Alliance Ambassador.

Introduction

We are in the middle of a climate crisis. The construction industry is a major contributor to the climate emergency, with building and construction estimated to account for 40% of energy-related CO_2 emissions. Sustainability is no longer a “nice to have” but something that has become a focus for governments, clients and industries. However, what does it mean to create a “sustainable” design and how does one achieve it? The word is evolving over time and nowadays often combines social, economic and ecological factors. As such, when a client requires a sustainable design or asset, you may need to dig down to understand what the client regards as successful achievement of the “sustainability” requirement. Every organisation and every person may have a different idea on what sustainability is and what they’re after to achieve it. This is why, in seeking more sustainable design, we need to also focus on the overall aspects, including documentation, processes and ethos. In implementing more sustainable designs we should not be inadvertently and unknowingly taking on additional liability or risks. Equally, how do we get the momentum and active support internally and externally to implement the necessary new processes and technologies to achieve our sustainability goals. This paper provides some practical views and suggestions on how to move forward positively in all these areas.

Assess how to implement technology and improved processes that produce more sustainable design, processes and practices

"*Only 20% of buildings use up to 80% of building data available*"
PikeResearch, Smart Buildings Managed Services

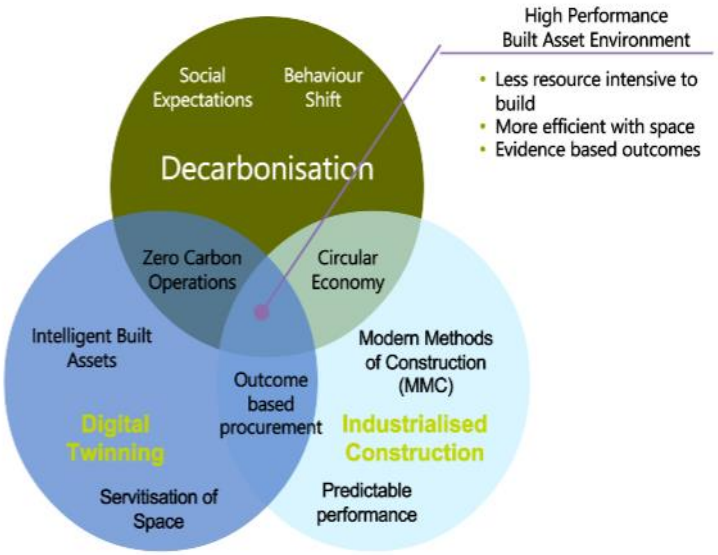
As the famous saying goes, "insanity is doing the same thing over and over again and expecting different results". The construction industry has innovated very slowly. It is historically inherently not environmentally friendly. It is resource and waste intensive and crucial aspects of it, like concrete, have been proven to be emission heavy. Cement alone is said to account for 8% of global emissions. So, we need a modernized or more sustainable way of designing and constructing buildings and infrastructure. There are a number of, primarily software-based, technologies increasingly in common use, that are being used effectively in this area.

These include Building Information Modelling ("BIM"), smart building technology, modular construction and Design for Manufacturing and Assembly (DfMA) and digital twins. Interrelated to these are complementary technologies of AI/machine learning, automation and a variety of bespoke toolkits and dashboards to facilitate progress.

Arguably the thing all these technologies have in common is that they are data rich, either in the amount of data they compile or the amount of data they process (or both). The significant increase in the amount of data, and speed it can be analyzed, means that parties are far better equipped to understand how an asset will function or is functioning; making informed decisions on how to maximize efficiencies, reduce environmental impact and calculate long-term needs.

It is important to bear in mind that how these technologies are implemented to produce more sustainable design, processes and practices may differ from region to region, and project to project. Fundamentally we must provide clients with solutions that they want and that work with their needs and budgets. What works in the UK or Germany may not be appropriate for India or the Kingdom of Saudi Arabia.

There is an increasing demand and movement towards partnerships between organisations within the construction industry and software or technology organisations. Buro Happold has already experienced this. Such partnerships help firms to increase collaboration, share knowledge, and speed up the progress in creating the best solutions for delivering data and insights.



Venn diagram: Example of technology and sustainability interactions

Modular construction and DfMA

DfMA has raised in profile recently, with governments like the UK issuing white papers and statements encouraging its adoption. New ways of designing for manufacture and assembly provides an opportunity to manufacture products for a building in a simpler, cost-effective manner with less waste and fewer resources. This is compared to the extremely carbon-intensive (and therefore not environmentally friendly) process throughout the traditional construction chain.

BIM and Digital Twins

BIM has already been proven to deliver projects faster and cheaper, with other benefits such as improved health and safety. However, BIM technology and processes also provide the tools to simulate various design and construction alternatives, to choose ones which have less environmental impact and optimized sustainability parameters. It has been suggested that BIM, including interrelated tools such as energy analysis, is in fact crucial to advancing green building design and achieving the intended low-carbon future. Being able to effectively build the asset multiple times virtually means that designers can track how different options will impact a project's performance and the environment and make sensible decisions with their client accordingly.

An article by Emmanuel Di Giacomo on BIM tools for sustainable buildings and infrastructure can be found on the Autodesk website here.

After an asset is complete, it is then possible to create a digital twin, i.e., a digital representation of the completed asset, for maintenance and operational purposes. Again, in the similar way of

using BIM models, parties could use the virtual representation to work out how to improve an asset's performance.

Buro Happold has worked with a number of different clients to create such digital twins. A case study of one such digital twin toolkit can be found within the Centre for Digital Built Britain's Digital Twin Toolkit. The Toolkit was created to provide parties worldwide with the means to implement digital twins within their organisations in an easy and informed way. Buro Happold's digital twin toolkit mentioned uses generative design and game engine technologies as pathways to achieve net-zero communities. It incorporates real-world data, generative design, gaming and 3D visualization to support intelligent selection and validation of domestic heat network solutions as well as net-zero carbon targets. To achieve immersive and dynamic interactions, the resultant data and insights are streamed to both standard 3D web mapping platform and Unreal Gaming Engine for multi-user, secure, confidential simulation and interrogation. The key to unlocking the decarbonisation challenge and developing innovative solutions to achieving Net Zero carbon emissions lies in the analysis and understanding of vast quantities of data that are derived from various sources. The value therefore is in the speed of understanding and assessment of alternative scenarios with real-time outcomes, transparency and stakeholder collaboration, and engagement, reduction in errors and risk of using incorrect data and data-driven, evidenced base and risk-informed decision-making.

Example of Buro Happold's digital twin platform with insight infographics

The live, additional data obtained via digital twins enables parties to understand the use of the asset, choices being made by the users and even track the implementation of efficient energy technologies, where relevant. This can then be used to speed up the understanding and assessment of potential improvements and alternative scenarios with real-time outcomes, transparency and stakeholder understanding, collaboration and engagement. Collection of data in this way has been shown to reduce errors and reduce the risk of using incorrect data, though we must caveat this by pointing out that computers are obviously not infallible. Where the processes require manual uploading of data, there is the risk of human error which will lead to errors in the data outputs, but this can be mitigated by appropriate checking processes.

To summarize, BIM and digital twins enable data-driven, evidence based and risk-informed decision-making.

Smart Buildings, Automation and Dashboards

There is no industry-standard meaning of "smart buildings". However, it is generally accepted that "smart" technologies are ones that optimize space, people, and operations, thereby enabling a reduction in operational cost and carbon. Technologies like smart buildings, and indeed digital twins, may feature various aspects of automation and machine learning or AI, which facilitate the creation and improvement of better design, better selection of materials and better management of data all as part of the circular design concept.

One of the great strengths and uses of technologies in the bid to create more sustainable design, processes and practices is as both an effective communication tool and an accelerator for processing large quantities of data.

As an example of this, Buro Happold has implemented a Building Performance Dashboard, as mentioned in the Buro Happold Global Sustainability Report 2020. This models and measures energy consumption, operational carbon and embodied carbon. It was created to enable central reporting on modelling and measured energy data for all projects over a minimum value, to provide collated information to facilitate organisation wide decision making in achieving overall net zero carbon. Fragmented data across a large organisation makes any overall decision making or improvements difficult. The Dashboard is constantly being improved and linked to or integrated with various other software and technologies to provide teams with informed information to make decisions.

As a powerful example of both automation and dashboards, needs arising in some projects in the Middle East region led to the creation of a climate toolkit or dashboard by some Buro Happold teams. It shortens the time taken to generate a climate or comfort report from 1 day to only 10 minutes thereby removing barriers and speed up processes to run the complex analysis and generate output. A comprehensive report is generated with a single click – containing wind speed, humidity, horizontal radiation, heat map and more. The usefulness is due to its speed of accessibility though this doesn't remove the importance of the engineers interpreting outputs correctly and making sensible design decisions based on the data. Without that interpretation, we will not achieve more sustainable design simply by using a technological tool. Automation is a great tool when applied sensibly, leading to more time being made available for designers to make better decisions and produce higher quality, sustainable designs (though we should never consider it a replacement of the years of experience, local knowledge, and precedent in the areas we work in which it supports). There is no single tool that could account for all those variables that are informed by knowledge and experience. Hence, they are tools to help improve efficiencies, not to replace an individual's input into the process.

Modelling Toolkits

Currently a lot of Buro Happold's technological advances in sustainable design are based within or centered around the BHoM, the Buildings and Habitats Object Model. This is a collaborative open-source model enabling greater collaboration within the industry.

One such example is the LCA toolkit, a modelling methodology used to quantify carbon emissions and other environmental impacts of a product or process through specific life cycle stages. A Life Cycle Assessment or "LCA" is comprised of several scope objects, which contain their respective building elements and materials. This Toolkit enables parties to assess carbon on early-stage models in an organized and systematic way, whether they're in Rhino, Revit or even a table in Excel with predicted values, providing assistance to the maximum number of designers. Without an organized system, one could easily neglect to assess certain building elements within their LCA. Using these methods, the resulting LCA will retain all information used throughout the process for more accurate comparisons. It can be used through specific life cycle stages using biophysical indicators such as Global Warming Potential, Eutrophication Potential, Ozone Depletion Potential, Smog Formation Potential and Acidification Potential.

Identify what contract terms or documentation will support and require more sustainable design, processes and practices

"*New business models, new platforms…new opportunities, new risks. It's called digital disruption. More than ever, the small print really matters*"
Deloitte, Commercial & Technology Services page

I have often heard it asked why contracts and documentation matters when discussing progress or change to ways of designing, processes, and practices. Isn't the contract something for the lawyers to worry about?

The truth is, at the beginning of the project, it is akin to the beginnings of all relationships. Everyone is on their best behavior and any differences of opinion will of course be settled amicably and collaboratively. However, when issues arise during the project, feelings of collaboration can go out the window and parties may look to their formal legal rights and obligations. Separately, vague or confusing rights and obligations within documentation can in themselves lead to disagreements and differing expectations when parties discover their understandings of what is to be delivered (and for what cost) are fundamentally different.

Vague requirements or specifications

When BIM first became popular, we saw various new terminology and acronyms being introduced into specifications and other documentation as it was, and still is, a developing area. Many of these expressions, like "BIM Level 2", have no standard or agreed legal or contractual meaning. Therefore, a simple specification to "Deliver Level 2 BIM" will mean different things to different people.

Sustainability is a similarly new and developing area with new language and terminology being introduced. The danger is always that parties may feel confident that they know what a term means when in fact there are a number of different accepted meanings. For example, if a specification requires a party to "Achieve net zero carbon" in its design, what does this really mean in practice? Does it mean the finished design, or the design as constructed and in use? Does it take into account the variations of the use of the finished asset and does it permit measures like carbon off-setting?

Going one step further, what if a specification simply requires a design to be "sustainable". Does this mean environmentally or socially sustainable? Who decides whether this has been achieved? Where KPIs are specified, are these reasonable and achievable? Have parties agreed a method of measurement for the KPIs?

Some Clients may require the use of a particular software to achieve their sustainability design goals, or a particular electronic output such as a digital twin or BIM model to facilitate ongoing sustainability after handover. Again, do parties have a mutual understanding of what the software will be used for and what it can reasonably achieve, bearing in mind no one software tool can solve all the sustainability issues at hand? Has it been established what data needs to be in the digital twin or BIM model, and in what format, to make it realistic for the Client to use it for ongoing sustainability maintenance and improvements? I have heard of many stories of

models that have been handed over, or produced, which prove worthless because the Client does not have the right systems or knowledge to utilize them, or they do not contain the data most relevant for the Client's aims.

These issues can be overcome by ensuring the contract terms and documentation are clear about parties' rights, scope of responsibilities and, equally importantly, what they are not responsible for. It will often be the gap in obligations, where documentation is silent or confusing on who takes responsibility for an element, that can be the cause of the most misunderstandings.

Not promising too much

Due to the new, exciting, and developing nature of this area of sustainability, designers' descriptions of their proposed services and their deliverables when issued may equally lack sufficient clarity, giving rise to potential disputes and differing expectations. For example, a designer may seek to reassure a Client that they are "experts" or "best in class" in this area, but a designer would be wise to check with their insurance broker whether such language is covered for this area of services by their particular professional indemnity policy.

A designer may issue a report or design without clarifying its use or the extent to which it can be relied upon by others. Where this is not clarified in the contract, this could leave a gap. For example, where a sustainability report is relied on by the contractor in finalizing the design, though it was not intended to be relied on for such an advanced stage of the project – and may not be sufficiently accurate for the purpose.

On the flipside, I have heard of various instances within the industry of parties seeking to pass over risk or responsibility for achieving certain sustainability specifications or goals where the documentation doesn't make the allocation of these clear. In some examples, contractors declined to progress certain sustainability aspects of designs on the basis these were not sufficiently apparent in the tender and would lead to unreasonably increase of costs to the Client. This then leading to the sustainability aspects being forgotten.

Some basic ways of mitigating these risks and issues are again about ensuring clarity in the documentation to ensure all parties have the same understanding. For example, setting out the clear basis of findings and including any appropriate, reasonable disclaimers on who can rely on the findings or designs and for what purpose. Obtain professional advice before seeking to make strict promises or warranting certain results, avoiding vague proposals that can be interpreted in several different ways. Given how standards and regulations in this area are progressing regularly, it may also be sensible to specify whether one is obliged to comply with any such changes to standards and regulations or whether one is entitled to additional time and costs to do so.

Implement internal processes and documentation to improve sustainability in working practices

"*Nearly 90% of respondents believe that sustainability will be important at scale…*
79% believe that the shift will take place in the next five years"
McKinsey, 'The Next Normal in Construction', June 2020

Once appropriate contracts and external documentation are in place, it is vital to also have internal processes and documentation that support these external facing interactions and intentions of the organisation in progressing its sustainability agenda.

Collaboration

Any improvements in sustainability within internal working practices can only be achieved with good collaboration within an organisation, and between the organisation,its clients and the rest of the project team. An engineer can only achieve so much itself; the same goes for an architect. However collaboratively they can achieve so much more particularly with commitment and buy-in from the client. During the Tencent Dachan Bay masterplanning project, Buro Happold worked with the architect to integrate sustainable design suggestions such as building height profile, wind-friendly measures and building massing to enhance the outdoor microclimatic performance. Clients can also push us to progress our sustainable designs beyond our own thinking. Buro Happold work a lot with developers who have set new targets and benchmarks and are pushing us to have quite a radical approach. One example is car-free districts. It's something we never thought about before, but now we've 10 car-free projects running in Germany. It's great; the speed of transformation is just astonishing.

In addition to this, where an organisation is spread across a number of offices, close contact between the offices to knowledge share is a great, powerful tool in this area. At Buro Happold, we have found that such cross-offices working has created situations where we can add value to project bids by our international teams by bringing local context and experience to the fore. For example, our engineers have worked internally to create an embodied carbon calculator tailored to the Indian market. This is allowing our engineers to quantify the embodied carbon saving based on different design options.

Organised Systems

A lack of organized resources, skills and technology can slow down or impair an organization's progress towards a more sustainable way of working. Sustainable ways of working or processes need to be systematic and clearly communicated to make it as easy as possible for busy designers to comply in a uniform way.

This can be progressed in a number of ways. As a starting point, standardizing templates, scope, and processes can reduce this aspect of teams' workload. This needs to be coupled with appropriate guidance, checklists, and training to facilitate sufficient understanding of the services on offer and processes in place. Complimenting this should include clear plans of action by senior management and those developing more sustainable services and methods of working. Ethos and vision plans of an organisation are discussed further below.

Assess how their organisation can successfully implement a more sustainability-focused ethos and design processes

"*As a business, we have a duty to do the right thing, both in our operations and on our projects*" BuroHappold Global Sustainability Report 2020

The success of implementation can be broadly split into two factors, the tools (technology and processes) and the mindset. We have discussed the tools above, and here we will focus on the mindset, including the important issue of encouraging and ensuring individuals' implementation of the sustainability-focused processes and technologies.

Technology is a tremendous enabler to make it easier for everyone to get involved in achieving more sustainable design and processes. For example, to calculate performance on sustainability, embodied carbon and more. Technology also enables better communication on projects and what is being achieved (and how to collaborate to achieve even more). We are however arguably not yet fully utilizing the power of the technologies available, and organisations may benefit from working with their IT and technology teams to ascertain how to harness this more effectively. In summary, collaborate internally to work out what tools you have to achieve the aims and intentions you have, how best to implement them and how to get this message out effectively within your organisation and externally to clients and collaborators.

There are many articles talking about how incorporating environmental sustainability into products, processes and assets can enhance profitability, decrease risk and provide attractive offers to potential clients. Autodesk has gone so far as to suggest that in the next few years, sustainable design strategies and green building will become a standard expectation, coupled with more traditional considerations like cost and durability.

Autodesk estimates that worldwide energy demand will double by 2050. This will require significant progression in the efficient use of energy and materials. In turn, this can only happen with the adoption of sustainability-focused design and processes

The ethos has to come from top down and bottom up. Senior management leading by example means that those within an organisation are more likely to feel compelled and enthused to follow. This is explored further below.

Summary of some lessons learnt about ethos and mindset

There can be a dichotomy between the traditional mindset and growth mindset within the construction industry, and allowances need to be made as to how to reach the range of people impacted. There will be many who do not necessarily believe the proposed changes are achievable or realistic or understand why they should alter the way they have been working successfully for the last 20 years. Lessons can be learnt in this regard in the implementation of BIM, which had a similar initial uphill struggle of skepticism. One can see how those bridging the gap between the innovators and the traditionalists can assist to progress understanding much faster.

Ultimately, the main lesson to remember in this aspect is that you must explain how the change (in this case, to a more sustainability focused way of working) is beneficial or relevant to that

particular listener. Technology provides tremendous tools for better communication in this regard, clearly illustrating the improved speed, cost or other direct benefits that are of most relevance.

Each person and team within an organisation will have its own limitations in skills or knowledge in this new area. For example, a sustainability engineer may not have the right skill set to be able to interpret all design data to achieve the best sustainable outcome. In all technologically advanced or new areas, collaboration is key to achieving success. This can be supported or progressed with the right purpose, targets, and steps, summarized below.
Organisations will need to be open and willing to invest in training, upskilling and supportive guidance as some people may be at an earlier part of this journey and require more support to reach the necessary understanding and skillset. This also ensures the individuals within the business are equipped to articulate the benefits of sustainable design to clients and collaborators – including from a cost and time saving perspective - and explain the services an organisation can offer in this area.

Vision

In business generally, having a clear vision is a critical tool to achieve desired results. An appropriate vision will be both unifying for the organisation and inspiring as well as being a focus-point for setting goals and plans in the short and long term, as well as guiding decisions being made. It also serves as a helpful public communication tool, to explain the aims and intentions of an organisation in this area, providing positive publicity and clear understanding for clients.

Purpose and Targets

For the purposes of this section, the difference between “Vision” and “Purpose” is intended to mean the difference between the big picture goal, and the more granular direction or purpose. For example, an organisation having the vision to improve the environment, and a purpose of having wholly sustainable designs. To implement widespread sustainability processes and practices within an organisation, we need the processes and practices to be put in place by the organisation but also for those within the organisation to be committed to the purpose behind these processes and practices. Without such commitment, people may only pay lip-service to the processes and practices or ignore them altogether. It has been said that most grand, transformational acts of leadership are built on a consistency of purpose. Or organisations that want to move towards a more sustainability- focused ethos, they may find it helpful to first start with a clear purpose that their staff can easily understand as relevant, coupled with stretch targets to achieve the purpose. I have seen this work effectively with stepped targets based on time (e.g., 2 year and 5-year targets) or other quantifiable measurements in a similar way to the shaping of an individual’s career goals. This provides a clear structure for both the organisation and its members to move forward consistently. For example, Buro Happold set out its vision, purpose and accountable targets in its Global Sustainability Report 2020 which also gave the chance to champion and acknowledge the work by the various individuals and teams in this area. Suitable recognition as we work towards these challenging, but important, sustainability goals is imperative to ensure continued motivation.

OUR BASELINE AND TARGETS

An estimate of our Global Carbon Footprint from May 2019 to April 2020 is:

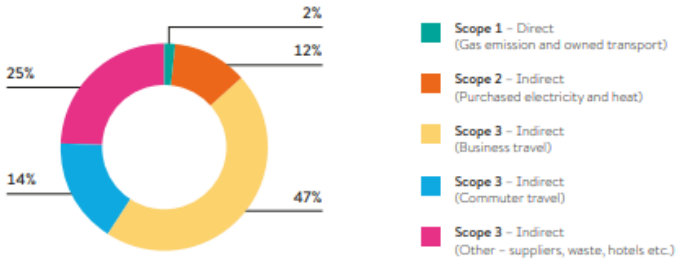
	Type of Emission	Tonnes of CO_2e/person	Absolute Tonnes of CO_2e	% difference compared to 2018/19
(a)	**Scope 1** – Direct (Gas emission and owned transport)	0.114	130	-26%*
(b)	**Scope 2** – Indirect (Purchased electricity and heat)	0.379	695	-13%
(d)	**Scope 3** – Indirect (Business travel)	1.533	3,086	+2%
(e)	**Scope 3** – Indirect (Commuter travel)	0.454	833	0%
(f)	**Scope 3** – Indirect (Other – suppliers, waste, hotels, etc.)	0.526	1,508	-14%**
TOTAL (without renewable energy)		**3.006**	**6,279**	**-6%****
(g)	Renewable Energy Supply		-277	
TOTAL (with renewable energy)		**2.738**	**6,002**	**-6%****

* This reduction in Scope 1 is due to a significant decrease in our new Leeds office and a realignment of scope in a leased office.

** Scope 3 now includes embodied carbon from purchased IT equipment and an estimated addition of other unmeasured Scope 3 emissions.

Buro Happold global emissions 2019-20

Tonnes of CO_2e/person



Buro Happold's targets published in its Global Sustainability Report 2020

Organisation-Wide Steps

Progressing this theme of consistency, the purpose and targets would need to be populated by coherent steps to achieve them. Otherwise again they risk being deemed as grand goals that get forgotten over time as the pressures of achieving profits, meeting programmes and other normal project pressures come to the fore. I have noticed that in Buro Happold, a positive side effect has been the amount of independent efforts and developments by individuals and teams in this area to compliment the overall steps and targets of the organisation as a whole.